THE EFFECTS OF A RAIL-RAPID OR UNDERGROUND RAILWAY ON A REGION

By MAURICE NORTON

Well over a hundred city regions in the world have underground railways operating in their areas or being planned. At the moment few regions can afford to embark on a new system, but in a few years we may find it essential to build either an underground railway, or a simpler version using rail-rapid trains or trams. Even existing suburban railways could be made to operate more efficiently by adopting some of the characteristics of an underground system. Whatever the method used, the effect on the surrounding region will be considerable. This holds interesing possibilities for the regional planner.

Relationship of Rail-Rapid to Underground Railway

First of all, it is necessary to clear some misconceptions. Very few underground railways run entirely below the surface. Montreal is possibly the only one. All the rest have only some sections underground. In Stockholm, for instance, 60% of the whole system runs on the surface, and only 40% underground. London is similar. In essence, most so-called underground railways are surface rail-rapid commuter lines which dip underground only at the city centre, or travel in tunnels where they have to pass through hills or under rivers. Many of the features of the underground system could be applied to a rail-rapid system. They are both designed as public transport systems running on their own rights-of-way to provide a fast commutor system for workers from their homes to the city centre or to other employment centres.

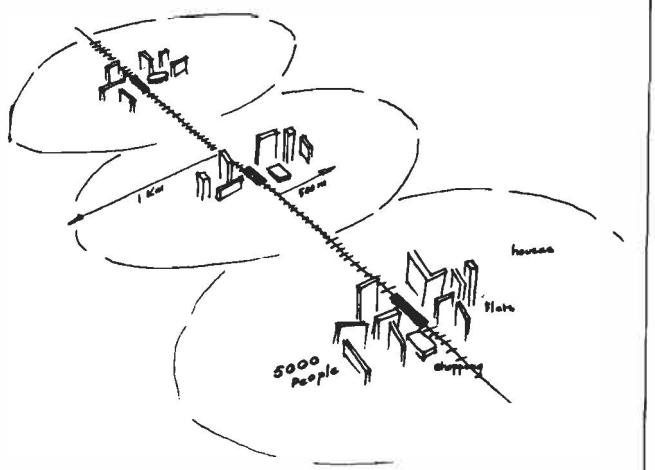
Rail rapid systems are designed to carry heavy commutor loads on fast trains on the surface running at close intervals. To maintain a high safety standard, it is preferable not to mix traffic by having goods or main-line trains running on the same tracks. In most cases, rail-rapid trains are intended to carry heavy commutor loads between selected suburban stations, and within these restrictions they are able to travel at high speeds. Where possible they have their own automatic signalling and train control systems.

The underground railway is essentially a high-density commutor line with fast acceleration and is run and operated on a slightly different basis from the national main-line railway system which carries goods traffic. The tracks must have a wide gauge because of the problems of rapid acceleration, cornering ability, speed, passenger safety and tunnel diameter. Bacause of this, they cannot be linked to the standard national railway, especially in South Africa where our gauge is particularly narrow.

Commutor lines, especially the underground ones, need close integration in planning and operation with bus systems, cars, parking and land use activities, and with malls and open spaces and the many surface activities in the city centre. For these reasons they generally have their own operating companies separate from that of the national railway system. Their interests are essentially based in the region.

Where possible, underground lines run at shallow depths below the surface to save construction costs and the expence of long passenger ascalators. A depth of a mere 16m below the surface is usually sufficient to avoid services, the foundations of buildings, and steep gradients. Tunnelling costs are high and deep excavations are avoided wherever possible unless the deeper strata are particularly favourable, as in the case of London's clay layer.

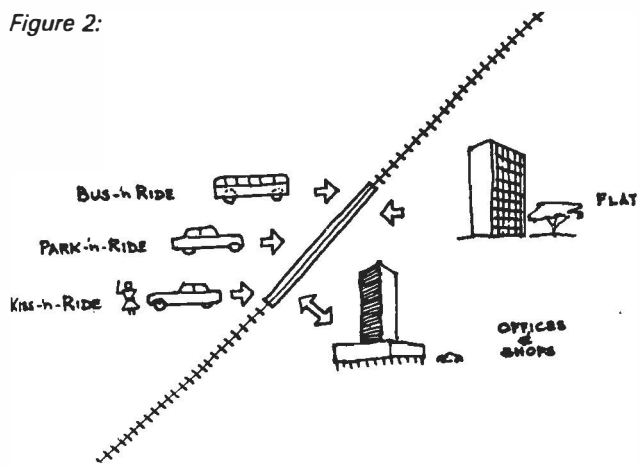
Figure 1:



DEVELOPMENT OF NODES AT STATION

ACTIVITIES AT UNDERGROUND STATIONS

Figure 2:



Regional Land use and Travel

Many metropolitan regions of the world have daily commuting up to 150 km from the city centre, and, beyond this, a ring of influence with some commuting up to 150 km, varying with the size and importance of the city. Depending on physical features, rail lines may run in tunnels which cross under the city centre and its fringe activities, and run for 5-8 km outwords, coming above ground as soon as possible where a suitable surface route can be found. Stations are usually placed 1-2 km apart. Where possible stations are located to serve existing regional activity modes, employment centres or high-density residential areas. Stations are also placed to give direct access to bus termini, car parks, freeway outlet points, and the stations of the main lines that cater for the outer area of influence and inter-city travel, so that commutors can come in from all parts of the region and change to the fast underground trains for the last part of the journey into the city. In Stockholm the objective has been set of having a potential of some 5 000 commutors at each station to improve the viability of the line. It is interesting to note that in Stockholm's outer areas where villages were at too low a dencity, the commutor line has deliberately avoided the centre of these, leaving them to be served by buses linked to the new stations. These stations are built in the centre of new high-density suburbs which have been planned around them to provide the necessary passenger potential when combined with the extra input of bus passengers from the surrounding low-dencity areas.

The effect of these land use policies has been to take surface lines out into the surrounding urbanised areas and create a string of employment , high density residential or transport interchange nodes throughout the region.

Where the line is no longer economic by itself, bus and car routes radiate out from the node into the surrounding region. The distance reached from the city centre becomes a function of the number of passengers that can be carried. Often the end station on the line is a major new node created to serve the region. As demand increases, the line may well be extended beyond this to a new centre.

One of the great shortcomings of our present regional thinking is that we build public transport to cater only for the peak-hour flow into work in the morning and the return journey in the afternoon. Mostly we have concentrated the places of work in the city centre. For example, two-thirds of Johannesburg's employment is concentrated in the core six square kilometres. If we were now to introduce the principle of reverse flow by carrying workers to their employment in the opposite direction to the city centre, so that in peak hours we run public transport vehicles full in both directions, we can double their use at no extra cost. This can consciously be done by creating attractive new employment centres along the public transport routes in the opposite direction of flow from the city centre. In other words, Land Use can be planned to make the public transport facility more economic. Returning to the underground railway concept, by planning large residential and employment centres away from the city centre we can improve the paying capacity or loading of the public transport system, but, more importantm we can plan and carry our required developments in the urban fabric. This tends to make the urban area more compact and accessible, and this is in the interest, not only of the Transportation authority, but also of the city and all its people.

The rail system in various countries show how important it is to coordinate the activities of Land Use development and all the different modes of travel. Such a transportation system serving the total urban development of the metropolitan region is very costly, and to make it economically viable careful planning and close coperation are vital. In South Africa, so far, rail commuting has developed as part of the national main line system, while in the cities bus services, freeways, roads, taxis and pedestrians have tended to be handled separately in an uncoordinated fashion. Each of the different modes of travel has been developed without much thought for its interaction on land use, or its inherent characteristics related to the other modes. Following North American cities we have based much of our thinking and planning on the motor car, without realising the two major problems that it brings, namely congestion at the city centre and increasingly high costs caused by the scarcity of fuel. On the other hand, the planners responsible for ordering Land Use activities are not in a position to provide solutions to the interaction problems. Freeways may provide some relief of congestion, but not in the city centre, and there is little coordination of the different bodies planning and operating transport systems.

Coordination

One of the key lessons that can be learned from the many cities that have built underground railways in the last twenty years is that one cannot attain any degree of economic viability on a new expensive solution until a single transportation body has been set up to replan and coordinate the operation of all transportation throughout the metropolitan urban region, together with its land uses. In numerous cities such as London, Washington, Toronto, Montreal, Stockholm, Philadelphia, Munich and Rome I found that only after the operations of the bus, train, taxi, freeway, parking authority and traffic control organisations had been brought under the control of one Transportation Authority was it possible to introduce an underground railway without risking economic failure. In most cases this one authority took over the right to replan the operations of the various components so that they could become complementary operations.

