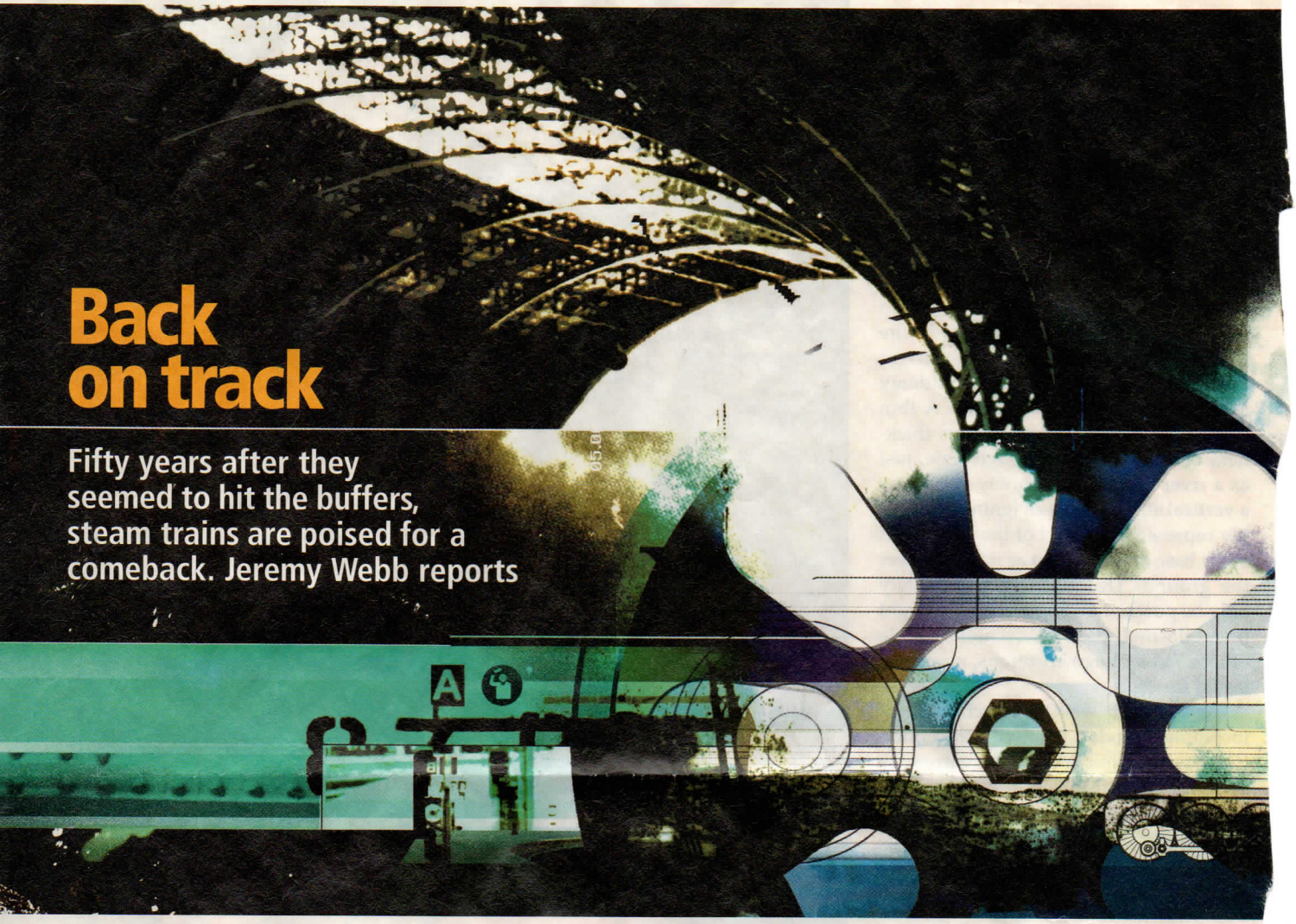


Back on track

Fifty years after they seemed to hit the buffers, steam trains are poised for a comeback. Jeremy Webb reports

AS THE ELECTRIC trolley bus sweeps quietly and cleanly through Winterthur, just north of Zürich, I try to imagine the person I'm about to meet. The notion of a Swiss engineer who is also a steam train enthusiast conjures up an image of someone between a boring banker and a socially-challenged adolescent in an anorak. Yet, a quarter of an hour later, having met Roger Waller, I realise that my preconceptions are in for a battering.

