

From technology driven inventions to transport demand innovations

Marten Janse¹, senior consultant traffic and transport, TNO Inro

Introduction

Negative side effects of car use in build-up area's jeopardise the quality of life. This fact requires an overall approach to work on Sustainable Urban Mobility.

Technology driven inventions like a Cybernetic Transport System, may very well contribute to this cause. Cybernetic Transport Systems, on-demand services with clean, economic, silent and automated vehicles, conceal some unique selling points. This paper will tickle your imagination on this point.

But to make a Cybernetic Transport System applicable to the city of tomorrow, a shift from a technology driven invention to a transport demand perspective and a business case based innovation, is required. The EU puts a lot of effort in research on this subject and learned a lot already. Some findings will be presented in this paper.

Municipalities can contribute to these new developments by hosting demonstration projects on their territories. In fact, their contribution seems to be required to accelerate the deployment of sustainable passenger transport.

1. General background

The introduction of the Ford model T in the beginning of the 20th century has been the inception of a period of mass mobility. Especially after the Second World War the passenger car became affordable for nearly everybody in Western Europe. A traffic growth not just by percentage but in factors has been the result. This was made possible by new infrastructure mainly as roads and airports. Roads and freeways were predominantly built in the fifties and sixties, whereas airports got enlarged and new airports opened up more in the eighties and nineties.

A general move can be stated from collective, mainly public transport towards individual and mainly private transportation. Customers have been willing to spend up to 30% of

¹ In co-operation with his highly appreciated colleagues: *Pascal Eijkelenbergh, Kerry M. Malone and Jan Uwland.*

their household budget in individual vehicles to enjoy the commodity, convenience and comfort of flexible usable cars. The same happened in the area of freight transportation and city logistics, where the popular concept of 'Lean Production', 'Customized Production', and 'Just-in-Time Process' has influenced the transport arena towards more transportation (The Rolling Warehouse) in general and specifically more Road Transport and Air Freight but less Rail Transport.

Despite the fact that vehicle's efficiency has been tremendously improved, energy consumption and air pollution per vehicle that customers buy and use, could not be lowered as expected and got easily outweighed by the overall traffic growth. A lot of the technical efficiency gained has been compensated in the market by the customer purchasing larger and more luxurious vehicles. And, nowadays, there are more cars per household and more Vehicle Miles Travelled.

More than 30% of world's population lives in cities. Cities still tend to get larger. Some of them we call Mega-Cities when they get more than 10 Mio inhabitants. Additionally, geographic fragmentation of activities (larger distance between Residing, Working, and Leisure) and Urban Sprawl (living in low-dense Suburbia) are key factors in increasing traffic. Based on such traffic-intensive land use policy and urban planning, not only the 'moving traffic' has tremendously increased (congestion) but also 'parked traffic' has taken up a lot of valuable urban space (parking shortage and, as an effect of that, higher parking cost).

2. The introduction of new transport concepts

Due to this shortage of urban space influenced by moving and parked traffic a decline of the quality of urban life is appearing. This, in turn, by diminishing the attractiveness of living and working at the city centre ends up in the birth of unsustainable suburbs.

Technology has the potential to contribute to a more sustainable development of our European cities. Many transport alternatives have been invented to solve the negative effects of private cars. Examples are the Helios, a flying car, which is meant to be the answer for bad accessible as well as densely populated areas. Personal Rapid Transit, like the one currently developed in the British city of Cardiff, the so called ULTra system, is another example. And so is the RUF-system for greater Copenhagen. Other inventions, in arbitrary order, are the transport of vehicles in a kind of containers (e.g. auto shuttle and AVT train), new innovative cycling concepts (like MITKA and TRANSLIDE 2000), underground transport (in example: capsule pipelines and CargoCap), cable railways (Aerobus, Schwebbahn, Whoosh, Pathfinder, SkyTrain, Highway and FLYWAY), electromagnetic support and guidance systems (Transrapid and MagLev), monorail systems (e.g. URBANAUT, POMA 2000 and High Road) and -not to be mentioned

without a little bit of pride- Cybernetic Transport Systems (Serpentine, ParkShuttle, CyberCab, et cetera). Cybernetic Transport Systems are the object that the EU 5th Framework Programme CyberMove² is studying.

