SHORT CIRCUIT:

The Lifecycle of our Electronic Gadgets and the True Cost to Earth

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Author: Philippe Sibaud, co-authored by The Gaia Foundation, edited by Amy Woodrow Arai.

Commissioned by: The Gaia Foundation
6 Heathgate Place
Agincourt Road
London NW3 2NU
United Kingdom
Tel. +44 (0)207 428 0055
Fax. +44 (0)207 428 0056
www.gaiafoundation.org

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Flysch in the Basque Country, Zumala / Shutterstock

DEDICATED TO THE ELEMENTS OF OUR EARTH

For us modern people, you are merely the 'chemical elements'. We consider you inanimate, dead, not worthy of a point of view. We've never given you thanks. Who cares about lifeless rock and air? But an ancient awareness stirs and grows in the face of the global crisis - that you are people; animate proto-beings, tiny atomic persons. The stuff of life. And so we do, after all, owe you thanks. Your quantum entanglements, your ultra sub-microscopic machinations your repulsions, and your love affairs, the sum of all your doings, create the vastness of the Universe and the shining, turning, deep blue-marble Earth in which we live, breathe and have our being.

Praise, then, be to carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur - the very elements of our physical bodies. We are made of you. Our every mood, our every conversation, our thoughts, our longings prefigure in your yearning for completion as you swap and share tingling electrons - those even tinier sub-atomic persons. Our consciousness and yours are consanguineous – we share the same cosmic quantum blood. You are our ancestors, our foundation. And so too of the air, the oceans, the bacteria, algae, plants, fungi and animals.

You flare forth in the consciousness of singing whales, the eerie intelligence of octopus, in elephant dreams, in our dreams. Praise be to those amongst you whom we mine with such abandon and with such destruction: you are the stuff of mountains, of deserts, of planets. You: tantulum, chromium, arsenic, aluminium, antimony, gallium, manganese, molybdenum, magnesium, tin and iron. You and your brothers and sisters, we praise you all.

And yet we denigrate you, we rip you out of your earthly homes in mineral veins. We crush you out of rock with scathing acids and searing heat. Do you rage, nitrogen, when we suck you from the swirling air into our fertilizers to be dumped on our fields, causing mayhem in the rivers and oceans? Elements, do you rage when we enslave you, when we disrespect your elemental rights, your needs? When we process you like dead stuff, when we mould and squeeze you into unnatural circuit board associations, like distant tribes forced to live together far from their natural homelands? Press-ganged into our service in shiny electronic devices, do you suffer the greed and madness of our culture? Are you the final recipients of our darkest shadow selves?

So how shall we treat you, oh elements? A melding of science and indigenous wisdom urges us thus: to implore the sacred Earth with ritual and ceremony for permission to extract you from her living flesh, as we must do to survive. To deploy our best science to calculate how many of your atoms and molecules we can safely take without upsetting the self-regulating dance of our living planet. To design recycling processes that keep you safely out of the biosphere in perfect closed loop cycles. But above all, oh flesh of our flesh, let us revere you truly as persons and beings of Earth. Let us recognise the fundamental, elemental right for as many of you as possible to stay in the ground and out of our clutches, the subterranean guardians of our world.

By Dr. Stephan Harding

Electronic waste / Shutterstock

ACKNOWLEDGEMENTS

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We stand in solidarity and offer this report to inspire us to rethink our relationship with our electronic gadgets and the way they are made; and to live our lives with respect for our only home - the Earth.

ABBREVIATIONS / ACRONYMS

ADB	Asian Development Bank
ASGM	Artisanal and Small-Scale Gold Mining
AMD	Acid Mine Drainage
BAN	Basel Action Network
CRESC	Centre for Research on Socio-Cultural Change
CEO	Chief Executive Officer
CIMA	Committee for the Integration of the Colombian Massif
DIY	Do-It-Yourself
DRC	Democratic Republic of the Congo
EEE	Electrical and Electronic Equipment
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
ETBC	Electronics TakeBack Coalition
EU	European Union
FARC	Revolutionary Armed Forces of Colombia
FLA	Fair Labour Association
FMS	First Majestic Silver Corporation
GAIA	Global Alliance for Incinerator Alternatives
GDP	Gross Domestic Product
GNP	Gross National Product
GHG	Greenhouse Gases
HP	Hewlett-Packard
HPI	Happy Planet Index
IPE	Institute of Public and Environmental Affairs
ICGLR	International Conference on the Great Lakes Region
ITU	International Telecommunication Union
KML	Katanga Mining Limited
LBMA	London Bullion Market Association
LCD	Liquid Crystal Display
LBMA	London Bullion Market Association
LME	London Metal Exchange
MEG	Metals Economics Group
MRB	Minera Real Bonanza
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PIC	Prior Informed Consent
POP	Persistent Organic Pollutants
PCB	Printed Circuit Board
PwC	PricewaterhouseCoopers
RAID	Rights & Accountability in Development
REE	Rare Earth Elements
RSA	Royal Society for the encouragement of Arts, Manufactures and Commerce
SEC	Securities and Exchange Commission
StEP	Solving the E-waste Problem
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USGS	United States Geological Survey
WGC	World Gold Council
WTO	World Trade Organisation

TECHNICAL GLOSSARY

$	All dollar denominations in US dollars
£	Pounds Sterling
CO2-e	Kilograms of Carbon dioxide equivalent
g	Grams
Kg	Kilograms
Km	Kilometres
KWH	Kilowatt hour
Li-Ion	Lithium Ion
Mt CO2-e	Millions of Tonnes Carbon Dioxide Equivalent
NiCd	Nickel-Cadmium
NiMh	Nickel metal hydride
PBDE	Polybrominateddiphenyl
TBBA	Tetrabromo bisphenol-A
Tonne/Ton	Metric Tonne

DEFINITIONS

Mobile-connected devices

Mobile internet connected devices such as smartphones, tablets, laptops and internet-capable phones.

POPs (persistent organic pollutants)

Organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they persist in the environment, are capable of long-range transport, build up in human and animal tissue, concentrate in food chains, and thus have potential significant impacts on human health and the environment. The Stockholm Convention on POPs is an international environmental treaty that aims to eliminate or restrict their production and use.

Mobile data traffic

The amount of data used while using mobile connected devices. Includes activities such as browsing the web, reading and sending e-mails, checking social media such as Facebook and Twitter, sharing photos, downloading applications, downloading music, listening to online radio and watching video sharing websites such as YouTube.

Information technology (IT)

The term is generally used to describe the application of technologies that store, transmit, receive and manipulate digital information, such as computers, computer networks, telephones and televisions. The industries associated with information technology include computer hardware, software, electronics, semiconductors, internet, telecom equipment, e-commerce and computer services.

Rock blasting in open cast mining quarry / Shutterstock

EXECUTIVE SUMMARY

The 2012 report *'Opening Pandora's Box: The New Wave of Land Grabbing by the Extractive Industries and the Devastating Impact on Earth'*, by The Gaia Foundation in collaboration with our allies, shows how land grabbing for the expanding extractive industries is increasing around our planet at an alarming rate and scale. The report takes a critical overview of global trends, demonstrating that a new global mining land grab is being facilitated and exacerbated by the convergence of economic, geological and technological factors.

Demand continues to be stimulated and promoted by the 'endless-economic-growth' model, in a drunken illusion that our planet's precious metals and minerals are infinite. Whilst this juggernaut continues unabated, irrefutable evidence shows that we are pushing our planet to the edge, resulting in mass species extinction, climate change, water depletion and more (see the Millennium Ecosystem Assessment and the Planetary Boundaries Study, page 13).

In addition, the depletion of the planet's more concentrated deposits of ore means that the extractive industries now dig up more earth - affecting ecosystems, plants, animals and water supplies - in order to extract the same volume of metals and minerals as before. For example, copper ore deposits today are typically one-tenth the purity of those mined a hundred years ago. A single gold wedding ring requires the extraction of approximately 20 tonnes of earth, or rather living ecosystems. The economic and depletion crises have stimulated developments in technology which now enable companies to mine deposits that were previously considered economically or politically unviable. Across the global North and South, the extractive industries are delving into new ecosystems and virgin territories, new depths of Earth and Sea, and exploiting the lands of local communities and protected areas.

As 'Opening Pandora's Box' illustrates,the social and ecological impacts of mining are becoming more and more devastating and unacceptable. On our current trajectory, we appear to be willing to allow ourselves to dig the Earth - our Source of Life - out from under our feet. It seems that we have not yet fully grasped the severity of the consequences of our actions for life on Earth and for future generations.

One of the major drivers of this global mining craze is the electronics industry, underpinned by our throw-away consumer culture. This new 2013 report - *'Short Circuit: The Lifecycle of our Electronic Gadgets and the True Cost to Earth'* - tells the second part of the story, and brings the analysis closer to home.

'Short Circuit' shows that our myriad electronic gadgets, (and the system that creates them), are stimulating the growing demand for metal and mineral extraction. It invites us to reassess and become conscious of what we really value in life, and to become part of a critical mass for change.

In recent years, technological developments in digital communications have led to a huge increase in the personal ownership of mobile devices, in particular, small, portable internet devices such as smartphones, tablets and laptops. These machines are fast becoming indispensible parts of everyday life. The number of mobile devices is projected to continue to increase - on course to exceed the number of people on Earth by the end of 2013. And this is only the beginning: *per capita* ownership is expected to reach 1.4 in 2017, representing a total of 10 billion devices.

Today, marketing strategies have created a culture of rapid technology upgrades, so that the time periods between purchasing new items are becoming shorter and shorter. They are often replaced by newer models after 18 or even 12 months, as a matter of course. Their slick designs are alluring but quickly out-dated, their colourful retina screens soon to be replaced by ever-more sharp and tantalizing displays.

This inbuilt obsolescence is one of the means by which electronics companies can ensure a perpetually hungry market. Many mobile phones have embedded batteries that are difficult to replace; when computer components break they usually cannot be easily removed and fixed; and hardware is not designed to keep up with software. Increasingly, it is cheaper to buy the new version than to fix the old one. These strategies are effective techniques for increasing sales. This has quickly become a habit which is hugely wasteful, and requires more and more elements from the Earth to be found, extracted, processed and then marketed - generating pollution at every step along the way, and ultimately ending up in toxic dumps.

The thinner and sleeker the design of our gadgets, the greater the illusion surrounding their real impact, and their true cost. Smaller does not equate to the product being 'lighter' on the Earth, because every new model requires the use of yet more resources and energy and the extraction of more specialised elements.

The materials that make up these gadgets are dug out from the body of our Earth and involve a complex and trans-national supply-chain. A mobile phone is made up of many types of metal, including copper, tin, cobalt and gold. Huge amounts of Earth are displaced and spoilt, biodiversity is destroyed, vast quantities of water are used for processing, and precious fossil fuels are squandered for energy at every stage of its extraction. As a result, enormous areas of toxic wasteland are created and left for future generations to deal with – and this is *before* the products have even been manufactured. These items are still yet to be made, marketed, purchased, used, and then dumped when the next version hits the market. And so the short circuit continues on, relentlessly...

All those involved in the supply chain - from mining companies to manufacturers, as well as us 'consumers' - either presume that there will be an infinite supply of metals and minerals required to build these products, or choose to turn a blind eye to the reality of the situation. This short-sighted way of thinking epitomises much of our modern economic and financial systems and approaches. In addition, finding these elements from the Earth is becoming highly politicised, with nations vying for territorial access and control of ever more remote areas, with frequently bloody results. Neither companies nor governments are taking serious steps to reduce the need for new mining, nor to improve systems for the recycling of all these metals and minerals.

As a result, the electronic waste (e-waste) produced by these throwaway gadgets is piling up. The vast majority of the world's e-waste currently ends up dumped or burned, contaminating air, water and soil. It is estimated that only a small amount of the world's e-waste is properly handled in recycling processes. Instead, the majority of 'recycled' electronic goods are shipped to Asia or Africa where they are 'recycled' in appalling social and environmental conditions, creating massive pollution, human health problems and water and soil contamination. In failing to create effective recycling systems, we are thus outsourcing our toxic waste and turning parts of the world into 'digital dumps'.

With the lifespan of electronic goods becoming shorter, and the extraction of the mineral and metal elements which make up these gadgets ever more destructive, it is clearly time for the electronics industry to take responsibility for developing a new approach. The depletion of our planet's minerals and metals; the horrific scale and intensity of our capacity to gouge deep toxic wounds in the body of our Earth; the geopolitical scramble for control of ever more expensive and profitable Earth materials; and the volatility of commodity prices, make a new approach not only ethical, but a financial imperative for companies too.

The linear model of 'take-make-dispose', is not sustainable on a finite planet. Designing for recyclability is critical – we must close the loop. In order to do so, we have to face a number of challenges. The manufacturing process for these products must be designed to ensure there is no waste from start to finish. Furthermore, those who manufacture must be responsible for ensuring their products can be completely recycled. And lastly, during the lifespan of each product, its components must be removable, repairable, and easy to take apart for recycling. This new approach to product design must be integrated into effective and efficient recycling systems that can recover our Earth's precious metals and minerals at each stage of the cycle, with a minimum of energy and pollution.

This essential transition is already beginning to happen. Production strategies - ranging from extended producer responsibility to 'closed-loop' or 'circular economies' - are being pursued by innovative organisations and individuals. These have much to teach us and pave the way forward for future creativity and transition.

So we *do* have a choice. We know our Earth's precious materials are finite. They will come to an end. We are therefore hurtling towards a precipice with two possible scenarios: we wait until vital elements for our gadgets run out and we are forced to mine our own refuse as the only source left. Or we have the foresight to change the whole system before it is too late - from extraction to the end of the lifecycle of everything we use. This is entirely possible if we focus our human ingenuity on the challenge.

There is also a bigger challenge here, because from the Earth's point of view, as a living system, we know that we have already pushed her beyond her capacity to maintain the dynamic equilibrium she has been able to sustain for millennia. It was during this period that the enormous diversity of species evolved, from which humans emerged.

It is we humans who have managed to destabilise her climate and create mass species-extinction in a matter of a few hundred years - a split second in Earth time. If the rate and scale of extraction of minerals, metals and water - and the toxification of vast ecosystems continues - the predicted collapse of ecosystems will very likely be triggered also. Then we will be asking very different questions...

We therefore need to address our consumption and the true drivers behind it. The necessary transition is two-fold: we must make changes to the way in which we take from the Earth and produce our gadgets; and we must re-direct our ingenuity and consciousness to minimise the number of gadgets we use, as well as designing systems for re-use.

With a growing global population there simply isn't enough to go around and for everyone to continue to 'consume' electronic gadgets in the way that we do now. Additionally, we would do well to consider the mounting evidence which shows that accumulating more 'things' does not make us happy. Owning more 'stuff' is not the route to a fulfilling and happy life, (see Happiness and Well-Being on page 80). And this is critical to understand, because the ultimate choice is between the living planet that sustains us with food and water and clean air, or continued rapacious consumption which pushes her ecosystems to the edge. The more we take, the quicker we reach the tipping point.

The answers are emerging daily across the planet. The next generation, who are faced with the legacy of our inertia, are already taking action, as we see from the myriad of social movements across the planet: from Occupy, to Food Sovereignty, to the growing community resistance to mining everywhere. It is when enough people stand up and take action that things change.

The aim of this report is to inspire us to take action – wherever we are in the system. Once we can see the true costs behind electronic items, which have become so integrated into our lives, we can re-evaluate their value and make informed choices.

Initiatives and insights such as '*The New Materialism*', the *Gift Economy* and *Transition Towns*, are part of the next era. They are all expressing ways in which people, communities and organisations are taking practical action to improve our quality of life without depleting the Earth's gifts and pushing our planet beyond her limits.

'*Short Circuit*' exposes a supreme irony – as we get more virtually connected to each other we are becoming more disconnected from what is happening under our feet, to the very source of our lives: our Earth. The tools that supposedly bring us greater and faster connection to our friends, family and work, are at the same time powerful symbols of our deepening disconnection from those living processes which actually sustain all of our lives. This calls for us to question our cultural addiction to throwaway consumer electronics.

We invite you to join the dots, to close the loop, to insist on the redesign of the lifecycle of electronic products and to think twice before you buy: do you really need the new model of this gadget? Can you repair it or share your electronic products? Above all, how can we all reconnect with the Earth processes that sustain all life on Earth, not just our own?

This is our vital task now, for the sake of the children of the future.

Mountain River in Riverside Park, North Vancouver, British Columbia, Canada / Shutterstock

CAN WE CHANGE OUR HUMAN LEGACY?

How One Species is Pushing Earth - our Planetary Life Support - to the Edge

Numerous scientific studies have shown conclusively that we are pushing the critical functions and ecosystems of our Earth to the edge. Here are two key examples:

The Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MEA) released in 2005, was commissioned by the UN to assess the conditions and trends of our planetary ecosystems. It was an international synthesis of the work of more than 1,360 of the world's leading biological scientists and experts. Its analysis of the state of Earth's ecosystems provides guidelines for governments and policy makers to inform the necessary actions for ecosystem conservation. It concluded that human activity is having a significant and escalating impact on the biodiversity of Earth's ecosystems, reducing both their resilience and biocapacity. The overall conclusion drawn was that: "Human actions are depleting Earth's natural capital, putting such strain on the environment that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted."[i]

In the field of biodiversity the MEA observed that since 1960, 35% of mangroves and 20% of coral reefs have been lost entirely; the amount of water stored by dams is three to six times that currently flowing through rivers; genetic diversity has declined globally and, "humans have increased species extinction rates by as much as 1,000 times background rates that were typical over Earth's history."[ii]

Despite this overwhelming body of evidence however, "the predominant paradigm of social and economic development remains largely oblivious to the risk of human-induced ecological disasters at continental to planetary scales".[iii] Allowing this state of affairs to persist will sign away any hope of a viable future for the generations to come. We are all standing on the front line of a precipice, and business as usual means throwing ourselves off the cliff.

The escalating scale and rate of extraction from the body of our Earth in the last few years is therefore quite literally suicidal. If enough of us wake up in time we can avert leaving a legacy of disasters for the next generation. Every step we take counts.

Planetary Boundaries Study

The Planetary Boundaries study was conducted by 28 internationally renowned scientists in 2009.[iv] The question for this study was to identify our planet's tipping points, in order to try to avert abrupt and potentially catastrophic ecological collapse. It set out to try to establish a "safe space for human development" which if respected, would allow Earth, and thereby humanity and other species, to thrive.

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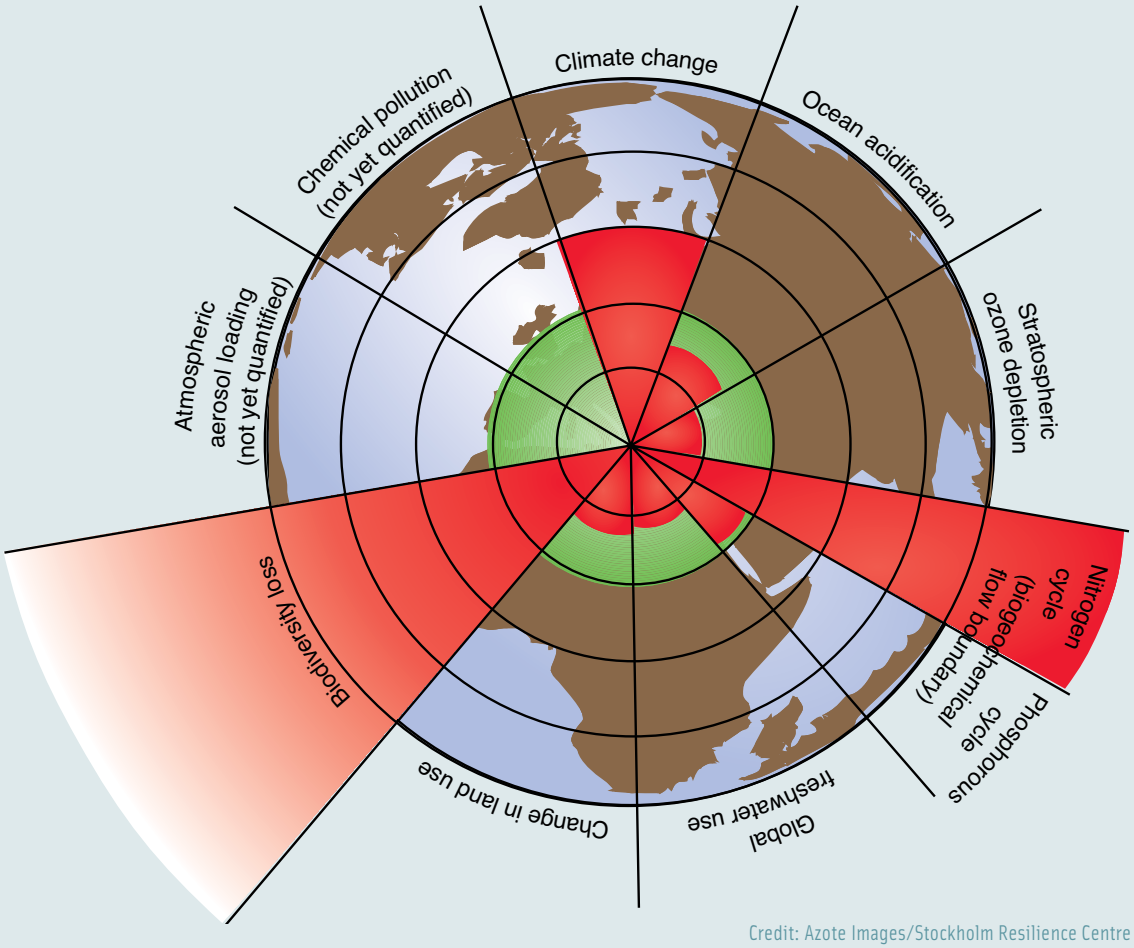
i See: http://www.unep.org/maweb/en/About.aspx#2
ii MEA (2005) Ecosystems and Human Well-Being: Biodiversity Synthesis. p.3-5. World Resources Institute. Available at: http://www.unep.org/maweb/documents/document.354.aspx.pdf
iii Stern, N. (2007) The Economics of Climate Change – The Stern Review. Cambridge University Press, Cambridge, UK.
iv Rockstrom, J. et al. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Available at: http://www.ecologyandsociety.org/vol14/iss2/art32/

The boundaries were identified as:

• Stratospheric ozone depletion	• Freshwater consumption and the global hydrological cycle
• Biodiversity loss	• Change in land use
• Chemical pollution	• Nitrogen and phosphorus inputs to the biosphere and oceans
• Climate change	• Atmospheric aerosol loading
• Ocean acidification	

The scientists found that three of the nine boundaries quantified thus far had already been transgressed. Thresholds for climate change, rate of biodiversity loss (or rather extinction), and changes to the global nitrogen cycle have been breached considerably, increasing the likelihood of irreversible ecological damage. Transgression of the threshold for climate change for example, has led to, amongst other things, significant retreats of sea ice and glaciers worldwide; rising sea levels; increasing coral reef bleaching and mortality; and a rise in the number of floods.



Credit: Azote Images/Stockholm Resilience Centre

The diagram (above) illustrates the nine planetary boundaries, which collectively delineate a safe operating space for humanity. According to the analysis, three boundaries have already been crossed associated with climate change, disruption of global cycles and, most notably, loss of biodiversity.

Given the interrelatedness of these boundaries, breaking through the threshold of one has serious consequences for the other eight, the responsibility for which can be clearly laid at the feet of humanity. In what the report's authors have termed the 'Anthropocene', we are the main drivers of changes in the Earth System and must therefore take responsibility as the culpable members of the Earth community.

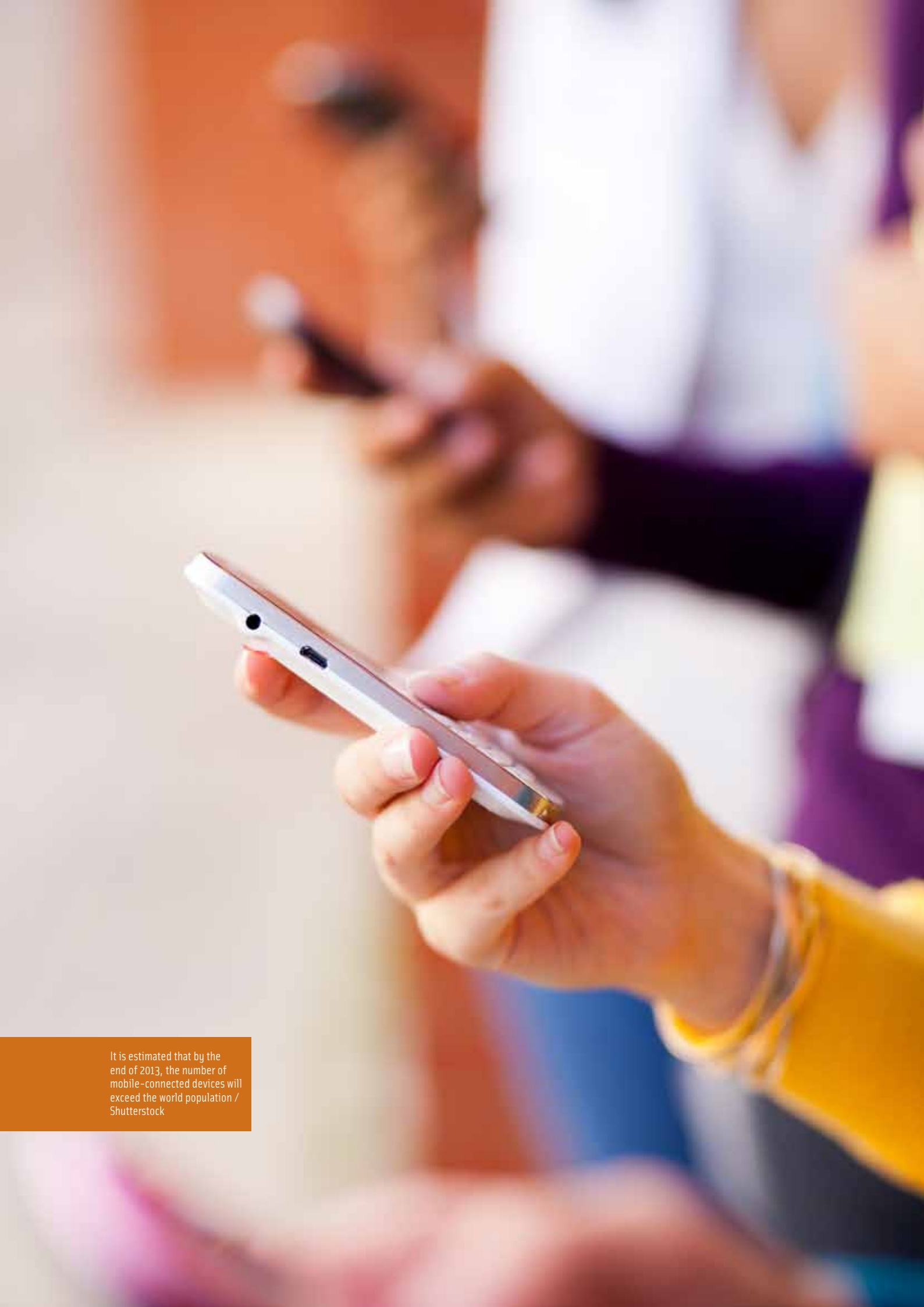
Drawing on this research, Peter Roderick, a public interest lawyer in the UK, proposed a draft United Nations Declaration on Planetary Boundaries[v] in 2011 which would recognise and respect the necessary Earth-system processes which sustain all life, and promote responsibility for safeguarding these processes from serious or irreversible damage.