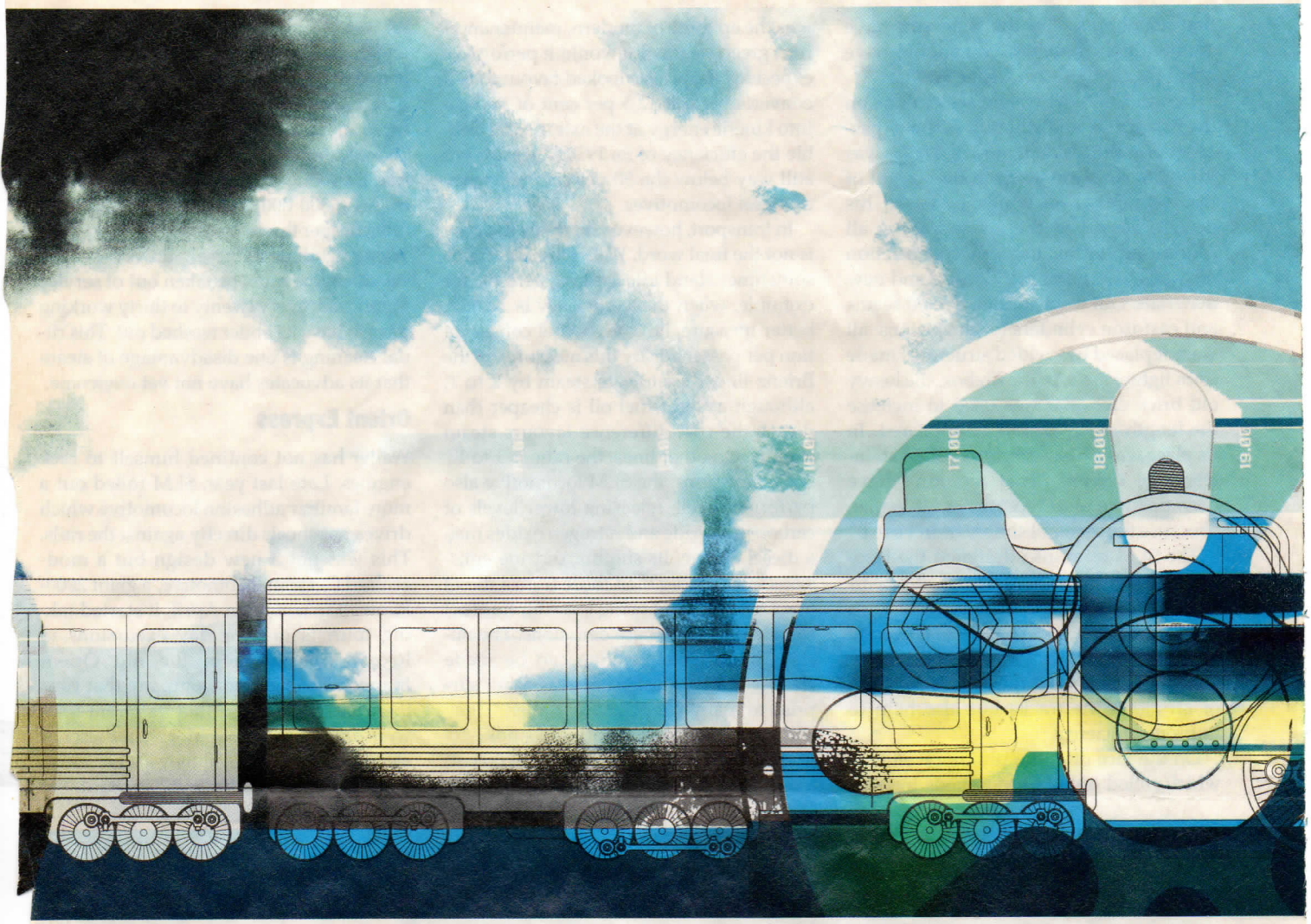
His flamboyant black and white shirt betrays a relaxed style and dry sense of humour. And he's clearly in touch with the way most people perceive steam. "The biggest problem facing steam is not efficiency, but its image," he says. "People see it as dirty and old-fashioned."

