

## TRANSPORTATION-ENVIRONMENT-ENGINEER'S RESPONSIBILITY

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'Navigare necesse est, vivere non est necesse'  
(Pompeius)

### Introduction

'Navigare necesse est, vivere non est necesse' — this quotation from Pompeius was chosen deliberately as the motto of my present lecture.

I can fully agree with the first part of the above quotation but the slight alteration that the verb 'drive' should be substituted for the Latin verb: 'navigare'.

However, the second part of this quotation, I think, cannot be accepted by contemporary people. The reason of it I am going to explain in this lecture.

### Introductory Thoughts about Circumstances

We are living in a transitory age — although present is always a transition between future and past. The political, economical, industrial structure of the world is changing at an extraordinarily quick pace through contradictions; the view, behaviour and thinking of people is changing at the same time.

I should now like to say some words about the responsibility of engineers.

The image formed in the society about engineers *is determined* by two extremes. According to one extreme, the engineer is a 'magician', the

embodiment of the 'good', who can create all the circumstances which will render the life of people more comfortable.

According to the other extreme, on the contrary, the engineer is the embodiment of the 'evil', who has come into the possession of the knowledge which can result in the liquidation of the mankind.

From the above said it follows that engineers have a huge moral responsibility which they should always be aware of; since our future will be decided on, first of all, by the solutions given not to the technical but the ethical problems.

The question arises whether the engineers can bear the burden of this responsibility?

When summarizing all the above, we can state: the technology itself is neither a moral nor immoral force acting within the society but the *human selection* between the values and goals rende it moral or immoral.

The activity of engineers should be imbued equally with a correct political, economic, legal, ethical and even a proper ecological attitude.

The technocrats are blamed generally for the exaggerated power consumption, for the pollution of water, air and soil, for the urbanization. The social scientists substitute for technocrats simply engineers. I don't want to discuss either the responsibility of technicians and of technology technic itself for the present — sometimes really disastrous — situation.

As to the future, nevertheless we can be confident that, regardless of the reasons, the solution will be found by the technicians. Humanity is not willing to renounce the blessings of Technology that is technical comfort, of course, he is neither able to renounce a large part of them. We engineers should reduce or eliminate the damaging side-effects.

The human, social and ecological problems boil down to a single sentence: 'The Earth is limited'. The sources of power and raw material, the utilizable areas, the loadability of the environment all are limited. Besides the natural environment, an artificial or built environment begins to develop, determined by human production. Limitation is obvious beside ecological problems, in economy as well. World Economy has become by the turn of the (second) millennium uniform all over, local events affect very quickly the operation of the whole.

This becoming limited is a quality change similar to the changing of the boundary conditions of differential equations from finite to infinite.

It is known that the main difficulty of the solution of partial differential equations is the adjustment to the initial values and to the boundary conditions. The solution of the problems of the world which has become limited is substantially more difficult than it was earlier when the world was considered to be infinite. But not only the solution has become more diffi-

cult, but the existence of the uniform, easily accessible solutions (recipes) are excluded by the boundary conditions changing in time.

Different solutions of the same differential equation belong to every different boundary condition.

Our position is yet more aggravated by the fact that while we were supposing the Earth to be finite and 'slow' changes in time, the phenomena could be considered locally linear. The 'limited' world — last but not least — in consequence of the ever increasing human effects — can scarcely be considered (as) linear. Now, if it is not linear, then even a small change in the boundary and initial conditions transforms the solution fundamentally (chaotic phenomena).

### Transportation and its Effects

The development of human civilization is inseparably connected with transportation, with mobility in a wider sense. Even the natural economy of the Primitive times and of the Antiquity could not work without transportation of people and products.

The present tasks of transportation can be grouped in the following way:

- 'Traditional' transportation of goods.
- Professional passenger traffic.
- Tourist travel.
- Shopping travel.

Seeing the large-scale amplification (extension) of traffic we can't be surprised by the appr. double increase rate of transportation performance (goods —  $t$ -km, passenger — km) compared to the increase rate of the national income.

According to the most recent (1991) OECD-report road transportation of goods almost has doubled during the past ten years in the OECD-countries, passenger traffic increased by more than 70%, the increase of railway transportation nevertheless reached only 25%, the passenger traffic 40%, resp.

The increase of the number of vehicles is very significant. The number of cars (automobiles) was doubled, the commercial vehicle park increased still more, appr. by 130%. In 1900 more than 500 million vehicles were operated and more than 80% of all the vehicles in the OECD countries.

