Cities were in many cases originally created for protection. This is about the only logic of urban growth that is no longer significant.

Robert Moses
***Working for the People*, 1956**

MATERIALS SCIENCE

Drive Your Car into the Ground

If you really want to impress your green friends, what better way than by driving a car that's made partially of grass? The car looks and feels like any other until it's composted in a landfill. Then, over time, microbes snack on remnants of the aging hulk and decompose them to carbon dioxide and water.

If that sounds farfetched, consider the activities of a group of scientists at the University of Warwick in the United Kingdom. Research fellow Nick Tucker and his colleagues in the university's Warwick Manufacturing Group have discovered that a grass called *Miscanthus* can be used to make biodegradable plastic parts such as hubcaps and dashboards. *Miscanthus*, also called "elephant grass," is truly a crop for the future: Europeans burn it in power plants as a source of bioenergy, and the stems can be fermented and distilled to produce an ethanol fuel. It grows quickly in arid climates to heights of nearly 12 feet without pesticides or fertilizers, and it produces up to 8 tons of biomass per acre.

Part of the grass's appeal lies in its C4 photosynthetic pathway, which allows it to fix high levels of combustible carbon from the air. "That's one of the reasons it's attractive as a fuel crop," Tucker explains.

Biodegradable materials are another use for this hardy perennial. Don't expect your *Miscanthus* car to look like a thatched hut, though. The plastics produced by Tucker's group look perfectly ordinary. The material base is created by bacteria, which under induced stress produce starch-based plastic-like polymers that can be harvested from a bioreactor. To reduce costs, manufacturers had until recently added inert, nonbiodegradable fillers such as talc or chalk to these bacterial polymers. "We felt these fillers didn't fit well with the goal of biodegradation," says Tucker. Substituting nonbiodegradable fillers with *Miscanthus* dust, he suggests, will allow commercially viable quantities of bioplastic to be produced at a competitive price.

Miscanthus requires less drying than other species. Also it has physical properties that enhance binding to the polymer matrix used in the filler material. Another example of a C4 plant that could possibly be used in the making of biodegradable materials is wheat straw.

Tucker and his university colleagues are working with a group of 20 British farmers who grow *Miscanthus* and who have created a company called Biomass Industrial Crops Limited to exploit the plant's multiple uses. Commercially available car parts made with *Miscanthus* should be available within 2–5 years, he says.

The current emphasis on car parts stems in part from a European Union directive, issued in 2000, that holds European manufacturers financially responsible for end-of-life disposal of their products beginning in 2003. Natural biodegradation could go a long way toward helping manufacturers meet these targets, says Charles Griffith, automobile project director at the Ecology Center, a nonprofit organization based in Ann Arbor, Michigan.

American automobile manufacturers don't face a similar mandate, but the problem of landfill space for expired cars in the United States is still acute: 75% (by volume) of the country's 10–11 million vehicles disposed of annually wind up in landfills. The nonprofit group Environmental Defense describes the situation as a "massive resource-consumption and waste-management problem."

That may be true, but would anyone buy a car that might decompose in the garage? "Not to worry," says Tucker. "Our goal is a biodegradable plastic that will hold up for at least fourteen years, which is the average life-span of a vehicle in the European Union. These plastics only break down in the presence of concentrated levels of bacteria, like those you find in a compost pile." **–Charles W. Schmidt**

***Miscanthus* can't miss!** *Miscanthus*, or elephant grass, grows hardily without pesticides or fertilizers and produces 8 tons of biomass per acre. It soon may also be a source for biodegradable car parts.

Iris Lewandowski/Universiteit Utrecht

The Beat

edited by **Erin E. Dooley**

HAZARDOUS WASTE

New Data Back Up Sludge Debate

Of the sewage sludge—or postprocessing sewage biosolids—produced annually in the United States, over half is applied to land. Sludges are treated to reduce odors and pathogens and their metal contents are regulated, but content of persistent organic pollutants such as polybrominated diphenyl ethers (PBDEs), chemicals found in brominated fire retardants and other products, has been largely ignored. PBDEs are considered emerging contaminants of concern because of their widespread use in consumer products, their persistence, and evidence that they may bioaccumulate and exert toxic effects at low levels.

