ULTRA LIGHT RAIL

Lightweight trams, railcars, people movers

No longer an idea ahead of its time

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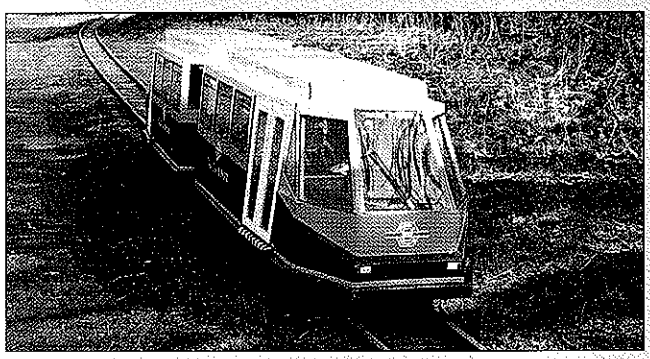
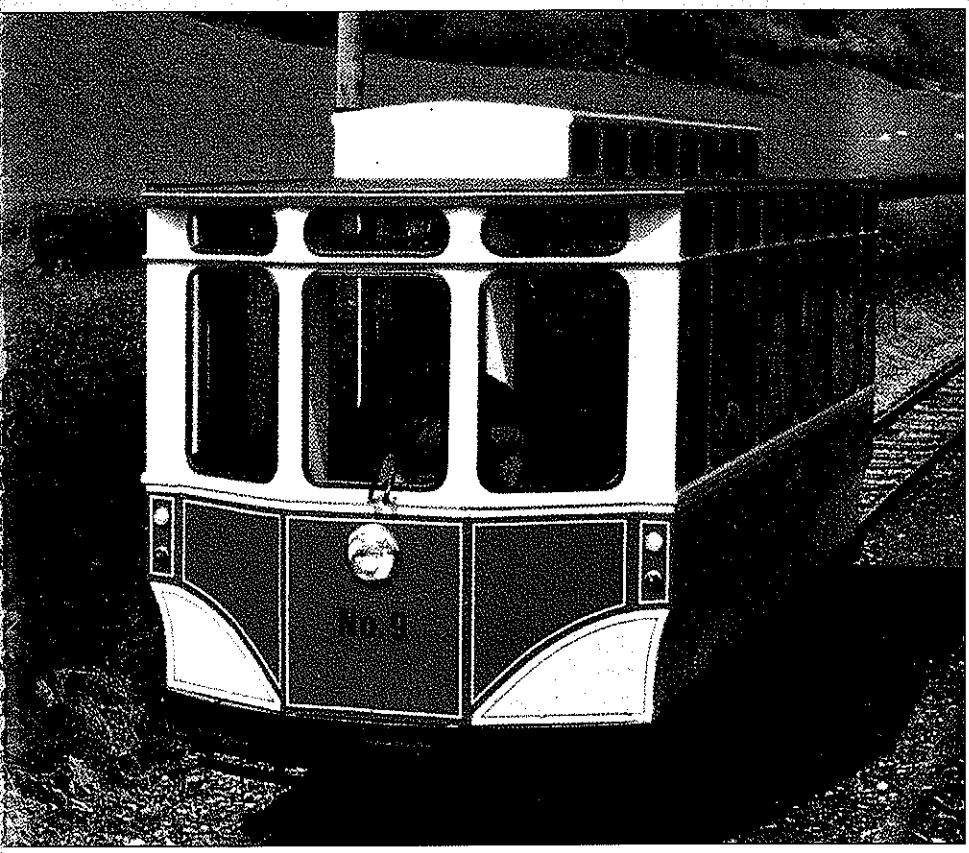
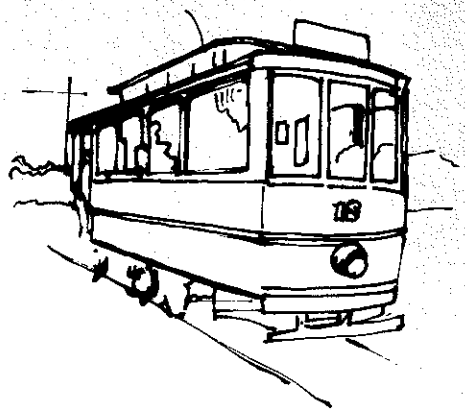
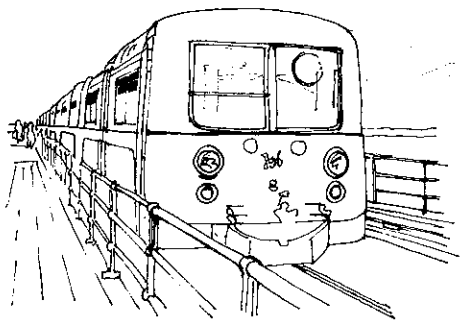
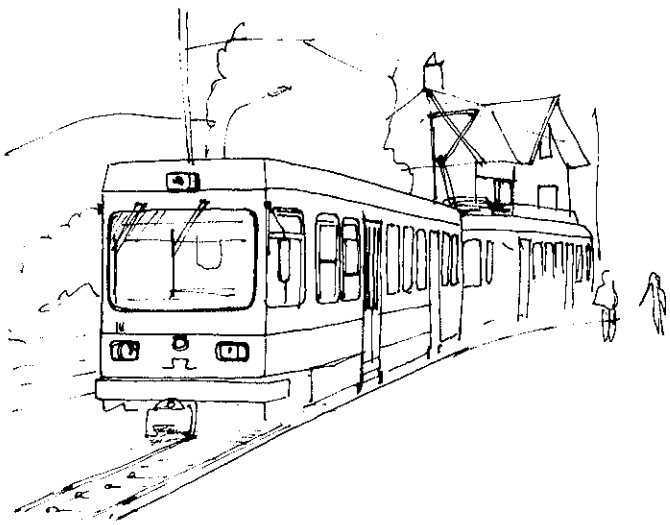










Light Rail & Modern Tramway

SPECIAL SUPPLEMENT

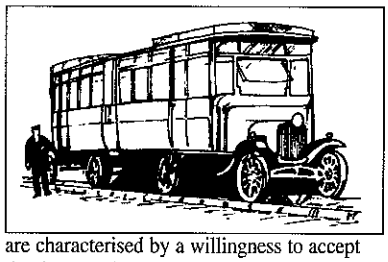
Patricia Watkins

ULTRA LIGHT RAIL

A new approach to street tramways

IN THE HISTORY of rail developments, there are many examples of vehicles or indeed entire systems capable of giving economic service in applications where conventional heavy rail capacity would be under used and uneconomic.

Among these can be petrol railbuses including the flimsy-looking units operated by Colonel Stephens on numerous pre-war British branch lines, and the Swiss metre-gauge light railways which even now fill a vital public transport role. Meanwhile, among preserved railways, a surprisingly advanced diesel set has entered service on the Festiniog line, which could provide affordable rapid transit if adapted to world markets. All these



are characterised by a willingness to accept that heavy rail technologies and operating practices are not the only way the rail mode can serve the needs of public transport.

It has been recognised that lightweight vehicles with shorter stopping distances do not need the complex signalling required by heavy rail, and can often run line-of-sight. Once the need to comply with heavy rail end loadings is removed, it is then possible to adapt automotive and other technologies to rail running vehicles, with corresponding reductions in vehicle weight and cost. Modern UK light rail systems, designed for high passenger loadings and built almost to heavy rail standards, suit only the most densely trafficked urban corridors.

There is a clear need for light, cheaper, smaller systems, closer to the first generation of British tramways in vehicle capacity. The re-born concept of appropriate-sized rail vehicles, described in the Department of Transport as Ultra Light Rail, can meet this worldwide need.

A new beginning for Ultra Light comes from recent technical innovations in energy transfer and power transmission, and identification of a new niche arising out of the vehicle traffic problems facing towns and cities.

THE CURRENT reappraisal of tramway systems, driven by the desire for zero-emission transport in city centres, has so far led mainly to development of very large trams, or 'supertrams', such as those running in Manchester and Sheffield and soon to appear in Croydon and other high density conurbations.

