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News and Views
Material Witness: Towards a materials ecology
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The appointment of Michael Leavitt as head of the US Environmental Protection Agency will create some uncertainty about the future of the US environment. Favoured by George W. Bush, Leavitt stands accused of being soft on industry — the state of Utah, of which Leavitt was governor, has been brazenly violating the Clean Water Act.

But whether or not Leavitt succeeds in cleaning up American air and water, that is no longer really the key issue for industry's environmental impact. There is increasing recognition that the introduction and enforcement of pollution laws is only one facet of so-called industrial ecology, in which cleaner technologies are part of the broader matter of sustainability.

Valerie Thomas and Tom Graedel have attempted to set out an "intellectual agenda" for the materials-related aspects of sustainable consumption (*Environ. Sci. Technol*., advance online publication http://dx.doi.org/10.1021/es034475c). They try to identify "tractable research questions for which good progress can be expected over a 1–2 decade time frame."

Thomas and Graedel distinguish between 'engineered' systems, meaning in effect how industries operate, and 'global' systems, meaning industry's impact on worldwide environmental problems such as global warming, as well as the effects on human health and welfare, economics and resources. Green engineering has generally proceeded on a process-by-process basis, with some significant results: energy consumption in new refrigerators has dropped by two thirds over the past 25 years, for example. But Urmila Diwekar has now proposed a generic integrated framework for greener chemicals processing, which may help to reconcile the conflicting objectives that such designs tend to pose (*Environ. Sci. Technol*. advance online publication http://dx.doi.org/10.1021/es0344617).

Experience shows that cleaner technologies are not necessarily delivered simply by ample research funding — legislation, in the form of emissions restrictions, for example, can itself stimulate innovation by creating a market for pollution-reducing systems (M. R. Taylor *et al. Environ. Sci. Technol*. 37, 4527–4534; (2003)).

At the global level, Thomas and Graedel say that we need to start analysing 'materials cycles' along the same lines as natural biogeochemical cycles of elements such as carbon, nitrogen and phosphorus. Materials cycles would of course be more dependent on human activities. A knowledge of how materials flow between reservoirs such as soil, mines, landfills and human tissues would help identify those flows that are most damaging or profligate, and could make it easier to quantify, say, health impacts or life-cycle analyses. In the same bio-inspired spirit, we can regard the transfer of materials such as metals, plastics and paper between industries as 'food webs' that might be engineered for greater efficiency, and we can consider cities as organisms having 'metabolisms' with certain materials inputs and outputs.

Thomas suggests that one future aspect of materials recycling and reuse might be "product self-management", whereby products themselves become responsible for their end-of-life fate through the use of bar codes or radio devices that advertise a product's availability for scavenging, salvage and resale (*Environ. Sci. Technol.*, advance online publication http://dx.doi.org/10.1021/es0345120) — creating what we might call smart trash.