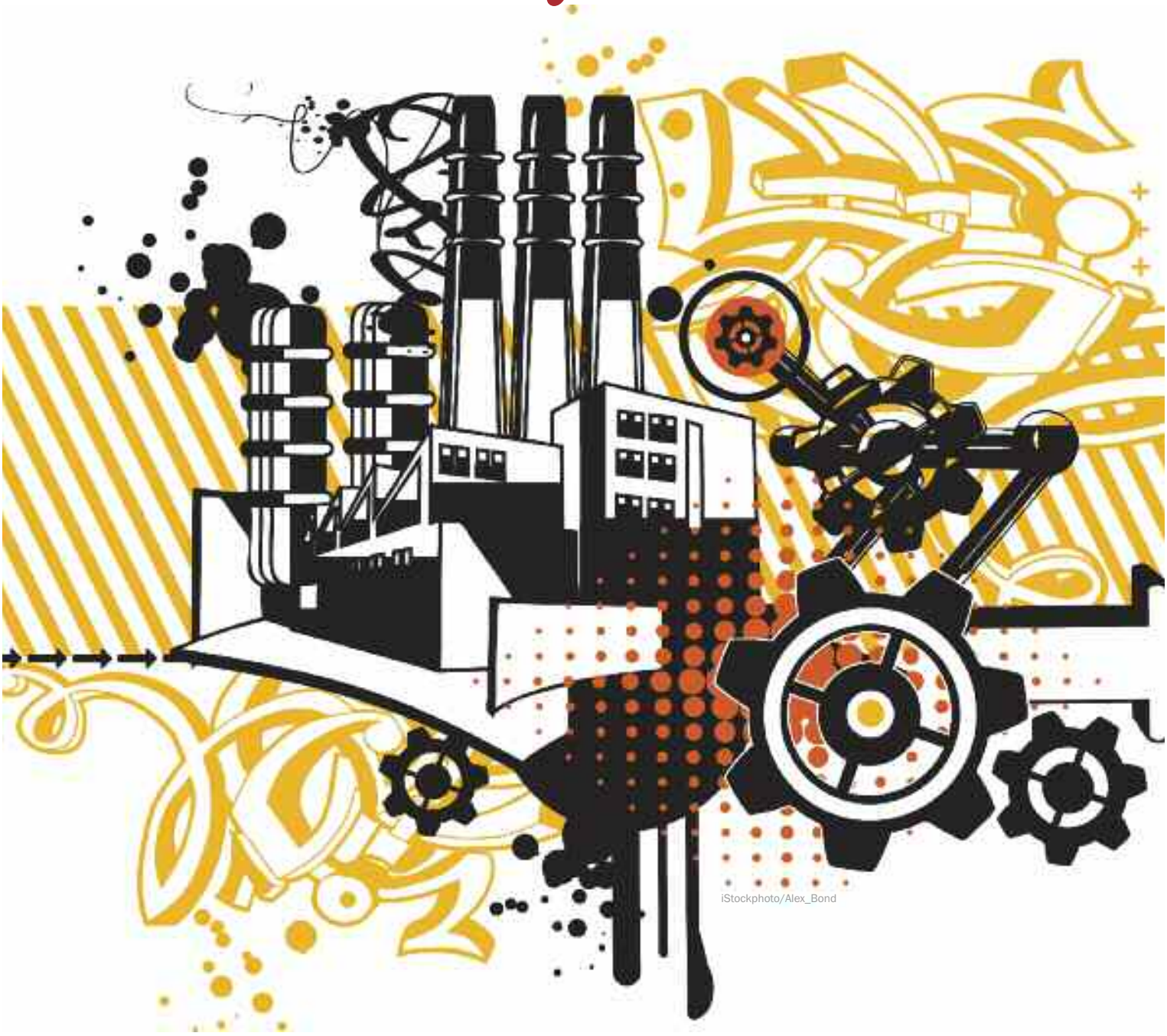
Closing the loop

Industries as ecosystems



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BY **DAVE SAMMUT**

‘Waste’ can be an opportunity for value recovery or improved practice, rather than just a red mark on the bottom line.

Australia has a problem. The decline of Australian industry, and with it the symbiotic relationships of industries sharing intermediate or ‘waste’ materials, has been noted more than once in *Chemistry in Australia* (June and July 2013 editions, p. 40). Along the way, local and global industries have been squandering millions of tonnes of materials potentially useful as intermediates and reusable feedstocks.

The trend has been exacerbated, unintentionally, by government regulation. Some legislative restrictions on the movement and processing of waste create enough red tape, delay and expense to deter all but the most dedicated recycler.