Are PDBEs in sludge dangerous?

New research by Robert C. Hale and colleagues from the Virginia Institute of Marine Science in Gloucester Point, Virginia, shows that brominated flame retardant levels in sewage sludge samples from four different U.S. regions are 10–100 times higher than levels common in Europe. The researchers also found the flame retardants in 87% of fish sampled from Virginia waters, with some of the highest levels ever reported found in a sampling of five fish. The study was published in the 12 July 2001 issue of *Nature*.

Used extensively in electronic devices, furniture, automobiles, textiles, plastics, and polymers to reduce the risk of fire, PBDEs have been compared to polychlorinated biphenyls because of their structure and properties. Three different commercial formulations are sold as penta-, octa-, and decabromodiphenyl ether, with each mixture dominated by congeners (variations) with 5, 8, or 10 bromine atoms, respectively. The most bioaccumulative and apparently most toxic PBDEs contain 4–6 bromine atoms.

Penta-BDE is to be banned in Europe in 2003 because of concerns about its reported exponential increase in human breast milk and perceived health risks. Based on laboratory experiments, prolonged exposure is suspected of damaging the immune system, thyroid, and liver. A study by Swedish researchers in neonatal mice also links exposure to behavioral problems such as hyperactivity [see "Firesafe but Not Failsafe," p. A434 this issue).

Hale and colleagues analyzed treated sludge destined for land application from 11 different sources located in Texas, California, New York, Virginia, and Maryland. The total concentrations of penta-like BDEs in the sludges ranged from 1,100 to 2,290 µg/kg of dry weight, "suggesting that input was high and consistent, regardless of the region of origin and irrespective of pre-application treatment," the authors write. Total PBDEs were even higher, with a deca- form of PBDE present at concentrations of 84.8–4,890.0 µg/kg in the biosolids.

The researchers also found PBDEs in 87% of 334 fish from Virginia waters that they tested. A composite sample of fillets from five carp found in one stream contained 47,900 µg/kg total PBDEs, "rivaling the highest fillet burdens reported in the world so far," the report states.

"Our study indicates that pollutants with [persistent, bioaccumulative, and toxic] properties that are not tracked in the United States are present at relatively high concentrations in material that is widely applied to the land and that it has reached fish in many areas," says Hale. He says he views pollutants in sludge as an early indicator of dissemination, and that their presence in fish means they are moving up through the food chain—perhaps to humans.

Hale and colleagues report that the contributions of PBDE congeners in the sewage sludge samples matched those in the penta-commercial formulation, which is used as a flame retardant in polyurethane foam. These same congeners dominated the residues in fish. (However, the tetrabrominated congener BDE-47, a main ingredient in penta-BDE mixtures and the component found at highest concentrations in the environment, constituted the bulk.) The source of the sludge PBDEs is uncertain, but the authors believe that the breakdown of discarded polyurethane foam, which may contain up to 30% penta-BDE by weight, may be a factor.

The presence in U.S. sludge of high levels of congeners common in penta-BDE mixtures follows an emerging pattern, according to Åke Bergman, a professor of environmental chemistry at Stockholm University in Sweden. North America accounts for about 98% of the global demand of penta-BDE, estimated at about 8,290 metric tons in 1999. Environmental levels in Europe appear to be stabilizing in response to regulatory initiatives, but levels in North America appear to be rising still. In response to the high levels in fish found by the researchers, Virginia and North Carolina last year passed the first U.S. health limits for PBDEs in fish, at 5 ppm for tetrabromodiphenyl in fish fillets.

–Rebecca Renner

Top to bottom: Reuther/EHP; David J. Tenenbaum

Quicksilver Clues

A screening method that can quickly and inexpensively detect mercury in fish has been developed by researchers from The Scripps Research Institute in La Jolla, California. The FDA has recommended a mercury limit of no more than 1 ppm for human consumption. The U.S. EPA warns that all women of childbearing age should further limit their intake of high-risk fish such as swordfish and king mackerel to prevent unintentional fetal mercury exposure.

