Spectrum

Compost from abattoir waste

More than nine million head of cattle are slaughtered each year in Australia, providing valuable leather and a range of useful by-products, as well as sustaining a beef industry worth at least $3·5 billion. But the meat industry also produces tonnes of waste that are difficult to dispose of. Without careful management, this waste could pose a threat to the environment.

When an animal is slaughtered in a modern meat-processing plant, the only materials not converted to commercial products such as meat, pet food and fertiliser are the manure from the stockyards and the partly digested paunch or stomach contents. Each year, a large abattoir can produce more than 3000 tonnes of this material and spend upwards of $17 a tonne on its removal and safe disposal. Meat researchers in CSIRO estimate that nationally abattoirs and feedlots produce more than 100 000 tonnes of cattle manure, meat scraps and stomach contents a year. Another 75 000 tonnes of waste are generated each year by the slaughter of 26 million sheep, pigs and calves, and more than 300 000 tonnes of manure are removed from cattle feedlots.

Ideally, this annual mountain of organic waste would be converted to fertiliser, but at present very little is so used because the cost of processing exceeds the commercial value of the product. While liquid wastes are treated on site or discharged to sewers, much of the solid waste either goes to municipal or private landfills or is simply dumped on farmland. The waste can contain dangerous pathogens and weed seeds, which make it unsuitable for use as fertiliser in market gardens and nurseries. Feedlot manure is currently used as a low-grade fertiliser on farmland.

In anticipation that environmental considerations will make landfill an unacceptable disposal method in the future, the Meat Research Corporation has funded a joint project of the Meat Industry Research Institute of New Zealand and CSIRO's Meat Research Laboratory in Brisbane to develop better disposal methods for abattoir waste. Using a technique first developed in the United States in the 1970s for treating sewage sludge, the researchers have successfully turned abattoir waste into high-grade compost suitable as a fertiliser, soil conditioner or potting mix.

Composting — essentially a form of bio-engineering — uses microbes to degrade organic compounds at an elevated temperature and produce a stable organic residue free of offensive odours and pathogenic organisms. Turning organic waste into compost has several advantages. The resulting product contains less moisture than raw waste, making it easier to handle, and the plant nutrients more concentrated. The heat generated in the composting process kills weed seeds and helps to eliminate substances that inhibit plant growth.

All of the numerous methods of composting depend on controlling temperature and oxygen supply. By using an aeration fan, linked to a thermostat, the researchers were able to maintain the temperature of their compost piles between 40° and 60°C. The fan pumps air into a loop of perforated pipe at the base of the pile, percolating it with oxygen to keep the micro-organisms alive. As the biochemical reactions produce more and more heat, the thermostat increases the fan speed, thus helping to cool the pile. The demand for air peaks in the first few days, then decreases as the reactions slow during the following 2–3 weeks.

Working with waste volumes of up to 50 cu. m, the scientists turned various mixtures of meat scraps and cattle and sheep paunch contents into a stabilised organic residue within 19 to 27 days. The residue, after 'curing' in non-aerated piles for several months, formed mature compost suitable for sale. Little odour was produced. Feedlot manure was more successfully composted using the simpler method of windrowing, turning the pile periodically with a front-end loader or specialised turning machine.

A commercial trial of the technique recently began at a Melbourne abattoir. If it succeeds, the researchers believe that up to 25% of abattoir paunch waste and solid effluent may be economically converted to compost.

Brett Wright

Application of a Composting Technique to Abattoir and Feedlot Waste Solids — Final Report. A.J. Oostrom and N.G. McPhail. (Meat Research Corporation: August 1991.)

Water management aid

Irrigation created such marvels as the Murrumbidgee Irrigation Area in south-western New South Wales and Sunraysia in South Australia; but it has also contributed to massive problems such as toxic algal blooms (see the previous issue, No. 72).

