ENVIRONMENTAL HEALTH, PRODUCTIVITY AND BUSINESS SUSTAINABILITY THROUGH GOOD GREEN MANAGEMENT: THE CASE FOR USED OIL

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Abstract

An overview of the Australian used oil industry is presented to demonstrate that the industry relies heavily on the transport sector for its base stock. The sustainable transport paradigm is examined and employed to demonstrate that the enviro-political pressures impacting on transport in general, and carbon fuel use in particular, are substantial and may bring about technological change which could seriously challenge the viability of the used oil industry. Some green tools and techniques are discussed and an opinion is offered that such green tools and techniques, if correctly and consistently used, will help promote business sustainability and profitability.

1.0 Introduction

This paper is about safety, health and the environment, the profitability and sustainability of the used oil industry, and strategic and competitive advantage in the era of sustainable development.

How is the paper structured? First a brief overview of the used oil industry is presented. Second the emergence of the sustainable transport paradigm is discussed and its implications for the used oil industry are examined. Third, a strategic response to the sustainable transport paradigm is outlined. Some green tools and techniques useful in maintaining profitability and the competitive margin are introduced. Fourth, conclusions are drawn.

2.0 The used oil industry: an overview

Narrowly defined in terms of *operations management*, the used oil industry consists of inputs, plant and process (including know how), and outputs. If the Basel Convention (1994) definition of used oil is adopted then plant, process and personnel in the used oil industry serve an eco-business founded on the supply of a primary input viz: “any semi solid or liquid used product consisting totally or partially of mineral or synthesised hydrocarbons (synthetic oils), oily residue from tanks, oil water mixtures and emulsions.” (Snow 1997, np)

The synthetic oils mentioned in the Basel definition often consist of synthesised hydrocarbons, esters of hydrocarbon and phosphate, glycols, chlorinated hydrocarbons and silicon oils.

Table 1 presents a snapshot of the "supply side" of the "used oil" Industry in Australia in 1996 and also presents the data in a manner which allows the environment to be kept in focus. The numbers are taken from the Australian Institute of Petroleum Survey (Australian Institute of Petroleum, 1998) and focus on "used oils which have arisen from their use as lubricating oils, with a water content of less than 15 %". Hydraulic brake fluid and grease are not included. Were these included, an additional 1,561 kilolitres of hydraulic brake oils and 14, 262 kilolitres of grease would need to be accounted for. (Australian Petroleum Statistics, Department of Primary Industries and Energy, 1996).

Whilst definitional and category problems are acknowledged, the figure of 50% of lubricating oil to the environment (row 5) is "in the same ballpark" as other estimates: La Ganza, (1997) – 50% for the world in general; (Graziano et al, 1995) - 42% for the USA, and Concawe (1996) –51% for Europe. The survey number given for the percentage of used oil collected (59%) is also in the same ballpark as the number reported for this statistic in Europe (57%) (Concawe, 1996) but below the number for the USA (75%) (Graziano et al, 1995). The 59% survey number for Australia was however adjusted upwards to 65% on the basis of estimates made in recognition of survey shortcomings.

Row 5 is interesting as it forces at least a questioning position in respect of environmental impact, preventive public policy, and collection potential for each used oil type. The present data allow questions. For example is all of the 27% of hydraulic oil spilled? Is all of the marine (or railroad) oil burned or is some dumped? Given that from time to time oil spills in Australian waters are reported (It must be those foreigners, Australians would not do it!?) is there a technically feasible and economically viable basis for collection of used marine oil at *all* ports, marinas and naval dockyards? What lies beneath the figures for metalworking and speciality oils? Are these "green"? The list goes on.

No doubt sound answers to some or all of these questions are known by various persons within the industry. Sound business principles alone (not to mention good environmental stewardship) require a full and thorough understanding of *all* aspects of the industry and more will be said about this later. Either alone, or in cooperation with government, the industry should find research funds to construct a more thorough and wide reaching survey instrument capable of being extended and applied to new products and processes as these emerge. Such a survey would be assisted greatly were the collection industry to be clarified through a system of registration and quality assurance protocols. Access should also be made available to life cycle pathway studies of all "used oil" products through a web-based clearing-house and studies should be commissioned when basic knowledge is not available. Some of this research could well be carried out at honours plus levels in the Australian university sector.

Data made more certain by research, registration, categorisation and quality control and assurance protocols of the type suggested in the preceding paragraph may help provide better answers upon which to base both the profitability and survival strategies of the industry and the environmental stewardship responsibilities of government and industry alike. In this age of sustainable development the challenge for us all is to make third wave environmentalism (identified by cooperation between industry, government and other stakeholders) work. This third wave environmentalism is very important and there are also dangers in it. For example the used oil the industry will, naturally, define its own boundaries and these, in no small part, will be determined by what is perceived to be profitable. As we have already seen by the oil category "omissions" inherent in the AIP survey, the industry boundary may not catch all

Table 1: Used Oil Data, Australia: 1996

	category	**automotive**					**other transport**			**industrial**							**base stocks**	**totals**
2	sub category	car	HD	trans-mission	gear	specialty	aviation	marine	railroad	process	t'former	hydrau-lic	gear	compr-essor	metal working	other		
3	sales lubricant[1]	98527	106295	18741	27707	12295	1100	25789	6291	60941	Note4	41633	9169	Note 4	5573	42568	41677	498306
4	used oil generated[2]	59116	63777	14993	22166	0	990	0	0	0	Note 4	30471	6877	Note 4	1115	25924	25006	250434
5	3-4: virgin oil to environment?	39411 (40%)	42518 (40%)	3748 (20%)	5541 (20%)	12295 (100%)	110 (10%)	25789 (100%)	6291 (100%)	60941 (100%)	Note 4	1116 (27%)	2292 (25%)	Note 4	4458 (80%)	16644 (39%)	16671 (40%)	247872 (50%)
6	total used oil collected[3]																	151999
7	4-6: total used oil to environment?																	98438 (39%)
8	virgin + used oil to environment																	346310 (89%)

Notes: 1 Excluded hydraulic brake fluids and grease. 2 Estimated on the basis of generation factors used in the 1996 Concawee study but adjusted for Australian conditions. 3 Australian institute of Petroleum survey, 1996there are estimation uncertainties in the data. 5 Included in the "other category. 6 By various pathways: eg burning, leakage, spillage, dumping, ejection, ejection from machinery, or because the figures are distorted due to disguised disposal of some

(Source: Adapted from Australian Institute of Petroleum, *1998 Survey of Used Oil*, passim.)

