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Competitive and sustainable transport of goods: Underground Logistic Systems as a regional competitive asset in 21st Century Europe?

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Competitive and sustainable transport of goods : Underground Logistic Systems as a regional competitive asset in 21st Century Europe ?

Hugo Gordijn

Paper prepared for 39-th European Congress of the Regional Science Association
Dublin, August 23-27, 1998.

Summary

Underground Logistic Systems are a serious option for the transport of goods in highly urbanised areas in the Netherlands for the next century. The objective is to achieve a sustainable transport system and guaranteeing the accessibility of cities and production- and distribution-centres. At the same time it gives an answer to the foreseeable labour-market problems for logistic personnel and is aiming at strengthening the competitiveness of regional economies. The paper gives an overview of the research and development, strategic planning and the several pilot-projects and feasibility studies which are in operation.

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Towards Sustainable Transport

Sustainability is a theme that runs throughout Government's policies. The UK-government document "Sustainable Development : Opportunities for Change" (DETR, 1998) states that :
"sustainable development means a new and integrated way of thinking about choices right across Government and throughout society, so that we can all share the highest quality of life now, without passing a poorer world to our children".

The Dutch Government has also set goals to achieve sustainable economic growth for the next century. ("Towards a sustainable Netherlands"). In this contribution we focus on the sustainable Transport of Goods.

Freight transport is expected to double within the next 25 years. This also means a growth in emissions of toxins, noise, traffic jams and unsafety. Improvement in engine-technology will reduce emissions, noise and unsafety per vehicle. Nevertheless we can expect levels of hindrance which exceed the desired sustainable level. So we need system innovations for attaining the desired quality of the environment, especially in the highly urbanised areas. Underground transport of goods by means of a tube-system is an option seriously proposed and investigated.

There are three objectives for the introduction of a robotised Underground Logistic System (ULS) :

- to secure and improve accessibility of cities and major economic areas for goods transport;
- to improve the quality of life in cities and major economic areas by reducing emissions of toxic particles, noise levels and traffic accidents caused by (heavy) trucks and vans.
- to strengthen the economic structure of regions by a competitive transport-system.

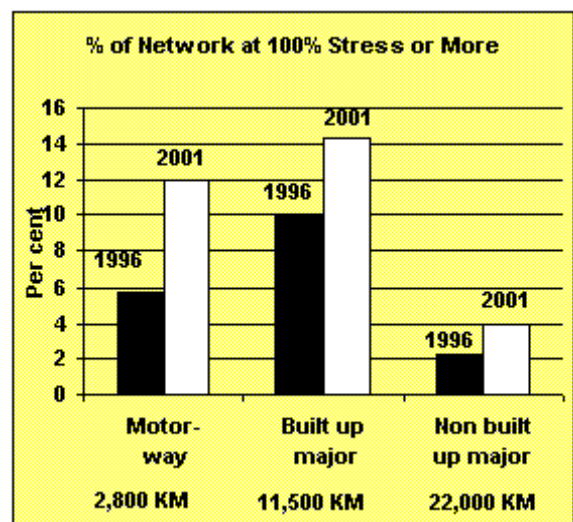
These goals are now not achieved.

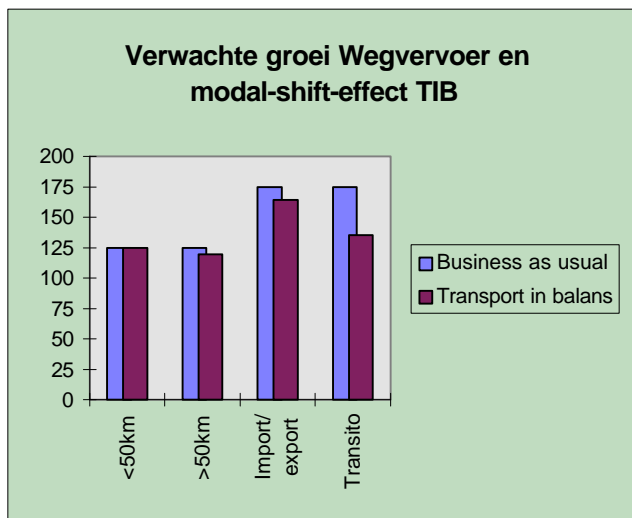
The *accessibility* of the most urbanised areas is troublesome. This is the case in almost every highly urbanised area in the world. Around the large cities in the Western conurbation, traffic jams will also have to be taken into account during the rush hour and also in the long term (MIT-1998-2002). In figure 1 a Congestion Probability Chart for The Netherlands in 2020 shows that forecasts indicate that the congestion problems will remain and even increase despite huge road investment programs.