Figure 3:

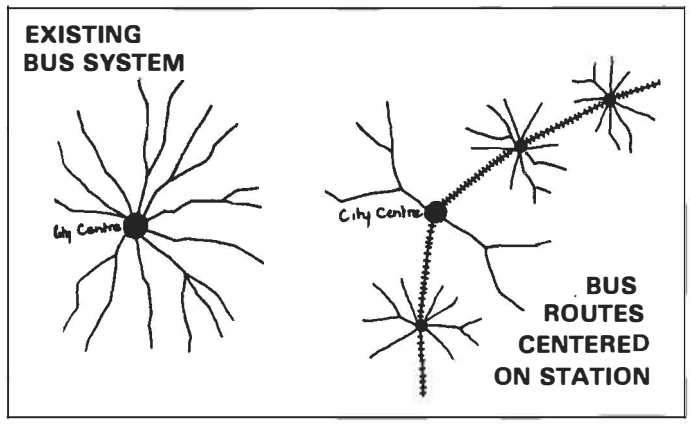


Figure 3 shows a typical re-organisation of existing bus routes so that the buses will eventually serve stations on the underground or rail-rapid system and not run into the city centre themselves. The change was introduced in each case to make each system operate efficiently in the way that suited it best without duplicating the operation of another system. How often haven't we seen a bus line-haul route running parellel to a rail route and in competition with it? The one system should not entirely displace the other, but they should be interdependent. It was particularly noticeable how in Montreal, when surface transport was hit by bad weather, or when the underground railway was crippled by a strike, the other transport system was able to be reorganised to take over its commutor load. This coordination actually took place in one room as the two operating centres for buses and trains were in the same building on the same floor.

An organisation to coordinate planning and operation of major transportation companies in this way can only be set up by government action at high level. New types of powers, and the financial provision to carry out imaginative and far-reaching schemes of this type must be made available to meet the needs. Obviously, also, highly qualified and skilled staff and management are an essential part of the operation.

In South Africa at the present time we have an excellent opportunity for setting up such coordination under the Transportation Authorities proposed by the Driessen Commission report, which gave rise to the Urban Transport Act, No. 78 of 1977. Due to the high cost, few South African cities will eventually be able to build underground railways, but it may well be that they could create a similar movement pattern with rapid-rail lines or bus-ways and tramways. The interaction of such a system with Land Use reconstruction provides interesting possibilities for the planner.

Planning Potentials

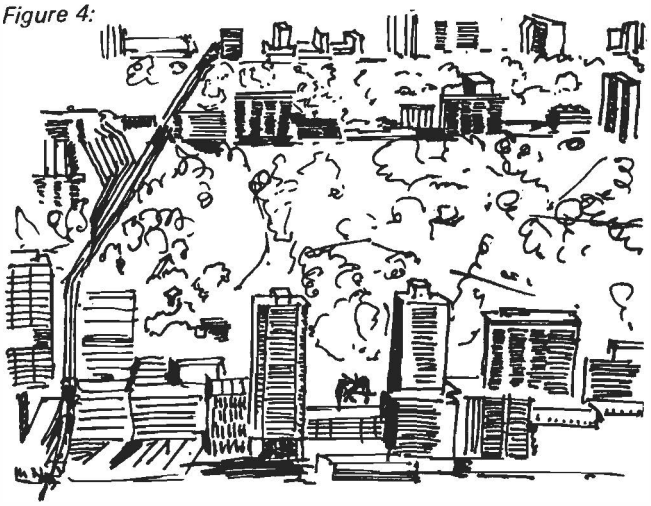
In introducing overall coordination of all forms of transportation for planning their underground railway systems, the various cities mentioned have found that the effect on Land Use development has been far-reaching. In transportation studies in the past we have taken account of existing Land Use and its estimated future demands, and on the results of these calculations have planned the future transportation system. Often we have missed the possibilities of reconsidering eventual Land Use alternatives as a *result* of the transportation recommendations. For example, it has been found on many underground rail

systems built overseas that the demand for extra floor space in offices, flats and dwelling units within easy reach of the railway stations has increased enormously *at many points* in the metropolitan region.