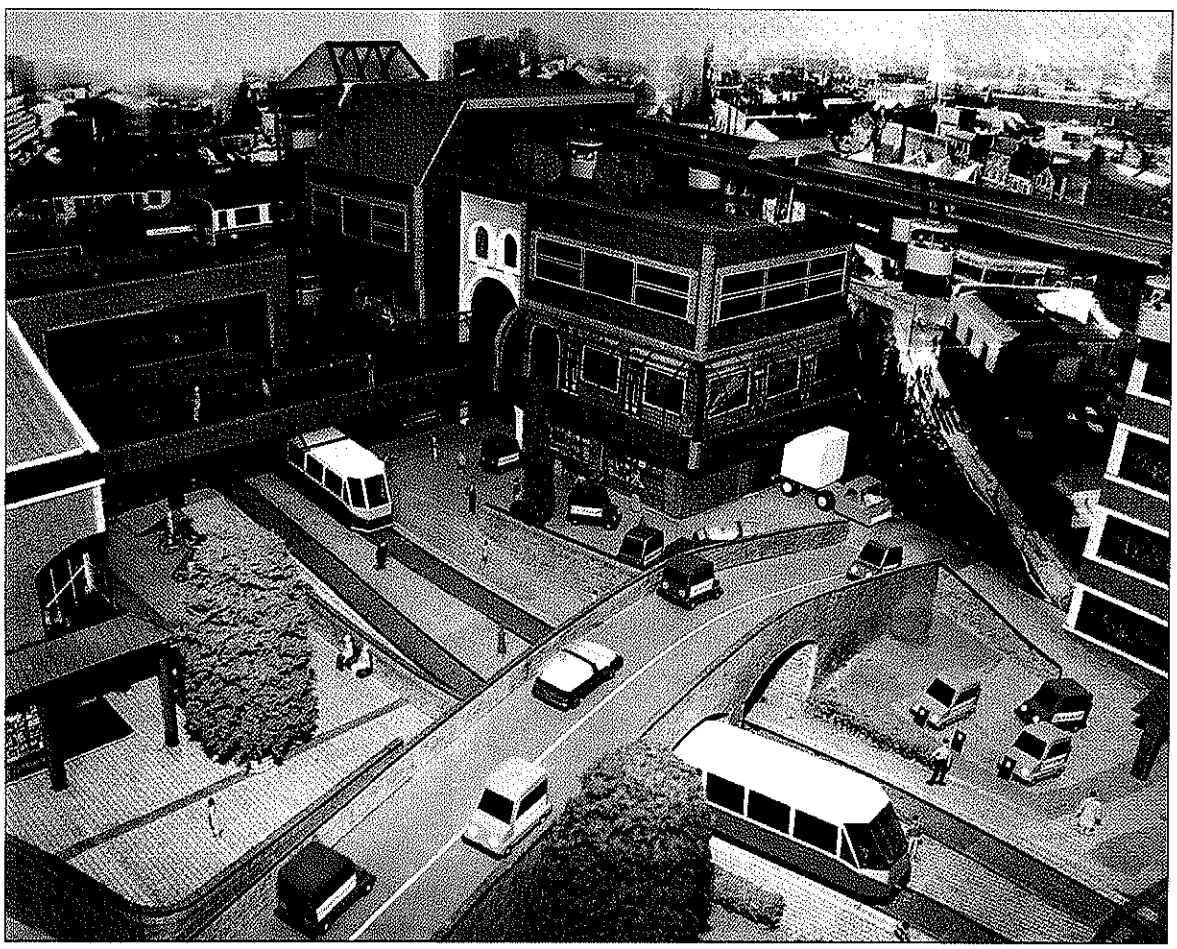
These trams, which derive from developments on the continent, where tramway culture was never extinguished as in the UK, are more than twice the size of former trams in this country and approximate in many ways to street-running trains rather than trams.

They have moved a long way from the tramcars remembered with affection by the over-50s. Supertrams perform very well travelling rapidly along reserved track from the suburbs to the city-centre. Then, as their large forms move through streets newly decorated with poles and wires, they are at best tolerated and command nothing like the public affection held by their predecessors. Ultra Light Rail represents an alternative line of development from tramway systems before the 'fall'.

The central problem for tramways versus buses was always the high fixed capital investment in the electric supply system, the track and the massive track footing, which was so difficult to move that all underground services had to be relocated. The modern economic response to this problem has been to accept the expense and go for very large passenger volume — hence the even heavier Supertram, which naturally can only be justified by the passenger flow in large and prosperous cities.

The ULR concept, on the other hand, moves in the opposite direction, using a smaller and lighter car, more 'people-sized,' requiring a far less substantial footing and in some versions no overhead supply at all. The ULR footing alone, which is easily removed and allows underground services to be left in place, represents an enormous cost saving. The result is a tramway system which may be typically a third of the capacity of a supertram system but less than a tenth of the cost. ULR will therefore be widely affordable and is expected to generate an exciting range of completely new tramway applications.

In the town centre the ULR tram, perhaps a little larger than a minibus and carrying around 35 passengers, will pass



A new role for trams, as an 'inner urban distributer' within a Clear Zone, a concept for improving urban centres proposed by the UK Technology Foresight Programme 1995.

One fifth scale concept model of the proposed 70 passenger ULT70, a stretched development of the Parry People Mover light tram.

If you build a transport system at no expense spared, with vehicles so large that they have to run infrequenlty — you may be building a Titanic which could run into a financial iceberg.
John Parry

A move towards the use of tram systems is a very serious option for us to consider. The Parry design could be a key part of the answer to urban transport problems.
EC Transport Commissioner Neil Kinnock

acceptably through car-free zones (which can consequently be much enlarged) and serve most shopping and business streets as well as bus and railway stations and peripheral car parks. In larger cities, it will serve as a feeder to the supertram, perhaps allowing the latter to stop less frequently and become even more like a train. Some ULR systems — those without overhead power delivery — will pass through indoor shopping malls or through the entrance areas of large shops, bringing a level of convenience for the car-borne shopper even greater than green-field retail parks, now as popular as both economically and environmentally questionable.

However, even though the cost of ULR will be a fraction of the cost of a conventional tramway, the installation of a tramway system remains a substantial undertaking, involving significant civil works, important implications for a wide range of town centre interests and consequent legal ramifications. The tram needs therefore to be able to show clear advantages over alternative transports, especially buses, minibuses and cars with their remarkable flexibility, world standard technology and mass production prices.

What are the features of trams, especially of the light variety, which particularly appeal in the conditions prevailing at the turn of the millennium? By far the most important quality of trams in the estimation of 1990s people is clean air. As our environmental standards have risen, town centre pollution has been getting worse, resulting in an ever more pressing demand for zero-emission transport. But, despite enormous expenditure by industry, especially on battery cars, truly practical systems have remained elusive. Affordable ULR is a major advance on this front: it could be the catalyst for a radical change in the way town centres are organised and promises a fundamental improvement in the quality of urban life.

Two further advantages follow from the rigidly predictable path of trams and consequently well defined swept area. When trams run through reserved corridors, e.g. on central reservations, land take is minimised; while when street running through pedestrian priority areas trams are safer and more acceptable than other transports. The swept area can be marked out in different-coloured tiles and pedestrians will know they can relax and not even have to watch the tram, whereas buses and cars do have to be watched, and given appropriately wide berths.

Trams have potential to be highly energy-efficient: steel wheels on steel rails present about one fifth of the rolling resistance of pneumatic tyres on tarmac, while electric motors are simple and straightforward compared with the internal combustion engine's compromises, reciprocating parts, waste heat management, etc. Trams are potentially very long-lived compared with buses and, with no steering and simple suspension and propulsion systems, are very easy to maintain.

The tram ride is very steady compared with buses, with no jolts over potholes or faulty road repairs and without the characteristic accelerating, braking and swerving of buses. Standing is much more acceptable in trams (and even preferred by some people), which makes efficient use of capacity at peak periods. At the same time buses, especially minibuses, battle to resist the compulsory wearing of seat belts and frequently have to settle with passengers injured on the approach to, and departure from, bus stops.