The same holds for other countries as figure 2 shows for England.

For passenger transport the general answer are metro-systems. These combine high investment costs with high transport-capacity. For the transport of goods a shift towards rail and waterway-systems is advocated in the policy documents (Transport in Balance). The expected effects are a -5% for

national transport over longer distances, -10% for international import/export transport and -40% for transit transport. The graph below shows the expected effects of the package of policy measures of the Policy Plan "Transport in Balance" (TIB). The graph shows clearly the effects of stimulating the performance of the railsystem and the inland waterways-system on



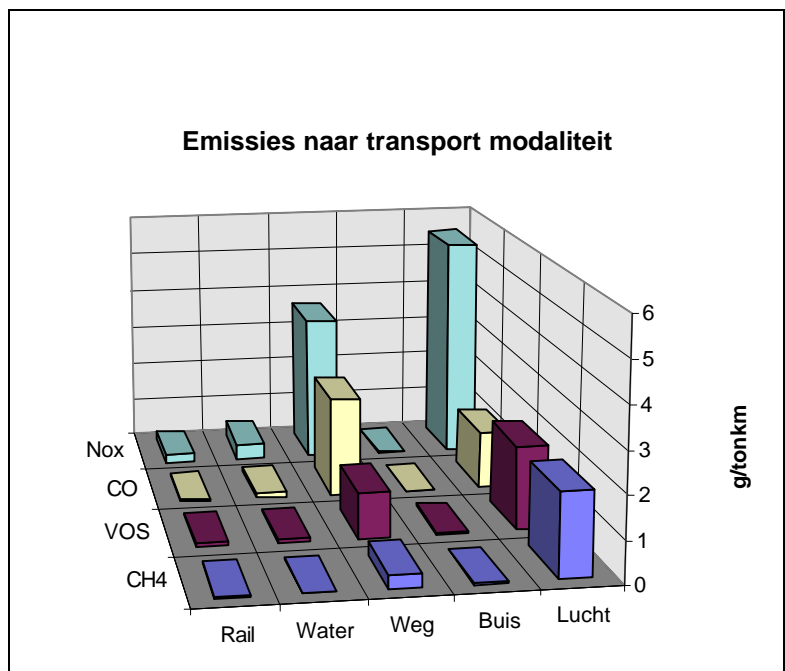


road traffic. The effects are great for the transport over longer distances such as Transit-traffic and import- and export traffic. For the short distances there is, as yet, no viable policy which will lead to a significant reduction in road transport. ULS are a solution for this transport-segment.

At the same time the *environmental quality* of the cities is bad. Too much noise, odour and injuries are the result of the transport systems nowadays in operation. The highest concentrations of pollution are also found in the cities and about 60% of city dwellers

are exposed to concentrations above the new target standard recommended by the WHO. The standard for ozone is exceeded in the whole of the Netherlands. (RIVM, 1998). In 1997 freight transport on Dutch territory grew at about the same rate as the economy, i.e. 4%, measured in tonne-kilometres travelled. Road haulage decreased slightly in favour of rail and water transport. Despite this growth in traffic, emissions from goods transport declined by 4% in 1997 as a consequence of the implementation of the Euronorm 2 emission standards. This fall, however, is expected to even out in the near future.

In the third National Environmental Policy Plan measures to gradually reduce emissions and noise-hindrances are taken. But this will not be enough. Needed is a quality-jump in a new innovative transport system. Like the metro-system does compared to motorised transport in the cities.