Table 2: Australian Institute of Petroleum estimates of volumes of used oil collected by state, and % of total generated, collected, 1996

Row No	**New South Wales**	**Victoria**	**Queensland**	**South Australia**	**Western Australia**	**Tasmania**	**Northern Territory**	**Total (Row 2)**
Volume (ML)	55	30	25	10	25	2	3	149
% collected	71 (inc. ACT)	49	47	75	69	76	78	

(Source: Adapted from *Australian Institute of Petroleum 1999, Survey of Used Oil 1998*, passim.)

categories of used oil and outside this boundary used oil may well become “oil to ground”. Further if the correct principles of ecological economics are applied “oil to atmosphere” also becomes an important criterion. It is thus very important that governments when talking to industry do more than talk to the major players. Governments should define a used oil boundary that is inclusive of all categories.

But to return to Table 1: rows 6, 7 and 8 could be made more complete if the collection protocols mentioned in earlier paragraphs were in place. The aggregate figures are interesting in themselves and show that 39% of used oil goes into the environment which, when added to the 50% of virgin oil so dispatched, gives a figure of 89% for the “environmental component” of virgin plus used oil in 1996. However because of difficulties with the data (perhaps due to estimation components) a figure of 69% can also be calculated.

The executive summary of the report notes, in addition to the overall collection of 59% (or 65%) of used oil mentioned earlier, (a) industry restructuring to the extent that the market structure is characteristic of an oligopoly, (b) a market that in 1996 was in “tenuous balance” (Table 3, row 5), and (c) the emergence of new re-refining capacity in Australia. Whilst the summary also reports no evidence of dumping, the report proper does attempt to explain the whereabouts of the estimated 90ML of used oil generated but not collected and raises questions about used oil disposal procedures used by “back yard mechanics.” (These are other than persons who do their own oil changes – the DIY market.) Some 61 % of used oil supply is generated through automotive use.

Table 3: matches the supply side situation (i.e. the Table 2 numbers) with basic information about the “demand side” for that same year.

Further information about the end use of the row 6, 7, 11 and 12 quantities (fuel oil versus other use) would help define the processor/refiner status of the Australian industry.

A *life cycle* perspective, if applied to “used oil”, (Table 4 column 1) can help extend the narrow *operations management* boundary of the used oil industry in a manner that is potentially beneficial for formulation of business strategy and for environmental health and safety. Life cycle thinking extends the “used oil industry” boundary by requiring questions to be asked about the rate and direction of technological change on input supply, and about disposal (Table 4, column 4).

The column 4 questions are just some of the questions that could be asked. The questions included for source reduction are vital to profitability and survival in the medium to long term but can not be fully appreciated from within a life cycle perspective alone. In order to pursue them further it will be necessary to address the emerging sustainable transport paradigm which envelopes the “green” and “used oil” industries. It will also be necessary to consider some green tools and techniques which, by further extending the “boundary” of the used oil industry, may assist firms to monitor the changes that the sustainable transport paradigm might bring and to formulate survival and profitability strategies based on sound green business principles. The paper now goes to the next section wherein the first issue (sustainable transportation) is discussed.

Table 3: Demand, supply and uses for used oil in Australia, 1996

Row	State	NSW	Vic	Qld	SA	WA	TAS	NT	Total
		Quantity in Megalitres							
	Supply (oil collected)								
1	Survey	30	28	20	10	25	0.5	0.1	113
2	Estimated additional	25	2	5			2	2.4	36.4
3	Survey + est. additional	55	30	35	10	25	2.5	2.5	149.4
	Demand (oil used)								
4	Survey	38	25	24	7	17	2.5	1.3	114.8
	Market imbalance (S-D)								
5	Row1-row4	-8	+3	-4	+3	+8	-2	-1.2	-1.8
	Row 3 –row 4	+12	+5	+11	+3	+8	0	+1.2	+34.6
	Uses								
6	Brickworks	1		3	3.5	3			10.5
7	Kilns	4	6	3		8	2.5	1.3	24.8
8	Coal spray	24			1.5				25.5
9	Lubricants			2					2
10	Fuel oil	2	7	8	2	2			21
11	Sugar mills	2		5					7
12	Power stations	5	12	3		4			24
13	Stockpiled			4	1	12		0.7	17.7

(Source: Adapted from Australian Institute of Petroleum 1999, *Survey of Used Oil, 1998*, passim and DPIE 1997, *Australian Petroleum Statistics 1996*, passim.)

Table 4: Extending the boundary of the used oil industry: life cycle analysis

R/C	1	2	3	4
1	**Life Cycle View**	**Operations Management View**	**Operations Management + Life Cycle Analysis**	**Strategic Business Considerations**
2	Source reduction		*Efficient use* • Smaller volume • Longer life *DOE* • synthetic biodegradable substitutes • design away	Will a substantial proportion of mineral automotive oils be replaced by vegetable or synthetic varieties? Will a substantial proportion of mineral automotive oils (or synthetic oil substitutes themselves) become obsolete and in what time line?
3	Input	Used virgin oil	Used virgin oil	Can I corner substitutes?
4	Operations (Plant and Process)	• Re-refining in lubricating oil refinery • Re-refining in business operations specifically dedicated to base oil production • Reprocessing to fuel or direct burning	• Re-refining in lubricating oil refinery • Re-refining in business operations specifically dedicated to base oil production • Reprocessing to fuel or direct burning	How can I employ known green business tools to increase profitability and move to a beyond compliance position: TQM, DOE, ISO 14000, full cost accounting and so on
5	Output	• base oil • fuel oil	• base oil • fuel oil	What other green products can be produced now and in the future?
6	Disposal			Biodegrading farms as a sunset strategy? 100% of product to green reuse?