For these reasons, especially cleanliness and the smooth ride, as well as others not easily defined in which nostalgia may play a part, trams are generally popular and well-liked by all sections of the public. If motorists are to be seduced (rather than compelled) from cars, the offer of a tram ride into town is much more likely to succeed than a bus.

If the Government's tentative plans (through its Technology Foresight Programme) to create large town centre areas free of motor traffic — the 'urban clear zone' concept — are progressed, it is likely ULR will make the scheme possible. If ULR is as affordable as looks possible, especially if overhead wires and high voltage electrics can be eliminated, tramways will begin to appear in many other unexpected places. Wherever large numbers of people come together, arriving in cars to visit an extensive site within which cars are unwelcome, there will be a case for zero-emission ULR transport. This could include airports, showgrounds, heritage parks (track could be almost invisible in the grass), industrial complexes, seaside esplanades, hospitals, university campuses and no doubt many other possible locations.

New ideas in the ULR field appear to be coming mainly from UK developers and manufacturers. A vast potential market awaits in the UK, on the Continent and overseas.

REALISING THE ULTRA LIGHT POTENTIAL

THE OPPORTUNITY FOR ULTRA LIGHT RAIL

Trevor Griffin

Light Rail Team Leader, BR Research

There appears to be an unaddressed need in the light rail market; 'The capital cost of conventional Metro/Supertram systems limits them to urban areas which have large populations and high density movement corridors. A new lighter, cheaper mode is needed for all those towns which cannot meet the requirements for a supertram but which still have problems to solve in their centres'.
UK Technology Foresight Programme Transport Panel Report - March 1995

LIGHT RAPID TRANSIT is proven as an attractive and effective means of public transport, capable of attracting passengers who would not consider any other form of public transport.

However, the high capital cost of new systems makes LRT suitable only in applications where a very high volume of traffic can be generated and where improved access will encourage economic development. In the UK and abroad, numerous applications exist where a fixed link, low pollution form of transport would bring environmental and social benefits, but where volumes of traffic would not justify full-scale LRT.

Although cheaper alternatives, such as guided bus systems are being developed or are already being marketed, they do not have the public acceptability of LRT and do not always meet the sufficient standards of low pollution operation.

A number of factors generate the high cost of 'conventional' LRT, but chief among these is the nature of the modern light rail vehicle. To cater for high capacity applications, vehicles capable of carrying up to 250 passengers with performance similar to suburban heavy rail stock have been developed. The cost of permanent way for such large, heavy vehicles and of the overhead electrification which powers them are both extremely high.

The conceptual leap which will enable the construction of light rail systems in areas where patronage would not justify investment in LRT is that a smaller, lighter vehicle carrying less passengers can operate on lighter, cheaper track. The need to move buried services from under trackbed accounts for about 25% of the total cost of conventional street tramway systems. With lower axle weight vehicles, the trackbed can be much shallower and the diversion of services almost completely avoided. The cost of other civil engineering work such as bridges is also greatly reduced.

Transport professionals have now recognised this concept of appropriate sized vehicles for medium to low capacity routes. The Department of Transport has categorised this as Ultra Light Rail, a valuable addition to the range of public transport possibilities. Aircraft, for example, are available in a range of capacities, so why not light rail vehicles?

Further cost savings can be achieved by the use of vehicles with on-board power storage, removing the need for investment in continuous electrification equipment. As yet, the only system available is the flywheel energy storage system developed by JPM Parry & Associates, but further developments now make use of fuel cells, super capacitors or batteries to give the advantages of electric propulsion without the associated costs.

BR Research, with its unique knowledge of the national rail network has been investigating how it can apply its expertise to the exploitation of a significant rail transport sector which exists on less heavily trafficked routes where Ultra Light technology may be suitable.

With our technical knowledge of operating parameters, including ride characteristics of vehicles using steel wheel on rail, we will be able to assist projects at the design and specification stage to obtain the best results, cost effectively. At an earlier stage in a new project, we can assist in the selection of optimum route alignments. We can apply further direct operational experience of the rail industry, its economics, working practices and customer profiles, all of which are relevant to the viability of future schemes.

BR Research has begun to work with an informal grouping of organisations, all of which have seen the potential of the Ultra-Light sector. The ULT group will comprise academic, research, testing, planning, design, construction and operational resources which together will be able to offer ultra-light rail technology as a 'package' in just the way larger, more expensive schemes are brought into being. The difference will be in the scale, value and quantity of the projects — small, affordable and much more frequent.

SUPPORT FOR SMART IDEAS

The Innovation Process

Supporting innovation is one of the Department of Trade & Industry's least straightforward tasks. Which idea to back, which to leave to struggle on its own, there is no guarantee of success. A DTI officer explains the system.

WHAT DO medical diagnostic kits, landfill gas burners, a microlight aircraft wing, high temperature coatings for aero engines and a flywheel-powered micro car have in common?

The answer is that all have been developed by West Midlands businesses with support from the DTI's SMART scheme. The flywheel-powered micro car is an extension to the Parry tram technology now under study.

SMART, originally known as the Small Firms Merit Award for Research and Technology and for the past two years as simply SMART, is intended to help individuals and businesses with no more than 50 employees to develop innovative products and processes which have commercial potential.

In particular, it is aimed at supporting the feasibility study stage with an award of up to £45,000 for six to 18 month study. The most promising projects go forward with a SPUR award which offers up to a further £120,000 to support the development of a prototype.

Structured as a competition, the annual SMART round opens with a call for entries in January. Entries close in April, and winners are announced in August. There are typically around 1500 entries nationally in the competition for the 180 awards made annually.

Other support for research and development is available in certain parts of the UK, including much of the West Midlands conurbation, through the Regional Innovation Grant (RIN) scheme. The scheme offers funding of up to £25,000 for projects in which the applicant business can demonstrate that there is significant technical risk to be overcome.

Parry People Movers is one of hundreds of West Midlands businesses that have benefited from RIN. In its case a grant was awarded to develop a solution to make the People Mover capable of being driven from both ends while retaining the simplicity of the mechanical control system which is a hallmark of the vehicle.

For details of SMART, SPUR and RIN contact your local Business Link in England. In Scotland, talk to the Scottish Office; in Wales, the Welsh Office and in Northern Ireland, the Industry Research and Technology Unit of the Northern Ireland Office.

PROTECTING YOUR INVENTION

William Lally

Prior to announcing the flywheel energy store concept, coupled with mechanical continuously variable transmission, JPM Parry & Associates investigated the novelty of engineering arrangements. With help from Chartered Patent agent Forrester Ketley, it identified the innovative content and obtained American, British and European patents.

NEW TECHNOLOGY relies on the patent system not only for its survival, but for its birth. If it were not possible to prevent other people from copying or exploiting your invention, you would be unlikely to go to the trouble and expense of making and developing the invention in the first place. The emergence of new technology nearly always involves considerable financial risk, which will simply not be undertaken unless profit is secured. This needs careful research and a certain amount of money. Some obvious questions:

What really is a patent? - It is a monopoly granted by the state by which an inventor can prevent anybody using his invention.

How do I get one? - The procedure can be complicated. First and most important, file an application at the Patent Office together with a specification of the invention in detail.

What if the invention is already in use? - You can only get a patent if the invention is new and not public knowledge. Even mentioning it to friends could prejudice your rights.

How long does a patent last? - Twenty years, although a renewal fee is due each year.

