

IVAN SMERDU, D. Sc.  
Fakulteta za pomorstvo in promet  
Portorož, Pot pomorščakov 4

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## IMPACT OF ECOLOGY ON THE PRODUCTIVITY OF ROAD COMMERCIAL VEHICLES

### SUMMARY

*It is understandable that any measure affecting the productivity of road commercial vehicles is faced with opposition by the holders and operators of transport companies. This opposition is so much the greater as much as its preparation and presentation have been insufficient. The opinion that ecological measures have a negative impact on the productivity of road commercial vehicles is quite widespread: however, laying such a great stress on that opinion is rather exaggerated. In the course of introducing ecological measures, a fall in productivity occurs, as a rule, which applies to the time required for the transport companies to adapt to it. The duration of the adaptation stage depends on the type of measure and the viability of the companies. If the adaptation of enterprises is integral and efficient, the original productivity will be surpassed after the initial fall.*

### KEY WORDS

*ecology measures, commercial vehicles, productivity*

### 1. INTRODUCTION

The protection of the environment is not only an impulse of the current moment, but it has already turned out as a new style of life, and must remain so. The developed countries were the first to become aware of that: the major environmental polluters were located in these very countries. If the pollution trends from the previous decade had continued, the human race would have experienced a true ecological catastrophe. It was established that the traffic was the greatest polluter of the environment. The problem is the more pressing because traffic pollutes the ground surfaces, the atmospheric layer on the ground and those in the ionosphere. As it is known, the pollution of the ground atmospheric layer causes the greenhouse effect, whereas the pollution of the ionosphere affects the ionic layer which prevents the invasion of cosmic rays on the surface of the Earth.

The awareness of the greatest polluter has generated a number of internationally imposed legally-binding measures. However, these measures have not

reached the whole world yet, in particular not the developing countries.

We are lucky to live in Europe, which rigorously introduces and implements measures to reduce damaging emissions in environment. The measures adopted are multi-layered, also such as to affect the productivity of road commercial vehicles. However, any absolute decrease in the productivity is hard to accept for the holders of transport companies, regardless of any general social benefit implied.

### 2. IMPACT OF TECHNOLOGY

At first sight, ecological regulations and requirements do not affect the productivity of commercial vehicles: however, that is not true. In fact, some regulations do not exert any influence on it, but there are also such regulations which do affect the productivity to a great extent, through their influence on the organisation of the road transport process.

The first ecological regulations were imposed in the USA and were meant to restrict the emission of harmful components of exhaust gases. The European Union followed forthwith by adopting the Directives ECE, R 20, ECE, R 49, ECE, R 83 in ECE, R 51. Characteristic of these regulations was their progressive implementation in time which was required for the producers of engines and fuels to adapt to the new requirements, and to replace the means of transport by road. The technology of manufacture can be replaced in a shorter time than the commercial vehicles in use, since the useful life of the vehicles is ten years.

A surprisingly quick response came from the producers of engines, who are quite ahead of the current legal requirements: such a quick response is by all means accountable to the competition among the commercial vehicle producers. Road carriers have started to purchase ecological vehicles before it was required by legal regulations. Lagging behind in this area would result in a real business disaster for a carrier: it does not only affect its productivity: moreover, it impedes its operations in the long run. In carriers,



any lagging behind in conforming to ecological regulations can be very problematic, chiefly in the international transport and in particular in the European Union.

Of special interest is the reduction of emissions of damaging gases by cutting down the consumption of fuel: any reduction in consumption most efficiently reduces the emissions of all products of combustion in the environment. This has occurred due to a general technical progress in the development of engines and fuels, which was in fact enhanced by the restrictive ecological requirements.

Parallel with the requirements for reduced emissions of damaging substances, also the regulations on the quality of fuels - this applies to minimising the content of sulphur, plumbic tetraethyl, oxygenates, benzene, aromatic compounds, and olefins - are continually becoming more severe, too.

The quality of combustion, and hence the damaging emissions of exhaust gases, depend on the quality of maintenance of the fuel system, in particular of the jets and high pressure pumps. No engine, no matter how well designed and conceived, can compensate for deficient or inadequate maintenance.

Ecological requirements that relate directly to the composition of fuels and to the emission of exhaust gases, do not have an immediate effect on the productivity. But a negative impact on the productivity is exerted in the course of restrictions for a definite time, in which the whole territories, or entire cities are closed to the traffic of commercial vehicles, in order to reduce the quantity of exhaust gases. In spite of the fact that such closures and bans are very temporary, they do disturb the system of planning and thus the rhythm of the exploitation process of commercial vehicles. The beginning of a program reducing the exhaust gases emissions goes back to the year 1983.

