PAUL MOBBS

A practical guide to sustainable IT

Unit 9

This unit is one of 12 sections to a "A practical guide to sustainable IT", a hands-on guide to working with everyday technology in an environmentally conscious way. The guide has been written by environmental activist and ICT expert Paul Mobbs, and was commissioned by the Association for Progressive Comunications (APC) with the support of the International Development Research Centre (IDRC). To download the full text of the guide, or any of the other units, please visit: greeningit.apc.org

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END OF LIFE AND DISPOSAL

All types of tools and machines have a limited functional life. How they are used, cared for and maintained has an important role to play in maximising that working life, but in the end they will fail or, compared to a new device, become inefficient to use. Electrical devices, due to the toxic materials they contain, represent a hazard when disposed of inappropriately. For this reason ensuring that all electrical items are collected and reprocessed to maximise the recovery of materials, and minimise the impact to the environment of waste disposal, is an important part of how we manage this equipment at the end of its life.

Assessing when a device has reached the end of its life, and then disposing of it in an ecologically safe way, are the last two stages in the life cycle of ICT equipment. In this unit we'll examine the environmental impacts of electronics and electronic waste disposal. In the next section we'll examine ways in which devices might be reused to prolong their service life.

9.1. THE PROBLEM OF TECHNOLOGICAL OBSOLESCENCE

When we examine our use of computers the issue of "obsolescence" not only applies to failed hardware; we also need to consider the logical as well as physical methods used to store data. A desktop computer or any other information storage device, such as a smart phone, is only as sustainable as the software and hardware used to store the data it holds. The reasons behind that statement are not obvious so let's consider a practical example.

One of the earliest mass market personal computers was the *Apple II*.[1] It used 5¼-inch floppy disks, and ran a bespoke disk storage system, and could store around 100 kilobytes of data. In the early 1980s the first versions of the IBM Personal Computer[2] also used 5¼-inch floppy disks, and ran the PC-DOS disk operating system, which wasn't compatible with Apple's system. At the time there was another competitor disk operating system, *CP/M*,[3] which was also incompatible. Jump forward 25 years to the world of computing today. Both the Apple, early IBM and CP/M disk operating systems are obsolete. If you had any 5¼-inch floppy disks containing some important information it would be very difficult to access it. 5¼-inch floppy disk drives became obsolete long ago, and even the 3½-inch floppy drive is now almost history – abandoned in favour of CDs/DVDs and USB memory sticks. There are commercial archive services which read old computer media and convert old file formats to modern equivalents, but they are expensive. Therefore much of the data generated on these early computer systems has effectively been lost.

Unlike books, which are directly accessible to human interaction, access to digital information is intermediated through technological standards – and as those standards change, important or historically valuable data can be lost. For example, if an early Apple or IBM computer user had written a literary or technical work of great significance, but it was never published in print, it is now inaccessible as a result of the obsolescence of the technology used to store the information. One notable example of this problem was the BBC's *Doomsday Project*,[4] an update to the English Doomsday Book carried our in the mid-1980s, the data from which was almost lost due to the obsolescence of the technology used to store it.

If data being created today has value for the future then you have to guard against the obsolescence of the hardware and software used to create it. Thinking about how we create information, and how we store it for the future, is an essential part of how we should plan our use of computers. The physical media which we store the data on, the file formats which we use to hold the data, and the operating systems which we use to run the programs which read those files, are all likely to become obsolete one day. While operating systems evolve, many of the programs we run on them stay largely the same. Even so, while the name or purpose of the program may not change, the way the data is physically stored by those programs changes from generation to generation of technology. In the proprietary software world, newer applications retain some backwards compatibility[5] with the older version, but only for two or three generations. As a result old files can, after a time, become inaccessible to more recent programs. If we are creating valuable work and we want to ensure that the information is available for "future generations" – an idea which forms the core of the concept of sustainability – then we have to think carefully how we decide to create and store our data.