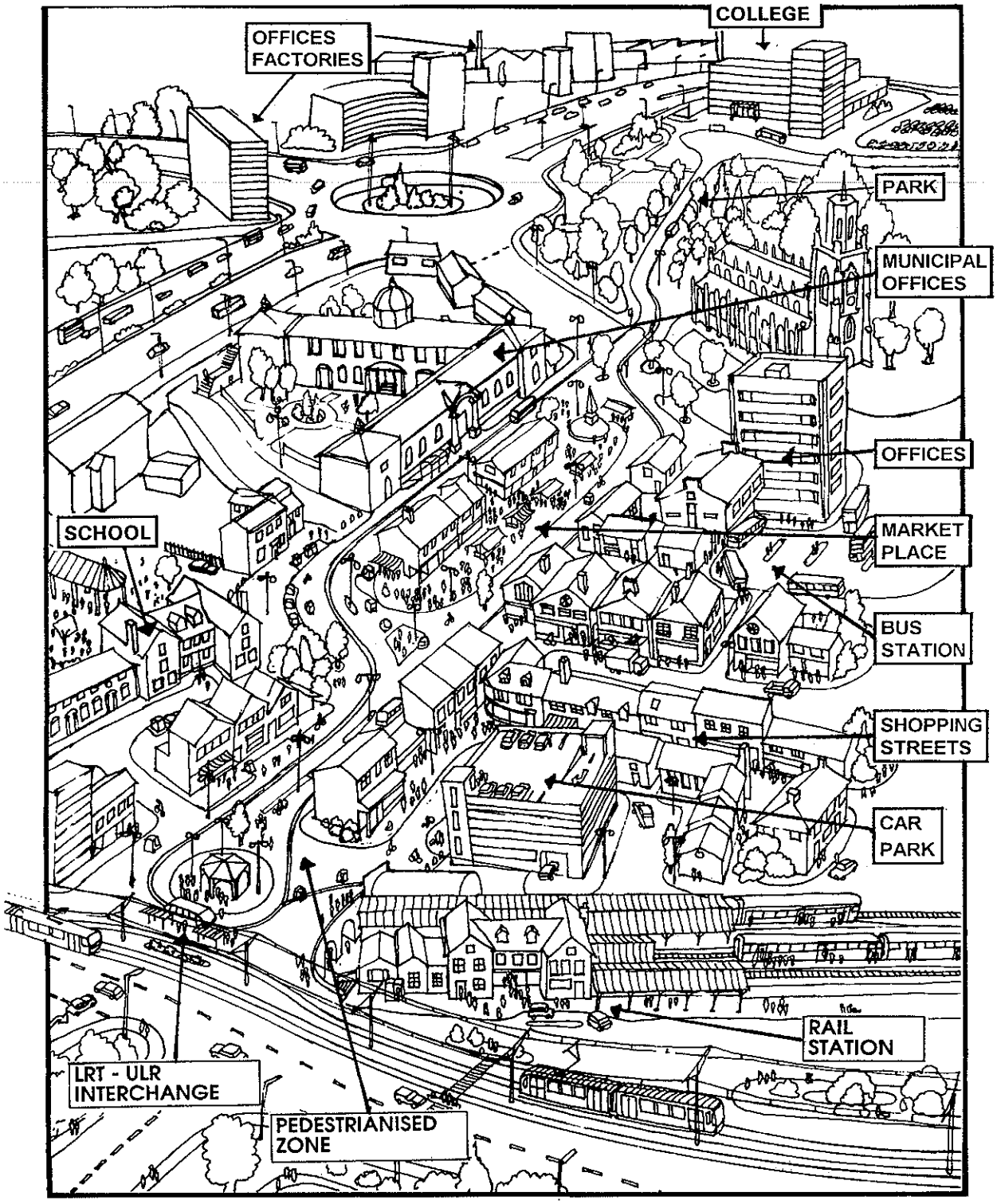
Talking of costs... A complicated invention, such as an industrial robot having six axles of movement, will be more expensive to patent than a DIY tool. A straightforward invention might cost £2,400 over three years. Plus VAT.

So I have to come up with £2,500? - No. An application can be filed for as little as £500.

What about overseas countries? Patents are national - a British patent is relevant only in the UK. If you want to stop your invention being used in USA, it needs a patent there.

What do I need to do to get detailed advice? - See a patent agent. Look in Yellow Pages, or write to the Secretary, Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, London, WC1V 7PZ.

How a small town centre, with trunk roads and public transport interchanges at its periphery, can have its public buildings and commercial centres connected by an ULR system.



PAVED AREAS IMPROVE APPEARANCE AND SAFETY

Andrew Riley

AN ARCHITECT, now retired we trust, was heard to say 'a brick is a brick is a brick'. This is not true. The more innovative and design-minded brick manufacturers produce a dazzling array of shapes, sizes, colours and textures of bricks. They do not only go into walls — the attractive multi-coloured surfaces which characterise new town centre pedestrian areas use durable paving produced by both the concrete and clay industries.

Baggeridge Brick Company, a West Midlands firm which dates back into Victorian time, supplied many of the blue, kiln-burnt bricks used in the early era of railway and tramway construction. History now repeats itself with the company's decision to help bring about the new tramway era.

Baggeridge Brick has provided standard and special products for tram track surrounds and boarding platforms, and assisted JPM Parry & Associates with temporary and permanent areas for demonstrations, including the prestigious setting of Centenary Square, Birmingham at the Light Rail '94 conference.

Baggeridge designers have developed coloured and tactile paving units to provide warning of dangerous situations such as road crossings, flights of steps, platform edges and demarcation of pedestrian pathways, cycle paths and tramways. Increasing use of contrasts in texture and colour can be imaginatively used within the built environment to provide more readily perceptible points of reference for people with impaired sight.

Directional guidance can be provided by different surface textures or units on pathways, some with raised ribs. For areas to exclude vehicular and/or pedestrian traffic, deterrent pavers can warn of hazards such as narrow footways or busy junctions.

Thresholds can be negotiated easily by wheelchairs. Gradual ramping (max 1:12) or falls means paving can be negotiated safely. Tram boarding platforms are a typical application. Dropped kerbs can be inserted for wheelchair users but, where visually impaired have to be considered jointly, a textured paver and contrasting colour can be used.

As in the past, the tram and the engineering brick go together like love and marriage and all seem to be coming back into fashion.

BY TRAM THROUGH THE PARK

Martin Smith

Senior Traffic Planner, Peak National Park

THE PEAK District National Park, wedged as it is between the industrial centres of Manchester, Sheffield, Nottingham and Stoke-on-Trent, is one of the most heavily visited national parks in the world.

Although it covers a large area, over 500 square miles, villages near the more attractive spots can be overwhelmed by motor traffic on summer weekends while in wilderness areas cars are in any case damaging and visually intrusive. Everybody would benefit from better organised movement of people in the Park.

While mass transit solutions such as those in Manchester and Sheffield are out of the question, low-cost Ultra Light Rail such as the Parry People Mover could well be the answer. Cars could be restricted to large car parks whence people could either walk to the nearby beauty spot or beyond or take the tram. The tram would stop on demand near the family car, track would run unobtrusively through the countryside (often concealed by grass) and visitors' enjoyment of beauty spots would be uncontaminated by the noise, smell, space-take and the visual incongruity of motor cars. The wonderful scenery of Pride and Prejudice would therefore almost be restored.

There are no firm proposals so far, but the Peak Park's Structure Plan refers to a number of areas where 'segregated public transport' is to be investigated, and this is now under way as part of the approach to the Local Plan.

Public consultation on the Local Plan will start later this year, and it is expected that ideas for Ultra Light Rail systems as measures for landscape relief will be given a preliminary airing.

PPM TO REPLACE HEAVY RAIL FEEDER?

Ray Hughes, Centro

THE PARRY People Mover technology has been carefully watched by Centro over the past seven years. It has been clear for some time that eventually the environmental impact of conventionally powered vehicles — whether public or private — would be unacceptable in city centres.

That is one of the reasons that Centro has pursued its proposals for a light rail system — Midland Metro — the first stage of which is now being constructed between Wolverhampton and Birmingham.

At the same time Centro has always been aware that conventional light rail is an expensive solution and not applicable or justifiable in all situations, so the concept of something that is both environmentally friendly and that could contain costs to a relatively low level was intriguing.

Until recently the Parry People Mover had been in that awkward phase of part experimental/part commercial which is a headache to non-risk taking public sector bodies looking for tried and tested transport solutions. However, the advent of the association with Brush Traction and BR Research has put the PPM into a different league.