The reaction of industries on poor accessibility is to withdraw from the city-centres and later from the cities. In some countries this is also true for shopping centres in the inner-cities. Shopping Malls at the outskirts of the cities are the result. They are only accessible by car, thus creating more transport, pollution and inaccessibility.

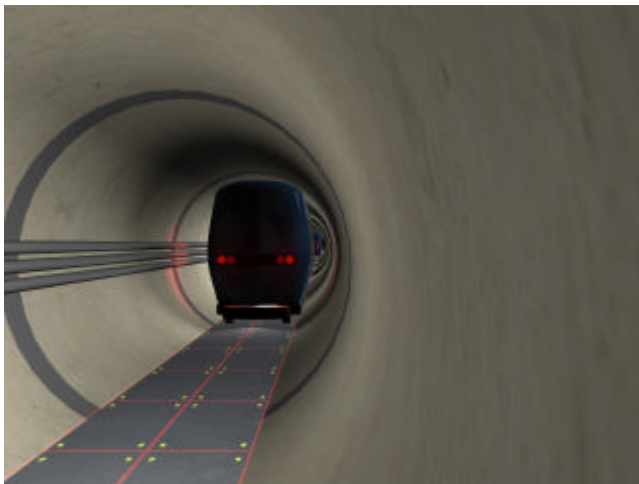
The *economic structure* of the cities is in danger.

With a sustainable, high performance system for goods transport a competitive climate for cities could be reached.

Towards system innovation

We have a good example of the merits of underground transport. *Pipelines* are famous for their record of cheap and reliable transport. Pipeline transport has a market share of 90 % of all transport, if the transport of Water and Waste-water is taken into the account. It goes without saying that pipeline transport for liquids and gases is a sustainable mode of transport. There are almost no emissions as is shown in the diagram (Source: Whitelegg, 1993). Noise-hindrance and safety-levels are very good. Underground transport is also very space-efficient. *The mere fact that water transport is not felt as transport indicates the sustainability of this type of transport.*

Can we develop a transport system for goods which is as sustainable as pipeline transport of liquids and gasses ? One of the promising possible answers is now under investigation : Underground Logistic Systems.



These concepts are now investigated in the Netherlands. They have the following characteristics :

- They aim at the segment of rolling containers and pallets
- a range up to 50 kilometres
- fully-automated transport including automated transfer
- non-rail but self-navigation system (such as Free Ranging On Grid)
- independent transport-environment (such as an underground system; but above-ground is fine as well).

Underground Logistic Systems are not new. In London the MAIL RAIL system is operated 20 meters below the streets of London for the movement of letters (4 million a day) and parcels. Since 1928 it is serving 9 stations on 10,5 kilometers of 2 foot gauge track between Paddington station and Whitechapel. Plans are made to use it for the distribution of goods to the large shops in Oxford street. (Metro-freight concept). However unfortunately the British government does not stimulates this development. It should be developed within the private sector. Private parties like John Lewis in Oxford street are serious interested but ask for government participation in a feasibility study. Now the current initiative is losing momentum.

The research carried out in The Netherlands.

The concept of ULS is elaborated in studies and in pilot projects. These influence each other mutually. The studies give rise to pilot-studies and the pilot-projects lead to further studies. In this interaction knowledge is expanding. The program is financed by the Fund for the strengthening of Economic Structure (FES) and partly by industry and local interest groups.

We give some results of the research and give an impression of the pilot-projects.

Environmental effects.

Underground transport is a proven technology for passengers, gas and liquids. Its performance record is impressive.

Research indicates a significant reduction in emissions if Underground Transport is fully implemented :

Emission	Unit	Reference 2020	With Underground Transport
CO2	million tons	19	- 6
Nox	million kg	202	-77
Fine particles	million kg	14	- 5
VOS (organics)	million kg	50	-19

Table 1 : Emissions by freight transport systems.

The same research (Dullemond and Dekker, 1998) indicates a reduction of noise levels especially in city areas and a reduction in traffic victims. Moreover there is a reduction in space otherwise utilised for transport. Also the costs of road-maintenance are significantly reduced.

The Logistics once the system is implemented.

