

SUSTAINABILITY AND ROADS: CAPTURING THE ESD OPPORTUNITY

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Tenth Australasian Flexible Pavements Industry Conference on Health, Safety and Environment
Melbourne July 21-22 2004

Abstract

This paper considers the meaning of the term 'sustainability' as it applies to roads and pavement. It documents the sustainability problems to which past approaches to roads and transport infrastructure have contributed, and proposes that past approaches are clearly unsustainable in economic, social and environmental terms. It then proposes a number of opportunities for the pavement industry to contribute towards a more sustainable transport service future.

Introduction

The pressure to move towards a sustainable society is mounting rapidly: even Prime Minister John Howard has announced that he wants a sustainable country. This raises many questions, but two that I want to address today are:

- What is sustainability?
- What does it involve for an industry such as the asphalt and pavement industry?

What is sustainability?

There are many definitions of sustainability and, indeed, books have been written on the subject. A way that I find useful to approach the issue is to consider a number of sustainability principles, such as those proposed by Lumb et al (2000):

- Precautionary principle: what we don't understand might hurt us
- Intergenerational and intragenerational equity: fairness
- Maintenance of natural resources and capital: we need to live on our 'income'
- Maintenance of biodiversity: diversity is critical to maintaining resilience
- Economic and social wellbeing: these are key objectives of any society

These principles can be interpreted in many ways, but the fundamental issue is that they shift the focus from short term, individual win-lose behaviour towards longer-term community benefit that includes environmental factors. And they shift the onus from those who oppose an action having to prove it is problematic, to the proponent having to prove it is low risk to the environment and society.

The narrow interpretation of market reform under national competition guidelines, as well as the increasing emphasis on short-term shareholder benefits in business means that it is, in many ways, becoming more difficult to deliver sustainable outcomes than in the past. On the other hand, privatisation of railways has led to the shedding of preconceptions and new analysis and belated recognition of the significance of rail for our future: it seems that governments listen much more carefully to private sector rail operators than they did to public sector agencies. In some areas such as water, the introduction of environmental costs, environmental flows and other elements to policy debates has supported development of more sophisticated methodologies that incorporate costings for sustainability factors.

A key problem in attempts to consider sustainability is that the range of issues keeps expanding. But we will have to live with this! In particular, we are seeing a rapid increase in emphasis on the social dimension of sustainability, where previously the focus was more on environmental and economic factors.

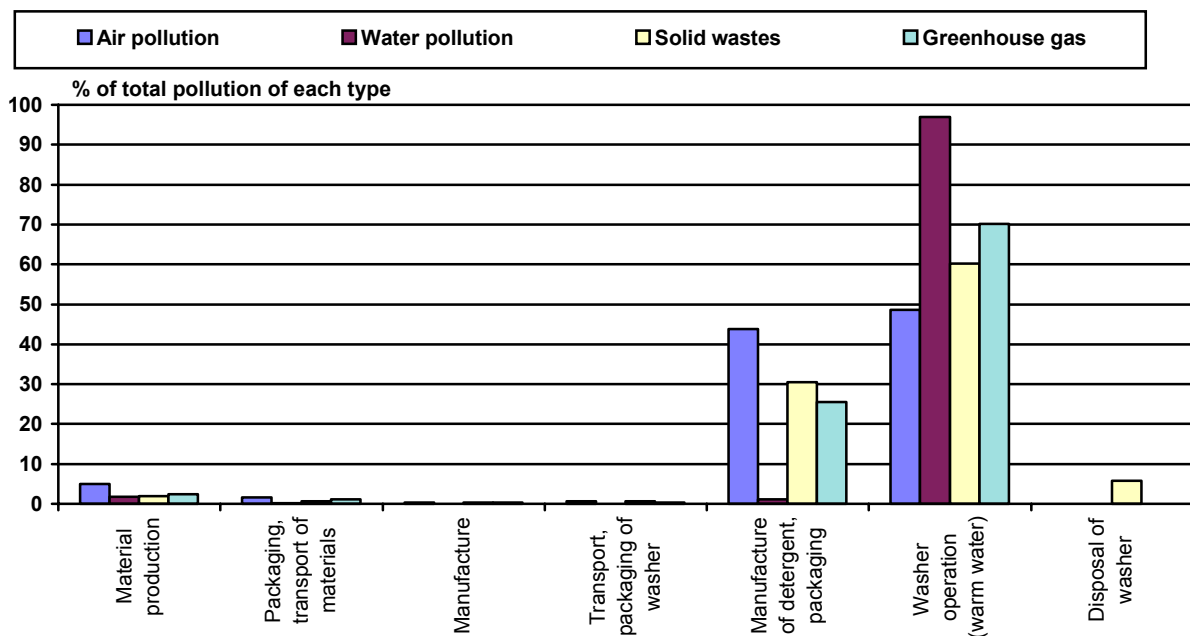
An example of application of the *precautionary principle* is release of carbon dioxide into the atmosphere. Today, the concentration of CO₂ is 20% higher than at any time in the past 400,000 years, and possibly the past 20 million years (IPCC, 2001). This is because, over the past 100 years, humans have released over 5% of the carbon stored by plants in fossil fuels over many millions of years: we are overloading the capacity of the natural system to cope with CO₂. Clearly the implications of higher concentrations of CO₂ are significant so, if we were applying the precautionary principle, we would not only drastically cut emissions, but we would work to increase the capacity of the earth's systems to absorb more CO₂. Our limited efforts in these areas to date demonstrate a failure to apply this key sustainability principle. The fact that transport greenhouse gas emissions are one of the fastest growing areas of emissions means that this sector will undoubtedly face increasing scrutiny and pressure to act.