Centro is currently considering applications for the introduction of the Parry People Mover to replace the heavy rail shuttle service between Stourbridge Junction station and Stourbridge bus station. The existing service is operated by a Class 153 vehicle operating a single track at 10 minute frequency in the peak. Maximum usage is 1500 passengers per day with an average loading of 8000 journeys per week.

The service is not just an interchange between people using the heavy rail line. The large station car park acts as a park and ride site for shoppers not wanting to drive into Stourbridge centre.

Although there are many institutional hurdles to be overcome, this proposal is believed to be an ideal prospect for the introduction of the Parry People Mover into regular service. With the co-operation of partners in Central Trains and Railtrack, Centro hopes that it could soon be a reality.

A concept scene: how the ULT70 might appear on the Stourbridge branch.

BUCKINGHAMSHIRE

ONE OF THE first to see the potential of the Parry People Mover was Roger Slevin, Passenger Transport Manager for Buckinghamshire County Council.

He immediately looked to Milton Keynes — his region's bright, new, centre of population. He was sure the Parry project had a future in MK.

Then came the latest local government re-organisation and the news that Milton Keynes was to become a 'unitary authority'. The formal separation with Buckinghamshire began in May 1996, with elections for a new 'shadow authority' to take full responsibility for services the following year.

Given time, the new Milton Keynes Unitary Council may look favourably on the Parry People Mover. Meanwhile, Mr Slevin and his team are also considering Aylesbury and High Wycombe, the two other large towns which will remain part of Buckinghamshire.

Says Mr Slevin: "My personal view is that projects such as the Parry People Mover will eventually fill a significant gap in transport technology for specific settings where there is at present no public transport provision."

"When we first took an interest in the Parry project we were already conscious of the possible uses of Ultra-Light Transit systems in town centres like Milton Keynes - and perhaps Aylesbury and High Wycombe as well."

"There is also the possibility of installing a longer run, using a disused railway line in the High Wycombe area."

"A group of county councillors saw a demonstration of the Parry system and were impressed enough to make two modest contributions to help take it from a rather crude demonstration vehicle to a full operational system. Reducing town centre traffic flows is a challenge facing all town planners and Ultra-Light Rail systems clearly have a future role as part of 'park and ride' policies."

Mr Slevin concludes: "As the PPM has developed over the past few years, it's become a much more powerful idea."

As technology advances, Ultra Light Transit will become more and more attractive. But councillors have to be cautious about how they spend council tax payers' money. When high-profile flagship projects start costing money, voters have a habit of removing councillors from office through the ballot box.

The big question is now this: Which local authority will be brave enough to be the first to invest in unproven technology to provide transport where none now exists?

ACADEMIC PARTICIPATION

Dr Felix Schmid and Prof Roderick Smith

Universities can play a key role in validating new transit systems such as Ultra Light Rail. Dr. Schmid and Prof Smith describe their past, present and future participation.

BOTH THE energy crisis of the 1970s and more recent environmental concerns has resulted in new concepts for energy-efficient and cost-effective urban public transport systems.

Some are still on the drawing board while others, such as Maglev people movers and monorails, have been built in prototype form or in one or two production versions. None have achieved the levels of penetration of the street tramway, pre-metro or heavy metro though, neither in Europe or elsewhere.

Ultra Light Rail (ULR) is often considered as just another product of the ingenuity of engineers, destined to a short period in the limelight, followed by obscurity. However, we believe that this is not so: ULR may well develop into the preferred mode of public transport for flows of between 1000 and 3000 passengers per hour and direction and relatively short distances of up to 8km. Thanks to low axle loads and a relatively small space envelope, the infrastructure needs are reduced substantially and installation is far less disruptive than for full-scale light rail systems.

ULR will be particularly suited to applications which do not justify investment in a traditional tramway or light railway system but where rubber-tyred vehicles (buses, trolleybuses etc) are inappropriate.

Academic bodies fulfil a range of important duties wherever new technologies and approaches are applied to the solution of problems: they help with the initial research for concepts which might satisfy the constraints presented by the environment, they ensure that the development process is characterised by rigorous enquiry rather than the haphazard search for 'quick fixes', and they assist with the establishment of the criteria for evaluating the product and its pilot implementations.

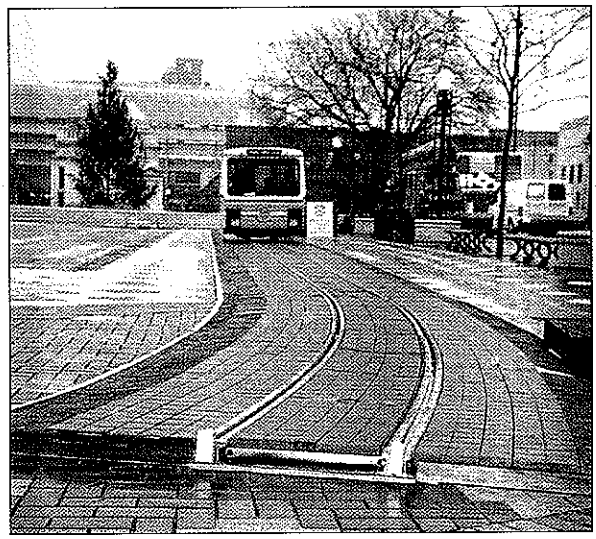
With ULR, the involvement of the university sector is of particular importance.

These are discussed in the context of the contribution made by staff at the Advanced Railway Research Centre (ARRC) to the development of the Parry People Mover.

Contact between the university sector (University of the West of England and Brunel University) and JPM Parry Associates was made early on and resulted in investigations of flywheel systems and assessment of design concepts for the infinitely variable gearbox.

Several projects tested the prototype gearboxes, the selection of optimum combinations of materials and the improvement of the drive train. More recently, ARRC has been involved in the simplification of drivers' controls, choice of bogie and articulation arrangements, as well as the development of a complete ULR system - including power supply and track components. Future work will include the design of a crashworthy bodyshell and driver's cab of an aesthetically pleasing design and research into further increases of the efficiency of the drive system.

To validate the concept, ARRC will assess the whole life energy cost of PPMs, in particular the relative benefits of nil-emission-at-point-of use vehicles compared with standard buses or LPG powered buses. Institutions of higher education are well placed to offer a central management development and research facility, possibly by subscription, for the new industry where most installations will be in medium sized towns and cities.



Above: Baggeridge blue paving used for the track surrounds during temporary demonstration of the PPM system in Centenary Square, Birmingham.

Felix Schmid is the Director of the MSc Programme in Rail Systems Engineering.

Roderick Smith is British Rail and Royal Academy of Engineering Professor of Railway Engineering at the University of Sheffield.

Other UK academic bodies have also contributed to the Parry People Mover development, some directly, others indirectly:

The University of the West of England in the Trials and Testing Programme

The University of Aston in hosting conferences on urban transport and park and ride.

The University of West London (Brunel) work on continuously variable transmission.

The University of Southampton in developing contacts with the research community and in helping to integrate ULR into Technology Foresight Urban Clear Zone concept.

AND A VIEW FROM THE METROPOLIS..

Scott McIntosh, London Transport

SECTION 2 of the London Regional Transport Act defines LT's role as "providing for...transport needs...with regard to efficiency, economy and safety." This encapsulates the challenge which faces all public transport providers. In meeting this challenge we already have a number of mature and well proven technologies. The suburban electric train and the Underground are unchallenged mass movers, albeit demanding high levels of investment. Classic light rail/modern tramway systems provide excellent service and have a proven track record of attracting travellers away from the private motor car. LT is proud to be part of the light rail revival, first as the developer of the Docklands Light Railway and now the Croydon Tramlink system, here the investment costs are far lower (at about £10m mile for a good modern tramway) but they are still significant.

Bus based solutions, including trolley or duo buses, are cheaper still but there are very real questions as to their ability to regain lost passengers and to provide the boost necessary to lead to urban regeneration.

One of the most interesting areas of development over the next few years will be in the development of attractive short-range transit links which are seen as better than walking and more attractive to users and urban designers than conventional minibuses. The system must be less expensive than LRT, less disruptive than automated people movers, quick and easy to install.

