Per Nilsson
Konst, Kultur och Kommunikation (K3)
Malmö Högskola
Sweden 2005

Electronic Waste, and a Proposal as to What to Do With It

Professors:
Livia Sunesson, David Cuartielles, Camille Norment

TABLE OF CONTENTS

INTRODUCTION

E-waste

This essay is a call out for more sensible resource management. In 2005, it is getting as common for households in Sweden to own a computer, as it is to own a television set, or toaster. In the first quarter of 2004, more than 70% of men and women in Sweden, aged between 16 and 54, used a computer at home at least once a week.[1] What is troubling is that the average "life span" of a personal computer is constantly decreasing. In 1997, a computer was used between four and six years before being replaced. In 2005, a computer is expected to last only two years before it becomes so-called e-waste.[2] It is estimated that between 2003 and 2005, 315-860 million computers will become "obsolete" in the US only. Furthermore, 80% of these computers will end up in a landfill, where toxic substances such as heavy metals leach into the earth and ground water.[3] Is this really necessary?

What does it mean that a computer becomes obsolete? Why is it that consumers feel a constant need to upgrade, to own the latest, fastest hardware? How was work getting done with this old hardware before? Is it possible that we could make do with hardware deemed "outdated"? What is the fate of the thrown out hardware?

Why is this important?

I am writing this essay to address a growing problem. A study cited by Scientific American shows that to make a two-gram, 32-megabyte memory chip, you use 1.6 kilograms of fossil fuel and 32 kilograms of water.[4] In manufacturing a single laptop computer, you generate waste close to 4000 times the weight of the final product.[5] It is clear that the electronics manufacturing industry will have to turn to more sustainable production methods. All the while, we do have an existing mass of computers manufactured using these wasteful techniques, and so should regard these as precious assets.

Some outdated computers are donated to organizations that distribute used computer hardware to people who otherwise wouldn't have the opportunity to become computer literate. Yet, the vast majority (in the U.S., 90%) of discarded computers are put away in storage, landfills, or exported to poor countries as hazardous waste,[6] mostly to Asia and China, where the circuits are broken down under primitive conditions, and many of the toxic substances found in this e-waste, simply washed into local rivers, causing devastating environmental damage affecting the people living there.[7] This trade of hazardous waste was banned in 1994's Basel Ban, under the Basel Convention,[8] a United Nations 1989 treaty. The Basel Ban has been ratified by 58 out of 62 countries needed to make it international law. The United States, the largest e-waste producer in the world,[9] has yet to sign the treaty.

---

[1] Statistiska Centralbyrån, IT bland individer. http://www.scb.se/templates/tableOrChart____112379.asp
[2] trueCycle, inc., "Shorter Electronics Life Span". http://www.truecycle.com/market1.html
[3] Whatis.com, "E-cycling, Where do all the old computers go?"
http://whatis.techtarget.com/content/0,290959,sid9_gci1066012,00.html?track=NL-37&ad=508273
[4] Scientific American in Thackara (2005:10). Source:
http://www.sciam.com/article.cfm?chanID=sa003&articleID=0000E57E-E47B-1DC6-AF71809EC588EEDF
[5] Hawken et al. in Thackara (2005:11)
[6] ibid.
[7] Basel Action Network. http://www.ban.org; See also article by Detroit Free Press, "Our computer waste is another's pollution. http://www.freep.com/money/tech/ewaste24e_20051024.htm
[8] Secretariat of the Basel Convention, United Nations Environment program. http://www.basel.int/
[9] Radio interview with Pucket, Jim, coordinator of Basel Action Network.
http://128.208.34.90/ramgen/archive/radiointersection/20030506intersection.rm

DILEMMA

Moore's Law

According to Moore's Law, the data density, or number of transistors per square inch on a microchip, will double every 18 months.[10] This means either double the processing power for the same price, or half the price for equal processing power every 18 months. What this *really* means for the computer industry is that they will never be able to make money off a slowly growing market, but they need that market to grow by 30-50% each year.[11] This, in effect, perpetuates a thinking that computers are made to last only a year or two, when in reality, today's electronic circuits have a potential lifespan that is much longer.