(Source: Adapted from a figure developed by Graziano et al (1995) and reported in Snow, Robert 1997, 'Used oil management', Paper presented to the 1st Used Oil Conference, Brisbane 6-7 August.)

3.0 The sustainable transport paradigm

3.1 Defining sustainable transport

The Vancouver Principles (Table 5) were endorsed at a 1996 OECD conference (*Towards Sustainable Transportation: the Vancouver Conference, 1997 pp. 62-65)* which was organised in response to government concerns about transportation and its role in sustainable development. Key stakeholders were assembled: "auto manufacturers, fuel producers, producers of alternative vehicles and fuels, researchers, government officials, city planners and others." *(Towards Sustainable Transportation: The Vancouver Conference*, p. 8). The conference concluded that "in short, transportation is unsustainable and is becoming more unsustainable." (ibid.p.7). It also cautioned that " sustainable transportation is a subject about which reasonable and informed people, including writers of conference reports, can have quite disparate and strongly held opinions" (p. 9). The asterisks in the marker column of Table 5 flag where health, safety and the environment is mentioned and it can be seen from this that environmental considerations are foremost in driving the sustainable transport reform agenda.

Table 5: The Vancouver Principles for Sustainable Transport

No	Sustainable Transport Principle	Marker
1	People are entitled to reasonable access to other people, places, goods and services, as well as responsible information that empowers them towards sustainable transportation	
2	Nation states and the transportation community must strive to ensure social, interregional and intergenerational equity, meeting the basic transportation related needs of all people including women, the poor, the rural and the disabled. Developed economies must work in partnership with developing economies in fostering practices of sustainable transportation	
3	All individuals and communities have a responsibility to act as stewards of the natural environment, undertaking to make sustainable choices with regard to personal movement and consumption.	
4	The transportation system should be designed and operated in a way that protects the health (physical, mental and social well being) and safety of all people, and enhances the quality of life in communities.	
5	People and communities need to be fully engaged in the decision making process about sustainable transportation and empowered to participate. In order to do this it is important that they be given adequate and appropriate resources and support, including information, about the issues involved, as well as the benefits and costs of the array of potential alternatives.	*
6	Transportation decision-makers have a responsibility to pursue more integrated approaches to planning.	
7	Communities should be designed to encourage sustainable transportation and enhance access as a contribution to providing comfortable and congenial environments for living. Transportation systems must make efficient use of land and natural resources, while ensuring the preservation of vital habitats and other requirements for maintaining biodiversity.	*
8	Transport needs must be met without generating emissions that threaten public health, global climate, biological diversity and the integrity of essential ecological processes.	*
9	Taxation and economic policies should work for, and not against, sustainable transportation, which should be seen as contributing to improvements in economic and community well being. Market mechanisms should support fuller cost accounting, reflecting the true social, economic and environmental costs, both present and future, in order to ensure users pay an equitable share of costs.	*

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, pp. 62-65.)

Table 6: Environmental impacts of transport

	Type of Impact							
	Local	**Regional**		**Global**				
	High Concen-trations	Acidification	Photo-chemical Oxidants	Indirect Greenhouse Effects	Direct Greenhouse Effects	Stratospheric Ozone Depletion	**Source of Emission**	**Health Effect of Pollutant**
Suspended articulate matter	x		x				Products incomplete combustion of fuels; also from wear of brakes and tires	Irritates mucous membranes; respiratory/pulmonary effects; carcinogenic
Lead (Pb)	x			x			Added to gasoline to enhance engine performance	Affects circulatory, reproductive and nervous systems
Carbon monoxide (CO)	x		x	x			Incomplete combustion product of carbon based fuels	Reduced oxygen carrying capacity of red blood cells
Nitrogen oxides (NOx)	x	x	x	x		x	Formed during fuel combustion at high temperatures	Irritates lungs; increases susceptibility to viruses
Volatile organic compounds (VOCs)	x		x	x			Combustion of petroleum products; also evaporation of unburned fuel	Irritates eyes, causes intoxication; carcinogenic
Tropospheric ozone (O_3)		x	x	x			Not an exhaust gas; product of photochemical reaction of NOx and VOCs in sunlight	Irritates mucous membrane of respiratory system; impairs immunities
Methane (CH_4)					x		Leakage during production, transport, filling and use of natural gas	
Carbon dioxide (CO_2)					x		Combustion product of carbon based fuels	
Nitrous oxide (N_2O)				x	x	x	Combustion product of fuel and biomass; also formed in catalytic converters	
Chloroflurocarbons (CFC's)					x	x	Leakage of coolant from air conditioning systems	

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 20.)

The conference adopted an OECD definition defining sustainable transportation as “that transportation that does not endanger the health and ecosystems and meets mobility needs consistent with (a) the use of renewable resources at below their rates of regeneration, and (b) the use of non-renewable resources at below the rates of development of renewable substitutes” (p. 12). This definition rightly reflects the concerns of our time about acid rain, global warming, and ozone depletion but gives less emphasis to other problems associated with transport: local air pollution, noise pollution, water pollution, land use, accidents, congestion, social disruption and the opportunity cost of financing transportation. As the *Principles of Sustainable Transport* reveal, this point was not lost on the conference delegates.

3.2 The forces driving the sustainable transport paradigm and the consequences for the used oil industry

It makes little difference whether sustainable transportation is understood from the definition or from its manifestation as principles, to attain it will require substantial change. The factors driving this change are perceived as urgent in human consciousness: see for example the environmental and occupational health concerns inherent in the information contained in

Table 7: Transport related emissions: extent of exceedences

Pollutant	Example of the Extent of Exceedances
Suspended particulate matter	• WHO guidelines exceeded by more than a factor of 2 in 17 of 21 cities surveyed
Lead	• One third of the world’s cities exceed WHO guidelines
Carbon monoxide	• WHO short term guidelines exceeded in many urban areas of Europe • 36 US regions are non-attainment areas. Los Angeles is serious
Nitrogen oxides	• WHO guidelines exceeded by a factor of 2-4 in non OECD megacities • Episodic values exceeding standards are found in cities in Europe, the USA and Japan
Volatile organic compounds	• Transport is said to be responsible for 94 % and 85% of emissions of 1,3 – butadiene and benzene, which respectively are implicated in 32% and, 5% of air pollution related cancers in the US. • May be a safe rate for these substances is zero
Tropospheric ozone	• Short and long term exposures frequently exceeded in OECD Europe, North America, and Japan.

