b) Aramis

This is a lightweight transit system by self-propelled pneumatic tyred cars. Carrying capacity is very versatile since the system will manage trainsets of 10 cars or more, and headway between trainsets may shrink to 40 seconds, when the capacity will reach 15,000 passengers/hour.

A first project is planned on territory of the SNCF's former "Petite ceinture" or Inner Ring rail line.

c) Articulated bus

This mode addresses larger passenger loads, say around 4,000 passengers/hour during peaks, which can also handle heavy traffic in the course of the day. In the case of particularly long trips, articulated buses offer a maximum of seated places, and optionally, possible baggage space.

Two routes have currently been outfitted with this type of bus, notably one route running from Paris to Orly airport.

5.2 Integrating the systems

It is clear therefore that the RATP has various subsystems at its disposal : Paris bus, suburban bus, Metro, RER. Each subsystem is in fact a specific transit mode.

Each subsystem can by itself respond in an attractive manner to an aggregate of demands for travel. In addition, there is every reason to believe that in the near future, whether one likes it or not, the transit modes will have to multiply in keeping with the diversification of demand.

Where some of the subsystems are present in parallel, the population may choose between one or the other depending on each patron's appreciation of the overall attractiveness of a given subsystem for a particular trip.

It appears that at the present time the subsystems are relatively heterogeneous, and that transitions between one and the other are not always laid out with a view to avoiding interruptions.

This being the case, the aim will be :

- To determine for the various components of the transit offer the means of integrating the various subsystems of the RATP into one system usable as a whole ;
- To give each patron the means of performing, in a single trip in space and time, over heterogeneous subsystems.

Thus the actions to be taken accordingly may be of several kinds :

- Physical integration i.e. reducing the penality of interchanges, and harmonizing the service coverage ;
- Fare integration i.e. simplifying and unifying the fare rates ;
- Improved signalling means and computerization.

Rapid Transport Systems, C. Podestà (editor)
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1712

TYNE AND WEAR METRO

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Tyne and Wear Metro is basic to the urban development and structure of the conurbation it serves and forms the backbone of Britain's first fully integrated system of public transport. It has been built at relatively low cost by making best use of existing but under-used railway routes and increasing their usefulness by the introduction of new alignments to access key areas. Metro is based on proven technology and its results in terms of passenger carryings, performance and reliability and influence on the local community and economy are encouraging.

INTRODUCTION

The County of Tyne and Wear (Figure 1) was created when local government in England and Wales was reorganised in 1974. It lies on the North-East coast of England some 430 km north of London and has Newcastle upon Tyne as its principal city. The County is a major industrial and business centre with an area of 208.5 sq. miles and a population of 1.18 million. Geographically it lies on the rivers Tyne and Wear, with 0.9 million people living on Tyneside and the remainder in Sunderland district, centred on the river Wear. The County has a largely rural hinterland and Newcastle is therefore the regional capital and a major centre for North-East England in general. It has enjoyed city status since 1080, but existed as a major centre and river crossing point (Pons Aelius) from the days of the Roman Empire and before.

The area was, and to some extent still is, rich in minerals. Coalmining was an established industry by the 14th Century but it was not until the Industrial Revolution of the 19th Century that rapid expansion took place. At that time the demand for coal expanded rapidly and the existence also of local ironstone deposits and other minerals such as lead gave rise to a thriving steel and heavy engineering industry. Tyneside and Wearside became major centres for ship-building and many famous merchant and warships have been built on the Tyne.

Railways were also important: George Stephenson, father of the railways, was born and started work in what is now Tyne and Wear County. By the early 20th Century a comprehensive network of local railways had grown up both to serve the needs of local industry and to facilitate the export of coal from the two rivers. Newcastle was a major staging point on the East Coast main line between England and Scotland.

Newcastle was also at the forefront of the development of electrical power and as a result was one of the first British cities outside London to have an electrified suburban railway (1904), which by the mid-1930s had been developed to serve 42 km of route, along both banks of the River Tyne. There was also an extensive net-

work of tramways.

The introduction of motor and trolleybuses in the years leading up to the second World War and economic considerations which applied after it led to a decline in tramway and eventually trolleybus operation. These events are related to the fact that at the time public transport was paying its way from fares revenue; the profits so earned by the municipally-owned transport undertakings were a useful way of keeping down local taxes so decisions were taken on short-run financial criteria rather than long-run transport factors which would have called for a more searching analysis regarding the best mode and would have involved spending money on infrastructure which had become worn out during the war years. In addition urban expansion was taking place with new estates being built on the periphery of the conurbation; the easiest and quickest way to provide them with cheap transport was by bus. But this was not always ideal as the estates were often designed with only the car in mind, as car ownership was increasing rapidly; public pressure and financial incentives from Government to invest in new roads were great.

By the late 1960s people had begun to realise that the problems of cities could not be solved by roads alone, indeed the economic and environmental problems of attempting to do so were enormous.

Locally this was a time of rapid change. The traditional industries of heavy engineering, shipbuilding and coalmining, whilst still important, were running down and concentrating in fewer, high production units. As a result unemployment was on the increase and new industries, locating in different areas to the ones they replaced, were not moving into the area fast enough to counter the decline. A comprehensive network of new roads had been built mainly outside the densest areas of population and ambitious plans existed for an extensive network of urban motorways. However, car ownership was one of the lowest in the United Kingdom; the trams and trolleybuses had been replaced by motorbuses and many of the local railways had ceased to provide passenger services and such electric trains as remained had been replaced in 1967 by diesel multiple units.

TYNE WEAR PLAN

It was against this background that the land use/transportation study for what is now Tyne and Wear County was put in hand in 1969. The study was commissioned by the Departments of Transport and the Environment as the two Government Ministries responsible and by the local authorities in the area having responsibilities for transport and land use planning; public transport operators were also involved. Together, these organisations set up a Committee to control the work of the study which was in the hands of two firms of consultants

- Alan M. Voorhees & Associates (for transportation)

and

- Sir Colin Buchanan & Partners (for land use)

They were assisted by staff seconded from local authorities.

Tyne Wear Plan reported in two stages; first a transport plan up to the mid-1980s and second a broad land use strategy to the turn of the century. It is the 'Transport Plan for the 1980s' (1) which was the genesis of Metro.

The plan undertook a detailed analysis of the characteristics of, and physical and economic changes taking place in the area and concluded that its transport problems could not be solved by roads alone. The changing industrial pattern,

which was accompanied by an increase in employment in service industries brought with it an expanding need for people to travel longer distances to and from work. This ran counter to past practice where local people tended to live and work in close proximity. There was therefore a need for good public transport to provide mobility in the short term for the majority without cars and in the long term to provide an attractive alternative to the private car.

At the same time, however, investment was not to be in public transport alone. The study called for a balanced programme in investment in roads and public transport. Bearing in mind that there had been a comprehensive programme of road investment prior to and during the study which had generated a momentum of its own, the study recommended first priority to public transport, with the road programme being slowed down over that period to give an annual rate of investment in real terms broadly matching the relatively high rate which obtained at the time.

