Information systems for the age of consequences

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ABSTRACT

This paper discusses what kinds of computer information systems might be of broad social value in the context of the increasingly severe ecological and social consequences of economic growth, and how they might be built and maintained. The paper has two parts. The first offers a particular understanding of the ecological and social "limits" to economic growth. The second considers how this understanding can inform computer information systems design and operation and characterizes good "limits-aware" computing research.

LIMITS AND CONSEQUENCES

The term "limits" usually concerns limits to economic growth. The most often discussed limits are ecological (e.g., Meadows et al. 1972, 1992, 2004; Wackernagel and Rees 1998; Turner 2008, 2014), but "social limits to growth" have also been discussed (Hirsch 1977). Ecological limits to, or consequences of, economic growth include depletion of nonrenewable resources, especially fossil fuels (Hirsch et al. 2005); climate change, ocean acidification, desertification, sea level rise, increased frequencies and severities of floods and droughts, and freshwater and food scarcity (e.g., Intergovernmental Panel on Climate Change 2014); pollution (e.g., National Research Council 2010; Epstein et al. 2011); and degradation of ecosystems and biodiversity loss (Millennium Ecosystem Assessment 2005). Socially and psychologically, beyond the income required to meet basic needs, increasing income has diminishing returns to both nations and individuals (e.g., Easterlin 1974, 1995; Schor 1999; de Graaf et al. 2002; Hamilton and Denniss 2005; Layard 2003, 2006; Clark et al. 2008; Easterlin and Angelescu 2009; see Stevenson and Wolfers 2008 for a dissent). And the social complexity of organizing economic activity may itself pose limits (e.g., Tainter 1988, 1994, 2006; Arrow 1974, esp. p. 35).

The nature of these phenomena is not uniform. Many, even the ecological ones, are not "hard" limits in the sense of points up to which growth proceeds normally but which it cannot cross. Rather they are consequences of growth. Most are seen as undesirable, but few directly undermine prospects for growth. The main exception is depletion of nonrenewable resources, especially fossil fuels, which directly power most economic activity. Degradation of freshwater resources and biodiversity loss may also undermine prospects for growth.

Framing these consequences as limits to growth has the salutary effect of challenging the notion that economic growth is indefinitely biophysically and socially sustainable. Yet it runs the risk of perpetuating the notion that economic growth is fundamentally desirable, and indeed the main social mechanism by which the human condition is improved. This notion has been roughly correct for several centuries and continues to drive economic policy globally. But as the severity and diversity of the undesirable consequences of past growth have come sharply into view over the past half-century, it has become clear that economic growth, defined as increasing economic activity, may become undesirable (or, as Daly [2007] put it, "uneconomic") long before it becomes impossible.

Economic growth is usually computed as growth in gross domestic (or national) product, which measures economic activity. But as Robert Kennedy said in 1968,

> *Gross National Product counts [as positive] air pollution and cigarette advertising, and ambulances to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. It counts napalm and counts nuclear warheads and armored cars for the police to fight the riots in our cities. It counts Whitman's rifle and Speck's knife, and the television programs which glorify violence in order to sell toys to our children. Yet the gross national product does not allow for [i.e., measure] the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile.*

Kennedy may have exaggerated slightly in his conclusion. But economists, including Simon Kuznets, the originator of the concept, have long understood the limitations of GDP and the social risks of using it as an indicator of well-being. Yet economic policy discourse remains dominated by the question of how to spur growth. This paradox is not new; in 1972, the economists William Nordhaus and James Tobin wrote:

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[The biologist Paul] Ehrlich is right in claiming that maximization of GNP is not a proper objective of policy. Economists all know that, and yet their everyday use of GNP as the standard measure of economic performance apparently conveys the impression they are evangelistic worshipers of GNP. (Nordhaus and Tobin 1972, p. 4)

"Alternative" indicators have been proliferated, many developed by economists, in the face of GDP's continued hegemony in policy discourse (e.g., Nordhaus and Tobin 1972; Talberth et al. 2006; New Economics Foundation 2012; Ura et al. 2012). But, with a few exceptions (e.g., in Maryland and Bhutan), these alternatives have not yet been taken up in guiding economic policy or activity at large scales.

Within firms, the organizations other than government that organize most economic activity, most decision making is guided by a distinct but related notion: the notion that economic activity should be organized to maximize financial returns to shareholders (see e.g. Gomory and Sylla 2013). In the absence of major repercussions such as lawsuits, protests, or consumer boycotts, this notion guides many corporate managers to increase profits without much regard to unpriced ecological or social consequences ("externalities").