Many of the newly invented transport systems mentioned above, cannot be realised without cost consuming new infrastructure. Most of the other inventions focus on reducing the number of changeovers, but do have rather complicated solutions at the start-up or slow-down of the trips. Only the Cybernetic Transport System can be seen as a solution which promises to solve almost all difficulties in urban areas: it operates on existing infrastructure; the fully automated vehicles cause no parking problems at the place of destination; the system is clean, silent and economic; and its service meets the transport demands of individual travellers. Moreover, Cybernetic Transport Systems, laid out with fully automated vehicles, reduce the personnel and operating costs. And, since they operate on the asphalt that is already there, investments are relatively low. There is no doubt that implementation of this transport system will lead to improvements in the quality of life.

Transport pilots (not only technical demonstrations) with cybercars have been realised in Capelle aan de IJssel, Schiphol Airport and the world horticultural exhibition Floriade 2002 -all located in the Netherlands.

3. The CyberMove project

The main objective of the CyberMove project is the development and deployment of Cybernetic Transport Systems. Cybernetic Transport Systems aim at improving passenger transport while reducing the negative effects of private car use in the urban area's, by complementing mass transit systems. The goal of the project is not to replace the private car, but to offer a real alternative in the urban area with more convenience and more efficiency than private cars.

CyberMove strives to bring together all European actors in this field, in order to test and exchange best practices, share part of the development labour and accelerate progress in the experiments. Several cities throughout Europe collaborate with the partners in the project, studying the potential to operate a Cybernetic Transport System, providing their specific constraints and accepting to do some preliminary tests of technologies and demonstrations. Co-operative work with selected cities will lead to conceptual design of systems for specific sites, optimised with regard to mobility, energy, environment, safety and will lead to the evaluation of these designs.

² www.cybermove.org

CyberMove is funded through the EESD-Programme (Energy, Environment and Sustainable Development) and started in December 2001. CyberMove has a 'twin sister' project with the same objective, called CyberCars³, which is funded through the IST-Programme (Information Society Technology) and started in August 2001. Both projects are funded for three years.

From the beginning of the CyberMove project, it has been clear that trying to organise demonstrations in cities, asked for a shift from the providers perspective to the perspective of city authorities. Why would a city be eager to have a Cybernetic Transport System on its territory ? And although the unique selling points from a technological point of view could be listed, some other major questions still remained unanswered. For example: how would end users behave towards such a system ?; which transport demand can be served best with a Cybernetic Transport System ?; how to fit in a Cybernetic Transport System in the build-up area ?; how safe can it be ?; how do laws have to be adjusted or changed to allow Cybernetic Transport Systems to operate on public roads ?; and, last but not least, what does the business case of a Cybernetic Transport System show ?

A user needs analysis [CyberMove D1.2-B] revealed some of the issues that have been put into question here. Almost all participants in a European wide interactive questionnaire stated that they would use a Cybernetic Transport System the very next moment it were in operation for their daily travels. Six applications were identified and illustrated in the following way:

1. Between a central car park and a business park.
2. At a holiday park.
3. From a central car park to the central business district.
4. From the (train) station to the university.
5. Between a central car park and a historic city centre.
6. From the (train) station at an airport to the departure terminal of an airport.

In total 2.855 respondents from 24 countries filled out the questionnaire. Practically everyone (98% of the respondents) did indicate that they would make use of the Cybernetic Transport System. The respondents preferred to choose the applications they could use daily: between a central car park and a historic city centre (27%) or towards the central business district (26%).

³ www.cybercars.org

4. Safety: the difference between liability and responsibility

Safety is without any doubt one of the crucial issues in the deployment of new transport concepts. Accidents that happen during the process of introduction, will cause a major setback. Legislation prevents unsafe systems to enter the public roads. So far so good. Unfortunately however, current legislation does not recognise driverless vehicles as safe or unsafe: it does not recognise automated vehicles at all !

Especially for passenger transport with automated vehicles there is a completely new legal situation [CyberCars D6.1]. Like any other vehicle cybercars procure approval in order to operate. There is a consistent and extensive set of standards for vehicles that make use of public roads. For non-rail systems and systems that do not use public roads there is the Machinery Directive 98/37/EEC. This directive, however, is not designed for transport modes and using this directive in a demonstration project is not a structural solution.

Current laws require the presence of a human driver in the vehicle in order to allow operation of the vehicle on public roads. Three main functions that human driving imply are: observing, analysing/deciding and executing these decisions. In fully automated vehicles, sensors, obstacle detection and vehicle controllers take over the human function. And while for traditional vehicles standards on component level exist, for components in these driverless cars, no such standards exist.

