DEVELOPING AN ENVIRONMENTAL RATING SYSTEM FOR CARS

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Prepared for:
7th International Conference
of the Greening of Industry Network
November 15-18, 1998,
Rome, Italy

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Introduction

The complexity and diversity of cars means that conventional eco-ratings such as those used for white goods, present insurmountable difficulties. A number of environmental ratings systems for cars are currently in use, notably in Germany (VCD Auto Umweltliste; Auto Motor u Sport), Sweden (Rototest), but also in the UK (Environmental Transport Association Car Buyers Guide). These are all primarily aimed at private consumers. However, they miss out a number of key indicators. In addition, the European Commission has announced it will introduce its own eco-rating for cars by 2000. This is likely to be based on CO2 emissions, although a more comprehensive system will be introduced in due course (AEA 42,1998, 13-16).

The system we are developing at the Centre for Automotive Industry Research (CAIR) in collaboration with a European car producer, is aimed at corporate fleet buyers, who are facing the increasing pressure of their own company's environmental performance and image. In the UK market, fleet or corporate sales represent between 50% and 70% of all new car sales, depending on the definition one uses. In 1997, for example, 1,018,419 cars were registered to businesses (Fleet News 16/1/98).

As UK companies are forced to take an interest in their environmental performance by various stakeholder groups - particularly customers - and are introducing environmental auditing systems, they are increasingly facing the fact that their large fleets of company cars - in scale at least a uniquely UK phenomenon - present a problem. Some such as Marks and Spencer have started to encourage employees to opt for more fuel efficient models as a first step (What Company Car? 1998, 15). Others are showing an interest in alternative fuels (ibid. 42-3). Some have sought help from CAIR.

Given the fact that few UK firms consider the abandoning of their company car fleet as an option at this stage - the company car culture is deeply embedded in UK corporate life (cf. Wells and Hutchings 1998) - the challenge is to optimise its environmental performance. The systems being developed by CAIR and its partners are a first step in this direction. It is by no means straight-forward to rate the performance of a car. It is easy in this area to err on the side of either oversimplicity or overcomplication and we will highlight some of these issues. A range of systems can provide fleet managers as well as 'user-choosers' among company employees with a simple basis for comparing the cars available to them. However as yet there is no clear concensus on the parameters to include.

In addition we are addressing some of the flaws of the existing systems by taking into account issues such as product durability, but also by incorporating a segmentation system allowing a more meaningful comparison of competing products to be made.

Overview of Existing Environmental Ratings Systems for Cars

A number of organisations produce comparative environmental ratings systems for cars for the use of prospective car buyers. We will assess four systems for their effectiveness, the UK-based Environmental Transport Association (ETA) produces a ratings guide every few years. We look at the 1995 edition. Another guide is the more comprehensive German VCD Auto-Umweltliste, we consider the 1996 edition. Next we will assess the Swedish Rototest system. In addition to these dedicated lists, the German car magazine *Auto Motor und Sport* has started to include an environmental rating in its road test reports, which we will assess.

ETA

The Environmental Transport Association first published its guide in 1994 (ETA 1994) and this was updated in 1995. The 1995 edition of the ETA Car Buyer's Guide (ETA 1995) rates some 350 models and relies on voluntary returns by car manufacturers and importers. As an example we give its rating for the Volvo 850:

Table 1: ETA Environmental Rating Volvo 850

Category	
Make	Volvo
Model	850
Type	GLT /SE
Transm	M5
Fuel	P
cc	2400
Power Kw	103
Consumption (l/100km)	
urban	12.6
90km/h	6.6
Top speed km/h	200
Noise dB(A)/50 km/h	72.0
Emissions	
soot	-
CO g/km	0.750
HC g/km	0.230
NOx g/km	0.100
HC+NOx g/km	0.330
Asbestos free?	-
Cadmium free?	-
Plastic parts labelled?	-
Dismantling manual available?	-
Points	43
Stars	**

The points scoring system excludes the yes/no categories and the type approval-based emissions data. They are based on an average of the models listed so have the sophistication of accommodating an overall improvement over time. The star rating has a maximum of 5 stars and a minimum of no stars, as follows:
The best 10%: 5*
The next best 10% : 4*
21% - 50% : 3*
51% - 80% : 2*
The next worst 10% : 1*
The worst 10% : no stars