The basic rule to guard against future obsolescence is to keep copies of data in different formats, preferably formats which do not use proprietary encoding systems, and do not lock up the data in ways which might block access to it in the future. There are a number of commonly used formats which, due to their history of use to exchange data between different operating systems or software applications, are more suited to long-term data storage:

1. Wikipedia, 'Apple II'. en.wikipedia.org/wiki/Apple_II
2. Wikipedia, 'IBM Personal Computer'. en.wikipedia.org/wiki/IBM_Personal_Computer
3. Wikipedia, 'CP/M'. en.wikipedia.org/wiki/CP/M
4. Wikipedia, 'BBC Doomsday Project'. en.wikipedia.org/wiki/BBC_Domesday_Project
5. Wikipedia, 'Backward compatibility'. en.wikipedia.org/wiki/Backward_compatibility

- If you are using a proprietary program, such as *Microsoft Word*, then save copies of the most important files in other file formats – such as plain text, RTF, PDF, or an open formatting standard such as XML or HTML.
- When creating graphical data, or using proprietary CAD or publishing programs, export a copy of the final work to a common open image format (such as TIF, JPG, PNG or GIF) or if the program permits export it as a PDF.
- When using databases or spreadsheets, export a copy of the data into flat text-based files (such as tab or comma-separated tables) or as an XML data file.
- Avoid compressing or collecting data inside archive files – for example ZIP, RAR, TAR, GZ, etc. Not only are compressed files more likely to suffer a greater amount of data loss as a result of later file corruption, certain proprietary compression formats may fall out of use and become inaccessible in the future.
- As a general rule when storing data for long-term retrieval, unless there are security concerns, do not lock files using the encryption or password locks of applications – it's likely the password will be lost. If you need to ensure the integrity of files use detached digital signatures to verify their authenticity, for example by using a cryptographic hash function[6] such as MD5 or SHA2.
- A popular file format, or a format conforming to an open standard (not a patented software format), is preferable to storing data using a file format tied to a single program or application.

What's important is that the conversion of data files is carried out when you are finishing and archiving a large project. That's because at a later date, when the system/application is about to become obsolete, to suddenly convert all the data that you have created over many months or years will be an onerous chore. By converting the formats when you finish a project/writing a significant piece of work, you also guard again hardware obsolescence. If all the files are openly readable on their current storage media (e.g. CD, DVD, memory card, etc.) then they can be easily copied to any new standard of storage media in the future. By collating our data in a future-proof way today we remove the obstacle of converting large amounts of data in a short space of time in the future, and make it easier to migrate those files to new types of storage media.

9.2. PLANNED/PERCEIVED OBSOLESCENCE AND SERVICE LIFE

If we look at graphs of how fast computers have become – for example the graphs which illustrate Moore's Law[7] – we might believe that we are working many times faster than we were five or ten years ago. In reality that's not true. As the power of computers has developed, and the speed of computer networks has increased, so the amounts of data being moved around have grown too. This raises an interesting ecological paradox for the entire IT industry; as its capacity has never been constrained, the IT industry has never had to try and make more efficient software or data standards. The result of this is that while the processing of data has increased for system users, the perceived increased in performance is nothing like the actual increase in system speed. A large part of those speed/capacity increases have been expended moving more and more complex data.

One factor in the increasing bloat of software is that older hardware can appear to become slow and inefficient. This usually happens when operating systems are significantly upgraded, for example the transition from *Windows XP* to *Windows Vista*. As a result, perfectly serviceable hardware may be scrapped due to changes in software, not as a result of the hardware's inability to function. This is an

7. Wikipedia, 'Moore's Law'. en.wikipedia.org/wiki/Moore's_law

6. Wikipedia, 'Cryptographic hash function'. en.wikipedia.org/wiki/Cryptographic_hash_function

example of *perceived obsolescence.*[8] Whether it is because the older hardware cannot run new software to the users expectations, or because older hardware is rejected because of the appeal of new/more fashionable products, the user scraps the system and buys a new one. The idea of perceived obsolescence has been at the heart of the marketing of new products since the 1950s,[9] and has been criticised since its development because of the costs to the consumer and the environment.[10]

Another process related to the use of technology is *planned obsolescence.*[11] This involves the developers or vendors of a particular system or product deciding not to support or service older equipment in order to promote the adoption of a newer model. Sometimes the operating life of a device can be hard wired into the logic of its electronics – and without having access to the detailed designs of the system it can be difficult to circumvent these restrictions. More commonly the producers of hardware or software will upgrade systems without backwards compatibility,[12] restricting the ability of the latest systems to read files from or export data to older versions. This tends to be more of a problem with proprietary systems, as open source/free software systems allow developers and enthusiasts to continue support for older versions long after the equipment has ceased being supported by its manufacturers.