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 25.)

Tables 6, 7, and 8. Also, the extent of change required is, of necessity, ambitious: see Table 9. As well, the socio-political and economic stakeholders having a vested interest in the management and exploitation of that change (governments of the "north" and "south", the petro-chemicals industry, the agricultural sector, and alternative energy research) are persistent and powerful. There may be much obfuscation and filibustering along the sustainable transport road and while these big elephants tango, the environment and some field mice (small businesses) may well be trampled.

Table 9: Transport's share in emissions 1985 and 1994 (tonnes x $10^{3)}$

Pollutant	**Emissions**		**Transport's share in 1994**
	1995	**1994**	
Volatile Organic Compounds	8,508	5,712	27%
Nitrogen oxides	7,340	6,833	32%
Carbon monoxide	66,560	55,420	62%
Sulphur oxides	474	268	1%
Particulate matter(<10 micrometers)	329	282	12%
Lead	14.5	1.3	29%

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 23.)

Given that emissions standards for new vehicles were improved by 98% for hydrocarbons, 90% for nitrogen oxides and 96% for carbon monoxide between 1960 and 1996 (*Towards Sustainable Transportation* p. 23) the Table 9 data indicate the inertia of the response lag occasioned by the phase in times for standards, the rate of vehicle replacement and the impact of the Jevons principle. Under the Jevons principle more efficiency in transport leads to greater use of transport so that the efficiency benefits are reduced or overwhelmed by costs resulting from extra use.

The extent of this extra use, that is, society's growing dependence on road transport in particular, can be glimpsed from an inspection of Tables 10 and 11.

Table 10: % increases in freight passenger kilometres 1970-1990

Parameter	**Amount by Year**		**% increase**
	1970	**1990**	
Tonne-kilometres of freight by road			
USA	3250	4,880	+ 50
Western Europe	1250	2,550	+ 105
Passenger-kilometres per capita by private auto			
USA	16,550	18,650	+ 13
Western Europe	4,620	8.710	+ 90

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 15.)

Mineral oil is essentially a non-renewable resource. Given that the world's transportation systems are almost entirely fuelled by oil (99% of transport energy use in 1990) and given that transportation accounts for between 50% and 60 % of oil products used and is the most rapidly growing type of oil use, (p. 17) will there be enough oil to sustain this dependency? This is an interesting and perennial question and, as usual, the question was left unresolved. One view was that the end of reserves is in sight and that oil production would enter a state of decline in the early part of the 21st century. The opposing view argued that known reserves are sufficient for some 35-50 years at present extraction rates and that this has been so for the past four decades. This view also has it that further reserves are available and that obtaining them is simply a function of cost.

Table 11: Estimated % change in vehicle numbers, kilometres travelled, and fuel used: 1990-2030

Parameter	**Light vehicles**			**Heavy vehicle comparison**
	1990	**2030**	**% change**	**% change**
OECD countries				
Number of vehicles (millions)	468	811	+ 73	+ 94
Kilometres travelled (billions)	7,057	12,448	+ 318	+ 100
Weight of fuel used (megatonnes)	563	520	+ 76	+ 97
Non OECD countries				
Number of vehicles *(millions)*	179	725	- 8	+ 300
Kilometres travelled (billions)	2,380	9,953	+ 305	+ 288
Weight of fuel uses (megatonnes)	167	394	+ 136	+ 289
All countries				
Number of vehicles (millions)	648	1537	+ 137	+ 190
Kilometres travelled (billions)	9437	22,400	+ 137	+ 192
Weight of fuel uses (megatonnes)	730	914	+ 25	+ 181

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 15.)

Table 12 contains an estimate of production and consumption for the year 2010.

Table 12: Actual and estimated consumption of oil (tonnes x 10^6), 1994-2010

	1994 (actual)		**2010 (estimated)**		**% Increase 1994-2010**
	amount	% of total	amount	% of total	
Production					
OECD	740	30%	620	19%	- 6%
Other	1690	70%	2,650	81%	+ 57%
Consumption					
OECD	1480	61%	1690	52%	+ 14%
Other	950	39%	1580	48%	+ 66%
Totals	2430		3270		35%

(Source: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris, p. 18.)

However the *quantity* of reserves per se may not be a sufficient basis on which to speculate about continued dependence. *Location* is important. In 1994 the OECD countries relied on others for 70% of production. That is, they used 2.4 times as much as they produced and by 2010 this figure is estimated to rise to 2.7 with 81% (Table 12) of consumption coming from other countries. Roberta Nichols (p. 93)[1] told the conference that the USA imported 60% of its oil needs. Many of the known reserves are located in politically sensitive areas (the Persian Gulf for example and in some of the countries of the former Soviet Union) and, without in any way whatsoever claiming that the next thoughts apply to the peoples of these countries, securing access to known reserves may not always be possible. The oil wars may well have had very different outcomes were chemical and biological weapons then widely available to one or more of the protagonists.

However the geo-politics of availability and supply have generally not strongly stimulated the search for *alternative fuel* supplies. And the non-fuel products of the petro-chemicals industry have been stunning: talking plastics and so on. However, as Table 6 reminds us, the enviro-political forces are substantial. While few will predict with certainty the consequences of continued person-made global warming, acid rain and ozone depletion, there is very little good news about any of them. These problems are no longer of "the consequences for our grandchildren type". People alive today witness the degradation caused by acidification, speculate about whether changes to their regional environments (the death of reefs and the like) are person-made, CO_2 - induced, and wonder whether ozone depletion-induced skin cancers will leak into their lymph systems. All of this can make people very interested in alternative fuel technology.

