The toxic legacy

Kevin Bridgen, David Santillo, Iryna Labunska and Paul Johnston discuss e-waste recycling in China and India…

We live in an electronic age. Although access and ownership vary greatly across the globe, few – if any – countries now remain untouched by the digital revolution. At over $1,000 per capita per year, spending on IT equipment in Europe, Japan and North America still far exceeds that in other parts of the world, though the fastest growing markets are now in Asia and South America. For example, whereas computer use globally almost doubled between 1993 and 2000, use in China increased more than 10-fold, with India, Russia, Brazil and Indonesia close behind.

Such explosive growth has had phenomenal impacts on society – the way we work, play and communicate. Some even hail the evolution of the 'paper-free office' as a major achievement in eco-efficiency. But, as with any revolution, there is a hidden side that is rather less attractive than the shining new computers and cell phones – an end-of-life inevitability we would probably all rather ignore: 'e-waste'.

Though barely acknowledged during the 20th Century, e-waste has come rather painfully into focus at the start of the 21st. Given our growing reliance on, and insatiable appetite for, electronic goods, it is not going to go away. All electronic devices have a finite lifetime, governed by the least durable components. However, the speed of new hardware and software developments render many devices technically obsolete well before they break down. Moreover, aggressive marketing and the 'must have' culture it has propagated mean that products become emotionally obsolete well before that. Specifications inexorably go up, prices come down. It has long been easier, and often cheaper, to buy new rather than upgrade old.

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The statistics are staggering:

- 183 million computers and 674 million mobile phones sold worldwide in 2004 (up 11% and 30% respectively on 2003);
- In the next three years, around 400 million computers will become obsolete, with more than 700 million new computers replacing them by 2010;
- Between 1997 and 2005, the average lifespan of a computer fell from six years to just two, and is already less than two for mobile phones.

From humble beginnings, e-waste has therefore become one of the world's fastest growing waste streams. In addition to the sheer complexity of modern electronics, their content of hazardous chemicals and materials also puts them among the most problematic. While plastic, metal and glass components may seem innocuous, they hide an array of toxic chemicals such as lead solder, cadmium-rich batteries, and even some mercury-laden switches and relays. Plastic casings and board resins commonly contain an amount of toxic and persistent halogenated (brominated or chlorinated) chemicals used as fire retardants. A device so sophisticated during its short lifetime all too soon becomes little more than an intractable composite waste.

So where does all the e-waste go? With the ever growing demands of a globalised IT economy, opportunities for re-use would seem vast. In practice, while re-use does account for a proportion of 'cast-off' mobile phones from richer nations, without dedicated refitting and upgrading, the re-use of IT equipment is likely to remain limited. In any case, periods of re-use for second-hand electronic products tend to be short, such that the overriding outcome of such seeming benevolence can simply be slightly delayed obsolescence coupled with transfer of the e-waste burden to countries that are even less able to cope.

By far the majority of e-waste ultimately enters the waste stream. Much still ends up in landfills or incinerators,

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which present their own problems for wastes rich in plastics, halogens and toxic metals. In Hong Kong (China), it is estimated that 10-20% of e-waste ends its life in a landfill. In the USA, some 4.6 million tonnes of electronics were landfilled in 2000 alone.

Recycling should be a better option. However, the very fact that most electronics comprise a heterogeneous and hazardous mix of components – designed for speed and miniaturisation, not dismantling and recycling – means that opportunities are limited here too. The separation and recovery of useful materials can be a difficult, resource-intensive and, all too often, dangerous task.

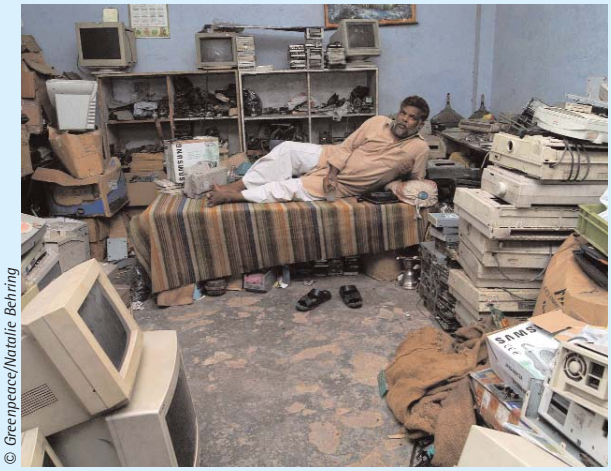
The mechanised separation available in some richer countries, under conditions that minimise workforce exposure to dusts and chemicals, handles only a small proportion of the global burden. For small items comprising myriad components, more wasteful bulk 'recycling' techniques such as smelting are often employed. After all, it is undoubtedly simpler to view a cell phone as a source of 20g of copper than a collection of 1,000 tiny components.