Water management is central to the search for solutions to algal blooms, especially regulating the flow of nutrients such as nitrogen and phosphorus into streams and rivers. Just as importantly, careful water management is crucial in controlling salinisation, especially where salinity levels are already high and where water tables are shallow.

A team led by Dr Wayne Meyer at the CSIRO Division of Water Resources' Griffith laboratories has developed computer software called SWAGMAN — short for Salt, Water And Groundwater MANagement — to demonstrate how irrigation managers can limit crop losses while also avoiding salinisation and shallow water tables; SWAGMAN is also aimed at advisors, teachers and students. Dr Meyer sees it as a demonstration tool that shows directions and trends rather than a prescriptive model.

Built in to SWAGMAN's database is comprehensive information on climate, water table height, soil type, crops (including pasture crops) and irrigation regimes.

To use the program, you can 'tell' SWAGMAN that you are — to take just one example — growing maize on fast-draining, non-saline clay soil in the Riverina climatic zone, with a normal year's rainfall and a water table 2 m below the surface. Then SWAGMAN adds details from its internal library of information: in this case, the sowing time for maize, its average root depth and that a normal year's rainfall for the Riverina is 416 mm, 128 mm of which falls in

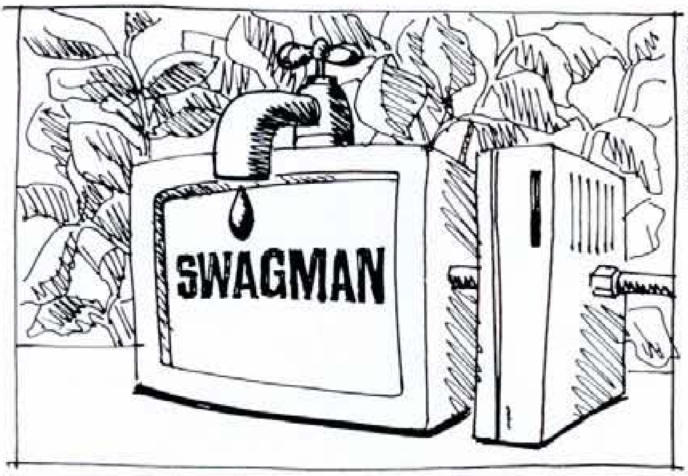


Illustration: Brian Gosnell

the growing season. The program estimates where the water table will be and how much salt will be within the root zone after a year. It also estimates relative crop yield losses as a result of too much salt, too much water or too little water.

Then the program's what-if features allow you to manipulate irrigation options to predict what effects different amounts and timing of irrigation will have on maize yield, and how soil salinity levels will be affected. You can see the changes in a dry or wet year and choose when to water (on any one day or combination of days during the growing year) and see how much to apply. You can also choose where to take water from (channel, bore, channel plus bore or rainfall alone) and so influence the salinity level of the water used for irrigation.

In a matter of moments SWAGMAN computes how much, if any, of your potential crop yield will be lost from salt damage, whether your planned irrigation regime will raise or lower water tables or whether it will affect the amount of salt in the crop's root zone. A summary option displays the same information graphically so you can see when, for example, too much water makes the crop waterlogged or when salt has risen into the root zone.

Dr Meyer describes SWAGMAN as a tool for understanding. While it doesn't provide all the answers, it allows people to understand how irrigation affects groundwater levels, salinity and crop yields.

Costing $95 for an instruction manual, companion booklet and a floppy disk or diskette, SWAGMAN can be used on any MS-DOS personal computer.

Carson Creagh

Saving fuel on time

Life in an ecologically sustainable society of the future may fall a touch short of Utopian bliss but one may, as did the Italians under Fascism, reasonably expect the trains to run to time. Late trains cost votes (as any politician, fascist or otherwise, will tell you); and they waste fuel too.

Because of unexpected delays or poor driver performance, trains that are running late often expend excessive amounts of energy trying to catch up with the timetable, thereby wasting fuel as well as the travellers' patience. A scheme for eliminating late trains would also conserve fuel and make rail systems more energy-efficient.

