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FUTURE EUROPEAN HEAVY GOODS VEHICLES

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ABSTRACT

The White Paper on a common transport policy was published by the European Transports Commissioner in September 2001.

For goods transportation, unless major new measures are taken by 2010 in the European Union, heavy goods vehicle traffic on the road will increase by nearly 50% in comparison with its 1998 level. The approach on which the White Paper consists of a number of measures to reduce the growth rate of road haulage to 38%, due to a better use of other means of transport. This level corresponds to a return to the 1998 market shares levels of the different transport modes.

Even in these conditions, important and urgent efforts must be taken by the road transport industry (including truck and tyre manufacturers, road authorities, etc) to progress towards sustainability and obtain by 2010 acceptable or improved levels of road congestion, polluting emissions, noise, road safety and transport efficiency.

This is a difficult challenge. However it has to be achieved and, taking into account the present and envisaged infrastructure geometry of 2010, several new vehicle configurations can be defined in a win-win approach. They are intended to reduce the number of vehicles and the congestion they contribute to, the fuel consumption and the corresponding polluting emissions, the pavement damage and maintenance costs and to improve the vehicle stability and safety as well as to improve road transport efficiency. These vehicle configurations do not meet present European Regulations but are viewed to be possible responses to the challenge mentioned above. They are described and discussed , with a precise as possible evaluation of their main characteristics, advantages and drawbacks.

The acceptability of these new future trucks by the existing infrastructure will be checked with respect to wear of pavements and bridges, as well as to traffic safety conditions and fair competition pricing.

GENERAL CONTEXT AND INTRODUCTION.

The White Paper on a common transport policy was published by the European Commission on September 12th, 2001. For goods transportation, unless major new measures are taken by 2010 in the European Union, heavy goods vehicle traffic on the road will increase by nearly 50% over its 1998 level. The approach the White Paper is based consists of a number of measures to reduce the growth rate of road haulage to 38%, due to a better use of other means of transport. This level corresponds to a return to 1998 levels of market share for road transportation.

Even in these conditions, important and urgent efforts are to be made by the road transport industry (including truck and tyre manufacturers, road authorities, etc) to progress towards sustainability and obtain by 2010 acceptable or improved levels of road congestion, polluting emissions, noise, road safety and transport efficiency.

In this respect, a reflection group was initiated between Michelin, Renault V.I. and the Laboratoire Central des Ponts et Chaussées (LCPC).

It has been started on a purely French basis, for convenience reasons and a good existing relationship, but has the potential to be extended to a European Group.

The following parts will cover :

- Possible ways identified for improvement and their potential effects.
- Action plans.
- Conclusions.

POSSIBLE WAYS OF IMPROVEMENT AND THEIR POTENTIAL EFFECTS.

From the beginning of the reflection, two ways appeared as possibilities to improve the situation as regards road congestion, polluting emissions, noise, road safety and transport efficiency. The first four requirements are the

societal ones, expressed by the European Commission. The fifth and last one represents the possibility to achieve a win-win evolution for the Society and the transport industry and therefore guarantee its success.
These two ways of improvement are "heavy vehicle weights and dimensions" and "interactivity between the vehicles, tyres and infrastructures".

Heavy vehicle weights and dimensions.

The target, in this respect, is to find the best possible solution of heavy vehicles' weights and dimensions allowing the preceding criteria to be optimised: minimise road congestion, polluting emissions and noise as well as maximise road safety and transport efficiency.
The most likely direction is to increase the volume and weight available for the cargo. Indeed, it is the only way to reduce the vehicles number and to develop the use of the most efficient engines.
Due to infrastructure reasons it is not possible to increase either the vehicle height (bridges' height) or width (roads' width). Thus, the only possible direction is to increase the vehicle length, together with weight and axle number.

Present European Regulations (Dir 96/53) allow, for the heavier vehicles with five axles or more, the following features :

- Articulated vehicles : Maximum length : 16.5 metres. Maximum weight : 40 tonnes.
- Road Trains : Maximum length 18.75 metres. Maximum weight : 40 tonnes.

The resulting most common European heavy vehicles are :

- Articulated vehicles : 4x2 tractor and tridem axle semi trailer.
- Road trains : Three axles 6x2 truck and two single axle trailer.

