ComplexTrans: the global land transportation system

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Abstract

ComplexTrans is a mixed global door to door land transportation system for public and private individual and mass, local and long-distance transportation of persons and goods in and inter cities based on deep cooperation between road and railway vehicles, which ensures more comfort, safety and speed, less energy demand and CO2 pollutions and the possibility to be independent on oil.
Keywords: mixed transport, railway-road, passengers-good, city-intercity, private-public.

1 The current problems of land transport

Today there are two main systems of overland transport of people and goods – namely road and railway transport. Both of these systems have their advantages and disadvantages.

The main advantage of the road transport is time independence and door-to-door transport. The disadvantages are lesser comfort and safety, high traffic density, frequent congestions in the cities and between them, duration of looking for a parking place, dependence on oil reserves, and dependence on weather and pollution of the greenhouse gases.

The advantages of the railway transport are: higher level of safety, lesser dependence on the weather, possibility of electrification and automation, possible independence from the oil reserves and thus the possibility of reduction in the greenhouse gases by emissions-free production of the energy. Its main disadvantages are the impossibility of the door-to-door transport and time-dependence.

In the last decades the road transport has prevailed because of its advantages. The problems resulting from the road transport (congestions, a lack of parking places, high accident frequency, deterioration of the environment and global

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warming resulting from air pollution) cannot leave us being content with the current situation in road transport.

The railway transport is nowadays used in some areas, namely urban and suburban traffic, high-speed transport or transportation of raw materials. Its share, however, remains deep under its potential. The railway transport can never wholly replace the road transport because it is not able to transport people and goods from door to door at any time and only on its own.

There have already appeared some systems of combined transportation in order to use the railway transport for the transportation of passenger cars (Autotrain) and lorries (RoLa). These solutions, however, support only a transport from the station of departure to the station of arrival and they can be used only in specific cases. Further expansion of these systems is limited by big time-demands of loading and unloading and by economic demands if compared with an individual road transport.

2 System ComplexTrans as a possible solution to the land transport problems

On the basis of cognition and persuasion, that

- although the individual road transport has gained supremacy, it faces difficulties,
- the railway transport can never wholly replace the road transport,
- the solution lies in combined road-railway transport, if we are able to utilize the advantages of both systems and eliminate their disadvantages,
- the current systems of combined transport are not optimal and are just partially efficient,
- when designing a new transport system, we might achieve new, unexpected aims,

a system of combined transportation (and not only transportation) of individual and public transport of people and goods between and within cities has been suggested (ComplexTrans).

The aim of ComplexTrans is to eliminate barriers, expand the combined transport and increase its use value over the total use value of current road and railway transport. ComplexTrans demonstrates the new options that can be found, if the development of the railway and road means of transport, their networks and building industry is coordinated.

It is also to say, that the systems is based on the existing technologies only.

The main principles of the system are:

- a change in shape and function of the passenger cars and lorries and an increase in their use value,
- a change in shape and function of railway vehicles,
- an establishment of a dense network of compound personal-goods trains,
- and the principle of partial aggregation of the individual transport.

The system ComplexTrans will be run parallel with the system of road transport and there will be an option to choice between these systems at any time. The system ComplexTrans utilizes the whole existing road network and a substantial part of the existing rail network.

3 Main goals of the system ComplexTrans

Transportation goals

- increase in comfort of the land transport
- increase in average travel speed of the land transport
- substantial increase in safety of the land transport
- increase in weather-independence of the land transport
- decrease in density of the road traffic
- strong elimination of congestions in the cities and on the highways
- removing of substantial part of the goods transport from the roads
- growth of the public transport quality (within and between cities)
- increase in number of parking places
- use of passenger cars for purposes different to the transport

Ecological goals

- substantial decrease in energy demands of transport
- substantial decrease in oil-dependence
- strong decrease or even elimination of carbon dioxide emissions
- growth of the robustness and tolerance of world electricity network

Social goals

- long-term increase in employment when constructing the system
- increase in work force mobility
- improvement in life in the cities and in the villages

4 Brief description of the system ComplexTrans (CT)

The system ComplexTrans consists of the following components:

4.1. Road vehicles CT

4.1.1 Coupémobiles – family vehicles of ComplexTrans system
4.1.2 Small ComplexTrans cars
4.1.3 Large ComplexTrans cars
4.1.4 Personal transport modules
4.1.5 Goods transport modules
4.1.6 Towing vehicles