Modern up-to-date economic life is inconceivable without transportation. World Economy would break down without transportation (and vehicles). In the developed countries every sixth person works in transportation

and automobile industry directly or indirectly. The ceasing of one job in the automobile industry would make superfluous further 3 jobs and inversely, extension of the vehicle industry would create three times more openings.

Beside the indispensable role played by transportation in social and economic life, it has of course negative effects, as well.

In the OECD countries, 30% of the produced power was consumed by the transportation in 1990. 82% was used by road transportation, 13% by aerial transportation and only 5% by railway transportation and shipping. Nearly 50% of the raw oil production of the world is consumed by the transportation.

Appr. 50 million new vehicles are manufactured in a year by the automobile factories worldwide. This needs power and raw material, as well.

The negative picture of power utilization outlined above is even grimmer because of the fact that the efficiency of the energy consumption of transportation is not more than 18%. It should be noted that the efficiency of electric power plants and networks is at most 30 – 33%, as well. (The assessment (calculation) of efficiency is rather fuzzy, it is not sure, for example if the power (energy) used to fight the air resistance should be considered as a loss.)

A very interesting comparison can be made between the specific power requirement of several main transportation branches (relative to goods load km or passenger km). The power requirement of transportation by ship, by train, by road (cars in the place) and by air resp. is increasing, at first approximation, in order of succession of the branches just by a magnitude each, that is, 1:10:100:1000. Of course, it can be accepted only as an approximative information, since these proportions don't take into consideration for example the considerable power requirement necessary for the double reloading on the average at railway transportation, which falls wholly out in the case of the door-to-door road transportation.

According to the above mentioned OECD-report one of the most important threat to the environment is the transportation. In the developed industrial countries

- 90% of CO-emission,
- 50% of NO<sub>x</sub>, CH<sub>x</sub> and Pb-emission,
- 80% of aromatic compounds emission

comes from the transportation.

25% of CO<sub>2</sub> which is not poisoning, but deteriorating climatic conditions (in developed countries nearly 40%), comes from transportation, too.

Transportation is the most important noise source. Urban noise, the noise of highways, trains, airports is becoming by and by intolerable. 110 million people are living with a 65 dB(A) noise level in the OECD countries. Automobile industry and maintenance contaminate the soil and the water by solvents, used oil and battery acid. The space requirement of transportation is taking more and more space away from agriculture and forest economy for roads, complementary areas, waste disposal (dumping). During the past 20 years, the road systems in the OECD countries — including highways — have been extended by 10%, motorways alone by more than 80%. The length of the complete network reached 13 million kms, including 130 000 km motorway. The area occupied by roads exceeds the territory of Hungary. (92 000 km<sup>2</sup>).

Finally, we have to mention the alarming increase of road accidents. The death-toll of a summer holiday-trip is by and by equal to the death-toll of a minor war. Those are especially endangered who are travelling by motorbikes and passenger cars. Those travelling by motorbike are suffering 178 mortal accidents per billion passenger km, those travelling by passenger car 20, those travelling by ship, plane or train only 1 – 5 mortal accidents per billion passenger km.

These (or similar) data were known already at the beginning of the century, partly even in the past century, nevertheless environment protection and energetic problems have practically emerged only during the last 30 years in the nonprofessional common knowledge, and even — as we should confess — in the knowledge of responsible politicians and experts as well.

What is the explanation of the belated reaction?

Nature is able to neutralize spontaneously environment damages up to a certain limit, but after the damage has reached a critical value, the self-curing, selfcleaning process doesn't evolve spontaneously any more. It seems that transport-motivated environmental damage reached this critical value by the sixties and seventies.

That is we are now facing with not new, but rather old problem. But humanity somehow acknowledged these nuisances earlier, because their growth was slow and the inhabitants became slowly accustomed to the nuisances. Development was slow too, it has lasted through generations, and the current state was generally accepted as natural.

The smog catastrophe in London in December of 1952 created nevertheless a new situation. For five days SO<sub>2</sub> — and the soot content in the air has increased to the fourfold of the otherwise usual quantity, in consequence of which death rate increased from 250 people per a day to 900 a day. This peak lasted only for two days, but it also didn't fall afterwards under 400 for the next six days. The coincidence of pollution and death

rate data showed, in an astonishing way, the vulnerability of human living space. We are also not excused by the fact that this catastrophe was generated, in the first place by the coal heating used in households and in the industry. The participation of transport was then still minimal.