'Transport Plan for the 1980s' was adopted in 1971 as a forward strategy by the various agencies controlling the study. This broad based acceptance was an important factor in the future development of Metro.

Specifically the Plan's recommendations for public transport recognised that the suburban services operated by British Rail along the north and south banks of the Tyne were not meeting their full potential. They carried less than 5 percent of local public transport passengers, largely because they did not provide good penetration to the central area nor to important local centres such as Gateshead and South Shields. Elsewhere, however, they were well placed to meet local needs. Their conversion to high frequency rapid transit operation with additional stations coupled with new alignments to serve key areas would enable rail to provide the backbone of a fully integrated transport system which would link-in with buses and the motorist and thus help to meet the economic, environmental and social aims of the area.

JUSTIFYING METRO

Responsibility for the detailing and precise justification of Metro was the responsibility of the then newly formed Passenger Transport Authority and Executive. It is first necessary to detail the responsibilities of these organisations and legislative provisions that made Metro development possible.

At about the same time as Tyne Wear Plan was being mooted in North-East England the Government recognised nationally that the organisation and financing of urban public transport was deficient. Operation was in the hands of individual undertakings either in local public or wholly or partly private ownership and there was only limited co-ordination and no comprehensive planning over conurbations as a whole. Nor were there any financial provisions allowing local authorities to invest in public transport infrastructure with the benefit of central government grant such as existed for building new roads.

The White Paper 'Public Transport and Traffic'(2) clearly spelled out the Government's views on the issues and proposed the solutions which were legislated for in the Transport Act, 1968 (3). This Act introduced three important provisions so far as public transport in the main conurbations was concerned. First it made possible the creation of Passenger Transport Authorities and Executives, and second it put the financing of public transport infrastructure on the same basis as road investment, namely that approved schemes would rate for a 75 percent Government Grant towards the cost of construction. Finally it made possible the payment of subsidies towards the cost of operation.

A Passenger Transport Authority and Executive were set up on Tyneside in 1969.

The role of the Authority - a political body made up of representatives of local Councils in the area together with two members appointed by the Minister of Transport to give a total of 17 - was to determine the broad public transport policy for the area and to detail the resulting financial policy. The Executive, comprising professional Directors appointed by the Authority was responsible for planning and securing a properly integrated system of public transport to meet the needs of the area. This would have to take account of the wider transportation and land-use policies of the constituent authorities.

The Executive's operational element was initially made up of the bus fleets of the previously municipally owned bus fleets of Newcastle and South Shields (Sunderland was subsequently incorporated in 1973 as a forerunner of local government reorganisation). Clearly not all public transport services were provided by the Executive and there existed a significant proportion of bus services provided by local subsidiaries of the National Bus Company (a nationalised industry) as well as British Rail's suburban services together with buses run by some private operators. The Act provided for the Executive to enter into agreements with such operators to provide a comprehensive network.

The new organisations had been created in time to participate in Tyne Wear Plan both at control and working level. In processing the public transport recommendations, more specifically for Metro, they had three distinct tasks

(a) Physical feasibility

(b) Financial justification

(c) Authorisation to construct

Physical Feasibility - The Metro recommendation involved converting 42 km of British Rail suburban line over which freight and other traffic operated to a new type of high frequency operation which would require, as far as possible, exclusive user of tracks. It was therefore first necessary to establish with British Rail that conversion could take place, with accommodation being made for other traffics either by re-routing or the provision of alternative facilities. This work was completed early in 1972.

Financial Justification - Investment in new roads had long been justified by a relatively simple form of cost benefit analysis which had by the late 1960s developed into a standard, national formula. Public transport schemes to be justified under the 1968 Act provisions however required a specific and detailed analysis.

Initially the Executive commissioned a study - the North Tyne Loop Study (4) to examine public transport provision in the area served by the most heavily used local suburban railway. A number of alternatives including conversion of such parts of the railway as might be available to a busway were tested with the result that the best solution was found to be an integrated system based on light rail operation (so confirming the Tyne Wear Plan strategy) followed by a network of buses on ordinary roads.

This led to a detailed analysis of the whole area, comparing the investment solution involving integration based on Metro with a non-investment case relying wholly on conventional but comprehensive bus services. This analysis embraced both cost benefit techniques (which on a searching basis gave a rate of return of 10.8 percent) and wider but less easily quantifiable factors relating to land use development and the broad economic aims of the area. The Tyneside Rapid Transit Analysis (5) was submitted to Government in Summer 1972 and a favourable

Fig. 1

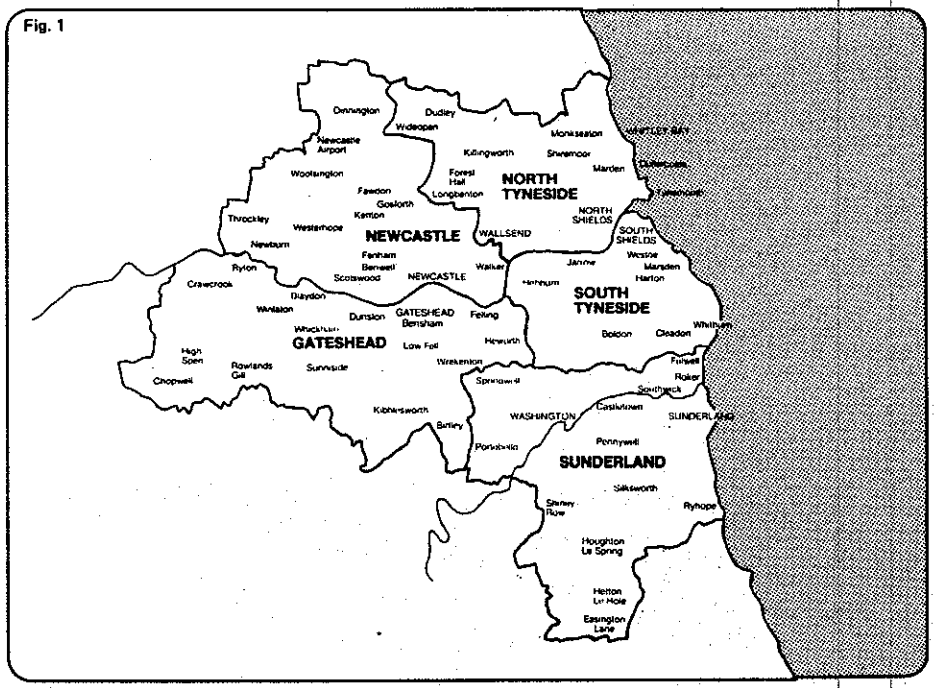
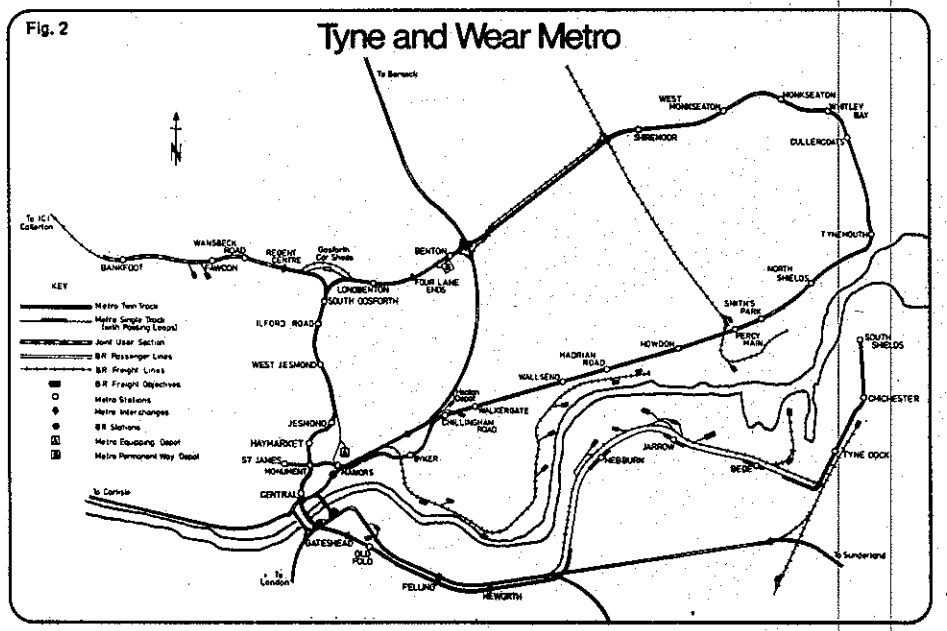