4.2. Railway vehicles CT

4.2.1 Passenger-goods double-deck coaches
4.2.3 Goods double-deck coaches
4.2.5 Fast goods wags

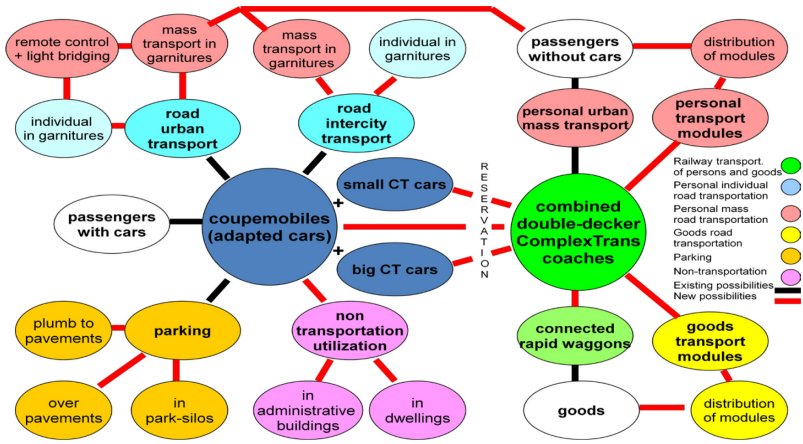

Figure 1: System ComplexTrans scheme.

4.3. Transportation buildings CT
- 4.3.1 Road-railway terminal
- 4.3.2 Coupling road terminals in cities
- 4.3.3 Uncoupling road terminals in cities
- 4.3.4 Light crossroad bridges

4.4. Buildings
- 4.4.1 More floored residential buildings
- 4.4.2 More floored administrative buildings
- 4.4.3 Motels

4.5. Parking facilities
- 4.5.1 Over-pavement parking areas
- 4.5.2 Over ground and underground parking-silos

4.6. Technical service equipment
- 4.6.1 Lifts for Coupémobiles
- 4.6.2 Over-pavement parking-site manipulators
- 4.6.3 Road-railway information and reservation system
- 4.6.4 Coupling equipment for Coupémobiles
- 4.6.5 Operation system for Coupémobiles combinations

4.7. Traffic networks
- 4.7.1 Railway personal and goods intercity transportation ComplexTrans
- 4.7.2 Railway connected wagons in the system CT
- 4.7.3 Road personal intercity transport CT based on Coupémobiles
- 4.7.4 Road personal (individual and mass) city transportation CT based on Coupémobiles
- 4.7.5 Connection of CT trains with city centres by personal transport modules trains
- 4.7.6 Gathering and distribution of goods transport modules CT

An individual transport of people in the system ComplexTrans will serve

specially adjusted personal vehicles - Coupémobiles (4.1.1) – which will replace the majority of current cars in the future.

The compact size and the new facilities of the Coupémobiles:

- make possible and economize the smart road-railway combination
- provide quite new parking options
- enable easier transport through the use of car combinations
- enable its use for non-transportation purposes
- guarantee the land transport electrification and strengthening of the electric network

The Coupémobiles are intended for transport (and dwelling) of up to 5 passengers. The Coupémobiles are shorter (2200 mm; or 3200 mm with extended axles), wider (about 1950 mm) and higher (about 1950 mm) than usual personal vehicles and they are equipped with one entrance door placed on the right side and with one entrance door placed on the front side (optional). The interior of the Coupémobile is variable and enables the crew to travel and dwell in the vehicle both in sitting and lying position. A hybrid drive (with the option of using an electric ride solely) is placed under the back seats and a luggage space is placed above the back seats. Extendable front and back axle enable to extend the wheel base, enlarge a clearance height and create deformation zone. There are catching points placed on the roof, which enable a vertical transport of the car by manipulators. The Coupémobiles are equipped with a coupling device for coupling of Coupémobiles into small vehicle combinations, which will be used especially for the city transport but potentially also for the intercity transport.