The regulations apply to the content of:

- nitrogen oxides       $\text{NO}_x$
- carbohydrates      HC
- carbon monoxide    CO
- solid particles, in gram per kilowatt hour.

More and more emphasis is laid on the emissions of gases which are not covered by the regulations, but have an unfavourable impact on the environment, such as:

- carbon dioxide       $\text{CO}_2$
- nitrogen oxide       $\text{NO}_2$
- formaldehyde      HCHO
- benzene               $\text{C}_6\text{H}_6$
- methane               $\text{CH}_4$

The emissions of damaging gases and solid particles have not been reduced only by an improved combustion and better fuels, but also by fitting filter sys-

tems in the silencers, and by installing various catalytic converters.

The quality of combustion has been improved by means of:

- an increase of the injection pressure
- the design of the combustion space
- the design of jets
- electronic control
- fitting filters into silencers
- by installing catalytic converters.

The pressure increase and its control were achieved mainly on the basis of technological development in electronics, by using better materials, more accurate processing, better fuels and different systemic solutions.

The diagram below presents the progressive reduction of emissions, according to years, for vehicles with total mass exceeding 3.5 t.

In the conditions prevailing in the exhaust system and through the exhausts, nitrogen oxides and carbohydrates ( $\text{NO}_x$  and HC) form very dangerous acids and even traces of cyanogen in the environment; as well as carbon monoxide, which is very toxic by its nature. Solid particles are deposited in the lungs of people, from which the secretion of particles is very aggravated, and their effect is cancerous.

The restriction of the emission of noise has appeared later on, following the restrictions in the dan-

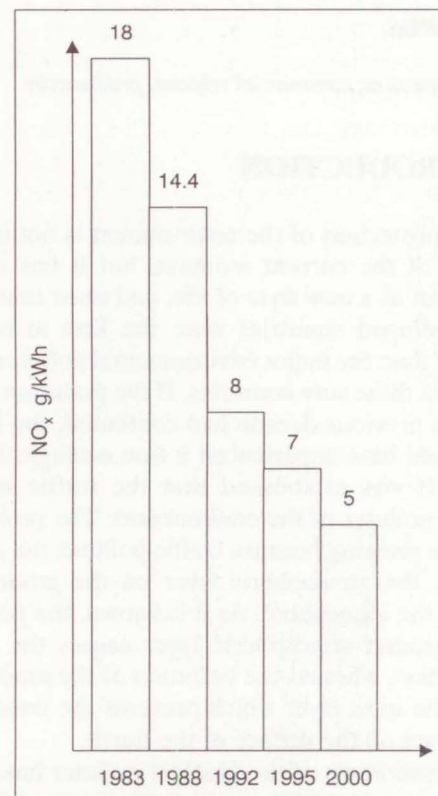


Figure 1



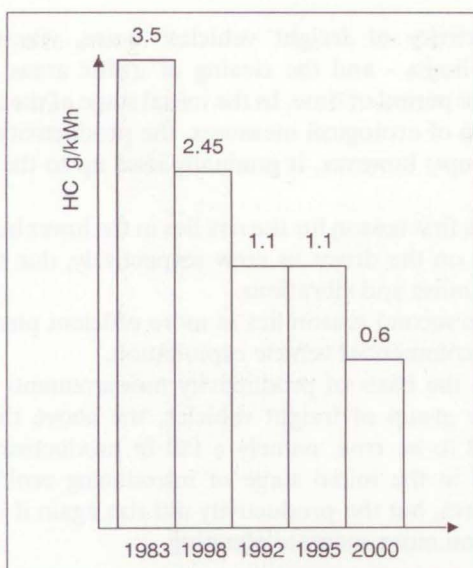


Figure 2

gerous gases emissions. As a rule, noise has an unfavourable effect on the productivity in two directions:

- First it affects the physical and emotional condition of the driver; moreover, noise is always combined with vibrations, and both features grow more intense with the speed of the vehicle. Noise and vibrations fatigue the driver and have a negative impact on his mood; in addition to that, they often cause occupational diseases of the auditory tract, the extremities and the spine. Accordingly, it has been proved that the productivity in a fatigued and indisposed driver is decreased, and this also affects the safety of driving.
- The other negative impact is the traffic ban on trucks in urban settlements during the night hours, or even on the motorways. Austria can be taken as an example here: non-conforming freight vehicles, such as those exceeding 80 dB of noise, are banned from traffic at night. Traffic bans on certain areas and at certain periods of time decrease the rate of driving and affect, or rather generate new problems in the planning of freight vehicle exploitation.