What is this exponentially increasing computing power being used for? When "the market" tells us, the consumers, that we need to buy the newest computers, they usually cite that modern software demands increasingly powerful hardware to be supported. While it is easy to see why this would be the case with 3-dimensional games, the visual effects of which today are approaching photoreality, it is harder to understand why desktop applications like word processing, web page authoring, film clip-watching etc. would need more computing power today than 18 months ago. Another area where more than normal computing power is needed is photo editing, something more average consumers are engaging in today because of the recent surge of popularity in digital cameras. Precisely how much computing power that is needed, however, must be decided on the basis of each user's unique needs. Many users don't ever use any more advanced photo editing techniques than resizing for e-mail and web use, and that doesn't warrant the use of a very powerful workstation.

The High Technology Market

Most factory-new computers come preinstalled with the Microsoft Windows operating system[12]. Thus, Microsoft controls an absolute majority of the home-user market, and has the power to mandate the hardware standard consumers should have. The next release of Microsoft Windows, "Vista", is said to require a minimum of 512 megabytes of RAM[13]. 1 gigabyte is recommended, and for running 64 bit mode (largely unnecessary for the average user), 2 gigabytes is needed. On top of this, everyone who doesn't play demanding computer games, and thus may not have prioritized the power of the graphics card in their system, will need to look into upgrading to a card with a powerful graphics processor and at least 64 megabytes of on-board RAM (128 megabytes or more is recommended).

These hardware requirements might look daunting in comparison with today's average PC, but again, looking at Moore's law, new affordable machines will probably be well above these specifications by the time Vista is released in late 2006. Windows Vista does come with a thoroughly re-worked user system much like the one found in UNIX-based operating systems, improving system security and making it much harder for malicious software to infect the system. It is in the interest of every Microsoft Windows user to upgrade to Vista. But should you be required to buy a new computer just because you want to use the latest, most secure version of an operating system you probably didn't choose in the first place?

Are we, the consumers, really in control here, or is this a cycle of supply and demand created entirely by software companies and hardware manufacturers themselves? Are the consumers of high technology stuck between the whirlpools of two giants feeding each other?

---

[10] http://www.webopedia.com/TERM/M/Moores_Law.html
[11] Cringely, Robert X. "Be Absolute for Death, Life After Moore's Law". http://www.pbs.org/cringely/pulpit/pulpit20011115.html
[12] Wikipedia, "Microsoft Windows". http://en.wikipedia.org/wiki/Microsoft_Windows
[13] Short for Random Access Memory. Hardware that supplies fast, temporary storage space.

My point is that the need for ever increasing computer power is a created need, driven by the market. Without constant improvements, creating new products or products with markedly better performance, the market for high technology would quickly become saturated. This has been argued by Economist R.J Gordon[14]. Yes, updates will always be needed as technology moves forward, but not at a rate of twice the computing power every 18 months. The things we do with technology, and how, do not change that fast.

Attitudes to High Technology in the West

There is in the developed world an attitude towards consumption that yesterday's news is almost embarrasing to own. Often people buy into new technology not for the performance on offer, but to raise their social status. The task of computer salesmen in electronics chain stores is to make a potential buyer maximize their spendings in the store, and so they try to sell as powerful a computer as possible. This reinforces the effects of modern western attitudes to high technology. While possibly avoiding the need for the household to upgrade the system in the very near future, it also means that the buyer does not actually buy a system that is optimized for them. Indeed, the systems on sale are by no means optimized for any one user's specific needs, but put together to make the deal look appealing to the average consumer. They might be over-buying into a system whose full capacity they will not use. My belief is that this is most often the case, because of the combination of ever-decreasing prices of high-performance hardware and the existing attitudes among consumers.

Science and the Market

However resource inefficient the global capitalistic economy may be, the relationship between market pressure on hardware manufacturers to constantly improve the microchip, and new scientific findings cannot be ignored. It is likely that without the huge consumer demand for faster and faster hardware, we would lack some important scientific breakthroughs of the last couple of decades. But it is my belief that we can move towards sustainable production, and still push science forward.

WAYS TO GO

Consumer Guidance and New Markets

If the consumers had a way to become better informed about how their needs corresponded to the available computer market, and if the idea of getting what you need, instead of getting what you are told was widely distributed, consumers would be buying into systems that were optimized for them, and calculated to last for an amount of time that is more proportional to the actual lifetime of a computer. I can imagine local governments taking the responsibility to educate information technology consumer guides, that would give lectures at schools and organizations for this purpose.