Fig. 2



decision received before the end of that year.

Authorisation to Construct - Local authorities in the United Kingdom have general powers to acquire land and build roads but, with some minor exceptions, specific approval of Parliament is necessary before railways can be built. It was therefore necessary for the Executive to promote the Tyneside Metropolitan Railway Bill which became an Act of Parliament (6) in 1973. This Act authorised the purchase of the necessary land, the carrying out of the required construction works and provided for agreements to be made between the Executive and British Rail regarding the ownership and operation of Metro.

THE CONSTRUCTION ORGANISATION

Within three years of having been formed, the Executive found itself faced with building and implementing the country's largest single urban transport development this century. At the same time it was a small organisation, comprising central functions including a relatively new planning department and two divisions concerned with running a fleet of some six hundred buses.

From the outset the Executive decided that it must take the lead in specifying the technical and operational requirements of Metro. It did not, however, wish to recruit a large organisation for design and to engineer individual contracts; rather it preferred to employ key personnel who would eventually play a part in running the system and employ consulting engineers for detailed design and to supervise building. Five such firms were appointed on the basis of the specific experience (tunnelling, bridge building, mechanical and electrical services, etc). In addition the Executive acted as Engineer to certain contracts such as signalling and communications having major operational influence.

The Executive decided that Metro must above all be simple and reliable; as a result it should be based on the best available proven technology. Extensive research was conducted at home and overseas, principally Northern Europe, to enable a design brief to be drawn up. A consultant architect working direct to the Executive was used to establish the overall design concept, with individual architects working with the consulting engineers to apply the concept to specific works.

The scale of the works and the number of consultants involved called for a high level of project co-ordination by the Executive. The difficulty of recruiting an established team expert in this task and the fact that they could not be offered continuing employment once construction was completed led the Executive to entering into a contract with a firm of consulting engineers to second a team to work as part of the management group.

Control of the project was exercised through the Metro Management Group comprising engineers, operators, finance staff and project co-ordination reporting direct to the Executive. This Group exercised a high degree of financial control and consulting engineers were required to submit any significant contract variations for specific authorisation.

THE METRO SYSTEM

When fully completed late in 1983, Metro will comprise 55 km of route (Figure 2) made up of 42 km of converted British Rail line and 13 km of new construction. The new construction can be divided into equal two parts - tunnels north/south and east/west under Newcastle and under Gateshead south of the Tyne and surface railway east of Newcastle city centre and through the centre of South Shields. The River Tyne, which runs in a deep gorge is crossed by a new bridge linking

the tunnel sections immediately to the north and south.

The new section immediately to the east of Newcastle crosses the Ouseburn Valley on a long concrete viaduct before running through the heart of an area of inner urban redevelopment where old housing has been replaced by new. The Metro route at this point is along an alignment which was originally earmarked for an urban motorway; beyond there the line runs through a short cut-and-cover section to join the existing railway east of Walkergate.

There is a new section in South Shields where Metro now runs through the heart of the town, replacing a riverside route which had become inconvenient as a result of industrial decline in the area it served.

The north-western branch of Metro between South Gosforth and the terminus at Bankfoot was built by double tracking a previously single track freight line, thus bringing passenger service to an area of rapidly expanding housing and office development, where there is also some light industry.

It is fortunate that over much of the British Rail system converted to Metro, local passenger traffic predominated so other traffics had not to be accommodated. The only section where there is joint operation of British Rail and Metro trains is between Benton Junction and Bankfoot where two freight trains a day in each direction serve lineside factories. Elsewhere British Rail traffics have been accommodated either by building new tracks or by modifying existing capacity. Specifically a new line has been laid parallel to Metro between Benton and Shiremoor to carry freight traffic between the main London-Scotland line and areas to the North East of Tyne and Wear. On the south of the Tyne, Metro uses two tracks of the four-track section between Gateshead Stadium and Pelaw with British Rail trains being concentrated on the other two; eastwards from Pelaw as far as Tyne Dock where the new section begins significant British Rail freight traffic has been accommodated by dividing the previous double-track railway into two single-track lines, Metro having long passing loops through the stations. These provisions help to ensure maximum service reliability for both operators by segregating trains with very different running characteristics.

Metro has been designed to be convenient, reliable, attractive and efficient. These factors have had the major influence on the characteristics of the system, which will now be considered in main categories.

Stations - There were 26 stations on the previous British Rail system; these have been increased to 41 on Metro and four more are shortly to be built. Stations vary from the five underground stations in Newcastle and one in Gateshead to a number of small purpose-built wayside halts. Interchange between bus and Metro as well as provision for the motorist is important, so five stations have specifically been built as interchanges with extensive bus provision and car parking. The latter is having to be extended at a number of locations because Metro is attracting a large number of people out of their cars.

All stations are unmanned. Surveillance is by close circuit television relayed to central control and is now being extended from underground stations and interchanges to the system as a whole; public address is provided throughout and enquiry points allow passengers to speak to the station controller at the South Gosforth Control Centre.

Station finishes have been designed to be light and attractive and make extensive use of the corporate colours of yellow and white applied to vitreous enamelled wall panels which are dureble and easy to keep clean. Station facilities vary from those at major stations where there are large ticket halls,

sales points for season tickets and kiosks for the sale of newspapers and confectionery to simple shelters and ticketing areas at the small halts. A number of stations north of the Tyne have been converted from existing ex-British Rail stations retaining the best of what was available but incorporating new facilities. Provisions have been made for the disabled throughout Metro, with lifts supplementing escalators at main stations, and ramped footbridges elsewhere.