So, the volvo 850 comes in the 51% - 80% category. However the system clearly favours small, light fuel efficient cars, as the top ten illustrate:

Best Ten
Fiat Cinquecento
Fiat Punto 55
Fiat Panda Selecta
Fiat Uno 1.0
Subaru Vivio 2WD
Peugeot 106 diesel
Suzuki Swift 1.0
Nissan Micra 1.0L
Ford Fiesta 1.1cfi
Citroen AX Debut

The system excludes the crucial environmental factor of durability, while the parameters for production (use of asbestos, cadmium, etc.) and recycling (availability of manual) seem too simplistic. In the case of recycling what matters is not so much whether a car is recyclable per se. Any visitor to the third world will testify to the fact that all cars can be virtually completely recycled given a need. What matters more is the extent to which cars are actually recycled. However, the ETA must be congratulated for attempting such an excercise in the first place.

VCD
The Verkehrsclub Deutschland's Auto-Umweltliste (auto-environment list) is not unlike the ETA version. It rates cars according to a series of parameters and then comes up with a number. Unfortunately where manufacturers or importers do not respond they are allocated 0 score for that parameter and this leads to some peculiar results. The ETA uses a weighted average in these cases. The higher the score, the more environment friendly a car is considered to be. The parametres scored are as follows, with ratings for the Volvo 850 2L 10V:

Table 2: VCD Environmental Rating Volvo 850

Category	
Model	850 2.0-10V
Body type	L/K (saloon/estate)
Price	46,400 DM
Kerb weight	1370
Power (kW/PS)	93/126
cc	1984
Top speed	195
Fuel type	S (Euro95)
Fuel consumption (l/100km)	
town	11.9
mixed	8.9
CO2 equivalent (g/km)	276
Noise (dB(A))	73

CO (g/km)	0.81
HC+NOx (g/km)	0.32
Particulates (g/km)	0
Technical score*	30
Environmental interest**	0
Total points	30

* this is a score which starts with 100 basic points, to which are added or subtracted points from the categories: power, top speed, CO2 equivalent, noise, HC+NOx and particulates.
** This category seeks to assess to what extent a manufacturer can be said to have a general interest in environmental issues. It is rated out of 50, but non-respondents (such as Volvo Deutschland) get a 0 score.

The VCD also incorporates a manufacturing score, which takes into account the following categories: paint sludge processing, water-based paint, high solid content paint, catalyst recycling, CFC-free production processes, formaldehyde-free production, closed loop water system, suppliers supply more than 50% by rail or water, supply to dealers more than 50% by rail or water, avoidance/replacement of combined materials, use of renewable raw materials, fewer plastic variants than a year ago, use of plastics compared with 1 year ago, dealer training in environmental protection, cold start technology built into all/some models, heated lambda-sensor standard, alternative fuel versions (AFVs) available, same environmental standards in non-EU as in EU plants, environmental report published, EMAS in some plants, information policy, fuel consumption according to new EU standards available, emissions values supplied on request, supportive of legal reduction of benzene to 1%.

Each of these categories gets a score varying from 1 to 5 points. These categories give an additional score with a maximum of 50 and a minimum of 0. Volvo Deutschland provided no reply and accordingly scored 0. The two sets of points are then added together to provide an overall rating with a maximum of 335. The authors recommend buying cars which rate at least 180 and advise against buying any car with a score of less than 60.

Many of the categories outlined by both systems are increasingly the subject of EU regulation and scoring them becomes irrelevant over time. At least where the is a binary answer: e.g. asbestos removed from brake/clutch linings: yes/no. Where the legislator sets minimum standards to be met, as in emissions, individual products can clearly exceed the standard. The inclusion of top speed or power output also appear less than relevant. Few people drive their car at or near their top speed and the fact that a car is capable of a high top speed does not automatically make it less environmentally sound than a slower car. Similarly with power output. The VCD published a new updated list in 1998, but we have not yet seen this.

