REDUCING THE ENVIRONMENTAL IMPACT OF ROAD TRANSPORT OPERATIONS: A REVIEW OF INTERVENTIONS THAT CAN BE APPLIED BY FLEET OPERATORS.

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1. INTRODUCTION

This paper reviews work that has been undertaken by the Transport and Logistics Research Unit (TLRU) based in the University of Huddersfield in the UK. It briefly explains the reasons for the research and then discusses what the research considers to be several successful fuel saving interventions. An intervention is defined as "a product or service that claims to improve fuel efficiency". A successful intervention improves the fuel consumption in miles per gallon (MPG) for example, 8.0 MPG (35.31 l/100km) to 8.8 MPG (32.10 l/100km)- a ten percent improvement. Due to the high cost of fuel in the UK both financial and environmental savings are indicated. The savings and their effect upon company profits are modelled at the end of each detailed discussion of a successful intervention. A caveat is introduced after each intervention explaining its sensitivity. Finally, a review of some other interventions on the TLRU database is given along with a summary of a report by the USA based Environmental Protection Agency (EPA). In the UK fuel consumption is expressed in MPG as opposed to the continental system which expresses it in litres per 100 kilometres (l/100 km). A formula to convert MPG to l/100 km is shown after this paragraph.

To convert MPG to l/100km use the following formula:

$$100 / ((MPG * 1.609344) / 4.54609) \quad (1)$$

2. REASONS FOR THE RESEARCH

The three main reasons for the research are

- the environmental impact of road transport vehicles
- the high cost of fuel in the UK, which has a large impact on costs and profitability of operators of large goods vehicles (LGVs)
- the lack of any independent rigorous scientific analysis of the claims made by suppliers of interventions

2.1 ENVIRONMENTAL IMPACT

Emissions from road transport vehicles are a major contributor to greenhouse gases and are suspected to be closely linked to respiratory problems and diseases such as cancer. The Environment Agency (1998) suggests that the annual total cost in terms of health effects to the UK is £1,500,000,000 or at the present exchange rate €2,388,000,000. Changes to engine technology brought about by European legislation have reduced the emissions produced by diesel engines. Table 2.1 indicates the weight of the emissions produced by 1,000 litres of standard diesel, not Ultra Low Sulphur Diesel (ULSD). Additionally, three tonnes of Carbon Dioxide (CO_2) are produced for every 1,000 litres of standard diesel consumed.

Whilst engines that meet Euro 3 specifications will reduce emissions further, it is being suggested that there will be a slight increase in fuel consumption, thereby increasing the output of CO_2. Many operators in the UK argue that because of their low profit margins (due partly to the high price of fuel) they cannot afford to invest in new vehicles that are fitted with Euro 3 engines. The effect of fuel costs is indicated in Section 2.2.

Table 2.1 Emissions per 1,000 litres of diesel fuel

Euro specification	*Pre Euro 1*	*Euro 1*	*Euro 2*
Carbon monoxide (kg)	12	12	11
Hydrocarbon (kg)	2	1	1
Nitrogen oxide (kg)	37	21	18
Particulate matter (kg)	5	2	1
Introduction date		1 Jan 1992	1 Oct 1996

Source: Freight Transport Association (FTA), 1997.

2.2 FINANCIAL CONSIDERATIONS

Fuel costs in the UK are the highest in Europe. Table 2.2 shows the costs associated with operating a 38 tonne 4*2 (two axles with the rear one driven) articulated unit in the UK used in conjunction with a tri axle trailer. The trailer costs are not included.

Table 2.2 Annual operating costs (UK) for a 4*2 articulated unit

		% of annual operating costs
Capital Cost £ (€)	47,000 (74,824)	
Annual distance km	120,000	
Ownership period (years)	5	
Fuel consumption MPG (l/100km)	8.4 (33.63)	
Standing Costs		
Overheads £ (€)	8,689 (13,833)	10.99%
Vehicle Excise Duty £ (€)	3,210 (5,110)	4.06%
Insurance £ (€)	2,530 (4,028)	3.20%
Depreciation £ (€)	7,595 (12,091)	9.60%
Finance 5 years £ (€)	2,186 (3,480)	2.76%
Drivers £ (€)	25,007 (39,811)	31.62%
Standing costs per year £ (€)	49,217 (78,353)	
Standing costs per km £ (€)	0.41 (0.65)	
Running costs		
Fuel & Oil £ (€)	25,000 (39,800)	31.62%
Tyres £ (€)	860 (1,369)	1.09%
Maintenance £ (€)	3,998 (6,365)	5.06%
Total running costs per km £ (€)	0.249 (0.40)	
Total operating cost per year £ (€)	79,075 (125,887)	100.00%
Total operating cost per km £ (€)	0.659 (1.05)	

Source: Wilcox (1999a)

It can be seen from Table 2.2 that fuel costs are one of the largest costs facing operators in the UK. Obviously these costs are sensitive to the vehicle configuration and gross vehicle operating weight (GVW).