For example, according the environmental report produced for the first series of Apple iPad, it has a design life of three years.[13] However, after just two years, the latest upgrades to the iPad's software cannot be used with the first series iPad, and so users of those devices are being forced to upgrade to the latest model of hardware if they wish to continue receiving software updates.[14]

The problem with planned obsolescence is that there is little that the user can do to avoid the cost and environmental impacts of being forced to upgrade – that's why many consider planned obsolescence to represent a greater problem than perceived obsolescence because it takes away consumer choice from the decision to upgrade.

In the final analysis, the end-of-life of any device must be a balance between the service it gives, the cost of using it in its current form, and the costs or benefits of upgrading it. Often that balance is reshaped by external forces rather than being motivated by a change in the way we organise our use of the system. For those who perform largely office-related and internet/communication activities, the use of the same computer system for a significant length of time should no affect the way they carry out that work. What tends to create problems are changes to the applications and related software required to view web content, to read documents or files imported onto the system, or problems finding compatible hardware when existing devices cease to function.

As noted elsewhere in this guide, one of the best ways to minimise our ecological impacts is to extend the service life of the equipment we use. In order to achieve that goal we must find ways to manage these external incompatibilities, finding alternatives which avoid the need to upgrade until it is absolutely necessary. Just because a computer or other device ceases to have a viable function in one role does not mean it would not have a viable future in another. As outlined in unit 4, older PC hardware can perform a variety of functions – from a small file server to backing up a laptop or other machine via a network cable, to a machine which provides local services on the network, or just a machine to "play" with, practising your skills manipulating hardware or installing software. Provided that the application serves a useful purpose, it is a valid use of that technology. Only when a machine no longer has a useful application should it be disposed of – and even then other uses may be found for it if the machine is recycled via a local computer refurbishing or training scheme.

8. Leonard, Annie (2008). The Story of Stuff: Planned and Perceived Obsolescence. www.youtube.com/watch?v=N2KLyYKJGk0
9. Dannoritzer, Cosima (2010). The Lightbulb Conspiracy. www.imdb.com/title/tt1825163/
10. Packard, Vance (1970). The Waste Makers. Reissued by IG Publishing, 2011. ISBN 9781-9354-3937-0.
11. Wikipedia, 'Planned obsolescence'. en.wikipedia.org/wiki/Planned_obsolescence
12. Wikipedia, 'Backwards compatibility'. en.wikipedia.org/wiki/Backwards_compatibility
13. Apple Computer (2010). iPad Environmental Report. images.apple.com/environment/reports/docs/iPad_Environmental_Report.pdf
14. Bevan, Kate (2012). You mean my two-year-old iPad can't take this year's software? The Guardian, 4th July 2012. www.guardian.co.uk/technology/2012/jul/04/apple-ipad-software-update

9.3. IMPACTS OF E-WASTE

When hardware does reach the end of its life it has to be disposed of. How that is carried out is intimately linked to the types of materials these devices contain, and how the ecological impacts of those materials can be controlled to prevent harm. It is difficult to control what substances our electrical devices are made from, as many manufacturers provide little information on the environmental impacts of production with the goods we buy – although some manufacturers now produce goods free of toxins such as brominated flame retardants and PVC.[15]

Ultimately, no matter how much we can reduce the toxic load, the physical volume of electrical waste will always represent a large expenditure of energy, resources and pollution to create it – which is why concentrating on maximising the use of these systems for as long as possible is so important. Perhaps due to the separation of our use of modern technology from wider ecological debate, there seems to be a sense that people have the right to access digital devices[16] irrespective of the impacts that might have. For example, we may argue about the carbon footprint of air travel or power generation at great length, but the ecological footprint of consumer electronics is equally problematic.[17]

As discussed in unit 2, our dependence upon scarce mineral resources poses some difficult questions for our technological society. If digital and consumer electronics require these resources then just how much are we willing to compromise to own them? This is not an abstract question – it's one that's already being played out in the global market for resources, and the ways in which the high prices for these materials drives their production in areas stricken by conflict, or using forced labour (so called "blood metals"). Similarly poor conditions exist in relation to the breaking up and reclamation of waste electronics in many parts of the developing world. The highly complex mixture of materials in e-waste, and the problems of recovering the substances they contain without causing any toxic pollution, make their reclamation in the developed world expensive. Even when the best reclamation technology is used, and high recycling rates are achieved, toxic waste streams requiring safe long-term disposal are still produced.