The Parry system fits into this requirement, with many of the advantages of rail transport, at low cost. I believe it will be particularly useful for linking new traffic generators, such as local airports, satellite housing, business parks or major retail centres to existing railheads, helping make downtown shopping centres more accessible, or serving large car parks.

There are a number of locations in London which could provide a suitable location for a Parry People Mover. Here John Parry has a distinct advantage over his nearest rivals. He has been developing his mechanical-stored energy system for years, and what would appear to be an elegantly simple traction package can now be assembled from proven components.

But, other developers must also be encouraged to offer alternative cars. Public sector tendering rules require effective competition. Competition is always a spur to innovation and if Parry People Movers can rise to the challenge it should have a prosperous future.

Below: A Parry People Mover in a downtown situation, in this instance Birmingham.

THE PARRY PEOPLE MOVER

IF OVERHEAD electric supply and the massive under-track footings required are the tram's chief handicaps, preventing its much wider adoption, then the newly developed Parry People Mover is an elegant solution, which could lead to a hugely increased role for trams in the coming years.

John Parry's objective was to produce an ultra light rail vehicle which would be acceptable in the car-free zones of town centres, and would also be economically viable in towns of population down to about 40,000. Overhead power supply was ruled out on grounds of installation and maintenance cost as well as visual appearance.

On-board energy storage meant a choice between either battery or flywheel. Batteries, despite enormous research, were still unable to provide all-day service for even a small public transport vehicle, so some sort of easy charge facility would be necessary. But batteries are vulnerable to mishandling and, since battery life would be a critical factor in operating economics, the battery route was therefore considered fundamentally unreliable. Company philosophy, formed by experience in the third world, insists on robustness, reliability, not too high tech and keeping well within the bounds of current engineering practice.

The PPM concept was thus developed on the basis of flywheel power — or 'kinetic energy storage'. This decision left a number of further fundamental choices to be made and the options selected again reflect the company's character. Thus, the flywheel is relatively heavy and rotates at modest speed instead of the trendier lightweight, vacuum-encased high speed flywheel now emerging from the laboratory.

The power transfer system is entirely mechanical, using a continuously variable transmission, instead of the electrical transmission used in earlier Swiss flywheel systems (in which the flywheel generates electricity to power motors at each axle). And the PPM's supply current, to spin the flywheel, is at a mere 70 volts DC, which gives an adequate charging speed but, being touch-safe, avoids expensive safety measures and helps to keep the product widely affordable.

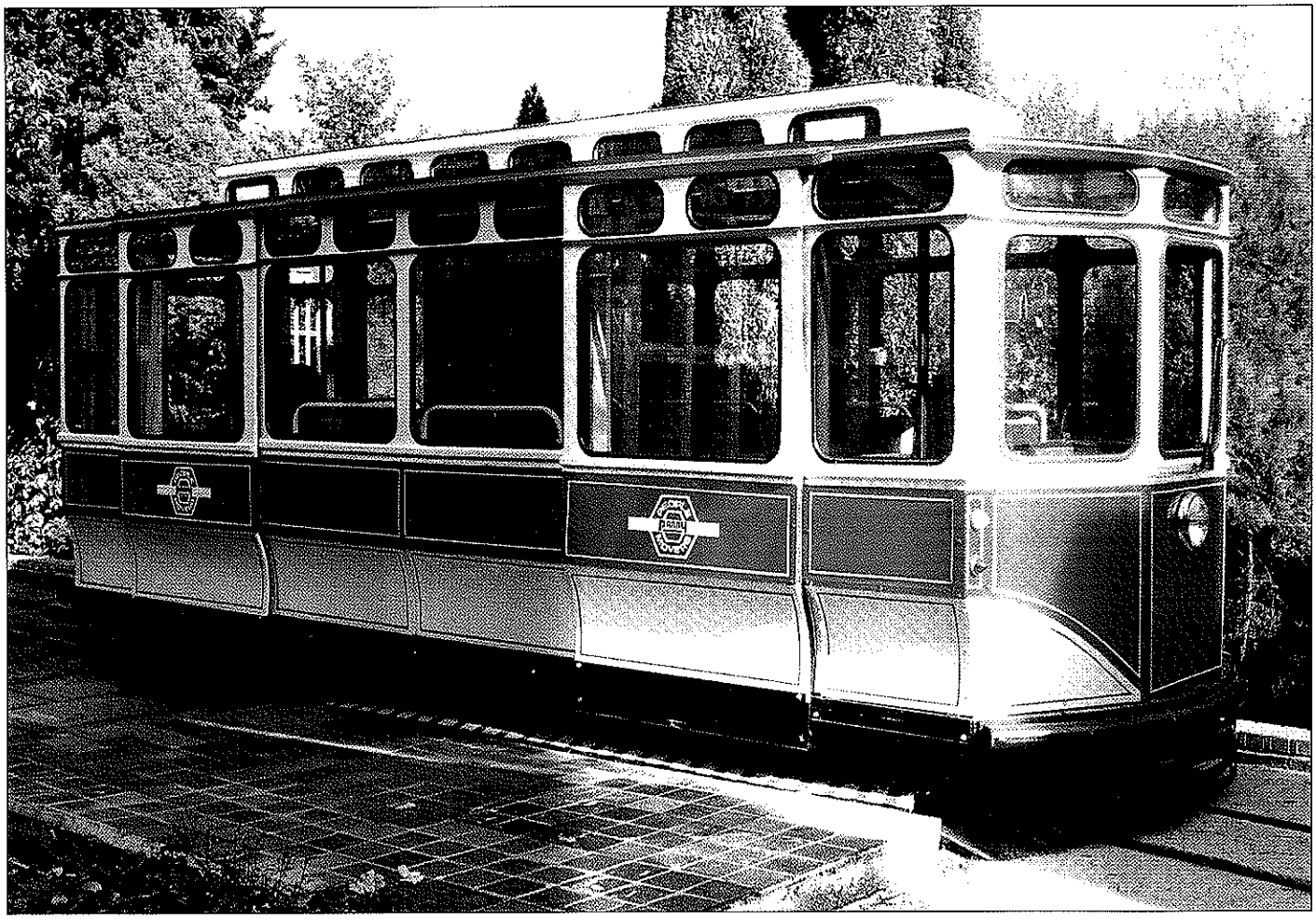
The PPM flywheel, in the current 35-passenger version, weighs 500 kg, is 998 mm in diameter and spins at up to 4000 rpm. This provides useful energy of about 1 kW/hr, which is sufficient to take the car some 3-4 km on level track. Re-charge would then take some 90 seconds but in normal operation the flywheel is topped up more frequently through railside contact at most passenger stops, mostly unnoticed by passengers. With the flywheel mounted horizontally below the

Left: Inertial energy storage device, a multi-laminate steel flywheel designed and built by Parry Associates in Cradley Heath and capable of absorbing or releasing energy at over 0.5kWh per minute.

Inset: The continuously variable transmission principle - a component of a pinch drive, cone- and ball variator.