As well, industry sectoral rivalry and industry politics involves big and substantial players. The agricultural sector is well into fuel and lubricating oil substitutes, the solar, electrical and nuclear sectors maintain their interest, natural gas is already in there, and the genetic and synthetic engineers: well who knows? Will the transport sector remain sustainable by phasing in alternative fuels and new lubricating materials? And how rapid might such a process be? These are important questions for the used oil industry.

3.3 Sustainable transport futures: what the experts are saying

The conference explored three visions of sustainable transportation: a high technology vision, the low activity vision, and an automobile industry vision.

The high technology vision: under this vision hybrid-electric hypercars would be an interim technology and allow fundamental reforms in urban form and land use. Hypercars would be followed by pollution free recyclable vehicles. Supersonic quiet wide bodied and fuel efficient passenger aircraft, and high speed maglev trains powered by pollution free electricity would accompany these cars. A super internet would connect everyone to everyone else but in the end all of these developments might well combine to create "a socially polarised world, that would be one continuous suburb peopled by aspatial communities of interest, with no opportunities to travel to unusual places, no fragile ecosystems, no street life, Orwellian law enforcement, remote political authority and little in the way of democracy." (p. 37.)

The low activity vision: this vision is based on the proposition that sustainability in transport will require making motorised transport less desirable and/or less necessary than non

[1] Page numbers appearing in brackets in this section refer to the following publication: OECD 1997, *Towards Sustainable Transportation: the Vancouver Conference,* OECD Publications, Paris.

motorised transport and that this would be complemented by appropriate policy in respect of town planning, non-transport infrastructure, the urban suburban placement of industry, and communal versus individual values reassessment. This vision faced a substantial challenge from the arguments that the modern industrial states and the people in them are automobile dependent (Peter Newman, p. 92). Apparently, when it comes to decisive action to separate the person from the car, cognitive dissonance (that mental process by which, human beings, when confronted with a problem, cope by altering their beliefs about the seriousness of the problem) is strong, alive and well. (Vlek and Steg, p. 102)

The automobile industry vision: the central position of private transport within the modern state was pointed out and so too the record of the industry in providing technological answers to safety, health and environmental problems. Under this vision working hours will fall (not demand for vehicles) and public transport will be propped up for the "have nots". Road traffic management and town planning science have an important contribution to make under this vision.

Many strands and themes can be extracted from the many and varied views offered at the conference and the next paragraphs will focus on the question of alternative energy sources for transportation.

James J Mackenzie from the World Resources Institute's Climate, Energy and Pollution Program puts the view that ground transport's near exclusive reliance of oil is unsustainable and will lead to an aggravation of global warming and regional air pollution and deepening congestion in metropolitan areas. Furthermore, carbon based alternative fuels (ethanol, methanol, compressed natural gas (CNG)) can offer no solution to global warming: 21st century vehicles are most likely to be electric, the energy source being batteries, hydrogen fuel cells, flywheels and ultra capacitors with electricity and hydrogen ultimately being obtained from pollution free and renewable resources (p. 83).

Laurie Michaelis from the OECG's Environmental Directorate agrees that greater reductions in fossil fuel use are needed. His paper (p. 84) also argues that reductions in greenhouse gas emissions of 30-50% can be technologically engineered by 2025. J. P. Bruce, Co Chair of the Intergovernmental Panel on Climate Change (IPCC) and Chair of Canada's Climate Program Board pointed out that intervention would be necessary in the transport sector if the IPCC plan to stabilise CO_2 emissions at 1990 levels by 2000 is to be achieved. The IPCC assessment is that these reductions are achievable by, inter alia, such strategies as full cost accounting, transportation planning, regulatory measures, and technological change. The University of California's Director of the Institute of Transport Studies, Daniel Sperling, argues that the solar powered hydrogen fuel cell car will enter the market at about 10 % above current costs and virtually eliminate oil consumption, greenhouse gases and motor vehicle pollution.

Martin Kroon from the Netherlands Ministry of Housing, Spatial Planning, and the Environment succinctly expressed the global warming challenge to the sustainability of transport: a 50% reduction in fossil fuel/CO_2 emission is needed now. Or put another way, if vehicle rates grow as predicted (one billion by 2015) and there are no fuel substitutes, then future cars will need to be some 300% more fuel efficient than they are now.

Amory B. Lovins, Director of Research at the Rocky Mountains Institute spoke about ultralight cars. These cars, moulded from advanced composite materials, will be "severalfold lighter and more slippery" (the marketing has begun!) than existing cars, and safer, sportier, more comfortable, durable and beautiful, probably cheaper. They will give competitive advantage to early adopting manufacturers through reductions in product cycle time, tooling cost, assembly effort and space and body parts count. Modern hybrid-electric propulsion will boost efficiency by between 5 and 20 times in hypercars as opposed to 1.3 to 1.5 times in ordinary cars. Not only will these hypercars crash the world oil price they will make private auto travel so available and cheap that we will run out of patience and roads rather than out of air and oil.

Roberta Nichols, recently of the Ford Motor Company and cited earlier, kept her four wheels on the ground. Her view was that greater use of alternative fuels (natural gas, propane, LPG, methanol, ethanol), could reduce harmful emissions (she was referring to air quality rather than to global warming) and that battery powered and/or hydrogen-oxygen fuel cell powered vehicles may have no harmful tailpipe emissions at all. However her view was that diversity of fuel type use would continue around the world for some time yet depending on economics and resource availability and that the transition to alternative transportation fuels would be a slow and difficult process. However like Lovins she had the view that the planet is hooked on autos and would not give them up easily.

Per Kageson (p. 95), Mary Nichols (p.106), and Yuichi Moriguchi et al (p. 105) reiterate the Martin Kroon line. Transport accounts for some 30 to 40 % of pollutants (Kagesen), has improved its act in that over the last 20 years exhaust emissions on a per mile basis have been reduced by 40% while fuel *economy* of passenger vehicles has doubled (Nichols), but even so over a life cycle of 100,000 km, emissions of CO_2 for an average sized (Japanese) car is the equivalent of 8.9 tons of carbon (Moriguchi et al). Hans-Holger Rogner and John D Wells (p.130) echo Roberta Nichols in their inquiry into the barriers to entry of zero emission fuel cell technology for light vehicle transport. It may take a while for such technology to become viable.