Research by scientists from the University of South Australia and the CSIRO Division of Mathematics and Statistics has apparently found a solution — a computer-aided system that provides *en route* advice for the suburban train-driver on when best to accelerate, coast or brake. Known as Metromiser, the system when used in the train cabin can tell a driver the best possible way to drive to reach the next station on time; at the base, it can tell a planning officer how best to draw up a train timetable to save energy.

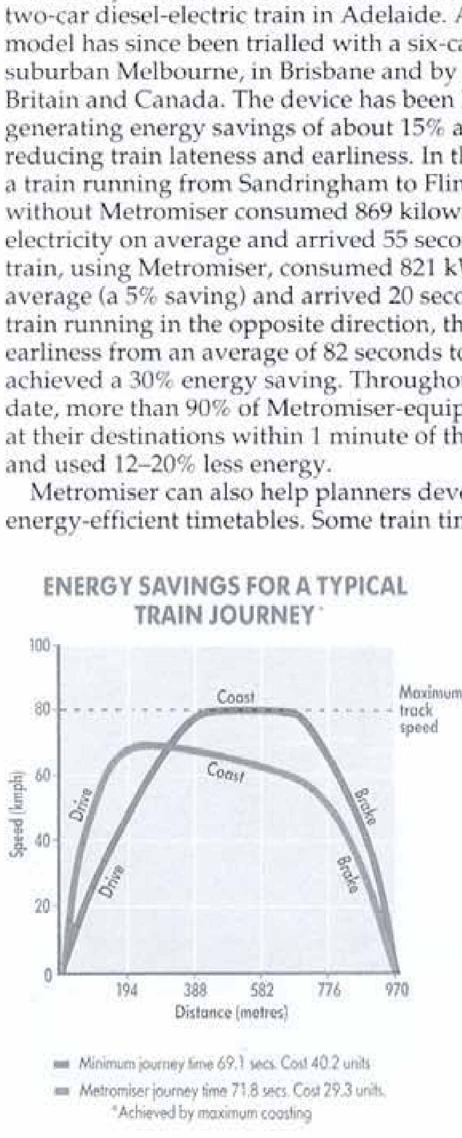
When used in the cabin, Metromiser generates continuous advice by calculating, on the basis of current speed and position, whether braking is required and whether the driver can reach the next stop on time without applying more power. To do this, the device uses data collected on previous journeys to predict the train's 'coasting performance' — that is, the part of each journey the vehicle can complete without application of either power or brakes. Metromiser combines these data with programmed information on arrival times, track gradient and braking performance, and adds changing information on speed and position supplied by a digital odometer mounted on a wheel.

As the train proceeds, Metromiser recalculates the optimal driving strategy, and gives the driver one of three pieces of advice: drive (at the maximum safe speed), coast or brake.

An early version of Metromiser was tested in 1985 on a two-car diesel-electric train in Adelaide. An improved model has since been trialled with a six-car electric train in suburban Melbourne, in Brisbane and by rail authorities in Britain and Canada. The device has been highly successful, generating energy savings of about 15% and substantially reducing train lateness and earliness. In the Melbourne trial, a train running from Sandringham to Flinders Street Station without Metromiser consumed 869 kilowatt-hours (kWh) of electricity on average and arrived 55 seconds late. The same train, using Metromiser, consumed 821 kWh of energy on average (a 5% saving) and arrived 20 seconds late. With a train running in the opposite direction, the system reduced earliness from an average of 82 seconds to just 1, and achieved a 30% energy saving. Throughout all the trials to date, more than 90% of Metromiser-equipped trains arrived at their destinations within 1 minute of the scheduled time, and used 12–20% less energy.

Metromiser can also help planners develop energy-efficient timetables. Some train timetables are too

ENERGY SAVINGS FOR A TYPICAL TRAIN JOURNEY*



An example of how Metromiser can save money.