Nevertheless, not only Coupémobiles but also other types of cars with the right measurements can be integrated into the system ComplexTrans. We can divide these cars into two groups: “small” and “big“ cars. The small cars (4.1.2) can hold two to four passengers, they have the length up to 2200 mm, cross-section lower than Coupémobiles and another arrangement of the doors. Big cars (4.1.3) with the measurements up to 4.5 x 2.2 x 2 meters are similar to the current cars but differ from them by special travel, which also enables a cross ride when loading into and unloading from the ComplexTrans trains (or when parking). This special travel can be replaced by the loading equipment of ComplexTrans terminals, which makes the use of standard cars possible.

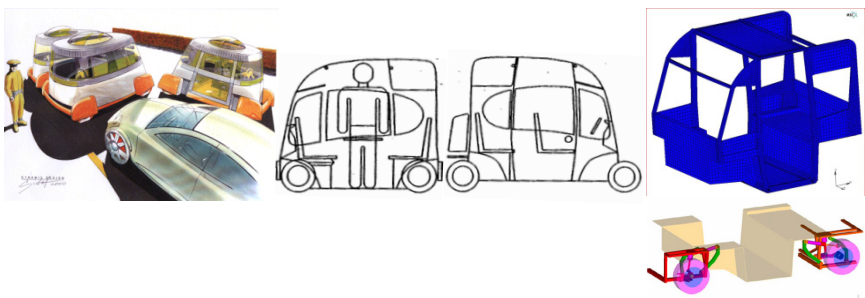

Figure 2: Coupémobiles – road vehicle of ComplexTrans system.

A transport of small-size or middle-size consignments in the system ComplexTrans is carried out by goods transport modules (4.1.5) with the dimensions of about 4.5 x 2.5 x 2 m. The modules are equipped with a travel that enables them an independent short-distance ride, an independent cross-motion and a road ride in combination consisting of a towing vehicle (4.1.6) and up to three goods transport modules.

The purpose of a complementary transport of people in the system ComplexTrans serve personal transport modules (4.1.4) with measurements 4.5 x 2.2 x 2 m and with an interior formed by two compartments designated for the transport of sitting passengers. The personal transport modules have an own travel as well, which enables ride in combination, an independent short-distance ride (e.g. in the area of the terminal) and a cross-motion (e.g. used on loading and unloading). The garnitures of personal transport modules towed by tractors connect than the ComplexTrans trains with the city area without any change need. A variant to it are the low buses (in profile similar to airport buses), which can come till the train platforms and make the change very easy.

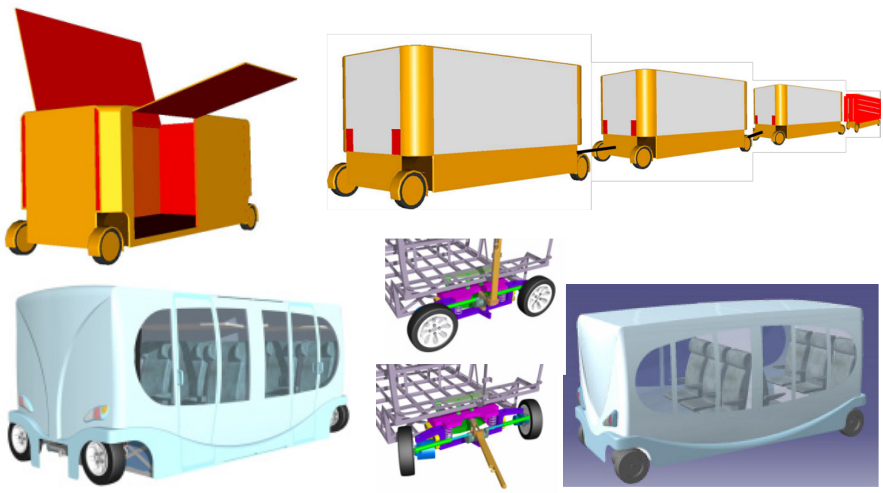

Figure 3: Goods and personal mobile models.

A dense network of trains (4.7.1) formed by double-deck passenger-goods coaches (4.2.1) serves an intercity transportation of Coupémobiles, small and big cars (including passengers), goods transport modules, personal transport modules and train passengers. The trains go in short intervals (5–15 minutes) at a speed not less than 160 km/hour between terminals that are roughly 50–100 km distant from each other and are situated close to the bigger cities. The upper deck of the train serves the transport of ordinary train passengers, the lower deck is designated for a transport of freight. We might consider Coupémobiles (with non-extended axles), goods transport modules or personal transport modules to be “freight” too.

