True cost environmental accounting for a post-autistic economy

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It has become clear in recent years that environmental policy must do more than simply combat harmful substances or put a filter on each exhaust or waste pipe to reduce pollutants to an "acceptable level." The catalytic converter is a good example of the problem, with almost 3 tons of non-renewable resources invested in each one (Schmidt-Bleek 1998, 1999). We need to rethink production to make it cleaner and more sustainable by improving our accounting (Bainbridge, 2006).

As the eminent British economist A.C. Pigou (1920) noted early in the last century, the market will fail unless it includes all costs. If the market were complete, any attempt at separate environmental and social accounting would not be necessary, and Milton Friedman's (1970) dictum, *"A company's only responsibility is to increase profits for stockholders*" might suffice. However, the flawed and incomplete market we have today, with enormous uncounted costs and incorrectly attributed costs, performs very poorly. It considers only a small fraction of the total transaction cost, leaving many "externalities" out of the picture (Bainbridge 1983, 2004, 2006; Antheaume, 2004). If full costs were known many current market transactions would not occur, and we would face a much more hopeful, secure and sustainable future (Ròbert et al., 2002; McDonough and Braungart, 2002; Young, 2006).

To reduce consumption of non-renewable resources and limit adverse impacts we need to understand the input and output of companies and the life cycle costs of products, from the cradle to the grave (made, used, disposed) or cradle to the cradle (made, used, recycled, reused, or returned to nature). This is the goal of most sustainability reporting, from the Eco Management and Audit Scheme to the Global Reporting Initiative (McDonough and Braungart, 2002; IEFE, 2005; IFA, 2005; GRI, 2002). It will not be easy, because we haven't studied these issues very often, and the flow pathways and impacts can be complicated and long term. The poor Inuit for example are facing severe health problems from PCBs, a chemical not used in their culture or region—but carried in by air pollution and fish and mammal populations, biomagnified in food chains and deposited in their bodies (Pereg et al., 2002). How do we account for these and other legacy pollutants? Synergistic impacts between multiple pollutants?

To understand both social and ecosystem effects we would like to know much more about material flows (Brigenzu et al., 2000; Palm and Jonsson, 2003; Hansen and Lassen, 2003; Pedersen and de Haan, 2006). We should be able to clearly describe:

1) What is the spatial distribution?
How much is there? Where does it come from? Where does it go? Does it move in air, water, food, dust? Is it local or global? Concentrated or diffuse? Are materials bio-magnified?

2) What secondary effects or pathways are there? Are metabolites or breakdown products more hazardous? Even when materials are non-toxic to humans they can lead to ecosystem catastrophes. Ecotoxicity is common for many materials that are used or emitted from power plants and cars, or used in buildings and equipment. Nitrogen, phosphorus and zinc are common examples (Günther, 1997; Vitousek et al., 1997; Karlen et al., 2001; Reck et al., 2006).

3) Are effects cumulative or instantaneous? Lethal? Mutagenic? Teratogenic? Can we and/or ecosystems shed materials if exposures are infrequent, or do they build up over our lifetime?

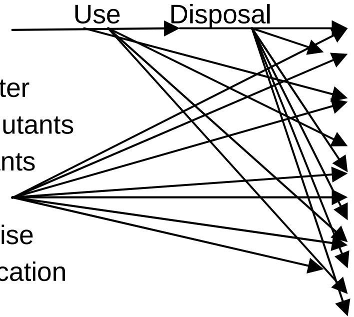
4) How persistent are the materials in the environment? Do they break down in hours? Days? Years? Millennia? Can they be collected and destroyed or recycled?

We also need to consider natural and human disasters. What happens to all the hazardous and ecotoxic materials in a fire? Flood? Hurricane? Tornado? This can be a major source of pollution. Each home may only have 10-20 kg of toxic materials and chemicals at any one time; but if 250,000 homes are destroyed (as they were in Hurricane Katrina) this can lead to the uncontrolled release of more than a million kilograms of hazardous materials into the environment. In addition, building materials, furnishing or electronic appliances that burn may release mercury, lead, chromium or be transformed into much more toxic materials such as PVC into dioxin. Large quantities of industrial, commercial and agricultural chemicals are also released in natural disasters, adding to the magnitude of the catastrophe and making cleanup much more difficult.

To understand these issues better we need to improve company balance sheets and update them regularly. These balance sheets will evaluate facilities, production, operation, maintenance and service (Sigma Project, 2002; ISAR, 2004; IFA, 2005). Only a few of the possible flow paths are shown for clarity.

A Company Balance Sheet

Input	Output		Local Impact	Regional Impact	Global Impact
Raw materials	Products	Use Disposal	Air pollution		
Energy	Energy		Water pollution		
Water	Waste water		Nitrogen pollution		
Air	Water pollutants		Thermal pollution		
Products	Air pollutants		Global warming gases		
Merchandise	Wastes		Ecotoxicity		
Communication	Merchandise		Biodiversity impacts		
Services	Communication		Health impacts – short term		
Transport/travel	Services		Health impacts – long term		
	Noise				



Stock (storage)	Inventory
Raw materials	Land area, land cover, landscaping
Energy	Structures
Water	Fixtures
Products	Plant and equipment
Merchandise	Vehicle fleet
	Parking lots and roads

Some input data already exists in most companies and is usually much easier to find and record than output data. Middleware should be able to mine billing and accounts records to retrieve and update input figures. Some types of output are already recorded because they are required by service providers (waste water, solid waste) or laws (toxics, larger amounts of air pollutants), but impact data is much more challenging to find and often doesn't exist. Additional research is critically needed to develop this information, and to refine the cost of lost ecosystem services (Howarth and Farber, 2002). Data mining middleware can help track down historic and ongoing research, impact calculators and conversions, to help converting output data to impact estimates and costs.