Overall, it has become clear that dedicated e-waste recycling systems established by some governments during the 1990s were unable to cope with the flood. Of the millions of discarded electronic goods remaining, irrespective of origin, the majority have since found their way to the many thousands of scrapyards located in poorer regions of the world, especially in Asia. In the last decade, market demand for electronic scrap as a source of raw materials has grown rapidly in India and China, where labour is cheap, working conditions rudimentary and manual dismantling financially viable. The sector has undergone explosive expansion, employing 25,000 workers and handling 10,000-20,000 tonnes of e-waste per year in Delhi alone, dispersed among innumerable backstreet workshops and yards.

It is in yards like these, in which e-waste is dismantled and processed in often appalling conditions, frequently by children, that the nightmare consequences of unsustainable production and consumption of electronics are fully realised. Here, recycling can mean burning the plastic coating from copper wires over open flames, melting lead solders on hotplates in unventilated workshops or dipping circuit boards into open vats of concentrated acids. Protective clothing is conspicuous in its absence; and measures to protect the environment, likewise. After a hi-tech start in life, the final days of a computer can be distinctly low-tech.

In the early part of 2005, Greenpeace conducted a study[1] into workplace and environmental contamination in and around typical recycling workshops in New Delhi and in Guiyu (Guangdong Province) in southern China. In both regions, component separation, plastic shredding, acid processing, open burning and residue dumping are typically conducted in small, poorly regulated workshops.

An analysis of industrial wastes, dusts, soils, river sediments and groundwater from both regions confirmed that these activities can severely contaminate the workplace and surrounding environment. For example, dusts collected from solder recovery workshops in China and a battery



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dismantling workshop in India contained levels of lead hundreds of times higher than those typical for indoor dust. This latter dust also contained the toxic and carcinogenic metal cadmium at 40,000 times typical levels. Persistent organic pollutants were also commonplace, including the highly toxic and bioaccumulative polychlorinated biphenyls (PCBs) and polybrominated diphenylethers (PBDEs), both of concern for their developmental toxicity and hormone disrupting properties.

Aside from the commercially valuable metals recovered, the processing of electronics generates wastes of little or no worth, typically discharged to surface waters without further treatment or dumped in makeshift landfills in an uncontrolled manner. For example, corrosive wastewaters from acid dipping of components to recover valuable metals such as copper and gold contained very high concentrations of antimony, cadmium, copper, nickel and tin. Wastewaters from circuit board shredders in Guiyu pollute waters and sediments adjacent to the workshops with a diversity of heavy metals and toxic organic chemicals, including PBDEs, estrogen-mimicking alkylphenols and the flame-retardant triphenyl phosphate (TPP), acutely toxic to aquatic life.

The haphazard dumping of residual plastics and other unwanted materials was frequently accompanied by open burning, generating ashes enriched with leachable heavy metals, chlorinated benzenes, brominated toluenes and traces of the most toxic chlorinated dioxins (TCDD), as well as complex mixtures of other compounds of which only a fraction could be identified.

Even where no overt releases were apparent, chemical contamination was detected beyond the workplace. In India, some persistent chemicals found in dusts from dismantling workshops were present in street dusts from the same district, though not in other areas. A preliminary investigation in China indicated that solder recovery workers may bring lead from the workplace into their homes.

Though merely a snapshot, this study illustrates the severity of health and environmental risks typical of the sector. Evaluations of the full impacts are long overdue. So far, it has been all too easy to turn a blind eye.

Governments are at least beginning to rise to the challenge. In November 2002, officials from eight Asian countries, including China and India, met[2] to discuss solutions, including some directed at electronics manufacturers. But in practice, little has changed. Despite a ban on imports to mainland China since 2000, e-waste is still routinely exported from Europe, North America and elsewhere to Guiyu and other centres of the recycling trade. In 2003, an estimated 23,000 tonnes of e-waste was exported illegally to Asia and Africa from the UK alone.

At the same time, the dangerous and polluting activities in the recycling yards continue. The case for immediate action to improve workplace health and safety and introduce proper waste management is compelling. But as long as new electronics are manufactured using hazardous chemicals and with little regard for dismantling and material separation, toxic exposure will remain inevitable.

New European Directives[3] go some way towards addressing the problem, though they are regional and cover only a fraction of the hazardous chemicals in use. Some leading companies have already gone further by pledging to phase out a wider range of toxic chemicals. Nevertheless, without strong and consistent regulatory pressure, progress throughout the sector will remain slow.

The electronics revolution should support greater eco-efficiency, clean production and the sustainable use of resources. The avoidance of hazardous materials, combined with company responsibility for end-of-life products (through take-back/leasing schemes or by contributing to well regulated collection, separation and recycling programmes), would mark an enormous step in that direction. The legacy of our wasteful past would remain. But from here on, at least, the demon of e-waste could begin to be tamed.

1 www.greenpeace.org/international/press/reports/recyclingelectronicwasteindiachinafull.

2 Under the auspices of the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal.

3 Directives on Waste Electrical and Electronic Equipment (WEEE) and related Restrictions on Hazardous Substances (RoHS).

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