To overcome legal barriers the CyberCars project will test a new certification method for Automated Guided Vehicles, based on the well known FMECA (Failure Modes, Effects and Criticality Analysis) analysis [CyberCars D6.2]. Similar to the FMECA, the proposed certification method focuses both on the *severity* of potential accidents and the *likelihood* that these accidents can occur, and combines these into a single figure. In order to decide whether or not the system is safe enough, this safety figure is compared to reference values, derived from accident statistics of traditional vehicles. Unlike the FMECA, the proposed certification method has to be applied on a system level (instead at the component level) and, if necessary, proceeds top-down to subsystems.

Dealing with legislation that -until now- prevents Cybernetic Transport Systems from entering the public road by moving demonstrations to private grounds and making them run with reference to the Machinery Directive 98/37/EEC, is not the robust solution one should be aiming at. By doing so, you cover your liabilities but you do not work on safety anymore in a responsible way.

Since safety is not guaranteed by adequate legislation, the CyberMove project has developed a risk reduction methodology [CyberMove 3.1]. This risk reduction methodology analyses the severity and likelihood of accidents to happen because of unlucky interference between the Cybernetic Transport System and its environment. The

methodology focuses on the establishment of both a risk profile of the environment where the Cybernetic Transport System is planned, and a risk profile of the transport system itself (vehicles, controller, infrastructure). Analysing these risk profiles separately and together, and proposing precautionary measures to reduce any risks, will lead to relatively safe sites.

Applying the risk reduction methodology to a pilot site will result in a ex-ante safety evaluation. City authorities who want to know whether their demonstration site is safe or not, should be encouraged to do such a safety assessment and not trust the provider of a Cybernetic Transport System on his word of honour.

5. Challenges for city authorities

A lot of effort has been put in European research to the development of Cybernetic Transport Systems. However without the participation of municipalities these systems cannot show their full advantage. More municipalities should try to integrate new and innovative transport concepts in their land use and transport planning. In this way they are able to realise a sustainable urban mobility.

The integration of public transport into the development of city centres is very common in Europe. Nevertheless, most municipalities give preference to the realisation of more traditional public transport systems. In the EU 5th Framework Programme Transplus⁴ project this is being researched. Transplus will identify best practice in the organisation of land use and transport measures in order to reduce car dependency in European cities and regions and promote economic, social and environmental improvement.

Transplus is part of the LUTR cluster (Land Use and Transportation Research: Policies for the City of Tomorrow) that links several different projects in the area of sustainable urban mobility, including land use, transportation, and the environment. The common objective is to develop strategic approaches and methodologies in urban planning that all contribute to the promotion of sustainable urban development. This includes issues of transportation demands and related land use planning, the design and provision of efficient and innovative transportation services including alternative means of transportation, and the minimisation of negative environmental and socio-economic impacts.

Just to give an example of how new transport systems can reshape the environment [Transplus D2.1]: the city of Nantes has implemented tramlines to remodel the city centre. With the first tramline came the transformation of an old tobacco factory into

⁴ www.transplus.net

social housing, offices and a leisure centre and the creation of the Mediathèque. The second tram line provided an opportunity for large scale building along the river Erdre, in Nantes city centre, and in social housing sectors both in the south (Rez ) and in the north of the urban area. The third tramway line implementation enables urban modifications for the city centre where a multi-site project is currently under construction. Objectives are:

- To bring a new dynamism to the central commercial area, which has been suffering, like most French cities from the development of large shopping centres on the outskirts;
- To link the upper city with the lower city;
- To restore space for pedestrians;
- To implement offices and housing facilities; and
- To create a new balance between car traffic, public transport and cycling.

This example shows that the integration of infrastructure and transport systems with the land use and transport planning could result into a higher quality of life. The described tramline system is the most rigorous form of transformation and will be especially applicable on a city scale. The transformation with a Cybernetic Transport System however, seems to be more applicable on the level of a historic city centre or a central business district.

6. Sustainable urban mobility

In general a high quality of life in the urban area can be achieved through the introduction of new innovative transport systems, but only if a programme of flanking policy contributes to this objective as well. The introduction of multi-storey car parks at the edge of the city centre, the prohibition of car traffic in the inner city or a (sub)urban residential development around public transport facilities, just illustrate the possibilities. Different transport approaches can be realised to support sustainable urban mobility strategies, such as car sharing schemes and car free housing districts. A Cybernetic Transport System can be the passenger transport system that achieves a significant change in the modal split towards sustainable transport modes.