This way, a new market space could open up, one for business that refurbishes used computers, and sell them with a one-year warranty, just like a new computer. It is easy to imagine that one reason people spend the money on a new computer instead of a used, is the risk of having to spend more money on the old one due to possible malfunctions that are not covered by any warranty. Buying a used computer from a business dedicated to make the purchase of a used computer as consumer safe as possible, would eliminate this risk. This would mean less waste of perfectly usable computers.

Free as in Freedom

The software market and the hardware market do not have to be two coupled beasts that drive each other. There's a new kid on the block. The Free Software Foundation[15] ("free" as in "free speech", not

---

[14] Gordon (2000) in Tuomi, Ilkka: "The Lives and Death of Moore's Law". http://www.firstmonday.org/issues/issue7_11/tuomi/#t5

[15] http://www.fsf.org,see also http://www.gnu.org

as in "free beer") is an ideologically motivated movement, made up by a community of software developers that are opposed to proprietary software development driven by market pressures. Instead, they believe that for software to truly be in service of its users, anyone must be allowed to examine how the software works, which requires the source code to be distributed alongisde the executable files. Anyone is then free to change the software according to their needs, and redistribute it, as long as the source code, and the original free software license, is distributed with it. This licence is called the GNU General Public Licence, and serves to guarantee that software developed under the Free Sofware paradigm cannot be used as part in making opaque, proprietary software.

There is another denomination for software with transparent source code, Open Source Software. The difference between the two mostly comes down to ideology. The Free Software Foundation believes it is unethical to provide software without the source code, while the Open Source community does it for the evolutionary advantages of software being developed by many, rather than a closed circle of programmers.

The development of Free Software and Open Source software is a community process, where anyone can contribute. Normal users can test-drive new releases and report errors ("bugs") back to the developers, who are users and/or contributers with programming skills, or a corporation. The aim of the Free Software Foundation is that anything that can be done with proprietary software can and should be done with free software instead.

Users of free software are the same users that might use proprietary software, and many use both kinds. The users of free software has for some reason made a conscious decision to take a step away from proprietary software, be it of ideological or practical reasons, but their needs should essentially reflect the needs of software users in general. What happens when these users gain control over the development process, and can actively propose changes in functions and usability?

One important difference between free software and proprietary software is that the development of the former is driven by utility, whereas the development of the latter is driven by profit margins. The former is available at no cost or low cost, whereas the latter usually represent a substantial investment. I think this means that the effort that is put by proprietary software developers into competing with others can be put by free software developers into making the software be of better utility and, importantly, of better usability. Instead of implementing the latest computing power-demanding graphical effects to make their software look better than others, free software developers can use the latest technology in a sensible manner, applying graphical effects where they should be applied, i.e. where they improve usability. My argument here is that proprietary software in some ways is designed to "fill out" the computing power of the users' computers, creating a constant need to upgrade to new hardware as it becomes available. Free software can be expected to use computing resources more sparingly, and to take into account backwards compatibility with older systems, if there are users running these systems.

Distributed (Grid) Computing

One way to make use of all the computing power potentially available throughout the developed world is to create grids of distributed computing power. In these grids, all connected computers share the workload of distributed computing tasks. In an interview, Ian Foster of the Globus Alliance, "a community of organizations and individuals developing fundamental technologies behind the 'Grid'," [16] says that "[o]ne important part of the evolution towards grid computing is […] the fact that our home computers are now as powerful as yesterday's supercomputers. […] But the transition to a system that enables participation in a grid as a true peer is something that's just happened in the last five years or so."[17]

[16] http://www.globus.org/
[17] Mau 2004:96

Two existing solutions to create clusters of workstations are the Globus Toolkit,[18] developed in part by the Globus Alliance, which contains core protocols and functions for implementation of grid clusters; and the Sun Grid Engine.[19] Both are Open Source projects, which according to the Globus Alliance "encourages broader, more rapid adoption and leads to greater technical innovation."

DESIGN PROPOSAL

Brief Description

Used computers are completely refurbished, putting them inside a visually appealing case instead of the dull "desktop grey", using parts from other used computers to upgrade selected components such as RAM, CPU, hard drive and graphics card. A custom made, free operating system is installed that is designed to make use of grid computing technologies. Other commonly used free software applications are installed, such as a word processor, an internet browser and e-mail client, a media player, simple games. All in order to provide an out-of-the-box usable system, the inner workings of which has cost nothing in investment. In a prominent place on the casing, a display is mounted. On this will be dynamically displayed the number of years the lifetime of the computer has been extended, given the effects of Moore's law and the number of computers on the distributed computing grid.