In 2012 Kate Raworth from Oxfam proposed combining the concept of planetary boundaries with that of social boundaries, as they are essentially interdependent. Her report: *'A Safe and Just Space for Humanity: Can we live within the doughnut?'*[vi] explains that the safe and just space for humanity to thrive in is within the planetary boundaries or ceiling and above the 11 social boundaries (which include food, water, equity, resilience and having a voice). This area is shaped like a doughnut. However today we are in breach of 8 of the 11 social boundaries, particularly access to food and gender equality. Raworth argues that any vision of sustainable development for the 21st century must recognise that eradicating poverty and achieving social justice must be addressed within the boundaries of our Earth's ecosystem.

THE DOUGHNUT OF PLANETARY BOUNDARIES AND SOCIAL BOUNDARIES

Raworth. K. (2012) A Safe and Just Space for Humanity: can we live within the doughnut? Oxfam Discussion Paper. Oxfam International: Oxford.

v See: http://planetaryboundariesinitiative.org/
vi See: http://www.oxfam.org/en/grow/policy/safe-and-just-space-humanity



It is estimated that by the end of 2013, the number of mobile-connected devices will exceed the world population / Shutterstock

INTRODUCTION

It is Saturday morning and Paul is leaving his favourite store. Under his arm, the latest offering from a famed electronics company: the new tablet computer. Definitely worth the expense, he thinks. He has been convinced by the new retina screen display and he doesn't think twice about discarding his last item, bought just 18 months before. His mind is full of images of fancy new apps and he can't wait to see the screen bursting with colours and near-perfect definition. Priceless!

Across the world, millions think just like him; there is something infinitely chic and refined about these pieces of technology, something clean and pristine, immaculate and incredibly appealing, the dawn of a new time. Infinite lines of communication available at a click, a constant stream of news, photos, shopping deals, movies, songs, games …the list is endless. It is believed that 7.8 trillion text messages were exchanged in 2011[1] and estimated that mobile data traffic will increase 13-fold between 2012 and 2017.[2] These devices have endless possibilities and are instruments of the future; having one places the happy owner amongst the trailblazers of that future.

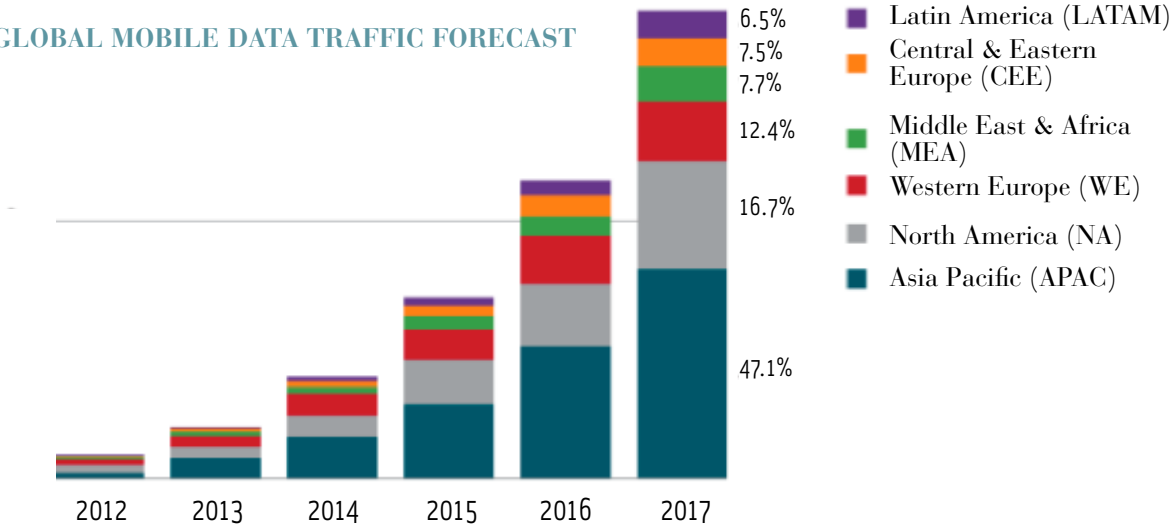
These machines are life-saving and life-changing sometimes too, especially in Africa where mobile phones have become an essential tool in reaching rural populations with no access to electricity, landlines or computers. More than half the population in Africa now owns a mobile phone, with m-banking and m-government enjoying massive expansion.[3]

It is believed that 7.8 trillion text messages were exchanged in 2011 and estimated that mobile data traffic will increase 13-fold between 2012 and 2017.

Furthermore, Africa and the Middle East will enjoy the strongest mobile data traffic growth of any region between 2012 and 2017, with rates increasing 17.3-fold over the forecast period.[4]

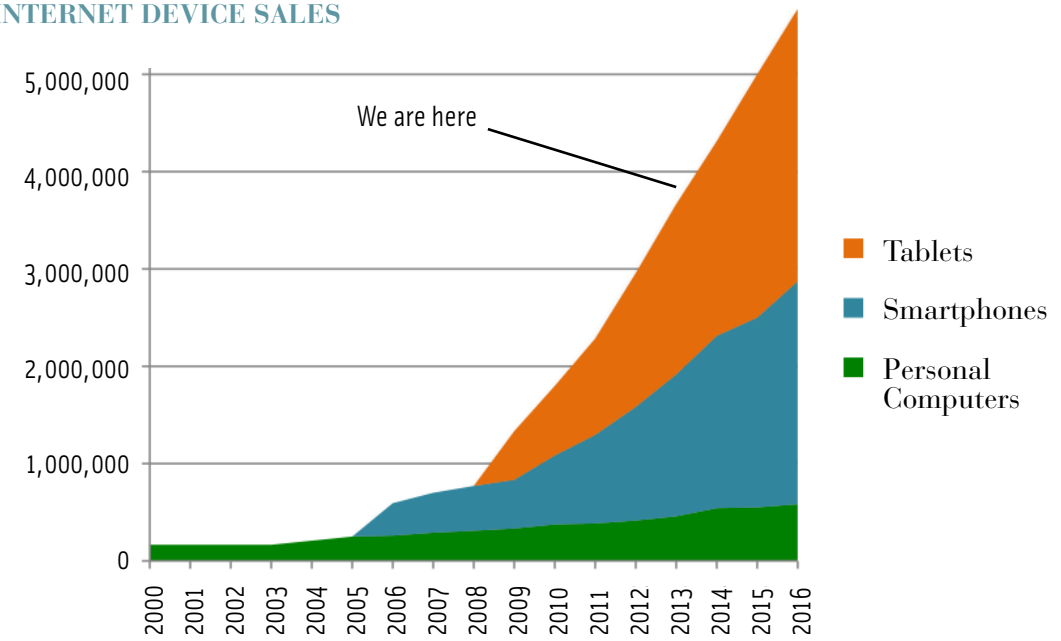
Access to mobile networks is now available to 90% of the world's population, and to 80% of the population living in rural areas, according to the ITU World Telecommunication/ ICT Indicators database.[5] There are now 5.9 billion mobile phone subscribers in the world (87% of the total global population)[6] and by the end of the year 2013, the number of mobile-connected devices will exceed the world population. This is only the beginning: *per capita* ownership is expected to reach 1.4 in 2017, representing a total of 10 billion devices,[7] with sales on a steep ascending curve until then, especially for smartphones.[8]

1. GLOBAL MOBILE DATA TRAFFIC FORECAST



Data Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017, p.6.

2. GLOBAL INTERNET DEVICE SALES



Data Source: Business Insider - The Future Of Mobile. Data Collected from: Gartner, IDC, Strategy Analytics, Company findings BI Intelligence Findings. p.6.

As priceless as these products seem, Paul does not realise their true costs. The slick design is alluring but quickly outdated, making way for 'new' and 'improved'. We are enthused by their physical aspect - a big part of the marketing proposition - but we are totally oblivious to their physical reality: the Earth processes involved in producing them, the many raw materials dug out from the Earth without which they cannot exist. This is disconnection at its rawest. It is a supreme irony: disconnection increases as we get more 'connected'!

These products are made of materials extracted from the body of the Earth with countless humans participating in the design, production and manufacture of a multitude of components coming from all corners of the planet. As Annie Lennox discovers in her book, *The Story of Stuff*, *"It is impossible to know the exact locations where all the components of a laptop were drilled for, mined, or made, because of the increasingly complex supply chain of the electronics industry, which the UN reports has the most globalized supply chain of all industries"*.[9]

These compact machines accrue huge amounts of unseen baggage in their production, baggage known as an 'ecological rucksack'. According to some calculations, a 20kg computer carries an ecological rucksack of 1,500kg of environmental resources used in the manufacturing process.[10] An 'ecological rucksack' is the total quantity (in kg) of materials removed from the Earth to produce a product, minus the actual weight of the product. Essentially each and every purchase of these machines has an impact on Earth.

And what of the after-life of these products? When our electronics are discarded, where do the products go? And where do the chemicals end up? Producing these items is only half the problem. Only a small amount of phones are currently being properly recycled - the impact of which is truly staggering. The huge amount of e-waste generated every year, estimated at 20 to 50 million tons, carries with it the legacy of all the toxic materials used in production: brominated flame retardants, lead, cadmium, plastics, and mercury among others. A semiconductor fabrication plant (factories where microchips for electronics are made) can use from five hundred to a thousand different chemicals.[11] High tech is anything but clean and ultimately the Earth and future generations will pay the price.

So, just as the Fairtrade movement has successfully managed to make the link between a bag of coffee in the local supermarket and the producers of that coffee on the other side of the world, uncovering the human and Earth stories, we need to make the connection between our electronic gadgets and the many stories leading back to Earth. We need to realise that however impressive and flashy high tech is, like everything, its origins are firmly and deeply rooted in the Earth. Being wasteful and complacent about the manufacture, consumption and disposal of these machines can only be characterised as Ecocide, as well as harmful to the future survival of life on Earth.[12]

ECOCIDE

"The mass damage, destruction to or loss of ecosystems of a given territory, whether by human agency or by other causes, to such an extent that peaceful enjoyment by the inhabitants of that territory has been severely diminished."

There is wide scientific agreement that the extent of human interference with the Earth system and the scale of the expanding extractive industries will continue to have increasingly dangerous consequences. Humanity has stepped out of what has been called a 'safe operating space' and has exceeded at least three defined planetary boundaries.[i]

Ecocide - the extensive destruction of ecosystems - is occurring today across the world. Some examples are:

- Significant pollution whether deliberate or incidental – such as oil dumping and spills. For example the oil spill in the Gulf of Mexico in 2010.
- Open cast mining where entire landscapes are removed – as is the case with oil sands and many coal and gold mining operations. For example Tar Sands extraction in Alberta, Canada.
- Large-scale land use change that causes the direct destruction of habitats – as is the case with deforestation in most tropical rainforests. For example the destruction of the Amazon Rainforest for logging, mining, crop planting and beef production.

Motivated by the realisation that Earth and her right to life are being violated, Polly Higgins, British lawyer-turned-campaigner, proposed to the United Nations in 2010 that Ecocide should be recognised as the fifth International Crime Against Peace alongside Genocide, Crimes Against Humanity, Crimes of Aggression and War Crimes.[ii] Higgins argues that, just as a human right to life is governed by the crime of murder (at an individual level) and Genocide (at the collective level), the Earth's right to life should be enforced by a crime of Ecocide. Furthermore, it should be recognised that there is an integral link between destruction of ecosystems and a breakdown in social relationships which lead to conflict and war.

Higgins argues that at present, environmental law is limited in preventing the destruction of Earth, because it fails to hold corporations to account for crimes against Nature. Thus, founded upon a duty of care to Earth, the proposed crime of Ecocide would hold directors of corporations and Heads of State personally responsible for their actions under 'strict liability', regardless of fault. Legal action could be brought on behalf of inhabitants, whether human or another species within the wider Earth Community, creating a legal foundation to criminally punish responsible persons and put a stop to practices giving rise to Ecocide.

The vision of the Eradicating Ecocide campaign is for a law of Ecocide to be fully implemented by 2020. When Ecocide is recognised as a crime under international law, it will have a profound effect on governments and industries blamed for widespread damage to the environment (e.g. fossil fuels, mining, agriculture, chemicals and forestry).

Ecocide ultimately serves as a preventive law to our current trajectory of increasing use of Earth's gifts, and encourages the necessary transformation of businesses to work in service for the planet rather than destroy her.

A crime of Ecocide is imperative at a time when Earth and her life forms are being damaged by human activities based on greed, and which threaten the survival of our planet both today and for future generations.

For more information see: www.eradicatingecocide.com

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i Rockstrom, J. et al. (2009) *Planetary Boundaries: Exploring the Safe Operating Space for Humanity* Available at: http://www.ecologyandsociety.org/vol14/iss2/art32/

ii Jowit, J. (2010) 'British campaigner urges UN to accept 'ecocide' as international crime' The Guardian [online] April 9. Available at: http://www.guardian.co.uk/environment/2010/apr/09/ecocide-crime-genocide-un-environmental-damage

Kennecott Bingham Canyon Mine / Hemera / Thinkstock

1. A PAINFUL BIRTH
Mining and Manufacture

WHAT'S IN IT?

Finding out exactly which materials constitute our basic smartphones or laptops is currently very difficult for two reasons:

1. **Competitive advantage:** to maintain their competitiveness, companies hide behind proprietary information (or trade secrets) so as not to divulge their processes or the materials that go into their products.

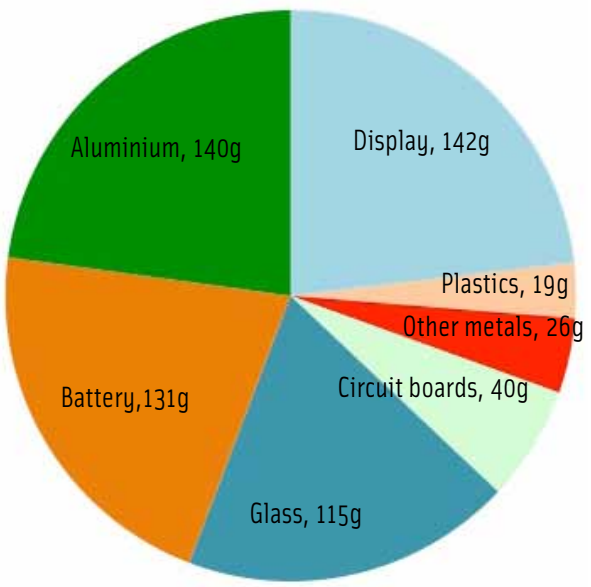
2. **Obscure Supply Chains:** as seen earlier, the electronics industry is the most globalised in the world. The making of these gadgets involves dozens of countries and hundreds of companies.

This latter point is emphasised by Eric Williams, an assistant professor of civil engineering at Arizona State University who has done extensive research into computer supply chains: *"HP [Hewlett-Packard] or Dell computers basically don't have anything HP or Dell inside them…[Those companies are] designers of computers, purchasers of components, and assemblers. They may even contract out the assembly"*.[13] Similarly, the Asian Development Bank recently tried to assess how the iPhone was made: *"This revealed a dazzlingly complex pattern, typical of numerous sectors. Manufacturing iPhones involves nine companies, which are located in the Republic of Korea, Japan, Taipei, China, Germany, and the US,"* adding that *"…the major producers and suppliers include Toshiba, Samsung, Infineon, Broadcom, Numonyx, Murata and Cirrus Logic"*.[14] Although it could, and should, be possible for companies to know exactly the source and nature of the multitude of components used in their products, the reality of such immensely complex supply chains means that it is extremely unlikely that they will be fully aware of exactly what goes into their products.

To break it down, a mobile phone's main components are: the circuit board (the 'brain' of the phone), the liquid crystal display (LCD) screen, and the battery. Altogether a phone is roughly 40% metals, 40% plastics and 20% ceramics and resin.

In its iPad 2 Environmental Report, Apple broke down the main materials used in the production of the iPad 2 (see diagram). The same Apple report also indicated that the total greenhouse gas emissions for the iPad 2 was 130kg of CO2-e (kg of CO2 equivalent), split between production (66%), transport (9%), consumer use (23%) and recycling

3. MATERIAL USE FOR IPAD 2 (WI-FI AND 3G)



Data source: Apple. iPad 2 Environmental Report 2012. p.2.

(2%) – although of course these ratios would depend upon real consumer use and what is meant by recycling. Overall, production of the iPad 2 accounts for 85.8kg of CO2-e and transport accounts for 11.7kg CO2-e.[15]

Many of the materials that go into the making of mobile phones and computers are toxic, in particular Brominated Flame Retardants such as TBBA (tetrabromo-bisphenol-A) or PBDE (polybrominateddiphenyl). Used (as the name suggests) to delay the ignition point these chemicals break off in the form of dust when computers are heating up even after only a few hours of use. PBDEs have been linked to immunity deficiencies and cancer. They have been banned in Europe[16] and are listed under the Stockholm POPs (Persistent Organic Pollutants) Convention.[17]

Crude oil, natural gas and chemicals are necessary to produce the plastics, sand and limestone to create the fibreglass. But what is of most concern is the sheer amount and diversity of metals that are used in the making of these products. Here follows a non-exhaustive list:

- **Circuitry:** gold, silver, platinum, palladium, copper, tungsten, nickel, zinc, beryllium, cobalt, tantalum, lead, tin.
- **LCD screen:** yttrium, a rare earth element, is essential for the red colour.
- **Battery:** mobile phones can use several types of batteries: nickel-metal hydride (Ni-MH), lithium-ion (Li-Ion), nickel-cadmium (Ni-Cd), or lead acid. Ni-MH and Ni-Cd batteries contain nickel, cobalt, zinc, cadmium, and copper. The lithium-ion battery is the most popular and is being increasingly used in electric vehicles, making lithium a very sought-after metal (see page 37).
- **Other metals:** arsenic, aluminium, antimony, gallium, manganese, molybdenum, magnesium, indium-tin oxide, iron, neodymium (another rare earth element), chromium, selenium, cadmium.

This is where the notion of items 'rooted in the Earth' takes its full significance, since every one of these metals has to be dug up from the ground, often in appalling environmental and social conditions.

In addition, many of these metals are highly toxic.[18] This is not necessarily a problem during use, but is a major concern during production and, crucially, during disposal (see chapter 3); metals leaking from discarded products affect both humans and the environment on a huge scale.

Toxic Leakage[19] During Production and Disposal

Selenium: high exposure causes selenosis, which can cause hair-loss, nail brittleness, and neurological abnormalities (e.g. numbness and other sensations in the extremities).

Beryllium: can cause cancer and chronic beryllium disease (breathing difficulties, coughing, chest pain, and general weakness).

Chromium: exposure can cause strong allergic reaction (linked to asthmatic bronchitis) and DNA damage to cells. Chromium can also be released into the environment from landfills and incineration.

Arsenic: long-term exposure may cause lung cancer, nerve damage and various skin diseases.

Cadmium: can cause kidney damage, and damage to bone density. Cadmium is also a carcinogen (cancer-causing).

Lead: can cause brain damage, nervous system damage, blood disorders, kidney damage, and damage to foetal development. Children are especially vulnerable.

METALS AND MINERALS

We will now examine some of the specific metals used in our electronics – linking the production of these machines to the raw materials they contain, and the mining processes involved in extracting them from the body of the Earth.

But first let us reflect on how these minerals and metals came to be- their evolution.

Recent developments in the field of mineralogy are challenging industrial values and perceptions of metals and minerals, as inert raw materials or commodities.

The Evolution of Metals and Minerals

In a paper published in 2008 Hazen and Papineau *et al,*[i] consider the evolution of minerals on Earth, in our solar system and in the Universe as a whole.They reveal that from the dozen or so minerals present in ancient interstellar dust grains, thousands more have since been formed through extremes of temperature, pressure by gravitational clumping, and volcanic and aquatic activity. In our solar system however, only Earth is home to more than 500 mineral species. In investigating why this is the case, the scientists found that both the variety and abundance of minerals, have changed dramatically over more than 4.5 billion years of Earth's history. A finding that poses the question: why has mineral diversity evolved so remarkably on Earth but not elsewhere?

The presence of plate tectonic activity on Earth is thought to be partly responsible, as it plays an active role in creating niche conditions for mineral development. But the planet's ability to create and sustain approximately 4,300 minerals cannot be put down to this alone. This large and unrivalled diversity of mineral species is in fact made possible by dynamic relationships minerals have forged with other constituents of the Earth, namely biological life forms.

Approximately 4 billion years ago life began on Earth, and with it the interactions between the organic and inorganic worlds within our planet, which have been crucial in drastically increasing the number of minerals present on the Earth today. According to Hazen: "*of the 4,300 known mineral species on Earth, perhaps two thirds of them are biologically mediated…for at least 2.5 billion years and possibly since the emergence of life, Earth's mineralogy has evolved in parallel with biology.*"[ii] The most significant factor in this mediation has been the creation of an oxygen rich atmosphere by microscopic algae. The 'great oxidization event' that began around 2.5 billion years ago has led to the mass creation of minerals, the products of oxidized weathering, such as ores of copper, iron and many other metals.[iii] Yet such minerals may not have found the conditions to develop, had existing mineral surfaces not already provided a niche for the microscopic oxygen providing algae. Thus the stories of both biological and mineralogical evolution are deeply entwined and cyclical in nature.

This understanding reminds us yet again that we are all inextricably part of complex cycles of life, including the minerals and metals of our Earth. Every metal in this report has a story that started long before its involvement in the lifecycles of electronic gadgets. Each has played some role in shaping, and has been shaped by our dynamic Earth. Recognising this should surely prompt us to value them more respectfully as part of the myriad web of interconnections that maintain the health of the Earth as a whole - the only blue-green planet we know of in our Universe.

i Hazen, R., Papineau, D., Bleeker, W., Downs, R., Ferry, J., McCoy, T., Sverjensky, D. and Yang, H. (2008) Mineral evolution. *American Mineralogist* 93, pp.1693-1720.
ii 'Mineral Kingdom has co-evolved with life,' *Science Frontline* (2008). Available at: http://www.sflorg.com/earthnews/en111408_01.html
iii See: http://hazen.gl.ciw.edu/research/mineral-evolution

GOLD

Gold has inspired and driven many to rapacious ambition. It has triggered wars and conquests in equal measure. And yet, it is estimated that there are 165,000 tonnes of gold in existence above ground - this would fit in a cube whose sides would be no longer than 20 metres.[20] A staggering statistic considering the untold destruction unleashed by its extraction, both in human terms and for the wider Earth community. Think of the Californian and Australian gold rushes, South Africa's deadly legacy of toxified water and soil from abandoned mines or Europe's Great Bullion Famine in the 14th century. "Get gold, humanely if you can, but at all hazards, get gold!" said King Ferdinand of Spain, leading the conquests that effectively wiped out the Inca and Aztec civilizations.

Despite being sought after for thousands of years, more than 90% of the total gold mined has been extracted since the Californian gold rush.[21] Today, 2,500 tonnes of gold are mined every year, and according to the World Gold Council (WGC), the livelihoods of 100 million people worldwide are dependent on it.[22]

But why is gold mined and what makes it so special? Its main uses are:

- **Jewellery (60%)** India and China are the biggest consumers. China in particular is seeing spectacular growth, with the government encouraging private ownership in sharp contrast to Maoist times when owning gold was forbidden.[23]
- **Financial (28%)** Either as official holdings in central banks or as investments. With the current uncertainty of the economy, inflation and currencies, gold is seen, more than ever, as a financial refuge. Its attraction can be seen in the following extract from the World Gold Council website: "*...since the 14th Century, gold's purchasing power has maintained a broadly constant level. To put this in practical terms, an ounce of gold has repeatedly bought a mid-range outfit of clothing. This was true in the fourteenth century, when an ounce of gold was worth £1.25 to £1.33; it was true in the late 18th century and it remained true at the beginning of this century (2000 to 2008), when an ounce of gold averaged £269 or US$472. Even the exchange rate between gold and commodities has been relatively constant over the centuries*".[24]

  But recent developments belie this; at the current price of US$1,600 an ounce, gold now buys a hugely expensive piece of clothing indeed! As an investment, gold is also gaining huge traction; since 2004 demand for investment has increased 1,000% to reach US$80 billion.[25] The London Bullion Market Association (LBMA) recently estimated that 10.9bn ounces of gold, worth US$15,200bn, changed hands in the first quarter of 2011 - that is 125 times the annual output of the world's gold mines and twice the quantity of gold that has ever been mined.[26]

- **Industrial (12%)** Gold finds its way into an increasing array of industrial applications due to its conductivity, malleability, ductility, biocompatibility, for its corrosion resistance, as an effective catalyst, and increasingly for its properties in the form of nanoparticles.[27] It is also used in the circuitry of phones and laptops; the Mineral Information Institute calculates that 4 tons of gold are to be found in the 130 million phones annually discarded in the USA.[28]

The embodied water of a kilogram of gold is estimated at a staggering 225,000 litres.

As we can observe, gold has numerous uses, but its attraction comes at a high price both ecologically and socially.

WASTE - converting 'life' into 'waste'

Producing a single gold ring generates, on average, 20 tonnes of mine waste.[29] And this is only going to get worse, with gold ore becoming more and more difficult to access. A case in point is the recently suspended BHP Billiton Olympic Dam project in Australia, a giant gold-copper-uranium-silver deposit. If the project goes ahead, trucks will have to haul 'overburden' every day for five to six years before reaching the ore body.[30] The technical terms used for mining processes reflect the complete disregard for life - 'overburden' describes the surface materials that lie above the gold deposits, this is the rock, the soil, and the living ecosystems.

WATER

Gold mining consumes vast amounts of water. The embodied water of a kilogram of gold is estimated at a staggering 225,000 litres. This compares with typical ranges of 20 to 100 litres for metals such as copper, lead and zinc.[31]

BATTLE FOR THE BIRTHPLACE OF THE SUN

Silver Mining in the Sacred Site of Wirikuta - A Story from Mexico

"What they want is to rip out the veins of the heart of Wirikuta - and that's why we are here. We're not interested in gold and silver; what interests us is life."

- Santos de la Cruz, Leader of the Wixarika community of Bancos de San Hipolito.[i]

The Sierra Madre Occidental mountains, in the states of Nayarit, Jalisco, Zacatecas and Durango, Mexico, are well known for their biodiversity and cultural diversity. It is in this region that the Indigenous Wixarika people and their ancestors have made their home for millennia, maintaining the health of the Sacred Natural Sites and local eco-systems on which their livelihoods depend.

Photo: Wixarika Pilgrimage. Tracy L. Barnett, The Esperanza Project.

A fundamental part of this ritual care is the Wixarika's annual pilgrimage through Wirikuta, their Sacred and traditional territory, observed by the people since time immemorial. Their ultimate destination is Cerro Quemado Mountain, the birthplace of the sun and all life. The entire journey, an undertaking of over 300 miles for some, is important for the Wixarika who call this yearly ritual their 'essence'. Through it they are able to retrace the steps of Creation geographically, spiritually and communally, stopping along the way at Sacred Sites repeating the prayers of their ancestors.