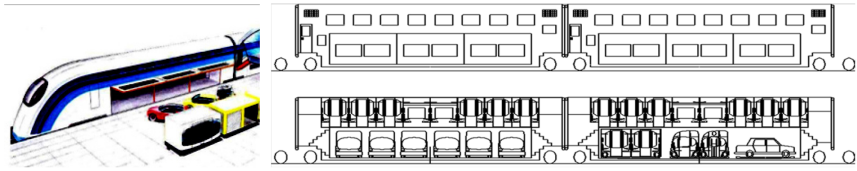

Figure 4: ComplexTrans train.

There might be added some goods wags (4.2.5) for large freight, which are able to go at the maximum speed of ComplexTrans system.

Coupémobile/car drivers are continuously informed about the free capacity in the trains. On the base of this information they can decide to use the ComplexTrans services at any time. This whole process is operated by the interactive information and booking system (4.6.3).

Figure 5: Information system over the road and in the car (Coupémobile).

A compact shape and smaller platform bring new interesting options to Coupémobiles. It concerns an easier parking in the streets, a possibility of vertical motion (lifting) by manipulators (4.6.1), a possibility of an economical and environment-friendlier transport in short vehicle combinations (4.7.3) and a possibility of using them for non-transport purposes.

As we have already said the Coupémobiles have the catching points on the roof part by which they can be grasped by the manipulators (4.6.1) in order to be moved vertically to the place of destination. The vehicles can be parked economically in over ground and underground parking silos (4.5.2), over-pavement parking places (4.5.1) and even on the balconies in this way. That means they can become a mobile part of a flat (4.4.1) or administrative buildings (4.4.2) that can be used for work, relaxation or entertainment too.

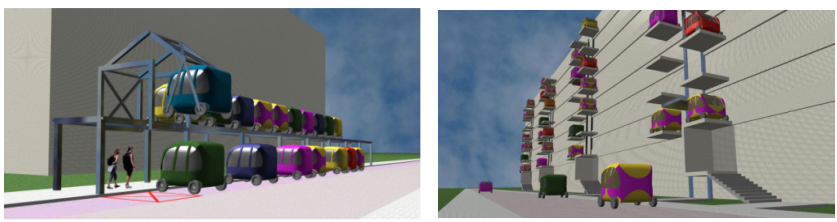

Figure 6: Parking by lifting over pavements and in the buildings.

However, some of these options might apply to small and big vehicles (of a system ComplexTrans) as well.

During their stay in the flats (4.4.1) parking places the batteries of Coupémobiles are connected to the public electric network and can take the cheap night energy and save the network against over lasting or voltage loose.

Moreover the Coupémobiles are equipped with the coupling device (4.6.4) that enables them a ride in short vehicle combinations (2–5 vehicles). The vehicle combinations together with a control system (4.6.5) and light cross-road bridges (4.3.4) enable better organization of the individual urban transport and increase in its permeability. The Coupémobile combinations can be integrated into the public transport as well.

Figure 7: Coupémobiles garnitures implemented to the city mass transport.

5 Some characteristics and bonds of the system ComplexTrans

5.1 Capacity of ComplexTrans trains

Since the trains ComplexTrans ferry first and foremost Coupémobiles and goods transport modules, they can be dispatched more frequently than, if they ferried only passengers or only goods. The capacity of one train consisting of 20 coaches is 120 Coupémobiles. When the interval between two successive trains is 5 minutes, then the capacity of the system ComplexTrans is comparable to the capacity of the road system in which the car frequency is 2.5 seconds in each direction. We assume that the trains ComplexTrans will be dispatched in 5–20 minutes intervals. In a day-time the main transport article will be the Coupémobiles replenished with goods transport modules, at night the main article will be goods transport modules replenished with Coupémobiles transported at a long distance.

5.2 The maximum and travel speed of the trains ComplexTrans. At what distances will they be used?

The first project assumed the trains ComplexTrans to go at speed of about 160 km/h. During a ride at distance of 200 km there will be approximately 4 stopovers (after approximately 66.6 km) – each one will last about 5 minutes. The approaching and receding maneuvers to and from the terminal will last 20 minutes in total. These loading times and speeds cause the interesting travel speed of 92 km/h. It is possible to reach an increase in the travel speed by

increasing the maximum speed or by using express trains. When increasing the maximum speed up to 200 km/h, the travel speed rises up to 102 km/h. By cutting out the intermediate stations the express trains can reach the travel speed of 117 km/h (if the maximum speed is 160 km/h) and the travel speed of 126 km/h (if the maximum speed is 200 km/h).