In 1974, the level of noise for freight vehicles was set at 91 dB, in 1988 it was 88 dB, and according to the EU regulations of 1990 it fell to the level of 84 dB; Austrian regulations allow 80 dB for night traffic and set the speed limit of 60 km per hour during night hours. The fact is that the Austrian regulation on the noise level is gradually being taken as standard: carriers who schedule to cross Austria during night hours must employ a vehicle with noise level below 80dB at 60km/h, which is the maximum speed. The motorways technically allow for the speed of 80km/h, whereas ecological requirements cut the speed limit down to 60km/h only. The speed is thus reduced by 25%, which inevitably affects - decreases the productivity in this route.

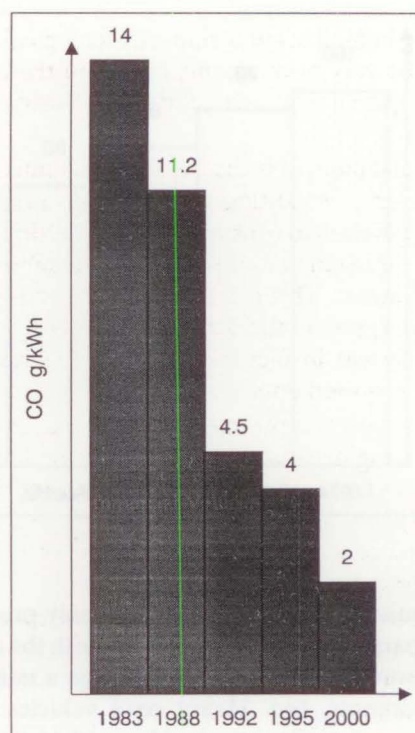


Figure 3

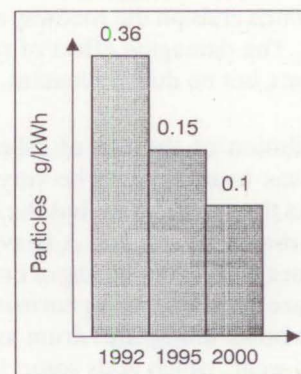


Figure 4

The noise level permitted depends on the engine power:

- engine power up to 75 kW permits noise level of 77dB,
- up to 150kW permits 78dB,
- over 150KW permits 80dB.

The emissions of noise are generated by several systems of a commercial vehicle: the engine, gear change, differential, exhaust system, and tyres. The tyres were a particularly tough nut for the manufacturers: the profile of running surfaces causes namely strong sound effects, without the profile the vehicle would be very inefficient in a wet or, in particular, snowy and mud-stained roadway. As consequence to this requirement, completely newly designed profiles have been developed on running surfaces, which comply with the maximum noise emission requirements, and guarantee good grip in unfavourable weather conditions.



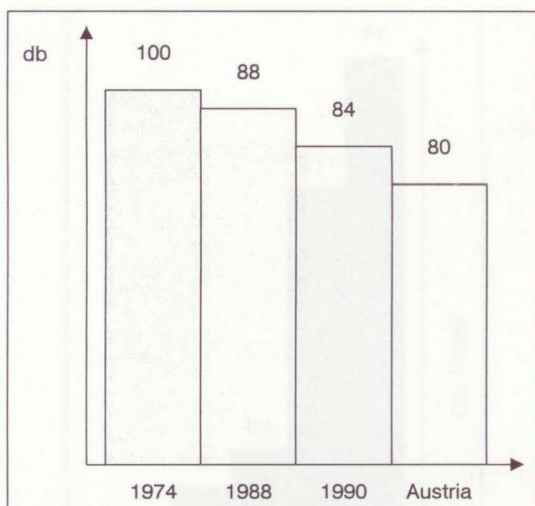


Figure 5

The emission of hard particles is only prescribed for those particles that are discharged with the exhaust gases. However, road vehicles discharge a number of other substances, too. Heavy road vehicles with a semi-trailer or a trailer attached have 12-16 tyres. The annual wear and tear of the tyres means some 60kg of rubber dust which ends on the roadway and its nearest surroundings. The damaging effect of rubber has not been proved yet, but no dust is pleasant, least of all, as pollution.

The prohibition of the use of asbestos fibres in brake lining has turned out to be very beneficial: it does not affect the productivity, but the health of people living in urban environment. A heavy freight vehicle (of 40 tonnes) uses up some 3kg of brake lining materials which are deposited in the environment as dust. In addition to brake lining, also drum and disc brakes are subject to wear, which adds some 1.5kg of metal particles to the emissions.

Very inconvenient for the environment is also the emission of lubricating oil and other lubricants. Lubricating oil is usually discharged from inadequately maintained vehicles, i.e. leaking from insufficiently sealed spots. Liquid lubricating grease is much used in central lubricating systems which are programmed to lubricate certain lubricating points. The grease is pressed into the lubricating point, which then pushes the used grease out, directly on the road; similar procedure occurs also in manually lubricated spots.