Rototest
The Swedish Rototest rating system is deliberately narrower in focus in that it limits itself to exhaust emissions. It is described (What Car 1998, 61) as an Environmental Pollution Index, so excludes all other factors. It can be compared with the Euro NCAP crash test (Daniels 1998) in that it deviates from established EU emissions test cycles in favour of a system which Rototest considers gives a more realistic assessment of vehicle emissions in real use. In order to do this they have developed their own test cycle, which includes, for example testing at full engine load. The test does not include diesel engined cars and considers the regulated toxins, HC, Nox and CO, as well as CO2.

The test then allows Rototest to come up with a single figure, the Environmental Pollution Index (EPI) for each vehicle. From this the cars are ranked. The lower the EPI, the better. Among the cars tested in the 1998 edition, the VW Polo 1.4i achieved the lowest EPI of 67, while the Chrysler Grand Voyager 3.3 LE had the highest EPI of 223. Although again perhaps too limited in ignoring most environmental impact factors, it at least has the advantage of simplicity and as such would be a useful tool for UK fleet buyers.

AMS

Auto Motor und Sport introduced its new environmental categories to its comparative road tests in March 1997 (Fischer 1997). The categories considered are as follows and are taken from a comparative road test of the VW Polo Sdi, Peugeot 106 1.5D and Ford Fiesta 1.8D, published in the issue of 12 December 1997:

Table 3: AMS Environment Rating

Category (max score)	**VW**	**Peugeot**	**Ford**
Fuel Cons/CO2 emissions (50)	50	47	44
Toxic emissions category (15)	15	15	10
Drive by noise (10)	7	7	7
Footprint (5)	4	4	4
Production (10)	5	5	5
Dismantling/recycling (10)	5	5	5
TOTAL (100)	**86**	**83**	**75**

Details of how the scores are arrived at were not available, but the format fits into AMS' existing test scoring system and is incorporated into the other elements to arrive at an overall score for each car of which the environmental rating is but one element. The AMS rating has a number of advantages, chief among these is its simplicity. Comparison with test results for larger cars also shows that these are not penalised unduly, each comparative test primarily scoring the cars tested relative to each other. A comparative test of the Mercedes E 55 AMG against the Jaguar XJR from the same issue, for example came up with ratings for these two cars of 77 and 67 points respectively. However in this case perhaps not enough attention is paid to the relative environmental impact of different sizes of car. Similarly, neither of the German systems take durability into account.

These ratings systems do raise the question of the validity of unofficial standards. It could be argued that EU regulation does not satisfy many EU citizens, expecially in the more environmentally aware countries such as the Nordic members, Netherlands, Germany or Austria. Such dissatisfaction can lead to a new unofficial set of standards being set as happened with Euro-NCAP or the AMS off-set frontal impact test. Daniels (ibid) warns against the dangers of such a development. On the other hand, there is an apparent need among consumers for such stricter standards. It is another example of the industry increasingly losing control of the debate. Although it is increasingly successful at lobbying government and the European Commission, it is undermined by NGOs, such as consumer groups, environmental groups and independent research institutes. Increasingly from such developments we can discern how 'The debate has moved outside the direct control and influence of the automotive industry' (Nieuwenhuis and Wells 1997, 12).

CAIR Proposal for an Environmental Rating System

Basic Principles

There is much confusion and misunderstanding of the environmental 'performance' of cars. Environmental issues are diverse, wide-ranging and often contradictory. It must be recognised that private consumers do not place environmental issues highly on their purchasing criteria list, and that companies purchasing fleets of cars are only just beginning to do so. Despite this, there have been a number of attempts to define an environmental index for cars as we have seen. To be a practical proposition, the environmental index should:

- Be simple to understand in itself
- Allow comparisons to be made between models and manufacturers
- Use data which are already available, or could easily be made available
- Be robust and difficult to challenge
- Allow improved environmental performance to be reflected in the index score
- Encompass the life cycle of the car

These considerations suggest that the environmental index should therefore have the following characteristics.

A weighted points system

The index should be a composite of several performance criteria. The environmental performance of cars is not reducible to a single factor such as fuel consumption in use. A total lifetime energy consumption measure has some value (i.e. lifetime carbon cost per car), but again would fail to capture all the issues. The composite should combine all the factors to give a final figure. Improved environmental performance should be reflected in an improved index figure. This is the approach we have also taken with our Environmentally Optimised Vehicle framework (cf. Nieuwenhuis & Wells 1997, Ch7). It should always be possible to improve the index score - that is, there should be no fixed ceiling or standard to be attained (though there could be a baseline minimum if the index were to be used as a regulatory measure).