The test, similar to a home pregnancy test, could be used by both consumers to test freshly purchased fish and scientists to test fish in the field. Using a tiny sample of tissue, the test solution changes color if the fish contains as little as half the recommended FDA limit of mercury. Live test fish may then be released back into their habitat.

Renewing the UK

The UK Department of Trade and Industry announced in March 2001 that over £155 million will be spent on renewable energy research and development in the next three years. This includes £50 million donated by the National Lottery, of which £33 million will go toward constructing power plants that use energy crops, £10 million will go toward offshore wind power, and £3 million will go toward small-scale biomass heat generation. Minister of Energy Peter Hain said the government hopes that 10% of UK electricity will come from renewable sources by 2010. He added that the government is determined to bring offshore wind and energy crop projects into full commercial production in the near future. The government is assuring a market for the power produced by these projects through the Renewables Obligation, which requires UK power suppliers to obtain a portion of the electricity they sell from renewable sources.

The GOLD Standard

Chronic obstructive pulmonary disease (COPD), characterized by decreased lung airflow, is the world's fourth leading cause of death. On 4 April 2001 scientists from the ***G***lobal Initiative for Chronic ***O***bstructive ***L***ung ***D***isease (GOLD) released international guidelines for COPD diagnosis, management, and prevention. These guidelines are the first step in an international program focusing on raising global awareness of COPD and decreasing its health effects and morbidity. Experts say early intervention can slow the progression of COPD and reduce symptoms.

GOLD scientist Romain Pauwels noted that COPD receives insufficient attention from health care providers and governments, considering the impact the disease has on the world's population. The next phases of the program will focus on educating family physicians and COPD patients on disease management.

RECYCLING

A Less Trashy Nova Scotia

In Nova Scotia, taking out the trash may now be easier because there's less to take out—in fact, 50% less. The eastern province has become the first in Canada to reduce solid waste disposal by 50% over 1989 levels, a nationwide goal set that year by the Canadian Council of Ministers of the Environment.

The reduction is the result of a comprehensive solid waste management strategy developed by the Nova Scotia Department of the Environment following the 1995 passage of the Nova Scotia Environment Act. The act stipulated a number of regulations and bans that would form the basis of the strategy. Bob Kenney, a solid waste resource analyst for the department, says that to meet the 50% reduction goal, Nova Scotians were encouraged to compost, recycle, and choose products with less packaging whenever possible.

As part of the strategy, a highly successful deposit/refund system for beverage bottles was implemented. The return rate on beverage containers sold in Nova Scotia is nearly 80%, with 215 million containers returned annually. The average deposit refund is half of the amount the customer paid, and Kenney says the Resource Recovery Fund Board—a private, nonprofit company that manages several components of the strategy—made Can$9 million with the program last year. Half that annual revenue goes directly back to municipalities in a yearly lump sum, and another quarter goes into waste education funding and equipment to reduce waste. The remainder goes to private waste diversion businesses.

The strategy also includes a recycling program for used tires (more than 2.3 million tires have been recycled since January 1997). And on 30 November 1998 Nova Scotia became the first province to ban compostable organic material from landfills. "We firmly believe that we could not reach 50% diversion [over 1989 levels] without the ban on compostable organic materials from disposal," says Kenney. By diverting waste, Nova Scotia has gone from hundreds of landfills in the 1970s to just 18 today. By 2005, Kenney expects there to be only 8–10 landfills, and each will be fully lined with a plastic collection system to collect and treat leachate.

The strategy has also helped boost employment. In this province of 940,000 people, there are 3,000 jobs in waste management and recycling, with 1,000 new jobs since the strategy began. New and innovative companies that utilize recyclables continue to spring up. For example, Novapet, based in Amherst, grinds up PET plastic (used in items such as soft drink bottles), then sells the material to Canadian and U.S. manufacturers to make carpet and clothing. Thermo-Cell, which has a facility in Debert, manufactures cellulose building insulation from old newspapers. Other businesses specialize in recycling items such as paint and used lumber.