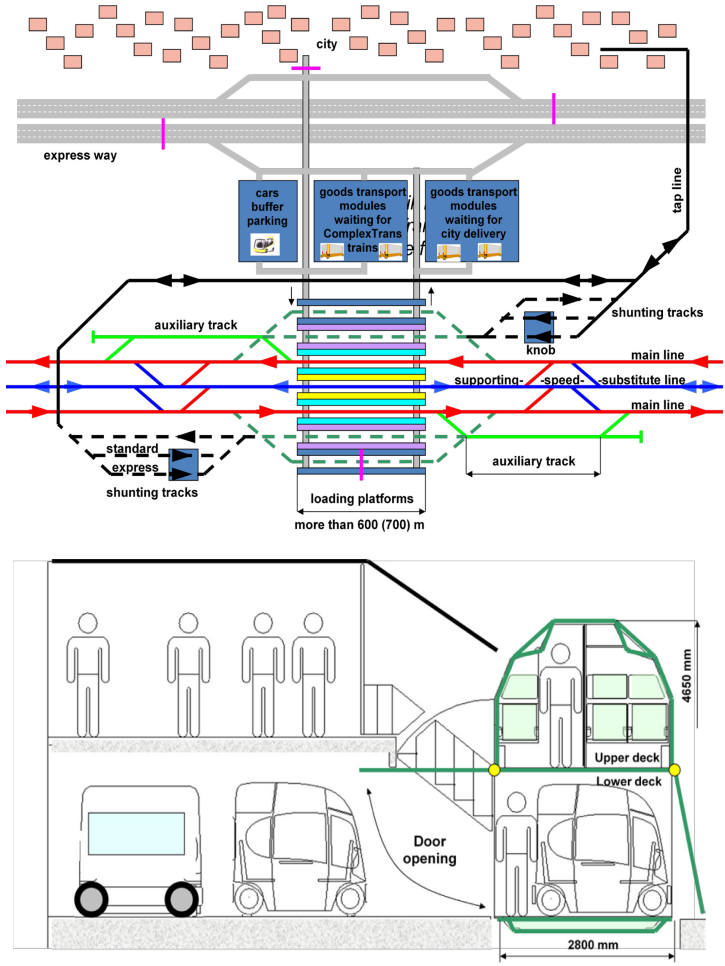

Figure 8: ComplexTrans terminal and platform.

With respect to the reachable travel speed we can suppose that the system ComplexTrans will be used by good weather by passenger cars especially for transport at distance longer than 100–150 km. With regard to the fact that it will be comfortable to sleep in the trains ComplexTrans, it will be possible to travel at night as well. Within one day (and two nights) it will be possible to overcome a distance over 1000 km and partially replace the continental air transport.