The operation of station facilities and services such as ticket machines, ventilation systems, fire detection, lifts and escalators is monitored by a remote control indication system which automatically scans equipment and notifies faults or difficulties on the station controller's desk.

Rolling Stock - There are 90 Metrocars (Figure 3). Each car is a 27.4 metre long articulated vehicle with the two outer trucks powered by a monomotor and a centre trailing truck. Power supply is at 1500v Dc from an overhead line and contactor control is provided. Normal service braking is rheostatic but with disc braking on the trailing bogie, which has two spring applied/air released disc brake units on each axle. Single units are fitted to motor bogie axles for final braking; should the rheostatic brake fail full service braking can be achieved by use of the air brakes. Electromagnetic track brakes are available for emergency use.

Air suspension is fitted together with chevron rubber springs between bogie frame and axlebox and resilient wheels. One-man operation is accommodated through a one-third width driver's cab diagonally located at each car end and cars can be run in multiple through automatic couplers. Maximum speed is 80 km/h.

Seating capacity is 84 with a crush load capacity of up to 200. Wide door bays with adequate standback areas together with the wide articulation unit help to accommodate standees. The doorbay areas also provide accommodation for wheel-chairs and prams; access is through plug doors with sensitive edges and the car floor and station platforms are essentially at the same level. Platforms are straight to minimise the lateral gap into the car and also to allow the trainman to look back along his train before sounding the warning buzzer and closing the doors. Normal train consist is two cars.

Five diesel electric works locomotives with exhaust conditioning for use in tunnels and a number of wagons and specialist equipments complete the rolling stock fleet.

Fares and Ticketing - Tyne and Wear has a fully integrated ticketing system providing through facilities between bus and Metro. The system must therefore be described as a whole.

The county has been divided into 32 fares zones (Figure 4) each approximately 5 km across. To overcome the traditional disadvantage of zonal fares systems whereby a short journey crossing a zone boundary incurs a financial penalty, up to the first 5 km of travel can be sold in 1 km stages but without the benefit of free transfer between vehicles. Transfers are available on all multi-zonal journeys.

Off-vehicle sales are an important means of increasing the convenience of the fares system and of speeding up bus journey times; also of reducing queueing time at station ticket machines. An extensive range of Traveltickets (season tickets) is available over a range of zones from two to the whole county area on an all-day or off-peak basis to give a total of almost 400 combinations. Individual tickets are available on a weekly, four weekly or annual basis and are

Fig. 3

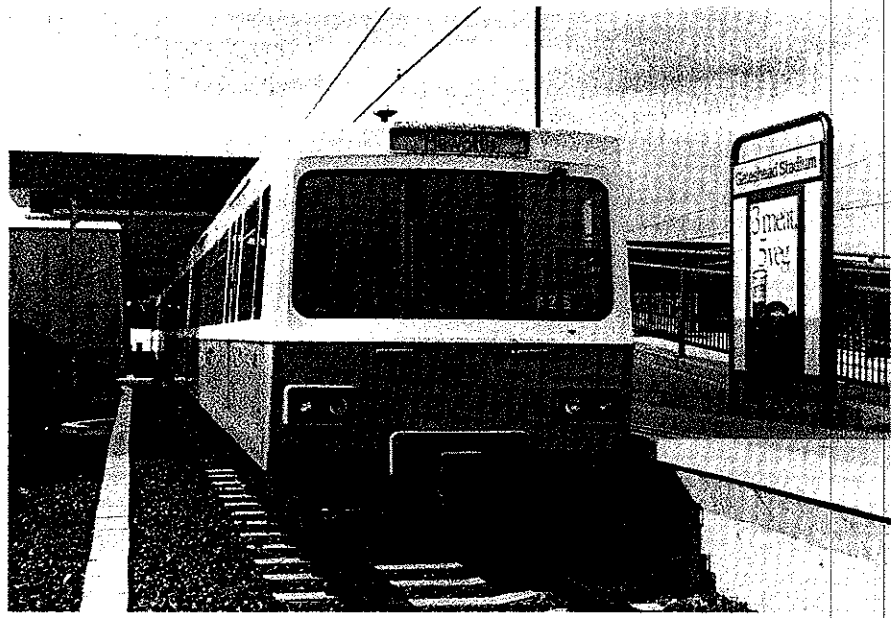


Fig 4

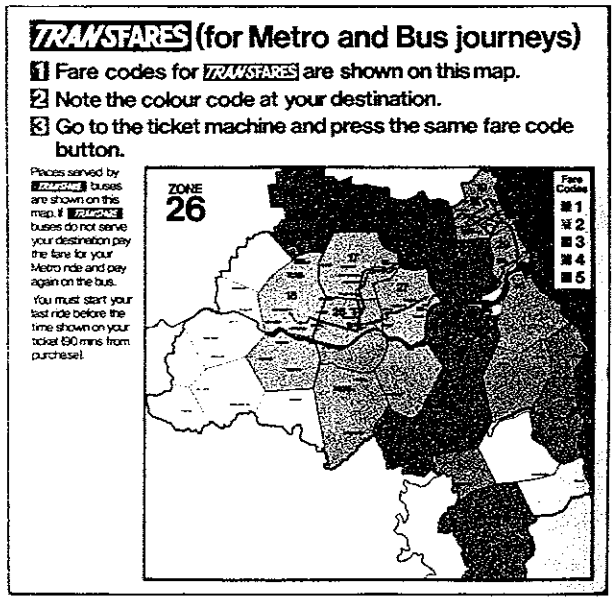
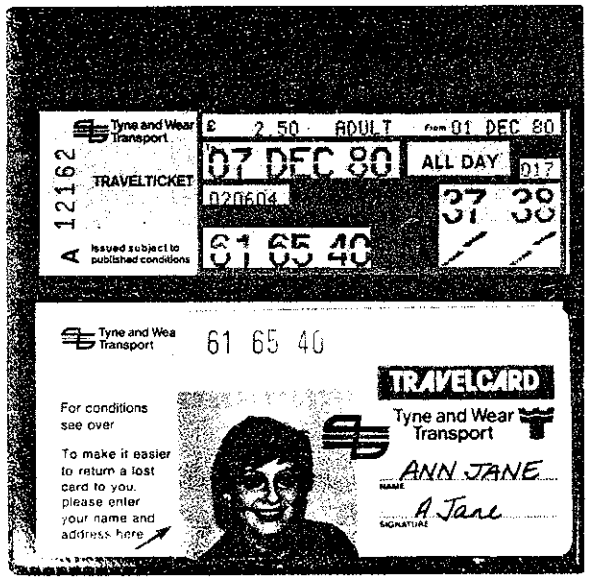


Fig. 5



associated with a photo identity folder (Figure 5)

All through tickets are magnetically encoded for interrogation by the Metro station entry barriers. Single tickets which have a one and a half hour time validity are sold by change-giving multi-vendors at Metro stations which also code, date and timestamp them; on buses pre-encoded magnetic ticket stock for transfer (transfare) journeys is overprinted by the same machine used to issue paper flimsy tickets for journeys made only on the bus concerned. Passengers validate their Transfare tickets by time-stamping them in a cancellor.