To end this section it is worthwhile to point out that a review of reports on the profitability of transport operators in the UK indicates that the average profit margin over the last few years has been in the range of 2.5% - 3%. Clearly any intervention that reduces fuel consumption will not only reduce the environmental impact but will improve profitability considerably. The next section will now introduce interventions and what the research has revealed.

3. INTERVENTIONS

There are approximately 400 interventions commercially available in the UK that claim to improve fuel efficiency. Many of these interventions are targeted at the operators of LGVs because of the effect that fuel savings can have on profitability.

3.1 ACCURATE DATA - THE FIRST INTERVENTION

The first intervention that any transport operator must take is to obtain accurate fuel consumption data. Whilst this might seem like common sense, examination of the fuel records supplied by operators in the research project (Coyle, Murray and Whiteing, 1998) revealed that up to 20% of the records had a field containing erroneous data. Until the data is of reasonable quality it is not practicable to introduce most interventions. The exceptions to this rule relate to interventions such as computerised routing and scheduling systems, which do not rely on MPG figures.

3.1.1 GOOD PRACTICE CASE STUDY 342

A case study funded through the European Commission's SAVE Programme (Good Practice Case Study 342) on improvements due to improved monitoring indicated an increase in MPG of 3%.

Applying this saving to Table 2.2 will show the following financial savings.

Annual km	120,000
Previous fuel consumption	8.4MPG (33.63 l/100km)
New fuel consumption	8.6 MPG (32.65 l/100km)
Fuel saved in one year	1,175 litres

Using Table 2.1 the environmental savings produced by the vehicle in Table 2.2 (assuming it is fitted with an engine specified to Euro 2) have been calculated and are shown in Table 3.1

Table 3.1. Annual environmental savings with a 3% improvement in fuel efficiency

Pollutant	Amount saved
Carbon monoxide (kg)	12.93
Hydrocarbon (kg)	1.18
Nitrogen oxide (kg)	21.16
Particulate matter (kg)	1.18
Carbon Dioxide (Tonnes)	3.53

Similarly applying the 3% saving to the fuel cost in Table 2.2 which was £24,939 (€39,703) - the annual oil cost was calculated to be £61 (€97) - produces a financial saving of £727 (€1,156). Dividing this saving by the total operating costs of £79,075 (€125,887) produces a profit margin of 0.92%. Applying the saving to the average industry profit margin of 2.75% of total costs, profits have been increased by 33%. However, whilst analysis such as this could be construed as playing with the figures, the format of applying the financial savings to total cost has great relevance.

The caveats to this intervention are that

- the improvement is sensitive to the quality of data management before the intervention
- the 'Hawthorne' effect (Handy 1985) whereby people may change their behaviour when they are being observed.

So far a 'win win' situation has developed. Both the environment and the operator have made a slight gain. However, this is not the end of the first intervention, a case study entitled 'Effectiveness Analysis' from the TLRU is now used to show in some circumstances even greater savings can be made through the use of accurate data.

3.2 EFFECTIVENESS ANALYSIS (EA)

Effectiveness analysis is making effective use of good quality data and the present configuration of the vehicle fleet. It has already been stated that the first intervention is to establish good quality data. Once this is accomplished then in certain circumstances the allocating of vehicles to routes can be undertaken in such a way that reduces fuel consumption.

3.2.1 BACKGROUND

A fleet of 17 tonne and 7.5 tonne rigid vehicles undertakes local distribution work. There are three 38 tonne units that undertake three overnight trunk runs and then one of these units is used during the day to take on an additional trunk run. The remaining two units are occasionally used for local delivery work.

The distances for the four trunk routes are shown below:

- Route 1 - overnight trunk of 300 miles.
- Route 2 - overnight trunk of 350 miles.

- Route 3 - overnight trunk of 410 miles.
- Route 4 - daytime trunk of 300 miles.

The traffic department assumed that because the units were identical models, were of a similar age and the trailers, which were of a similar specification, were carrying similar weights they would produce the same fuel consumption figures. Obtaining and analysing accurate fuel consumption figures revealed that the average MPG for the three vehicles was:

- Unit 1 - 7.3 MPG
- Unit 2 - 7.15 MPG
- Unit 3 - 6.5 MPG

Note: The drivers were rotated between vehicles and the vehicles rotated between routes to ensure it was the vehicle which produced the above results.

Before applying EA to the fuel costs, unit three was used on routes one and four, unit two on route three and unit one on route two. The average daily fuel consumption is shown in Table 3.2.