But this doesn't deter to Waller, who is in charge of developing steam power for Sulzer Winpro, an engineering firm based at the historic Swiss Locomotive and Machinery (SLM) plant in Winterthur. In this huge and once bustling site, half of which now stands sadly empty (but scrupulously clean) in the drizzling rain, Waller has managed an astonishing feat. Fifty years after most commercial development of steam engines ended, his team has designed, built and sold steam locomotives that run as economically as diesels and are more environmentally friendly. "When we started this thing, everybody thought we were mad," he says. "Now we have trains in regular, daily service."

Other groups have modernised old steam locomotives, or built replicas, but the SLM team is unique in the 1990s because it has built a steam engine from scratch using modern ideas. Waller believes that in the right place "new steam", as he calls it, can compete with electric and diesel traction. Many rail engineers think this, too, is mad. Just how far this miniature renaissance will spread depends in large part on how well Waller and a small group of like-minded engineers round the world can change people's prejudices.

When Waller joined SLM in 1978, he designed and developed electric and diesel locomotives. But by this time he was already hooked on steam. "Book a steam trip yourself," he says. "You will see, feel and hear, even smell the power and the speed. No other human invention has so much life in it as a steam locomotive." So strong was his craving that, in 1982, he quit his job and headed for South Africa. Here, he joined a British engineer, David Wardale, who had modernised a locomotive called the Red Devil in an attempt to convince South African Railways that steam still had lots to offer. While he was there, he had a revelation.

"I saw an economic study by South African Railways comparing steam, diesel and electric for the Kimberley to De Aar line," he recalls. "It concluded that under the conditions then prevailing in South Africa, steam would be the most economic form of traction." Electrification would have required the installation and maintenance of costly overhead wires, and



Mark McClure

diesel oil was in short supply while coal was cheap and plentiful. "I started believing that there could be a future for steam," says Waller.

Spurred on by this study, and by now back at SLM, Waller started analysing the disadvantages of steam locomotives and concluded that they could all be overcome with modern technology. He chose to focus on the one area where everyone agrees that steam is an asset rather than a liability—tourism. "For tourism, people see that steam adds to the value of a train journey," he says. He approached the operators of the only non-electrified railway in Switzerland, which runs steam trains and diesels up the steep ascent from Brienz to Rothorn. He proposed building a locomotive for them that would look like a 1930s steam engine but perform as well as, or better than, their most modern diesel engine. The reply was "go ahead".

One of the big cost disadvantages of steam is the need not only for a driver, but also for someone to shovel coal into the firebox. Waller's team removed the extra person by replacing coal with oil, which is far easier to control. "Almost every boiler in industrial service is operated more or less automatically," he says. "Nowhere in industry do you see a fireman sitting next to the boiler, so our view was that this could be done on a locomotive, too."

'Most railway engineers nowadays do not have enough knowledge of steam locomotives to be able to judge the possibilities. I simply suggest using modern steam wherever it is more economical, or ecological'

Oil-fired steam engines have run before, especially in the US. But these used heavy fuel oil, which is dirty and needs preheating before it can be burnt. Waller and his colleagues decided to use light oil, like that used for heating homes, which is easier to handle and less polluting. The oil-firing system they designed, which atomises the oil in a stream of air and steam, is highly efficient, leaving only about 0·5 per cent of the fuel unburnt so what comes out of the stack is virtually smoke-free.

The SLM team also wrapped the firebox and boiler in a blanket of insulating mineral wool. Old engines had no, or very poor, insulation, so they radiated vast amounts of heat whenever they were fired up. They also cooled down overnight unless they were continually tended. Getting up a head of steam next morning could waste a lot of time and fuel.