Sustainability and the Pavement Industry

A Lifecycle Perspective

For any industry considering its sustainability impacts, it is useful to look at a lifecycle perspective. Figure 1 provides an example of relevance – a lifecycle assessment of the environmental impacts of a clothes washing machine. You may ask what is it that a washing machine and the pavement industry have in common? The answer is that most of the impacts associated with both are not directly due to their construction phase, but result from ‘policy’ decisions regarding how to satisfy a ‘need’ and how they are used.

Figure 1. Lifecycle environmental impacts of a clothes washing machine (Greene, 1992)



This example highlights the reality that the sustainability impacts of most products and systems are spread across their lifetimes. Many separate agents are involved, and each has some influence on the lifecycle outcome, but controls only one stage of the process, while potentially influencing others.

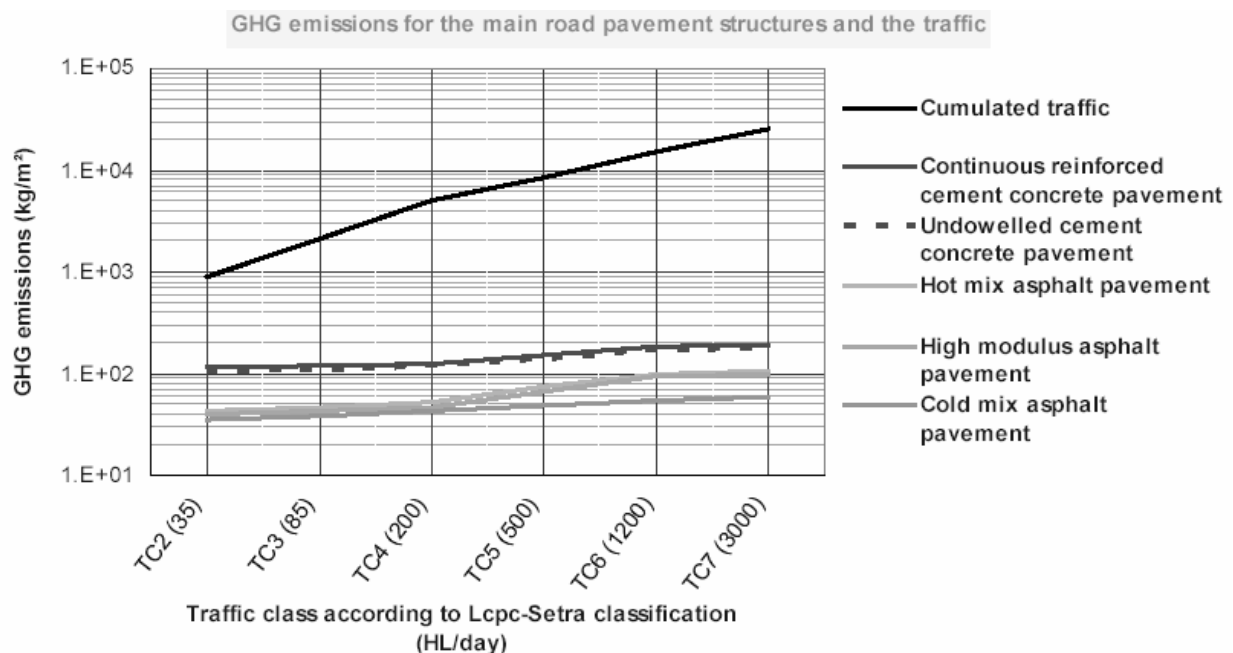
This complicates development of lifecycle-optimised strategies, as often a given agent may incur a cost but not capture a benefit, or simply be constrained by the decisions of others. In the case of a washing machine, it can be seen that the type and quantity of detergent, and the choice of washing temperature by the user has a much bigger impact than the energy efficiency of the manufacturing plant. But designers and manufacturers can ensure a clothes washer uses a minimum of detergent, water and energy, and can specify low environmental impact materials and design for long life and recyclability.