The experience of using the refurbished computers will optimally not differ from using much newer hardware, since every Free Computer workstation will be a node in the grid of load-sharing computers.

These computers are adopted to selected users who are required to subscribe to high-speed internet connections. They have agreed to participate in an experimental technology/art project, and understand that there are certain terms to adhere to upon adopting the computer. First, they can never turn off the computer. Second, they must not install any non-free software on the computer. Third, they agree to let their internet connection be used for the distribution of free software. The computers will not only act as nodes on a distributed computing network, but also as download mirrors for free software.

For other, independent, users with an interest in promoting the art project, grid client software will be available for download that will turn any computer into a node in the distributed computing grid. The more Free Computers that are distributed, and the more that download the grid client to use on newer machines, the longer the extended life of the free, refurbished computers.

A Conceptual Product

The users that volonteer to adopt one of these Free Computers is not simply getting a great deal for a new technology, but are picked to become pioneers of a new movement. One that fuses the ecological activist movement with the movement for free software. The Free Computer is what is referred to by Dunne and Raby as a conceptual product, "[…] that fuses complex narratives with everyday life. [Rather than being a passive consumer,] the user would become a protagonist and co-producer of narrative experience".[20] The complex narratives in question are the ways of the western world, the scavenging of resources, the offloading of problems unto others. Everyone that interacts with the Free Computer distributed grid, is taking part in rewriting the story of e-wastefulness into e-usefulness.

---

[18] http://www.globus.org/toolkit/
[19] http://gridengine.sunsource.net/
[20] Dunne and Raby (2001)