Wixarika passing through and honouring Wirikuta (a UNESCO recognised Natural and Cultural Ecological Reserve located in San Luis Potosi state) is integral to keeping their culture alive and for maintaining the Earth's equilibrium, a responsibility for which the Wixarika believe rests on their shoulders. New learning forms an important part in ensuring Wixarika responsibilities are fulfilled, and the Earth provides this. It is in the deserts of Wirikuta that the people search for Kauyumarie, the deer spirit that connects them with their deities, via the peyote cacti that grow there. From the 'The Blue Deer' Wixarika are able to learn how to live their lives in accordance with the Earth.[ii]

Quite literally, another key element in the Sacredness of the entire Wirikuta area and the cause of recent controversy is silver.

i Barnett, T. (2012) *People, Land, Truth.* p. 38. Available at: http://intercontinentalcry.org/wp-content/uploads/2012/07/PeopleLandTruth-webview.pdf
ii Ibid. p. 37.

The economic potential of silver in the region has been recognised since the 1700's. Towns such as Real de Catorce sprung up as a result of mining activity in the area but when silver markets slumped, and the UNESCO Reserve was established in 1988 the mines began to close. Tourism became the chief selling point and boosted the economy, but when tourism began to flounder, a Canada based mining group, The First Majestic Silver Corporation (FMS) and its Mexican subsidiary Minera Real Bonanza, renewed interest in mining near Real de Catorce, creating the La Luz mine.

In 2010, FMS was granted 22 mining concessions by the Mexican government, despite it being a UNESCO Reserve. These concessions amounted to more than 6,000 hectares of land, 70 percent of which was within the Reserve.[iii]

It is estimated that the La Luz mine will produce over US$1.3 billion worth of silver over 15 years,[iv] yet for the Wixarika, the mineral holds meaning and significance that goes far beyond the financial value. Jesus Lara Chivarra, Wixarika leader of San Sebastian Teponahuaxtlan, explains that for his people the silver in their Sacred lands creates a strong energy or force which was originally responsible for the Wixarika coming to be in this place. This force, originating from the minerals themselves is what, according to Lara, gives this place its essence today. Lara perceives that mining here poses an existential threat:

"What these people don't understand is that all the region of Wirikuta is Sacred, not just the Cerro Quemado... if they remove the silver it will no longer be what it is today. It's like having an empty bottle; the bottle may remain, but the content will be gone... to take this place from us is to do away with the Wixarika ethnicity."[v] *Silver is at the energetic core of Wixarika existence: what is taken from Wirikuta is taken from the people, and as Wixarika spokesperson Marciano de la Cruz Lopez has said, neither will be the same, "if you take away its soul".*[vi]

Thanks to a creative campaign by the Wixarika people and their many allies in civil society, mining activity by FMS has not yet commenced. The pressure exerted on the government and a lawsuit filed by the community of San Sebastian, has ensured that mining activity is prohibited until concerns regarding the Wixarika people's rights are addressed. Despite this success, another threat now looms in the form of a proposed open pit mine in the Sacred desert by another Canadian mining company, Revolution Resources. The Mexican government has granted concessions for this much larger project, and exploration has begun in an area where the Wixarika gather peyote.

In spite of this new threat from Revolution Resources and a 'disinformation' campaign initiated by FMS,[vii] the Wixarika have been able to welcome a recent government proposal to create a Biosphere Reserve spanning 191,504 hectares in Wirikuta and San Luis Potosi, itself a Naturally Protected Area.[viii] By maintaining a dialogue with the government concerning the creation of this Biosphere, the Wixarika are hopeful a future decree will help preclude further attempts to mine in the region.

Until they can be sure the silver which forms the heart of their territory is safe in the Earth however, the Wixarika will continue to resist: *"Wirikuta no se vende, Wirikuta se defiende."* - *"Wirikuta is not for sale, Wirikuta is to defend."*[ix]

iii See: http://frenteendefensadewirikuta.org/wirikuta-en-bk/?page_id=886
iv Zhorov, I. (2012) Re-opening Silver Mine Could Save Town but Destroy the Sacred Site of the Huicholes, ICTMN. Available at: http://indiancountrytodaymedianetwork.com/article/reopening-silver-mine-could-save-town%2C-but-destroy-the-sacred-site-of-the-huicholes-127755
v Barnett, T. (2012) People, Land, Truth, p. 37. Available at: http://intercontinentalcry.org/wp-content/uploads/2012/07/PeopleLandTruth-webview.pdf
vi Zhorov, I. (2012) Re-opening Silver Mine Could Save Town but Destroy the Sacred Site of the Huicholes, ICTMN. Available at: http://indiancountrytodaymedianetwork.com/article/reopening-silver-mine-could-save-town%2C-but-destroy-the-sacred-site-of-the-huicholes-127755 (Accessed: 22 March 2013)
vii Barnett, T. (2012) Canada meets Wirikuta: Visit from Council of Canadians' Maude Barlow. Available at: http://theesperanzaproject.org/2012/11/canada-meets-wirikuta-visit-from-council-of-canadians-maude-barlow/
viii Schertow, J.'Wixarika Respond to Government Proposal for Biosphere Reserve in Wirikuta'. Intercontinental Cry. [online] Available at: http://intercontinentalcry.org/wixarika-respond-to-government-proposal-for-biosphere-reserve-in-wirikuta/
ix Barnett, T. (2012) People, Land, Truth. p. 38. Available at: http://intercontinentalcry.org/wp-content/uploads/2012/07/PeopleLandTruth-webview.pdf

ARTISANAL AND SMALL-SCALE GOLD MINING
A Global Story

It is estimated that 10 to 15 million people are involved worldwide in Artisanal and Small-Scale Gold Mining (ASGM), collectively accounting for 12% to 20% of worldwide gold production. Of this number, 3 to 4.5 million are women and 1 to 1.5 million are children. In total, 100 million people in 55 countries depend on ASGM, a number constantly growing with the rising price of gold.[43] Given its high value and relative ease of extraction, gold attracts many artisanal, small-scale, unskilled miners. Driven by poverty, they are often willing to endure harsh working and living conditions where they face dangerous health risks, due to the use of mercury and cyanide in the mining process. Furthermore, many miners are often unfairly labelled criminals or guerrillas. A recent report related to mining in Peru argues that the term 'artisanal mining' has wrongly become synonymous with 'illegal mining' despite many operations being formalised and complying with legislation. Undoubtedly irresponsible and with illegal operations aplenty, it is important to recognise the wider context of ASGM, with high gold prices, set against acute poverty and lack of employment, as key drivers for participation.[44]

Whether legal or illegal however, artisanal miners often find themselves operating in pristine ecosystems and have a damaging impact on the environment. Small-scale miners are called 'Garimpeiros' in the Amazon, 'Ninjas' in Mongolia or 'Galamsey' miners in Ghana. Sometimes, illegal gold mining is controlled by criminal organisations with little respect for the environment or workers' wellbeing. Conflicts arise between miners and farmers whose land is taken over forcefully, and indigenous communities' livelihoods are threatened when their lands are encroached upon. Child labour and industrial accidents are common. 1,000 tonnes of mercury are believed to be released in the environment every year from ASGM activities – 300 tonnes directly vaporised in the atmosphere and 700 tonnes discharged into soils, lakes and rivers, potentially exposing 100 million people to its toxic effects, not to mention the impact on plants and animals, especially aquatic life.[45]

Gold mining has also been known to pitch artisanal miners against large companies. A case in point is the Santa Isabel mine in Colombia where in 2012, multinational mining companies were conducting preliminary exploration around the mine, which was worked by artisanal miners. On February 21 2012, approximately twenty-five small-scale miners were arrested. Miners and the Comité de Integración del Macizo Colombiano, (Committee for the Integration of the Colombian Massif - CIMA), a rural social movement allied with the miners, claimed that this is part of a government strategy to phase out informal mining in order to pave the way for foreign multinationals. Police forcefully removed small-scale miners, accusing them of funding the FARC (Revolutionary Armed Forces of Colombia). Ferney Gamboa, one of those arrested, argued that compared to his small-scale operation, a massive gold mine in the area would be far more detrimental to the environment. *"A large-scale mine will have a much larger impact. These companies use cyanide and huge amounts of water".*[46]

The veracity of this claim is a matter of dispute. The Artisanal Gold Council[47] believes that artisanal mining is more energy efficient than large-scale mining (in joules per unit of gold), releases less greenhouse gases (in CO2e per unit of gold), produces less tail rock and tailings per unit. Conversely, it releases 40 times more mercury and those who use cyanide release twice as much per unit of gold produced, suggesting that ASGM is not better or worse but simply creates a 'different' kind of impact from large scale mining. One thing is for certain - whatever the method of extraction, the Earth is undoubtedly the loser.

A number of initiatives and campaigns have been launched to deal with the devastating impact of gold extraction. For example: No Dirty Gold,[48] the Responsible Jewellery Council,[49] Fairtrade and Fairmined Gold,[50] The International Cyanide Management Code For The Manufacture, Transport and Use of Cyanide In The Production of Gold,[51] and the UNEP's Mercury Treaty.[52] These are all important initiatives, but whilst demand persists, the scramble for access to more land (legal or otherwise), spurred by ever-higher gold prices and dwindling reserves, will continue.

Water is now a huge battleground all over the world. In Mongolia for instance, the massive Oyu Tolgoi copper and gold mining project, co-owned by Vancouver-based Turquoise Hill Resources (of which Rio Tinto has a majority share) and the Mongolian government, is expected to contribute 34% to the country's Gross Domestic Product (GDP) when it starts full production later this year.[32] But this economic bonanza is causing concern for some, as the project will consume invaluable water in the already-arid Gobi. Some say the mine could use up to 920 litres of water per second.[33] Where there is no water, there is no life.

MERCURY AND CYANIDE

In order to recover the gold from the ore, miners use either mercury and/or cyanide. Both have terrible consequences for health and the environment. The average large-scale gold mine uses 1,900 tons of cyanide per year.[34] Mercury use is favoured by small-scale, artisanal miners because it is an inexpensive, quick and easy way to extract gold particles – but it is the cause of the second biggest source of mercury pollution in the world (after the burning of coal) and artisanal miners are often not aware of its dangers.[35] The UNEP (United Nations Environment Programme) is working on an international treaty to regulate the use of mercury, though its enforcement in remote areas will be a challenge.

WORKERS' HEALTH

Workers' health is frequently endangered in underground mines. In South Africa, 17,000 ex-miners are currently filing a class action lawsuit against 30 mining corporations. They claim that they contracted the debilitating lung disease silicosis due to negligence in health and safety. The companies involved owned or operated 78 different gold mines from 1965.[36] On December 21, 2012, South Africa human rights lawyer Richard Spoor filed an application for class certification of an action for damages in the South Gauteng High Court on behalf the former gold mine workers.[37] One of the companies said it, "…works to prevent future incidences of occupational lung disease through continual improvements in underground dust management and reducing the dust exposure of our mining employees. The health and safety of [its] employees is central to how we run our business".[38] The case continues.

IMPACT ON COMMUNITIES

Mining operations are often accused of setting up their projects without respecting the wishes of local communities. Increasingly, indigenous peoples, farmers and other local communities in places as diverse as Peru and Papua New Guinea are speaking out to protect their lives and livelihoods from the impacts of harmful gold mining operations.[39] The impacts of gold mining are truly global. Fluctuations in the price of gold cause ripples around the world and affect disparate communities, from urban street gold miners sweeping the streets of Kolkata's jewellery district,[40] to un-contacted indigenous communities threatened by illegal gold miners in the Amazon,[41] to the spread of gold pawn shops in poorer city suburbs;[42] all are directly affected by the price of gold.

CONFLICT MINERALS IN THE DRC: the 3 Ts (tantalum, tin, tungsten)

The Democratic Republic of the Congo (DRC), formerly Zaire, has been the theatre of ruthless exploitation for more than a century. First in the form of colonialism, and more recently in the most violent conflict since World War II. After a decade and a half of civil war, almost 6 million people have been killed in eastern DRC[53] and over 2 million are currently displaced[54] - victims of various armed groups fighting for power and access to minerals.

Government and rebel militias continue to fight for control of the DRC's mines, which hold an estimated £15 trillion in gold and rare earth minerals.[55] The profits from conflict minerals finance the violence and labour abuses and exploitation facing some of the most vulnerable people on Earth. Thousands of displaced people, unable to make a living or return to agricultural land are trapped into forced labour in mines,[56] many of them children.

The DRC's disorganised military and police are ill equipped to stop this. Armed groups, operating without accountability, often use mass rape and murder to intimidate and control local populations in order to gain control of mines, trading routes, and other strategic areas. At Kamituva gold mine in South Kivu Province, for example, workers can earn as little as 33 pence per day, and women are routinely raped and beaten.[57] Margot Wallstrom, the UN's special representative on sexual violence in conflict, has described the DRC as "the rape capital of the world".[58]

Child miners in the DRC / Sasha Lezhnev / Enough Project

BLOOD IN THE MOBILE
A Story from the Congo

"I can't live with the fact that my mobile phone might be financing war, I can't keep sending loving text messages to my wife, or talk to my daughters if it has cost lives in the Congo - if there is blood in my mobile" - Frank Poulsen.

The 2010 documentary Blood in the Mobile shows the linkages between our mobile phones and the civil war in the Democratic Republic of the Congo. As a loyal customer of mobile phone brand Nokia, director Frank Poulsen wanted to find out if minerals contained in his phone come from mines that are funding civil war. The DRC is rich in natural resources like gold, diamonds, rubber, coltan and cassiterite. But instead of creating wealth for the population, these resources have ended up fuelling a war in which it is estimated that over 5 million people have died, and an estimated 300,000 women have been raped.

The film focuses on cassiterite - a mineral used for producing tin, which is used for the production of all kinds of electronic devices - including mobile phones. Poulsen visits one of the largest and most notorious illegal mines in the region – the Bisie mine in North Kivu Province. He finds crude mines dug out in clearings in the dense forest. This is by no means a small operation - towns have sprung up around the mine which employs 15-20 thousand people. This includes children who work for days in narrow mine tunnels to dig out the minerals, sometimes staying below ground for weeks. Every month, mineshafts collapse and miners are buried alive.

Armed gangs patrol the perimeters of the mines and extort taxes from those who work there – demanding payment for entry to the mine, transport and even for the makeshift huts they live in. People come from miles around in the hope of making money but often find that due to the extortionate taxes, they get stuck there. The illicit trade in 'conflict minerals' from these mines provides rebel groups and sections of the national army with money to buy guns and finance their rival campaigns. It is clear that the perpetuation of armed warfare has evolved in tandem with the profits from these mines.

Bisie is just one mine among hundreds in Eastern Congo. It's estimated that this mine alone produces minerals worth US$70,000 per year. The raw materials are shipped out to Malaysia and elsewhere, smelted into tantalum and it is at this point that electronics corporations buy it, disinterested in its place of origin and the circumstances surrounding its extraction.

NGOs such as Global Witness and Raise Hope for Congo assert that company transparency of supply chains would do much to address the issues of conflict minerals, in addition to legislation that requires companies to carry out checks on their supply chain – known as *due diligence*. The fact that Nokia had not made significant progress in tracing the supply chain of its materials (even, as claimed in the film, after 10 years of knowledge of the situation in DRC), is indicative of the competitive electronics industry. An industry where gaining market share and increased profits rely on the secrecy of material and suppliers used, so as not to leak new designs or technologies to rival companies. When interviewing a Nokia representative, who explains these corporate 'confidential sensitivities', Frank Poulsen is exasperated: *"So on the one hand you have competition, which is a race to get profit…and on the other hand we have dying children, women raped, millions of dead…"*

Poulsen takes his quest for answers further, and travels to the Nokia headquarters to enquire how much they know about the minerals that are used in their phones. As an industry leader and known for their corporate social responsibility, he asks why, one of the largest companies in the world, which launches a new phone every three months, has not done more to deal with the fact that there may be minerals in their phones that are fuelling the conflict in the DRC. He secures an interview with the Director of Corporate Social Responsibility, who explains that the company's power to effect change is limited to the fraction of the market that Nokia represents, but they are working towards a sustainable long-term solution – this will include governments, citizens and consumers. From 2012, Nokia has implemented the Global e-Sustainability Initiative (GeSI) and Electronic Industry Citizenship Coalition (EICC) *Conflict Minerals Reporting Template,* designed to facilitate disclosure regarding smelters and refiners that provide material to company supply chains.

For more information about the film see: http://www.bloodinthemobile.org

ACID MINE DRAINAGE
A Story from South Africa

"For residents of Johannesburg or Witbank, the most visible legacy of 100 years of mining is not the country's well-developed engineering and financial service sectors. It is tainted water sources and dust blowing off old mine dumps."[i]

Adding to the immediate environmental impacts of mining, are the long-term effects of large-scale mining activities. In South Africa, as is the case of many intensive extractive economies globally, mining activities have left a devastating toxic legacy. The historic gold mining sector in South Africa in particular, highlights the gravity and challenges of post-mining zones for the ecosystems and communities.

Gold mining in the region is linked to the very development of the country, shaping much of the nation's socio-economic and ecological landscape. However, when mines are depleted or production declines, the resulting abandoned or unused mines pose an on-going risk to people and the environment. For more than a century, the waste from gold and coal mines has seeped into the water systems and soil in north-eastern South Africa. In some areas soil has become so polluted that people can no longer grow food.

Acid Mine Drainage (AMD) is the outflow of sulphuric acid during and after mining activities. It occurs naturally, but is exacerbated by large-scale disturbances, which cause sulphide minerals to be exposed to air and moisture, creating acid. The resulting acid is toxic for aquatic and terrestrial life; it poisons water and soil, affecting local communities through carcinogens in watersheds, and through the heavy metals that enter the food chain. It impacts local livelihoods linked to agriculture, and other economic activities associated with tourism and fishing.

In South Africa, AMD is an issue both during mining operations and once mines are abandoned and water begins to flood mining shafts. For decades, water levels within these shafts have risen, affecting certain areas. However, the risk of these overflowing is now imminent, and this will generate further devastating effects on a far greater scale. In the Witwatersrand region of South Africa, one of the most intensely mined regions of the country, with mines that closed decades ago, AMD is now leaking at a rate of 15 – 20 million litres per day, with devastating implications for urban and rural populations.[ii] The vast networks of mine shafts and surrounding geological characteristics mean that the current outflows threaten the surrounding Vaal River and Limpopo River watersheds, which supply water for millions of people in the region. The extent of the toxification of the river systems in the area has resulted in hundreds of crocodile deaths in the Kruger National Park – with 170 carcasses recorded in 2008.[iii]

Historical and present mining practices in South Africa, combined with weak environmental legislation, underscore the severity of AMD and the need for sound environmental management strategies to deal with current and future mines and their risks. However the case of AMD in South Africa and its geo-political context highlights the complexity of the task of addressing this toxic legacy. The key issue concerning AMD, is that of liability - it has been hard to pinpoint the blame given the quantity of companies and myriad subsidiaries who operate (or have operated) in the region. Furthermore, re-enforcing existing environmental regulations is difficult due to the lack of political and financial will for rehabilitation, and because loopholes in funding clean mine closures are still prevalent.

The case of South Africa and AMD provides a clear example of the lasting and hidden legacy of large-scale mining activities. The impacts of mining are not confined to the operational life of a mine; abandoned and decommissioned mines continue to pollute for generations to come, who pay the cost of our negligence, long after the mine has closed.

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i Financial Mail (2012) Mine Rehabilitation: when the dust settles. Financial Mail. 29 March. Available at: http://www.fm.co.za/fm/2012/03/29/mine-rehabilitation

ii Du Toi, S. (2011) 'All that glitters... Acid mine drainage: The toxic legacy of gold mining in South Africa' Earth Magazine [online]. Available at: http://www.earthmagazine.org/article/all-glitters-acid-mine-drainage-toxic-legacy-gold-mining-south-africa

iii Kruger National Park Media Release: Crocodile deaths continue in the Olifants River. 22nd June 2009. Available at: http://www.sanparks.org/about/news/default.php?id=1252

Hundreds of millions of dollars can be made every year by those who are able to control the exploitation and export of these minerals – minerals that are essential components in the production of our electronic products:

- **Tantalum:** found in the coltan (columbite-tantalite) ore, tantalum is essential for storing electricity and for high speed processing devices. Nobody knows exactly how much coltan can be found in the DRC but some estimates say the country could have up to 80% of world reserves. "This region [Eastern Congo] has so much of this coltan, you just dig on any hill and you find it." Denis, miner, Bukavu, South Kivu.[59]

- **Tin:** from cassiterite ore. Large amounts of cassiterite from the DRC originates from the province of North Kivu, in an area named Walikale, where the richest deposits are found in the Bisle mine. In 2010 almost 40% of the entire revenue of North Kivu came from the Bisle tin mine.[60] Tin is used for solder in printed circuit boards and in other components. It has become a hot commodity after recent European environmental regulations came into force, requiring the electronics industry to use tin instead of lead. At present the global solder market accounts for almost half of global tin consumption. 70% of solder sales goes to the electronics industry.[61]

- **Tungsten:** from the wolframite ore, tungsten, among other applications, enables your mobile phone to vibrate. Along with tantalum, it has been classified by the EU as a critical material due to its high economic importance and its high supply risk (see next chapter).[62] The DRC is a major producer but more than 80% of the world's production originates in China. The British Geological Survey places tungsten fourth in its list of the 52 most critical metals and minerals needed to maintain the UK's economy and lifestyle.[63]

- **Gold:** although a very small producer on a worldwide scale, eastern Congo holds gold deposits targeted by armed groups to finance their operations. And just as is the case in other parts of the world, miners working in armed areas are subject to abuse, appalling working conditions and child labour - for a salary of just US$1.00 to US$5.00 per day.[64]

Trying to isolate these metals in the global supply chains feeding the electronics industry is not easy, but neither is it impossible.

In their report, From Mine to Mobile Phone, The Enough Project identifies six steps in the supply chains:[65]

1. Production at the mine; 2. Transported to trading hubs in the DRC - Bukavu and Goma are the main ones, 90% of them operating illegally; 3. On to international markets through exporters who rely solely on verbal assurances that the minerals do not originate from conflict zones (meaning there is, in effect, no control or knowledge concerning the origin of the minerals); 4. Transit through neighbouring countries (Uganda, Rwanda or Burundi), where smuggling and corruption are major obstacles to the efficient monitoring of minerals: 5. Refining and smelting in Asia, Europe or the US - this is a critical step since this is the place where minerals from all over the world are mixed together; 6. On to electronics companies at various sub-stages of the supply chain and eventually ending up in our smartphones or laptops.

4. SUPPLY CHAIN IN 6 STEPS

Source: From Mine to Mobile Phone: The Conflict Minerals Supply Chain. Enough Project Data Source: From Mine to Mobile Phone: The Conflict Minerals Supply Chain. Enough Project report, p.1.

The electronics industry is the single largest user of minerals from the DRC and therefore bears a special responsibility in tracing conflict minerals.

The Enough Project has engaged with 21 consumer electronics industry leaders to call their attention to this issue and inquire about the steps they are taking to ensure their products are conflict-free. It is also asking us, as consumers, to lobby the companies and add our voice to the chorus.[66]

Governments and international bodies are trying to address the issue too:

- The USA's 2010 Dodd-Frank financial oversight law, brought about after the 2008 financial crisis, required the SEC (Securities & Exchange Commission) to establish new rules forcing companies to disclose whether they use tantalum, tin, gold or tungsten from the DRC and adjoining countries.[67] After months of wrangling, the SEC confirmed in August 2012, section 1502 of the Dodd-Frank Act, which specifically deals with conflict minerals. From 2014, companies listed in the US who buy minerals from eastern Congo must confirm that their purchases are not fuelling the conflict. The practicality of the law remains to be seen in what are admittedly complex supply chains.
- The EU is advocating greater use of the recent Organisation for Economic Co-operation and Development (OECD) Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.[68] The Guidance provides a five-step framework for risk-based due diligence in the mineral supply chain, including the need for regular independent, third party audits.
- The International Conference on the Great Lakes Region (ICGLR) has been developing a set of regulations mandatory for all 11 member states in order to monitor and regulate the flow of minerals in Central Africa.[69]
- The government of the DRC said in February 2012 that it would block exports of tin ore, gold, coltan and wolframite unless traders can prove the minerals come from mines that are certified by the state as conflict-free.[70]

RARE EARTHS AND TECHNOLOGY MINERALS: the new battleground

Rare earth minerals have recently come to symbolise the increasing importance of technology minerals in our consumption habits, and the world's big dependence on China to supply those minerals. What are technology minerals?

Kaiser Bottom Fish Editor John Kaiser defines them as "*… metals that are a minor input for an end product, in terms of the total value of the end product, relative to the cost of that input, and yet that input is critical to the overall functionality of the end product. For example, steel pipes are not made of molybdenum, but molybdenum, which makes up 0.5% of the alloy, gives it corrosion resistance and strength. That makes molybdenum critical to gas pipelines*".[71] Technology minerals today are essential to the functioning of a vast range of technologies, in particular consumer electronic items such as smartphones, laptops and flat screen TVs.

What are Rare Earths?

Rare Earth Elements (REEs) are a set of 17 chemical elements in the periodic table (scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, luthertium). Despite their name, rare earth elements (with the exception of the radioactive promethium) are relatively plentiful in the Earth's crust. However, because of their geochemical properties, rare earth elements are typically dispersed and not often found in concentrated and 'economically exploitable forms'. The few more accessible deposits are known as rare earth minerals.

Rare earths are vital components for the most recent technological developments in consumer electronics, as well as in 'green' technologies such as solar panels, wind turbines, energy efficient electric motors and hybrid vehicles.

