Precarious infrastructure and postapocalyptic computing

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INTRODUCTION: "NONLINEAR CHANGES" AND HCI

Discussions of "global change" [1] and "the challenges of sustainability" [2] outside HCI have been concerned with climate system destabilization ('global warming', 'climate change', 'global climatic disruption'), sea level rise, degradation of ecosystems and their services, biodiversity loss ('anthropogenic mass extinction', 'the sixth mass extinction'), freshwater and food scarcity, deforestation, desertification, oceanic acidification, peaking oil production and rising energy costs, and many and various related causes, effects, feedbacks, and forcings. There is too much literature on these topics to cite here, but for HCI-relevant overviews of a few subsets see [3], [4], [5]. One entry point into the academic literature is the journal *Global Environmental Change*.

Most sustainable HCI and ubicomp research efforts abstract from these concerns, focusing instead on either (a) encouraging users to adopt 'more sustainable' behaviors or (b) exploring how users relate to their technologies in support of (a). Examples include [6], [7], [8], [9], [10], [11], [12], [13], [14], and, outside HCI and ubicomp proper but inspiring them, [15]; exceptions are mentioned in [16]. In the terms of climate change discourse this approach is *mitigation*-oriented: it aims to support or instigate social changes that reduce the material causes of the more pernicious facets of global change. A tacit assumption of much of this work is that the infrastructures that most interactive technologies rely upon will persist as the *risks* of current unsustainable practices become urgent *challenges* to well-being and survival. While mitigation is desirable, and mitigation-oriented research valuable, this assumption seems risky.

In this article we shed this assumption to develop approaches to designing interactive technologies that acknowledge the many, dramatic, and complex phenomena associated with global change. These approaches, denoted by the term *post-apocalyptic computing*, aim to prepare for "nonlinear changes" [3] (p. 1) in raw material availability and ecosystem services associated with global change that could disrupt the functioning of the infrastructures which support current technologies.

*APOCALYPTIC COMPUTINGS

The term 'apocalypse' is dramatic. We offer a working definition that builds on a number of other dramatic terms: collapse, emergency, and disaster.

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Collapse denotes "a rapid, significant loss of an established level of sociopolitical complexity" [17] (p. 4). The term often refers to an entire 'society,' an analytical boundary which becomes troublesome in the context of globalization and the geographically distributed effects of global change. We will ignore this problem for now, while acknowledging that it complicates all questions of the form 'Is *X* an apocalypse?'

Emergencies and *disasters* can both be classified as events that can be observed in time and space that have impacts on social units, which mobilize responses to these impacts [18] (p. 50). Disasters are distinguished from emergencies in that "the demands of [a] disaster situation exceed[...] the capacities and the precautions of society which, prior to impact, had been culturally accepted as adequate" [19] (p. 260).

In our usage, *apocalypse* denotes an event in the intersection of the spaces of events denoted by the terms *collapse* and *disaster*. That is, it denotes a rapid, significant loss of sociopolitical complexity which *in itself* constitutes an event whose impacts exceed the responsive capacities of the affected social units. In this formulation a distinctive characteristic of an apocalypse is that previously coherent social units disintegrate, exacerbating the vulnerability of their former constituents.

We posit a space of apocalypse-related (or '*apocalyptic') approaches to technology design, some of which are mitigation-oriented. 'HCI as usual' tends to assume no serious disruptions to infrastructure or the availability of energy and raw materials, we call it *non-apocalyptic computing*. This prefix, like the ones discussed below, denotes a set of working assumptions.

Pre-apocalyptic computing acknowledge a future apocalypse may occur. *Post*-apocalyptic computings, on the other hand, act as if it has *already* occurred. A mitigation-oriented pre-apocalyptic computing aims to avert future apocalypse. This category borders the space of existing non-apocalyptic sustainable HCI research projects. It differs from them in that instead of assuming the infrastructure required for continued use of interactive technologies will be available, it imagines that infrastructure as *at risk* and attempts to devise strategies, tools, and techniques for preserving it. It takes an ecological perspective, examining the way in which processes interact over space and time, watching for externalities, paying attention to complex dynamics, and evaluating holistically at the broadest relevant scale (see [20] for a discussion of evaluation). It is not oriented to growth, unless such growth would

help avert future apocalypse. An adaptation-oriented pre-apocalyptic computing assumes future apocalypse is likely. It develops tools for users to negotiate it successfully (to make it 'less apocalyptic') by making use of materials and social relations available at design time (pre-apocalypse) but likely to be unavailable at use time (during or after an apocalypse). An adaptation-oriented post-apocalyptic computing also assumes future apocalypse is likely, but aims to help users negotiate it successfully by acting as if it has already occurred. Design constraints are adopted that mirror assumed post-apocalyptic conditions. In this view, when an apocalypse occurs its human cost will be much lower if people adapt to post-apocalyptic conditions ahead of time. A mitigation-oriented post-apocalyptic computing may at first seem like a contradiction in terms: it assumes that apocalypse is likely and seeks to avert it by acting as if it has already occurred.

To flesh out these perspectives, consider a hypothetical rapid increase in oil prices to USD 250 per barrel. This may seem unlikely, but it is an outcome of converging factors—for example, declining global oil production, commodity speculation, unexpectedly powerful storms, and/or violent attacks on oil infrastructure—conceivable within the next decade. If such an increase were to occur, physical and economic systems for producing and distributing food and other essential commodities would be at risk.

A non-apocalyptic computing practice, seeing this as an undesirable outcome, might develop social network applications encouraging users to share cars, providing logistical leverage to users that allows them to reduce their oil consumption and thereby reducing total demand for oil. If such an effort is successful, it is valuable, even from an *apocalyptic perspective. A mitigation-oriented pre-apocalyptic computing practice however might observe that in the face of USD 250/bbl oil, physical or economic arrangements that supply power to data centers might fail. Similarly, local electrical power for user computing devices might be intermittent or unavailable. Such a practice might attempt to reduce data center oil dependence—for example by improving power use efficiencies, or working with data center operators to purchase renewably-generated electricity. Many such projects are already underway, and many initiatives in the "green IT" space might be classified as mitigation-oriented pre-apocalyptic computing projects. An adaptation-oriented pre-apocalyptic computing practice, in contrast, might seek to devise low-power (or hand-powered) devices that would facilitate peer-to-peer resource allocation in the absence of a functioning data center or central server. An adaptation-oriented post-apocalyptic computing practice might seek to develop strategies for building and distributing such devices in the absence of functioning manufacturing capability or commodity distribution channels, perhaps through a combination of appropriating other devices, salvaging discarded materials, and combining multiple devices into ad-hoc assemblages. A mitigation-oriented post-apocalyptic computing practice, after developing such strategies, tools, and techniques, might encourage their speedy adoption in order to reduce *current* oil consumption, thereby reducing the human cost of disruption to oil-reliant information infrastructure.

COUNTERFACTUAL ASSUMPTIONS?

The view that an adaptation-oriented post-apocalyptic computing practice might be a viable strategy for averting the disaster that it assumes can be interpreted as an experiment in operating under counterfactual assumptions. It recalls the strategy of Polish dissidents under Soviet rule of acting "as if" they lived in a free society [21] (p. 44). Ulanowicz et al. [22], [23] observe that practices optimized for present infrastructural arrangements can lead to unsustainable systems, but their *current* efficiencies make it seem ridiculous to develop (much less use) alternative practices. Counterfactual assumptions obviate the need for sociopolitical legitimacy in developing alternatives. We proceed in preparation for a hypothetical eventuality we acknowledge may never occur.

In another view, a 'real-world' practice of adaptation-oriented post-apocalyptic computing prevents apocalypse by reconfiguring use practice with an eye to reducing *vulnerability* to likely disruptions. If successful, an event that would have been disastrous under previous configurations is no longer so (cf. [24]). Oil prices may still spike, but to post-apocalyptic users this is unproblematic. They have adapted ahead of time.

In a third view, however, an orientation to *future* disasters is parochial. Following publication of the results of the World3 model in the widely-circulated *Limits to Growth* [25], the 'Bariloche Group' of Latin American systems modelers offered the following critique: "The view that global crises *will* occur *in the future* reflects a parochial, developed-world perspective. For two-thirds of the world's population, crises of scarce resources, inadequate housing, deplorable conditions of health, and starvation are already at hand" [26] (p. 45). In this view, local disasters (if not apocalypses) occur every day, mostly out of view of the users and makers of mainstream IT products, so the assumptions of *apocalyptic computing are not hypothetical or counterfactual at all. Postapocalyptic computing, within a broader perspective on collaborative infrastructure design beyond computing, could provide a practice-based approach to developing functional responses to contemporary crises.

ALLIES AND TRAJECTORIES

The '*apocalyptic computing' classification may ultimately prove analytically problematic—Tainter, for example, in defining 'collapse,' defines 'rapid' as "taking no more than a few decades" [17] (p. 4); disasters, in contrast, develop over the course of days or weeks. This temporal question adds to the spatial one mentioned above in complicating demarcation of 'apocalypses.' Further, the term itself may simply be too inflammatory to be of scholarly use. Finally, we may not wish, as designers, to constrain ourselves to rethinking the role of only *computing* in our increasingly precarious infrastructural environment. Following Wong's paper from last year's workshop [27], we may wish for example to examine Greer's term "descent" [28]—a long, slow, multi-century reduction in sociopolitical complexity (Tainter calls

this "decline" [17], p. 4)—and to imagine these *apocalyptic computings and other related practices as constituting a 'deindustrial techne.' A deindustrial orientation might create space for a 'long view,' with close attention to sociotechnical dynamics over time.

The ingredients of *apocalyptic computings and deindustrial techne are already all around us: practice-based research programs and projects in disaster informatics, community informatics, ICT4D, HCI4D, humanitarian logistics, sociotechnical action research, and "post normal science" [29] offer compatible perspectives and useful resources. Conceptual and material resources have been developed within the sustainable HCI community itself: consider, for example, an extension of Huang's notion of "situated sustainability" [30] to include the point that sustainable practices in one region may be unsustainable elsewhere, and Truong's ongoing work repurposing used cell phones [31] (p. 2). The next question is how to appropriate them productively.

REFERENCES

1. Tainter, J. Complexity, problem solving, and sustainable societies. In Costanza et al., eds., *Getting Down to Earth: Practical Applications of Ecological Economics*. Island Press, 1996.
2. Huang, E. M., et al. Defining the role of HCI in the challenges of sustainability. *Proc. CHI '09*: 4827-4830.
3. Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press.
4. United Nations Development Programme, 2006. *Human Development Report 2006*. Palgrave.
5. Hirsch, R. L., et al., 2005. Peaking of world oil production. US DOE Natl. Energy Tech. Lab. Report.
6. Hanks, K., et al. Sustainable millennials. *Proc. CHI '08*: 333-342.
7. Huang, E. M. and K. N. Truong. Breaking the disposable technology paradigm. *Proc. CHI '09*: 323-332.
8. Paulos, E., et al. Ubiquitous sustainability: citizen science and activism. Workshop, *UbiComp '08*.
9. Woodruff, A., et al. A bright green perspective on sustainable choices. *Proc. CHI '08*: 313-322.
10. Xiao, J. and J. Fan, 2009. PrintMarmoset. *Proc. CHI '09*: 109-112.
11. Froehlich, J., et al. UbiGreen. *Proc. CHI '09*: 1043-1052.
12. Chetty, M., et al. It's not easy being green. *Proc. CHI '09*: 1033-1042.
13. Tomlinson, B., 2010. *Greening Through IT*. MIT Press.
14. Blevis, E., 2007. Sustainable interaction design. *Proc. CHI '07*: 503-512.
15. Sterling, B. *Shaping Things*. MIT Press, 2005.
16. Goodman, E. Three environmental discourses in HCI. *Proc. CHI '09*: 2535-2544.
17. Tainter, J. *The Collapse of Complex Societies*. Cambridge University Press, 1988.
18. Krebs, G. A., 1985. Disaster and the social order. *Sociological Theory* **3**(1): 49-64.
19. Britton, N. R., 1986. Developing an understanding of disaster. *Australian and New Zealand Journal of Sociology* **22**(2): 254-271.
20. Silberman, M. S. and B. Tomlinson, 2009. Toward ecological evaluations: tools for evaluating sustainable HCI research. Submitted to CHI 2010 WIP. wtf.tw/text/ecol_eval_chi2010_wip.pdf.
21. Goldfarb, J. C., 2006. *The Politics of Small Things: The Power of the Powerless in Dark Times*. U. Chicago.
22. Ulanowicz, R. E., et al., 2009. Quantifying sustainability. *Ecological Complexity* **6**(1): 27-36.
23. Goerner, S. J., et al., 2009. Quantifying economic sustainability. *Ecological Economics* **69**(1): 76-81.
24. Luers, A. L., et al., 2003. A method for quantifying vulnerability. *Global Env. Change* **13**(4): 255-267.
25. Meadows, D. H., et al., 1972. *The Limits to Growth*. Universe.
26. Meadows, D. H., et al., 1982. *Groping in the Dark: The First Decade of Global Modelling*. Wiley.
27. Wong, J., 2009. Prepare for descent: interaction design in our new future. Presented at *Defining the Role of HCI in the Challenges of Sustainability*, CHI 2009. elainehuang.com/CHI-2009/p6-wong.pdf.
28. Greer, J. M., 2008. *The Long Descent: A User's Guide to the End of the Industrial Age*. New Society.
29. O'Connor, M., et al., 1996. Emergent complexity and procedural rationality: post-normal science for sustainability. In Costanza et al., eds., *Getting Down to Earth*. Island Press, 1996.
30. Huang, E. M., 2009. Designing and evaluating for situated sustainability. Presented at *Defining the Role of HCI in the Challenges of Sustainability*, CHI 2009. elainehuang.com/CHI-2009/p20-huang.pdf.
31. Truong, K. N., 2009. Research statement. tinyurl.com/khaitruong.