In spite of any historical preliminaries, the present pollution of the environment produced a new situation characterized by the following three main factors:

- Environmental pollution became global, extending practically over the whole world. The increase in quantity of this pollution is exponential and the pollution reached, locally, the critical value at numerous places.
- Human and political sensibility increased considerably partly in consequence of the cultural development and partly in consequence of the publication of several famous environmental catastrophes (Tschernobil, Soweto, Bhopal).
- The measurement technics registering the pollution were developed and, first of all, became more refined. A controlling, monitoring system was built up at a lot of places.

As previously mentioned, more than 1/2 billion vehicles are consuming (and wasting) the energy from unrenovable sources, polluting the environment. This 1/2 billion vehicles cause, in accidents, human loss that is equal to that caused by a lesser war. 20 million wrecks contaminate and disfigure our environment in a year. Shall I go on?

What would happen to the world if the present averagely 80 car/1000 people density increases to the 250 - 550 car/1000 people density of the OECD countries?

This process is irreversible. At the same time World Economy would break down without transport (and vehicles).

Indeed, today we must agree with Pompeius: 'Navigare necesse est ...' freely translated: 'We must have transport'. We have to think nevertheless about the second part of the quotation too: '... vivere non est necesse!' 'We need not live' said Pompeius. As if the men of our days confirmed Pompeius by wasting raw material and power, by the increasing number of traffic accidents, by the unbearable environment pollution due to transport. We must drive but we need not live (road transportation is necessary, living is not necessary).

The man of our days cannot accept the second part of the slogan, but it can be rewritten correctly in the following way: '... vivere quoque necesse est!', that is, we must live as well. How? That is the question.

### Tasks and Possible Solutions

After the previous sketchy review three fundamental social and political (or perhaps industry-policy and transport-policy would be happier expressions) requirements seem to be natural:

- The influence and the probable critical values of the environment damaging factors generated by transport as well as the circumstances and deeper motivation of traffic accidents should be revealed. Internationally accepted immission standards followed by adequate emission standards, as well measures warranting active and passive security and partner protection should be elaborated, continuously evaluated and updated. These standards should be legally enforced.
- While we actually have only few scientific and internationally valid immission, emission and emergency security standards everything should be done in order to reduce pollution as well as material and energy consumption until the elaboration of these (standards). Reduction should be extended to those emitted materials and emission effects, too, which — according to our present notions — do not damage (poison) the environment.
- Recycling of used material and waste should be increased. Due to quick growth in economy, the accomplishment of emission regulation isn't able, by itself, to protect Nature from noxious effects. Reassuring results can be reached only when the regulations are accompanied by a possibly perfect recycling.

These three social requirements entail four tasks relating to vehicle development. The possibly best solution of these tasks are a 'sine qua non' for vehicle marketing.

In consequence of the comprehensiveness of the problem, it is not even worthwhile to deal with the details of the technical solution in this lecture. It is worthwhile, on the contrary, to familiarize ourselves with the conceptional possibilities of these solutions. Currently, four solution directions — based on political and on economic considerations — are conceivable.

#### *a) Prohibition, Prevention, Limitation*

Drastical limitation of transportation can be realized only locally (for example in city centres). A global prohibition would nevertheless paralyze the economy and limit politically unacceptably individual freedom. This global prohibitive program appeared only in the policy of some green parties, but it is not a fair solution for mankind.

### *b) Looking for Alternative Solutions*

Most of the alternative solutions is technically elaborated or is appropriate to be elaborated within a short time. Their introduction faces economical, and sometimes with psychological obstacles. Here are some examples of the alternative solutions:

- *introduction of alternative transportation,*
- *alternative vehicles,*
- *alternative fuel,*
- *alternative energy,*
- *alternative materials,*
- *manpowered transport.*

### *c) Escape Forward by Technical Development*

Actually, this direction has been represented by the most important automobile factories with more or less success. More is the pity that the operators (last but not least due to their being divided) are not very much inclined to follow this direction. Here are some examples of the recent achievements:

- use of catalysators and unleaded fuel,
- more reasonable utilization and reduction of waste in production,
- introduction of paints with watery solvents,
- to improve the efficiency of paint dispersion from 30 to 70%,
- regeneration (recycling) of used oil,
- recycling of broken down batteries,
- to develop new agents for oil,
- active and passive noise reduction (modern electronics already provides counter-noise sources, too),
- commonly known results of active and passive safety and partner protection,
- radical reduction of the air-resistance factor (drag coefficient) from 0.4 to 0.29,
- weight reduction.