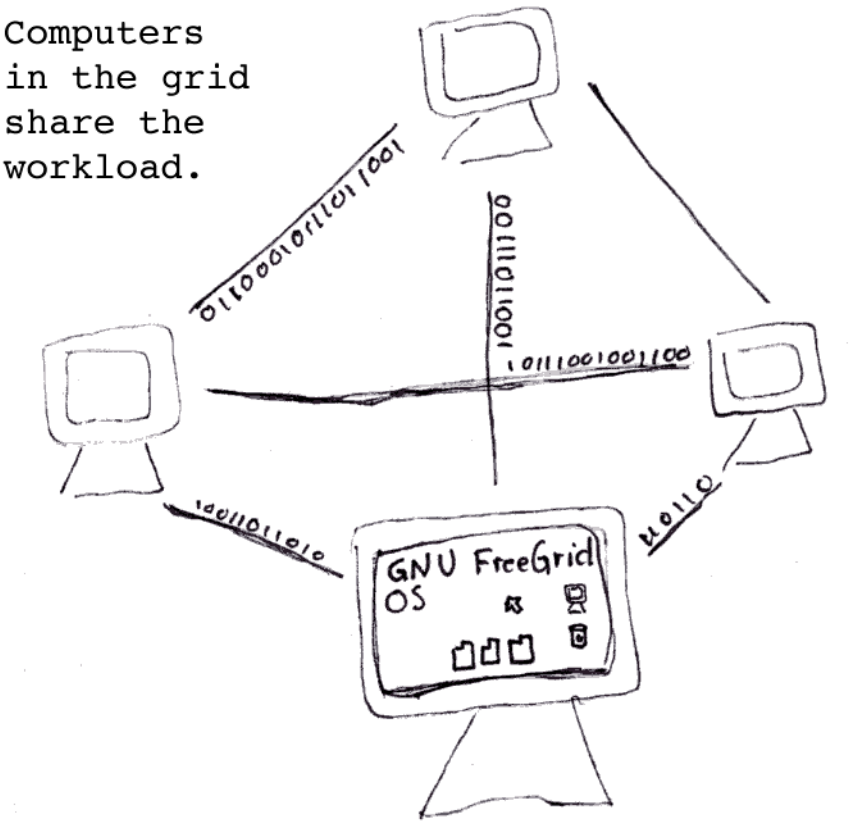
Related Projects

1. Electric Sheep.[21]
   This is an open source screen saver, distributed under the creative commons license. When the screen saver comes on, the computer becomes a node in a distributed computing rendering farm, sharing the workload in creating morphing animations called "Electric Sheep". In effect this creates a collective "android dream", in homage to Philip K Dick's novel "Do Androids Dream of Electric Sheep?"
2. BIOPC: The Key to a Sustainable Future[22]
   This contribution to the 2004 GreenBlue eDesign Competition[23] won the third place award. It is a design proposal for a future computer made of organic materials: biodegradable plastics made from corn starch, and a processing core made up entirely by a bacterium called Bacteriorhodopsin, renowned for its information storage capacity. This computer, apart from gracefullt decomposing at its end-of-life, would not need any physical upgrades as the bacteria would simply be remotely triggerd to "mutate" in a controlled fashion, to meet new requirements.
3. Computer Take Back Campaign.[24]
   Under the slogan "Take it back, make it clean!", this campaign fights for the establishment of extended producer responsibility (EPR) in the U.S. to take back products that have reached their "end-of-life" for recycling, as has been done in the European Union; as well as the phasing out of hazardous materials in electronic products. EPR should be an incentive for electronics corporations to develop means of sustainable production.

[21] http://www.electricsheep.org/
[22] Bradley (2004)
[23] http://www.greenblue.org/edesign/
[24] http://www.computertakeback.com/

Illustration:

Computers in the grid share the workload.



REFERENCES

Basel Action Network, website. http://www.ban.org 2005-10-30

Basel Convention, secretariat of the. Website. http://www.basel.int/ 2005-10-30

Bradley, Joe et al. (2004). "BIOPC: The Key to a Sustainable Future". University of Illinois Urbana-Champaign. http://www.greenblue.org/edesign/winners/BIOPC.pdf 2005-10-30

Computer Take Back Campaign. Website. http://www.computertakeback.com/ 2005-10-30

Cringely, Robert X (2001). "Be Absolute for Death, Life After Moore's Law". http://www.pbs.org/cringely/pulpit/pulpit20011115.html 2005-10-30

Dunne, Anthony and Raby, Fiona (2001). "Design Noir: The Secret Life of Electronic Objects". Berlin, Germany: Birkhäuser. Page 46
.

Electric Sheep. Website. http://www.electricsheep.org/ 2005-10-30

Free Software Foundation, the. Website. http://www.fsf.org/ 2005-10-30

Globus Alliance, the. Website. http://www.globus.org/ 2005-10-30

GNU Operating System, the. Website. http://www.gnu.org/ 2005-10-30

Gordon, R.J. (2000). "Does the 'New Economy' measure up to the great inventions of the past?" Journal of Economic Perspectives, volume 14, number 4, pp.49-74

Graham, Sarah (2002). "Making Microchips Takes Mountain of Materials". Scientific American.com. http://www.sciam.com/article.cfm?chanID=sa003&articleID=0000E57E-E47B-1DC6-AF71809EC588EEDF 2005-10-30

GreenBlue. Website. http://www.greenblue.org/edesign/ 2005-10-30

Mau, Bruce et al. (2004). "Massive Change". London, England: Phaidon Press. Page 96.

McDiarmid, Hugh Jr (2005). "Our computer waste is another's pollution". Detroit Free Press. http://www.freep.com/money/tech/ewaste24e_20051024.htm 2005-10-30

Pucket, Jim (2005). Interview on National Public Radio. http://128.208.34.90/ramgen/archive/radiointersection/20030506intersection.rm linked from: http://www.ban.org 2005-10-23

Statistiska Centralbyrån (2004). "IT bland individer". http://www.scb.se/templates/tableOrChart____112379.asp 2005-10-30

Sun Grid Engine Project. Website. http://gridengine.sunsource.net/ 2005-10-30

Thackara, John (2005). "In The Bubble". Cambridge, Mass., U.S.A: MIT Press. Page 11.

Tuomi, Ilkka (2002). "The Lives and Death of Moore's Law". First Monday, volume 7, number 11. http://www.firstmonday.org/issues/issue7_11/tuomi/#t5 2005-10-30

trueCycle, inc. (2003). ”Shorter Electronics Life Span”. http://www.truecycle.com/market1.html 2005-10-30

Webopedia Computer Dictionary. “What is Moore’s Law?” http://www.webopedia.com/TERM/M/Moores_Law.html 2005-10-30

Whatis.com. ”E-cycling, Where do all the old computers go?” http://whatis.techtarget.com/content/0,290959,sid9_gci1066012,00.html?track=NL-37&ad=508273 2005-10-30

Wikipedia, the free encyclopedia (2005). “Microsoft Windows”. http://en.wikipedia.org/wiki/Microsoft_Windows 2005-10-30