A life-cycle based system

It is an important principle of environmentalism that the whole life cost should be established. That is, the index should capture the resource and pollution costs of manufacture, use and disposal. In principle, renewable resources are to be preferred, as is reduced material consumption generally. As an extension of this idea, the index should reflect and reward instances where vehicle manufacturers, their suppliers and the franchised dealer network have environmental accreditation (e.g. ISO 14001, EMAS, etc.).

Again it could be argued that vehicle weight be used as a proxy measure of resource consumption. That is, within a given size segment a lighter vehicle is to be preferred over a heavier one. However, lighter does not necessarily mean that fewer resources have been consumed - it may mean that different materials have been used. Measuring resource consumption by weight disadvantages steel and cast iron compared with aluminium, magnesium or plastics. As we will see below, our ESS captures this well as in the example of the Audi A8. This positively affects use, but ferric materials may have other environmental advantages in production, for example, which need to be captured somewhere in the system; so weight should not be the sole criterion.

Product Durability

Another important environmental principle is that products should be durable, because this saves the environmental cost of disposing of and then replacing the product. While it is the case that durability has to be set against the continuous improvement in product that arises from innovation, product improvement is not in itself a justification for making products which are less durable. The index should therefore reward those vehicle manufacturers whose products have a record of longevity. Clearly, this is difficult to apply to all vehicle manufacturers - new entrants can have no record to point to. Equally, it could be argued that some vehicle manufacturers will be penalised by the retrospective application of a criterion which did not apply when their vehicles were originally manufactured and sold. Generally speaking, the products of the specialist vehicle manufacturers have longer average lifespans than those of the volume vehicle manufacturers. Longevity is partly a function of quality and design, partly a function of price / value. The higher the value of the car, the more worthwhile the investment to keep it on the road. Longevity also varies by market, a factor which complicates any assessment of the durability of the products of a particular vehicle manufacturer. However the necessary data can probably be obtained from most national registration authorities.

An alternative approach could be to reward those vehicle manufacturers who undertake to support the product (through spares, service, etc.) beyond the statutory minimum required (currently 10 years after the cessation of production of the model). The German ELV self-regulatory regime commits manufacturers to take back their products back only up to 12 years. German producers or importers who improve on this, by for example extending the free take-back to 15 or 20 year old cars could be rewarded in some way. Longevity is perhaps one of the most important environmental criteria, yet largely ignored by an industry driven by consumerism (cf. Deutsch 1994; Nieuwenhuis 1994).

The environmental index using a points system
Taking the above considerations, it is possible to create a quite straightforward index which captures some (though not all) of the issues. Table 1 gives an illustration of such an index.

Table 4: An environmental index using a points system

Phase	Index variable	Points
Production	Assembly plant has ISO14001 or similar	Yes = 50 pts
Use	Average km/l	1 km/l = 10 pts 2 km/l = 20 pts etc. No limit.
Use	Carbon monoxide	% below prevailing standard = pts Zero emissions = 100 pts
Use	Hydrocarbons and NOx	% below prevailing standard = pts Zero emissions = 100 pts
Use	Particulates	% below prevailing standard = pts Zero emissions = 100 pts
Use	Dealer network environmental standards?	Yes = 50 pts
Disposal	Is there a vehicle manufacturer approved disposal and disassembly process	Yes = 50 pts

This is quite a simple basic index, strongly orientated to the ‘popular’ concerns over emissions. The only area where there is scope for improvement in the total score beyond a defined limit is fuel economy. The vehicle manufacturers would gain credit for having their own manufacturing processes ISO14000 tested. A problem could emerge if an engine plant lacked such accreditation while the assembly plant has it for example. Equally, no attempt is made to reflect the environmental performance of the materials and automotive components suppliers to the vehicle manufacturers. The last two variables, covering the franchised dealer network and vehicle recycling respectively, are the most difficult to measure. However, the emphasis is on having a system in place (rather than actual ‘performance’ *per se*). With the franchised dealership networks comprising over 100,000 outlets in Europe it is clear that the level and extent of environmental good practice is going to vary widely by vehicle manufacturer and by country. With respect to recycling, the vehicle manufacturers have in recent years undertaken a range of experiments on vehicle disassembly. A useful measure therefore is whether a manufacturer approved disassembly process exists and is documented / available to the recycling industry.