For the pavement industry, relevant factors driving lifecycle impacts include:

- Decisions by planners and politicians about transport and urban development strategy
- The relative economics of transport options – and alternatives to travel
- Distortions in funding of different transport options due to failure to include environmental and social factors, historical factors, funding mechanisms, and so on
- The environmental and social costs of the materials used
- Site impacts (eg biodiversity, noise, run-off)
- The environmental performance of vehicles using roads
- Developments in transport technologies
- Choices made by individuals and businesses regarding where they locate, the transport modes they choose, and how much they travel

It's fairly clear that the lifecycle impacts of pavement are dominated by its use as infrastructure supporting car and truck usage, as shown in Figure 2. People other than the pavement industry make the decisions regarding where roads will be located, and how they are used. And the future of the pavement industry will be strongly influenced by those outside the industry, too. Nevertheless, the pavement industry can play an important role in progress towards sustainability in many ways, including input to policy debates, detail design, specification of materials, and response to issues raised through the sustainability debate. Those working in the pavement industry should take some comfort from the fact that they are not alone: the appliance industry and many others face similar challenges.

Figure 2. Greenhouse gas emissions for construction and maintenance of pavement structures compared with the emissions of the expected traffic over a 30-year service life (Chapat and Bilal, 2004). Note that the vertical scale is logarithmic.



Indeed, it is instructive to look at past developments in the appliance and water industry as an indicator of the kinds of pressures the pavement industry will increasingly face. In the early 1980s, Australia's appliance industry saw its role in fairly narrow terms: it built appliances and sold them (hopefully at a profit). Today, the appliance industry is actively involved in mandatory energy and water efficiency labelling schemes, Mandatory Energy Performance Standards, and product stewardship programs involving development of appliance recovery and materials recycling strategies. These are now part of core business. They reflect the reality that community pressure has forced the appliance industry to redefine its core business in much broader terms, and to take responsibility for aspects of its products' lifecycles that it previously saw as the responsibility of others. Similarly, the water industry has progressed from seeing its role as delivering sufficient quantities of safe and clean water, to an involvement in all aspects of the total water service system.