Some former studies have been carried out, which give clues for the possible future optimised solutions.
In particular, in COST 334, a 6 axle configuration with a maximum weight of 48 tonnes was envisioned and compared to the present 5 axle 40 tonnes configuration.
The axle positions and chassis layout would be set so that the maximal axle weight would be homogeneous and equal to 8 tonnes. The tyres would be the same on all axles and would consist of low rolling resistance extra-wide-base single tyres. This solution would optimise the fuel consumption and reduce the road aggressivity, especially on the motor vehicle.
The vehicle length was not explicitly analysed but it was assessed that the load rate (ratio of actual payload versus maximum payload) was maintained, which implies a proportionality between maximum payload and cargo length.
The comparison was made regarding pavement damage, environmental impact (polluting emissions, noise, recycling) and vehicle operating costs.
The main conclusions were as follows :

1. The use of such vehicles would reduce the number of heavy vehicles by about 20% for the same traffic (in tonnes.km) when compared to present vehicle configuration.
2. The pavement distress would also be reduced by about 20% for the same amount of traffic. The pavement maintenance cost would consequently be reduced.
3. The fuel consumption would be decreased by about 14% for the same traffic. This benefit would both reduce the polluting emissions (including CO_2) and reduce transportation costs.
4. Safety would be improved by the use of extra-wide-base single tyres, due to better road handling. It could also benefit from the use of two driven axles on the motor vehicle. However such a feature would reduce payload capacity and increase fuel consumption and vehicle cost.
5. Haulage productivity would be improved due to the increased payload handled by each driver.
6. Tyre and wheel recycling would be improved because of the decrease of tyres and wheels material weight used for the same traffic.
7. Driver and payload comfort would be improved by the use of the extra-wide-base single tyres. This benefit could result in driving being less tiring (inducing improved safety) and possible savings in packaging of the payload.

The case of present Nordic 7 axle - 60 tonnes - 25.25 m vehicle was also envisioned by COST 334. It showed a very low road-aggressivity level per transported tonne of payload (about -30%). Even if the case study was not carried out as precisely as the previous, this vehicle configuration would lead to very important progress in vehicle number reduction (about –35%), haulage productivity and probably fuel consumption reduction.

These examples show that there should be room for a win-win optimisation between the societal improvements required (congestion, pollution, safety) and the haulage industry.

In order to ensure the acceptability of such possible future truck designs, together by the infrastructures, by the traffic and by the national and European authorities, the following matters should be assessed:

- The maximum load effects on all types of bridges should not be increased, because it would be extremely expensive to perform reinforcement of all the existing bridges; local and distributed loads should be maintained within reasonable limits, i.e. those taken into account to calibrate the Eurocode EN1991-1-3 on Traffic Loads on Road Bridge (Flint and Jacob, 1996). The issue of fatigue lifetime will have to be carefully investigated for steel and composite bridges, which are sensitive to repeated loading (Jacob, 1998).
- Longer and heavier trucks will have to be much safer than the current ones, in order to reduce the risk of accident, either induced by the truck itself or by other vehicles. In order not to disturb the traffic flow, some operation regulations may be necessary to be taken (minimum spacing, special routes or time for operation, etc.).
- It will be important to ensure a fair competition between transport modes, and between different types of road vehicles. The pay-load or gross weight of a truck should be one of the parameters of the tax or toll fees. This will require automatic weighing systems, such as WIM (Weigh-in-motion) equipment's, to be installed and operated (Jacob, 1999; WAVE, 2001; COST323, 2002).

Interactivity between vehicles, tyres and infrastructure.

The introduction of "smart" technologies inside vehicles, tyres and infrastructure presents a significant new potential for innovation in the field of road transportation.
Indeed, new types of information can be measured, acquired and transmitted simultaneously to all the actors.

For instance, we can anticipate the generation of many types of information by :

- The vehicle : Identification (type, engine, maximum load per tyre position...), geographic position, speed, acceleration, driver behaviour, travel optimisation type (time, economy...), status (OK, failure, breakdown, accident..), available payload capacity, forecasted route, actual load per tyre position, distance from the preceding vehicle...
- The tyres : Identification (type, age, load index, speed index...), inflation pressure, temperature, revolution count, wear, efforts in the contact area, strains, pavement grip....
- The infrastructure : Identification (motorway, trunk road, bridge,..., speed limit, weight limit...), status (dry, wet, icy, snowy..., unevenness, potholes, grooves...), temperature and other meteorological conditions (fog...), wheel, axle and/or vehicle weight, warnings (works, accidents...), distance from the preceding vehicle, presence of pedestrians on pedestrian crossings...