Consider the problem created by a difference in the landfill levy between New South Wales, at $108 per tonne, and Queensland, where there is no levy. Thousands of tonnes of waste are sent across the border each week at a transport cost significantly less than the landfill levy in New South Wales. Systems that create such situations are the enemy of good environmental practice. However, the protocols intended to redress this hinder environmentally sensible trans-boundary movements (controlled by the National Environment Protection Measure, NEPM), even before the substantial economic, environmental and social costs of long-distance transport are taken into account.

Very similar problems occur internationally. The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal is an essential impediment to dumping in developing countries, but it is also a major obstacle to sensible reuse or recycling of certain Australian wastes overseas. Australia has limited standing recycling pathways for selected industrial wastes, including metals (predominantly steel, copper, brass and lead), some clean and uncontaminated plastics, paper and cardboard, and construction and demolition wastes (notably concrete and bricks). Many other materials, due to low volume and resulting high unit costs, would be more sensibly recycled or reused internationally, where economies of scale could transform their value.

The volume and tonnage of industrial and consumer waste that ends up in landfill each year is both astonishing and abhorrent. Many old landfills are now considered so rich in resources that proposals have been put forward to mine them.

Businesses have improved to some extent in accordance with the ‘reduce, reuse, recycle’ mantra. Encouraging evidence from businesses in New South Wales shows recycling rates are

increasing. However, tonnages are also up: ABS data (2013, cat. no. 4602.0.55.005) shows that the total amount of waste generated per capita has more than doubled over the past 15 years alone.

Many of the waste issues that organisations face can be addressed through applied industrial ecology. While some academics have described industrial ecology as the 'science of sustainability', there is no consensus, and definitions will probably be debated for many years to come. Notwithstanding any controversy, a particularly significant strategy developed by industrial ecologists and others describes this developing science as:

> *… the shifting of industrial process from linear (open loop) systems, in which resource and capital investments move through the system to become waste, to a closed loop system where wastes can become inputs for new processes. (Wikipedia)*

One of the key barriers to practical industrial ecology is the lack of access to useful information. Our industries have become so compartmentalised, the sites so physically remote from each other, that identifying potential users of waste or sources of usable material is extremely problematic. Some state governments (such as New South Wales and Victoria) have introduced programs intended to overcome this limitation. As the regulatory authorities, the state environmental protection authorities hold considerable amounts of potentially useful information about the wastes being generated in their jurisdiction.

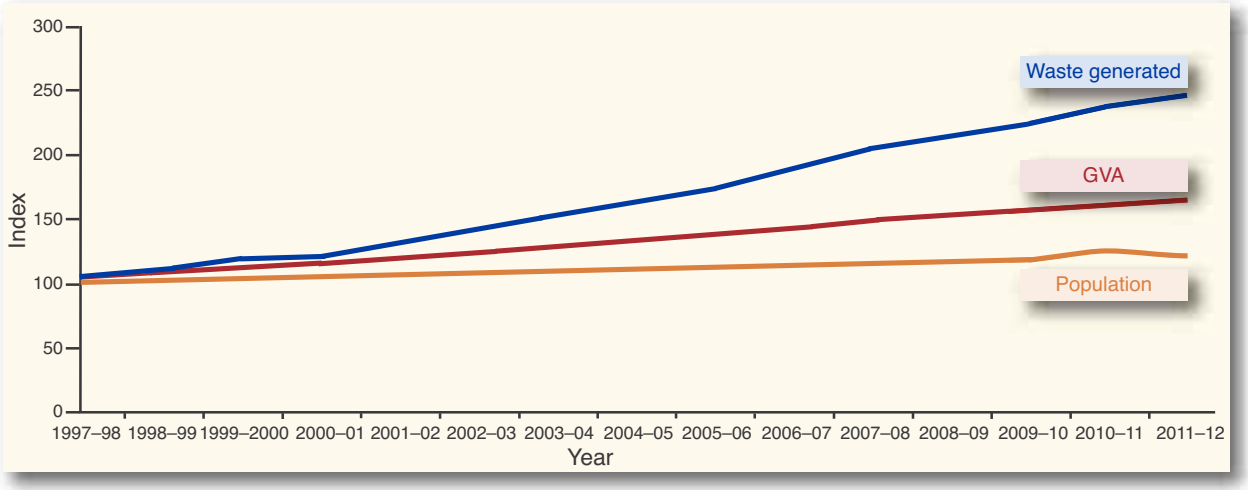
Networking is a principal way of overcoming information 'silos'. In the late 2000s, the Victorian EPA hosted HazWaste Expo events, which brought together those with waste problems and people with the means to address them. The Sustainability Advantage program run by the Office of Environment and Heritage in New South Wales has many similarities with this approach. Both state governments run vital grants programs funded, notionally, from punitive landfill levies.