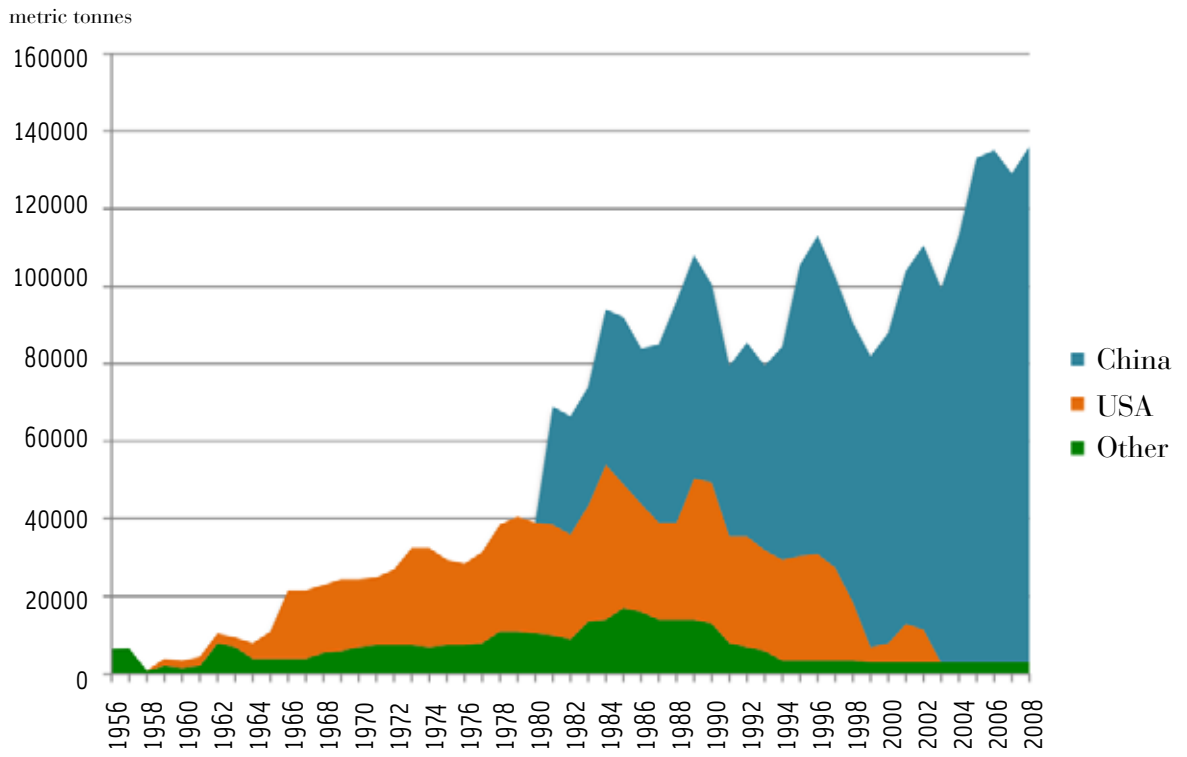
Rare earths have captured the public imagination because of the prominent role played by China which accounts for 95% of worldwide production.[72] With China introducing export restrictions a few years ago, Western governments have suddenly become painfully aware of their extreme dependency on Chinese supplies. It was not always so. For years the biggest producer was the US, until China entered the picture in the 1980s, producing big quantities at very low prices; prices that miners in the West could not match. The final nail in the coffin for Western production was in 2002, with the closure of the mammoth Mountain Pass mine in California six years after a major tailings disaster.[73]

Given the growing importance of REEs, it is important to ask: why has China become so dominant? And why have Western governments been so complacent in letting one country corner the market to such an extent?

The potential of rare earths was recognised in China very early on, with Deng Xiaoping reportedly remarking in 1992 that, "the Middle East has oil, China has rare earths". From an industrial point of view this was an astute move as China, having eclipsed the competition, has used its strategic position to attract numerous downstream industries needing the metals – chief among them, the manufacturers of electronic consumer items.

All of this has come at a heavy environmental price, which explains why governments the world over have been quite happy to let the Chinese do the 'dirty work' of digging up the minerals.

5. DEVELOPMENT OF RARE EARTHS GEOGRAPHICAL PRODUCTION (1956-2008)



Source: China's Rare-Earth Industry, 2011, USGS Report, p.3. Data sources: Global rare-earth-oxide production trends. The Mountain Pass deposit is in California, U.S.A. Graph from D.J. Cordier (U.S. Geological Survey, 2011)

The exploitation of rare earths has created extensive ecological damage in the Chinese provinces where it is taking place, especially in the Baotou area of Inner Mongolia, 650km west of Beijing, which is responsible for half the world's supply. Here, seven million tonnes[74] of earth – or rather, living ecosystems considered 'waste' - are being mined every year, ending up in a huge man-made lake having been doused in acid and chemicals to recover the minerals. Witnesses talk of *"…cauldrons of sputtering acid and ore amid acrid fumes"*.[75] This giant toxic dump is also radioactive because thorium is a by-product of rare earths extraction. Plants, animals and humans living in the vicinity have been severely affected, with unusually high rates of cancer, osteoporosis, and skin and inflammatory diseases. The radiation levels in the lake are said to be ten times higher than in surrounding areas.[76] The toxic tailings pond (which is actually a lake) covers more than ten square kilometres. Whilst the water, which is over 6 metres deep, holds by-products of rare earths and iron extraction processes, including leftover rare earth elements, heavy metals such as niobium and other substances. Underground water has been polluted by the pond and nearby wells have turned yellow with foul smelling white foam lingering on the surface.[77]

The story is similar in the Jiangxi province of southern China, where the countryside is dotted with hundreds of small open-pit mines into which miners pour water and chemicals, producing a sludge rich in rare earths and toxins. As reported by the Financial Times: *"Farmers in Jiangxi have mastered the art of small 'leach' mines, which often use high-potency fertilizer to dissolve the rare earths and have left the countryside scarred with barren tailings ponds and eroded hilltops"*.[78] According to China's Ministry of Industry and Information Technology, repairing the environmental damage in Ganzhou in Jiangxi province will cost a total of 38 billion Yuan (US$6 billion).[79] Despite the enormity of this figure, it still fails to convey the magnitude of the cost of this toxic legacy, which will be felt for generations to come.

For years, China has been supplying the market with sufficient volumes of rare earths and at cheap prices. In line with conventional economics, the true cost of extracting rare earths has not been factored in – the damage to the Earth and communities is simply not part of companies' bottom lines. China has, belatedly, become more aware of the ecological mayhem it has created, and of the scale of smuggling taking place from hundreds of small-scale operations across the country.

If we add into this equation the relentless increase in domestic demand (China itself could become a net importer by 2015), it makes perfect sense for China to have introduced an effective control of the amount of rare earths it is exporting – a control which is having four major consequences:

1. A huge increase in the levels and volatility of prices.

2. A big drive internationally to develop new supply outside of China. To date there are over 350 'commercially interesting' rare earth projects, mostly in early stages of recognition, with up to 50 or so at varying stages of advanced exploration and development.

3. A giant geopolitical battle is under way, with the US, Europe and Japan mounting a legal challenge to China - through the World Trade Organisation (WTO) - for 'unfair' commercial practices and for export restrictions on rare earths, tungsten and molybdenum.[80]

4. Governments have recognised the risk posed to their industries, and even to their own security, by potential shortages of critical minerals – be they commercial, political or physical shortages. As a first step, many have responded by identifying what minerals are most at risk. The USA's Department of Energy for instance released a report in December 2011: 'Critical Materials Strategy',[81] analysing the minerals most at risk in the clean energy supply chains: wind and solar power, electric cars and other 'green' energies are indeed big consumers of technology minerals.

We live in an increasingly technological world and technology minerals are becoming of paramount importance – for our electronics, for green energy and for all sorts of other industrial, medical and military applications. The world has woken up to the reality of vulnerable supply chains, with many elements only produced in a limited number of places. The immediate consequence is a race to find and secure these minerals – almost at any cost. By stirring up the competition between nations, this hunt is having (and will continue to have) a devastating impact on the Earth. For governments and companies alike, the last remaining patches of wilderness count for very little with so much at stake in the short-term. More than ever, it is essential to realise the consequences of our behaviour as consumers, recognising the link that unites our electronic machines with the stress this is putting on the Earth. Upgrading our smartphones every 18 months is simply not an option if we want our children to inherit a viable planet.

LITHIUM: the white gold

Among the myriad metals and minerals currently in use in the world, lithium has been one of the biggest growth areas of the last decade. 2011 figures from the United States Geological Survey (USGS) showed that worldwide lithium production (excluding US production) increased 25% from 2010, and 77% compared to 2009.[82] The reason is simple: it has a great capacity to store energy and thus, is key in the production of rechargeable electric batteries. With the world's attention focused on finding alternatives to fossil fuels, the ability to store electricity has become a major challenge and the lithium-ion battery is currently leading the way.[83]

Representing 30% of lithium's current uses, batteries are expected to represent 50% of lithium's demand in the next ten years (other uses are in glass, ceramics and lubricants). Lithium demand itself is expected to see average growth rates of 10% annually in the next ten to fifteen years (translating into a doubling of demand every seven years).[84] Lithium battery technology is critical to President Obama's energy plan, as a first step towards transforming electric cars into a major clean energy revolution for transportation, with billions of dollars earmarked for the development of the sector. The consulting firm Pike Research estimates that the global market for lithium-ion batteries could grow from US$877 million in 2010 to US$8 billion by 2015.[85] But electric cars are not the only application for lithium-ion batteries, as consumer electronics are also increasingly dependent upon them for their energy supply, albeit on a different scale - it is estimated that an iPhone requires 5g of lithium carbonate while an electric car needs 30kg.[86]

The production of lithium is concentrated mainly in four countries: Chile, Australia, China and Argentina, accounting for 95% of total production.[87] A vast number of projects are now being pursued worldwide to meet expected demand, so much so that some analysts are now forecasting an excess in production of lithium in years to come.[88] Looking forward, the focus is clearly on the arid region of the Puna Plateau in the Andes, where the borders of Argentina, Bolivia and Chile meet. Made up of the the Salar de Atacama (Chile), the Salar de Uyuni (Bolivia) and the Salar de Hombre Muerto (Argentina), this region is often referred to as the 'Lithium Triangle' and is said to hold 80% of known reserves. The three countries above are known as the Lithium ABC's and Forbes magazine has called the region 'The Saudi Arabia of Lithium'.

6. MAP INSET: SOUTH AMERICA'S LITHIUM REGION

Photo: Salar de Uyuni, Bolivia / Shutterstock

The Salar de Uyuni, the world's largest salt lake, located at an altitude of 3,656m above sea level, is said to hold the biggest reserves. Since the demand for lithium is projected to more than double by 2020, most of the production needed to satisfy the market will come from this region.[89] At the moment, both salt flats in Argentina and Chile are under production. Bolivia holds the largest reserves of lithium containing up to 50% of total world reserves[90] (although what is really recoverable is disputed). Bolivia has not yet exploited its reserves, however, President Evo Morales announced the opening of a pilot plant in Llipi, on the edge of the Uyuni salt flats in January 2013.

Rising global demand for lithium used in 'green' technologies threatens to create an enormous ecological wasteland. Complaints from people living in Argentina's Salar del Hombre Muerto have emerged showing that lithium operations are contaminating air, water and soil used by rural populations.[91] More importantly, water intensive mining and water scarcity is an issue for the livelihoods of the people living in the region. An imminent risk remains as demand for lithium increases: the exploitation of these deposits will undermine the livelihoods of local communities, especially their agricultural production of quinoa, livestock, tourism, and salt extraction.[92]

COBALT: the king of critical metals

Cobalt has for a long time stayed under the radar but its varied applications and its importance in lithium-ion batteries are making it one of the most sought-after metals in the world, with the electronics industry accounting for a quarter of its uses. The name is said to arise from the Erzgebirge region of Saxony that was a silver mining area. The term "Kobald" referred to spirits (gnomes) who frequented the mines causing trouble. The problems were due to cobalt interfering with the silver smelting, causing respiratory problems to the miners (cobalt is arsenic-containing compound). Although it is one of the 30 most abundant elements within the Earth's crust, its low concentration (0.002%) means it is usually mined as a by-product of copper and nickel mining. A large percentage of this is mined as a by-product of copper extraction in the DRC and Zambia, and the rest as a by-product of nickel extraction in the rest of the world (China, Canada, Russia, Australia, Cuba).[93]

The story of cobalt brings us back to central Africa, and especially to the DRC, by far the most significant producer of cobalt in the world (accounting for half the world's production). The challenges associated with cobalt production in the DRC are both similar and of a somewhat different order from what has been previously encountered with the three T's - Tantalum, Tin and Tungsten. Although some proceeds from its extraction inevitably fall into the hands of armed groups, making cobalt eligible as a conflict mineral, it is mainly governments and corporations exploiting and reaping the economic benefits. As the main manufacturing centre for IT products, Asia is a major importer of the metal. China in particular, despite producing its own, is heavily dependent on cobalt imports for the mass production of electronic items, with a reported 90% of imports coming from Central Africa.[94] These items end up, for the most part, on European and American markets, so in effect, Western consumers are the main consumers of cobalt, but it is Chinese companies and China's government that are at the forefront of the extraction of the metal in Katanga (DRC) and Zambia.

Many criticisms have been levelled against Chinese corporate behaviour in Katanga and Zambia. In 2009, RAID (Rights and Accountability in Development) issued the report, *Chinese Mining Operations in Katanga, Democratic Republic of the Congo*.[95] It is based on direct interviews with employees, both Chinese and Congolese, working in the many Chinese companies established in Katanga – miners, traders and smelters. The results showed the distinct set of problems experienced by both sides. Issues included: dangerous working conditions, little or no health and safety regulation, child labour, discrimination, beatings, and non-compliance with Congolese laws and environmental standards. This was, according to the report, all compounded by the inefficiency of the Congolese police force in dealing with the problems.

The point here is not to single out China. Western operators are accused of similar malpractice. One of them, Glencore, the biggest commodities trader in the world (which bought a 77% share in Katanga Mining Limited (KML) for US$250 million) has been repeatedly accused of human rights abuses, child labour, pollution and tax evasion in the DRC. Swiss NGOs - Bread For All and the Catholic Lenten Fund, published a report in 2012[96] accusing Glencore of taking advantage of corruption and state absence to ensure large profits. In response, a spokesperson for Glencore denied the allegations, claiming that the company has invested $23 million in social and environmental projects since 2008, and some of the issues exposed in the report were inherited issues from previous mine operators.[97] The issues remain however, and the problem is not confined to the DRC: similar examples are readily found in neighbouring Zambia.

Another major issue is the ecological damage caused by the joint extraction of copper and cobalt. In 2005 a comprehensive study, funded by the World Bank and the Nordic Development Fund, revealed that the mining industry had caused significant damage in the Zambian Copperbelt. The area is blighted by the toxic legacy of over five hundred years of mining – disused mines, tailing ponds and mine waste. The research team concluded that the most significant contamination was being caused by ongoing mining, processing and smelting operations. Assessments of the Kafue River that runs through the Zambian Copperbelt and has historically sustained one of the world's greatest wildlife ecosystems, showed that waste material from mining activities had polluted water affecting aquatic life downstream.[98]

In the DRC, Katanga is marked by a long history of ecological damage caused by mining activities. Damage which has even given rise to a special term, 'the Katanga Syndrome', which describes the problems associated with resource extraction, especially in countries with weak environmental legislation and economies geared toward raw material extraction for export. Mining activities in Katanga have led to irreparable destruction of the ecosystems with waste samples showing high levels of arsenic, cadmium, lead and zinc that cause damage to humans and the river fauna.[99]

COPPER: the essential metal

Copper is essential to all living organisms as a trace dietary mineral. In humans, it helps our bodies to make red blood cells and keeps nerve cells and immune system healthy. It is a base metal, the third most mined metal in the world, and it is a vital constituent of our industrial world. It was also one of the first metals ever extracted by man - mined almost 10,000 years ago for coins and ornaments, and later alloyed with tin, leading to the Bronze Age 5,000 years ago.

Copper is easily stretched, moulded, and shaped; it is resistant to corrosion and conducts heat and electricity efficiently. Today its applications range from building construction, power generation and transmission, electronic product manufacturing, and the production of industrial machinery and transportation vehicles. Copper wiring and plumbing are integral to the telecommunications links used every day in homes and businesses. The average car contains 1.5kms of copper wire, and the total amount of copper ranges from 20kgs in small cars to 45kgs in luxury and hybrid vehicles.

It is estimated that every American who was born in 2008 will use 595kgs of copper in his or her lifetime.[100] Much has been said of the crucial role played by technology metals and minerals but in the vast scheme of things copper is much more essential to our technological world. So much so that given its prevalence in so many different applications, copper has gained a reputation as a bellwether for economic activity and thus been nicknamed Doctor Copper, "the only metal with a PhD in Economics".

The scale of copper mining is huge: the biggest open-pit mine in the world is the Bingham Canyon Copper mine in the US – it is 4 kilometres wide and more than a thousand metres deep. Copper deposits are also frequently associated with gold, as with the giant Grasberg mine of Indonesia and the Pebble Mine project of Alaska. Both operations have attracted much criticism. Rio Tinto and Freeport McRoran have for instance been excluded from the investment portfolio of the Government Pension Fund of Norway, the world's second-largest pension fund, due to criticism over the environmental damages caused by the Grasberg mine. The Pebble Mine is being ferociously opposed by environmentalists and local populations, concerned by the impact of waste water, waste rock and mine tailings on the Bristol Bay in Alaska.

As stated by Jack Caldwell, a respected mining columnist, more used to promoting the mining industry:

> *"Do we need yet another gold mine? Do we need a gold mine in every state and county? Surely there are some places we just should not mine? Surely at least once, we should put food ahead of gold?" And: "I oppose the [Pebble] mine for the very simple reason that I know we cannot build waste rock dumps and tailings impoundments to last forever and never be subject to the inevitable forces of geomorphology. I repeat what I have written before: (a) prove there is no need for perpetual water treatment; (b) prove that you can walk away at the end of mining and not do long-term surveillance & maintenance; (c) show how the waste facilities will perform in the next 1,000 and 10,000 years; (d) prove that there is zero probability of failure and zero probability of fish impact. Unless you can satisfy me, you should not be allowed to mine".*

A courageous stance, all the more remarkable since it was voiced on Mining.com, an industry website mostly reporting on commodity prices, mining exploration, mine development and mining company activities.[101]

Dikes at an open pit copper mine / Shutterstock

METALS AND MINERALS DEPLETION AND FINANCIAL SPECULATION

The inclusion of copper in our report is important, as it highlights two different sets of problems increasingly associated with metal extraction: the depletion of metals and minerals and financial speculation.

Metals and minerals depletion

Copper exemplifies one of the problems encountered today by miners: ore degradation. Today, the same amount of ore dug up from the ground yields much less metal than was previously the case. In the US for instance, the average grade of copper ore has fallen from about 3% in 1900 to 0.5% a hundred years later. A similar picture emerges in Australia with gold (from 0.0025% to 0.00025%) and lead (from 15% to 5%).[102] In fact this situation can be observed for almost every metal in the world and it is a consequence of the mining activities of the past because all of the 'easy catches' have now been made. The consequence of this degradation is not an immediate shortage of materials as such, but a profound intensification of our human impact on the Earth. More energy and more water are needed, more pristine areas are desecrated and more aggressive techniques are employed in order to extract similar amounts of metal. Compounding the problem further, is the increase of metal demand and consumption.

As an example Chile, the biggest producer of copper, accounting for a third of the world's supplies, has been experiencing one of the most dramatic falls in production as a consequence of ore degradation.[103] At Escondida for instance, the world's most productive copper mine, the average copper content of the ore being mined fell from 1.72% in the final quarter of 2007 to 0.97% at the end of 2011, with production falling 7.9% in just one year, between January 2011 and 2012.

Similar stories are found at Chuquicamata, the world's number two mine, and Collahuasi, the world's number four. All in all, Chilean production dropped 8% from January 2011 to 2012, and 20% from December 2011 to January 2012.[104] In order to sustain and increase production, billions of dollars will have to be spent. Diego Hernandez, former head of Codelco, the world's biggest copper mining company, claims that electricity usage in the copper industry will need to increase 27% in the coming years, as companies need more power to get copper out of the mined minerals.

But power has to come from somewhere, and public opposition on environmental grounds, to planned projects such as the Hacienda Castilla coal-fired power plant or the US$3.2 billion HidroAysen project is mounting fast.[105]

Financial speculation

Copper has been traded on the London Metal Exchange (LME) ever since its foundation in 1877. Exchanges such as the LME have been created in order to standardise the sale and purchase of various 'natural resources', agricultural or industrial. Their main goals were to facilitate the exchange of these minerals and metals, facilitate price discovery (determining the price of metals on the basis of supply and demand) and provide a hedging tool against future price fluctuations for both producers and consumers. Increasingly though, and particularly towards the end of the 20th century, commodity markets have been used for pure financial plays, speculatively, first on their own, in isolation from other commodities, and then as one element among many others in complex portfolios. Portfolios that include anything from commodities (from sugar to oil, from orange juice to copper), currencies, bonds, stocks and various increasingly sophisticated financial products.

In this way, exchanges have deviated from their original mission – they are now mere tools in vast financial strategies and the price of a commodity can be quite disconnected from the physical reality of the market based on pure supply/demand fundamentals. Gold is a typical example: its value as a 'financial haven', as a hedge against currency moves, geopolitical tensions and financial policies such as money-printing, plays as big a role in its price as it does in its supply and demand equation. Financial speculation tends to exacerbate potential imbalances in a market, if not outright create them.

Whilst one may think that financial plays are disconnected from the physical reality of a metal, the opposite is true. When prices are artificially inflated on the back of financial speculation, the incentive to dig up and produce is more acute than ever, with immediate consequences for Earth. Gold is a case in point once again. The current high prices are encouraging hundreds of thousands of small miners to aggressively search for the metal, at tremendous cost to the environment, as seen in the Amazon and in Africa. It is also encouraging companies to develop ever more gold mining projects: according to MEG (Metals Economics Group) half the exploration budgets of companies in 2011 were dedicated to gold, with copper in second place.[106]

Electronics factory in Shenzhen, China / Bartlomiej Magierowski / Shutterstock

MANUFACTURING:
BLOOD, SWEAT AND TEARS - THE TRUE COSTS

"We are like prisoners…it seems like we live only to work. We do not work to live. We do not have a life. Only work."
- Teenage worker at the KYE Systems factory, China.[107]

As we have seen, the level at which we are consuming electronic products is driving the extraction of a vast array of minerals and metals, despite their lessening availability, and with significant social and ecological impacts, or 'externalities' as an economist would call them. It is important now to turn to another facet of the product cycle: the manufacturing phase. This phase has become emeshed in a complex and highly specialised framework of activities, and takes place in an ever-growing capital, labour-intensive and inter-dependant system. The sheer scale of demand among leading electronic companies has created the need to decentralise and expand manufacturing. 'Delocalisation' or 'outsourcing' as it is known, has become a pathway via which companies can increase production without actually operating or directly controlling the entire manufacturing process. The increase of players in a wider and more complex web of processes has however, been accompanied by growing concerns over regulations and working conditions, ecological impacts, and overall corporate responsibility.

WORKING AND LIVING CONDITIONS

The increasing demand has not only brought a rise of investment capital and employment in emerging countries, but a myriad of new concerns. There is growing evidence that factories, brand-name corporations and governments are neglecting human rights in many of these countries as a result of the systematic pressure to deliver products on tight schedules and at low prices.[108] The exploitation of workers in consumer electronics supply chains of many Asian - especially Chinese – factories has been widely documented over the last few years.[109] Local governments are alleged to succumb to pressure from factories and brand-name corporations and not enforce existing labour laws in order to keep production costs low. As a result of this, workers are likely to face low pay, excessive working hours, a wide variety of labour rights violations, health and safety risks, and a lack of social benefits related to retirement and mental and physical health.[110]

A catalogue of misgivings, pointed out repeatedly in a number of reports (see endnotes) show that intimidation, exhaustion and labour rights violations have occurred in many manufacturing companies. This mistreatment affects those making products for Western companies including Apple, Amazon, Hewlett-Packard, Dell and Nokia. Issues vary but can be grouped into the following:

- **Overtime:** Given the drive to meet global demand, factories rely on employees working overtime, but the way in which it has been applied is often illegal and inhumane. For example under Chinese Labour Law, work must be limited to eight hours per day, and any overtime must be limited to 36 hours per month.[111] Often, however, during peak seasons, workers spend 80 to 90 hours per month working overtime, as suppliers are under great pressure to meet large quotas and overtime even becomes mandatory.[112]

- **Abuse:** In order to maintain productivity and control over manufacturing processes, issues have emerged which have included humiliation, verbal harassment and physical abuse of workers during shifts, being shouted at for minor mistakes, and forced to recite quotations.[113] Some of these incidents are a form of punishment and others are arbitrary.[114] It has been reported that workers have also been committing suicide at an alarming rate.[115] The reported wave of suicides at Foxconn,[116] the world's largest electronics contract manufacturer measured by revenues, dramatically highlights the problem.

- **Discrimination & child labour:** One of the main issues that appear in reports and investigations into manufacturing companies, highlight instances of underage workers or recruitment discrimination due to age, gender and the infirm (e.g. Hepatitis B). The legal working age under Chinese law is 16 and factories often hire 'student interns' or 'work-study' students, recruited from schools, to avoid paying the social security insurance required for adult employees.[117] According to the National Labour Committee, an NGO that investigates and exposes human and labour rights abuses against workers in China, factories hire students because they are "easy to manage and control".[118]

Like their adult co-workers, these 16 and 17-year-olds work shifts in excess of 12 hours and frequently work nights. They are also exposed to the same hazardous conditions as adult workers at workstations where they are required to perform dangerous tasks, often involving toxic chemicals.[119]

- **Health & Safety:** Long working hours and conditions have generated further concerns, with workers complaining of muscle strains, eye problems, allergies, dizziness, exhaustion, burn injuries, cuts, chest pains and weight loss.[120] These persistently bad working conditions lead to long-term problems.

- **Wages:** Minimum wage or living wage? A living wage is a wage that covers the cost of food, housing, clothing, medical care, education as well as providing some savings. Despite increases in the legal minimum wage in 30 provinces of China, factory workers in the electronics sector suffer low wages that violate the workers' right to an adequate standard of living and are insufficient to overcome rising food and living expenses.[121] In Shenzhen, China for example, electronics workers interviewed by Make IT Fair reported that they find it very hard to live on the minimum wage that most employers offer as basic wages for full-time work because of the high prices for accommodation and housing. Therefore most have no option than to stay in the factory dormitories and rely on overtime to make ends meet.[122]

According to research given to *The Guardian*[123] by the Centre for Research on Socio-Cultural Change (CRESC), the cost of assembling the iPhone 4G in China is US$178.45. This compares with a selling price (including applications) of US$630. Thus Apple makes US$452 on each phone, a difference of 72%. The cost of labour accounts for a tiny proportion of the company's costs, just US$7.10 for each phone, which accounts for about eight hours of assembly. It is well understood that a major factor in a company's success is the ability to control costs, but at what costs to their workers?

Overall, the issues highlighted so far have been a matter which the manufacturers of electronic products would rather keep quiet; these modes of operation have helped companies keep a distance from the production processes. They claim that what happens inside the factory is out of their reach - an argument which is true, technically speaking, but which disregards the particular responsibility that these companies have, especially due to their immense commercial leverage.

With each passing day it becomes more difficult [for factories] to obtain contracts ... without hiring child labour, cheating workers on overtime pay, imposing merciless quotas and operating unsafe facilities.

In early 2012, Apple published a list of 156 suppliers[124] as they had become increasingly conscious of the damage that failing to account for the actions of their suppliers was having to their reputation. Tim Cook, Apple's CEO, is at pains to explain that his company is putting, "a ton of effort" into addressing the issues, especially overtime. Apple has, for instance, mandated the Fair Labour Association to investigate working conditions at Foxconn - the biggest manufacturer, accounting for a massive 40% of the world's electronics products with a workforce of 1.2 million people.[125] Unsurprisingly, the report "*...observed at least 50 issues related to the FLA Code and Chinese labour law, including in the following areas: health and safety, worker integration and communication, and wages and working hours*".[126]

For critics, the marketing model of electronics giants itself only compounds the problem. By creating massive hype around the launch of new products, the pressure on contracted manufacturers to deliver huge volumes on time becomes immense. As David Korten writes in When Corporations Rule the World, "*with each passing day it becomes more difficult [for factories] to obtain contracts from one of the mega-retailers without hiring child labour, cheating workers on overtime pay, imposing merciless quotas, and operating unsafe facilities*".[127] It is well-known for instance that Apple's main bottleneck on sales is that it cannot get enough products to the market on time – simply put, supply never manages to catch up with demand. Illustrating this, is the explosion at an iPad factory in Chengdu in May 2011, killing three workers and injuring fifteen. The workers were inside a building that was still under construction even as they were "*frantically assembling iPads*".[128] Nonetheless, with vast volumes of capital at stake, the competition between manufacturers of a country, or between countries, to attract these mega-contracts and generate local employment is intense and continuous. Therefore issues of worker safety are often compromised.