Some of these possible information sources can be combined in a relevant way in order to reach a specified goal. For example, fit trucks with tyres able to measure the local grip on the surface they are being driven on, detect slippery conditions (ice...) and transmit the information to the truck. The truck will then be able to include the relevant parameters in its electronic stability program (ESP) and correct its speed and applied torques. It will also be able to locate the concerned area with its GPS sensor and, with its GSM or other communication means, transmit the information to the infrastructure management systems. These systems will then be able to activate road surface salting, in the case of icy conditions and inform the other vehicles entering the concerned zone. The other vehicles will then integrate the information in their GPS/ESP systems to avoid any damage, follow its evolution with their tyres, give back information to the infrastructure and so on.
An alternative could be to equip identified problematic sections of the road network with appropriate sensors instead of equipping the vehicles' tyres.
This choice should be made by balancing the costs and benefits of the two possibilities.

Many other vehicle-tyres-infrastructure interactions can be imagined, such as virtual high speed truck trains (safety, congestion, pollution), inside-tunnel safety systems, on-road dynamic force limitation (road surface damage limitation)....

These examples show there is room in this field for dramatic improvements. However "smart" technology is rapidly evolving and becoming obsolete nowadays. Also this kind of evolution can be very expensive for the different actors. It is thus necessary to stand back and reflect carefully with the help of the different actors before defining a relevant and realistic target.

ACTION PLANS.

This action was decided and launched in 2001. The meetings held in 2001 were used to deepen and organise the ideas and concepts and to define an action plan starting in 2002. It is now described for the two discussed ways of actions.

Heavy vehicle weights and dimensions.

The provisional action plan is shown in figure 1. The project duration should be 3 years, including the building of a demonstration vehicle and the validation of its technical and economical performance.

The first part, with an 18 months duration, will be a feasibility study.
In a first step (about 9 months), the existing situations will be thoroughly examined regarding the different aspects

- Vehicles : Existing configurations linked with local regulations, in the EU, North America, Australia.
- New concepts recently proposed by the truck manufacturers, with their described benefits.
- Impacts of the possible vehicle configurations on the users (payload, costs, drivers' numbers and skills, specific driving licences, possible re-use of existing vehicles, logistic platforms, modularity, vehicles resale...) .
- Impacts on the "external" aspects :
    - Traffic (insertion in traffic, manoeuvres, itineraries, overtaking by passenger cars, visibility including during raining and winter conditions...),
    - Infrastructure development (roads, bridges, crash barriers, escape lanes, roundabouts, service areas, tunnels ...),
    - Safety (accident seriousness, collisions, emergency manoeuvres, road handling, rollover, braking distances, sweeping radius, vehicle stability and braking in curves...),
    - Environment (emissions, noise, tyres and pavement wear particles, recycling ...)
- Impacts on the regulations, including vehicle lights....
- Impacts on the truck manufacturers (engine power, brakes, stability, ground clearance (logistic platforms, ferry-boats, intermodal shifts...)

In a second step, the most promising new possibilities for the EU will be listed and investigated. Their feasibility and technical and economical performances will be investigated.

The second part will also have a 18 months duration.
It will consist in designing, building and testing a full scale vehicle demonstrator.
All the technical and economical performances of the retained vehicle configuration will be checked and, based on the results, proposals will be made.

Interactivity between vehicles, tyres and infrastructures.

The provisional action plan is shown in figure 2.

It covers a 18 months period including the feasibility study and a preliminary 6-month period dedicated to the target definition.

The target definition will be achieved through the following process :

- Extensive examination of all the possible ways of interaction between tyres and vehicles, between vehicles and infrastructures, and finally between tyres and infrastructures will be carried out.
- From all these ideas, possible scenarios will be built. They will be designed with the goal of bringing improvements on road congestion, polluting emissions, noise, road safety and transport efficiency. They will also involve the three parties, vehicles, tyres and infrastructures.

Then the three or four best ones will be retained and a feasibility study will be carried out for each of them.

This feasibility study will deal both with the technical and the economical point of view.

This 18-month period will be followed by building the demonstrator and evaluating it but, in this particular field, we are not yet able to draw realistic outlines. Indeed the target definition must first be defined.

SUMMARY.