Nova Scotia's program is attracting inquiries from Russia, China, Ireland, and other Canadian provinces. The Department of the Environment also hosts environmental science students from France and Britain who wish to work with and learn from the program. "I think a program similar to ours could be successful anywhere," says Kenney. **–Lindsey A. Greene**

PHARMACEUTICALS

The Genetics behind Drug Breakdown

Individuals with a common genetic variation may not metabolize certain drugs as readily as those without the mutation, researchers report in the April 2001 *Nature Genetics*. As a result, they may be particularly sensitive to these medications. This finding is a "big step forward" toward understanding the genetic variants behind drug reactions, says Rochelle M. Long, head of the NIH Pharmacogenetics Research Network, which helped fund the study.

The protein CYP3A5 is part of the family of CYP3A enzymes, which break down cholesterol-lowering, anticancer, anti-HIV, and immunosuppressant drugs passing through the digestive system. Research from the late 1980s had shown that CYP3A5 helps metabolize drugs, yet is not in the tissues of some people. The new study reveals that these individuals have one of two variant alleles that express only short, inactive versions of CYP3A5, report scientists led by Erin Schuetz, a pharmaceutical scientist at St. Jude Children's Research Hospital in Memphis, Tennessee. One normal allele is needed for the body to express the active protein.

In the United States, 60% of African Americans and only 25–30% of Caucasians have the active protein, the team reports. People without the protein may need smaller doses of the drugs it normally metabolizes, or they risk side effects, Schuetz explains. "CYP3A5 may be the most important genetic contributor to interindividual and interracial differences in CYP3A-dependent drug clearance and in response to many medicines," the team concludes. CYP3A proteins break down 50% of clinical drugs, and CYP3A5 is the most common of the proteins, normally representing as much as half of all CYP3A enzymes, Schuetz says.

In their study, Schuetz and colleagues analyzed DNA samples from 159 individuals. They first identified the most common single nucleotide polymorphisms in the CYP3A genes. Then they related these variants to differences in how the participants metabolized midazolam, a common sedative. People who metabolized the drug slowly were found to carry the *CYP3A5*3* or *CYP3A5*6* alleles, and the faster metabolizers carried *CYP3A5*1*.

Depending on the variant, CYP3A5 proteins can affect how the body metabolizes certain environmental contaminants, including aflatoxins, compounds produced by molds and found in some animal feeds and peanuts, Schuetz says. They can either help the body break down the contaminant, or they can take the contaminant from an inert to a DNA-damaging form. So the CYP3A5 allele that people carry may also influence their susceptibility to environmental diseases, she says.

A matter of metabolism. Variation in expression of a particular protein may explain people's different reactions to the same drug.

PhotoDisc

Companies are interested in marketing CYP3A tests, and pharmacogenetic tests to show whether a person has genetic variants that could affect his or her response to drugs may become widely available within the next few years, says Long. Researchers can already identify the CYP3A5 protein by analyzing buccal cells, explains Schuetz. Nevertheless, before tests for genetic variations become routine, "there will be lots of clinical studies to determine for many [medications] the importance of whether you have 3A5 or not," she explains. "Second, for those drugs where 3A5 is making a difference, there may be testing to guide appropriate dosing." **–Tina Adler**

The Consumers Union Guide to Environmental Labels

As U.S. manufacturers and retailers rush to tap into the multibillion-dollar-per-year "green merchandise" market, labels on items ranging from eggs to diapers tout an ever-expanding number of qualifiers such as nontoxic, all natural, and organic to appeal to consumers' desire to make as healthy and environmentally friendly purchases as possible. Unfortunately, the spending public has traditionally been left to its own devices to determine how meaningful these claims actually are and whether they are supported by an overseeing body—important facts to consider, especially as such products are often more expensive than alternatives without the claims.