The CIVITAS Initiative⁵ addresses ambitious cities that are introducing, or that are seriously committed to introduce, sustainable urban transport policy strategies. The challenge is to achieve a radical change in urban transport through the combination of technology and policy based instruments and measures. Eight measures have been identified as the corner stones of such a strategy:

⁵ www.civitas-initiative.org

1. Energy-efficient, cost-effective and clean public and/or private vehicle fleets and the necessary fixed infrastructure (e.g. fuelling) can be considered as a core measure that is to be combined with a wider package of measures in order to cover both the transport demand and the supply side
2. Demand management strategies based upon access restrictions to the inner city areas and other sensitive zones by means of introducing access control permitting access only to clean and energy efficient vehicles and to cycling and walking.
3. Demand management and revenue raising strategies based upon integrated pricing strategies by means of area wide or city wide pricing schemes.
4. Stimulation of collective passenger transport and its quality of service by means of introducing clean and energy efficient vehicle fleets; non-conventional transport systems; innovative organisational, financing and management schemes, improved accessibility, security and safety; integration with walking, cycling and other modes.
5. New forms of vehicle use and/or ownership and lifestyle by means of introducing new mobility services based upon clean and energy efficient vehicle fleets; car free housing; shared use/ownership of cars, motorised two-wheelers and bicycles.
6. New concepts for the distribution of goods by means of introducing innovative logistics services using clean and energy efficient vehicle fleets, dedicated infrastructure and information services.
7. Innovative 'soft' measures for managing mobility demand by means of introducing new approaches to integrated planning; promoting green transport plans, safe walking and cycling, mobility marketing and awareness.
8. Integration of transport management systems, including related information systems, and passenger services, such as those for intermodal travel information, transport pricing and payment, vehicle location and guidance and traffic management.

Pilot cities participating in the CIVITAS programme, have to implement a policy mix taking on board packages of several measures. Why not take into consideration the realisation of a Cybernetic Transport System being one of them ?!

7. Support from Netmobil⁶

Many of the new innovative transport systems are still in a pilot phase. This is also true for the Cybernetic Transport System. To accelerate the deployment of new transport concepts, the EU has launched the 5th Framework Programme accompanying measure Netmobil.

⁶ www.netmobil.org

The principal objective of Netmobil is to enable local and national government bodies, international organisations, industry and commerce, interest groups and individuals to obtain maximum benefit of long term sustainability from the results of research undertaken by the cluster of research activities within the field of: automated vehicles, personal rapid transit, advanced driver assistance systems and automated vehicle guidance systems, as well as their underlying technologies. High quality research in the area of new vehicle technology for transport will be identified at regional, national and international level, and integrated within the Netmobil project. Synergies between the projects and common issues that would benefit from a co-operative approach, as well as gaps in research areas, will also be identified. The European potential would be determined and appropriate dissemination undertaken to encourage active exploitation of project results. New areas of research that will enhance Europe's position as a research leader will be identified.

The strategic objective of Netmobil is to support sustainable urban mobility by:

- reducing stop/start flow characteristics of urban areas through driver assistance and automation technologies;
- reducing urban pollution through use of automated electric vehicles;
- improving driver and passenger safety through driver assistance and automation technologies; and
- by developing high quality customer oriented services through provision of door-to-door, demand responsive and high speed collective transport.

As a first result of the Netmobil activities, it has been stated [Netmobil D1] that the technologies and applications that are being researched, do possess the potentials for both better and safer passenger transport and environmental improvements. And, in a more generic way, they provide the opportunity to improve quality of life for the whole urban community, including the non-users of the system.

In February 2004 Netmobil organises its first dissemination workshop. The dissemination workshop will present the objectives of Netmobil and the opportunities deriving from the projects to representatives of end users and policy makers from cities, national governments and the EU, and to other stakeholders including transport operators, experts and industry. It will promote the application of new transport systems to current and future urban problems, and discuss the barriers to implementation. The workshop will give the opportunity to discuss with the recipients the information needs expected from the projects.

I would personally recommend every municipality to take an interest in this dissemination workshop.

References

CyberCars D6.1, Jan van Dijke: *Safety Standards for Cybercars, Part 1: Existing standards and guidelines*; TNO; September 2002.

CyberMove D2.1-B, Marten Janse: *User Needs Analysis - Part B: An interactive questionnaire amongst end users about cybercars in passenger transport for the city of tomorrow*; TNO; December 2002.

CyberMove D3.1, Jan Uwland: *Safety and reliability, Preliminary Guidelines*; TNO; December 2002.

Netmobil D1, Georges Gallais: *Co-operation and Co-ordination among 4 Cluster-Projects with International, National & Regional Projects*; INRIA, September 2003.

Transplus D2.1, Merijn Martens: *Land use and transport planning: experiences in European cities*; TNO; May 2002.