The thick insulation and a cap on the chimney to stop draughts drew the sting from these problems. The pressure in the new locomotive's boiler might be 14 atmospheres at the end of the day. Heat retention is now so good that by next morning, the pressure will still be about

8 atmospheres. "By the time you have shunted your coaches, you should have a full [head of] steam," says Waller.

In order to meet weight restrictions on the Brienz line and still pull as many passengers as the resident diesels, Waller was forced to cut 5 tonnes from the weight of the locomotive on which he based his design. He saved this by scrimping all round, exploiting modern construction methods, computer calculations and new materials. Out went antique riveted seams and cast-iron cylinders for the pistons: all were replaced by welded structures made from lighter steel. In the firebox, the heavy old brick arch that was used to increase the length of the flames disappeared. In its place was a lighter, heat-resistant stainless-steel screen. "That wouldn't have been possible until recently," says Waller, "because the material simply didn't exist."

The SLM team also designed the locomotive axles to run in modern roller bearings. The original 1930s engine had plain bearings, simple brass collars that needed constant lubrication. The new sealed bearings not only cut out the steady dripping of oil along the tracks but also help to improve efficiency.

On the face of it, the prototype engine, which rolled out of SLM's sheds in 1992, was the epitome of modern, maintenance-free, green steam. But would it perform as expected? Early tests looked favourable. It converted about 12·5 per cent of its heat into kinetic energy at the axle, nearly double the efficiency of its 1930s ancestor but still way below the 30 per cent efficiency of diesel locomotives.

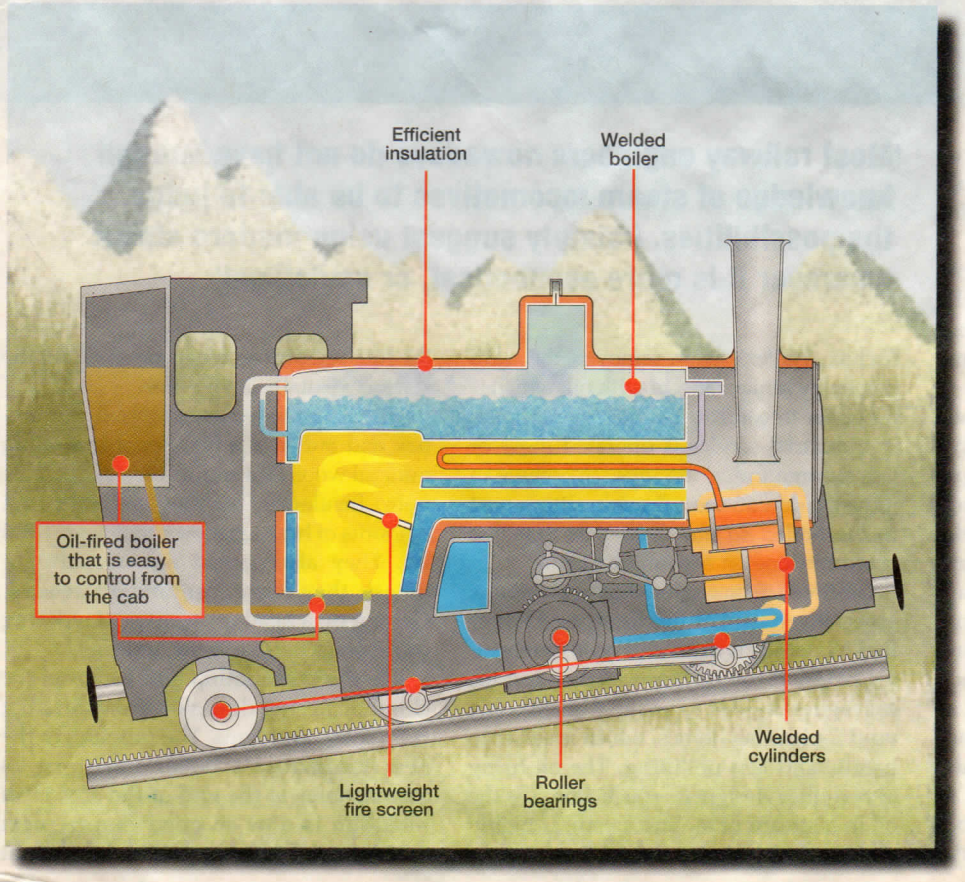
In transport, however, thermal efficiency is not the final word, Waller argues. Trains sometimes stand idle for long periods, for example, when their efficiency is zero. A better measure, he says, is fuel consumption per passenger. By this measure, on the Brienz line, diesel beats steam by 2 to 1, although as light fuel oil is cheaper than diesel, the cost difference favours steam slightly. On other lines, the ratio is 1 to 1.