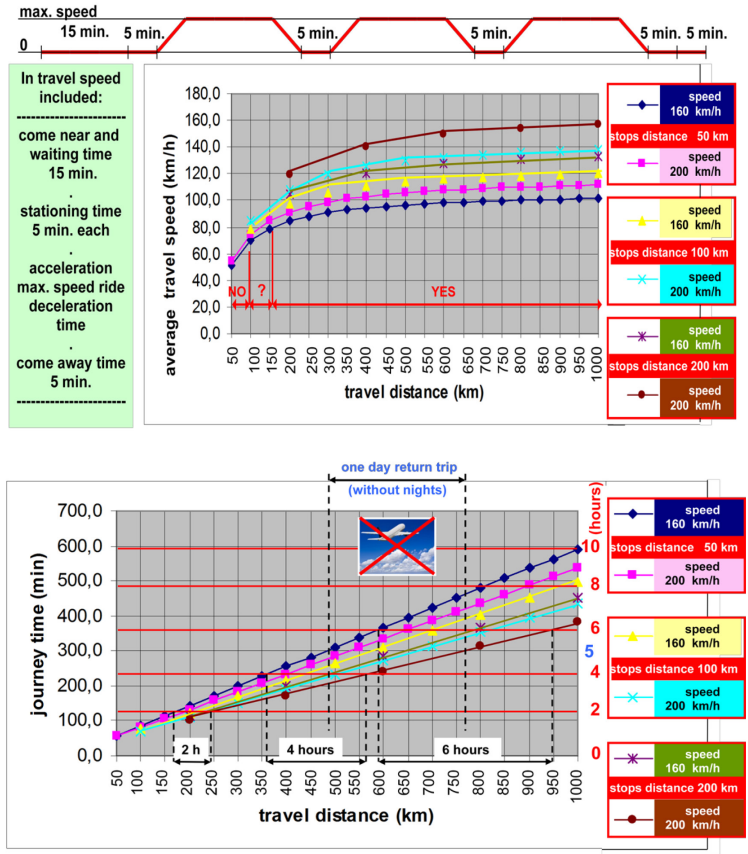

Figure 9: Average speed and range area.

5.3 Energy demands of Coupémobiles transport in the ComplexTrans trains

One 40-tons-heavy ComplexTrans coach can transport six Coupémobiles including their passengers plus other train passengers. If the average fuel consumption of the car is 5 l of gas per each 100 km and the specific energy consumption of the train is 25 Wh/tkm, than the energy consumption of the Coupémobile transported by a ComplexTrans train comprises about 39% of the consumption of the individual car transport (the efficiency of production and transfer of the electricity wasn´t counted in).

Considering the 2010 prices of energy (1 € per 1 liter of diesel oil and 0.07 € per one industry kilowatt-hour), the price of the energy consumed by a Coupémobile transported in a ComplexTrans train amounts to about 26 % of the price of energy consumed by one car going independently. However, we have to mention the variety of taxes imposed on the above mentioned energy resources.

The transport of goods in the goods transport modules and transport of passengers without cars improves the efficiency of the transport in the trains ComplexTrans furthermore.

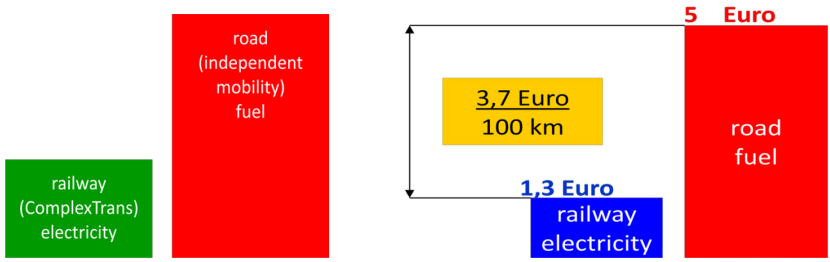

Figure 10: Energy demand and energy costs (distance 100 km) for the Coupémobile transportation on rail and road.

5.4 Economy of the trains ComplexTrans (based on prices 2010)

In our calculations we consider a train unit consisting of one locomotive (90 t) and 20 coaches (800 t). We assume, that drivers of Coupémobiles pay only such a price, that is equivalent to the price of gas (0.05 €/km) and the haulers pay only price equivalent to the price of transport by pick-ups 13 m^3 (0.30 €/km), lorries 40 m^3 (0.60 €/km) or big lorries 100 m^3 (1.20 €/km).

When considering a daily covered distance to be 1500 km and 300 days utilization a year, than the train unit earns after deducting energy settlement this money to settle the other costs (amortization – about 40 Mio. EUR, staff, maintenance, track).

Possible utilization of lower deck capacity:

- transport of Coupémobiles and their passengers only 2 mil. Euro/year or;
- transport of goods transport modules only (big lorries) 3.5 mil. Euro/year or;
- transport of goods transport modules only (pick-ups) 7 mil. Euro/year.

Possible utilization of upper deck capacity:

- 5 paying train passengers in each coach (0.02 €/km) 0.8 mil.

We can assume the average revenue of a train unit to be 3–4 million Euros a year (after deducting the energy costs). But it is depending on the energy prices, which are today higher than 4 years ago.