Direct Impacts

If we assume that someone has made a decision to build a road, then the direct impacts that the builder of the road can control include:

- Impacts of materials used (in mining/harvesting, processing and during construction)
- Design, which influences quantities and types of materials, scale of disturbance, future energy and resource usage, etc
- Site impacts, such as biodiversity loss, social impacts (eg dividing communities) and future noise, run-off, etc
- Transient construction impacts such as on-site energy use, dust, noise, water pollution, occupational health and safety, etc
- Lifetime issues, including design for flexibility regarding upgrading or changing uses, longevity, and potential for recovery of materials at end of life

The pavement and construction industries have made substantial progress towards addressing many of these impacts and, to be honest, I am not particularly expert on these topics. Nevertheless, I'll make a few observations regarding opportunities to reduce environmental impacts:

- A large proportion of the greenhouse gas emissions from materials associated with road construction are due to concrete and steel use. High extender cements (blended with 30-85% blast furnace slag, fly ash, etc) and alternative cementitious materials (Hes and Bates, 2003) and steel reinforcing and structural steel sourced from recycling (produced by electric arc furnaces) offer opportunities to significantly reduce the total embodied energy and greenhouse gas emissions. Cement kilns and electric arc furnaces that combine high efficiency and use of renewable energy resources further reduce the environmental impacts of production.
- Lower temperature asphalt production, such as WAM (Warm Asphalt Mixtures), which cuts process energy use by 30% (Larsen, Moen, Robertus and Koenders, 2004), as well as recycling of bitumen and asphalt also offer reductions in energy use, greenhouse gas emissions and landfill. Lower temperature processes can also reduce VOC emissions, improving worker health and reducing indirect greenhouse impacts
- Recycled concrete can replace virgin aggregate not only for road base, but also as aggregate in concrete.
- Optimisation of designs can minimise material requirements, which is often a profitable way of cutting environmental impacts.
- Road surfaces can help cut rolling resistance of tyres, saving fuel. BTCE (1994) estimated that decreasing roughness of the national highway system could save cut greenhouse gas emissions by 3.8 million tonnes of CO₂ between 1996 and 2015, but at quite high cost
- Many new roads incorporate facilities for bicycles and pedestrians: this trend must be further developed.

The Big Picture

The future of the pavement and asphalt industry is inextricably linked with future developments in urban planning and transport. And we need to keep in mind that our road infrastructure has played (and will in future play) a vital role in the economic and social development of Australia. But, just because it made good sense in the past doesn't mean we should keep doing it the same way as in the past.

Some Facts

In thinking about where we might head, let's review a few facts.

Some economics:

- Australians spend close to \$30 billion each year buying new cars – over \$5 billion of this is lost as depreciation in the first year of ownership. Overall, Australians lose tens of billions of dollars each year in depreciation of the value of cars.
- Subsidies to the Australian car industry total \$840 million per year, dropping to \$560 million from 2005 when the import tariff drops to 10% (Productivity Commission, 2002)
- The total cost of road crashes in Australia in 1996 was conservatively estimated at \$15 billion dollars, of which human costs were \$8.4 billion (BTE, 2000)
- In 2000-01, total national expenditure on roads was \$7.6 billion (BTRE, 2004). BTCE in 1997 estimated that \$16.8 billion would be required for non-urban sections of the National Highway System from 2000 to 2020 (BTCE, 1997)
- Total government revenue from taxes and charges on road use was \$13.7 billion in 1997-98 (BTE, 1999) and \$14.2 billion in 2001-02 (BTRE, 2004)
- Travel in urban areas of Australia has grown almost nine-fold since 1945, with almost all of that growth from cars and other road vehicles (BTE, 1999a) and a further 45% increase is projected by 2020 (BTRE, 2002). This has driven, and been driven by, massive investment in road infrastructure
- The cost of traffic congestion in mainland capital cities was estimated at \$12.8 billion for 1995, and is expected to rise to almost \$30 billion by 2015 (BTE, 1999a)
- Around 85% of all Australian oil is used for transport. If ABARE is correct, net cost of imported oil (mainly for transport) could increase from around \$2 billion to \$5.5 to \$9 billion by 2020, depending on oil price (Dickson et al, 2003). By 2020, we are expected to be net importers of half of our oil requirements.
- There is wide recognition that funding and pricing of transport is distorted. As the consultants ACIL (2001, p.v) note: "The case for reviewing Australia's road charging regime is strengthened, as present distortions favour the mode which causes the greatest external costs."
- The road infrastructure cost per dwelling for higher density development is lower: for example, the Greenhouse Neighbourhood project (Loder & Bayly et al, 1993) estimated that road infrastructure and traffic management costs for development at 25 dwellings per hectare were \$1,820, compared with \$4,270 for development at 10 dwellings per hectare