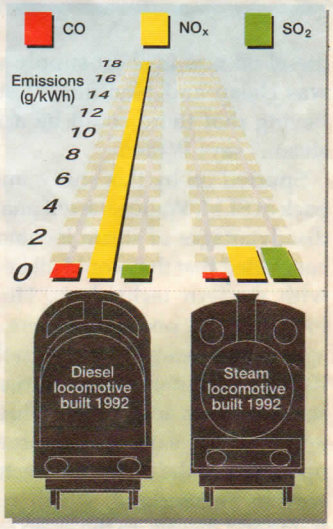
On emissions, the SLM locomotive also performed well, releasing lower levels of carbon monoxide and nitrogen oxides than a diesel engine. Its sulphur dioxide emissions were higher than those from a diesel (see Diagram), but using low-sulphur fuel can almost halve these emissions. The notion that a steam engine can be made cleaner than a diesel comes as a big surprise to many people, says Waller. "They still see steam engines belching smoke."

The SLM team designed the 300-kilowatt locomotive especially for mountain lines. Its pistons drive a large cog, or pinion, which locks into the teeth of a "rack" bolted to the ground between the rails. To date, eight of the machines are running on three mountain lines at Brienz, Glion—above Montreux—and at Schafberg in Austria. Each one costs about 2 million Swiss francs (£800 000), which is about 20 per cent cheaper than a comparable diesel, says Waller. Unlike a diesel, however, each steam engine must be taken out of service for one day every twenty to thirty working days to have its boiler washed out. This ritual cleaning is one disadvantage of steam that its advocates have not yet overcome.

Orient Express

Waller has not confined himself to rack engines. Late last year, SLM rolled out a more familiar adhesion locomotive which drives its wheels directly against the rails. This was not a new design but a modernised German locomotive, a giant 2000-kilowatt machine. In April, it started taking tourists out for day excursions in luxury coaches from the old Orient Express. The German company that runs the excursions found that its steam trips were always more popular than diesel or electric equivalents, but they also received complaints from the public about the





Steam cleaned: replace diesel engines with new steam locomotives like those made by SLM (left) and you can slash the pollutants emitted into the environment

smoke. Today, after the full SLM treatment, the train emits less pollution than a comparable diesel, and fuel costs have fallen by as much as 40 per cent. "We've made big efficiency gains," says Waller. "But it was a compromise because we didn't start building from scratch."

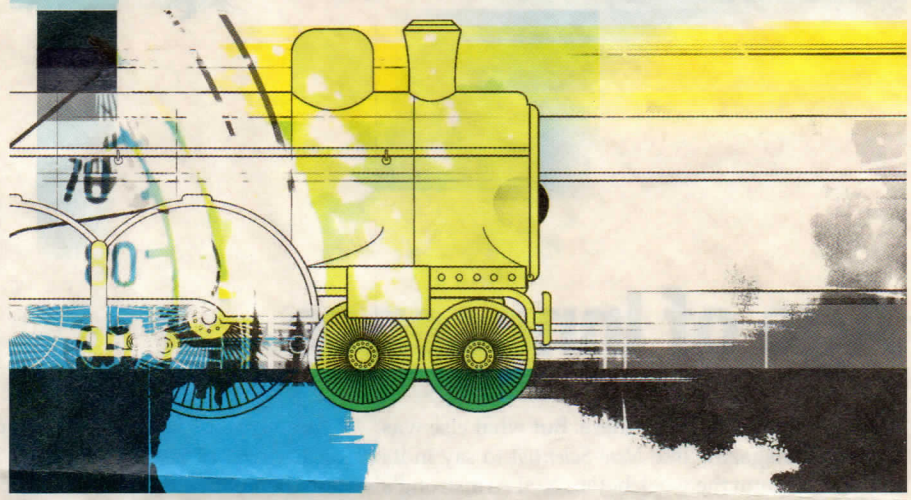
Another of SLM's projects has a sweet irony. The company is making new steam engines for four paddle steamers that ply Lake Léman. These were originally driven by steam, but the old engines needed an engineer and stoker to operate them. Forty years ago, the ships were converted to diesel so the engines could be operated from the bridge. Today, with the diesels reaching the end of their lives, Waller has convinced the operators to switch back to steam, but this time one-person operated new steam.