5.5 Use of Coupémobiles for non-transportation purposes

Thanks to its measurements and unique characteristics the Coupémobiles can be parked not only in the special parking facilities but also on the balconies of the dwelling houses or administrative buildings. To the balconies the Coupémobiles can be transported by outdoor elevators which replace current interior ones. Owing to their dimensions, interior arrangement and equipment the

Coupémobiles can also serve for administrative work, study, entertainment and relaxation. The advantage of parking on the balcony is also the fact that you can be always sure there is a vacant parking place for your car, nobody harms or steals your car and you can load and unload your luggage easily.

The Coupémobiles can be used for work, entertainment or relaxation also during the transport in the trains ComplexTrans.

5.6 Connection of the Coupémobiles to the electrical networks

When parking in the dwelling and administrative buildings the Coupémobiles are connected to the central electrical network, from which they draw the energy for their operation and for the battery recharge (in the periods of low electricity consumption). When necessary the electrical energy drawn by Coupémobiles during the "trough hours" can be given back into the electrical network during the rush hours. Moreover, the fuel engines of Coupémobiles can be used as a standby supply during a power failure.

The total of the power capacity of Coupémobiles will be roughly equivalent to the power capacity of the power plants.

5.7 Decrease in energy consumption, in consumption of petroleum products and in production of exhaust gases

Transport in the system ComplexTrans is substantially less energy-intensive than the current road transport. It follows from the fact that:

- the system ComplexTrans prefers railway transport to road transport for a long-distance transport of Coupémobiles, which is by 60% less energy-intense than the road transport,
- the upper floor of the trains ComplexTrans is used for a transport of another people, which further decreases the affectivity of the transport,
- in the cities the Coupémobiles are often connected into the car combinations, which eliminates aerodynamic resistance of the particular vehicles and substantially decreases their energy consumption,
- by integrating Coupémobiles into the system of (city) public transport and by better utilization of their capacity the density of vehicles declines and therefore the energy consumption declines as well.

We can estimate the decrease in energy consumption caused by utilization of the transport system ComplexTrans to 50% in comparison to present. It follows the relevant decrease in carbon dioxide emissions in a road transport by 50% – i.e. 2.5 milliard tons per year.

For a long-distance transport of passenger cars and lorries the system ComplexTrans uses electrified railway transport, which doesn't have to use petroleum products.

The Coupémobiles are designed as the vehicle with the hybrid drive that is able to cover at least 50–100 km using solely an electric energy. Their batteries will be recharged when travelling by train or parking on the balcony. It follows, that the Coupémobiles will able to be operated mainly in the electric regime, which further contributes to the substantial decrease in consumption of

petroleum products. We may say that the system ComplexTrans enables the transport to become almost wholly independent from the petroleum consumption.

6 Conclusion

The system ComplexTrans can convert the current road transport "jungle" into the transport "heaven". The private "residential" transport units – Coupémobiles – serve for safe, fast and comfortable individual transport of people. Moreover, they can be integrated into the intelligent systems of long-distance and local transport (both individual and mass) as well as into the systems of space-saving parking. Besides, the unique interior arrangement of the Coupémobile enables its utilization for non-transport activities such as relaxation, work or entertainment.

The goods transport will be improved substantially as well. For the fast goods transport the mobile driver-less containers will be used. These mobile containers will be able to be integrated into the intelligent system of long-distance transport, they won´t hamper the traffic in the streets and they won´t need a constant attendance.

The mass transport will be improved substantially as well, because it will become to be more keenly priced, faster and there will be a seat for each passenger.

There exist many progressive projects of transportation systems, however, they have always solved only some of many transportation problems using first of all public transportation means and new and costly transportation networks.

ComplexTrans, based foremost on private means of transport, solves all the transportation problems at once, it can use current transportation networks and it can be introduced and extended gradually.

It is interesting, that together with the significant improvement in transport and lifestyle, it is possible to save a lot of energy, become independent from oil, do away with the majority of carbon dioxide emissions caused by road transport (up to 5 milliard tons a year), secure the long-term employment and GDP growth and contribute to the increase in social security and welfare.

However, it won´t be easy to persuade the society about the need to start the construction of the system ComplexTrans (or similar project) and a general consensus of many states and their citizens will be necessary to realize the project. It will be very important to set the right strategy of the gradual implementation of the system ComplexTrans, so that it will be accepted positively. The mass media will have to be involved into the information campaign in order to inform the people about all the potentials, advantages and assets of this transportation system in an appropriate way.

The global implementation of the global transportation system like a ComplexTrans is a challenge for the mankind of the third millennium.