These problems are industry wide and are by no means limited to Apple, but its reputation as a 'cool' brand, an innovator and a market leader as well as one of the largest companies in the world makes it particularly exposed to criticism. It also gives the company a particular responsibility with regards to the modus operandi of its supply chains. Profits skyrocket yet wages remain comparatively meagre; with an imbalance of gigantic proportions between the few at the top and the multitude at the bottom, not only in terms of salary but in every dimension that makes a human being – his or her work, living conditions and social environment. The Earth is paying the price too; as voiceless as the workers in the factory assembly line.

ECOLOGICAL CONTAMINATION AND DAMAGE

Underpinning the issues presented above is a growing list of ecological impacts generated at the manufacturing stage of the supply chain of electrical and electronic equipment (EEE).

Because of China's growing share of global EEE production, it is important to look into the impacts generated by this economic powerhouse. The country's electronic manufacturing sector has seen a dramatic and rapid expansion in the past decade, contributing to an intensive reliance on energy and water, and importantly on the use of hazardous chemicals. The processes involved in the manufacturing of electronic components have produced large amounts of contaminated wastewater (with heavy metals), and waste gases (lead and tin fumes), which have resulted in widespread environmental pollution.[129]

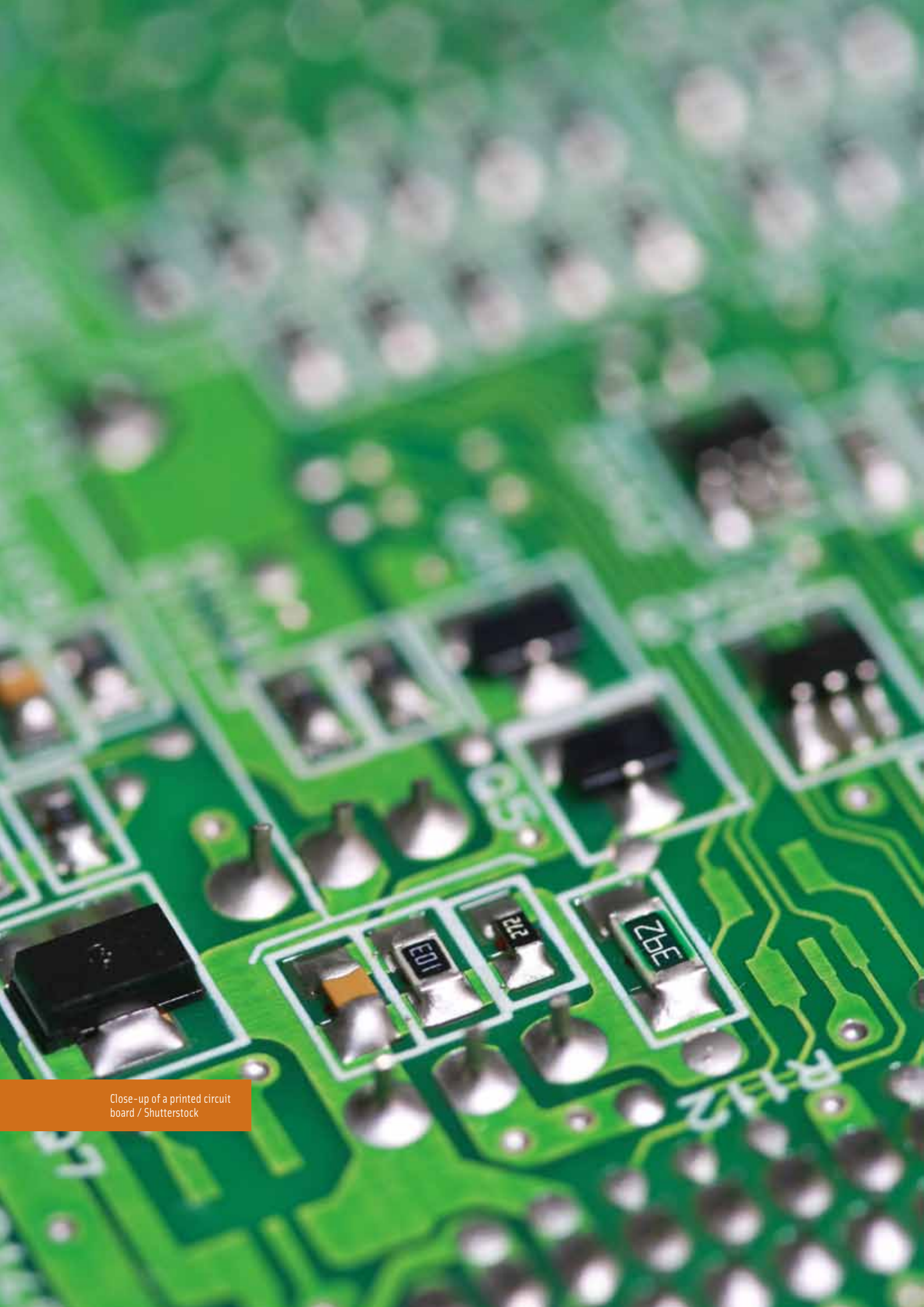
The production of printed circuit boards (PCBs) in particular, highlights the issues. Over the years, China has become the leader in the production of PCBs, which are at the heart of electronic equipment such as smart-phones and tablets.[130] Consequently, the large scale of many PCB manufacturers operating in China means that the volume of hazardous waste being generated has been huge, posing a major potential risk to public health and ecological safety.[131] The risk of pollution in the manufacturing of these is high, due to the large volumes of water required, chemicals and treatment methods, and the need for multiple repetitions of phases such as etching and cleaning.[132] Furthermore, the diverse range of chemicals used in manufacturing limits the effectiveness of waste treatment facilities in addressing the issue.[133] Studies conducted by a coalition of different national and international organisations, demonstrate that in China, the current use of carcinogenic chemicals and unsuitable practices in the manufacture of PCBs is resulting in the contamination of streams, rivers, lakes and impacting air quality in the vicinity of these industries in China's industrial hubs.[134]

The case of Wuhan Meiko Electronics, a Japanese listed company in the province of Guangzhou, illustrates this. An investigation conducted by the Institute of Public and Environmental Affairs (IPE) found that the factory's storm water discharge channel and the nearby Nantaizi Lake were both seriously polluted with carcinogenic chemicals. The company had not been disposing of waste water in the appropriate manner and had disregarded the possible effects on the local community, including people, animals and the broader ecosystem on which they depend. This was through the infiltration of pollutants into ground water and soil.[135]

Given the rapid increment in the production of EEE in general and PCBs in particular, the concern over the use and disposal of hazardous chemicals and materials has been mounting in China. However, the enforcement of legislation and monitoring is still insufficient. A multitude of companies[136] have been found to continuously violate environmental rules, while complaints from locals suffering from a rise in cancer cases are usually undermined or not appropriately addressed. What we see happening in China is true wherever manufacturing is taking place.

While there might be a growing willingness of some manufacturers to accept responsibility for their ecological stewardship of their products (e.g. Apple),[137] this has not yet been widely matched by an effort to make manufacturing processes more environmentally responsible across EEE lifecycles and supply chains. The manufacturing phase of electronic products is critical and problematic, not only because of its ecological repercussions, but because it is incredibly complex. It relies on an array of different components, manufactured in numerous facilities in a number of different countries.[138]

The outsourcing and overall globalisation of these processes has consequently created a disconnection in the supply chains. The monitoring of PCB suppliers for example, is highly challenging because the suppliers are upstream in a company's supply chain, making it harder for a company to manage them. Furthermore, addressing the ecological problems and installing pollution prevention measures among PCB manufactures requires high levels of investment which some suppliers are reluctant to make. In addition, the ecological issues can be very complex, which further encourages suppliers to inadequately address them, if at all. This in turn makes the use and monitoring of hazardous chemicals in the manufacturing phase extremely difficult.



Close-up of a printed circuit board / Shutterstock

2. LIFE EVER SHORTER
Product Life-Span

The previous chapter looked at the beginning stage of the lifecycle of our electronic products. It explored the origin of the materials dug from the Earth, (though the true life story of these metals and minerals began millennia ago when they were formed), and how they are processed and manufactured into the gadgets we use every day. More importantly it exposed some of the underlying 'externalities' or unaccounted for impacts that their production is having on the Earth and people along the supply chain. This chapter will shed light on the factors at play in the product design phase and in the way we use our electronic products.

As we have seen, the number of mobile-connected devices is on course to exceed the number of people on Earth by the end of 2013, and by 2017 there will be over 10 billion mobile-connected devices, for a population of 7.3 billion.[139] This tidal wave of consumption, with its inevitable consequences for Earth, is the result of three main factors: population growth, marketing strategies, and planned obsolescence.

The expansion of virtual connection

The proliferation of mobile-connected devices reflects the way in which a globalised world is becoming more and more digitally linked. This means it is increasingly difficult to function in the world if we are not connected. There are also many practical advantages in various contexts, for instance, mobile banking is enjoying considerable success in Africa, and helping people with limited access to electricity or financial services to enjoy some of the facilities taken for granted in Europe or the USA.

In this sense, being connected does indeed mean what it is supposed to do: it breaks isolation, which is often due to accessibility, poor infrastructure and social exclusion.

7. HIGH-END DEVICES SIGNIFICANTLY MULTIPLY MOBILE DATA TRAFFIC

* monthly basic mobile phone data traffic

Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017. p.9
Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf

As a result, Africa has experienced an incredible boom in mobile phone use over the past decade, with figures increasing from fewer than four million mobiles on the continent in 1998 to more than 500 million today.[140] These trends have also been followed by a rapid expansion of mobile governance (m-government) and mobile commerce (m-commerce) which have allowed a better flow of information between citizens and governments or businesses, and added new dimensions to the role of mobile phones in a growing capitalist and globalised world.[141] M-commerce is predicted to reach US$119 billion in 2015, with Japan the uncontested leader, while in the US, the m-commerce market will be US$31 billion by 2016.[142] With constant improvement in broadband technology and increasing numbers of devices, mobile data traffic is also consequently expanding at incredible rates.

This is further accelerated by continual upgrades in design and functions. The development of technologies and features that come with each new generation of 'high-end' handsets, tablets, and laptops generate significant increases in mobile data traffic, because these devices offer the consumer both content and applications not supported by previous generations of mobile devices. A single smartphone can generate as much data traffic as 50 basic-feature phones; a tablet as much traffic as much as 120 basic-feature phones; and a single laptop can generate as much traffic as 368 basic-feature phones.[143]

The consequence for the Earth of producing these billions of new devices - the 'hardware' - has been partly covered in the previous chapter and will be further examined in the next; but what about the management of the data that feeds this hardware? Often assumed to be virtual – that is, immaterial, with no physical reality - the staggering increase in mobile data traffic, and the need to store, exchange and generate this data in order to feed our mobile devices presents new challenges.

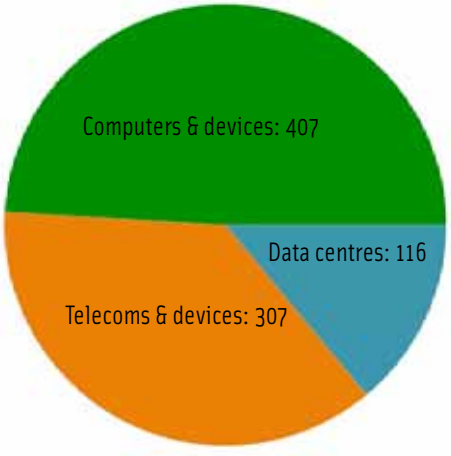
Data is hosted in massive 'cloud' data centres that can be measured in multiples of football fields. The concept of the 'cloud' is a nice and convenient metaphor that compounds the perceived absence of physical reality of this data and conveys notions of cleanliness and remoteness. The growth and scale of investment in the cloud is truly mind-blowing, with estimates of a 50-fold increase in the amount of digital information by 2020.[144] However with this growth is the question of how clean the storage of this data or cloud is? Data centres have been described as, "...the factories of the 21st century information age, containing thousands of computers that store and manage our rapidly growing collection of data for consumption at a moment's notice".[145]

The concept of the 'cloud' is a nice and convenient metaphor that compounds the perceived absence of physical reality of this data and conveys notions of cleanliness and remoteness.

Leading companies such as Facebook, Amazon, Apple, Microsoft, Google, and Yahoo, among others, rely on cloud data centres, many of which can be seen from space. They consume a tremendous amount of electricity, some the equivalent of nearly 180,000 homes. Unfortunately, despite the tremendous innovation they contain and the clean energy potential they possess, many IT companies are rapidly expanding without fully considering how their choice of energy could impact society.[146] The report: Make IT Green: Cloud Computing and its Contribution to Climate Change, released by Greenpeace in 2010,[147] suggests that electricity consumption of data centres may be 70% higher than previously predicted. To understand the scale, demand in 2007 was approximately 623 billion kilowatt hours (kWh), meaning that if the cloud were a country it would have the fifth largest electricity demand in the world.

8. ESTIMATED GHG EMISSIONS OF INFORMATION AND COMMUNICATION TECHNOLOGY SECTOR

GHG (MtCO2e = Million Tonnes Carbon Dioxide Equivalent



Data source: Fig. 2.3 The global footprint by subsector – 2007 figures. SMART 2020: Enabling the low carbon economy in the information age. (2008). Climate Group and the Global e-Sustainability Initiative. p.18.

Network cables and servers in a technology data centre / Shutterstock

More worryingly, *"based on current projections, the demand for electricity will more than triple to 1,973 billion kWh, an amount greater than the combined total demands of France, Germany, Canada and Brazil"*.[148]

From the above discussion, we come to understand that our current consumption of electronic products does not only pose issues in its production, but also in their use - the cloud is not the clean, virtual place it initially appears to be.

VIRTUAL (DIS)CONNECTION

The rapid rise in mobile communication over the last few years has inevitably changed the way many people communicate, socialise, organise, do business and shop. This has had various impacts in different parts of the world.

In the West, the increase in online shopping has meant that the marketplace for many people is now a home laptop or mobile phone where you can browse products, click to purchase, and receive delivery within the week. This has also spurned a whole new area of marketing – fora that used to be private places to connect with friends and family are now one of the biggest growth areas in marketing.

Online and social media marketing are set to expand dramatically in coming years, with marketing budgets for social media more than doubling over the next five years.[149] As a result, online shopping has changed the way people shop in Europe - 25% of residents of EU member states made online purchases in 2004, this more than doubled to over 40% by 2011, and it's forecast to rise to over 50% by 2014.[150] This means that this is the decade when the majority of Europeans will be online consumers - a shift which will have further consequences for communities. Online shopping bypasses all the human and communal relationships that happen in local shops or markets. Goods are transported from farm, to processor, to supermarket - and now a further severing of the links – packaged up and delivered to your door. Coupled with an increase in out-of-town shopping complexes, it has also changed the face of the High Street and is undermining the social value of high streets as hubs of towns and cities. It is predicted that up to 40% of high street shops in the UK could close over the next five years.[151]

A LIFE CUT SHORT: a business model designed to fail?

Today, it is extremely difficult to exist in the modern world without a mobile device – it is the most pervasive arena of communication, and if you are not part of this system you are likely to find yourself considerably isolated. The desire (and the need for some people), to own a mobile device is now quasi-universal, and who is to say that this is not a normal aspiration, given the benefits that come with digital technology? The purpose of this report is certainly not to undermine or belittle the desire to be connected, rather to invite a more conscious and careful use of these ubiquitous gadgets. We must recognise the strain we are putting on the Earth, and the consequences for the next generations. It is important to become aware of the connections between the product and the processes of their production, to acknowledge the physical reality behind what is essentially viewed and presented as 'virtual', and to find a way to curb uncontrolled consumption because the true cost is a burden too great for the Earth to carry.

And so this brings us to one of the most critical issues that we must address: the economic model driving the system is culpably flawed. Owning a device is all well and good, but our economic system wants more: it wants you to own more than one device, and it wants you to renew it, or them, as quickly as possible in order to make way for new ones. This is achieved through the accelerated and programmed obsolescence of these machines. In this way companies are able to hook us into ongoing and increasing consumption as we become an assured market for new products.

One way in which consumption is increased, is through the strategy employed by leading companies to constantly market new, innovative products that renders the previous ones obsolete and unattractive – Apple and its products is a case in point (see Box 1. page 53). This is reinforced by millions of dollars spent in advertising, public relations (PR) and social media strategies that create a huge hype around each new launch and drive 'the need' to update electronic products. For example, a study by Australia's CleanUp campaign[152] reveals that Australians are on average updating their mobile phones every 12-18 months.[153] Not content with replacing their devices more rapidly than ever before, it is increasingly common to own more than one device. According to Cisco, by 2016 one-quarter of mobile users will have more than one mobile-connected device, and 9% will have three or more mobile-connected devices.[154]

Computers and mobile technology have drastically altered the way we communicate, share information, shop and do business / Shutterstock

BOX 1: The Launch of a new iPad

On March 19, 2012, only three days after the launch of its new iPad (3rd generation), Apple issued the following press release: *"The new iPad is a blockbuster with three million sold - the strongest iPad launch yet. Customers are loving the incredible new features of iPad, including the stunning Retina display, and we can't wait to get it into the hands of even more customers around the world this Friday"*.[155] On launch day, polling a total of 165 eager buyers queuing up in front of a New York store, investment firm UBS found that while 46 % of iPad buyers were new to Apple's tablet, a huge 38% were upgrading from the original iPad.[156] And when was the original iPad launched? April 2010, a mere two years before. In three days, as per Apple's press release, 3 million new iPads were sold.

Assuming that this sample is broadly representative of the customer base of these products - if 38% of these buyers were indeed upgrading from the original model (not to mention the iPad 2 which came out in between these two models in March 2011), it means that 1.14 million customers have used their iPad for less than two years before rejecting it to make way for new and better. And this is only a three-day sale figure. Is the difference between the original iPad and the 3rd generation so big and the upgrading so essential that it justifies discarding a piece of equipment that has been dug from the Earth, with all the violent processes as seen in the previous chapters?

PLANNED OBSOLESCENCE

On June 18th, 2011, the people of Livermore, California held a big celebration in honour of a light bulb - the reason? 'The Centennial Bulb' had by then been lighting the local fire station for one hundred and ten uninterrupted years.[157] But why such a fuss over a bulb? One reason might be the contrast between the Centennial Bulb and the average bulb today, which only lasts between 750 and 1,000 hours, equivalent to 40 days of uninterrupted use.[158]

This story reminds us of how things have changed since there was skill and pride in making quality products that lasted. Now the drive for increasing profits through market expansion is the hallmark of the dominant economic model, and this phenomenon has increased throughout the 20th century. Products that were once meant to last, are no longer designed to. Even worse, they are often designed for a limited useful life. This is described as planned obsolescence.

Planned obsolescence is a big factor in pushing customers to replace their goods quickly, for the simple reason that they no longer work or are not able to perform the services they were once meant to. Repairing them is an option, but more often than not, they are more expensive to fix than to replace. It is a vicious circle, the costs of repairs are high because they are labour-intensive, and skilled labour in Europe and the US is expensive. Products are often designed in a way which means that they are difficult, if not impossible to repair. New items are cheap because they do not take into account the true costs of their fabrication: they are made in other countries, where labour is cheap (often the result of exploitation as seen in the previous chapter), and the cost to the Earth of making them is not included (i.e. air pollution, loss of biodiversity, deforestation, destruction of ecosystems, CO2 emissions, toxification of water etc).

Planned obsolescence is present in most items on the market today: electronic gadgets as well as clothes, cars, washing machines and fridges to name a few. We are presently bound to an economic model which promotes wasteful consumption, and continues to expand in speed and scope, while at the same time the Earth is fast running out of the capacity to produce these items, and to deal with the damage to our life support systems.

The situation is no different for information technology (IT) machines, although planned obsolescence can take more subtle forms. Often hardware does not keep up with software and has to be replaced for the simple reason that computers cannot handle the new generation of programmes appearing on the market.

As seen in Chapter 1, the processes involved in producing electronic products involves a severe assault on Earth. Everything should be done to extend the life of these items as much as possible so as to mitigate the impact on the Earth. But as we see, the way in which products are designed, effectively reduces the life of these products. This occurs on various fronts: commercial, technological, technical and aesthetic.

The current implications of this way of thinking and designing, clearly generates issues at all levels of the production cycle. This also produces a major challenge once the product reaches its death or life-end, in terms of recycling, re-use and disposal. These issues form the topic of the next chapter.

Zakaria Salifu, Agbogbloshie Market, Accra, Ghana 2010 / © Pieter Hugo / Courtesy of Stevenson, Cape Town Johannesburg and Yossi Milo, New York.

3. DEATH BY THE ROADSIDE
The End-of-Life Stage

In a perfect world, all electronic equipment arriving at the end of its life would be collected and properly recycled for two main reasons:

1. To make sure that toxic elements found in electronic products (i.e. lead, cadmium, mercury, plastics and the likes) do not affect the environment.
2. To re-introduce back into the manufacturing circuit, the elements (metals) that are available in discarded items so as to reduce the need for 'new' materials.

At present, we are dismally failing on both counts.

E-WASTE: a tidal wave of junk

The current runaway consumption discussed in the previous chapter, creates an acute problem: what do we do with the mountain of products that have reached the end of their useful lives? To get a clearer idea of the issue, consider that in 1990, 19.5 million tons of electric and electronic equipment (EEE) were produced and sold globally. In 2000, this number rose to 34 million tons, in 2010 to 57.4 million tons and by 2015 it is estimated to reach 76.1 million tons.[159] What happens at the end of the life of these products is another figure however; the UN estimates that 20 to 50 million tons of electronic waste (e-waste) is created every single year[160] which poses fundamental questions on how to address its disposal.

In Australia for example, a staggering 16.8 million TV sets and computer equipment reached their 'end-of-life' in 2007-2008,[161] only 9% of which were recycled and 88% sent to landfill.[162] In the USA, the Environmental Protection Agency (EPA) estimated that in 2009, 2.37 million tons of electronic equipment reached their end-of-life, of which only 25% of these tons were collected for recycling.[163] The rest ending up dumped or burned, contaminating air, water and soil – and effectively leaving the government, aid agencies, taxpaying consumers and future generations to pick up the cost of dealing with it.

The reality of these numbers and furthermore, the notion of 'recycling' itself, is confusing. A very tiny minority of the recycled e-waste is properly handled. The majority (80%, in the case of the US),[164] is actually shipped to developing countries in Asia or Africa where it is handled in appalling social and environmental conditions, creating a crisis of massive proportions. Various studies and reports show that West Africa serves as the major trading route of used EEE into the African continent,[165] with Ghana and Nigeria as the main import hubs,[166]. Huge dumping sites have also been created in India, Pakistan, Bangladesh and China.[167]

Yet, not all products arriving in Africa are technically e-waste (defined here as broken or irreparable EEE); among them are used and second-hand products that can still serve their purpose. With Africa keen to join the internet revolution, but having limited resources, some have advocated that these discarded products sent to Africa from Europe and the US could in fact create a win-win situation.

However, as the Basel Action Network (BAN),[168] a leading US charity fighting toxic waste, points out: "*Seen at ground level, the massive importation of used equipment is a success story seriously clouded by the smoke of a growing environmental and health disaster. The reality is that this burgeoning new trade is not driven by altruism, but rather by the immense profits that can be made through it and those involved are oblivious to, or unconcerned with, its adverse consequences. Too often, justifications of 'building bridges over the digital divide' are used as excuses to obscure and ignore the fact that these bridges double as toxic waste pipelines to some of the poorest communities and countries in the world. While supposedly closing the 'digital divide', we are opening a 'digital dump'*".[169]

The ongoing consumption of new and second-hand EEE, means that many African countries are now facing a rising tide of e-waste generated by this domestic consumption, and more importantly, are faced with the burden of dealing with it. Major findings from a UN report titled: Where Are WEee in Africa[170] reveals that in Ghana during 2009, around 70% of all imported EEE was used, and 30% of the EEE was determined to be non-functioning (and therefore should have been defined as e-waste). This meant that some of the EEE from that year was repaired locally and sold to consumers, but a significant amount was un-repairable and discarded.

Almost all the material imported or collected ends up in the hands of the informal, unregulated recycling sector, which performs the functions of collection, handling, manual dismantling, and open-burning to recover metals from e-waste material. These recycling activities take place on open ground where harmful substances are released. Unprotected workers, many of them children, dismantle computers, phones and televisions with little more than hammers and stones in search of metals that can be sold.

The burning of copper cables and wires, as well as computer monitors and old television casings, creates a dangerous accumulation of ash and partially burned materials at the burning sites. The insulation foam from refrigerators or old car tyres are often used as the main fuels for the fires, contributing to acute chemical hazards as well as emitting ozone depleting substances and greenhouse gases into the atmosphere.[171]

The inability to properly deal with hazardous waste is compounded by the following factors: lack of environmental laws and enforcement; lax worker health and safety; a cheap and disempowered labour force; inadequate medical care; little awareness of a communities' right-to-know; and few options - if any - for final disposal of toxic residuals.

STEMMING THE E-WASTE TIDE

The impact of toxic waste has been recognised by the international community for more than 20 years and there have been many different attempts made to deal with it. Among them are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted on the 22nd March 1989[174] and ratified by 178 countries. Prior to export, it requires the authorities of the sending state to notify the authorities of the prospective state of import and transit, to provide them with all relevant details of the shipment, and proceed only after receiving their consent (note: an importing state has a right to prohibit the import of hazardous or other wastes under Article 4(1) of the Basel Convention). This was followed in 1995 by the Amendment to the Basel Convention (the Ban Amendment), that prevented all exports of hazardous wastes covered by the Convention intended for final disposal, reuse, recycling and recovery.[175] Although initially opposed by a number of countries (e.g. US, Canada, Australia, Germany, Canada, Japan and the United Kingdom), the Ban Amendment has been increasingly accepted, and if ratified by enough signatories could become law.[176] However, until then, it is still legal for businesses in some countries to maximize profit by exporting toxic electronics to developing countries, even when this export is a violation of the laws of importing countries.