Flywheel CVT powered Ultra Light Rail Vehicles

Serial No.	Year Built	Description Function	Capacity (Seats)	Main Engineering Features: Motor Voltage	Power	Flywheel Weight	Flywheel Diameter	Track Gauge	Experience	Present Status Location
1	1989	Proof of concept	3 (1)	12v	3hp	60kg	300mm	610mm	Demonstrations at at Cradley Heath & Himley test tracks	Operational Cradley Heath
2	1991	Proof of concept	12 (12)	415v	10hp	80kg	300mm	610mm	Test running at	Dismantled
2A						200kg	900mm	610mm	Cradley Heath	
3	1992	1/2 scale Demonstrator modern steel shell	10 (8)	36v	10hp	80kg	300mm	610mm	Passenger demonstrator at Cradley Heath, Leicester, National Exhibition Centre	Dismantled
4	1992	1/2 scale Heritage minitram	6 (6)	70v	20hp	200kg	900mm	610mm	In service, Himley Park, 1992-95	Part dism Himley
5	1992	1/2 scale Modern style demonstrator	10 (8)	70v	20hp	250kg	900mm	610mm	Passenger demonstrator at Cradley Heath	Part dism Cradley Heath
6	1993	2/3 scale railbus	14 (14)	70v	20hp	250kg	900mm	610mm	In use Himley Park 1993-95 Demonstrated at Birmingham, Stoke, Barking, Brighton	Operational Himley (system not in service)
7	1994	2/3 scale Heritage street car demonstrator	25 (13)	70v	20hp	250kg	900mm	610mm 760mm	Mainly Crad. Heath but tested at Welshpool and demonstrated in Barking, Brighton and Swansea	Operational Cradley Heath
8	1994	Test bed	6 (6)	70v	20hp	250kg	900mm	610mm 760mm	Cradley Heath and Welshpool & Llanfair	Dismantled
9	1995	Single car Heritage streetcar, dual control	30 (12)	70v	30hp	500kg	996mm	610mm 1000mm	Cradley Heath and Llanfair	Operational Cradley Heath
10	1996	Testbed, standard gauge	6 (6)	70v	30hp	250kg	900mm	760mm 1435mm	Cradley Heath and Weymouth tests	Operational Cradley Heath



Prototype No. 9, a tram which looks like a tram. PPM's *STREETCAR* is designed to appeal to the nostalgically inclined with 1990s engineering beneath the floor.

floor there are no gyroscopic effects. Indeed, there is a positive benefit to ride quality which is particularly noticeable on narrow-gauge track. This can be an important cost-saving option because of the tighter bends permitted and consequently the reduced need to remove obstacles or adapt street layout.

Flywheels are safe: laminated sandwich structure prevents disintegration, flywheels give plenty of warning of bearing failure and, in the unlikely event of sudden failure, a spinning flywheel shows a marked preference for staying where it is. They are much safer and contain far less energy than tanks of petrol. And, unlike batteries, they can be cleanly scrapped at the end of their long life.

While flywheels have been used before as a means of propulsion, the combination of flywheel and continuously variable transmission (CVT) is unique to the Parry system. The CVT performs the remarkable task of matching input rpm (from the flywheel) descending steadily from 4000 to 1500 with vehicle speeds randomly variable between 0-50 km/h. CVTs with this capability and with the required power throughput capacity are a fairly recent development.

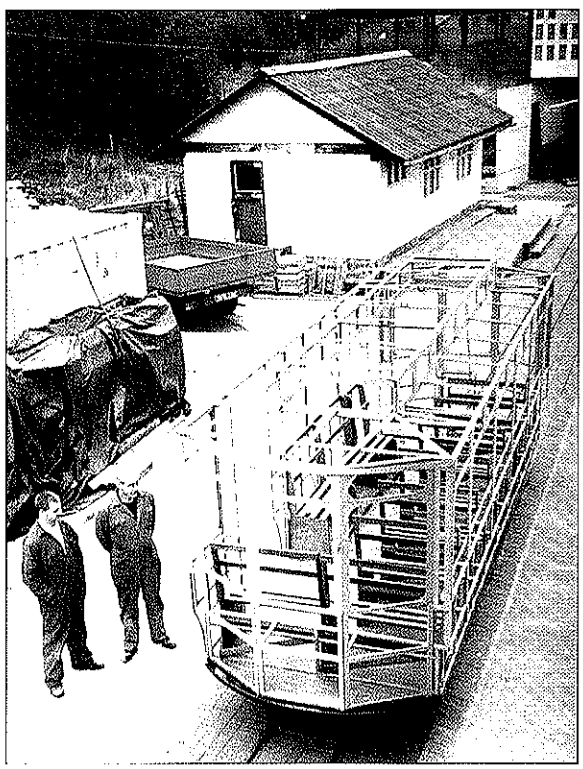
The Parry People Mover uses the CVT not merely to transfer energy to the rail wheels but also as the primary means of controlling the speed of the vehicle. Change gear upwards to increase speed, downwards to slow down. One consequence of this arrangement is that reducing vehicle speed accelerates the flywheel, thus capturing for re-use energy normally lost in braking.

As a result of these innovations the Parry tram is expected to transform the economics of tramway operation, notably by the following cost savings:

- **No overhead wired required;**
- **Lightweight vehicle requires a mere four inches of ballast below track;**
- **No need to move underground services;**
- **No high voltage protection measures required;**
- **No screening against stray currents, and;**
- **Civil works and road engineering minimised.**

In addition, for the local authority installing or facilitating a PPM system as an essential component of a 'clear zone' policy, there will be large development gains due to release of land and buildings previously dedicated to stationary and moving traffic.

The PPM system has completed at least 12 months of operational testing under simulated urban conditions. Feasibility studies for PPM installations are now being carried out by a number of local authorities and the first fully commercial system is expected to appear before the end of the year. Assuming the economic and environmental promise is fulfilled, by the end of the century Parry-type trams could have become a familiar feature of the urban scene.



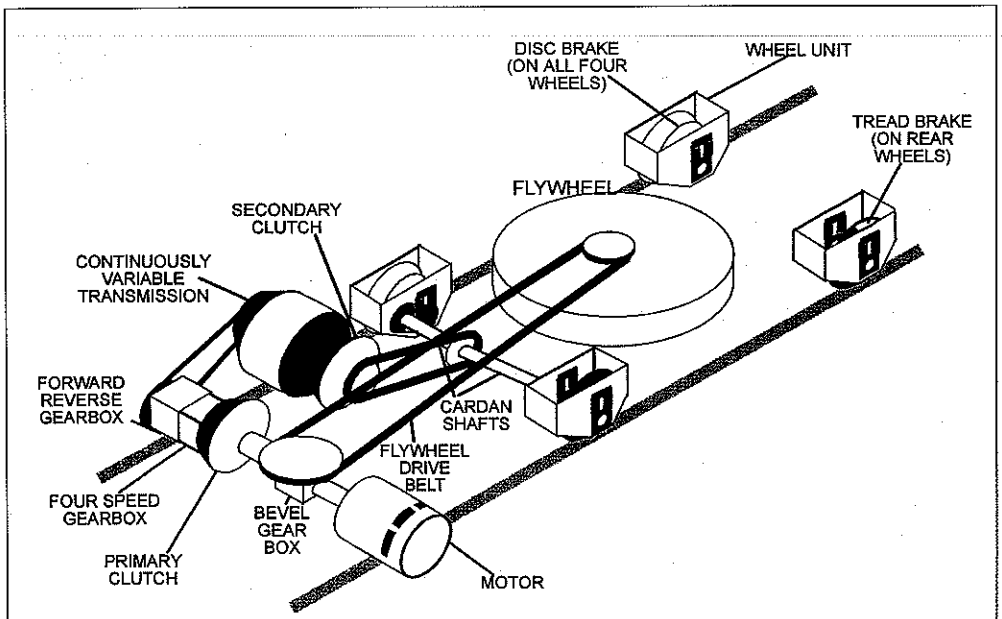
The skeleton of Number 9 during construction at Parry's Works in Cradley Heath.

The Parry Light Tram – How it works in detail

WHEN THE tram stops to let passengers on and off, an electrical shoe makes contact with a short conductor rail sited below the passengers' mounting platform. Power is supplied at 70 volts DC to an on-board electric motor which transmits drive through a bevel box and belt to the FLYWHEEL (see diagram). When the clutch is engaged power is fed from the flywheel via the bevel box and clutch to a forward/reverse gearbox and thence to the VARIATOR. It then passes, at finely adjusted speed, through a second clutch (operating in tandem with the first) to the final drive shaft (cardan shaft), rail wheels and TRACK.

THE FLYWHEEL The flywheel is mounted horizontally below the floor of the vehicle, avoiding unwanted gyroscopic effects enhancing stability of the vehicle. In the 35-passenger version the flywheel has a 998mm diameter and weighs 500 kg. It is composed of high tensile steel plates, resin bonded with grain variously oriented. Flywheel rotation speed in normal operation is 2000-3500rpm, although maximum speed is much higher. Charge time through normal operating range is about 60 sec but top-up charges at each passenger stop are normally about 30 sec.