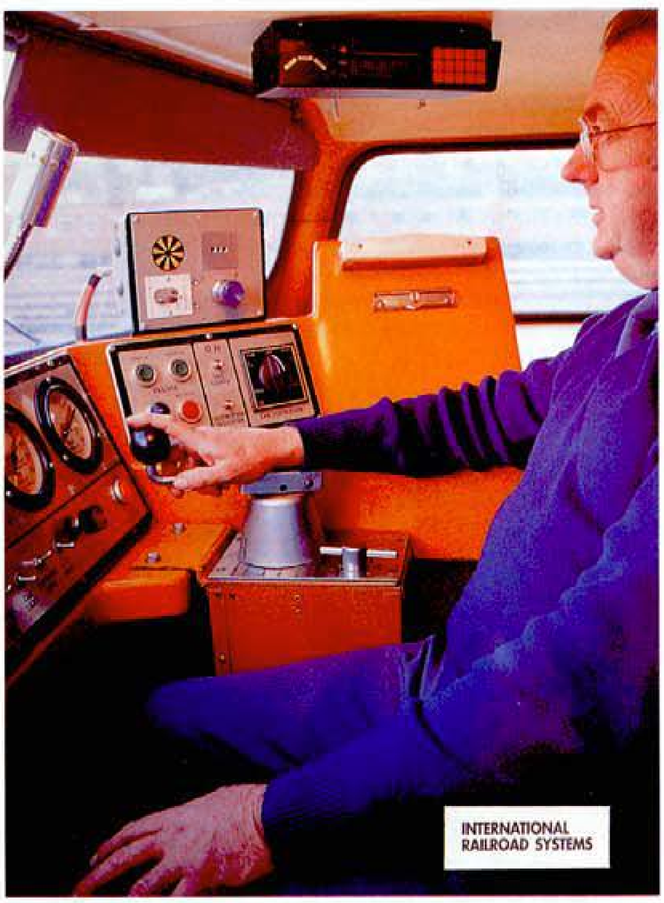
tight, allowing too little time for coasting or recovery from delays; others are too slack, making trains arrive early, thereby wasting energy. The recommended amount of 'timetable slack' is about 3 to 4% of journey time. Using data on railcar performance and the rail network, Metromiser can generate a timetable that distributes the available 'slack' throughout the network in an optimal way.

A timetable study for a new suburban network in Perth used Metromiser to reschedule a train journey of about 35 minutes with 18 stops. Although the schedule changes were small (the biggest time difference for any stop was 69 seconds), the Metromised journey was calculated to reduce energy consumption by one-fifth.

The researchers have found that small changes in scheduling can have a significant impact on energy use. Even rounding the timetable entries to the nearest minute typically incurs an energy penalty of 10% or worse on suburban train journeys.

Despite the success of the trials, the leader of the team, Dr Graham Mills of the Division of Mathematics and Statistics in Melbourne, says rail authorities have been slow to take up Metromiser as a way to boost energy efficiency. The system is being installed on new passenger railcars in Adelaide, but other cities have shown little interest to date.

More recently, the researchers have extended their work to the problem of reducing train lateness and energy consumption on long-haul trains. In particular, Dr Mills and two Masters students — Sonya Perkins and Peter Pudney — at the University of South Australia have developed a 'Dynamic Rescheduler' that generates and maintains an energy-efficient schedule for crossing trains on long-distance single-line networks.



Metromiser in the train cabin.

Australian Overseas Information Service

Will they leave, and arrive, on time?