Table 3.2 Daily Fuel Consumption

Unit & MPG	Route	Distance		Fuel Used	
		Miles	(km)	Gallons	(Litres)
1 – 7.3	2	350	(563)	47.945	(218)
2 – 7.15	3	410	(660)	57.342	(261)
3 – 6.5	1 & 4	600	(966)	92.308	(420)
Daily Fuel Usage				**197.595**	**(**898**)**

3.2.2 ACTION

By assigning the vehicles with the best fuel consumption to the longer trunk runs fuel consumption was reduced, as shown in Table 3.3.

Table 3.3 Reduced Fuel Consumption

Unit & MPG	Route	Distance		Fuel Used	
		Miles	(km)	Gallons	(Litres)
1 – 7.28	3 & 4	710	(1,143)	97.527	(443)
2 – 7.15	2	350	(563)	48.951	(223)
3 – 6.6	1	300	(483)	45.455	(207)
Daily Fuel Usage				**191.933**	**(**873**)**

3.2.3 OUTCOME

The daily fuel saving was 5.662 (197.595 - 191.933) gallons or 2.87%. At a price of £2.81 per gallon, operating five days per week for 50 weeks per year an annual saving of £3,939 (€6,271) is produced. Route four involved the most hill work and therefore accounted for the slight change in consumption figures when it was reallocated to unit one from unit three. The saving in total fuel used is 6,390 litres, which if applied to the emissions in Table 2.1 produces the savings in Table 3.4.

Table 3.4 Annual environmental savings due to effectiveness analysis

Pollutant	Amount saved
Carbon monoxide (kg)	12.38
Hydrocarbon (kg)	1.13
Nitrogen oxide (kg)	20.27
Particulate matter (kg)	1.13
Carbon Dioxide (Tonnes)	3.38

Note: these figures apply to the case study not the vehicle in Table 2.2

Effectiveness analysis shows what can be achieved with good quality data if the operational conditions are suitable. The caveat in this case is that the improvement depends upon whether changing the allocation of vehicles to routes can be achieved and how bad the previous allocation was. Section 3.3 explains the correct method for determining the fuel consumption over any specified period of time.

3.3 THE CORRECT METHOD TO CALCULATE FUEL CONSUMPTION

A major problem that has been identified with computer generated fuel management reports is the manner in which a periodic average of fuel consumption is produced. A control vehicle that is being used in a test of an intervention by a company in the research project produced the data in Table 3.5. The problem indicated in Table 3.5 has been found to occur quite often. It is of such a major concern to the TLRU that it plans to give away free software that will overcome the problem and produce a CuSum average, which is explained in the following paragraph.

In Table 3.5 the distance (*D*) is the difference between the previous odometer reading *OD1* subtracted from the present reading *OD2*. The fuel issued at the refuelling *F* is represented in the middle column, titled 'Fuel '. Application of formula (2) produces the individual MPG figures in column 4. The week numbers represent the week in which the data was generated. This particular vehicle tended to be refuelled at base twice a week. It can be deduced that on the 30-March-1999 the vehicle was not refuelled correctly and received a short delivery of fuel which produced a high MPG figure which was compensated for at the next refuel on the 01-April-1999. The TLRU average is a CuSum average (formula 3) in that it is total distance divided by total fuel used. When instances such as this occur they aid the production of erroneous average MPG figures because they give equal weighting to each MPG figure. Whereas CuSum weights individual data according to each data's contribution to the total.

$$\text{MPG} = \frac{D}{F} \qquad (2)$$

$$\text{CuSum MPG} = \frac{\sum D}{\sum F} \qquad (3)$$

Table 3.5. Fuel consumption data for a four-week period (vehicle R515)