To educate consumers about products with so-called eco-labels (a seal or logo indicating that the product has met a set of environmental or social standards), the Consumers Union (CU) launched The Consumers Union Guide to Environmental Labels at http://www.eco-labels.org/ in early 2001. Said Urvashi Rangan, director of the CU eco-labeling project, in a CU press release, "Our goal is for shoppers to be able to use this independent source to discern which labels really help the environment and which amount to little more than marketing hype. This awareness would help raise the bar for what consumers expect from manufacturers' environmental labels and claims." The CU is a nonprofit organization established in 1936 to educate consumers about all types of goods and services, research and test products, and advocate for consumer issues.

From the home page, visitors can search for information by label, product, or certifying organization. Label categories group claims under themes, including Organic, Pest Management, Social Responsibility, Sustainable Agriculture, Sustainable Fishing, Animal Welfare, Sustainable Wood, and General Claims. Certifying organizations for each category include government agencies such as the U.S. Department of Agriculture, grassroots groups such as Mothers & Others for a Livable Planet, international accrediting organizations such as the Marine Stewardship Council, and professional groups such as the American Forest and Paper Association. Selecting any of the label categories from the Label Category pull-down menu takes the visitor to a list of logos used on labels alongside links to information about the certifying agency or organization, including a program summary, a CU evaluation, program contact information, a list of the board of directors, and what products are certified by the program.

The General Claims page, accessible through the Label Category pull-down menu, currently lists 43 nonspecific claims that might show up on labels, including *dolphin safe*, *earth smart*, *environmentally friendly*, and *recycled*. For each claim, there is a definition if applicable (or not; for instance, the site says there is "currently no standard definition" for terms such as *environmentally friendly* and *environmentally safe*), a statement of which group or groups endorse the claim, and a CU evaluation of the use of the claim on labels.

Visitors can also search for information by product or certifier. The Product Area pull-down menu lists 35 types of foods and other products, while the Certifier option allows searches by one of 27 certifying organizations or 30 certification programs. **–Erin E. Dooley**

FAO Push against Pesticides

Hazardous pesticides now banned elsewhere, including methyl parathion, are still being sold in Southeast Asia, especially in Cambodia, and used without proper precautions. In 1993 the UN FAO launched an innovative integrated pest management program in Southeast Asia. Now, to further reduce human risk from pesticides in a country where 85% of the population depends on agriculture for its livelihood, the FAO is staging field schools in which farmers learn about rice ecology and the effects of pesticides on ecosystems, and is showing farmers how to organize their own field schools so that information can be disseminated to an even greater audience.

So far 30,000 rice farmers have attended the schools. Of these, 330 have completed training to become trainers themselves and are currently setting up their own field schools in their home provinces.

Postal Service Gets Electrified

Quiet, clean, ultramodern vans are making their way into California and D.C. neighborhoods as part of the U.S. Postal Service's efforts to make its 200,000-vehicle fleet as environmentally beneficial and cost-effective as possible. Five hundred battery-powered electric vans, developed by Ford Motor Company, have been purchased. Nearly 143,000 lbs of carbon monoxide, 11,000 lbs of hydrocarbons, and 16,000 lbs of nitrogen oxides will be kept from the air yearly as a result of using these vehicles.

Aside from their low-noise and zero-emission benefits, the vans require less maintenance and are cheaper to run than comparable gasoline-powered vehicles. Fleet usage will also aid California power suppliers as van batteries will be recharged during low-demand nighttime hours, utilizing otherwise unused electricity and providing a new revenue source for those utilities.

Smoke-Free Soccer

Although it will lose millions of dollars in tobacco sponsorship each year, the South African Football Association (SAFA) has added its support to the growing worldwide movement away from smoking. On 14 March 2001, SAFA announced its partnership with the WHO in a joint program promoting a smoke-free soccer environment. This follows a January 2001 act in South Africa banning smoking in public places and curtailing tobacco company sponsorship of sporting and cultural events.

The program seeks to reduce the number of South Africans—currently some 25,000—who die each year from tobacco-related diseases. Anti-smoking posters featuring prominent South African players will go up in soccer venues, announcements during matches will remind spectators of the new policies, and SAFA chief executive Danny Jordaan hinted in an interview that no-smoking clauses may be written into future player contracts.

Top to bottom: Ford Motor Company; KPT, Reuther/EHP