Season tickets, and also senior citizens' and disabled persons passes which are provided free by the County Council are issued at Travelcentres manned by transport staff located at main bus and Metro stations and other major transport centres. Key passes to enable parents with prams to use the special wide disabled gate at Metro stations in conjunction with a normal ticket are also available from these centres.

A standard fare of £3 (the normal maximum single fare is 70p) can be charged for those with invalid tickets or who are travelling without a ticket.

Signalling and Control - Safety signalling on Metro is by two aspect colour light signals associated with ac track circuits. Electromagnetic train stops located at every stop signal will actuate full emergency braking should a train over-run a signal. Thereafter the train can proceed at a maximum speed of only 30 km/h until the next signal at clear is reached, when the trainstop will automatically be reset.

Train movements are monitored at an illuminated panel in the central control room. There is provision for manuel control of points and signals but signal and route setting is normally automatic, with on-train equipment set up by the trainman transmitting running number (which is also the radio call sign) and route data via trackside transponders straight into the control computers. Local interlocking panels allow monitoring and control to be exercised 'on site' in the event of a failure of a link to the control centre. Train controllers can speak to trainmen on a dedicated radio frequency. Voice conversations are recorded and there is also a printout of key movement data.

The station controller is responsible for all station monitoring and control, using close circuit television and the remote control indication system which has already been described. Fault indications are immediately drawn to his attention and he can identify the precise location of a fault on his visual display unit to give accurate information to mobile inspectors or maintenance staff with whom he is in contact on separate radio frequencies. He, and the train controllers have a 'hot line' direct to the police and emergency services.

Power control is located in the same control room. The power controller has his own desk and can monitor the whole power supply network from substations downwards; he can also undertake remove switching operations. Equipment monitoring is via the remote control indication system, computer printout and visual display units.

Track and Power Supply - Metro uses standard British trackwork, principally continuously welded 113 lb/yard (55 kg/m) flat bottom rail laid on concrete sleepers set in deep stone ballast. Track in the 4.75m diameter tube tunnels under Newcastle is laid on tied concrete block sleepers set in concrete, and to save weight on a continuous concrete slab over the 815m long Byker viaduct.

The minimum radius of curvature on passenger lines is 210m and there is a ruling

gradient of 3.3 percent. Jointed track is used on the sharper curves, together with high manganese rail where rapid rail wear might otherwise take place. Track gauge is 1432mm.

Power to the trains is provided at 1500v Dc from an overhead line; the choice of an overhead rather than a third-rail system being governed in part by the requirements of United Kingdom safety regulations for new electrified railways. The nine substations are fed at 33/11 kV from the national 'grid' system; each of them has a dual supply fed from separate supply points so as to ensure a high level of security of supply. A dedicated 11 kV ring main connects the three central area substations to maximise security in the most heavily used, underground, part of the system.

The overhead equipment uses standard British and European components and has been designed to minimise intrusion. Twin contact wires are used where clearances are tight, such as in tunnels and under bridges, also in surface stations where it is supported by spanwires. Elsewhere catenary with a single contact wire is the normal form of construction. A feature of the system is the use of irradiated silicone rubber insulators which are small and proof against vandalism.

CONSTRUCTION OF METRO

The first contract for the main system was awarded in 1974 although prior to this a short test track, separate from the rest of Metro had been opened for the testing of two prototype cars and the proving of systems and procedures. There have been about sixty main contracts on the system as a whole, mainly in the hands of specialist firms but with British Rail using their direct labour workforce on sections which involved their own operations. These aspects have been well documented (7, 8, 9, 10, 11).

The tunnels under Newcastle were driven mainly through boulder clay in good conditions although there were areas where water and sand lenses necessitated the use of compressed air. A feature of building the underground stations in the city was the extent of service diversions (gas, water, sewers, electricity etc) and the need to protect historic buildings of good architectural quality. To ensure that where roads were involved the works proceeded smoothly and there was minimum disruption to bus services, the highway authority used traffic management measures to give extensive bus priority. It proved possible to link Monument, the main station under Newcastle, directly into a large new shopping mall, and to create a pedestrian plaza at street level where there was previously a busy traffic intersection.

The ground under Gateshead comprises alternate layers of sandstone and coal seams which were worked as long ago as the 14th Century. It was first necessary to locate and infill those worked-out seams that would be affected by the Metro tunnels. The latter, in contrast to the tube tunnels under Newcastle, are of an inverted 'U' shape because a different method of construction had to be used. Gateshead Station (Figure 6) was built by the cut-and-cover method in an area of filled ground; the bus station at its surface level is designed to be built over.

The Queen Elizabeth 11 Bridge (Figure 7) over the River Tyne is a conventional steel truss girder bridge of bolted construction; the Byker Viaduct was constructed in a difficult location of concrete segments made in a casting shed adjacent to the works.

The above constitute the main features of an extensive system which has been built to a high standard at economical cost.

Fig. 6

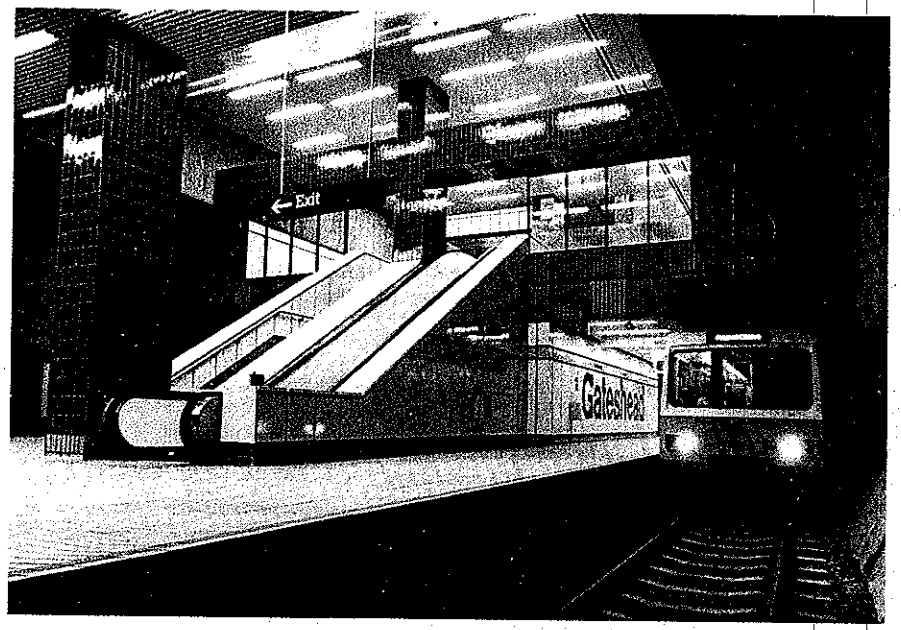
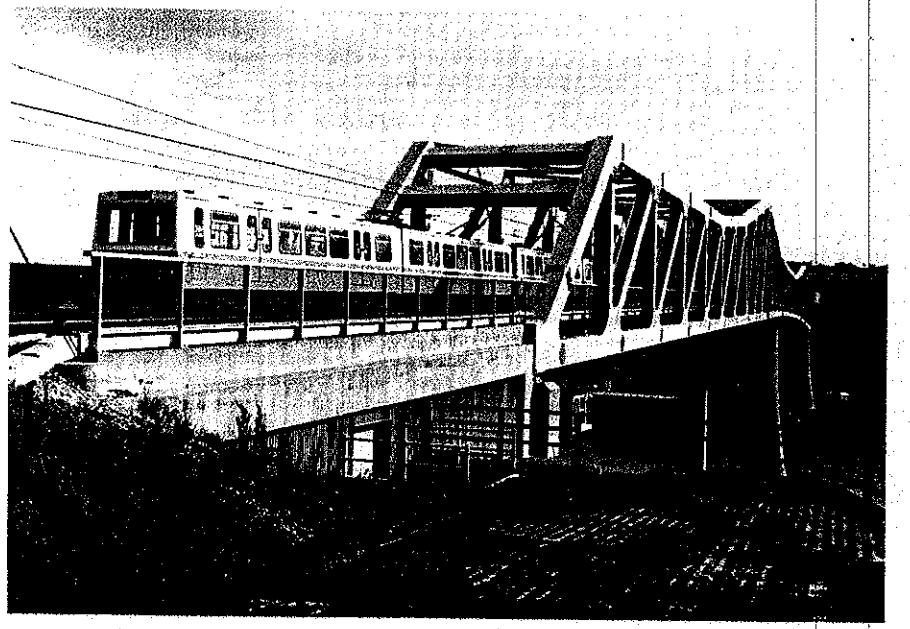