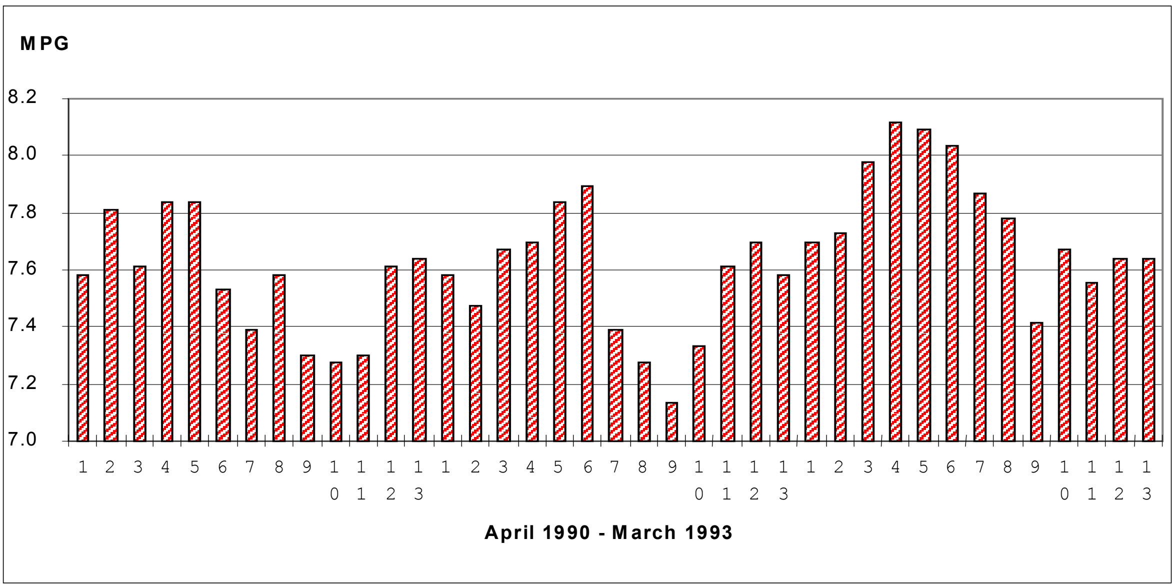
Date	Distance *D* (Miles)	Fuel *F* (Gallons)	MPG	Week
17-Mar-99	651.96	74.70	8.73	12
20-Mar-99	1,011.90	103.80	9.74	12
23-Mar-99	530.14	62.14	8.53	13
26-Mar-99	650.71	73.58	8.84	13
30-Mar-99	1,062.77	98.27	10.81	14
01-Apr-99	247.36	43.99	5.62	14
07-Apr-99	709.76	83.70	8.48	15
09-Apr-99	463.02	54.71	8.46	15
10-Apr-99	299.56	36.56	8.19	15
Total	5,626.48	631.45		
Average of MPGs			8.60	
TLRU average			8.91	
Difference (Abs)			0.31	
Difference (%)			3.46%	

Improving the quality of fuel data and calculating it correctly does not incur a great expense, in many organisations it requires a change in how certain tasks are carried out rather than the introduction of new tasks.

3.4 SEASONALITY

Figure 3.1 shows the MPG pattern for a fleet of 600 vehicles, operating throughout the UK. The data is supplied from summary reports that are run every four weeks, for accounting purposes. Period one is the first four-week financial period beginning in April 1990. In 1992, the company began fitting aerodynamic aids to the vehicles. The data clearly indicates a seasonal pattern.

Figure 3.1 Seasonal profile of a 600-vehicle fleet 1990 - 1993



Source Coyle 1998
For any company wishing to test MPG enhancing interventions it is important to understand seasonal trends and to determine whether they are testing during a peak, trough, upward trend or a downward trend. This also reinforces the need for control vehicles in any test. When examining data provided by the suppliers of interventions it is advisable to look at the period in which the 'before' and 'after' data was collected. Where possible 'before', 'after' and 'as before' testing should be undertaken. This seasonality is clearly very important, but is all too often overlooked when testing interventions and can be exploited by unethical sales people.

Having identified issues of data quality and seasonality (both of which should be understood before attempting to introduce other interventions) it is appropriate to review the results from a fuel efficiency survey conducted by the TLRU in 1999. Care must be exercised when examining the results because some of the companies whose responses are shown in Table 3.6 also claimed that there was no seasonal influence upon their fuel consumption!

Table 3.6 Success or failure rates of interventions

Intervention	**Attempts**	**Successful**		**Unsuccessful**	
		Actual	**%**	**Actual**	**%**
Aerodynamics	49	38	78%	11	22%
Driver training	42	40	95%	2	5%
Different vehicle manufacturers	39	32	82%	7	18%
Improved routing and scheduling	38	35	92%	3	8%
Changed vehicle specifications	35	33	94%	2	6%
Semi/Fully synthetic engine oil	33	20	61%	13	39%
On board data recording	33	21	64%	12	36%
Semi/Fully synthetic transmission oils	27	16	59%	11	41%
Fuel additive	25	7	28%	18	72%
Low energy tyres	24	11	46%	13	54%
Fuel bonus	23	9	39%	14	61%

Source Coyle (1999)

4. DRIVER TRAINING:

Many companies still do not appreciate the benefits of driver training; yet driver training if managed correctly can produce impressive results. However, there is a caveat that the training needs to have some sort of reinforcement mechanism. This can take the form of league tables, targets, individual letters and fuel bonuses. The reinforcement mechanism needs to be carefully thought through to ensure it has a continual incentive effect. The following data and the averages presented in the tables were all calculated using the CuSum method.