As a result, when many electronic devices reach the end of their life, they are exported from western states to poorer countries with less demanding environmental laws for "recycling". In many west African states,[18] India[19] and east Asia,[20] this is creating a highly toxic legacy for future generations. As these schemes tend to target only the easy-to-extract metals (gold or steel) it means that the metals valuable to digital devices are scrapped or lost in the system. Even when old computers and mobile phones are exported to Africa for reuse they will, after a short period of use, be discarded – and in many African and east Asian states the lack of any formal collection systems and advanced processing of e-waste means that they are unlikely to be responsibly recycled.

As pressure groups highlight the issue, and consumers begin to question the environmental costs of the products they buy, government and policy organisations are beginning to address the problem of e-waste.[21] The United Nations

15. Greenpeace International (2010). Why BFRs and PVC should be phased out of electronic devices. www.greenpeace.org/international/en/campaigns/toxics/electronics/the-e-waste-problem/what-s-in-electronic-devices/bfr-pvc-toxic/

16. De Decker, Kris (2008). The right to 35 mobiles, Low Tech Magazine, February 13th 2008. www.lowtechmagazine.com/2008/02/the-right-to-35.html

17. Greenpeace International (2010). Toxic Transformers Briefing. www.greenpeace.org/international/en/publications/reports/toxic-transformers-briefing

18. Basel Action Network (October 2005). The Digital Dump Exporting Reuse and Abuse to Africa www.ban.org/films/TheDigitalDump.html

19. Greenpeace International (August 2005). Recycling of Electronic Wastes in China and India. www.greenpeace.org/international/PageFiles/25502/recyclingelectronic-wasteindiachinafull.pdf

20. Basel Action Network/Silicon Valley Toxics Coalition (2002). Exporting Harm: The High-Tech Trashing of Asia www.ban.org/E-waste/technotrashfinalcomp.pdf

21. United Nations (2010). As e-waste mountains soar, UN urges smart technologies to protect health. www.un.org/apps/news/story.asp?NewsID=33845&Cr=waste&Cr1

Environment Programme[22] has been working to develop a framework to control the impacts of e-waste under the Basel Convention[23] (see box 9.1), which controls the global trade in hazardous wastes. In March 2012, the Basel Convention adopted new rules to address the movement of e-waste to African states.[24]

Slowly the regulatory process is catching up with the problems of e-waste. To make this process successful, a more general change in the culture of use surrounding our consumption of electrical goods is required – both reducing their toxic content and maximising their useful life in order to minimise their impact on the global environment. In the end this is a design issue; it is a matter of how we choose to build technological systems. It also requires the users of electrical goods to be mindful about the impacts of the goods they demand, and how they should care for and responsibly dispose of those goods in order to minimise the global impacts of their use. If we respect the physical boundaries to the natural world then we can make a truly sustainable culture. The difficulty is that recognising these limits inevitably means applying limits to ourselves.

9.4. E-WASTE DISPOSAL SCHEMES

As legislation has only recently begun to catch up with the increasing use of electrical goods, the system of controls for e-waste management is, at the global level, still fragmented (see box 9.1). While global legislation is in development, both the electronics industry and many national governments are waiting to see what procedures current negotiations will enact.

At present the world leader in the control of e-waste is the European Union. The directive on e-waste (the WEEE directive) was agreed a decade ago. This enacted controls over the disposal of e-waste. Since then the EU has also agreed on the *Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).* This seeks to control the range and concentration of toxic materials in industrial and consumer products, and complements the objectives of the WEEE Directive by reducing the toxic contaminants present in the waste stream.

While recent revisions to the WEEE Directive have sought to increase the amounts of electrical waste collected, there has been criticism of the way the problem is being tackled.[25] At present the focus of the directive is on waste collection, and without any other legislation which seeks to control the life cycle and service life of goods. This means that functional/usable electrical goods can be disposed of – which under the current system is likely to lead to them being crushed, fragmented and incinerated. For those who seek to reuse computers and other electrical items, this takes away items which they might have been able to reuse as the centralised collection of e-waste inevitably leads to usable computers and other goods being scrapped.