From a social perspective:

- Car ownership and use costs the average household around 15% of total expenditure on goods and services (over \$6,000 each year), second only to food purchases, and more, on average, than rent or mortgage payments – and for many low income households, it's a larger proportion (ABS, 2000)
- A large proportion of young, old and unlicensed people are disadvantaged in a society in which it is assumed that everyone has access to a car
- Even car drivers can suffer disadvantage: one study showed that almost a quarter of all car trips in Melbourne involved the driver taking someone else where they wanted to go, not where the driver wanted (Industry Commission, 1994 p.56). That is, the driver is often an unpaid chauffeur.

- The laissez-faire planning that accompanies the car-based society leads to a poorly organised urban system, which increases travel time for everyone – as well as time spent looking for parking spots.
- The human cost of car crashes goes far beyond the costs identified above: people's lives are dramatically changed by these events.
- It is early days in research, but it seems that a car-based lifestyle may be causally linked to obesity and lack of fitness.
- Trucks, particularly as they grow bigger, are increasingly incompatible with local road systems designed to promote bicycles, pedestrians and low speed vehicle use.

What about the environmental impacts?

- Construction materials comprise a large proportion of the enormous quantities of materials consumed each year: Australian construction material consumption is estimated to be 5.2 tonnes per person, a significant proportion of which is for road infrastructure (Newton et al, 2001)
- 40% of nationally listed threatened ecological communities are on urban fringes – under threat from urban sprawl (Newton et al, 2001)
- Road transport is a major contributor to urban air pollution (EPA 1998) and noise (ACIL, 2002)
- Transport generates over 14% of Australia's greenhouse gas emissions, and is growing rapidly - with road transport the dominant contributor (AGO, 2004).

There is increasing debate among experts about when world oil production will peak. The BP Statistical Review (BP, 2004) states that reserves are sufficient to supply today's demand for 40 years, and the US Energy Information Administration (Wood, 2000) suggests that world production will peak at some time between 2030 and 2075, depending on the rate of growth in demand. On the other hand, others argue that widespread manipulation of reserve estimates has occurred and that, when correction is made for this, and physical constraints on rates of production are considered, it can be concluded that oil production may peak between 2000 and 2020 (see, for example, Roberts, 2004). The recent announcement that Shell had overstated its oil reserves has reinforced the arguments of the 'early peak' analysts. This would have serious consequences for oil consumers.

Regardless of the debate over when demand will peak, all agree that the bulk of the remaining oil reserves – 63% according to BP, are located in the Middle East. This has major implications for world oil prices and security of supply. This situation is already driving efforts to develop new transport energy sources such as biodiesel, alcohol and hydrogen. It is also possible to convert natural gas to petrol, use natural gas and LPG directly, and even produce oil from coal, oil shale or tar sands. However, most of the non-renewable options involve higher levels of greenhouse gas emissions per unit of delivered fuel. And building the capacity of renewable sources to meet a significant proportion of projected demand will take time, and may exceed resource capacity.

Overall, our car-based society consumes staggering amounts of resources, impacts on equity and the environment, and costs a lot to run. It is unsustainable. That is not to say the future of cars, and roads, is bleak. But it will be different from the past.

Where to?

The broad picture

Very large changes in our transport systems are necessary if we are to move towards sustainability. Cuts in greenhouse gas emissions of 50-80% are needed over a few decades. The increasing costs to households of car ownership and use must be reduced.

The mix of strategies needed to move towards a sustainable transport system is well known. It includes:

- Stop urban sprawl
- minimise the need to travel by:
 - locating people, services and employment as near to each other as possible – this involves more than locating them close to each other, it also means organising urban systems better, so one trip places a person part-way towards reaching other likely destinations. We have to deliver urban consolidation smarter than we have in the past if we are to capture the full transport and sustainable development benefits
 - using computers and communications technology (such as route optimisation software, telecommunications), redefining tasks to avoid travel (eg buying locally), and so on
- use low environmental impact, socially equitable transport modes for appropriate trips by using:
 - public transport
 - walking, bicycle riding, low speed electric vehicles: electric buggies are rapidly emerging as a very important local transport mode, and electric bicycles (if regulations are modified to allow up to 250 watt motors) could also play a major role
- maximising the efficiency of all vehicles used – not just cars, but also public transport and other vehicles
- manage provision of car parking at homes, in shopping areas and at work to limit the space available, and make it less convenient, while reducing the costs of provision of parking
- shifting towards low environmental impact, renewable energy sources
- sending signals to car buyers and users to more accurately reflect the real costs of their actions, for example using skewed purchase taxes, road user charges
- reduce road capacity and parking availability as the capacity of alternatives to car use are expanded – to avoid the ‘induced traffic’ problem
- look for solutions that also deliver other benefits for health, equity, amenity and resources.

Key challenges for policy makers involve implementation of effective policy that recognises the systemic aspects:

- if road capacity is freed up by effective strategies that encourage less travel, mode shifting, etc, then if this road resource is underpriced, additional traffic will tend to occupy the available space – the ‘induce traffic’ problem
- if the effective cost of transport is reduced, for example by bikes, fuel-efficient cars, reduced congestion, etc, then people will have more disposable income, some of which may be spent on more travel – the ‘rebound effect’. This money could be utilised by effective policies that drive additional investment in emission reduction to mop up the additional available funds
- it will be critical to avoid a ‘victim’ mentality. For example, indiscriminate introduction of road user pricing can impact on those who are not in a position to relocate, switch to other transport modes or reduce travel. Taxes on fuel use or increased registration fees for fuel guzzlers can impact on low income households trapped in low cost, poor access housing. In contrast, strategies such as focusing higher charges on purchases of new vehicles means decisionmakers are being influenced.

Obviously in many areas, especially low density areas, regional and rural areas, super-efficient cars and trucks, running on an increasing proportion of renewable fuels, will play an important role in our sustainable transport future. But in a large proportion of urban areas, cars will have to play a decreasing share of the transport service task. Even if sustainability were not becoming critical, the growing problems of congestion, parking and car ownership costs would create pressure for change.

A key issue will be increasing pressure to re-allocate funds now spent on roads to other options.

The pavement industry

The pressures to do more with less money and resources, extend infrastructure life, minimise traffic disruption during construction and improve maintenance will not only continue, but also increase. The

importance of reducing environmental impacts of materials and during construction will also increase, while community expectations regarding noise and aesthetics will continue to rise.

Some of the possibilities for the pavement industry to respond to the ESD imperative that come to mind include:

- making surfaces permeable to water and/or managing run-off, including facilitating capture for treatment to drinkable standards
- facilitating safe mixed-use of roads by a variety of vehicles and pedestrians, for example by managing vehicle speeds, considering gradients, wind protection, including provision for vehicle battery re-charging, etc
- designing for future flexibility, such as addition of light rail at a later date
- lighter coloured surfaces to reduce ‘heat island’ effects
- incorporating more features for road user charging, traffic management and driver feedback
- integrating renewable energy collection capacity into road infrastructure – for example, solar cells, wind generators, solar thermal collection and production of biomass
- developing lower energy intensity road lighting and traffic management solutions
- ongoing reduction in embodied fossil fuel content of road structures, including maximising lifetime and design for recovery of resources
- minimising biodiversity impacts while maximising potential to support increased biodiversity

Conclusion

After 50 years of building a car-based society reliant on fossil fuels, it is clear that this is not a sustainable option, at least for urban areas where the majority of people live and work. Further, it is clear that the costs of this system are not being accurately reflected in price signals. The good news is that, if we are smart about how we change, we can save money and improve quality of life while reducing our environmental impacts. The choice is ours.

The asphalt and pavement industry has many opportunities to play an important role in our transition towards sustainability.

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