The conference contained many more contributions about issues over and above the question of alternative fuels. Air and road transport, town planning, monetary and fiscal tools, education and community awareness, infrastructure planning, transport substitutes (eg telecommunications), access, and barriers to sustainable transportation are just some of the areas in which contributions were made. Discussion of these is beyond the scope of this paper. But with respect to alternative fuels (and the impact of these on the used oil industry), the genie probably has its head out of the bottle. Various forces are probably attempting to re-cork it (the LPG and petroleum producers) whilst others (solar, genetic and fuel cell engineering interests, the agricultural sector, and natural gas producers) are probably aiding and abetting its escape.

How far away is the “future shock”? It may well be on the doorstep.

For example at the time this paper was being written (May 1999) a Government Department in Canada was testing a biologically degradable, disposals “neutral” agricultural oil substitute for its transport fleet. Modern non stick surfaces require less oil of all kinds and solar vehicles can already travel long distances. In Australia’s case there is an interesting twist: Australian crude does not always contain those fractions (Table 13) which produce mineral oil. Crude stocks for this purpose must thus be imported which exposes the Australian “used oil” industry to the serendipity of factors which, at different times, might be out of its control. It also places the industry up against a very strong import replacement argument were a viable agricultural oil substitute to be found. However, presumably, such oil itself would need to be recycled.

The theory of technological innovation (and the business cycles it is said to produce) leaves many questions unanswered. But from observation, it seems that when an innovation's time comes, it will take its course and oftentimes with a speed that is brutal to individuals and firms in its way. The demise of printing technology (and the compositors that accompanied it), the electric typewriter, the 100 year technological advantage of the Swiss watch, are cases at point. The demise of these jobs and industries happened very quickly once the innovation became viable. An interesting example near to home illustrates the point. If a trial involving the use of used car tires (a different form of used oil) instead of coal, in cement industry furnaces in Central Queensland is successful, then bang goes King Coal in that market, a

Table 13: Fractions obtained from the distillation of petroleum

Row No.	The Fractions (Approx. No. of C Atoms)	% of Total Volume	Boiling Point (0C)	Common Names of Products
1	C1 – C4	1-2%	<30	Methane, ethane, propane, butane
2	C4 – C12	15-30%	30-200	Naptha or straight run gasoline
3	C12 – C15	5-20%	200-300	Kerosene
4	C15 – C25	10-40%	300-400	Gas oil
5	>C25	Undistilled	> 400	Residual oil, paraffin, asphalt

Source: Zumdahl, Steven 1883, Chemistry, D. C. Heath and Company, Lexington, Massachusetts.

victim to savings in the order of $2,000 per day, better greenhouse results and a bonus for recycled steel. But to dwell on the question of "substitutes" to used oil is not to be the bringer of dispair and gloom. The challenge for the used oil industry is to change technology "shocks" into survival opportunities and this question, and some relevant green business tools and techniques, will be discussed in the next section.

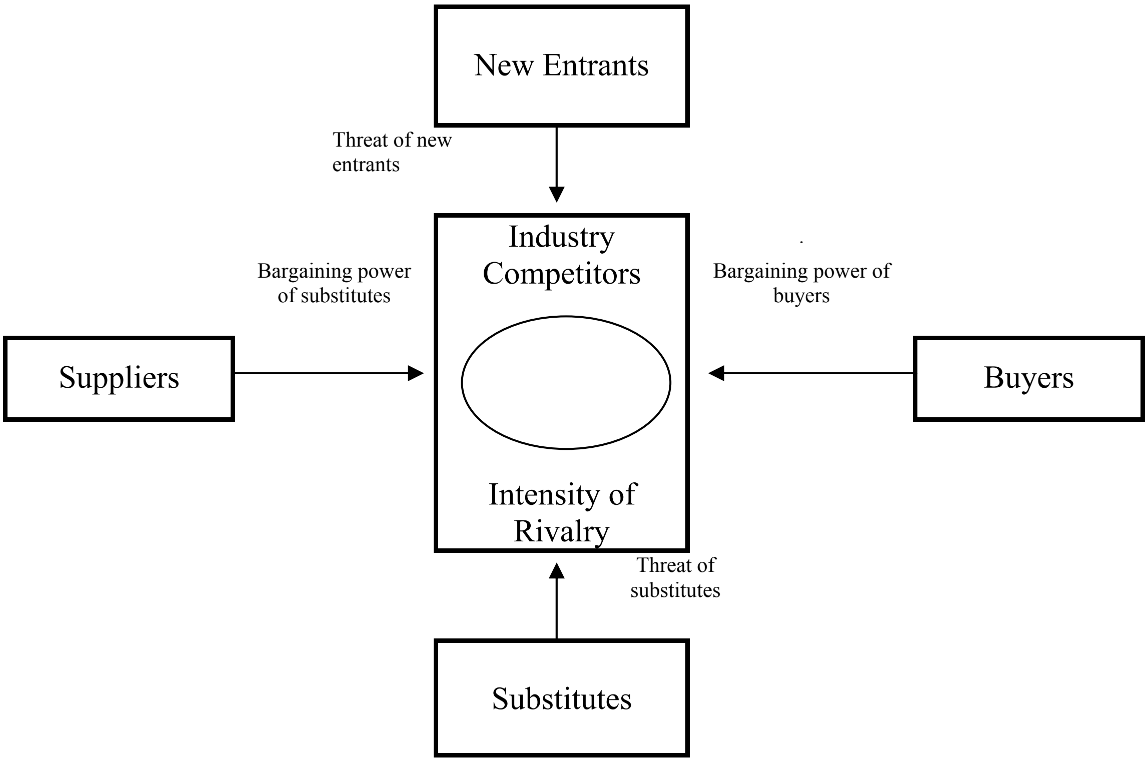
4.0 Green tools and techniques

We are all green now. There are many green tools and techniques and there is a long way to go in learning about them (including whether they are effective or not) and about how to use them. The big systems are in place: Design for Environment, Integrated Environmental Management, Sustainable Performance, Enviromental Risk Management, the ISO 14000 system of Environmental Management are examples. The hand tools are being developed and improved: full cost accounting, green communication, green investment, green marketing, green management, life cycle assessment, green technology assessment, green venture capital and new product venture, are some examples. And it is probably true to say that they are more useful in the hands of industry practitioners who understand them than they are in the hands of talking heads from the business schools.