An action was started by Michelin, Renault VI and the LCPC in order to help reach the objectives of the White Paper on European transport policy.

This action will concern the whole transportation system, including the vehicle, tyre and infrastructure.

Two major parts will be dealt with, the vehicles weights and dimensions and the "nteractivity".

Started with French partners, it is open to other European actors in order to become a European project.

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FIGURES

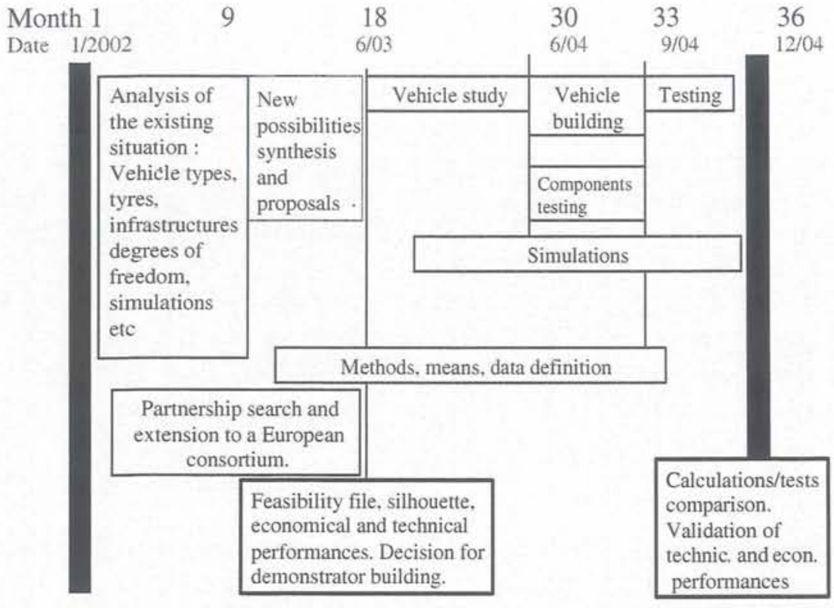

Figure 1 – Action plan : Heavy vehicle weights and dimensions.

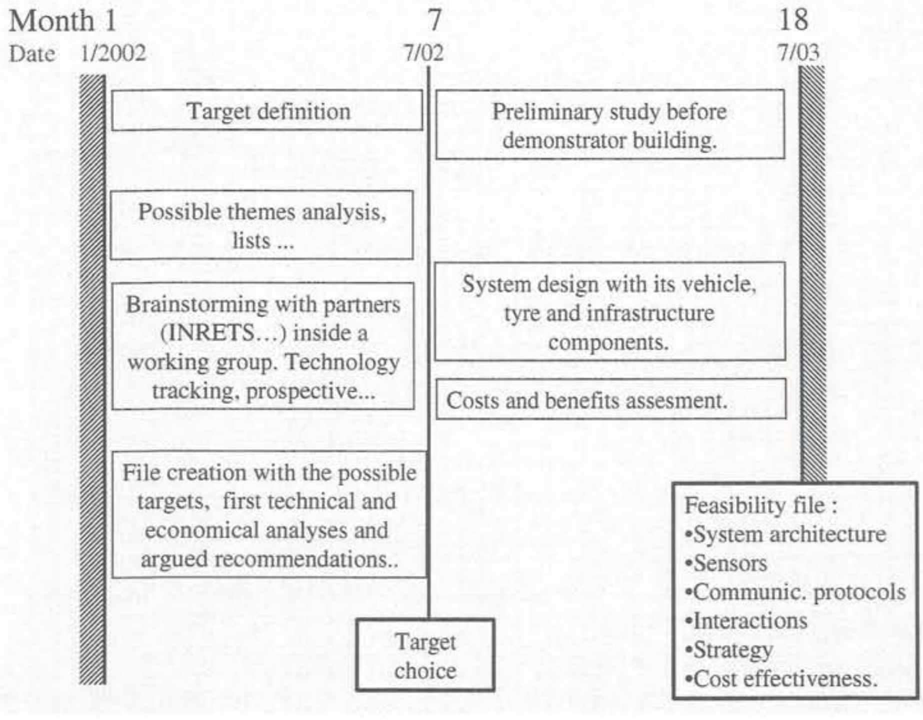

Figure 2 – Action plan : Interactivity between vehicles, tyres and infrastructure.