### *d) Infrastructural Developments*

As a matter of fact this is the concern of transportation policy first of all. It is obvious from the preliminaries, that environment pollution can be re-



duced most effectively by reducing energy consumption, and by improving the efficiency of the utilization of energy. As it is known, the methods of these depend partly on the producers, partly on the operators. Accordingly the infrastructural development should cover

- the optimization and continuous maintenance of the traffic network,
- the optimization of traffic process (flow) for example green wave,
- the on-line process control with aim/purpose/target function selected the ground of environment consideration,
- organization of return cargo (trains, truck transport),
- improved maintenance of the vehicles.

The fulfilment of the 'compulsory' tasks in vehicle production and operation (or even in the entire transport policy) cannot in itself resolve the social and ecological problems. The car became a symbol of personal freedom in the developed countries. Nobody can be limited drastically in his freedom by decrees, and nobody can be forced, by decrees, to travel by public transport instead of cars (by bus or train for example).

The designers of the public transport vehicles have to undertake, in addition to the 'compulsory' tasks, some freely selected tasks as well, in order to make public transportation attractive. The most important tasks in my opinion are as follows:

- to increase comfort,
- to increase reliability,
- flexibility,
- to improve customer services.

### Responsibility of the Engineers

Environmental problems can be only resolved through conflicts or compromises. We quote here several virtually insoluble contradictions:

- The catalysator reduces all the damaging emissions, but increases fuel consumption, the CO<sub>2</sub> emission, and the costs of the vehicle.
- The improvement of combustion efficiency reduces CO emission and fuel consumption, but increases the emission of NO<sub>x</sub>.
- Tyre noise can be reduced to appr. 75 dB, but because of the deterioration of adhesion, the risk of an accident increases.
- Electric automobile (electroautomobile) reduces damaging emission, but it is essentially more expensive and requires a new infrastructure for fuel provision and increases substantially the quantity of used batteries that should be recycled.

We could enumerate further examples too.

The selection between contradictory requirements waits for us, engineers, in spite of the fact, that this decision can be rarely based on technological or economical reasoning. These are often moral decisions. So we reached the point, where the problem of responsibility emerges again. The engineer's responsibility is deep, exceeding the updating of vehicles, or the perfection of combustion processes, the improvement of driving line efficiency. The engineer's responsibility covers every aspect of transportation: the infrastructure of transportation and the organization of the traffic process, as well as recycling.

Beside the technical responsibility there exist, of course, political, economical, legal and ethical, responsibility. In my opinion, the engineer has some parts in these, too. Because alas, — be the division of labour in the society during history as it is — political responsibility cannot be considered only a task for the government, responsibility for the economy cannot be considered as a task for the bankers, responsibility for the law cannot be considered as a task for lawyers, responsibility for ethics cannot be considered as a task for priests. A politically, ethically, and legally correct, ethical even ecologically right view should be valid also in the engineering activity.

We were talking until now about responsibility. But the question is: does responsibility mean at the same time competency, too? I think the answer is YES. We are told, again and again, the opinion mentioned already in the Introduction: for the polluted environment, for the ecological damages, the technocrats (i. e. the engineers) are to be blamed. Expertise has ruined (is ruining) the mankind and all the living world. Consequently expertise cannot be coupled with the right of decision-making experts who are not competent in the problems of environment protection.

Expertise in itself — without a sense for moral responsibility — is really not sufficient for competency, but I cannot either accept the reverting of the above mentioned lay environmentalist's declaration, according to which:

'Professional incompetency gives the right to resolve the problems of the environment.'

To join the lack of expertise and competency can have as result only the further deterioration of the present situation, that is complete chaos.

The slogan of the FISITA is: 'Progressions en commun', i. e. 'With joint efforts for progress'. It means that engineers engaged in the car industry of different countries should make joint efforts in technical development for the sake of a more reliable and environmentally beneficial motor-vehicle production. In my opinion, this kind of cooperation is indispensable not only between the automobile designers and manufacturers of the differ-

ent countries but the engineers engaged in the car production within the individual countries, too, should cooperate with the engineers of service-stations, users and the specialists in transportation of their own country, and in some cases, even with the legislative authorities formulating the traffic rules and prescriptions. This two-side cooperation — i. e. between nations and within one's native country — is considered to be indispensable for achieving a high-level efficiency in this field.

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