Trains on single-line networks must stop at sidings or 'crossing loops' and wait for others to pass. Energy and time are wasted if one of two trains gets to a siding much before the other. Traditionally long-haul trains are driven flat-out and controllers will attempt to move them through a network as quickly as possible, resulting in high fuel costs and longer-than-necessary delays at crossing loops. Big savings can be achieved by slowing some trains in a way that reduces waiting time at crossings. The Dynamic Rescheduler calculates a crossing schedule for all trains on a network for the next 24 hours, minimising the 'cost' of each journey in terms of energy use and lateness. The data are then transmitted to each train and updated every 15 minutes. While the system has similarities with Metromiser, the computational task is more complex due to changes in the weight of the train and wind direction during the journey.

In a series of experiments using sample problems drawn from sections of the Trans-Australian Railway network, the Dynamic Rescheduler was able to reduce the cost of nine trains traversing a 433-km section of track in South Australia by 6%. Increasing the reliability of long-haul trains in this way, the researchers believe, can make rail transport more competitive with road transport.

Brett Wright

Using tiny wasps to control pests

Australia's pecan- and macadamia-farmers spend hundreds of thousands of dollars a year battling pests such as the native stem girdler moth *Maroga melanostigma*. A CSIRO Division of Entomology scientist, Dr Jamie Seymour — whose principal area of research is the green vegetable bug, an important pest in many crop species — is acting as scientific adviser to Stahmann Pecan Farms, funded by the Horticultural Research and Development Corporation. He is investigating the life cycle of the *Maroga* moth in the hope of finding biological control agents that will reduce pesticide bills (and help lower the risk of environmental damage from insecticides).

Adult *M. melanostigma* live for a fortnight or so, during which time they lay about a thousand eggs on the branches of pecan, macadamia and other trees. On hatching, the larvae eat through the bark then burrow down into the wood, often moving in a circle around the branch and effectively ringbarking it (hence the soubriquet girdler moth). Buried deep within the tree's living wood — and therefore shielded from pesticides or other control measures — the larvae continue to grow for 8–10 months, then pupate; the adults emerge between October and late December.

Dr Seymour collected moth egg masses and took them back to his laboratory in Moree, the heart of Australia's pecan- and cotton-growing area, looking for predatory insects that eat the eggs, or parasites that lay their own eggs inside those of the pest.

By chance, he found a tiny native wasp — a member of the genus *Trichogramma* — which grows to no more than half a millimetre in length, laying its own eggs inside those of the moth. The emerging wasp larvae feed on the immature caterpillars then pupate, still inside the host's egg-case. A week or so later an adult wasp emerges; if female it can parasitise some 25 other eggs, laying three of its own eggs inside each and thus producing about 75 young over a period of 5 or 6 days.

Almost all of the hundreds of *Trichogramma* species described to date are known to be egg parasites; they have long interested scientists and, fortunately for Dr Seymour's research, the technology for breeding them in large numbers is well known.

Dr Seymour is currently supervising the breeding of *Trichogramma* wasps in his Moree insectary for inundative release: when the insectary is fully operational, the farm will release 4–8 million wasps each week — or about 100 wasps per tree — between October and December. Stahmann Pecan Farms has agreed to suspend insecticide spraying during the release period, providing Dr Seymour with ideal field conditions in which to assess the species' impact on girdler moths. It's a courageous decision, given that a population of no more than 50 moth larvae on any one tree can induce so much stress that total premature dropping of nuts can occur. Girdler moths are responsible for pecan crop losses worth more than $800 000 — some 10% of the industry's annual export earnings.

Other farmers in the Moree district are paying close attention to Dr Seymour's research, too. The *Trichogramma* wasp also lays its eggs in those of the *Heliothis* moth, the single most important pest of cotton. If it succeeds in controlling this major pest, it may offer cotton-growers an alternative to the moth pesticides that cause environmental pollution in cotton-growing areas and that contaminate cotton fibres even after processing.

Carson Creagh

Jamie Seymour

A female *Trichogramma* wasp emerges from the egg of a *Heliothis* moth after consuming the moth larva within.

Jamie Seymour

A *Trichogramma* wasp lays its egg inside that of a *Heliothis* moth.

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