Table 4.1 shows the results of a driver-training programme that took place in November when the seasonal trend was showing a reduction in MPG. Despite this downward trend an improvement was made. The training was 'on the job'.

Table 4.1. Results of driver training

Driver	MPG(1)	MPG August	MPG September	MPG October	MPG(2)	MPG(3)	Improvement %
Artics							
1	6.59	6.72	6.49	5.92	7.98	7.78	31.42
2	6.51	6.25	6.76	6.67	6.87	6.86	02.85
3	7.04	7.52	7.00	7.23	7.56	8.18	13.14
4	6.61	8.25	6.83	5.73	7.91	7.52	31.24
Rigids							
1	7.3	6.27	6.29	6.14	8.36	7.07	15.15
2	7.27	7.93	7.13	7.45	7.69	8.14	09.26

MPG(1) Previous year's (January to December) MPG
MPG(2) MPG achieved on training day
MPG(3) MPG for November
Improvement % is calculated by ((November MPG - October MPG) / October MPG)

Two of the drivers (3 & 4) in this analysis both went to the same destination 217 miles (349 km) away, departing at the same time. Most of the journey was via the motorway network and the departure time was 3:00 AM. The first vehicle, an F10 was speed limited to 60 miles per hour (MPH), the second a FL10, was limited by its driver to 56 MPH. The difference between the arrival times at the destination was four minutes. The return journey required the vehicles to make slightly different detours but the overall distance was the same as can be seen in the Table 4.2. The effect on fuel consumption can also be seen. However, the fact that they are two different models[1] must be taken into consideration when comparing fuel consumption. This also took place the day that driver 4 was being trained.

Table 4.2 Comparison of maximum speed and fuel consumption

Driver	Max speed	Distance (KM)	Fuel used (Litres)	MPG
3 - FL10	56	718	237	8.55
4 - F10	60	718	256	7.91

At a fuel price of 61.8 pence (€0.98) per litre the saving is £11.74 (€18.69) in one day.

Discussions with companies within the research project who have vehicle fleets ranging in size from 5 to 800 vehicles and with other companies that have introduced successful driver training schemes indicates long term improvements in fuel consumption of 10% to 15%. However, the caveat for this intervention is its sensitivity to the level of a driver's skill (as reflected in Table 4.1) prior to the training, the quality of the training and the reinforcement mechanism. For the purpose of example the minimum figure of a 10% has been arbitrarily selected and using Tables 2.1 and 2.2 the environmental and financial savings can now be calculated.

[1] The FL10 is usually more fuel efficient than the F10

Table 4.3 Environmental savings due to driver training

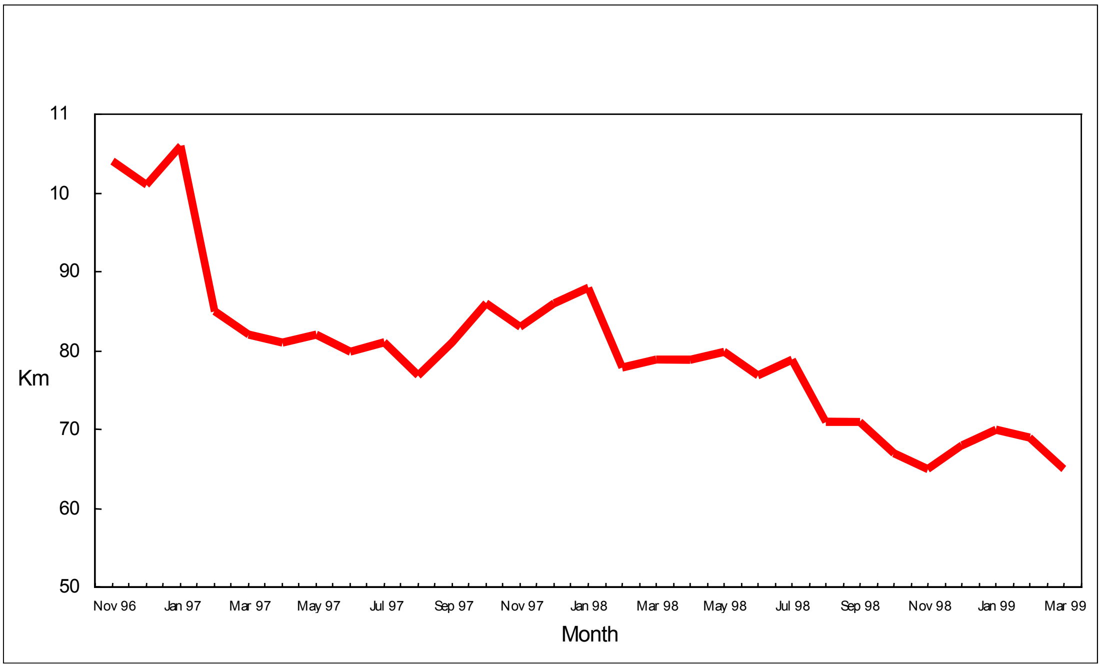
Pollutant	Amount saved
Carbon monoxide (kg)	40.35
Hydrocarbon (kg)	3.67
Nitrogen oxide (kg)	66.03
Particulate matter (kg)	3.67
Carbon Dioxide (Tonnes)	11.01

Applying the fuel saving to the model in Table 2.2 the financial benefits can be calculated as £2,267 (€3,609) per annum.