It's not just Waller who recognises the potential of new steam. Engineers in other countries, such as South Africa and Argentina, are also working on improving steam locomotives. In Ushuaia, near the southern tip of Argentina, for example, Sean MacMahon is modernising two oil-fired engines that run on a tourist line dubbed the railway "at the end of the world". Just about every system from the burner to the brakes will be updated to improve its performance. The line runs through a national park, so MacMahon has particularly strict emission and noise targets to meet.

Perhaps the most influential thinker on steam development is Argentinean engineer Livio Dante Porta, who has made big improvements to combustion and exhaust systems. Much of his recent work has been done in Cuba. "He has totally transformed a 1919-built steam engine into a machine that is cheaper to operate and maintain than a diesel or electric locomotive," says MacMahon. It can burn coal, oil, wood, even bagasse—waste left from the sugar cane industry—as required. If all goes well with their existing projects, Porta and MacMahon hope to build a modern locomotive for the Ushuaia line to show off what new steam can do.

For Waller, too, modernising steam engines is just a step towards the real goal of building modern locomotives. This means finding customers, and when rail operators think of steam, they still think of old steam. Very few, if any, of them even consider steam when modernising a line. Waller thinks this is a mistake. "I claim that there are many lines in the world where new steam is the best option," he says. Some lines, such as the Zillertalbahn, near Innsbruck in Austria, run steam locomotives for tourists and diesels to carry local people and freight. "One could look at replacing all of these with new steam," he says. "The tourists will hardly notice, and the change will reduce maintenance costs."

'Out went antique riveted seams and cast-iron cylinders for the pistons: all were replaced by welded structures made from lighter steel'



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Negative response

The reaction to all this from other rail experts is often negative and unequivocal. "The Stephenson form of steam locomotive has no potentially useful role on the modern railway, despite all the improvements made to it by Porta, Wardale et al," says Michael Duffy, senior lecturer in engineering at Sunderland University in the north of England. He accepts that steam will continue to thrive on tourist lines, and that it may also find a place in developing countries where labour costs are low. But he argues that steam locomotives are still fundamentally labour intensive and inefficient, that they destroy the rails on which they run, and that they cannot sustain the kinds of speeds that modern trains need. Rail networks today are becoming highly computerised so that virtually everything from signalling to the very motion of trains themselves will be controlled from one centre. That vision "has no place for a steam engine", he says, "least of all one that is crudely monitored and controlled by two men on the footplate".

Waller shrugs. "Most rail engineers nowadays do not have enough knowledge of steam locomotives to be able to judge the possibilities," he says. "They usually forget that the power provided to drive their electric locomotives is produced in a steam-cycle power plant, all remote controlled. Is it all that difficult to imagine that this could be done on a locomotive too?" He stresses that he's not advocating TGVs driven by steam. "I simply suggest using modern steam wherever it is more economical, or ecological."

Ultimately, it may even be possible to abandon the traditional look and workings of steam trains altogether and just retain the steam cycle. Use higher pressures, condensers to keep the steam circulating in a closed loop, perhaps even drive shafts. Static steam engines, Waller points out, can reach efficiencies of as much as 30 per cent. "This shows you what potential is left in the technology," he says. "Actually, I'm quite happy when other engineers don't see the potential in modern steam, for as long as they don't see it, they won't start competing with us." □