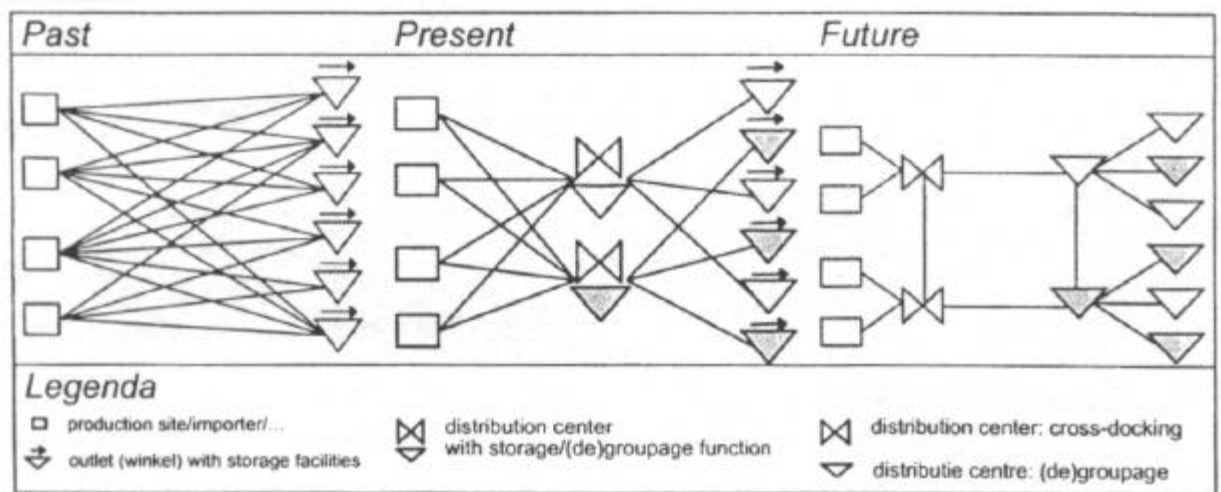
For the organisation of freight flows we distinguish between a number of categories:

- business-to-business and business-to-consumer flows
- flows to and from the City area with destinations within and destinations outside the inner city

The first distinction is important because businesses tend to optimise their logistic behaviour in a consistent way and are looking for ways to cut costs while maintaining service quality. Consumers are less well organised and are not only focussed on cost reductions but also to many other aspects that make life agreeable. Another distinction is the fact that consumers have a wide range of activities that require small and infrequent good flows while most companies, especially those that produce or tranship goods, generate large volumes of frequent freight flows that allow consolidation and optimisation.

In our vision the transport of goods to the city centre should be minimised as much as possible while maintaining its economic liveability. It is not necessary to transport goods from warehouses to shops and then from shops to consumer homes if it is more efficient and easier to transport them more directly from warehouses to homes or via an interchange point that is easier to reach than a shopping centre (that has very expensive parking places or can only be reached by public transport). A consumer that goes to the city centre goes either completely by public transport or uses a parking facility somewhere at the edge of the city and uses public transport from there. In both cases (s)he has to find a way to transport the goods that (s)he has bought to the parking garage or to some other point where (s)he can pick them up later. This means that many shops (except those that sell goods that need to be consumed right away (ice cream) or need to be seen and touched (antiques)) can work as a “kijk-shop” (see-shop). For these shops a disconnection of the shopping activity and the good moving activity can be envisaged.

In principle there should be few or no goods producing activities in inner cities that are not directly or indirectly related to consumer consumption activities. Most business-to-business freight movements without any consumption linkage should take place outside the inner city area. Of course the logistic chain management and the trading activities could very well take place in offices that are located in inner cities. Here the disconnection of freight flows and information flows could be used to locate non-freight handling related activities in the inner



city and freight related activities somewhere else.

In combining and integrating freight flows also major logistic cost reductions can be achieved. The transport of products to central warehouses instead of the transport to a large number of individual shops could lead to the use of larger and more environmental friendly modes of transport. At the same time the centralisation of inventories in (virtual) warehouses could lead to significant reduction in warehouse costs. For the individual consumer or company that orders products it is not essential where these products come from, it is important that they arrive in time and according to specifications.