5. LOAD PLANNING AND VEHICLE ROUTING SOFTWARE

Another company in the research project developed a key performance indicator (KPI) kilometres per drop (km/drop) to monitor its efficiency. The introduction of this software has produced a major improvement in the productivity of the fleet. The daily distribution activity measured by the KPI has fallen by 25% since the introduction of this software in January 1997. The total km travelled has been reduced from 3.2 million to 2.4 million, saving 784,000 km or 25%. In this case, the intervention has improved the efficiency of vehicle use rather than improving fuel consumption. Figure 5.1 shows the trend of the KPI over the period November 1996 to March 1999.

Figure 5.1 Reduction in km/drop (Nov 96 - March 99)



Source Watson (1999)

Whilst Table 5.1 shows the individual monthly figures what is not revealed is changes to the number of drops undertaken by the company. Changes to the number or location of drops could also have an effect upon the KPI. Payback on the system was estimated to be three months.

Table 5.1 Annual environmental savings due to improved routing and scheduling

Pollutant	Amount saved
Carbon monoxide (kg)	110.97
Hydrocarbon (kg)	10.09
Nitrogen oxide (kg)	181.59
Particulate matter (kg)	10.09
Carbon Dioxide (Tonnes)	30.27

Assuming that the annual distance covered by the vehicle in Table 2.2 could be reduced by 25% the financial savings to the company would be £6,235 (€9,926) per annum per vehicle. The caveats are whether or not such a saving can legitimately be applied (which would have to be the subject of further research) and it is sensitive to the skills of the planners prior to implementation. The intervention is also sensitive to the size and type of operation.

6. AERODYNAMICS

The Energy Efficiency Office (EEO) produced two significant guides on the use of aerodynamic aids in 1990. Savings produced through the use of aerodynamic styling kits or aids can be quite substantial. However, these savings are highly sensitive to road speed. The higher the speed the greater the saving. Where vehicles spend a great deal of their operational distance at low speeds the aerodynamic aids will not have a significant effect. Two substantial case studies indicate the savings that can be made when aerodynamic aids are fitted in the appropriate circumstances. Both of these case studies are available from the UK's Energy Efficiency Best Practice Programme (EEBPP).

The first project, 'Fuel Savings Using Aerodynamic Styling On Articulated Trucks' (Energy Efficiency Demonstration Scheme Expanded Project Profile 355) identified the savings to be made by comparing two specially styled articulated trucks with two unmodified trucks. The results are shown in Table 6.1.

Table 6.1. Savings produced by aerodynamic styling of articulated vehicles

	No. of journeys	**Mean fuel consumption l/100 km**	**Fuel saving**
Thetford to Atherstone (return)			
Aerodynamic vehicle	49	30.9	16.3%
Unmodified vehicle	49	36.9	
Durham to Atherstone (return)			
Aerodynamic vehicle	77	31.2	15.7%
Unmodified vehicle	77	37.0	

Source: Energy Efficiency Demonstration Scheme Expanded Project Profile 355

The average saving in fuel consumption during the monitoring period was 16% applying this saving to the data in Table 2.2 produces the following environmental and financial savings.

Table 6.2 Annual environmental savings due to use of aerodynamic equipment

Pollutant	Amount saved
Carbon monoxide (kg)	61.23
Hydrocarbon (kg)	5.57
Nitrogen oxide (kg)	100.19
Particulate matter (kg)	5.57
Carbon Dioxide (Tonnes)	16.70

The annual financial savings to the company are £3,440 (€5,476)

The second project 'Fuel savings through aerodynamic styling of trucks' (Energy Efficiency Demonstration Scheme Expanded Project Profile 335) identified the savings to be made by comparing two specially styled rigid trucks with two unmodified trucks. The improvement in fuel efficiency was 19.36%. A major point of interest is the fact that the final drive ratio was also changed in the intervention vehicle. This permitted even greater savings and technically it might be said that the overall saving was achieved by combining two interventions (aerodynamic aids and improved vehicle specification).