Nevertheless the paper will examine just one of these tools, (viz the Porter Value Chain) and the insights it may provide for survival of firms in the "used oil" industry and for survival of the "industry" itself.

Figure 1 illustrates the five major forces Porter believes are driving industry competition. The structure of the industry itself (the middle box - for used oil an oligopoly) together with the buyers and suppliers, and the ever present threat of substitutes and new entrants, constitute the business ether in which firms exist, make profits and evolve. The competing firm must position itself against substitutes and entrants and strategically manage the balance of its operations between supplier and buyer. This whole process is also influenced by the stage of industry life cycle in which the firm finds itself.

Figure 1: The five competitive forces and elements of industry structure

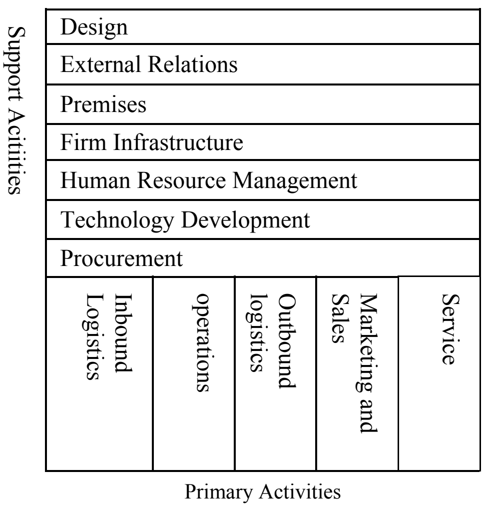


(Source: Adapted from Beaumont, J et al 1993*, Managing the Environment: Business Opportunity and Responsibility*, Butterworths, Oxford, p. 54)

In all of this Porter represents the firm (at the level of a strategic business unit) as a value chain in the form illustrated in Figure 2. The primary activities are the operations themselves the primary life cycle/operations management activities described in columns 1 and 2 of Table 4 above. The support activities complement the primary activities. There are now green tools and techniques being developed for each category of primary and support activity but these will not be discussed here. Rather a green management version of the value chain (James' Sustainability Octagon – Figure 3) will be used to put the view that profitability in the used oil industry and its medium to long term survival depend on more than good green management at each of the levels of primary and support activity. The industry could better prepare itself to accommodate shocks by extending its boundaries and redefining itself as an industry having a vision and core business something akin to *substance recycling and energy loss prevention.*

In Figure 3, James has added three primary activities (design, product disposal and risk management) and two support activities (external relations and premises). The addition of these activities appropriately extends the boundary of the firm (and therefore the industry) by requiring it to address an eco margin, a risk margin and a social margin. For example there is a contention raised throughout this paper that the public would accept agricultural oil substitutes and fuel cell power for lubrication and energy were these available at competitive prices and without loss of performance utility. This narrowing public acceptability margin raises the question of an evolving product mix for the "used oil" industry of the future.

Figure 2: The Porter value chain



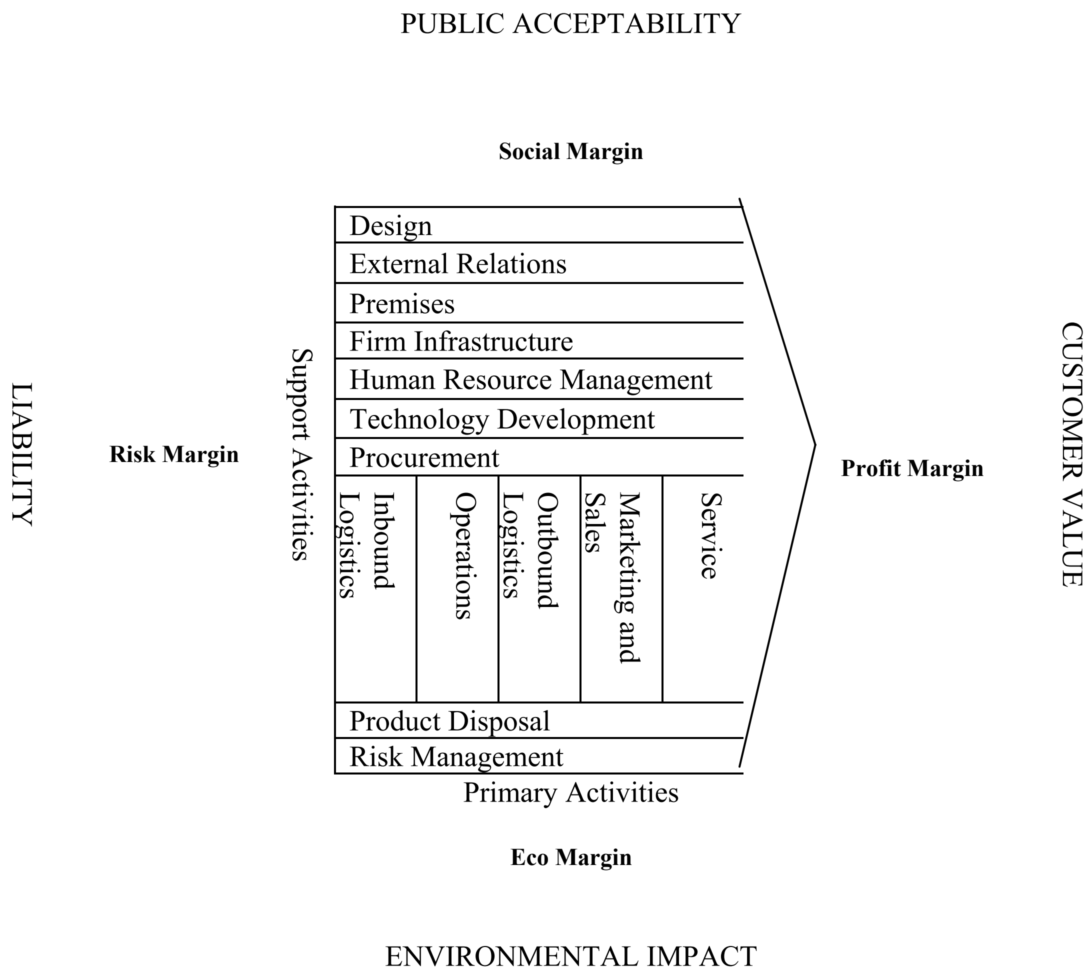
(Source: Adapted from Beaumont, J et al 1993*, Managing the Environment: Business Opportunity and Responsibility*, Butterworths, Oxford, p. 62)