Observations and statistics show that a heavy freight vehicle with a semi-trailer uses up to 30kg of liquid lubricating grease, which inevitably ends up on the road. This can be reduced to a certain extent by applying closed lubricating points and using materials which do not require lubrication (Teflon materials).

As it was established above, the following phenomena or action exert an unfavourable influence on the

productivity of freight vehicles: noise, vibrations, speed limits - and the closing of traffic areas for a definite period of time. In the initial stage of the introduction of ecological measures, the productivity usually drops; however, it gradually rises up to the final stage.

The first reason for the rise lies in the lower burden placed on the driver or crew respectively, due to reduced noise and vibrations.

The second reason lies in more efficient planning of the commercial vehicle exploitation.

On the basis of productivity measurements on a sample group of freight vehicles, the above finding proved to be true, namely a fall in productivity occurred in the initial stage of introducing ecological measures, but the productivity did rise again if it was based on more accurate planning.

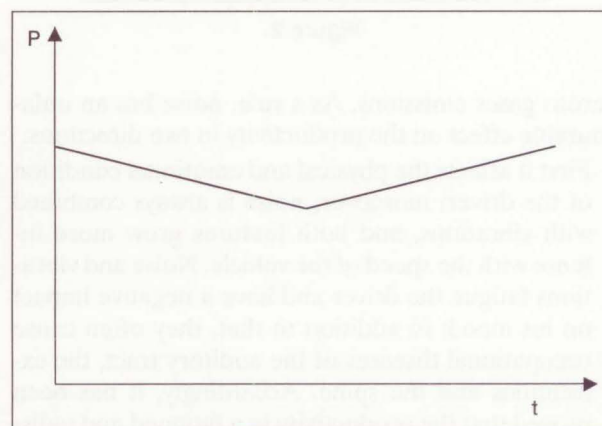


Figure 6

$$P = f(v, d, e, t)$$

P – productivity

v – number of vehicles

d – number of staff members

e – influence of ecology

t – time observed

### 3. CONCLUSION

Supported by the facts obtained from my observation over several years, and by analyses on productivity and ecological regulations, I have found that any restrictive regulation brings about a fall in productivity: nevertheless, after a certain time the productivity rises again. As a rule, the fall in productivity is compensated by better planning, an integral information system, an improved transportation technique, and total quality management of operation. On the whole, the ecological policy has not reduced the productivity, but it has contributed greatly to a better and more decent working environment.

## POVZETEK

Iz ugotovljenih dejstev na osnovi večletnega opazovanja in analizah tako produktivnosti, kot ekoloških predpisov sem ugotovil, da ob vsakem novem omejitvenem predpisu produktivnost najprej pade, vendar se po določenem času zopet dvigne. Padec produktivnosti se praviloma kompenzira z boljšim planiranjem, celovitejšim informacijskim sistemom, boljšo transportno tehniko in celovitim obvladovanjem kakovosti poslovanja. V celoti gledano ekološka politika ni zmanjšala produktivnosti, je pa mnogo pripomogla k boljšemu in človeka vrednemu delovnemu okolju.

## REFERENCES

- [1] **Lowe, D.:** *The Transport Manager's & Operator's Handbook*, London, 1993
- [2] **Županović, I., Ribarič, B.:** *Organizacija i praćenje učinkavosti cestovnih prijevoznih sredstava (Organisation and Monitoring the Performance in Road Transport Vehicles)*. Sveučilište u Zagrebu, Fakultet prometnih znanosti, Zagreb 1993 (University of Zagreb, Faculty of Transport and Traffic Engineering)
- [3] **Županović, I.:** *Tehnologija cestovnog prijevoza (Road Transport Technology)*. Sveučilište u Zagrebu, Fakultet prometnih znanosti, Zagreb, 1994.
- [4] **Zelenika, R., Jakomin, L.,** *Suvremeni transportni sustavi (Advanced Transport Systems)*. Sveučilište u Rijeci, Ekonomski Fakultet, Rijeka, 1995. (University of Rijeka, Faculty of Economics).
- [5] **TNO Policy Research,** *Emissions in the Transportation Sector*. Delft, 1991.
- [6] **Zbornik referatov, 2. Slovenski kongres o cestah in prometu (Collection of Papers at 2<sup>nd</sup> Slovenian Congress on Roads and Traffic ).** Portorož, 26 - 28 October 1994
- [7] **Smerdu, I.:** *Doktorska disertacija, Utjecajni parametri produktivnosti grupe teretnih vozila u cestovnom prijevoznom procesu (Doctoral Thesis: Parameters Influencing the Productivity of a Group of Freight Vehicles in Road Transport Process)*. Sveučilište u Zagrebu, Fakultet prometnih znanosti, Zagreb 1998