At present the greatest difficulty with the regulation of e-waste, and to some extent the laws on the restriction of hazardous substances, is that they deal with waste as an end-point of the consumer process. We are still looking at resource use as a linear process – involving production and disposal – rather than a cyclical process[26] which focuses on reuse, recycling and zero waste production.[27]

22.UNEP (2010). Urgent Need to Prepare Developing Countries for Surge in E-Wastes www.unep.org/Documents.Multilingual/Default.asp?DocumentID=612&ArticleID=6471

23.Wikipedia, 'Basel convention'. en.wikipedia.org/wiki/Basel_convention

24.United Nations (2012). UN-backed initiative to address electronic waste problem in Africa adopted. www.un.org/apps/news/story.asp?NewsID=41570&Cr=Electronic+Waste&Cr1

25.Guardian Environment Network (2012). EU beefs up electronic waste recycling. www.guardian.co.uk/environment/2012/jan/24/eu-electronic-waste-recycling

26.Leonard, Annie (2010). The Story of Electronics. www.storyofelectronics.org

27.Wikipedia, 'Zero waste'. en.wikipedia.org/wiki/Zero_waste

Box 9.1.

The control and recycling of electronic waste

There are various schemes around the world which seek to control the production and disposal of electrical waste. Some are run by industry organisations whilst others are mandated by national and regional law. The notable schemes which exist at present are:

- *The Basel Convention*
  The *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal* provides a basic minimum standard for the international movement and processing of hazardous substances, including waste electronics. In 2006 the parties to the Treaty agreed the *Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste.* Under this agreement regional systems to control the shipment and processing of electronic waste are now being created. The first of these regional agreements, covering African nations, should be completed during 2012. for more information see – www.basel.int
- *Sustainable Electronics Initiative*
  The USA has no federal law on the control of electronic waste – waste electrical goods are dealt with as another part of the general municipal waste system. Certain parts of the e-waste stream, such as batteries or television monitors, are covered by other legislation, and some states implement controls over the disposal of articles containing toxic substances. In 2009 the Sustainable Electronics Initiative was set up by the Institute of Natural Resource Sustainability to encourage a more proactive effort on electronics waste, both managing the disposal of waste but also trying to minimise the production of it. It is hoped that this and similar schemes will eventually lead to a national/federal initiative on e-waste. Some states, such as Washington and California, are already enacting their own stricter controls over electronic waste. For more information see – www.sustainelectronics.illinois.edu
- *Waste Electrical and Electronic Equipment Directive*
  Globally the European *Waste Electrical and Electronic Equipment Directive* (the "WEEE" Directive) is the flagship scheme for the control and reclamation of electronic waste. It covers all electrical goods, both computers and every electronic appliances. Consumer electronic goods sold after 2005 are required to be collected by the companies producing or selling them – although most companies contribute towards industry-based schemes which organise the collection on their behalf through retailers and local authorities. For more information see – ec.europa.eu/environment/waste/weee/index_en.htm (contacts for each EU member can be accessed from this site).
- *Chinese RoHS/electronic waste law*
  In 2007, the Chinese government enacted the *Administrative Measure on the Control of Pollution Caused by Electronic Information Products* law. This law has many similarities to the European Union's Restriction on Hazardous Substances (RoHS) laws, and is intended to encourage more responsible waste disposal, provide better information on consumers of the hazards of certain goods, as well as providing an incentive for cleaner production.

For more information see – www.chinarohs.com

A practical guide to sustainable IT

This practical guide to sustainable IT offers a detailed, hands-on introduction to thinking about sustainable computing holistically; starting with the choices you make when buying technology, the software and peripherals you use, through to how you store and work with information, manage your security, save power, and maintain and dispose of your old hardware. Suggestions and advice for policy makers are also included, along with some practical tips for internet service providers.

Written by IT expert and environmentalist Paul Mobbs, the purpose of the guide is to encourage ICT-for-development (ICTD) practitioners to begin using technology in an environmentally sound way. But its usefulness extends beyond this to everyday consumers of technology, whether in the home or office environment. We can all play our part, and the practice of sustainable computing will go a long way in helping to tackle the environmental crisis facing our planet.

This is also more than just a "how to" guide. Mobbs brings his specific perspective to the topic of sustainable IT, and the practical lessons learned here suggest a bigger picture of how we, as humans, need to live and interact in order to secure our future.

The guide is divided into 12 sections (or "units"), with each unit building thematically on the ones that have come before. They can be read consecutively, or separately. The "unit" approach allows the sections to be updated over time, extracted for use as resource guides in workshops, or shared easily with colleagues and friends.

The guide has been developed on behalf of the Association for Progressive Communications (APC), with funding support from the International Development Research Centre (www.idrc.ca). It is part of a APC's GreeningIT initiative, which looks to promote an environmental consciousness amongst civil society groups using ICTs, and amongst the public generally. Other publications and research reports completed as part of the GreeningIT initiative can be downloaded at: greeningit.apc.org

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