Other Conventions have been signed in the last fifteen years: the Rotterdam Convention, adopted in 1998 which came into force in 2004, creating legally binding obligations for the implementation of the PIC (Prior Informed Consent) Procedure.[177] Others include the Stockholm Convention on POPs (Persistent Organic Pollutants) a global treaty which requires party states to take measures to eliminate or reduce the release of chemicals that remain intact in the environment for long periods, in order to protect human health and the environment.[178]

Managing the e-waste stream however, will always be a challenge and opportunities for leakage are numerous. The OKO-Institute,[179] a leading European research and consultancy institute whose aim is to work for a sustainable future, estimates that 90% of illegal e-waste shipments from Europe are loaded into used cars shipped into containers. Additionally, used and end-of-life EEE are often declared as 'second-hand goods', 'private goods', 'for charities', 'for personal use', and 'miscellaneous'".[180]

Trying to stem the flow of e-waste is akin to the legendary Dutch boy who fought the dam's leak with his finger – but the dam here is leaking in many places. E-waste is generated by our wasteful attitudes and deficient designs, the result in fact of an economic system designed to be wasteful.

In addition to the attempts being made by the international community outlined above, there are efforts being made to deal specifically with this problem. Created under the umbrella of the UN, StEP (Solving the E-waste Problem)[181] for example, is trying to come up with alternative objectives:

- Optimise the life cycle of electrical and electronic equipment.
- Improve supply chains and close material loops.
- Reduce contamination.
- Increase utilisation of resources and promote re-use of equipment.
- Exercise concern about disparities such as the digital divide between the industrialising and industrialised countries.

Praiseworthy objectives, however what is needed is no less than a complete revolution in our economic modus operandi. 'Less bad' is clearly insufficient. As McDonough and Braungart write somewhat bluntly in their seminal work Cradle to Cradle, presenting the 'circular economy'; *"Relying on eco-efficiency to save the environment will in fact achieve the opposite; it will let industry finish off everything, quietly, persistently, and completely"*.[182]

PASSING THE POISONOUS PARCEL

A Story from India

Priti Mahesh of Toxics Link,[i] an environmental NGO dedicated to bringing toxics related information into the public domain, describes the plight of workers in India:

In a small room in the bylanes of Silampur in East Delhi, Aslam is busy breaking open computers. He's been doing this work for years at this recycling hub and knows exactly which parts are valuable and need to be separated. His tools are at hand: hammer, screwdriver, pliers and blowtorch.

He shares this 6 feet by 8 feet workplace with three other teenage boys. They work 10 hours a day for a meagre US$3.00-5.00 each. Aslam's friend Sabir is using a blowtorch to remove the so-called "jewels" (such as capacitors and integrated circuits) from the circuit boards. The small, poorly ventilated room immediately fills up with fumes, making the boys uncomfortable, but they wipe their eyes and carry on. They know these fumes. They inhale them every day. What they don't know is that they contain lead, a poison that permanently damages their lungs and kidneys.

Photo: Dismantling shop. Priti Mahesh, Toxics Link

In Tilla Shabazpur, a small village on the Delhi-Uttar Pradesh border, Suresh is busy trying to extract precious metals from printed circuit boards, using chemical poisons like concentrated nitric and sulphuric acid, caustic soda, mercury and arsenic. The hands of his wife Kajal, who works in the same unit, are a chequered map of cuts and bruises, from prolonged metal scraping and caustic soda exposure. The couple's two children, aged 3 and 4, play within this informal recycling junkyard, strewn with drums filled with acid, caustic soda and waste.

This is the daily story not just of Aslam, Shabir, Suresh, Kajal and their families, but of thousands like them working around India. More than a hundred thousand people are employed in these e-waste scrap yards, mainly concentrated in and around large cities. Men, women and children, spend 10 to 12 hours a day in this toxic environment, trying to salvage components or materials from discarded e-waste, with little or no knowledge of the hazards hidden in computers, televisions and mobile phones. The rudimentary recovery processes include physically breaking and segregating hazardous parts, open burning, and melting and heating lead and mercury-laden components. Residues and effluents are released into open drains or nearby vacant land, leading to water and soil contamination. There are large numbers of women and children engaged in these activities who are even more vulnerable to exposure. Low- cost, poor working conditions and cheap labour makes recycling a lucrative business: no one accounts for the environmental or health costs involved.[ii]

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i Toxics Link: http://www.toxicslink.org/

ii This case study can be found: UNEP (2011). *'Chemicals Management and Marine plastics' Our Planet*. p. 16. Available at: http://www.unep.org/pdf/op_april/EN/OP-2011-04-EN-FULLVERSION.pdf

Thorough and proper recycling, ('closing material loops'), is a key element in this strategy of mitigation but here again, we are collectively hugely deficient. Often, what is talked of as recycling is no more than 'down-cycling': materials are reused into lesser objects before becoming waste. This strategy buys a bit of time but is in no way a long-term solution. In fact it could even have the opposite effect, by giving people (consumers), a false sense of security, which encourages them to consume more by believing that their waste is properly handled.

RECYCLING - OR LACK THEREOF

As we have seen, rapidly growing consumption of metals and minerals has been triggered by the increase in human population, the economic push for 'development', and the drive by companies to promote new products to expand their market share and their profits. There is also a growing recognition that this cannot go on forever – the materials will run out. Abundant deposits of critical minerals and metals are harder to find, more difficult and expensive to access, and their extraction is causing enormous ecological and social problems. An inevitable knock-on effect of this is that the material supplies required by manufacturing companies are becoming increasingly unstable, with disruptive implications for businesses, as a recent PwC report- 'Minerals and metals scarcity in the manufacturing sector: the ticking time bomb'- highlights.[183]

So the trend is clear: the world is on course to use more and more metals, and if physical scarcity is not an issue (yet) for a number of these metals, their diminishing and uneven distribution, the political risks attached to their exploitation, and the sheer amount of mining that will be necessary to meet the growing demand, (and its consequences on the Earth), should in themselves be compelling enough to make sure that as many metals as possible are recovered from products reaching the end of their lives. Yet the reality is that our current recycling trends are constrained by a number of socio-economic factors.

For some metals, especially base metals, recycling has been under way for some time, with reasonable results. Iron and steel scrap for instance, are some of the world's most recycled materials and amongst the easiest materials to reprocess. The amount of recycled iron and steel in the EU is equivalent to 56% of its metal production output.[184] Aluminium is another widely recycled material – with some 40% of EU production based on recycled aluminium.

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Aluminium production is a huge consumer of energy and recycling aluminium uses only 5% of the energy required in its virgin production.[185] Approximately 70% of the zinc produced worldwide originates from mined ores and 30% from recycled or secondary zinc, while almost 80% of the zinc available for recycling is now believed to actually be recycled.[186] Metals are ideal candidates for recycling: they are never lost, (with very few exceptions, e.g. lead in paint), they are merely dissipated and transformed from one manifestation to another. They are also infinitely recyclable, the properties of a recycled metal being similar to a primary one.

But the notion of 'recycling' itself is multi-dimensional, and is dependent upon many different factors. Waste is produced at every stage of the life cycle of a metal. An effective recycling operation therefore involves more than just the recovery of metals from end-of-life products. Every stage of the life cycle must be properly addressed, due to the fact that a significant proportion of the metal is lost in the process. Often overlooked, primary supply is an important area because this is where metal is taken from virgin ores and as such it presents its particular brand of problems, especially for specialty metals.

RECYCLING AND EFFICIENCY IN THE MINING AND SMELTING STAGES

1. In the mining stages:

- Production of specialty metals is often coupled with, and therefore dependent upon, base metals (e.g. indium, a by-product of zinc mining); recycling them is therefore of paramount importance since their economic lifecycles depend upon other metals with their own, different, cycles.
- Losses appear in tailings, and because of the costs involved, the ore containing lower concentration of the sought-after metal is discarded. But interestingly, the deterioration of virgin ores now observed throughout the world is pushing some companies to look into tailings as potential sources of additional supply.[187]

2. In the smelting stages:

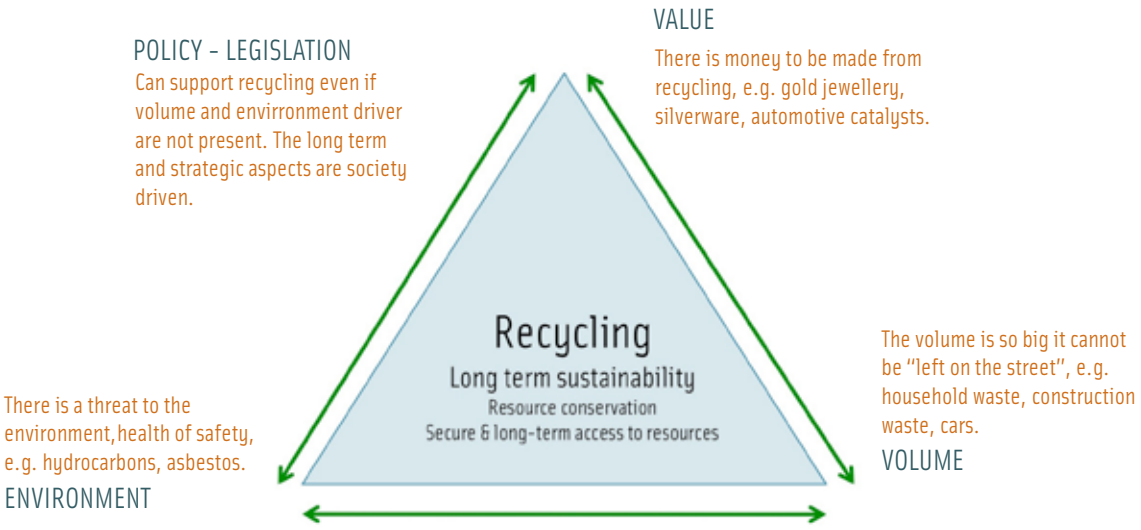
- Losses occur in parent metal (base metal), slag, (the waste product of the process of smelting) and in residues.
- The smelter has to be equipped with the capacity for special metal recovery.
- By-products of the smelter must be sent to specialised treatment facilities for recovery of precious or special metals (such as Umicore's plant in Hoboken, Belgium).

To understand the current trends in recycling we need to consider that the effectiveness of recycling essentially depends upon three factors, each of them presenting its own challenges:

- **Economic:** the value of recoverable metal must be high enough to justify the cost of recycling. Higher metal prices, as seen in the last decade, definitely provide more incentives for recycling. If the true costs of metal extraction were factored in, instead of being externalised as is now the case, the economic incentive for recycling would be infinitely stronger.
- **Technological:** does the design of the product facilitate or prevent recycling? This is an area were companies are significantly at fault, as there is little or no consideration given in the design of the product - for the future disassembly and material separation of the different elements. As we have seen previously, some products are specifically designed to prevent easy disassembly such as is required for recycling and/or repair. In addition, consideration must also be given to updating the recycling technology and collection processes so as to keep up with the constant stream of new products arriving on the market.
- **Societal:** how committed are public institutions and citizens to promoting recycling? European countries have made a start in raising awareness and supporting collection and recycling schemes but big differences can be seen from one country to the next.[188] A majority of products still end up idle in drawers or are simply thrown away (ending up in landfill), either for lack of awareness or because of complicated collection schemes. A 2008 consumer survey by Nokia showed that only 3% of people return their old mobile phone for reuse or recycling whereas 44% store them at home.[189]

As the demand for metals increases and the potential risk of shortages becomes more apparent, higher prices and tighter supply chains become increasingly real, and new pathways for the role these elements play are being generated. Over the past few years a number of companies, especially in resource-poor Japan and Korea, have been actively trying to close the loop as much as possible on the materials they need. Honda for instance has teamed up with Japan Metals & Chemicals to begin extracting rare earth metals from used nickel-metal hydride batteries collected from Honda hybrid vehicles at Honda dealers inside and outside of Japan. Up to 80% of rare earths contained in the batteries will thus be recovered. The new operation will be the first in the world to extract rare earth metals as part of a mass-production process at a recycling plant.[190]

9. THE DRIVERS FOR RECYCLING ARE SEVERAL:



Taken from: Vliegen, J. (2010) Battery Recycling. Presentation at Capital Markets Event on Recycling, 18-19 November. p.5

Higher metal prices have also had unexpected outcomes. The recent spike in copper prices for example has created strong competition between demolition groups in the UK to get their hands on scrap metal from demolished buildings.[191] More surprising even, *The Sunday Times* has even reported that Veolia Environment was planning to extract precious metals such as platinum, palladium and rhodium from London streets in order to recycle them. The company intends to filter palladium from 30,000 tons of road sweepings each year at a processing plant in Rugby, the worth of the metal being around £15 per gram.[192]

In a similar vein, many voices are promoting urban mining – which involves reclaiming raw materials, minerals and scrap metal from end-of-life products in urban areas (old electronic equipment, buildings and waste) and recycling them. Indeed, the concentration of metals in discarded products is much higher than in virgin ore. The US Environmental Protection Agency for instance estimates that circuit boards contain 40 to 800 times the concentrations of gold ore mined in the United States.[193] Similarly, studies by Belgium-based materials technology company Umicore, (one of the world's largest recyclers of heavy metals from electronic waste and industrial residues), show that urban mining can result in gold grades of 200-250g per ton[194] from computer circuit boards, and 300-350g per ton from mobile phones. This contrasts with gold grades in primary mining of perhaps 5g per ton in ore.[195]

10. CONTAINED METALS IN MOBILE PHONE SCRAP VERSUS COPPER-GOLD ORE

Contained metals in mobile phone scrap versus copper-gold ore (Boliden, 2008)[196]

1 Tonne of Mobile Telephones Yields:

50-150 kg copper

500-700 g silver

150-400 g gold

1 Tonne of Ore Yields:

3.7 kg copper

4.2 g silver

0.2 g gold

Data source: Boliden (2007) Sustainability Report. Boliden AB, Sweden. p. 29

It is estimated that about 130 million mobile phones are thrown away annually in the United States. Collectively, these mobile phones weigh about 14,000 metric tons and contain almost 2,100 metric tons of copper, 46 metric tons of silver, 3.9 metric tons of gold, 2 metric tons of palladium, and 0.04 metric tons of platinum. These are valuable resources and should be treasured as such.[197]

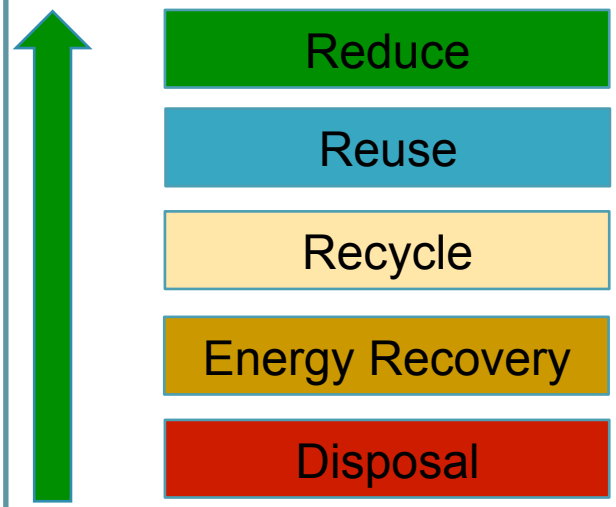
Lastly, an even more radical proposal would be landfill mining, whereby closed landfills are reopened to extract whatever resources lay dormant in the myriad of waste buried in the ground. In China, the largest municipal recycling park is capable of recovering one million tons of copper per year. The largest copper mine in China produces less than half of that. Altogether, a global stockpile of 225 million tons of copper is estimated to reside in landfills in the world.[198] Landfill mining could be a viable option for recycling, however it needs investment and resources, as re-opening sealed landfills to extract products is energy-intensive and time consuming, as useful waste is mixed with 'useless' waste - that which cannot be reused or recycled.

All of these initiatives are certainly a step in the right direction, especially in the light of the previous chapter and the terrible effects of e-waste, but their limitations must also be recognised. Recycling is not a zero sum game. It is energy intensive because waste has to be collected and processed. It is estimated that reusing working computers is 20 times more efficient than recycling them.[199] Besides, even with 100% collection rates from urban waste, in the context of rising demand and given the lifetime of metals in use, we will always be playing catch-up...and losing. For example, copper and nickel products remain in use for 25 years on average – that means materials contained in urban waste might roughly equal the copper and nickel input into urban areas circa 1985, estimated to be only 30% that of today.[200]

Ultimately recycling is a mitigation strategy, and again reducing consumption holds the key to a sustainable world. It is much better to leave the metals in the ground in the first place. This understanding urges us, as consumers, to rethink and reconsider the way in which we buy, create and waste. Disposal of products should be the last environmental option, while the reduction in the overall consumption is the aim that we should strive towards.

Altogether, a global stockpile of 225 million tons of copper is estimated to reside in landfills in the world.

11. WASTE HIERARCHY



The 'waste heirarchy', which ranks different waste management options, in order ot relative environmental benefit.

Taken from: Computer Aid International (2010) ICT and the Environment - Special Report Series. p.3 Source: Zero Waste Scotland.

Computer recycling / Shutterstock

A growing disconnect from Nature / Shutterstock

4. INTO THE BARDO
A Critical Juncture Between Two Worlds

The previous chapters have illustrated the complexity and extent of the processes that feature at different stages of the lifecycle of electronic products. Having explored the origins, manufacturing, existence and eventual end-of-life of products, we are left with an understanding of a mode of production that needs to be addressed and reconsidered. How can we ameliorate the end-of-life of electronic products and reincarnate them into their next life?

Bardo - Used loosely, the term 'bardo', (a Tibetan Buddhist concept), refers to the intermediate state of existence between two lives on Earth. For the prepared and appropriately trained individuals, the bardo offers a state of great opportunity for liberation, since transcendental insight may arise with the direct experience of reality, while for others it can become a place of danger as the karmically created hallucinations can impel one into a less than desirable rebirth.

PRODUCER RESPONSIBILITY AND DESIGN

We are at a juncture, we can carry on as we are, continuing to consume electronic products in the same way, or we can employ our ingenuity to re-imagine our relationship with technology and the Earth. A number of people around the world have been looking at improving lifecycles of electronic products, and have come up with interesting ideas such as the Bloom laptop (see below) or with new, more encompassing methodologies and far-reaching initiatives, such as the circular economy or the Cradle to Cradle model. None of these ideas constitute a complete solution alone, but they have the merit of asking the right questions and trying to come up with pertinent answers. At the heart of it all, our addiction to consumption will have to be tackled, and in much more radical ways than through a 'green' economy which is still based on a model promoting relentless growth.[201]

This chapter draws together some ideas that may help us to shape a transition from the current way of producing and consuming electronic goods to one that operates within the Earth's planetary boundaries, (see page 13),[202] securing a safe and viable planet for future generations.

12. THE BLOOM LAPTOP

Will the Bloom laptop herald a revolution in design concept? In 2010, a group of graduate students from Stanford University, were asked to create an easily recyclable consumer electronics product, and came up with the Bloom laptop, which can be completely disassembled by hand by the user in under 30 seconds, and in ten steps. By contrast, a traditional laptop requires three tools, up to 120 steps, and takes about 45 minutes. A by-product of making the computer modular was the development of a detachable wireless keyboard and trackpad – a feature that allows users to type from wherever they wish, without having the screen right in from of them. Upgrading is also much easier, as users can just pop out the obsolete piece, buy or exchange for a new one, then slot it in. The students won Autodesk's Inventor of the Month award but more importantly, they showed that products can be designed with repair and recycling in mind.

Image courtesy of: Autodesk, Inc.

"You could spend £100 putting something right in production that would've cost £10 to solve in development and a measly £1 in design stage."

EXTENDED PRODUCER RESPONSIBILITY

'Extended producer responsibility' (EPR) is the idea that manufacturers have a responsibility for the entire lifecycle of their products and especially for the take-back, recycling and final disposal of them. One way to encourage producer responsibility is to legally require companies to reflect the environmental costs of a product's lifecycle in the market price of the items.

A further way to focus the onus of responsibility of consumer products onto the manufacturers would be to lease products rather than sell throw-away items. In effect, the customer would not purchase a given product but purchase the service for a limited period - for a one, two or three-year period. When the product is returned to the manufacturer the consumer is issued a new one. This transfers the responsibility to the manufacturer to handle the product in a responsible way. In this way, manufacturers will have a huge incentive to reuse the product, and its many components.

The Electronics TakeBack Coalition (ETBC) advocates the use of EPR as a policy tool to promote sustainable production and use of consumer electronic products. Made up of a group of 34 organisations, based in the US, they aim to influence policy makers, manufacturers, and government agencies by pressuring companies to take responsibility for their products and resulting wastes, throughout the *entire product lifecycle*. This includes taking back products for free when consumers are done with them, to reuse or recycle, rather than relying on consumers, taxpayers and local governments to pay for disposal or recycling of the products they produce.[203]

DESIGNING FOR THE NEXT LIFE

E-wastelands and burgeoning landfill sites around the globe are testament to the fact that our electronic goods have a limited one-life expectancy - a short circuit where materials are dug from the Earth and return to the Earth at the end of their life as toxic waste. Whether through poor design or through planned obsolescence, they are effectively 'designed for the dump'.

As we have seen, problems emerge at every stage of the lifecycle of electronic goods. One of the most vital stages in the life-cycle of electronic goods, where change must occur - is in design. For the industries whose existence is entirely dependent on the availability of materials to be fabricated into products via creative minds, it is in their interests to design products and systems to ensure that these materials do not disappear. As such there is a business as well as a practical imperative attached to ensuring that innovation in design will lead the way in re-defining the lifecycle of electronic products.

Several factors make the design phase of electronic products important. First, it is the most cost effective stage to implement change, as Mark Shayler, founder of Ticketyboo Environmental Consultancy, points out: "*...you could spend £100 putting something right in production that would've cost £10 to solve in development and a measly £1 in design stage*". Second, design offers a platform from which, to a certain degree, demand for 'new' raw materials can be curbed through the design-based decision to minimise the amount of raw materials used in a product and the extension of its life expectancy. If designed for longevity, this could encourage consumers to "buy once, buy right". Thirdly, manufacturers are already aware that we are running out of raw materials and prices will continue to increase in the near future.

Currently, electronics manufacturers are very good at designing and marketing objects that are desirable and efficient but they are not designing items to last, or thinking about how to recover the component metals and minerals. The absurdity of this is put into context when we are reminded that the elements on the periodic table that make up these items have taken billions of years to form, and yet they are plucked from the Earth, fabricated, used and dumped – often within just one year.

It is estimated that indium for example, (which is used in touch screens and is integral to smartphones and tablets) has less than 20 years of remaining supplies, yet according to the UNEP, end-of-life recycling for indium is currently less than 1%.[204] This is because products are not designed for recovery and there are not proper recovery facilities to recycle indium.

By designing for easy disassembly, recycling, re-use and repair, designers can ensure that the wealth of materials contained in the end-of-life stage of items can be transferred and recouped for the next, hopefully sustainable, 'generation' of products, thus minimising costs, waste, and the need for further mining.

Mark Shayler recognises that *"we need to design products to have a second or refurbished life"*, and in order to achieve this has provided designers with six key phrases[205] to keep in mind when creating products. He hopes that products, (and their components), created with these principles at the heart of the design process, stand a better chance of seeing out more than a single lifecycle. These principles are to design for: Disassembly * Energy efficiency * Less raw materials * Recyclability * Longevity * Modularity

The task ahead for design is to expand its remit to consider the multiple lives of electronic products. This presents all those who work in the field with an exciting opportunity for innovation that will benefit the Earth and those who are seeking to be able to use electronic products responsibly.

ZERO WASTE

Nothing in Nature is wasted - the waste of one species is the food for another. We see this on the micro and macro scale: decomposing organisms and excrement are nutrients and fertiliser for other plants and animals; a forest is made up of mutually enhancing ecosystems where nutrients and water circulate over and over again; the Earth is a living, self-regulating, complex system that maintains the conditions for life on the planet.

'Zero Waste' is a philosophy, a strategy and a set of practical tools.[206] It emulates the cyclical qualities of natural systems, and occurs when a given process has no output which cannot used again. It includes, but ultimately goes beyond recycling, as it looks at the broader system in which waste is created, from extraction to production, all the way through consumption and disposal. There are numerous initiatives around the world working towards zero waste including communities and local governments.[207]

The international organisation GAIA (Global Alliance for Incinerator Alternatives) lays out eight components of Zero Waste programmes:[208]

1. Reducing consumption and discards
2. Reusing discards
3. Extended producer responsibility
4. Comprehensive recycling
5. Comprehensive composting or bio-digestion of organic materials
6. Citizen participation
7. A ban on waste incineration
8. Effective policies, regulations, incentives, and financing structures to support these systems

CLOSING THE LOOP: Cradle to Cradle design and the Circular Economy

Integrating the concept of zero waste into an economic model which addresses the unsustainability of the 'take-make-dispose' model of production has been encapsulated in 'Cradle to Cradle' design and the idea of the 'circular economy'.

By learning from the ingenuity of natural systems, we can work effectively with and within Nature and rearrange our economic system to mimic the way ecosystems re-use materials within a lifecycle. The living world operates in a restorative cyclical pattern, thus basing our economy on this practice can not only deal with the problems we have outlined in previous chapters but also help renew our relationship with Earth.

Cradle to Cradle is was first proposed by Walter Stahel and developed further by William McDonough and Dr. Michael Braungart. Their 2002 book, Cradle to Cradle: Remaking the Way We Make Things, is a seminal text on the subject.[209]

As the name suggests it is a mode of production that is restorative as opposed to the 'cradle to grave' model born of the Industrial Revolution. It aims to put humans in the same 'species' picture as other living beings, so as to show that the misuse of mineral resources is not just suicidal for human generations but catastrophic for all life. With the idea that 'WASTE = FOOD' this system looks at materials as either biological or technical nutrients.

They recognise two types of metabolisms on Earth – the biological metabolism (the cycles of Nature or the biosphere) and the technical metabolism (the cycles of industry or the 'technosphere'). With the right design, all of these materials and the products produced by industry will safely feed these two metabolisms, providing nourishment for something new. Technical nutrients should include only materials that do not have a negative impact on ecosystems (thus non-harmful synthetic ones are accepted), while biological nutrients are organic and can be returned to the soil without specific treatment to decompose and eventually become food for the ecosystem. It is a holistic economic, industrial and social framework that seeks to create systems that are not only efficient but also essentially waste free.

An architect and chemist respectively, McDonough and Braungart have created a practical framework for industry and businesses for quality assessment and innovation: the Cradle to Cradle^{CM} Certified Programme.[210] The Cradle to Cradle Products Innovation Institute prescribes a set of design principles, based on the Laws of Nature, to help businesses create products that are safe for people and the Earth. This is a rethinking of design, manufacture, use and the reuse of materials. Their view is that it can spur a new era of innovation, simultaneously driving economic, ecological and social prosperity.

This approach calls for a restructuring of the industrial system to one that is restorative or regenerative by intention and design, enabling growth through material and energy savings and sustainable practices. It envisages a circular economy which is a 'closed loop model' based on a biomimetic (life-imitating) approach, considering that our systems should work like organisms, processing nutrients that can be fed back into the cycle. This approach has its roots in industrial ecology, and is grounded in the study of non-linear systems, particularly living systems.[211] Therefore integral to this model is the elimination of waste by designing and optimising a cycle of disassembly and re-use.