The Australian Industrial Ecology Network (AIEN), established in 2009 under the auspices of the Waste Management Association of Australia, has the aims of industrial symbiosis. I am involved with this group, and together we foster affiliations between industry, government and academia. One of our main objectives is to eliminate unnecessary disposal of materials in landfill.

AIEN organised the fourth Australasian Industrial Ecology Conference, held in Sydney during October 2013. Over two days, the breadth of opportunity discussed across both the formal presentations and the many informal meetings (some examples follow) was truly encouraging.

Several resource-intensive industries are particularly suited to the principles of industrial ecology. The cement industry can reuse silicaceous and thermal materials, and there are substantial additional opportunities in civil construction. A broad range of organics can be used in agriculture, as well as certain beneficial inorganics such as nitrates and phosphates. The minerals industry offers excellent reuse opportunities for metalliferous wastes.

The calorific value of carbon-based waste is low-hanging fruit. The modern approach is more sophisticated, but regulatory (and community) attention remains against memories of older models of incineration. Other interesting approaches include the preparation of biochar from forestry residues and municipal solid waste streams, of which biomass represents 50–60% of total tonnage. Mark Glover of Renewed Carbon Pty Ltd talked engagingly of the opportunities for biochar use in the petrochemical sector, manufacturing/smelting, agriculture and soil productivity, and even in liquid transport fuels.



Rate of waste generation in Australia compared to gross value added (GVA) and population growth 1998–2012

Data source: Australian Bureau of Statistics

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Barriers to industrial ecology in Australia

- Inadequate integration of high-level resource recovery policies and strategies government portfolios (e.g. industry policy and environmental planning)
- Regulations that inhibit the search for industrial waste reuse
- Costs of licensing and approvals
- Lack of markets to absorb recyclables
- Contamination and quality issues
- Lack of communication between manufacturers and recyclers
- Site planning issues and NIMBYism

Adapted from conference presentation by Grant Musgrove, CEO, Australian Council of Recyclers

Many tonnes of materials such as old concrete, fly ash and coal washery rejects have been used in roadbase and concrete aggregate. In each case, the reuse of existing material offers several advantages, including elimination of the environmental effects of disposal and displacement of fresh materials, with substantive environmental and cost savings.

Efforts to recycle old mattresses is an excellent case study from the conference. Although the total tonnage arising from the 1.2 million mattresses disposed annually across Australia is modest (19 000 tonnes), the landfill volume is considerable: 900 000 cubic metres on average. A presenter at the conference showed a video of the operation of a prototype high-pressure disintegrator to shred mattress material and foam off the steel frame, each mattress taking approximately 40 seconds to process (if received dry and flat, which is a major problem in municipal collection). The resulting foam may be reused, if only for its calorific value, and the steel and wood recycled.

The downside is that mattresses are manufactured by many small facilities throughout Australia, using differing designs and materials. The lack of standardisation, the move to non-recyclable 'body' foams, and the lack of design attention to end-of-life issues are all major impediments to economic reprocessing. The same is true in the automotive industry, consumer packaging and portable electronics, where combination materials are increasingly being chosen for their appearance or other consumer-oriented factors, with little or no attention to end-of-life issues.

Industrial ecology is making headway at the end of industry's pipeline, but it should do so very much more than that. It should be in the design of industrial processes and their products with end-of-life reuse and recycling in mind. In every step from product design to industrial waste, scientists should be taking the lead, paying particular attention to the separability of materials in the end-of-use streams, the recyclability of those materials and their economic value.

The solution needs to be seen as part of daily working practices, reducing unnecessary complexity in waste streams. We need clear and consistent definitions of waste and resource recovery to reflect better reuse and recycling. Most importantly, we need to break down the barriers of communication, and to drive long-term legislative trends towards sensible outcomes.

Ultimately, legislating good practice is not possible. Market factors have to drive industrial ecology, and while governments can influence crude economic drivers such as landfill costs, the New South Wales–Queensland experience clearly shows that even local variations in regulation can seriously distort markets. As scientists driving innovation, we should always bear in mind the economics of our work, with a plan for waste as something more than a red item at the bottom of the list.

Dave Sammut MRACI CChem is Principal at DCS Technical Pty Ltd. He is a member of the Waste Management Association of Australia, and is on the committee of the Australian Industrial Ecology Network. A small fraction of annual revenue is derived from waste industry clients. None of the companies mentioned in this article is a current or former client of DCS Technical.