Fig. 7



CAPITAL COST

The initial estimate for building Metro was £65.5 million at 1971 price levels, but this did not include all contingencies and was made at a time when only outline design had been completed. It was the figure on which the Government awarded 75 percent grant, to be adjusted for inflation. The remainder of the cost was made up from local taxation as part of investment in transport infrastructure as a whole.

Metro has been built at a time of high inflation; by 1973 the cost of the scheme had risen to £114 million, of which 5 percent was due to real cost changes; the figure rose to £170 million in 1976. At that time Government which was grappling with the problems of a major national financial crisis called a halt on the awarding of new Metro contracts whilst the scheme was reappraised. The re-appraisal confirmed the rightness of the decision to build Metro it was able to proceed after an eight month delay.

It is now possible to estimate with some accuracy a final outturn cost of £274 million. This is less than 11 percent more in real terms than the original estimate inclusive of all contingencies and includes additional items such as provisions for the disabled (£9 million) and four more stations.

Metro has received £9 million towards building the Pelaw to South Shields section from the European Regional Development Fund.

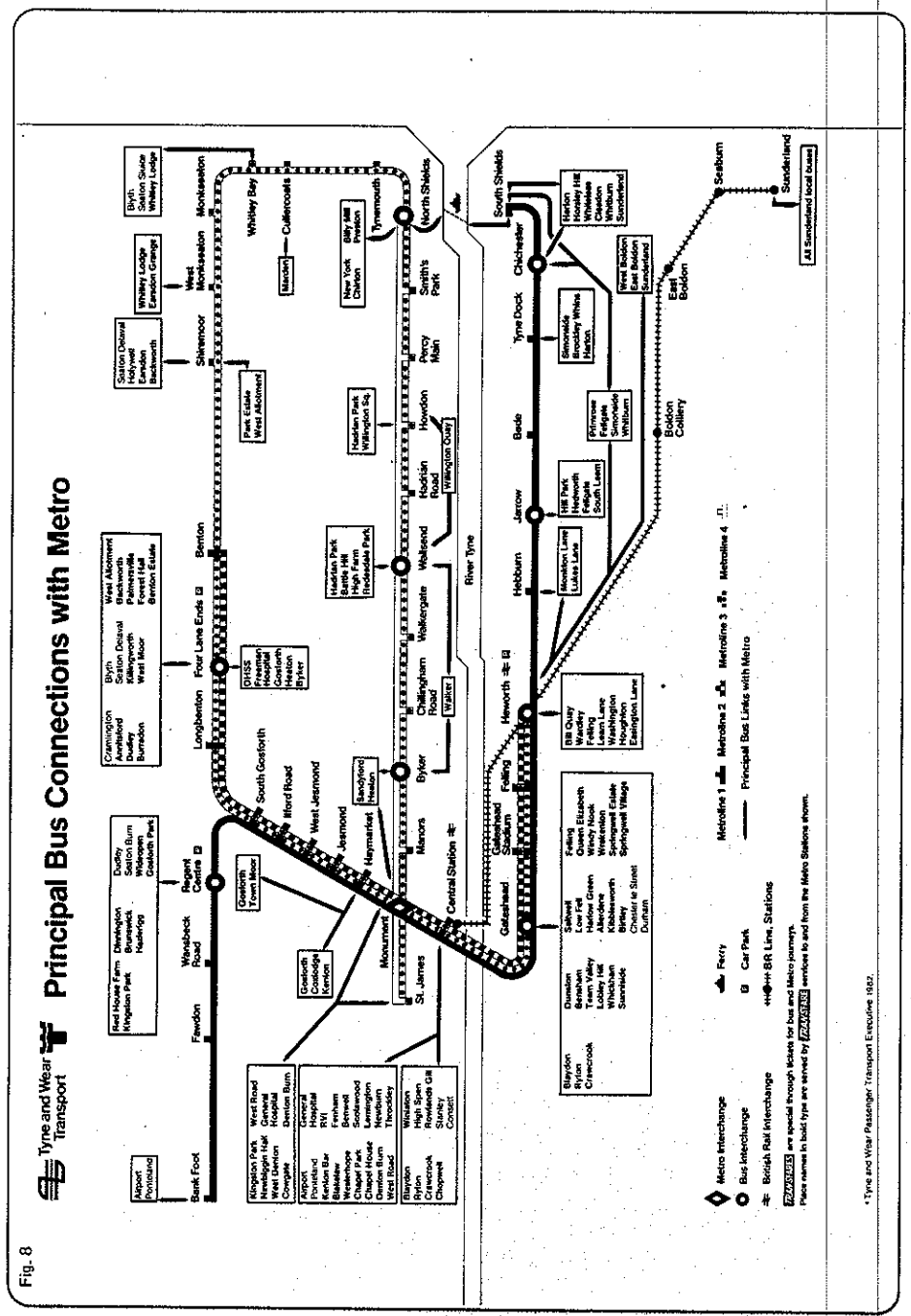
At £5 million per kilometre inclusive of rolling stock, Metro is a low-cost system.

INTEGRATION

Integration is a cornerstone of the Metro philosophy, as is its relation with highways, parking and traffic management. Achieving a properly integrated system has been materially assisted by the local government reorganisation of 1974, when a single authority - Tyne and Wear County Council - was created with responsibilities which included transportation policy as a whole, highways, traffic management and parking. The role of public transport could therefore be set in the context of a comprehensive and consistent policy for the conurbation as a whole, something which could not easily be achieved with the previous individual authorities.