Is the eco margin narrowing? That is, is the extent to which the industry's product(s) and the firm's product(s) meet or surpass environmental benchmarks and performance standards losing ground to the performance of substitute products or potential entrants? Is the eco margin working for or against the social margin? For example is the bio-degradability factor (say) of the industry product superior to that of its competitors? Depending on the answers to questions of this kind, what is to be done? Should there be a move into the marketing and waste management of the new products? Should the firm plan a sunset strategy for the existing product or find alternative green uses for it? Other questions can be asked: is the risk margin sufficiently wide to allow an orderly phase in of countervailing strategy or are there wildcards in the pack? What phase of their life cycle are the source industries in, and what are the implications of this?

In order to obtain more complete answers the industry might have to extend the boundary of its thinking a number of steps along the value chain even though there are uncertainites and unknowns involved. Writers of text books and some academics who read them are so used to representing the value chain as a linear process that they tend to believe it after a while. The business ether is complex and changes in any one factor may cause new linkages to enter the chain. Business life is multi-dimensional and to keep this in mind is to strengthen the use of value chain thinking, not to weaken it.

For example, in the “used oil” industry the supplier’s supplier is the petro-chemicals industry whose fuel product is under threat from agricultural, solar, electric-hybrid and fuel cell power substitutes. The organisation’s suppliers (the used oil merchants or those from whom the organisation buys directly) like the organisation itself, are under threat from new non stick materials technology, green biodegradeable synthetic oils, and new agricultural oils. The buyer of the organisation’s product may cut the organisation and its suppliers out of the chain in substantial ways if alternative fuel and lubricating substitutes are comparable and cheaper. Sunstitute products and competing firms can break into the chain at any link and substantially alter the survival and profitability status of the organisation.

Figure 3: The James sustainability octagon



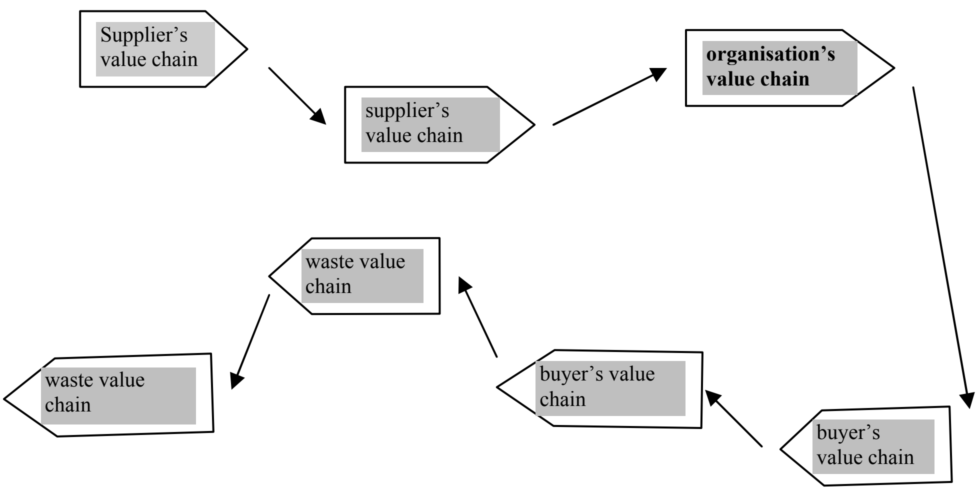
(Source: Adapted from Beaumont, J et al 1993*, Managing the Environment: Business Opportunity and Responsibility*, Butterworths, Oxford, p. 64)

It is now possible to bring this paper to a close. Two types of green tools and techniques have been discussed.

First a claim was made that that functional green tools and techniques are available for application at each of the support and primary activities of an oganisation’s value chain. Some of these tools were named but detailed explanation of them was not attempted in this paper. These tools are primarily loss prevention tools which contribute to the firm's profitability by non price production strategies which, at the end of the day, win their benefits through good stewardship of the environment. These tools employ procedures and protocols which call up environmental and safety standards and benchmarks.

Second, two less functional (but more strategic) tools – the value chain and the sustainability octagon – were introduced to carry a discussion of the proposition that the "used oil" industry (and the firms within it) could better position themselves to counter competetive and innovations shocks through (a) extending perception to address a wider "industry" boundary, and (b) redefining its core business to something akin *to (green) substance recycling and energy loss prevention.* It is easier to suggest such changes than it is to implement and manage them. Making such changes will not be easy for they are in the nature of a Gestalt shift. But a mind set of this kind will help keep the firm's focus both on competition and emerging product substitutes, and the basis from which its own existence springs – the principles of ecological economics.

Figure 4: The inter-organisational value chain



Source: Strategic Business Management p. 63

Conclusion

The "used oil" industry was examined and shown to be a functioning sector whose participants are able to win productivity and environmental health benefits from business activity. The emergence of the sustainable transport paradigm was examined and it was shown that the harmful impact of transport (the main supplier of the used oil industry's supply source) on health and the environment is so substantial as to be driving a serious reappraisal of basics. The question of alternative fuels and lubricating oils is at the centre of this reappraisal. Whereas the supply of crude oil does not appear to be a pressing factor, mineral oil substitutes for lubrication in automobiles are beginning to appear viable and climatic change fears catalyse the search for emissions free fuels. By redefining its core business and extending the boundaries of its product and its thinking the “used oil” industry and the firms within it may position themselves to benefit from the changes sustainable development may demand.

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