Elaborations on the environmental index

The basic index could be elaborated or expanded upon in all of the main lifecycle phases, as is shown in Table 2. This represents a more detailed attempt to measure the environmental impact of a vehicle, and clearly demands a higher level of data input. One problem with measuring the manufacturing performance e.g. in terms of energy consumption per car, is that no account is made of differences in vertical integration.

There are clearly several objections that could be made to the above criteria in terms of data availability, the suitability of the measure, and the relative weight accorded. Note there is no post-use measure. This is because the issue is actually captured by the earlier measure on % recycled materials on a new car. A theoretical measure of how recycleable a car is will be of little value to an index. Whether recycling happens is the issue and this depends upon the economics of each material and the availability of suitable processing technologies.

Should some sort of measure of recycling be deemed necessary, there are several approaches which could be adopted. One is to estimate how much of the car can be recycled under current technologies and economic conditions. An alternative would be to give ‘credit points’ to the vehicle manufacturers in proportion to the number of cars they disassembled. A third approach, as used in the simple index, would be to ensure there is a documented disassembly process which seeks to maximize the economic recovery of materials and components. A fourth approach would be to base the index on the (current) scrap value of the materials which comprise it. An added complication would be re-manufacturing. While not used in the automotive industry for the supply of components to new cars, re-manufactured parts are used for aftermarket components. All the vehicle manufacturers can point to many practical and technical problems with trying to use re-manufactured parts on new cars, but in principle the re-use of an existing component is better than making a new one.

An attempt has been made to integrate car safety performance to the index. This is an important issue but difficult to measure. One could include the relative availability of safety equipment (seatbelts, airbags, abs, etc.) but the true ‘worth’ of all of these features can be debated. A better approach would be to use insurance industry data (as happens in Sweden with Folksam, and the US) to establish real life safety performance by which cars can be compared; while the safety of other road users should also be addressed. Clearly, there would be an issue of data availability here.

Table 5: Refinements or elaborations to the index

Phase	Index variable	Points
Production	Energy / car KwH	Less = more points
Production	Water / car M3	Less volume = more points
Production	VOCs / car g	Less weight = more points
Production	Dust per car g	Less weight = more points
Production	Total waste kg / car	Less weight = more points
Production	Landfill waste kg /car	Less weight = more points
Production	Supply base ISO14001 or similar	10% by value = 10 pts 20% = 20 pts
Production	Recycled material per new car	10% by weight = 10 pts 20% = 20 pts
Production	Renewable material per new car	10% by weight = 10 pts 20% = 20 pts. Note if both recycled and renewable, get points on both accounts.
Production	Black list chemicals or processes	Deduct 10 pts per
Production	Grey list chemicals or processes	Deduct 10 pts per
Use	Average fuel economy km/l divided by vehicle weight (note: can include petrol equivalent for non-IC cars)	Multiply result by 1,000 = points, no limit
Use	Average (historic) lifespan of cars in domestic market. Years.	1 yr = 10 pts 2 yr = 20 pts etc. no limit
Use	Average safety performance in real use, adjusted for segment.	In top 25% = 50 points In top 50% = 25 points Lose points for below average performance
Use	Environmental policies in franchised dealership network (EMAS, etc.)	% of franchised dealership network = points.

Some approaches simply seek to count the number of safety equipment features on a car (e.g. number and type of seatbelts, airbags, etc.). This is rather unsatisfactory, especially when considering features such as active cruise control, because the relative safety merit of equipment is highly debatable.

A contentious measure is that which seeks to capture the relative efficiency of the vehicle in use. This is expressed as average fuel economy (as measured in the EU test cycle) in km/l divided by mass in kg. In effect it is a measure of how efficiently a car is able to move a mass over a distance. The result would have to be multiplied up to be compatible with the other index variables. However, in principle it yields a higher score for cars that are lighter and / or more fuel efficient. As a guide, a roughly average EU car achieves 9 km/l and weighs 1,300 kg. This translates to a points score of 69.23 (9 divided by 1,300 and then multiplied by 1,000). A car which achieved the EU target of 30 km/l and weighed 1,000 kg would score 300 points. Clearly, any approach based on fuel economy would tend to favour diesel engines. It could be argued that fuel economy alone is a sufficient measure as it inevitably accounts for vehicle weight. However, an alternative view is that weight is a useful proxy of the wider demands a car makes on the environment (see ESS below).