The challenge of the organisation of pipeline transport lies in the creation of transport facilities that are still as reliable and cost effective to the existing modes of transport. In order to achieve these targets these pipelines should be highly automated, in order to omit extra handling costs, and at the same time they should be highly flexible in order to cope with varying demand and reliable lead times. Another point of attention will be the connection of these pipelines with the prime origins and final destinations. In order to facilitate these access and egress connections, easy and environmental solutions must be developed for this.

The function of the pipeline for inner city goods transport is 3-fold:

- to connect warehouses with exchange points, where customers from outside the Motorway-ring area that have come by car to the city can pick up their goods shortly after they have bought them (normally less than one hour); these interchange points will also be used by express delivery services that deliver goods at home for those that came by public transport or do not want to transport the goods themselves
- to connect warehouses with intermodal terminals if the warehouses are not already intermodal exchange points themselves; this connection is especially relevant for the procurement of goods to the warehouses from factories that are located on longer distances.
- to connect warehouses, exchange points and intermodal terminals with delivery points within the conurbation for consumers who live in the neighbourhood of that delivery point.

Not necessarily the same pipeline system will be used for each of these connections. One could envisage that the high volume transport flows could use a larger unit loading device than the relatively less frequent and less voluminous flows that are dedicated for individual customers. The first category would need pipes that can transport pallets of 1-2 m³, the latter could well be served by containers holding packages of ¼ m³ maximum.

Of course, not all flows will be able or will prefer to use pipeline transport as the most attractive mode. One could imagine goods of a dangerous nature or products with eccentric shapes not to fit within this system. For those types of transport the ring area would of course still be accessible, but one could foresee that severe emission standards will be imposed on trucks entering the ring area. For the inner city area even more severe standards and time windows are likely to be imposed in order to keep this area as safe and pedestrian friendly as possible. Of course the public transport facilities in the inner city would have to be very frequent and have a high service quality.

The costs of the system.

Underground systems are very capital intensive. On the other hand operational expenses are low because the transport is automated. The research indicates that about 80 percent of the costs of ULS are capital expenses. In road transport 75% is labor-related.

The investment costs are high because of the separate infrastructure. There are numerous ways to build such a system. The "Bouwdienst Rijkswaterstaat" (Fokkema c.s., 1998) conducted a research towards 13 construction methods, 9 systems of vehicle navigation, 7 systems for traction etc. etc. Each case has its own cost-profile. Let's take one example.

- Pipe jacking of 2 a 2.5 metre diameter tunnel is about Euro 5.000 per metre.
- A City Logistical Park (at the edge of a city, with transfer from road and rail) is about 10 million Euro
- a city outlet is about 5 million Euro
- Vehicles, computers and power-management systems are about 10 million Euro.

A system for the city of Utrecht is estimated to cost about 100 million Euro.

This system can transport 80% of all goods to be transported to the city-centre, reliable, just in time and with an very important effect on the environmental quality of the city-centre.

Pilot projects : The ULS-Aalsmeer-Schiphol-Hoofddorp (OLS-ASH)

Since some years the OLS has been in development. It is a system for underground transport of goods between three places: Schiphol Airport, the Aalsmeer Flower Auction and a rail terminal still to be built near Hoofddorp. At this rail terminal the OLS will connect to the railnetwork.



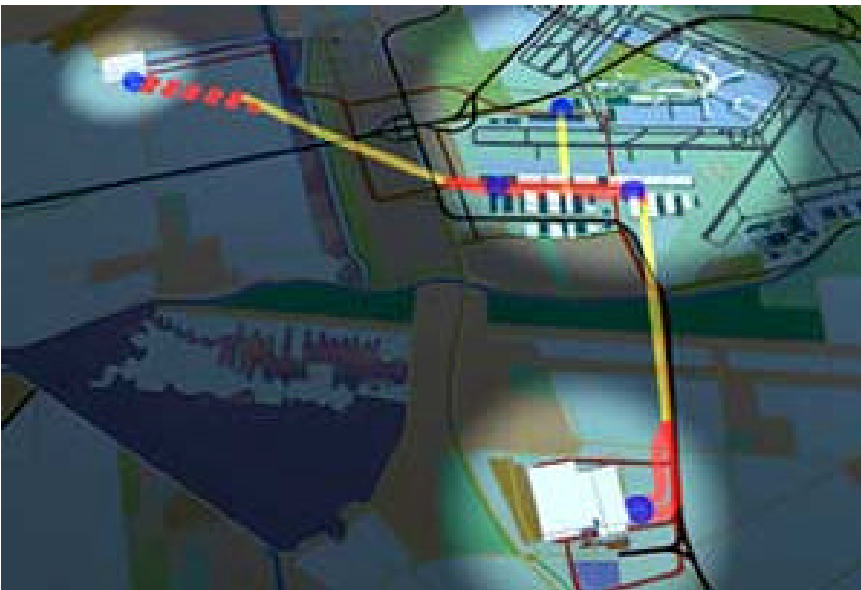
The OLS is an initiative of Amsterdam Airport Schiphol (AAS) and the Aalsmeer Flower Auction (AFA). This initiative resulted from the expectation that the congestion on the roads around Amsterdam will increase. Nowadays, the

supply and distribution of goods over land both for Schiphol and for the Flower Auction takes place completely by road. For time-critical goods, like air freight, flowers and fruit the congestion is an increasing threat, because stagnation in supply or distribution badly affects the quality of the products and disrupts the process in the industrial column (a morning paper no longer has much value in the afternoon).

The OLS combined with its connecting railnetwork has to be a substitute for the road transport of time-critical goods from and to Schiphol and from and to the flower auction. With regard to airfreight, it is also a matter of substituting the transit transport: air freight at Schiphol destined for transit to other European airports (Schiphol's mainport function) is increasingly transported by road instead of by air. OLS and rail will partly be able to take over and reinforce this function.

The route chosen has a length of approx. 13 km and runs from the flower auction through the freight areas on the southern side of the airport to Hoofddorp. The system will fully run underground and will only come above the ground at the flower auction and the rail distribution centre.

Beside the directly involved parties already mentioned, many more parties are involved with the OLS, viz.: Centre for Underground Building (COB), Centre for Transport Technology (CTT), Netherlands Distribution Country (NDL), Air Transport Association Netherlands (ATAN), Railway Task Organising Management, Rail Infra Management and Rail Netherlands, the municipalities of Aalsmeer and Haarlemmermeer, Directorate-General for Transport of Goods and Department of Waterways and Public Transport North Holland, knowledge institutions (among which TRAIL Research School), shippers, suppliers, building companies, financial institutions etc. The OLS is



a complex project, if only because of the many various parties concerned, each with its own interests, in which good communication and understanding of the different interests are critical factors in the process. This is enhanced by the nature of the OLS: though many technical components have been tested, the system as a whole is a novelty. It relates to a conceptual development which, in a dynamic process, will have to result in a functional and physical design. Besides, in a social sense it will have to offer sufficient additional value. The relief of the road network, the positive influence on the activity of a reliable transport of goods, and aspects in the field of use of space, environment, safety and quality of life are issues here.

Because of the application of a mixture of building methods and a partly single-track construction, the investment in the realisation of the OLS Aalsmeer-Schiphol-Hoofddorp will amount to approx. EURO 200 million.

The total OLS project can be distinguished into a number of consecutive phases:

- Feasibility study
- Definition study
- Preliminary design phase
- Draft phase
- Preparation of specifications, construction, establishment etc.
- Building, realisation, foundation, layout
- Exploitation, follow-up and additional research

The first two phases have been rounded off with a positive assessment, so that preparations for the preliminary design phase could be started. Before the end of 1999 an investment proposal will be made for the commitment of various parties to the actual building and exploitation process.

Pre-feasibility studies for ULS in City's.