Cradle to Cradle feeds into the notion of a circular economy. As explored by the Ellen MacArthur Foundation, and inspired by the yachtswoman's time confined to the limited space of a small boat during her solo navigation around the world, the circular economy relies on five core principles:[212]

1. Waste is food
Eliminate waste. The biological and technical component parts (nutrients) of any product should be designed for disassembly and re-purposing. The biological parts are non-toxic and can be simply composted. The technical, polymers, alloys and other man-made materials are designed to be used again with minimal energy.

2. Diversity is strength
Diverse systems, with many connections and scales are more resilient in the face of external shocks, than systems built just for efficiency – it applies to economies and communities too.

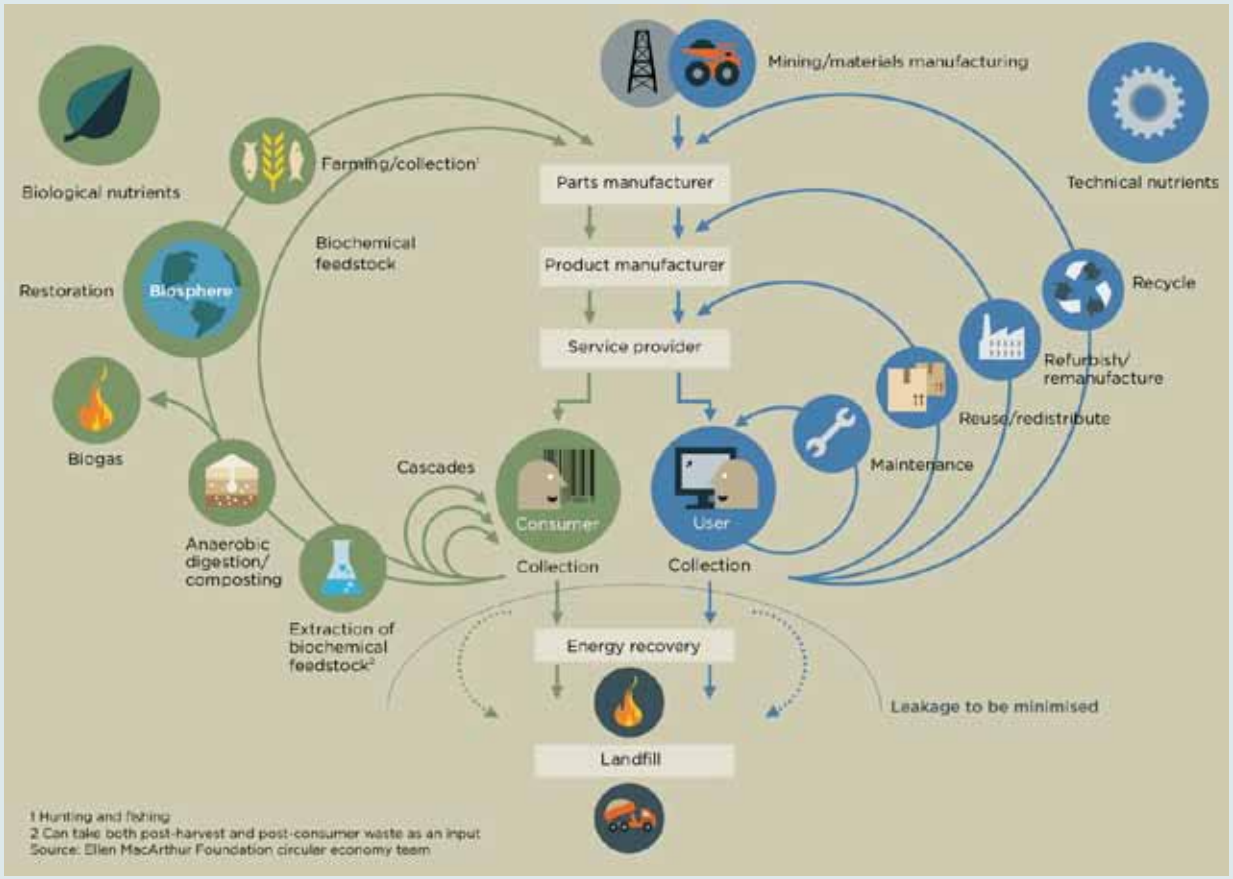
To make this happen...

3. Energy must increasingly come from renewable sources
As in life, any system should ultimately aim to run on 'current sunshine' and generate energy through renewable sources.

4. Prices must reveal the truth
Prices are messages and to use resources rationally these prices should reflect the real cost of our activity. It is part of setting the 'rules of the game' for positive development cycles.

5. Money = goods as services
Money is primarily conceived of as a medium of exchange, sufficient to enable all material flows to be effective.

13 THE CIRCULAR ECONOMY



Terminology (key to Figure 13 above)

- **Reuse of goods:** The use of a product again for the same purpose in its original form or with little enhancement or change.
- **Product refurbishment:** Returning a product to good working condition by replacing or repairing major components that are faulty or close to failure, and making 'cosmetic' changes to update the appearance of a product, such as cleaning, changing fabric, painting or refinishing.
- **Component remanufacturing:** A process of disassembly and recovery at the subassembly or component level. Functioning, reusable parts are taken out of a used product and rebuilt into a new one. This process includes quality assurance and potential enhancements or changes to the components.
- **Material recycling:** Functional recycling - recovering materials for the original purpose or for other purposes, excluding energy recovery; downcycling - converting materials into new materials of lesser quality and reduced functionality; upcycling - converting materials into new materials of higher quality and increased functionality.
- **Extraction of biochemical feedstock:** Applying biomass conversion processes and equipment to produce low-volume but high-value chemical products, or low-value high-volume liquid transport fuel - thereby generating electricity and process heat fuels, power, and chemicals from biomass.
- **Composting:** The biological process - the natural way of returning biological nutrients to the soil.
- **Anaerobic digestion:** A process in which microorganisms break down organic materials, such as food scraps, manure, and sewage sludge, in the absence of oxygen. Anaerobic digestion produces biogas and a solid residual. Biogas, made primarily of methane and carbon dioxide, can be used as a source of energy similar to natural gas. The solid residual can be applied on the land or composted and used as a soil amendment.
- **Energy recovery:** The conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of 'waste- to-energy processes', including combustion, gasification, pyrolysis, anaerobic digestion, and landfill gas recovery
- **Landfill:** Last resort - disposing of waste in a site used for the controlled deposit of solid waste onto or into land.

ELLEN MACARTHUR: FULL CIRCLE
A Story of Innovation and Hope

"I learned from sailing – if you're faced with running out of something the solution is to use less. But it doesn't solve the problem, it just buys us more time."[i]

It was the culmination of different personal experiences - documented in her autobiography, *Full Circle* - that prompted Dame Ellen MacArthur to devote her time to promoting the Circular Economy.

In 2005, Ellen MacArthur became the fastest and youngest woman to circumnavigate the globe non-stop. Drawing on her remarkable career in sailing, she sought to apply the lessons, realities and circumstances she faced at sea, to question and re-think the way we use resources and respond to the ecological issues we face today.

To break the Round-the-World record, she needed to be fast, and to be fast her trimaran sailing boat needed to be as light as possible. This meant she could take only minimum resources and had to manage them carefully and consciously - to the last drop of diesel and the last packet of food. During her global nautical race, she could waste nothing. It made her realise that this applies to any finite entity, whether a yacht at sea or our own unique planet.[ii] Her time at sea inspired her to forge a renewed relationship with our Earth, and she began to think about how the human population operates and how we need to change.

Ellen took it upon herself to research more, and she came to understand that the Earth has evolved and adapted to perfect itself over billions of years - always within a basic framework: materials endlessly cycled, energy provided by the sun, and all life made to be made again. It has only been the very recent human industrialised blip which led to the extraction of fossil fuels, that sees us trying to function outside the rules of nature. We are trying to apply a linear system to a circular world.[iii] She also realised that using less, making things more efficient, recycling, and throwing away less, will only buy us more time – it will not address the systemic problem.

Her quest to persuade people and businesses to address these issues, led her to retire from competitive sailing and establish the Ellen MacArthur Foundation in 2010. The Foundation is an independent charity that explores and promotes the economic opportunities of the Circular Economy among businesses and through educational engagement with schools and universities.

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i Re-thinking the Future: Ellen MacArthur meets Jon Snow (2011) VIDEO. Available at: https://www.youtube.com/watch?v=6xj-h1BfmW0

ii Full Circle book review, Ocean Cruising Club. Available at: http://cic.oceancruisingclub.org/articles/2527/Review8.pdf?1297551447 (Accessed: 12 March 2013)

iii The Circular Economy. The Ellen MacArthur Foundation. (2010) VIDEO. Available at: http://www.youtube.com/watch?v=N-cWaRRLh3k

Figure 13 (on page 70) is a diagram from the Ellen MacArthur Foundation showing the main feedback cycles of a circular economy. The tighter the circles are, the larger the savings in terms of material, labour, energy and capital. Equally, greater savings occur if materials go through numerous consecutive cycles and when they spend more revolutions within the same cycle. The optimum scenario is that materials continue to circulate indefinitely - landfill as the very last option.

Many businesses and manufactures are realising that they will have to address the reality of materials depletion, the geopolitics of global supply and volatile prices, and are supporting and investing in a transition to a circular economy. The Cradle to Cradle Products Innovation Institute and the Ellen MacArthur Foundation are leading the way, and more recently in the UK, the RSA (Royal Society for the encouragement of Arts, Manufactures and Commerce) in partnership with the Technology Strategy Board, launched the Great Recovery.[213] This project is engaging designers, material experts, manufacturers, resource managers, brands, retailers, consumers, policy makers, government, investors and academics to share expertise and ideas to create initiatives to move towards a circular economy.

The circular economy and zero waste economic models are exciting and innovative ways of addressing the unsustainability of the current system. The fact that many businesses are already investing in designing for the circular economy is definitely a move in the right direction. However, a driving factor for businesses is that they recognise that they will have to protect their supply chains against volatile commodities markets and future scarcity. Electronics manufacturers will have to develop improved design and improved recycling in the near future regardless – it simply makes good business sense; as we can see from the Pandora's Box report – metals and minerals are fast diminishing while demand is increasing. The bottom line for businesses is to make profit – this means that even in a circular economy, it requires consumers to continue purchasing more new products. But what is not addressed in this scenario is the deeper systemic issue of consumerism.

DISCONNECTING FROM CONSUMERISM

So far we have looked at the true costs behind our consumer gadgets – their unnecessarily short circuit on Earth and how we are disconnected from their true costs to both the Earth and communities the world over. This highlights a greater disconnection from the reality of our economic system and from the natural systems that support life.

The ever-increasing production and consumption of these gadgets is driven by a consumer culture, which is in turn largely fuelled by electronics companies which continually upgrade products and produce new models and technologies in order to promote demand and increase their market share.

Beyond the brilliant utility of these gadgets they are also status symbols, each new advertising campaign telling consumers that with this new product they won't be left behind. That with the latest function, life really will be better! So why not upgrade your phone for free? Especially if sticking with your old phone makes you feel like a conspicuous unfashionable luddite or means that your apps and functions are incompatible with your friends and family's mobile devices.

The reality is we simply cannot continue to consume electronic products at the present rate. If we are to address the problems illustrated throughout this report, we also need to look at consumerism as the key driver of extraction and production. Improved design and recycling all have a part to play in this transition, and will alleviate some of the pressure we are putting on Earth, but we must also realise that we need to drastically reduce what we consume.

The 'greening' of technologies is a case in point – we can design better, use less toxic materials and recycle products, but large amounts of energy and materials are still required for this process – especially during the extraction and production phase. The growth in green technologies and renewables requires ever more mining for rare earths and often the energy used in the production and recycling of a 'greener' electronic product outweighs the amount of energy saved during its useful life.

A study of laptops by the Öko Institute[214] shows that 56% of the total GHG emissions of a laptop is produced in the production phase. This means that if you were to buy a new laptop which is 10% more energy efficient, it would take up to 89 years of use to cancel out the GHG generated in the production, distribution and disposal of the product. With the average lifespan of a laptop of 3-5 years,[215] it is clear that buying new 'greener' products can make only a limited contribution to energy saving and GHG emissions reductions.

Rethinking our relationship with these items is key. A more circular approach to the 'waste hierarchy' (see diagram on page 73) might be one way to unhook ourselves from the wastefulness of throwaway consumer culture. Extending the waste hierarchy to include The *8 Rs* could be a useful tool to help us rethink our consumption habits.

14 WASTE HIERARCHY EXTENDED – THE 8 RS

FULL CIRCLE: People and Planet, a Renewed Relationship

It is clear that the current way we consume products and energy is pushing our planet to her limits and stretching her capacity to support life on Earth. We may fear for our future and for future generations but what can we do about it? How can we unhook ourselves from the current unsustainable consumer system? The aim of this report is certainly not to make us feel guilty - for most of the world, electronic products and communication technology are now integral parts of our lives. Yet once we can see the true costs behind these products we can re-evaluate the value of these items and how we use them.

There are many individuals, communities and movements around the world waking up to the reality of our predicament, and imagining a different relationship with economics and the material world. A dissatisfaction and frustration with systemic inequity and the acceleration of climate change have manifested in global movements such as the Occupy movement and Transition Town networks. The following case studies are just some examples of some of the ways in which individuals and communities are responding to the current economic system and nurturing ways of transforming our relationship with each other and with the Earth.

Circuit board and seedling / Shutterstock

STORIES OF CREATIVITY, innovation, reconnection & hope

A 'NEW MATERIALISM':
WHY FALLING IN LOVE WITH 'STUFF' (IN A GOOD WAY) COULD SAVE US ALL

By Ruth Potts and Andrew Simms

> Material: c.1300, "material of thought, speech, or expression," from Anglo-Fr. Matere.
> Mater: "origin, source, mother."

Like an abusive relationship with the real world, *Materialism* became synonymous with consumerism – wasteful, debt-fuelled and ultimately unsatisfying. Yet, inescapably, we are part of the material world. How then, might we develop a healthier relationship with it? Could a 'new materialism' in which we develop a more deeply respectful and appreciative relationship to the world of 'stuff' be both good for humanity, and the planet?

Criticism of conspicuous consumption and consumerism is nothing new. Nor is it owned by any one political persuasion. Consumerism's foibles and often self-defeating character were pointed out by both Adam Smith and Karl Marx.

Smith, author of *An Inquiry into the Nature and Causes of the Wealth of Nations* and, ironically, in some senses the great, great grandfather of consumer culture, ridiculed lovers of novelty and luxury goods who, "walk about loaded with a multitude of baubles . . . some of which may sometimes be of some little use, but all of which might at all times be very well spared, and of which the whole utility is certainly not worth the fatigue of bearing the burden".

Following in these thematic footsteps around a century later, Karl Marx pinpointed a false promise at the heart of material accumulation that even today many deny. He described the mechanisms of dissatisfaction that drives the spiral of demand for baubles and palaces, suggesting that, "A house may be large or small; as long as the neighbouring houses are equally small, it satisfies all social requirement for a dwelling. But let a palace arise beside the little house, and it shrinks the house to a hut".

It doesn't have to be that way. Good evidence suggests that a 'new materialism' could enhance our wellbeing and help create the conditions in which we can all thrive whilst living within our planetary means. More than that, it represents a better economic strategy for our current challenges, such as the need to generate enough good-quality jobs - and a way of making daily goods and services available that escapes the consumer debt-trap.

This 'new materialism' has deep roots. For Lucretius, Roman devotee of Epicurus, the world was not formed of lifeless stuff, but matter in motion. Without that, he thought, "all things would fall downwards through the deep void like drops of rain… so Nature would never have brought anything into existence." In her book Vibrant Matter, Jane Bennett, argues that, "so-called inanimate things have a life, that deep within is an inexplicable vitality or energy, a moment of independence from and resistance to us and other bodies: a kind of thing-power".

Greater awareness of this sense of the strangeness of things, and how they relate to us, says Bennett, may encourage us "to treat nonhumans – animals, plants, our Earth, even artifacts and commodities – more carefully, more strategically, more ecologically". Disconnected from the material world we are part of, we have been able to rationalise exploitation of the Earth's 'natural resources', not to mention the people engaged in working with them. As Herman Daly, an Ecological Economist, points out, we have treated the Earth as if she is "a business in liquidation".

What then, might we do to transform that relationship before it is too late? In the Iliad, Homer uses the word *Sophia* (wisdom) to refer to the skill of the carpenter. When making and mending we learn something fundamental about how the world works: about give and take, limits, and the dangerous weaknesses that can build up in a system. It is a deeper kind of knowing compared to the mere receipt and retention of information.

Using skills to make, do, and mend, brings engagement, allows expression and encourages growth through learning. It extends and helps both the doer and the done to endure. Action supersedes the short-lived and ultimately disappointing 'sugar highs' of passive consumerism. Such approaches offer clear environmental 'benefits', but they also suggest a different way of being in the world.

Recent growth in the popularity of public talks and courses, investing in our own personal development by learning more about everything from art, to mechanics, music, history, design or how to grow and conserve food, suggests that transformation is already underway. It is part of the necessary shift from an economy based on material extraction, throughput and waste, to a circular economy of care and conservation.

Such an economy calls for practical people and artists in equal measure – menders, makers and entertainers. It requires a huge growth in practical services that will boost the numbers of plumbers, electricians, builders, carpenters, farmers and engineers, as much as upholsterers, seamstresses, painters, sports coaches and storytellers. Maintenance, quality and entertainment may be the watchwords by which we maintain the economy through a great transition to an economy that supports more with less.

Far from eschewing materialism, a deeper understanding of humankind's place in a living material world suggests the need and opportunity for a different kind of love affair with 'stuff' – a long-term relationship of appreciation, slow pleasures, care and respect. That invites re-writing the relationship manual for the objects we use. For example, wherever practical and possible, we can develop healthy and lasting relationships with things by having and making items that are designed to last. Sharing is good too. Far from suggesting abstinence and austerity, embracing a new materialism could have profoundly positive effects on our own well-being, that of the communities we live in and the Earth of which we are a part.

Find out more: http://www.thenewmaterialism.org

Ruth Potts is co-founder, with Molly Conisbee, of Bread, Print & Roses and has a Masters in Economics for Transition from Schumacher College. Andrew Simms is an author, activist, and Fellow of nef (the new economics foundation). His book, Cancel the Apocalypse: The New Path to Prosperity (2012) is published by Little Brown.

SACRED ECONOMICS - The Gift Economy

"The distant origins of our things, the anonymity of our relationships, and the lack of visible consequences in the production and disposal of our commodities all deny relatedness. Thus we live without the experience of sacredness… of all things that deny uniqueness and relatedness, money is foremost… as a universal and abstract medium of exchange, money is divorced from its origins, from its connection to matter". **Charles Eisenstein**, author of *Sacred Economics: Money, Gift and Society in the Age of Transition*

In his book *Sacred Economics*, Charles Eisenstein explores disconnection between humans and the material world, and how this is integral to the current global economic system. He describes how the shift in the history of monetary systems from gift-economies to our current capitalist model has contributed to many of the most pressing crises we face today. He shows that from the embers of a collapsing system, we can forge a meaningful transition toward a more connected, ecological, and sustainable way of being with the gift at its core. "The purpose of this book is to make money and human economy as sacred as everything else in the universe".

Financial crisis, climate change, biodiversity loss - the origins of our current global predicament can be found in a story of the 'self'. Every culture has one: what am I? What does it mean to be human? In modern Western culture, our story or 'mythology' has its foundations rooted in faith in science, reason, technology and man's dominion over the Earth. It has enacted the separation of, "humanity from nature, of me from you, of each from all" and contributed to the disconnection many are only now discovering to be so harmful.

Money is the mediator of this disconnection. As a standardising agent, money has reached a "divine property of abstraction, of disconnection from the real world of things". Our global economic system has grown out of the Story of Separation. Anonymity, depersonalisation, polarisation of wealth, endless growth, ecological despoliation, social turmoil, and irremediable crisis are built into our economic system. As we can see with the recent global financial crisis and the challenges we are facing with climate change – this system is not working and nothing less than a redefining Story of the People will heal it.

The global economic system depends on continual economic growth which necessitates converting something that once was nature into a product, and something that was a gift relationship and turn it into a service. It requires that you take away something that people once got for free or did for themselves or did for each other, commodify it and sell it back. By turning things into commodities we get cut off from nature in the same way as we get cut off from community. When we do this, we see nature a just a lot of unconnected 'stuff'. This leaves us lonely with many basic needs which are not met. If you have money - you might fill this hunger by buying things, status symbols, or accumulating money itself.

However, humans have an innate sense of the Sacred. Life is a gift, the air that we breathe, beauty, love, sustenance – we didn't earn these things. Charles Eisenstein believes that, "non-monetised cultures," reveal that humans instinctively know this and so when one feels they have received a gift, the human response is to want to give one back. In such a way, gift economies foster not competition but sharing, community rather than isolation, security and gratitude rather than greed and inequality and our new Story must reflect this:

"The new mythology, which is also very ancient, says that we are not separate from nature, you are not separate from the totality of all things, that everything you do has vast significance and you will know how… but everything you do is significant…this is something we can feel."

The task is to align money with the true expression of our gifts and this requires very different mechanisms for the creation and circulation of money. They include things like: negative interest (where money becomes less valuable over time – an effective penalty on the hoarding of money, encouraging instead its circulation and investment in productive capital); the internalisation of costs (the social and ecological costs accrued by a product or service is reflected in the price); a social dividend where we collectively share in the wealth of the commons (land, aquifers and cultural heritage for example); a re-localisation of a lot of economic functions, and peer to peer financing (circumventing banks and financial institutions).

The transformation of the current economic system is necessary and possible, "when things fall apart the unthinkable becomes common sense". In a time of change we cannot afford to be without a positive vision for a new Story. Eisenstein provides us with this through his Sacred Economics which urges us to re-animate a world that has become stagnant and inert in our minds and to recognise the gift we have all been given: the Earth.

HAPPINESS AND WELL-BEING

"It's a very risky strategy for us individually if we need objects and external things to make us feel better. It's much safer to be comfortable with who you are and to have your own intrinsic motivations, things that are authentically you". - **Nic Marks**, Founder of the Happy Planet Index and founder of the nef Centre For Well-being.

Nic Marks is a pioneering researcher in the field of Human Well-being. A statistician and a qualified psychotherapist, as well as founder of the New Economics Foundation's (nef) Centre for Well-being. Nic has devoted his work to finding out what makes us happy and how to balance this with the needs and limits of our planet. In order to try and find a way to facilitate both personal well-being and sustainable development Nic created the Happy Planet Index, which acts as a new indicator for progress which asks, 'is the world heading in the right direction?' and 'how can we create a happier planet?'

Well-being is not a straightforward issue and nor is measuring it. For too long in the West we have imposed and come to believe an economic ideology of what makes us happy, a linear model that asserts that if we improve our material conditions we will become happier.

Such thinking lies behind the use of gross national product (GNP) as a global measure for human progress and yet many have come to believe that simply measuring economic activity is an inefficient way to understand well-being. As early as 1968 Bobby Kennedy declared that GNP "measures everything except that which makes life worthwhile," revealing that the challenge, for those who believe the well-being of people should replace GNP as the key indicator of progress, is to find out what *does* make us happy?

In contemplating the issue of our own happiness it is essential to simultaneously consider that of the Earth, whose health is the foundation of our own. The Happy Planet Index (HPI) does just this, asking what makes us happy? What makes the Earth happy? And, drawing results from the combination of the two in an efficiency measure for nations, how does our happiness cost the Earth and how much does it need to? It looks at two things – the well-being of citizens in countries and the amount of resources they use - i.e. how much well-being do you get for your resources.

Countries that fare best in the HPI are located in Latin American countries and small islands of the world, which do well because of their strong community life. Of the 151 countries on the 2012 HPI ranking list, the UK is 41st, the USA is 105th and Botswana is bottom of the list. According to the HPI, it is as bad to have a high ecological footprint as it is to have very low well-being. Costa Rica for example, whose inhabitants have a carbon footprint a quarter of the size of their Western brothers and sisters fared best of all. Industrialised Western nations do not do so well, which demonstrates that good lives do not have to cost the Earth – the countries where well-being is highest are generally the ones that have low environmental impact.

The reasons for this are many and varied but the scale and rate of consumption in the industrialised West is a key factor in making our happiness inefficient and unsustainable. Electronic products feature prominently in our consumption habits today as symbols of modernity and even futurism and as such are emblematic of a broader problem in the way we think happiness can be achieved. It is a myth, emerging from the same discourse that has made GNP the global indicator for human progress, that buying the latest phone or laptop will make us happier. These gadgets promise connectedness, trendiness and status but are hugely wasteful of resources, tipping the balance negatively where the HPI is concerned. "When you start thinking about all the minerals and the damage caused by mining - you realise that the planet is in these little machines…it makes you think again, what do I need this thing for ?" says Marks.

This is an especially poignant fact given that well-being research reveals that there is in fact a negative relationship between materialism, defined as a set of beliefs about the importance of acquiring possessions, and happiness. It is "a poor strategy to let your objects be your meaningful things…the more interested we become in extrinsic values, the more it crowds out the intrinsic ones of community, of relationships, of authenticity, of meaning", says Marks. Factors that contribute positively to our personal happiness, are in fact decidedly un-materialistic, intrinsic, inexpensive to the planet and can be summed up in five key ways to well-being:

1. **CONNECT.** With family, friends, colleagues, neighbours and Nature, our source of life. Our relationships are the most important things for our well-being.
2. **BE ACTIVE.** Physical activity makes you feel good!
3. **TAKE NOTICE.** Being engaged with the world, being aware of what is around you, letting yourself be moved by beautiful things.
4. **KEEP LEARNING.** Learning throughout our whole life is great for our well-being, it gives us confidence as well as being fun.
5. **GIVE.** We actually feel great when we give. It's reciprocity working - seeing yourself and your happiness as linked to the wider community can be incredibly rewarding.

These five things don't have any carbon content, they don't need a lot of material goods to be satisfied, thus de-bunking the myth that happiness can be built externally from the self, from community and from the Earth.

The fact that our happiness is not dependent on these materially intensive ways is good news. It means that buying happiness at the Earth's expense will be a blip in human history. This is not to say it can be ignored however. We must take steps to reconnect with what makes us *and* the Earth happy in order to recognise and address the tensions that exist between a happy planet now, and a happy planet in the future.

For more information please visit the website: http://www.happyplanetindex.org

LOCAL HEROES
How Transition Towns are strengthening local economies and reducing consumption

By Teresa Anderson, The Gaia Foundation

The Transition Town movement has been heralded as one of the most inspiring and important social movements of our time. In just a few years, this growing phenomenon has led communities in the UK to declare over a thousand Transition towns, villages, boroughs, islands, peninsulas, initiatives and projects, with another thousand declared around the world.

As society drives itself towards ever-greater consumption - resulting in ever-greater destruction and toxification of our planet and a collapsing global economy - the importance of the Transition Town movement is more apparent than ever.

By making the linkages clear between climate change and Peak Oil, the Transition approach has energised and empowered communities around the world to take action to build resilience to turbulent times ahead, and to create the world that we wish to see in our own towns, villages and boroughs.