Transport operators must remember that the savings are highly sensitive to road speed and vehicles that travel a high proportion of their distance at speeds below 40 miles per hour (MPH) will see a very low improvement in fuel consumption. It is generally accepted, as a rule of thumb, that at speeds below 30 MPH there are no savings to be made through the use of aerodynamic aids. Table 6.3 shows the results of an aerodynamic test that was conducted at the 1999 Brewery Transport Advisory Committee (BTAC) Technical Trials, under the auspices of the Institute of Road Transport Engineers (IRTE).

Table 6.3 The sensitivity of aerodynamic aids to road speed

		Aerodynamic Intervention	**Aerodynamic Intervention**	
		Not Applied	**Applied**	
Speed (mph)	Distance (miles)	Consumption (MPG)	Consumption (MPG)	Difference
37	13.914	14.248	14.479	1.64%
50	13.914	9.345	10.097	7.45%
56	13.914	8.577	9.459	9.31%
Average		10.212	10.956	6.80%

Source: Wilcox, August 1999b

7. OTHER INTERVENTIONS

Having looked in some detail into what can be described as basic interventions it is only correct to mention other basic and not too expensive interventions, though in less detail.

- Fit an engine speed limiter.
- Correct specification of vehicle and trailer to reduce the gap between the front of the trailer and the back of the cab.
- Specifying bodywork that gives the necessary cubic capacity whilst minimising height and width.
- Monitoring maintenance reports and fuel consumption to identify rogue vehicles and drivers
- Monitor fuel stocks accurately
- Obtain an accurate MPG figure for vehicles and driver through the use of 'base of neck' to 'base of neck' refuelling.
- Develop a fuel efficiency culture for all staff, if feedback on MPG is to be given then indicate the reductions in emissions achieved, also tell your suppliers and customers what you are doing.
- Use spreadsheet models to indicate the fuel efficiency costs and benefits of decisions.
- When purchasing a new Large Goods Vehicle have the fourth needle on the tachograph activated to record engine revs and use the information
- Review maintenance procedures for example, are tyre pressures being checked when cold?
- Truck manufacturers are providing free training for drivers aimed at improving safety and fuel consumption, take advantage of it. If you operate a car or van fleet ask your supplier why they don't supply a similar service. Some truck manufacturers also make cars and vans.
- Reinforce driver training for all staff.

There appears to be a constant stream of interventions that claim to improve fuel consumption, it is not intended here to highlight any particular intervention or type of intervention but rather to raise awareness of validity. A recent analysis of the United States based Environmental Protection Agency (EPA) device and additive test list (EPA420-B-98-003) indicated that of 107 interventions on the list:

- Six were considered to have "*Indicated a statistically significant improvement in fuel economy without an increase in exhaust emissions although cost effectiveness must be determined by the consumer for his particular application*".
- Four interventions "*Indicated a statistically significant improvement in fuel economy but with an increase in exhaust emissions. According to Federal Regulations, installation of this device could be considered tampering*".
- One was found to "*Reduce carbon monoxide and hydrocarbons on older emission control technology vehicles*".