Pre-feasibility studies have been carried out in the cities of Utrecht and Leiden. In Utrecht the primary goal is to the Inner City where a multi-million investment in shopping & congress centres etc. will take place. An ULS from the edge of the city to the city centre

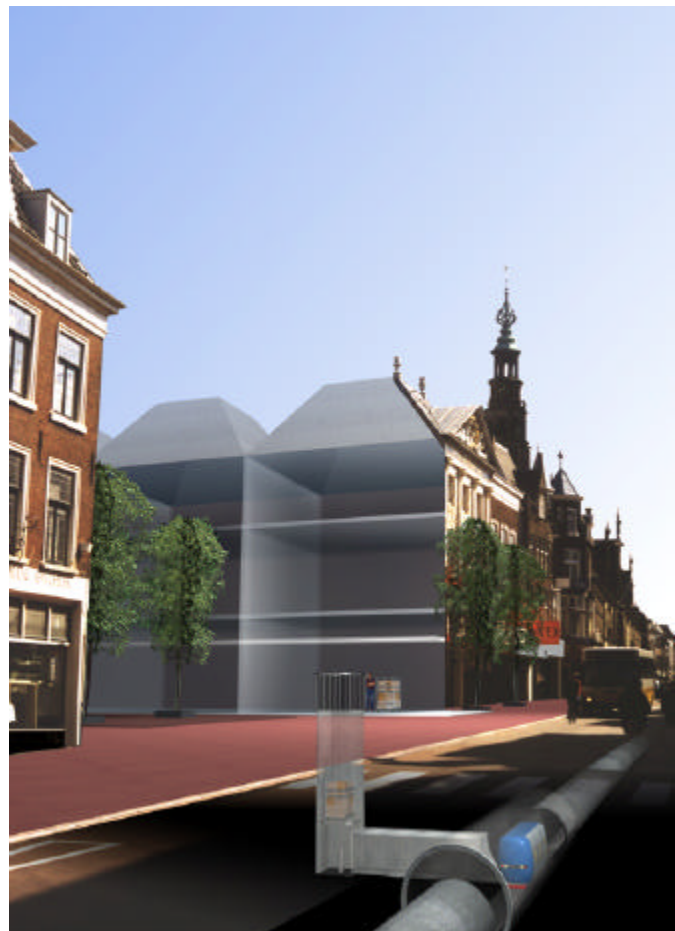
The research indicates that such a system can be profitable if the entrance at the edge of the city is developed as an "Logistical Park" with public warehouse functions and value added logistic possibilities. Also the transfer from long distance road and rail delivery systems must be fully automated.

In Leiden the primary target for the ULS is to protect the historic city from heavy trucks while remaining its economic viability.

Pilot projects, Industrial estates

In September 1999 a new pre-feasibility study will start in the Twente region. The possibilities for ULS on a large industrial estate will be investigated. An ULS will serve as :

- the connection of industries with the barge-terminal (like the brewery of Grolsch),
- the interconnection of the various industries on the estate and
- the connection with a rail-terminal.



Partners are various industries in Twente, the regional development company, municipalities, province and the Interdepartmental Taskforce on Underground Transport.

A regional competitive asset in the 21st Century ?

the prolonging of industrial transport systems. In many industries internal transport is already robotized. Computerisation and the new telecommunication systems make Automated Guided Vehicles (AGV's) a cost-competitive and flexible competitor for the short distance road transport.

The cost of road transport will continue to rise. First because of the rising personnel costs.

Second because congestion will rise and therefore the costs of road transport.

So the question is not IF Underground Logistic Systems will come but WHEN.

The role of government is quite crucial in the development stage. The societal benefits of ULS, noise reduction, emissions, traffic victims have no market power. The government represents the thousands of small interests. So it will be a political decision whether tax money will be spend for the difficult initial stages of a new transport system. The Dutch government has decided to contribute to general research, pre-feasibility studies together with private sector. The more it comes to actual investments the less the role of government. But we may expect also a role as shareholder for Local, Regional and State government in the first pilot systems for underground transport.

Now to the question raised in the title of this contribution to the RSA-congress : Will Underground Logistic Systems mean a regional competitive asset in 21st Century Europe ?

In short : The transport costs of the system by unit of transport will decline the more users will be interconnected by the system. Logistics will be optimised. Just in time delivery for continuous replenishment the standard. The quality of the transport system is high.

My conclusion is clear :

Regions which are early adapters will have an competitive asset in the 21-st century !