Segmentation is Essential
The problems with existing environmental rating systems illustrate the need for some sort of segment-based approach. Without this, the smallest, lightest most fuel-efficient car will always automatically win. However this ignores the importance to the customer of other criteria such as safety, durability, the need to carry a large family or larger loads, comfort on long distances and even such intangibles as prestige. These elements play an even greater role within UK company car culture and it is important to develop a system that company car users can relate to before attempting to 'wean them off' these other concerns. In truth, customers tend to choose not from the entire product offering available in the market, but from a small selection, although this does not always coincide with the segments as perceived by car makers or industry observers.

Price is often a key element in existing segmentation systems, but has little relevance for environmental performance. In fact, it could easily distort segments. In terms of price, for example, the Lotus Elise might be in the same segment as the Land Rover Discovery, however few buyers would have both on their shortlist, while they vary dramatically in terms of their environmental performance. For these reasons we are proposing an environmental segmentation system, which will allow the totality of vehicles in the market, or even the parc, to be grouped according to a basic set of environmental criteria. We at CAIR tried a number of approaches, but for the sake of simplicity and availability of data we settled on a simple proxy formula representing the impact made by a vehicle on the environment, which is proving surprisingly robust. The formula is as follows and relates size and weight:

Vehicle length (metres) x width (metres) x weight (tonnes) = ESS

As a proxy for the environmental impact of a vehicle it is a fair measure as it relates the vehicle's weight to its 'footprint' and thus relates literally to its impact on the

Table 6: The CAIR Environmental Segmentation System (ESS): Examples

ESS Segment 0 (0-2)		
ProFlex 656 MTB	: 1.72 x 0.58 x 0.01236	= **0.012** *
FlevobikeAllewederHPV	: 2.50 x 0.75 x 0.030	= **0.056** **
ESS Segment 1 (2-5)		
MCC Smart	: 2.50 x 1.51 x 0.72	= **2.72**
Daihatsu Mira	: 3.31 x 1.395 x 0.63	= **2.91**
Subaru Vivio	: 3.295 x 1.395 x 0.64	= **2.94**
Mini	: 3.05 x 1.41 x 0.685	= **2.94**
Lotus Elise	: 3.73 x 1.70 x 0.67	= **4.25**
Renault Twingo	: 3.435 x 1.63 x 0.79	= **4.42**
Peugeot 106	: 3.565 x 1.61 x 0.78	= **4.47**
Nissan Micra	: 3.70 x 1.59 x 0.775	= **4.56**
Citroen Saxo	: 3.72 x 1.595 x 0.805	= **4.77**
ESS Segment 2 (5-10)		
Ford Fiesta	: 3.83 x 1.635 x 0.93	= **5.82**
Mercedes A140	: 3.575 x 1.71 x 1.061	= **6.48**
Ford Escort	: 4.105 x 1.69 x 1.065	= **7.39**

Nissan Primera	: 4.40 x 1.70 x 1.075	= **8.04**
Volvo S40	: 4.48 x 1.72 x 1.20	= **9.24**
BMW 3-series	: 4.435 x 1.70 x 1.235	= **9.31**
Audi A4	: 4.48 x 1.735 x 1.225	= **9.52**
Ford Mondeo	: 4.48 x 1.75 x 1.225	= **9.60**
Mercedes C-class	: 4.485 x 1.72 x 1.28	= **9.87**
GM EV1 by Saturn	: 4.31 x 1.765 x 1.301	**= 9.89**
ESS Segment 3 (10-15)		
Saab 900	: 4.635 x 1.71 x 1.295	= **10.26**
Renault Espace 1996	: 4.43 x 1.795 x 1.33	= **10.57**
Volvo S70	: 4.66 x 1.76 x 1.37	= **11.24**
Saab 9000CS	: 4.79 x 1.765 x 1.345	= **11.37**
Audi A6	: 4.795 x 1.785 x 1.37	= **11.72**
Volvo V70	: 4.71 x 1.76 x 1.42	= **11.75**
Mercedes E-class	: 4.80 x 1.80 x 1.37	= **11.84**
BMW 5-series	: 4.775 x 1.80 x 1.41	= **12.12**
Audi A8	: 5.03 x 1.88 x 1.46	= **13.8**
Lamborghini Diablo	: 4.46 x 2.04 x 1.57	= **14.27**
ESS Segment 4 (15-20)		
Lexus LS 400	: 4.995 x 1.83 x 1.68	= **15.35**
BMW 7-series	: 4.985 x 1.86 x 1.67	= **15.48**
Land Rover Discovery	: 4.52 x 1.81 x 1.92	= **15.70**
Mercedes S-class	: 5.11 x 1.88 x 1.89	= **18.15**
Lincoln Town Car	: 5.56 x 1.945 x 1.83	= **19.79**
ESS Segment 5 (20+)		
Rolls-Royce Silver Spirit	: 5.295 x 1.915 x 2.43	= **24.64**