This increasing demand opens possibilities for the creation of new modes. If we can anticipate the possibilities of the swing to increased public transport, we could, at an early stage, examine alternative forms of Land Use in the region. The planning or transportation authority could even consider buying land for development, rezoning and sale to finance the acquisition of land for the stations. Creating or planning extra urban growth at the sites of future stations would help the viability of the rail-rapid system. Alternatively, completely new nodes could be created in between present urban centres to give a more even loading along the rail line. This calls for a very real imaginative and positive planning input to the LandUse/Transportation planning process. It could lead to a freer approach to our long-term goals for improving the quality of the urban environment.

Examine for a moment the changes that are affecting our urban areas at present. We have recently entered a time of energy crisis for which there is no clear answer. Oil-based fuel supplies are being reduced and costs are rising. The cost of cars is also very rapidly rising. Free movement by car may well become too expensive for the average individual. On the other hand, coal is plentiful and could be converted to electricity, though here also costs are rising fast. Public transport can be run on electricity, e.g. for rapid rail and tram systems. Buses are at present dependent on oil, but battery power is already a possibility. Although other more plentiful energy sources may become available in the near future, at present electricity seems to hold out the best hope. In terms of metropolitan-wide transport this would appear to favour the fixed route rail-rapid/underground railway or the light rail/tram system. If, as is anticipated, our metropolitan population doubles by the year 2 000, large-scale housing and urban development will have to be planned. This will include renewal and rehabilitation of existing buildings. Planning of these facilities should give more opportunities than were available in the past. Type and location of employment is likely to be different in the next thirty years, and may well be more flexible, less place-related and able to be moved to outer areas. In other words, it would appear that there is a great need for planning new housing and creating new employment centres by the end of the century in a much more compact area based on transport facilities available. To keep this growth compact enough to keep down travel costs we will probably need to rebuild existing housing in its present location but at higher densities. New centres should be close to existing rail facilities or small extensions of them to allow for more efficient use of the system. The experiences of cities that have constructed new underground railways can be very relevant to these plans.

Figure 4:



NODAL DEVELOPMENT AT STATIONS — TORONTO.

Progressive Development of Public Transport

The Driessen Commission Report has given us some very clear goals to strive towards in our urban transportation:

> to improve *mobility* and *convenience* for all trevellers at *reasonable cost* with *minimum side effects.*

This is particularly appropriate in times like the present of rapidly rising costs and a lack of clarity in direction and priority on the part of everyone, but particularly government authorities.

One way of applying these goals to public transport in the metropolitan region is to experiment with a progressive program of development of transport facilities. So many people seem to think in terms of 'Underground or Nothing' and if the possibility of an underground seems to be rules out by the costs, then nothing is done to change the existing transport system. But obviously the planning of an underground railway is a good example of planning a fixed location public transport system closely related to expanding urban development. There is much to be learnt from experience in other cities. An underground railway is an expensive solution and is only suitable for a highly concentrated compact but large urban region with a population, preferably, of over half a million. Low densities, outward sprawl and long distances between stations at centres of activity all cause inefficiencies and make the system very costly. Rail-rapid systems, suburban railways (as in South Africa) and tram systems are all being tried as less expensive, light capacity forms with many similar characteristics to those of the underground system itself.

For instance, appreciating the ideal form of the underground system to which it may aspire, an urban region might start off by planning the eventual route to serve its future development and by establishing a structure for future Land Use development. It may even be possible to decide on future locations for stations and even acquire the land needed for stations and their surrounding activities. If the Transportation Authority buys more land than it needs for its own purposes, such as parking, stations, etc. as well as future flats and offices, it then has freedom to plan and build for its needs with spare land to sell at a profit later. This, in fact, is a good method of financial land purchases. Long term plans for routes of the underground railway or for location of stations would have to be kept a closely guarded secret to avoid speculative competition.