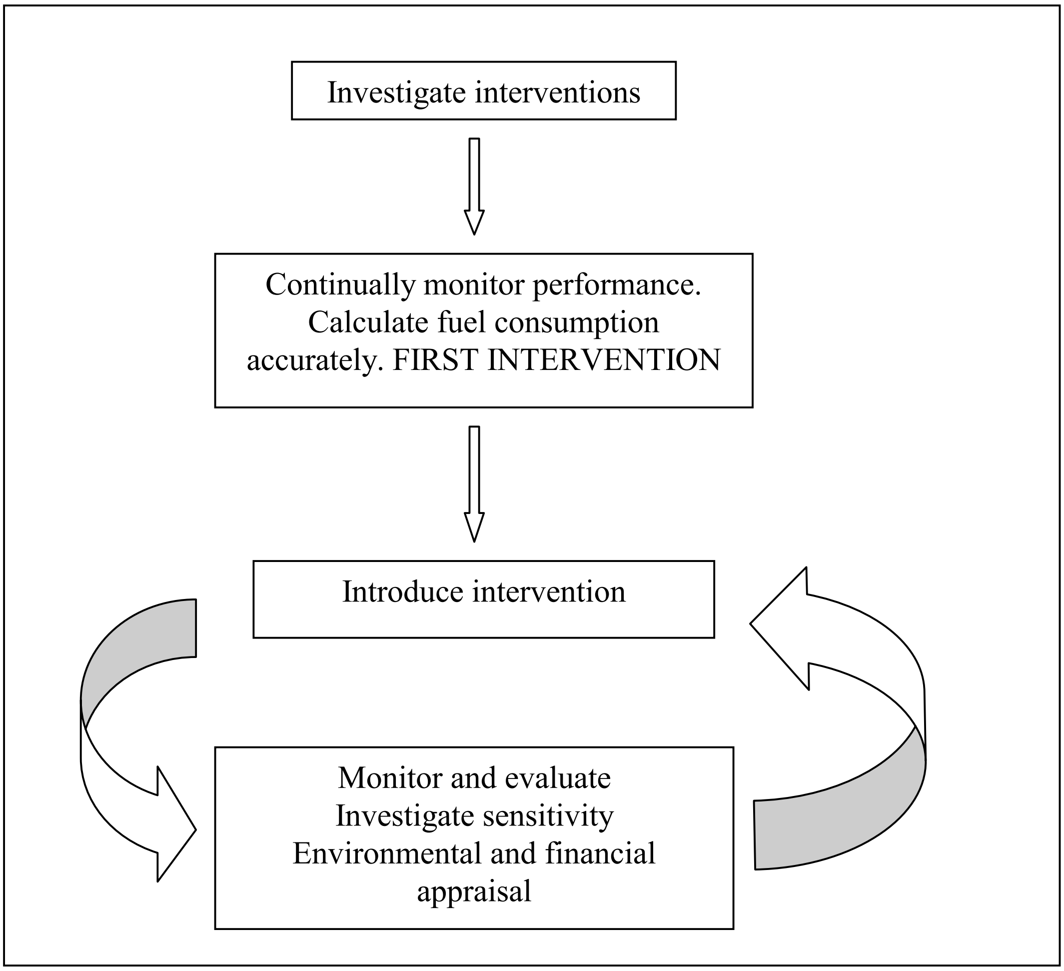
Most of the devices are aimed at cars with petrol engines though some can also be applied to cars with diesel engines and larger vehicles. The tests are carried out in a laboratory. The testing is voluntary unless the agency is directed to test a product by an EPA administrator or the Federal Trade Commission (FTC). **The EPA does not approve, certify, register or endorse products**. Furthermore, the evaluation programme is restricted to fuel additives and devices and does not apply to oil additives, lubricants, low energy tyres and aerodynamic aids.

By introducing basic interventions that cost very little in terms of time, effort or money, savings can be generated which permit the introduction of more expensive (in terms of payback) interventions. Additionally, gaining experience in data collection and management will aid the development of a more fuel-efficient culture.

8. CONCLUSIONS

This paper has introduced the environmental and financial benefits that can be obtained by the introduction of fuel-efficient interventions. In order to give a balanced approach it is pointed out that interventions are sensitive to operational considerations such as the present level of driver skills, the amount of time a vehicle operates at speeds that would benefit from the fitting of aerodynamic aids and whether or not the use of computerised routing and scheduling would be appropriate. For these reasons the savings have not been cumulatively summed together at the end of this document. However, none of the interventions are mutually exclusive and therefore operators may benefit in varying degrees by applying more than one of them. The strategy is illustrated in the flow chart in Figure 8.1

Figure 8.1 Flow chart of activity



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About the Author

Michael Coyle has more than 25 years experience in the transport industry. He has worked as a vehicle technician, Large Goods Vehicle (LGV) driver, lecturer in motor vehicle studies, depot manager, project manager and driver training executive. Academically he has a teaching qualification, a BSc (Hons) in Transport and Distribution, a MSc in Operational Research and is presently researching a PhD titled OPTIMISING THE FUEL EFFICIENCY OF LARGE GOODS VEHICLE (LGV) FLEETS. Membership of professional organisations includes Member of the Institute of Logistics and Transport (MILT), Associate Member of the Institute of Road Transport Engineers (AMIRTE) and is a co opted member through the institute to its Technical Committee and its Brewery Technical Advisory Committee (BTAC) Technical Trials Planning Group. Additionally, he is a member of the Operational Research Society, registered as an Incorporated Engineer (IEng) with the Engineering Council and is a member of the Institute of Mechanical Engineers (I Mech E) Automobile Division - Operators and Users Action Committee. He is also an adviser to the government's Energy Efficiency Best Practice Programme (EEBPP).

About the TLRU

The unit contains Members and Fellows of the Institute of Logistics and Transport who contribute to conferences and journals and are members of special interest groups. The unit has links to many companies through previous research and consultancy, its alumni and placement students. Additionally, the department has its own Transport & Logistics Society made up of over 600 former students and staff, complete with its own journal. Staff are closely involved with the road safety research organisation BRAKE and one is an honorary adviser to the organisation. Another member is an adviser to the government's Energy Efficiency Best Practice Scheme (EEBPP). They are currently undertaking research funded by industry trade bodies, individual companies (both manufacturing and transport & distribution operators), Department of the Environment Transport and the Regions (DETR) European Regional Development Fund (ERDF) and provide specialist support to other consultancies.