*This is an aluminium-framed full-suspension mountain bike
** This is an aluminium monocoque full-suspension three-wheeler human-powered vehicle

earth. The system shows how light-weighting of larger cars can pay off, but also tackles our Elise vs Discovery anomaly. In each case we use the lightest variant listed; i.e. with the lowest level of specification. It must be remembered that optional extras can add significantly to the weight of a car. Some examples of how the rating works are outlined in Table 6; some non-cars have been added for comparison.

The system's surprising level of sophistication is shown by the fact that the Elise appears in ESS segment 1, while the light-weighting strategy followed by Audi for its A8 - not otherwise apparent in any absolute rating system - is clearly illustrated by its environmental segment rating, especially when compared with the S-class, with which it competes. It also shows that the Saab 900/9-3, with which its maker competes against the BMW 3-series and its ilk actually belongs one segment higher than its perceived competitors. It comes in fact very close to its stablemate the 9000CS, soon to be phased out, which does remarkably well for its segment, together with Volvo's V/S70.

The main strength of the ESS is its simplicity. Work which CAIR carried out recently for one of the leading UK leasing firms showed the importance of this. This firm with an own fleet of 200 company cars was seeking to improve its environmental performance. For the sake of simplicity it finally settled on limiting its improvements to CO_2 emissions, as anything more complex was considered unacceptable.

Although the ESS could be used as a stand-alone rating system, at present CAIR intends to use it as an input figure for a more comprehensive rating system, incorporating some of the elements reviewed thus far, which is still under development. Developing such a system is proving difficult and some of these difficulties were outlined above. Several of the ratings systems described use an initial input figure, although these seem somewhat random by comparison to our ESS. By using this segment-based approach - albeit departing somewhat from the conventional segmentation systems used in the industry - we hope to avoid some of the problems with existing environmental rating systems.

Finally, it is worth considering the value of the Volvo ELU system (Volvo 1991) in creating an environmental index. While it is clear that this is not the purpose of the ELU system, the approach has some merit. If each material can be given an ELU score, then the relative environmental performance on a per car basis is simply a matter of multiplying the weight of each material by the ELU figure. Obviously, a heavy car will have a higher ELU score than a light car. There are some problems of course. First, the ELU/material figure assumes that all materials producers are the same in terms of the environmental cost of production. This is clearly not the case. Second, it assumes a given level of fuel consumption per km in use together with a given distance travelled. While these assumptions may be valid at the material specification stage for a given model, they will not be for the wide diversity of cars produced fulfilling a wide range of functions. As a simple illustration, BMW have released data to show that their cars have a much higher 'motorway content' (as well as higher overall distances travelled) than the average car, and thus to use the EU average fuel economy figure as a basis for measuring the performance of BMW cars is misleading. Still, the approach has some merit and, as the materials producers themselves conduct comparable life-cycle analyses, so data which could input into this approach will become available.

The issues are complex, however it is increasingly important to make available some sort of eco-rating for cars. Both private car users and fleet buyers are beginning to expect it, while EU and individual country legislation and taxation is increasingly relying on environmental criteria and the European Commission is committed to producing some form of eco-rating for cars soon. Besides it is important to move away from the narrow emissions-only view of the environmental impact of cars, as we have argued previously (Nieuwenhuis et al. 1992; Nieuwenhuis & Wells 1994).

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