The Public Transport Network - The principle of public transport integration is that Metro, in the areas it serves, provides the backbone of the local public transport system handling the heaviest flows by means of a fast, frequent and reliable service (Figure 8). Bus services are restructured so as to feed Metro whilst at the same time meeting local travel needs - the consequent absence of specific rail-feeder services enables resources to be used to best advantage and buses to operate in areas which are relatively free from congestion. The higher average speeds and increased reliability so obtained are an added attraction to the transport system as a whole. In restructuring bus services the opportunity has been taken to eliminate parallel running whilst at the same time introducing new links which improve network coverage in an economical manner. Major benefits to road users have been the reduction of the number of buses in hitherto congested areas such as over the Tyne Bridges and in central Newcastle and Gateshead.

Not all the County is served by Metro so steps have been taken to provide local services and fast trunk links which as far as possible parallel the principles of the network in Metro corridors - 'Fastline' services using in the main double-deck vehicles with coach-style seating provide rapid, limited stop links between



outer areas and major centres.

The Motorist - Newcastle is the regional capital of a wide hinterland of North-East England. Parking supply in the central area is limited but demand is high, so the County Council's pricing policy is aimed at encouraging the short-term parker whilst discouraging those such as commuters who wish to park for long periods of time. Car parks have therefore been provided at Metro interchanges and at or near other convenient stations, with provision for long-term free parking and for short-term (kiss and ride) parking.

Demand for facilities has been such that the number of parking spaces is now being increased at various locations.

Highways - Metro was conceived as part of a total programme of road and public transport development which envisaged a high annual rate of investment. In the event road traffic and in particular car ownership whilst still increasing has not done so as fast as predicted and at the same time the availability of Government grant has hardened and strict controls applied to local government expenditure. Environmental considerations also became more important.

These factors resulted in a reappraisal of the road proposals with the outcome that many urban motorway proposals have been discarded and other schemes postponed. By reducing the number of buses in central areas and at key river crossings the integrated network has freed congestion and made road space more generally available. Emphasis is still placed on bus priority, which is now directed towards services from those areas which are not served by Metro.

PROVIDING THE SERVICES

Operationally, the PTE is not in a monopoly situation. It runs Metro, buses and a ferry service, with other bus services being provided by the National Bus Company (NBC) subsidiaries (Northern General Transport and United Automobile Services) and some private operators. British Rail operates local services between Newcastle and Sunderland as part of the integrated network and also other suburban services north and south on the East Coast Main Line and westwards.

In terms of bus mileage the NBC subsidiaries are the major bus operator, running some 60 percent of the services as compared with the PTE's 40 percent; however, the PTE buses carry the greatest number of passengers thus reflecting their concentration in the more densely populated urban areas.

Agreement with the NBC subsidiaries was essential to the creation of the integrated system so the County Council and the Executive entered into a Partnership Agreement with NBC under which the PTE carries out the countywide function of financial and strategic planning, publicity and marketing, service planning and system monitoring, with operations being co-ordinated through a joint PTE/NBC Management Committee.

These arrangements have led to a better use of resources such as uniform bus replacement programmes with transfer of vehicles and centralised radio and ticket machine maintenance.

MANPOWER

The basic concept of Metro was for an efficient and economic system with minimum manpower levels. These aims have been achieved and there is - in general - a high level of output which is reflected in international comparisons which will

be highlighted later.

The manpower implications of changing from a largely bus-orientated transport system to one in which rail plays a major part are important. The concept of a 'total pool' of local public transport manpower was conceived, within which transfer could take place to Metro by British Rail employees who would otherwise be made redundant by the replacement of the previous suburban services and by busmen (PTE and NBC) whose services would be reduced as Metro was progressively introduced. This meant breaking new ground as far as the Trades Unions were concerned. A comprehensive manpower policy based on continental rostering, standard hourly payments and co-ordinated negotiating machinery for Metro and bus staffs was agreed, giving good working conditions and a high level of flexibility and productivity. Metro opened on the planned date with the manning levels and practices which had been fundamental to the original concept.

Detailed training was necessary before the new system could be brought into use and it was first necessary to set up a training school and organisation to handle the work, with the assistance of local technical colleges and skill centres. Financial assistance was provided by the European Social Fund and the Metro Training School now provides courses for overseas organisations.

THE RESULTS

Metro has been progressively introduced since August 1980. Its achievements cannot be wholly separated from the performance of the integrated public transport system as a whole, and it would be misleading to do so. This section will therefore consider the performance of the total system in terms of passengers and operating factors and then go on to comment on certain aspects which are specific to Metro.

Passengers - External factors such as population decline, increasing car ownership and most important the economic recession have seriously eroded the base of public transport ridership since the County was created in 1974. The annual figure could have been expected to fall from the 282 million passengers carried in 1975 to 251 million by 1982; in fact, the network carried 310.5 million passengers that year. This is contrary to national trends which show a falling off in public transport ridership.

This increase is attributable both to the introduction of Metro and to the creation of a comprehensive network with through ticketing, all of which have been aggressively marketed.

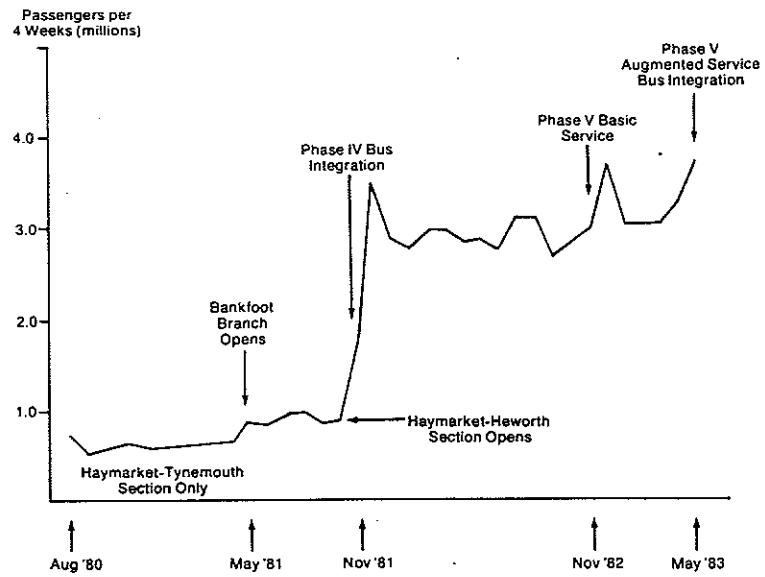
The rise in Metro ridership has been dramatic from the first opening in August 1980, with a very rapid rise when services were introduced over the Tyne in November 1981. The system now has an annual ridership of approximately 50 million representing over 16 percent of the total for public transport; the railways it has replaced carried well under 5 percent of the 1970 total.

Reliability - Good reliability is fundamental to a successful transport system. The need for a high level of reliability on Metro, as backbone of the system, therefore goes without saying. Typically over 99.8 percent of scheduled mileage is operated with under 0.75 percent of them being more than two minutes late.