As a first step the transport authority or the local authority could run line-haul bus services approximately along the route, or establish special rights-of-way for buses to allow for rapid services. Improvements such as these could result in reduced travel times and tend to attract added ridership to public transport routes. Ons is impressed by the speed of travel in a bus moving fast on an unimpeded busway alongside a congested road. As ridership increases and the demand for public transport trips improves along the route, the transportation authority may well consider introducing a trolley-bus or tram system along the 'busway' route. A few decades ago the tram systems in many cities were taken away in favour of the more flexible bus routes. The trams had many faults, such as noise, staff costs, interference with car traffic etc. but they could carry fairly large numbers of passengers. Many cities, particularly in Europe, have re-introduced the tram in improved forms which are proving very satisfactory. If these routes have been carefully designed, it may well be possible to develop the tram system later into a lightweight rail-rapid system or even a light underground system, as has happened in Goteborg in Sweden. Obviously the right-of-way must be so arranged to avoid interference with surface road traffic at intersections. When surface traffic builds up too much towards

the city centre, a change may have to be made to take the system underground. No city has followed all these stages through in the development of their own underground railway system, but the stages illustrate the development of the concept. Many cities have recently introduced some stages, such as busways, tramways, or light tram/underground systems. Development of the full sequence is a feasible proposition.

In South Africa some cities have already got a suburban system operarted by the South African Railways which is nearly equivalent to a rail-rapid system. Some have special lines operated for black or non-white commutors only, which provide up to a quarter million journeys to work each day. In part these railways are supplemented by commuter buses, taxis and private cars, but these generally have to use heavily congested streets. Cape Town is exceptional in that it has a fairly extensive and efficient suburban commuter rail system serving white as well as non-white areas. This handles approximately 60% of the non-white and 30% of the white daily work trips into the city cente.

Land Use Structure

In cases where the rail line exists, Land Uses in the metropolitan area could possibly be more densely developed near to these commutor lines, and particularly to the stations. In the past there has been a tendency to place rail stations near to suburban shopping centres. But perhaps Land Uses in the vicinity could be more fully integrated with the stations in a more conscious attempt to strengthen the activities at the stations and increase ridership on the suburban line. These nodal centres could be planned to develop as foci for transportation routes, for bus termini, for taxi ranks, and for daily commutor parking garages as well as being closely related to shopping centres, decentralised nodes of employment and nodes of higher density residential areas.

These station nodes would form hierarchies of urban centres and transportation interchange. Not all would be of the same importance, but they could form a useful framework round which to structure our future land use planning or renewal of the existing development. Accentuating the stations could lead to much greater use of the existing asset of the railway. We would be doing ourselves a service in putting the accent more on existing public transport and less on unbridled use of the motor car.

Costs

Comments on the effect of an underground railway would be incomplete without mention of costs. Capital costs of construction of an underground are high — too high for any local government to pay on its own. Most of the cities visited were being subsidised for 80-90% of their capital costs by the Provincial and central government. (Note: this percentage subsidy is similar to that paid on freeways, expressways and main roads in the Cape province.) Land acquisition is not generally a large amount. Where the line is underground, nominal compensation only is paid, though buying land for surface rights of way is expensive. The major costs are buying land for stations, bus termini, parking etc. The method mentioned earlier of buying more than enough land and selling off the remainder with high bulk zoning is a very good way of recouping most of the land costs for the whole system. Many cities are beginning to realise this advantage and are also planning to sell air rights over the tracks for development of large office buildings and flats. Running expenses on the lines are only partly covered by revenues, and may also have to be subsidised.

Where the lines or right-of-way already exist in a city, the capital cost will be mainly for rebuilding stations and their other interchange facilities, rolling stock, signalling etc. These high costs cannot be ignored, though they will obviously be lower where a start is made with a less complicated system, such as trams or rail-rapid. But by careful use of planning powers for zoning and land development part of the costs can be covered. The costs do, however, accentuate the need for very careful coordination and planning throughout the region for all forms of transport and Land Use. Close cooperation and commitment to the project by all those concerned with urban development in the region can make a success of the change to public transport.

We have had such a long period when the whole region developed in the basis of free use of the car that the inevitable change to public transport will not be easy. We need new thinking in all our planning directed towards more compact urban development with the accent on short journeys to work, less congestion, and efficient use of good public transport. Any methods we can learn from other regions are worth experimenting with if they will help to convince us that the change can be made.

Footnote: Mr Norton was a member of a multi-disciplinary team to investigate Underground Railways in Europe and America by Johannesburg City Council, to whom acknowledgement is made for use of published material.

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