As an example, suppose we run a small manufacturing firm in San Diego. We want to account for our energy use, this includes:

Input	Output	Impacts	Information needed
Electricity (KWH)	air pollution	global warming gases	utility production mix from SDG&E
		health impacts	Dept of Health medical cost impacts, asthma, pulmonary disease and treatment cost
		ecosystem impacts	hydropower environmental impact air pollution impacts thermal pollution impacts nuclear pollution impacts
		nitrogen pollution	and CalEPA, CEC or EPA production impact data
		financial impacts	decreased tourism near coal power plants from smog
Natural gas (therm)	air pollution	global warming gases	loss factors in transport and use
		health impacts	pollutant emissions (manuf. or CEC, AQRB, EPA or CalEPA)
		ecosystem impacts	air pollution impacts water pollution impacts
		nitrogen pollution	efficiency factor (appliance manuf.)
Gasoline/diesel/jet fuel (gallons)			
	air pollution	vehicle emissions	(DOE, EPA, CalEPA,
		global warming gases	or APCD)
		nitrogen pollution impacts	
		health impacts	Dept. of Health
		ecosystem impacts	
	water pollution	increased costs	Wastewater Treatment
		health impacts	City Stormwater, RWQCB
		ecosystem damage and restoration costs	DFG, FWS
	war fighting cost	military equipment and training	DOD, Congress
		energy cost	
		environmental costs of war	

If we are being responsible, we would also account for the employee commutes, by miles driven and/or gallons of gas and diesel burned. This may be one of our largest impact factors.

We then need to look at all of our other material and resource flows (in and out), starting with the most hazardous, ecotoxic and common. We should look carefully at water and waste water, because it would be easy and is important. We should also consider stormwater impacts. We should evaluate our use of materials, steel, aluminum, plastics (by type), paints, dyes and other finishing materials. And we should include paper, paints and packing materials. For key resources we might try to compare alternative sources of more sustainable materials – recycled steel and aluminum, eco friendly paints and packaging materials, and more sustainable shipping practices (train instead of plane).

Material flow analysis can help with demateralization and creation of more sustainable industrial ecologies (Orbach and Liedtke, 1998; Bainbridge et al., 2004; Jacobson, 2006). To redirect the economies of the industrialized countries back onto a more "sustainable path," the enormous quantities of materials that are moved in order to provide people living in industrialized countries with their prosperity may need to be reduced by a factor of 10 or more (Schmidt Bleek, 1998; Ròbert et al., 2000). Sufficient examples exist to show that this is possible, but true cost environmental accounting will be needed to drive the process.

The development of an environmental accounting spreadsheet for a more complicated multinational corporation will be considerably more challenging but is also more important. We would want software/middleware that could easily develop detailed information across the firm and across the globe. We would, for example, want to know the numbers of vehicles (gas, diesel, biodiesel, ethanol, LPG), fuel use, and the miles or km driven each year (Forum for the Future, 2003). Middleware data mining might be used to develop this information from vehicle inventory data bases and fuel billing. If we wanted to be more accurate we would also want to know the type of driving, city or highway, and where it took place: so we could better estimate impact per mile and distribution of impacts. This may eventually be done by data mining the vehicle fleet global positioning records This would also require area specific impact factors – by nation, state or province. Texas has made a start by offering a set of calculators for some types of impacts, ECALC (2006), and others should follow suit.

Although much progress has been made in environmental accounting (Gray et al., 1995; Rikkhardsson et al., 2002), the work has really just begun. Much more accurate and complete information is needed on a wide range of costs and benefits (Bainbridge, 2006). It also has to be made much easier. If we undertake this type of accounting today it is labor intensive and therefore costly. What we need to do is develop the tools that make this efficient and easy for even small firms to use to their advantage. For larger firms this software/middleware might interact with Microsoft, SAP, Abacus and other office accounting and management packages. For the smaller firm it would be ideal if it could be integrated with Quicken or Quickbooks. Quality assurance and auditing systems will also need to be refined (Beets and Souther, 1999; Wallage, 2000).

Database developers, information source managers, and accountants must also be educated on the importance of this work and the need for readily accessible information (Daly and Cobb, 1989; Lintott, 1996; Gray and Collison, 2002; Chua, 2006; Wallage, 2000; Bainbridge, 2006). Considerable additional research and increasing integration of information across disciplines is needed to make sustainability reporting faster, cheaper, more effective, and more fun: but it is perhaps the most important work in the world for the next decade. If we can't convert to true cost accounting we are unlikely to prosper, and may not survive.

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Web resources

Environmental Management Accounting Research and Information Center	www.emawebsite.org
Environmental Management Accounting Network-EU	www.emanu-eu.net
International Federation of Accountants	www.ifac.org
Global Reporting Initiative	www.globalreporting.org
US Society for Ecological Economics	www.ussee.org
International Society for Industrial Ecology	www.is4ie.org

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