Taken together, these two norms—the agreement to increase GDP within nations and the agreement to increase shareholder returns within firms—seem to explain a great deal of the apparent inability of global economic and political leadership to respond substantively to "limits to growth." In this age of increasing undesirable consequences, it seems clear that a goal for orienting economic policy is needed other than increasing GDP, and that a goal for corporate management is needed other than increasing shareholder returns.

In this view, while the notion of limits is useful as part of our understanding of the social and ecological dynamics of our time (e.g., Rockström et al. 2009), its utility as the main framing of their consequences is, so to speak, limited. We need, simply, a way to understand *what is happening*, *why it is happening*, *whether we like it or not*, and *what we can do about it if we don't like it*. For the purposes of this paper, I will frame what is happening in three points. The first describes our new global biophysical context. The second describes the social drivers of the dynamics shaping this context. The third considers how these drivers can be, and are being, changed.

1. The major ecological dynamics of our time are indexed in the relevant literatures by the term "global change" (e.g., Steffen et al. 2004). Global change refers to the ecological "limits" or interlinked consequences discussed above (climate change, nonrenewable resource depletion, ecosystem degradation, etc.). Global change is largely anthropogenic. Specifically, it is recognized within the literature as being caused by growth in human population, affluence, and technological sophistication (see Chertow 2001 for a review); that is, it is caused in large part by economic growth.

2. The lack of a substantive response to global change thus far from global economic and political leadership, despite increasingly widespread knowledge of its dynamics and consequences, is due in large part to the widespread notion that economic growth is desirable. Specifically, it is due to the agreement to increase GDP among nations and the agreement to increase shareholder returns among firms.

3. To redirect economic activity, new agreements are needed to reorient economic policy and corporate management practice. Efforts are underway to develop such agreements for both governments (in the form of alternative economic indicators) and firms (in the form, e.g., of the B Corporation legislation in the United States).

To answer the questions shortly: "global change" is happening; it is happening at least partly because of our outdated economic agreements; it is largely not good; and it can be addressed by replacing our outdated economic agreements with new ones attuned to the new social and ecological reality.

But information systems practice and research has largely taken place within organizations aiming to increase economic activity and shareholder value. Indeed information systems have been designed largely as means to these ends (e.g., increasing productivity, increasing leisure consumption of goods and services). A crucial question for information systems workers in the age of consequences is: how can we adapt to a new context in which the operating framework within which our field was conceived is no longer seen as universally valuable, and indeed is seen as a source of problems?

COMPUTING IN THE AGE OF CONSEQUENCES

Because of the complexity of scaling, maintaining, and responsively evolving computer information systems, the necessary expertises, and the associated costs, almost all long-running computing systems have been developed at least partially within formal organizations of some sort, the most common being for-profit corporations. The signal exceptions are commons-based peer production efforts such as free software development and Wikipedia. While these efforts do incorporate a "long tail" of contributors who are not formally organized, most contributions to both efforts are made by a relative few, both efforts have formal organizations at their core, and free software development is heavily subsidized by for-profit organizations. It is organizationally hard to maintain information systems with many diverse users.

Computing systems are not inherently pro-growth or pro-shareholder value maximization, but neither do they inherently promote the development or adoption of effective collective responses to global change (i.e., contrary to the views advanced by proponents of "dematerialization," computing is not inherently "pro-sustainability"; see e.g. Tomlinson et al. 2011; Pargman and Raghavan 2014). In theory, computing systems can enable or support any kind of activity, but in practice, long-term responsive evolution and support of information systems with large user bases seems to require some degree of formal organization. And the social, political, and economic norms and influences over formal organizations constrain the kinds of information systems that can be built (e.g., Agre 2002; Benkler 2005, p. 17; Sassen 2005; Lessig 2006) and the kinds of practices they can support. Insofar as the logics of existing organizations and organizational forms for sustaining the operation, maintenance, and evolution of large-scale software systems tend to support growth and/or shareholder value maximization, researchers and others aiming to support alternative priorities in software development may benefit from considering the relationship between software priorities and organizational structure and accountabilities. Put this way, the matter may sound somewhat sociologically or even legally esoteric to computing researchers who typically focus on technical aspects of system development and operation. But it should, at least on reflection, also sound rather obvious or tautological, because influencing organizational practice to yield better design outcomes is exactly the point of much effort expended in HCI, CSCW, and software engineering on design methods (see relatedly Penzenstadler et al. 2015, this workshop).

Having raised the question of the relation between the organization of software work, the design of the software, and the activities supported by software, the question remains of what sorts of activities to aim to enable or support through information systems design in the age of consequences. We can postulate one answer to this question by considering what technological development does generally. In the short term, technology is largely an amplifier of existing human intent and capacity (e.g., Agre 2002; Tomlinson 2010; Toyama 2010). In the long term, technology creates entirely new possibilities for action and forms of life that are difficult to predict or compare quantitatively with previous forms (e.g., Nakamura 2003; Suchman 2006; Kaptelinin and Nardi 2012, esp. Chs. 2-3). Eventually, effective trans-scalar responses to global change will require that the global networked information-industrial society become a fundamentally *different society*: one with different industrial technologies, information technologies, structures and practices of organization and governance, educational institutions and practices, subjectivities, and ideas. Yet one cannot fully map the road from here to there *from here*, as if from above; rather, the process is one of "navigation," in which we discover the road as we walk it: "any successful quest for sustainability will be a collective, uncertain and adaptive endeavor in which society's discovering of where it wants to go is intertwined with how it might try to get there" (National Research Council 1999, p. 3). The sociologist C. Clare Hinrichs uses the term "remaking" to describe this incremental process of change in the context of the North American food system:

The social location and resource endowments of different individuals and groups afford different skills and opportunities for [system change] work and different understandings of what the work should be. Overall, remaking first involves deliberate, sometimes dogged efforts simply to grasp what currently exists, and it requires second a refashioning of some of the institutions and practices of agriculture and food in more desirable ways... Remaking the food system then suggests neither a revolutionary break nor a radical transformation but rather deliberate, sometimes unglamorous multipronged efforts in areas where openings exist to do things differently. Supporting a farmers' market may never shut down the local big box supermarket, but it does divert consumer dollars to local food producers, consequently helping them stay in business and providing some consumers with fresher, local foods. Such activities quietly and modestly remake parts of the food system. Whether pursued by individuals, groups, or communities, such remaking is not a linear or foreordained process that possesses some clear, known endpoint. It is instead movement in what is hoped to be a more promising direction. (Hinrichs 2007, pp. 5-6)

This view offers one answer the question of what sort of activities "limits-aware" computing should aim to support: other "limits-aware" activities!—and especially those that seek to transform existing social arrangements, such as the norms of increasing economic growth and maximizing shareholder returns without regard to ecological or social consequences. This answer is simple and actionable: we should help other people trying to respond effectively to global change. While following this advice requires some familiarity with the ecological and social issues, it does not require us to become political economists, climate scientists, or environmental sociologists. Much of the knowledge and tools developed in computing practice and research can serve us well; but they must be deployed in service of different ends.

The remainder of the paper aims to sketch computing research and practice that fits this description—that is, computing research and practice that I think is likely to contribute substantively to effective responses to global change.

Good computing research in the age of consequences

What will good "limits-aware" computing research look like? With the goal of stimulating vigorous debate, I offer here six pieces of advice for computing researchers aiming to do work that contributes substantively to broader efforts to change our society in response to our growing awareness of the limits to, and consequences of, economic growth.

Be embedded and engaged. Build real systems for use by people working in their real contexts (i.e., as opposed to time-limited usability studies) to grapple with the specific consequences, risks, and opportunities posed by global change to their particularly socially and ecologically situated communities and livelihoods. Use technology and social action together to create substantively new options (in collective action, livelihoods, etc.) for people in their everyday lives. Do research *with* stakeholders with whom you share deeply felt concerns and aspirations, not research *on* subjects you detachedly study. Be an active participant, not a disinterested observer producing "objective knowledge." (See also Hayes 2011; Crabtree et al. 2013.)

Draw on research beyond computing to develop a rich understanding of the relevant ecological and social dynamics, risks, and opportunities. As is by now widely discussed, systematic outreach to relevant natural and social science research has not been a strength of computing research motivated by ecological issues thus far (e.g., DiSalvo et al. 2010; Froehlich et al. 2010; Knowles et al. 2013; Pargman and Raghavan 2014; Silberman et al. 2014). This is not because such literature is hard to find or understand, but largely because ecological issues are a new topic for computing researchers, computing researchers are busy, and developing intimate familiarity with a new literature takes time. Working in a specific context offers both a motivation for delving deeply into relevant natural and social science research and a way to know when to stop reading.

Maintain your system(s) over time. The small, short user studies typical of human-computer interaction research motivated by ecological issues (see Froehlich 2010 for a discussion) can produce useful insights. But if your main goal is to produce a computing conference paper describing those insights, it is unlikely your system will influence practice or create real opportunities for people struggling to respond to global change. Build systems for real people to use, and maintain those systems so they continue to be relevant in their contexts of use (e.g., Irani and Silberman 2014). "Remaking" takes time. If you have made a system people use in a "real" context, you have an opportunity to contribute to the development of real changes to practice by maintaining your system and, over time, finding a way for it to grow independent of you and your research. (But watch for ways traditional technology transfer practices can recapture otherwise economically innovative work into growth-oriented paradigms.)

Build social and human capital, not just technology. Technological systems are typically complex. If you build complex systems for use in a community, and there is not widespread capability to manage, maintain, repair, and evolve your systems, you have built a brittle system that will require your indefinite oversight. Build bridges between communities (e.g., farmers, advocates, and technologists; businesspeople, policymakers, and researchers) and within communities. Work with young researchers and non-technologists to build capacity to understand relevant ecological and social dynamics, consequences, risks, and opportunities, and to imagine, build, operate, maintain, and repair social and technical systems and practices for responding effectively to them.

Be prepared to change course. Systems design "in the wild" is one part software engineering and one part ethnographic sensibility. You may not know what technological contributions are called for until you've put yourself out into "the field." And the relevant technological contributions may change over time. Especially in contexts where few stakeholders have extensive experience building information systems, part of the technologist's task is to stimulate stakeholders' "sociotechnical imaginations"—that is, to catalyze and support rich, actionable discussions of what might be socially and technically possible. Low-budget working prototypes are often especially catalytic inputs to such discussions, and may even themselves yield value and constitute a sociotechnical base for expansion. Iterative development, short "sprints," face-to-face conversations with stakeholders, and other tools of agile development are likely to be useful.

Focus on the social and ecological benefits, risks, and consequences of real sociotechnical-ecological practices, not on novel technologies per se. In the age of consequences, returns to technical innovation per se are in decline (e.g., Tainter 2006). But technologies tailored to the needs of particular communities can yield startling social returns, even if they are not technically novel (e.g., Woelfer and Hendry 2011; Dimond et al. 2013; Irani and Silberman 2014). Coming out of our roles as technology specialists aiming to produce knowledge and novel technologies in the service of increasing economic growth or shareholder value is an opportunity to reassess the centrality of technology in our work. Technology is extremely powerful, and our facility with it gives us relatively unique powers. But these powers are only meaningful if we situate them within the contexts of ongoing efforts whose main content is not necessarily technological. The information scholar and self-identified former technologist Philip Agre gave this advice:

Show how the technology you envision intertwines with other things. Free yourself from the assumption that technology is a separate sphere unto itself. Technology can't be your whole story; if it's 5% of your story then you have the proportions right. This will bother people who need technology to be the bottom line. Set those people straight. (Agre 2000)

CONCLUSION

What kinds of research can we do now that fits this description? I would like to call for increased cooperation between computing researchers and "community" organizations, including non-profits, small businesses, and local government. Especially relevant are initiatives that aim to support increasing social capital and the growth of local economies (e.g., timebanking, Bellotti et al. 2014; local businesses, Knowles et al. 2014; and resource sharing, Ganglbauer et al. 2014; see also generally Le Dantec et al. 2011; Le Dantec 2012; Dillahunt 2014; DiSalvo et al. 2014; Harvey et al. 2014; Jen et al. 2014; Kim et al. 2014; and Voida et al. 2014). Although much such research already exists in "human-centered computing" (i.e., human-computer interaction and computer supported cooperative work), much work remains to connect this work to understandings of the ecological, economic, and social dynamics of global change.

Growth and profit are not uniformly sources of problems, even now, when we face so clearly the consequences of their excess. Our task as social actors living in the age of consequences is to read, think, and discuss widely and do our best to determine what collective social and technological arrangements will enable us to effectively face the challenges caused in part by our policies and their successes. My focus on growth in this paper is motivated by its apparently diminishing social, psychological, and ecological returns, especially in industrialized countries. I hope it is clear that this is not a call to cease market-mediated economic activity; rather, the age of consequences poses the questions to every economic and political actor (which is to say, all of us, insofar as we sell our labor; buy our food, shelter, transportation, and clothing; and are subjects of political regimes into which we have at least some input) of what economic activities should be collectively rewarded and prioritized; how they should be organized; which consequences should be avoided and which tolerated; what distributions of benefits, costs, consequences, and risks are acceptable in a democratic society; and who gets to decide all of the foregoing and how. If we are attentive and engaged, computer information systems can play a significant role in supporting the collective development, *in practice*, of just, sustainable answers to these questions.

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