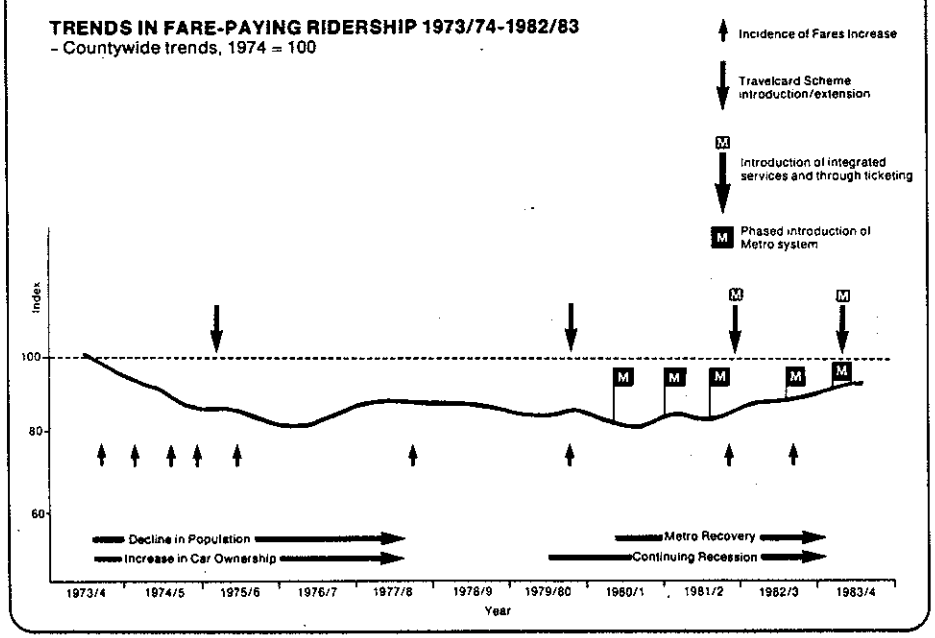
The fact that, as a result of integration, buses in the main now operate in the less congested areas of the county has led to an increase in reliability and a reduction in lost mileage.

Fig. 9

TYNE AND WEAR METRO SYSTEM: RIDERSHIP BY 4-WEEKLY PERIOD



TRENDS IN FARE-PAYING RIDERSHIP 1973/74-1982/83
- Countywide trends, 1974 = 100



Productivity - Productivity comparisons can quite easily be drawn between bus operators because of the nature and extent of bus services in the United Kingdom. The fact that there are only three rail rapid transit systems in the United Kingdom, each very different in character, means that meaningful comparisons are difficult if not impossible.

However, recent work by the Metropolitan Railways Committee of the International Union of Public Transport resulted in a comparison of 26 Metros worldwide being presented to the 1983 Biannual Conference of UITP. Meaningful figures for Metro were not available at the time it was prepared but it is now possible to make comparisons which place Metro high in terms of operational efficiency and output.

Operating Costs - The operating cost breakdown for Metro reflects the levels of productivity achieved, with only 46 percent of the 1983/84 total of £14.9 million being wages and wages-related costs. The next highest single figure is for power supplies (24 percent). The cost per passenger mile compares well with the other elements of the public transport system, figures for 1982/83 being:

	Pence/Passenger Mile
Bus	8.8
Metro	8.5
BR	9.8
Average	8.8

By 1984/85 when the system is fully operational the figure for Metro is expected to be 8.0p per passenger mile, reflecting the full use of manpower and assets which are now deployed to run a system which is only approaching completion.

The overall level of revenue support for the integrated network is 29 percent and fares are adjusted to keep broadly in line with inflation.

Public Reaction - Public reaction to Metro and the integrated system can be gauged from the passenger figures which have already been referred to. There have been some complaints from those whose previously through bus services have been curtailed at interchanges but these are outweighed by the number of people who have been afforded faster journeys to a wider range of travel objectives and who, by virtue of through ticketing have been able to travel more cheaply than before.

Perception of Metro is good and local people appreciate the practical design of stations and vehicles and the high standards of cleanliness which is maintained. Staff attitudes, related to a relatively small number of people being involved in a new system are also good. However, there have been some problems of thuggery and vandalism particularly where Metro runs through 'difficult' areas in North Tyneside. Closé co-operation with the Northumbria Police, who are responsible for policing Metro, is helping to reduce the level of bad behaviour; it is encouraging that stiff sentences have recently been imposed on Metro offenders by Newcastle Crown Court.

Metro is becoming a factor in determining land-use patterns and is influencing decisions on where businesses locate themselves and in the housing market. House advertisements now frequently refer to the proximity of a Metro station, and evidence shows that house prices are increasing more rapidly near Metro stations than elsewhere. Established shopping centres served by Metro have

benefited from it; in particular there is a high level of activity in central Newcastle.

INTERNATIONAL SIGNIFICANCE

There is worldwide interest in light rail systems similar to Metro as solutions to urban transport problems, and an increasing number of them are being built. Britain has much to offer in terms of consultancy and hardware. Metro has played its part in helping British industry obtain orders in Hong Kong and the United States, whilst involvement in the scheme has assisted consulting engineers in obtaining overseas commissions. The Executive has been active in consultancy overseas, recent examples being in Canada (as part of a US/West German/UK team) and Singapore.

FUTURE PROSPECTS

There will always be a need for good public transport if cities are to function efficiently and be decent places to live and work in. There are already commitments to improve passenger facilities such as surveillance and information systems. Extensions have been mooted and will, it is hoped, be built in the future, for example from the existing Bank Foot terminus to the Airport and to Killingworth and Washington New Towns. The timing of these will require justification and the financial support of Government.

CONCLUSION

Tyne and Wear Metro has the merit of having been conceived as part of a total package of investment in transport infrastructure which took full account of land use implications. It can therefore help to fulfil the comprehensive role which public transport should be able to play in major conurbations. Its introduction has been facilitated by the fact that it received broad political and professional support from the outset.

Metro is an economic system in that it makes the best use of existing infrastructure by linking it with new construction. Tunnels and underground stations have only been built where there was no practical alternative. The use of carefully chosen, proven technology and emphasis on simple, durable design has resulted in a reliable and attractive system.

As the background of a fully integrated public transport network Metro's performance and contribution can only be considered as part of the whole. Network design has allowed the most suitable mode to be used in individual situations; marketing the system, regardless of operator, as an entity with a strong corporate image and the provision of through ticketing have attracted significant new business. What could have been a 10 percent decline in passengers from 1975 to 1982 became a 10 percent increase. Staff commitment to the network is good, largely because arrangements have been made as far as possible to use existing transport staff by redeployment and retraining. The desired levels of productivity and efficiency have essentially been achieved without disruption and delay.

It is only 12 years since Metro was first recommended. The system will be completed in full by the end of the year at a cost of £5 million per kilometre and within 11 percent in real terms of the original estimate. It now forms an essential part of local infrastructure and has been described by a respected United States practitioner as a system 'for the world to see - and follow'.

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