The recognition of Peak Oil, much like that of Climate Change, was resisted by oil companies, governments and vested interests for many years, but is now accepted as fact in almost all circles. Peak Oil points out that the world's oil resources are not infinite. Discoveries of large deposits are dramatically slowing down, and have become rare in recent years. World discovery of oil peaked in 1964 and has been declining ever since. However, our extraction and use of this resource is growing. We currently consume 4 barrels of oil for every 1 barrel discovered.[i]

Oil companies deny that we are running out of oil. And in a way, they are right – it is estimated that half the Earth's oil remains. The problem is that it is the cheap oil - the light sweet crude in accessible oil fields - that is largely exhausted. The extractive industries now have to look to more inaccessible energy sources such as shale oil and gas, Arctic drilling and the Alberta Tar Sands. The fact is that these pose technical, ecological, political and many other challenges, as well as releasing more emissions per gallon in extraction and processing. These areas would not be explored if there were other options.

We live in the petroleum age, where almost everything in the modern world is dependent on oil. Getting food onto our plate requires fertilisers, tractors, shipping, aviation and road transport, processing, packaging and refrigeration. The average food item has travelled 1000-1500 miles before arriving on our plates. For every 1 calorie of food, on average 10 calories of fossil fuel energy has been used.[ii] Housing, heating, clothing and commodities - all of these are also vulnerable to peak oil shock.

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i Campbell, C. (2002) Peak Oil: an outlook on crude oil depletion. Available at: http://www.greatchange.org/ov-campbell,outlook.html

ii Hopkins, R (2008) The Transition Handbook. Green Books: London.

Peak oil therefore has severe implications for oil-dependent societies. But it also offers an opportunity, a huge incentive for us to create the resilient world that we want to see. And fortunately, the solutions for creating resilience to peak oil are also the solutions that can prevent climate change. The real brilliance of Transition is to realise that a town using much less energy and resources than we presently consume, when properly planned for and designed, can be more resilient, more abundant, and more pleasurable than the present ones.

By creating a space where community members can discuss and implement strategies for resilience to peak oil and climate change, the Transition movement has galvanised an important discussion about our economic system and consumption habits.

Transition works to identify the elements of our daily lives that are dependent on oil and other distant, finite resources. Communities then work to shift towards systems and strategies that reduce vulnerability to oil shocks and increase use of local and renewable resources. Transitioners tend to think twice before buying the latest fashionable item to replace last season's throwaway trends.

But with many governments telling us that shopping is our patriotic duty to revive the economy, we might presume that reducing our consumption in this way could spell economic disaster. Instead the reverse is true. By buying locally- sourced products from locally-owned businesses, we encourage money to stay circulating in our communities, creating a "local economic multiplier" effect, and stronger, more resilient economies.

In Totnes, the small town in the South West of England where Transition was born, hundreds of homes are retrofitting to reduce their energy use. A community company has been set up to provide wind energy. 150 homes have bulk-bought solar panels. An Energy Descent Action Plan has been taken up by the local council. A local currency, the Totnes Pound, encourages shoppers to support locally-owned business in order to keep money circulating in the community. Numerous projects support people to grow food, while encouraging shoppers and businesses to source from local producers. (An impressive nine out of ten shoppers now buy local produce). This vibrant local food system provides important and stable employment in the area.

In Transition towns around the world, initiatives include community gardens, land and local food activities; strategies to enable access to renewable energy; eco-housing, retro-fitting, draught-busting, energy saving, bike fixing, skills sharing, linen and wool processing, transport hubs, local currencies, tree planting, and much, much, much more. Each activity that reduces oil use also reduces the impact on climate change and increases resilience to economic turbulence. Each Transition town inspires people - their passion, their expertise and their dreams - to make their town more resilient to peak oil and climate change, in different ways.

THE RESTART PROJECT

By Ugo Vallauri

The Restart Project is a new London-based social enterprise and charity aiming at changing our relationship with information technologies. The organisation facilitates 'Restart Parties', community self-repair events, where all kinds of electronics are taken apart and repaired by owners together with volunteer repairers, with the aim of reducing e-waste, promoting increased lifespan, sharing repair skills and promoting sustainable and informed consumption of information technologies. While recycling has an important place, the team concentrates on intervening before disposal – diverting and delaying electronics from their 'end of life'. At this time of global economic, financial and environmental crisis, debates on the 'circular economy' have become mainstream, but often with a focus on technological fixes encouraging recycling, disassembly and re-manufacturing of electronics – but always with a goal of creating new economic growth and market opportunities for technology players.

The Restart Project has instead a post-growth agenda, concentrating on people and behaviour change as the real, pragmatic solutions to environmental sustainability in the information society. By demystifying the technical challenges and enabling us to open-up, troubleshoot, upgrade and repair the electronic devices we use and already own in our digital lives, The Restart Project inspires an understanding of planned obsolescence and design flaws. This creates alternative opportunities for citizens and communities to resist the dominant throw-away culture of tablets, smartphones, laptops, printers – and to focus on more frugal and conscious consumption models.

At each event, laptops get cleaned and sped-up, printers might receive a second lease of life, digital cameras, mobiles, headphones, as well as vacuum cleaners and electrical shavers no one knew how or where to repair, are joyfully taken apart, troubleshooted and often fixed on the spot. At times a repair solution is not immediate, but the collective intelligence of participants provides support and tips on procuring needed spare parts as well as finding affordable and reliable commercial repairers who might be able to fix the problem. Everyone learns something, and the community keeps growing.

The Restart Project's vision is one based on collaboration and creativity – combining online knowledge sharing and cooperation with tangible activities in real life. By doing this it is extending the reach of grassroots repair resources already available on specialised websites and YouTube video channels, to new communities in real life, which would otherwise not be able to act on these resources and put them into practice.

In the words of the co-founders, Janet Gunter and Ugo Vallauri: "Our activities empower participants to extend the lifespan and functionality of the electronics they own, actively reduce e-waste and collectively understand the central role of repairability in designing future products".

The Restart Project has so far run 20 Restart Parties across London in its first 9 months but is now scaling-up, developing guidelines and online tools to help other groups start their own nodes. The vision is to establish a global network of Restart Parties and a platform helping to map and connect all skilled repairers, amateurs or professional, with conveners and participants of Restart Parties. Many groups and individuals have already expressed interest in replicating the model not only from across the UK, but also in France, Spain, Italy, the United States, Mexico and Egypt. Similar DIY repair initiatives are gradually spreading across the world. The Restart Project will use a crowd-sourced map to list similarly-minded projects in all continents.

The Restart Project is engaging with universities, civil society organisations, technology groups and public libraries in order to promote a culture of repair at all levels, equipping citizens with critical skills for ensuring a more resilient approach to the technology in our life. The organisation is expanding to run public lectures, repair trainings and to prototype new forms of repair services able to bring repairability and upgradeability to the centre of debates on information technology.

The key to all of this is to bridge the divide between the tech community and 'normal' users, who might not feel comfortable in the *Hackspace*[iii] or *Fablab*[iv] -workshops where the Makers Movement thrive. The Restart Project is an initiative to inspire those of us increasingly frustrated with the current direction taken by software and hardware manufacturers, pushing for less and less open, repairable, upgradeable devices, and with software platforms that are often far from free and open. This is an opportunity for everyone to take action and to rebuild real life community while doing so.

To find out more about the *Restart Project*, and for events listings for *Restart Parties* see:
www.therestartproject.org

iii A Hackspace is a community-operated space where people with a common interest in computers, technology, science, digital art or electronic art, can meet and collaborate. They incorporate elements of machine shops, workshops and studios where people can share resources and knowledge to build and make things. Many hackspaces participate in the use and development of free software, open hardware, and alternative media.

iv A Fablab (fabrication laboratory) is a small-scale workshop offering (personal) digital fabrication. They are generally equipped with an array of flexible computer controlled tools that cover several different length scales and various materials, with the aim to make 'almost anything'. This includes technology-enabled products generally perceived as limited to mass production.

BANGKA ISLAND AND THE 'MAKE IT BETTER' CAMPAIGN

By Julian Kirby, Friends of the Earth England, Wales and Northern Ireland.

The islands of Bangka and Bellitung in Indonesia are barely any larger in size than the Gambia, in Africa, but they are giants in one important respect: together they make Indonesia the world's largest exporter of tin. This has brought cash for some in the local economy - but at a vast cost to the marine and terrestrial environment, and to the communities dependent upon them.

The damage is most striking from the air: as you fly over the island you can see vast swathes of grey, pocked wasteland where the tin mining has left once lush tropical forest and farmland barren and inhospitable. Offshore the dredgers pour mining tailings overboard, smothering coral reefs, sea-grass beds and mangroves, and destroying the habitat of fish and the livelihoods of small fishing villages.

Friends of the Earth, with its sister groups Walhi in Indonesia and Milieu Defensie in the Netherlands, has publicised the plight of Bangka and Bellitung through the 'Make It Better' campaign. The resultant international coverage has encouraged some of the biggest electronics companies to come together to work out a process for addressing the problems. Just over half of all mined tin goes into making solder for use in electronics products: pretty much everything with circuitry in it, from cars to fridges to smart phones, has solder in it.

But whilst recognition of the problem is a start, the truth is - so long as we continue to design, manufacture and consume products in the same way, Bangka's problems will be replicated the world over. That is why we need systemic change.

'Make It Better' calls for a shift in how we design products, so that we move away from the linear economy model where products are designed without regard for the elements of the Earth, the 'natural resources' from which they are made; where soon enough they are binned or, at best, smashed up and partially recycled. Instead products need to be designed to be durable, to be reparable and upgradable, and we need to adjust business models to promote leasing instead of physical sales. But how do we get there? A large part of the answer to that is driving what you might call 'resource literacy' – getting companies to report on how much land, water, materials and greenhouse gases their operations and products are responsible for, and to disclose the other social and environmental impacts of their operations.

As the adage goes, you cannot manage what you don't measure, so Friends of the Earth has been pushing these four footprints into European laws for Europe-wide, national and company level reporting. This is so as to get all levels of the economy to the point at which the full impacts of our consumption are properly understood, and steps are then taken to ensure we only consume 'natural resources' respectfully within the constraints of our fragile ecosystems. We should all do our bit to ensure our individual shopping and lifestyle habits minimise our impacts on our planet. Ultimately, the companies that make the products we buy must take responsibility, and governments need to ensure that necessary legislation is in place.

Many of those products are fantastic innovations – smartphones included – but how they are made continues to cause escalating damage as seen today on Bangka Island. Through proper supply chain transparency and reporting we should be able to get to the point where we both love the product and the way it is made – and knowing how precious these electronic gadgets are, we use less of them.

For more information about the Friends of the Earth 'Make It Better' Campaign see here: http://www.foe.co.uk/makeitbetter

RECONNECTING WITH EARTH

Our Source of Life and Law

By Carine Nadal - The Gaia Foundation

Spiralling consumption, and the accumulation and discarding of electronic products, means that we are dangerously living beyond our Earth's cycles and planetary boundaries.[v] This is the consequence of our human-centred way of thinking, which sees Earth as merely a 'resource' or 'property' to exploit and use, rather than the source of all life.

While technology has increased a certain type of communication among the human species, it has decreased communication with Nature; it has dis-connected us from our Earth's magnificent web of life. There is a risk that we are spending more time in a relationship with our electronic gadgets than with our Earth. Nowadays, many of us attach a certain status to our electronic goods, ignoring or ignorant of the fact that their components are mined from the Earth, which is literally resulting in 'Ecocide'.[vi]

How can we re-connect with Earth and relearn her laws? Thomas Berry (1914-2009), a renowned cultural historian, was a prophetic voice, reminding us that we are all interconnected into an Earth Community – "a communion of subjects not a collection of objects". He called for us to recognise 'Earth Jurisprudence' to remind us that Earth, not humans, established the laws which govern life. He argued that all life on Earth has inherent rights to exist, to habitat and to fulfil their function in the evolution of life; and we humans have an ancient pledge and responsibility to ensure the health and integrity of Earth for future generations of all life.

In other words, the way we govern ourselves needs to embody an ethical code of practice to ensure that we live according to Earth's laws. So law is a living practice not just a written document. This is a philosophy held and practiced by indigenous peoples who have lived for millennia in a harmonious existence with Nature. Those societies that have undermined their source of life, their territory, are no longer with us. However, for the first time in human history we are witnessing how one dominant culture has devastated the planet in just a few centuries. This is why Thomas Berry called for us to participate in The Great Work, to rehabilitate ourselves, as the damage we have done to Earth we have also done to ourselves – diminishing who we are. We have become obsessed with 'things' and have lost sight of our true human potential and our search for greater meaning in life.

The Gaia Foundation and our global network of partners have been inspired by his profound insights to promote Earth Jurisprudence in a range of ways – by reviving community practice of Earth-centred ways of living; developing legal precedents that recognise indigenous governance systems as founded in the laws of our Earth; advocating the rights of Nature; and by upholding the responsibility as citizens of our Earth to live according to our planet's laws and within her boundaries.

Over the past 25 years Gaia and our partners have been working with communities who are committed to reviving their traditional knowledge, seed diversity, local foods, agro-ecological farming practices and ecologically-centred ways of life. Together we have developed tools, such as eco-cultural mapping and calendars for communities to reflect their holistic worldview, which demonstrate how interwoven our lives are with Nature. These same tools assist the communities to re-imagine the future they want to see – a future where humans live in a mutually enhancing relationship with the wider Earth Community, and do not 'short circuit' the natural cycles of Earth.

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Sheka Forest, Ethiopia /
MELCA-Ethiopia

CONCLUSION

We have seen that the dominant industrial culture has spread its increasing dependency on technological developments and gadgets and its addiction to consumption into the farthest reaches of the Earth. This process has been driven by an ideology which believes it is possible, and in fact a priority, to grow profits endlessly, in order to keep the economy growing. It requires those selling 'things' to keep selling more, and to find 'new markets', or rather more people to become 'consumers', in order to continue to grow. This has escalated into a frenzy of 'getting and spending' – to the point where, 'retail therapy', 'shop til you drop', 'must have', 'to die for', and queuing overnight to buy the latest version of a new gadget, has become something to aspire to, indeed, a way of being, for increasing numbers of people. Marketing and advertising strategies are geared to pull ever more people and parts of the planet into this world of endless 'stuff'.

Yet electronic products and mobile technology also offer exciting and creative new possibilities. They are becoming increasingly integral to our everyday lives, even for those trying to resist the pull. The big question is therefore: how do we develop these electronic gadgets - and manage our relationship with them - in a manner that does not further undermine our life support system, the Earth, and the possibilities for the generations to come?

Perhaps the greatest challenge is that in spite of our intelligence, one of the weaknesses of the industrial culture is its tendency to focus on the particular (here, the production of gadgets) and to lose sight of the whole - the impact that this is having on our planet. Very few of us connect our devices with the Earth, or consider where the 'raw materials' making up the device have originated from; how they have been extracted; the way in which the product has been produced; by whom; where, and in what conditions.

In so doing, we have severed our relationship with our Earth, and how we affect her through the way in which we live our daily lives. We see in this report that our electronic items embody a supreme irony: while they are supposed to 'connect' us, they have actually accelerated our disconnection from our planet. We are swamped by a constant flow of information – an infinite virtual library available at our fingertips, and yet at the same time we are experiencing an era that can be described as the 'great unlearning'.

In many parts of the world, the spread of technology, urbanisation and mechanisation is discontinuing people's centuries-old relationship with the land and with it, knowledge and wisdom passed down through generations.

This disconnection from the Earth and her living processes enables us to invest ever more of our ingenuity and fascination into limitless technological gadgets and their possibilities; a virtual reality that numbs us to the fact that we are causing the demise of the physical world we depend on for our own lives. In fact many of us seem to have forgotten that the Earth is the Mother of all of life, including our own. The more gadgets we create, the more we get distracted, the more we mine the Earth, the more we destroy living ecosystems. The vicious circle is as direct and simple as this.

As we have seen in the report, this system promotes a behaviour which is nothing short of absurd. Mountains of our Earth and increasingly our oceans, are being gouged out and toxified by the extractive industries, whose *raison d'être* is to create the need for more mining. Mountains of waste are being endlessly created so as to feed us with new items ever more rapidly. Vast amounts of energy and water are being consumed in the process, without regard for the toxic consequences.

From the Earth's perspective, and from that of future generations, we need to stop destructive mining and toxic waste production now. We have seen from the Millennium Ecosystem Assessment, published in 2005 and produced by 1,360 scientists, that many of the Earth's ecosystems were already, even then, on the verge of collapse. And many have collapsed, such as fish stocks, coral reefs, desertification rapidly eating up biodiversity rich areas, and Arctic melting. Later, in 2009, the Planetary Boundaries study shows the fragility of many of the Earth's ecosystems, stripped of flora and fauna, which are also under pressure from climate change. Given this scenario, the cry of the Earth and future generations must be heeded, as escalating extraction and toxification of the body of the Earth is likely to be the final straw.

The purpose of this report is to encourage us to ask what's really behind our smartphone or laptop? To get beyond the allure of the myriad applications and functionality of the products hitting the market with even better features: 'revolutionary', a 'game changer', a 'new experience', and so it goes every 12 to 18 months. And as 'consumers', to see through the wonder of it all - the illusory wonder which masks a multitude of hidden costs.

Nowhere is this more important, and difficult, than with electronic products, which constantly offer new exciting promises while carefully obscuring their true costs. Like Dorian Gray, they are ever young and appealing, but the Faustian pact that underlies them has to be seen for what it is. Unless we urgently devise new strategies to deal with it, technology, seen by many as the liberator of humankind, will only hasten our demise. As Albert Einstein warned: "*I fear the day that technology will surpass our human interaction. The world will have become a generation of idiots*".

Ultimately, we need to rethink the way we produce and use electronic products and all the products that are made from materials taken from the Earth. We need to become conscious of the legacy of these gadgets and find ways to reduce our consumption, to recycle, reuse and share our electronic products. Manufacturers must, and can, design for recyclability, close the short circuits in their system, ensure safe and fair working conditions and invest in production models that produce little or no waste. Governments must introduce and enforce legislation that halts and controls the juggernaut of the extractive industries, and addresses the failings at every stage of the manufacture, production and marketing of these devices.

Above all, as citizens of the world, we need to put pressure on the producers and policy makers to make the necessary changes. The lifecycle of electronic products does not need to be one of destruction, obsolescence and waste. We can close the circuit and reincarnate these items over and over, and thus radically reduce the negative impacts on people and our planet. We can choose to take responsibility by consciously minimising our impact on the Earth and the possibilities for generations to come

We must recognise what we are doing to the Earth, through our addiction to technological gadgets – and realise that we can do something about it! History shows us time and again that when 'the people' decide to take action, things *can* and *do* change: The abolition of slavery, the women's vote, apartheid – to name but a few. These changes took place because a critical number of people said "enough is enough", and now we look back and see the horror, inequity and absurdity of these systems which once prevailed.

WHAT NEXT?

- **Spread the word!**
  Share this report and the key messages with colleagues, family and friends. Knowledge is power and the first challenge is to open our eyes to the destructive system which we are currently unwittingly supporting. The report is available in print (we ask for £5 donation to cover design and printing costs), or as a pdf online at www.gaiafoundation.org

- **Do what you can to build a critical mass for change.**
  Visit www.gaiafoundation.org to find out about the excellent campaigns of various groups around the world, which you can support to put pressure on governments and corporations to change the system.

- **Be part of the great transition.**
  Find out more about the Transition Town movement, New Materialism, the Gift Economy, the Circular Economy and many, many more inspiring initiatives which are taking matters back into our own hands: re-designing the way in which we live, rebuilding communities, and reconnecting with what really matters in our lives.

Butterfly on Milk thistle / Shutterstock

TABLES AND GRAPHS

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1. Global mobile data traffic forecast
   Data Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012–2017, p.6. Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf

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8. Estimated GHG Emissions of Information and Communication Technology Sector
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10. Contained metals in mobile phone scrap versus copper-gold ore
    Data source: Boliden (2007) Sustainability Report. Boliden AB, Sweden. p. 29. Additional graphics by Stig. Available at: http://investors.boliden.com/files/press/boliden/Boliden_HR07_ENG_15.5.pdf

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12. The Bloom Laptop
    Image courtesy of: Autodesk, Inc. For more information about the project see: http://usa.autodesk.com/adsk/servlet/item?linkID=10914938&id=15890796&siteID=123112

13. The Circular Economy
    Diagram courtesy of the Ellen MacArthur Foundation. You can find out more information at: http://www.ellenmacarthurfoundation.org

14. Waste Hierarchy Extended – The 8 Rs
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ENDNOTES

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"This report will touch the consciences of all who read it. It is vital, therefore, that it has the widest possible distribution because it relates to areas of our daily lives that are growing out of all proportion. It has become an assumed and unquestioned necessity for which we crave impatiently - the latest electronic gadget, the 4G upgrade we apparently can't do without. The need for speed. Rarely do we consider the extractive processes that have had to be engaged, the energy consumed, the e-waste created. The 'instant' as well as 'the medium' has now become 'the message'. It is a virtual reality which has to be unmasked."-
Michael Mansfield, QC

"When you think about all the metals and minerals that go into our gadgets, the ecological damage caused, and circumstances in which they are manufactured you end up asking yourself: 'do I need this new gadget?' Is it worth it?' Those questions come into even sharper focus when we consider that, as amazing and useful as these things can be, constantly buying new 'things' does not make us happy. They give us a kind of sugar rush but cannot take the place of authentic value like relationships, community and connection with nature. The Short Circuit report highlights the fact that neither our happiness nor the planet's happiness can be bought, mined or manufactured and that we urgently need to rethink our relationship with consumption - for the wellbeing of ourselves, the planet and future generations."-
Nic Marks, Founder of the Centre For Well-being at the new Economics Foundation.

"The Short Circuit report highlights a great irony relating to our modern phones and gadgets – the more connected we appear to be, the greater our disconnect with the planet. It shows us that we live in an alienating society, disconnected from the lifecycles of the Earth's gifts, which we consume as mass produced, commoditized and quickly obsolete consumer products. Can these compensate for our lost connection to nature and community? Let us rediscover our gratitude for the gifts of Earth and life, so that we can live more richly even as we consume less."-
Charles Eisenstein, author of Sacred Economics.

"London Mining Network exists to hold mining companies to account for the massive ecological destruction and the human rights abuses that the industry is responsible for around the world. But it's really important to understand the factors that drive this industry. 'Short Circuit' makes clear that the absurdly wasteful practices associated with a status-driven, throw-away consumer culture are encouraging unprecedented levels of devastation. It makes clear that it is no good relying simply on technological fixes: we have to abandon contemporary consumer culture before it destroys us by devouring the life-sustaining ecosystems on which we rely. It also presents workable, hopeful possibilities for a saner economic order. We have to make far better, more careful use and reuse of the materials we really need to use, and construct a society based on human community rather than individual material accumulation. If we do, it suggests, the Earth will be healthier and we will be happier. Amen to that." -
Richard Solly, Co-ordinator, London Mining Network

"The Short Circuit report reminds us of a simple fact which we do not often consider. Each and every piece of technology - in our hands, on our desks, in our living rooms - comes from the Earth. We simply cannot go on devouring the hand that feeds us or the reality will become all too stark and irreversible. We should take the opportunity not only to overhaul our system but also to renew our relationship with Earth."-
Nnimmo Bassey, Chair of the Board, Environmental Rights Action & Coordinator, Oilwatch International

"We all seem aware to some degree that the insatiable consumption habits of the industrialised world are unsustainable, but I doubt whether many people have really absorbed their true impact. This report shows the impact of our smartphones and laptops at every stage of their life and forces one to join the dots in relation to the amounting impact that these gadgets have on people and planet. We have the intelligence to stop this juggernaut - and for the sake of future generations we absolutely must."-
Dr Vandana Shiva, Founding Director, Navdanya, India

"Africa is hugely implicated in the growing demand and use of mobile phone technology and computers. The number of phones in Africa is increasing at an incredible rate daily, and here we are dealing with the 'outsourced' environmental damage of the global electronics industry. Mining is expanding across Africa with devastating consequences for communities, livelihoods and ecosystems. In the DRC the brutal working conditions of mine workers – many of whom are children - have been well documented. Whilst in Ghana the skeletons of TV sets and refrigerators from Europe paint a disturbingly bleak landscape and a toxic legacy. Today, Africa is faced with the worst challenge ever, as multinational mining companies target the continent for mineral resources to satisfy this want, at the expense of livelihoods of whole communities. We at the African Biodiversity Network are pleased that the Short Circuit report raises the alarm of the real story behind our gadgets. It is through these efforts and insurmountable evidence that the pressure for change in the electronics industry can become so strong to ignore." -
Gathuru Mburu, African Biodiversity Network

"This audacious and timely report looks into the pressing but poorly-explored question of the ecological impacts of our modern, mobile, high-tech society. More importantly, it explores the concrete measures that need to be taken to diminish those effects. Mining has always been a matter of destroying nature in order to improve people's well-being – or at least some people's – but our dependence on rarer elements is growing. The exhaustion of more easily-mined deposits means that even with improved mining practices, more and more remote places and sacred mountains are being dug up to feed the consumer economy, more peasant and Indigenous communities are being displaced, more rivers are being diverted, and more watersheds are being destroyed with little hope of remediation. To restore some balance to the equation, economic calculations and social decisions – individual choices as well as political decisions – must begin to incorporate the true costs of mining. We need to find ways to honour the real value of the materials produced by mining. We, as communities, activists, and organisations must state our demands and our proposals clearly and pursue them relentlessly. This report is an excellent contribution to that struggle". -
Jamie Kneen, MiningWatch Canada

"Those that have had the sad experience of walking the e-waste dumps of China, Ghana or Nigeria, know well that our once loved e-products have made a vile toxic pile on another's doorstep. The fact that this techno-trash graveyard is out of sight for the vast majority of us consumers, is no justification for it to be out of our minds. Globalization, and global information must no longer be an engine and excuse for a digital global dump. I commend the Short Circuit report for shedding much-needed light on the entire life-cycle of our electronic hardware addiction and boldly proposing new design paradigms and consumer habits to remake the electronics industry."-
Jim Puckett, Executive Director, Basel Action Network.

"The Short Circuit report lays out in stark detail the costs to people and nature of our rampant extraction of primary resources. The force of this report, though, lies in how it ties the everyday 'must-have' gadgets routinely used, to their too-often destructive origins; that's a connection few of us understand. But whilst we should all think about our shopping choices and consumption patterns, the truth is that much of what this report reveals was determined when those gadget companies decided how to design their products and how to manage those supply chains. It is those industry leaders, and those in government we elect to act as regulators to protect our health, rights and homes, who should be most spurred by this report to make real, lasting change to the way these products are made and marketed. And it is for the rest of us to use it as inspiration to help ensure that that change happens." -
Julian Kirby, Resource Use Campaigner, Friends of the Earth England, Wales and Northern Ireland

'The Short Circuit report reminds us just how short sighted we're all being. Our insatiable desire to consume, our obsession with owning 'stuff', our need to look the same as one another, like some sort of social identikit with the latest smartphone, all these things are driving us to acts of madness as we devour the very planet we need for our survival. Future generations will look back at our behaviour in disbelief, I'm certain. Be proud to dress differently, choose to buy something which is quality and will last, think about whether or not you really 'need' it in the first place. Join the climate revolution and say no to the system which promotes this lifestyle and forces it upon us.' -
Vivienne Westwood, Climate Revolution

In collaboration with: