Resource Availability

This essay focuses on the question of resource availability, or rather the decline of available resources. Figure 1 shows some estimates for the decline of various natural resources, assuming that consumption (and related to that population) continue to grow in a fashion similar to what is currently happening. Rather than asking directly how HCI can change this, we take a top down approach and ask what would have to change more broadly to avoid this future.

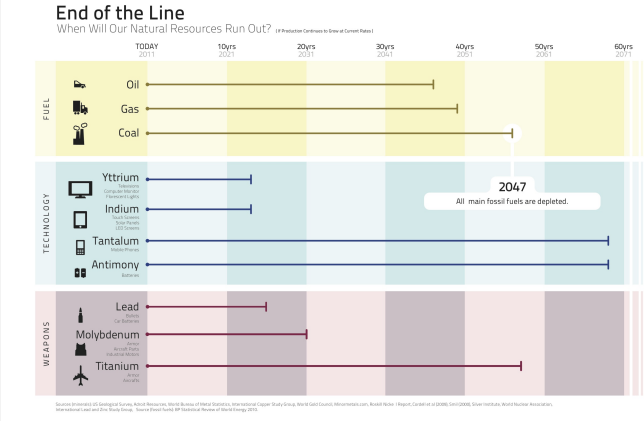

Figure 1: How many years left? Non-renewables: Taflin Laylin , also see a more detailed graphic from New Scientist viaCool Infographics

Optimistically, humans could evolve new technologies or cultural precepts that avoid decline of resources. This might involve evolution within the human genome [6]. Thus, the question is what might push changes in the *right* direction, what the right direction is, and how long it might take. This is a place that HCI is currently engaged with and could be influenced by knowledge about

- Factors affecting individual behavior drawn from fields such as psychology and economics
- Social forces (within families, across families, and so on), drawn from sociology, psychology, economics and more
- The study of non-human agents (governments, corporations, culture, etc) drawn from organizational psychology, political science, anthropology and many others
- Society level forces drawn from macro-economics, studies of socio-technical evolution

However, even among those humans who consider themselves most green, the vast majority are intimately chained to a set of cultural assumptions that are difficult to for them to see, much less modify [4]. For example, in a finite world, infinite growth is clearly an impossibility [5]. Yet economies, as constructed today, benefit greatly from growth [11]. As a result, economists aim to "dematerialize" growth (ensuring that its basis is not in material, i.e. limited, natural resources) [5]. While in principal the models espoused in this area of economics appear sound, the practice feeding, clothing, and housing billions of people takes a great deal of natural resources which will continue to be depleted. In addition, it is by no means clear that humans are willing or able to do things that will perturb the system or that the system is easy to control. Some may be positive, but others are likely to be negative — humans can't replace fossil fuel production, for example, without affecting the bottom line of fossil fuel companies, their employees, and so on. As long as those negative consequences are unacceptable, the degree of positive change is going to be equally limited. Only when negative consequences come from outside, such as natural disaster, is this problem avoided.

Alternatively, technology rather than society might evolve. For example, perhaps we might solve the problem of cold fusion (*e.g.* see Rossi's e-Cat). Let us suppose, for a moment, that Rossi really has discovered a way to achieve cold fusion. It is tempting to think that the human world would step up, replace existing energy production devices with this new (hopefully cheaper) technology, and *voila*, the world no longer would produce destructive amounts of CO2

emissions. Optimistically, let us go so far as to suppose the political willpower to do so would be easily created, despite the negative impact it would have on many individuals through the loss of jobs and collapse of markets. Even given these optimistic assumptions, it is unclear that Rossi's invention can truly solve the world's problems. First, because of the need for a catalyst, could the e-Cat may simply shift issues such as peak oil to a new issue ("peak nickel")? Perhaps, perhaps not: Nickel is present in meteorites in high concentrations, and it is plausible that human could harvest metals from space with the right infrastructure [7]. Second what are the side effects of the new infrastructure that would be built? What waste is produced in the production of e-Cats, what about the emissions associated with (potential) spacecraft harvesting nickel, or mining nickel from the ground? What about the catalytic reaction itself? At what scale might its waste products, even if small, begin to cause problems? These problems may be manageable (and no worse than current solutions for producing energy, but there is a final problem that is even more daunting.

Population growth, unchecked, will eventually lead to species collapse, and I would argue that easy access to energy is one of the things that facilitates population growth. We are already at 7 billion. As Tim De Chant argues in per square mile, the structure of a human society enables humans to live at increased density by making certain resources easier to find. I would argue that energy allows humans to live at even greater densities because it increases the reach of food, and the amount of food that can be eked out of each plot of land. So could fusion could in fact increase world population to even greater levels.

Population Decline

In the end, cold fusion, if Rossi's results are real, would be a great boon to humanity. This is easy to see. But it is not a panacea. It might replace one problem (CO2 emissions) with another (increased population growth), and it certainly would not address the myriad problems human presence on earth has caused. In the end, if the human species is to succeed, it must *reduce* its population, reduce the amount of waste it produces, and end the destruction of the ecosystem it depends on. Reducing CO2 emissions is only a small piece of the puzzle.

Being optimistic for a moment, let's consider instead a future in which population growth halts and even declines (this is already beginning to happen in some places, see Figure 2). Population decline would address some resource issues, though not all immediately. For example pollutants that take a long time to be absorbed back into the natural order of things would continue to build up even with a decline in population. However, this scenario is certainly better than continued growth.

A question that must be asked is how drastic the decline is, and what its impact is. For example, rapid die off on a large scale could result in positive things (such as an opportunity for flora and fauna to recover land) but also negative (imagine an abandoned nuclear power plant, war, or other possible consequences). Let us assume optimistically for the moment a not-too-rapid, controlled decline followed by a leveling out when the population reaches a level that can more easily be sustained by my currently groaning body.

What might that look like? According to the Global Footprint Network, the 2007 footprint of the human population was 1.5 earths [1]. This would mean that (assuming no technological advances), the human population needs to decline by 33% (approximately) from the 2007 levels (6.67 billion), or by 2.5 billion people from the current 7 billion person population.

Over what time period might this take place? If the world population declined by 250 million people per year for 10 years, or 25 million per year for 100 years, we might achieve that goal. This is a very large number (a the list of anthropogenic disasters on Wikipedia has WWII as the worst, with a death toll of between 40 and 70 million over 5 years, or between 2% and 3% of the world population at the time) [2].

How might this happen? A steady increase in chronic illness is visible looking as far back as "prehistory" as well, as in a 2002 study of respiratory illness over time [9]. A 17% increase in chronic illnesses of all types is expected over the next 10 years, worldwide [8]. Yet despite the clear negative impacts of civilization on health [10], the effect of these trends is much smaller than necessary to control the human population. Alternative thoughts on how this might happen can be found in books like *Apocolypse When* (Willard Wells), a mathematically based analysis of the likely lifespan of the human species; and *Guns, Germs and Steel* (Jared Diamond), a historical

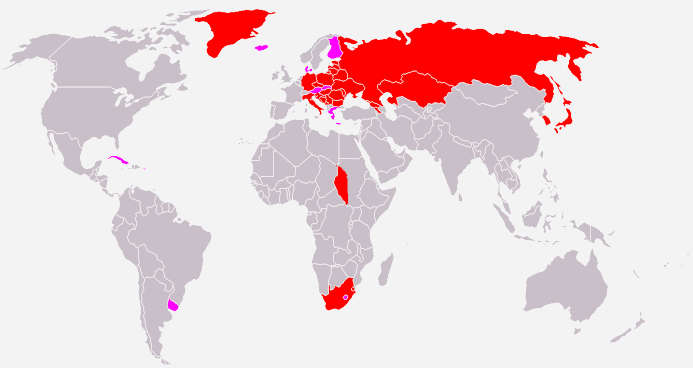

Figure 2: Population Decline. Red is decline, pink is approaching. @Doseiai2, Wikipedia. CC (some rights reserved)

account of the fates of human societies that covers a huge range of time (starting in "pre-history"), cultures, and concepts and has a fascinating case study of Easter Island that has daunting implications for the future of human society.

Although it is hard to find many attempts to model the impacts of population decline on humans themselves, there are some research articles on the topic. In particular, one consequence of controlled population decline is an excess of elderly individuals. According to Bloom *et al* [3], the relationship between fertility decline (which leads to population decline when births per year are less than deaths per year, and also to an aging population) and the size of the workforce is difficult to predict. For example, it may be positive in the short run (meaning an increased percentage of the population is of working age) but negative in the long run (as the number of elders rises).

Implications for Design?

An apparently open question is how controlled but large population decline (or even controlled but small population decline) would impact economic growth. Factors worth considering include how it might push off the end date of certain finite resources, how it might effect "dematerialized" growth, what institutions might be affected by the decline period (for example, how would a declining population of young people affect educational institutions?), what policies would best support a population with a relatively small workforce (compared to the number of aging adults) and so on.

Additionally, it would be worth considering how such a decline might affect key resources (for example would it imply food scarcity without a shift in where people live?). An optimistic model of population decline (meaning one that does not assume causal disasters) would ideally help to shed light on which forms of decline might be more likely to lead to conflict within and among nations (if any). In examining all of these variables, it would also be fruitful to explore at what rate decline is most manageable, and to test these assumptions against existing examples of populations that have experienced decline.

HCI's role in supporting the study of these factors could be considerable. Assuming controlled population decline is a goal, it could also be used to explore education, planning, and other aspects of intentional decline. Finally, the issue of 'dematerialization' is a ripe area for HCI work.

Other people's posts about population decline: [Wikipedia][Regions of Canada][Japan][Projected changes in Europe and impact of immigration][Russia]

[1] http://www.footprintnetwork.org/en/index.php/GFN/page/data_sources/
[2] http://en.wikipedia.org/wiki/List_of_wars_and_anthropogenic_disasters_by_death_toll

[3] Bloom, David, David Canning, and Jaypee Sevilla. The demographic dividend: A new perspective on the economic consequences of population change. Rand Corporation, 2003.

[4] For an accessible description of many of these assumptions, see http://www.whatawaytogomovie.com/

[5] Jackson, T. (2009) *Prosperity without growth: Economics for a finite planet.* Earthscan.

[6] Cochran & Harpending *The 10,000 Year Explosion*

[7] Sparks, D. R. (1986). Recovery of asteroidal metals for terrestrial utilization. *Acts Astronautica,* **13**(3):101-104.

[8] Preventing chronic diseases: a vital investment. WHO global report http://www.who.int/chp/chronic_disease_report/contents/en/index.html

[9] Roberts, C. A. and Lewis, M. E. (2002) 'Ecology and infectious disease in Britain from prehistory to the present : the case of respiratory infection.', in Ecological aspects of past human settlements in Europe. Budapest: Eotvos University Press, pp. 179-192.

[10] Cohen, M. N. (1991) Health and the rise of civilization http://www.primitivism.com/health-civilization.htm

[11] D'Allesandro, S., Luzzati, T. & Morroni, M. (2008). GDP growth, consumption and investment composition: feasible transition paths towards energy sustainability. Paper written for *International Conference: DECROISSANCE ECONOMIQUE POUR LA SOUTENABILITE ECOLOGIQUE ET L'EQUITE SOCIALE*