THE VARIATOR A Kopp variator, using the ball and cone principle, provides continuously variable ratios from 3:1 to 1:3. The control over the variator ratio is the primary control over the speed of the vehicle. The vehicle starts with the variator at the lowest ratio position. Raising the ratio raises the speed of the tram. To maintain a given tram speed, the ratio must be slowly increased as the flywheel speed decays. Sharp reduction of the ratio slows the tram and speeds up the flywheel, converting the tram's momentum into re-usable flywheel energy.



FLYWHEEL ENERGY STORAGE LIGHT TRAM TRANSMISSION

TRACK The 35-passenger version of the tram weighs 8.5 tons laden, which, distributed through four single wheel units, allows the use of 30 lb/yd track laid on 4 in of ballast. Track can easily be moved and re-laid elsewhere in the event of road works or repair of underground services. And, since the tram is not normally powered electrically away from passenger stops, there is no need for elaborate screening against stray current interference.

BRAKES The tram is equipped with automotive type disc brakes and electrically operated tread brakes. While speed control in normal operation is through the variator, final stop and emergency stops are effected with the disc brakes. The tread brake is only used for parking.

CONTROLS The controls of current versions are all mechanical or mechanical/hydraulic operated (except for the parking brake mentioned above). Duplicate controls in double ended versions are operated in the same manner but there is an arrangement, for safety reasons, to disable the controls at the end of the tram not in current use.

Schematic diagram of PPM transmission layout. This current transmission incorporates many improvements which have been made as a result of the extended trials and testing programme.

THE REDISCOVERED FLYWHEEL

A neat illustration of the advantages of flywheels over batteries for on-board energy storage is offered by David Hartland, chief engineer of Brecknell Willis, supplier of conductor rail and other power delivery equipment.

"THE RATE AT which batteries can be charged is only one tenth of the discharge rate. Thus, if a battery-powered tram were to run continuously around a loop, say a circle, then the tram would need an external power supply (e.g. through a conductor rail), for nine tenths of the circuit and be able to run independently for only one tenth.

Flywheels, on the other hand, can be charged at 10 times their discharge rate. A flywheel-powered tram travelling continuously around our theoretical loop would need external supply for only one tenth of the circuit and run independently for nine tenths."

Mr Hartland's illustration explains the battery dilemma.

Batteries have to be re-charged while their customers are sleeping, flywheels while they are getting on and off the vehicle. But batteries cannot take on enough charge to last them through waking hours without becoming unacceptably large (and displacing passengers). Anyone who has followed a milk float uphill in the late morning will appreciate the point as does the Oxford Bus company which conceded a reduction of passenger capacity from 40 to 18 per vehicle as a result of substituting the diesel engines of 4 Optare Metroriders by battery-electric equipment.

The energy-sipping flywheel is inherently more flexible and will maintain service however long the day. Parry's use of a flywheel, coupled with the decision to run its passenger vehicle on rail rather than road, yields four times the energy efficiency for each passenger carried (0.03kWh per passenger mile on a PPM tram as opposed to 0.122 for a battery bus).

The final points of comparison between flywheels and present day batteries is the life expectancy of each and the consequences of end of life disposal. Batteries have an inevitable limit to the number of charging and discharging cycles which they can undergo — 1000 to 2000 seems to be the typical range. They are built of 'unfriendly' materials which cannot be readily recycled from the contaminated state they are in at the end of the battery's life and therefore inevitably pose a serious pollution threat.

By contrast a steel flywheel may need a change of bearings (a two hour task) as it approaches its millionth charge cycle, but if it ever becomes redundant its valuable high performance steel plate will immediately be found use for other purposes.

University of West of England engineering research students recording instrument readings during PPM trials up the 1 in 30 Golfa Incline on the Welshpool & Llanfair Railway.

The working demonstration of PPM technology at Brighton in July 1994. No. 7 approaches a specially installed tram stop and shelter.

THAT SUMMER IN BRIGHTON

Steve Miller

A new light tramway in a town centre will create quite an impact but the impression of regeneration will be greatly enhanced if other measures are brought in at the same time

Modern 'street furniture' has the effect of greatly enhancing the look of a town centre. Steve Miller of Universal Street Furniture explains:-

IT WAS in the summer of 1994, when Universal Street Furniture was one of the sponsors of a successful tram demonstration in Brighton, that we first realised the potential of the Parry People Mover.

A normally busy street had been closed to traffic for the duration of the trial and we had provided modern shelters at either end as well as information displays and other associated furniture. The only mode of transport was the Parry People Mover, which carried members of the public wanting to experience the benefits of a modern zero-emission transport system.

Our staff, on site for the full length of the trial, were constantly being asked if the system was permanent and, if not, when would it be introduced?

So that was the scene: no road traffic, no fumes and street furniture and landscaping that considerably enhanced the area. Was this going to become the town landscape of the future?

Universal Street Furniture is currently offering a service to provide PPM with design and manufacturing facilities so that each tram system can have its own identity to suit the area in which it functions.

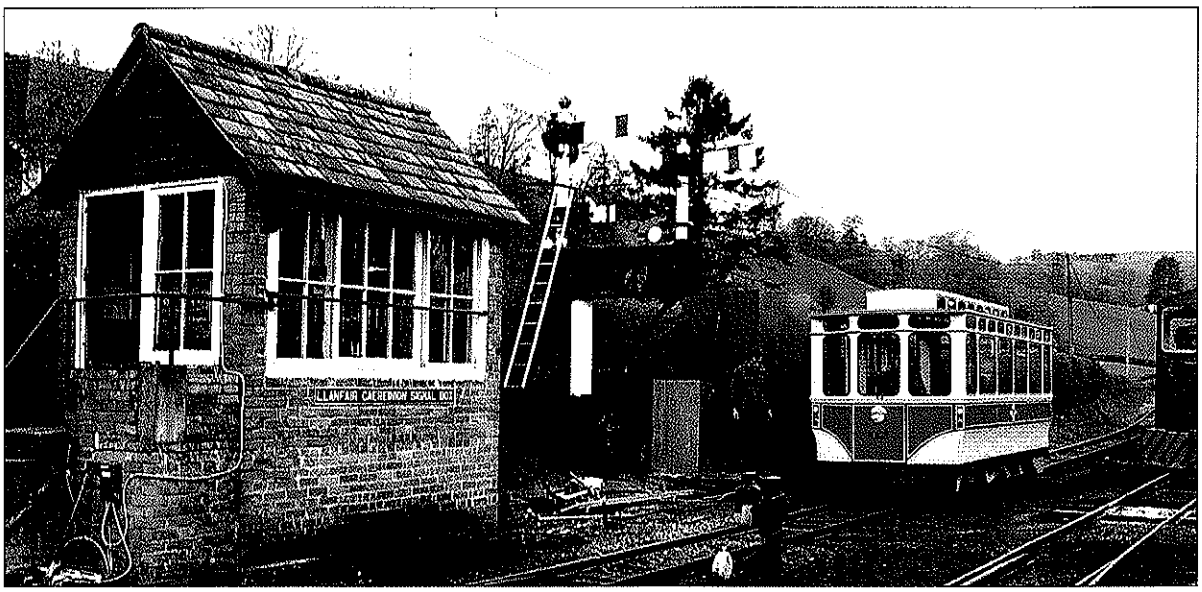
This will include specially designed shelters that can incorporate every facility from telephones to self-cleansing toilets. The company also offers a range of street furniture such as bike locking systems, covered walkways, street signage, park and ride stations, to name but a few.

A full maintenance back-up is also provided with all of our products. Where polycarbonate is used, Universal Street Furniture cleaning teams are trained to use the 'Polykleen' care and restoration system.

We are constantly reviewing new technology which can be used to provide updated information to the travelling public. Our illuminated advertising and information signs are made to give a perfect spread of light and use less power.

Well designed and good quality street furniture and associated facilities make an important difference to the pleasure and convenience of the travelling public and to the quality of the town environment. These are important values for the 1990s and it is Universal Street Furniture's mission to serve this need.

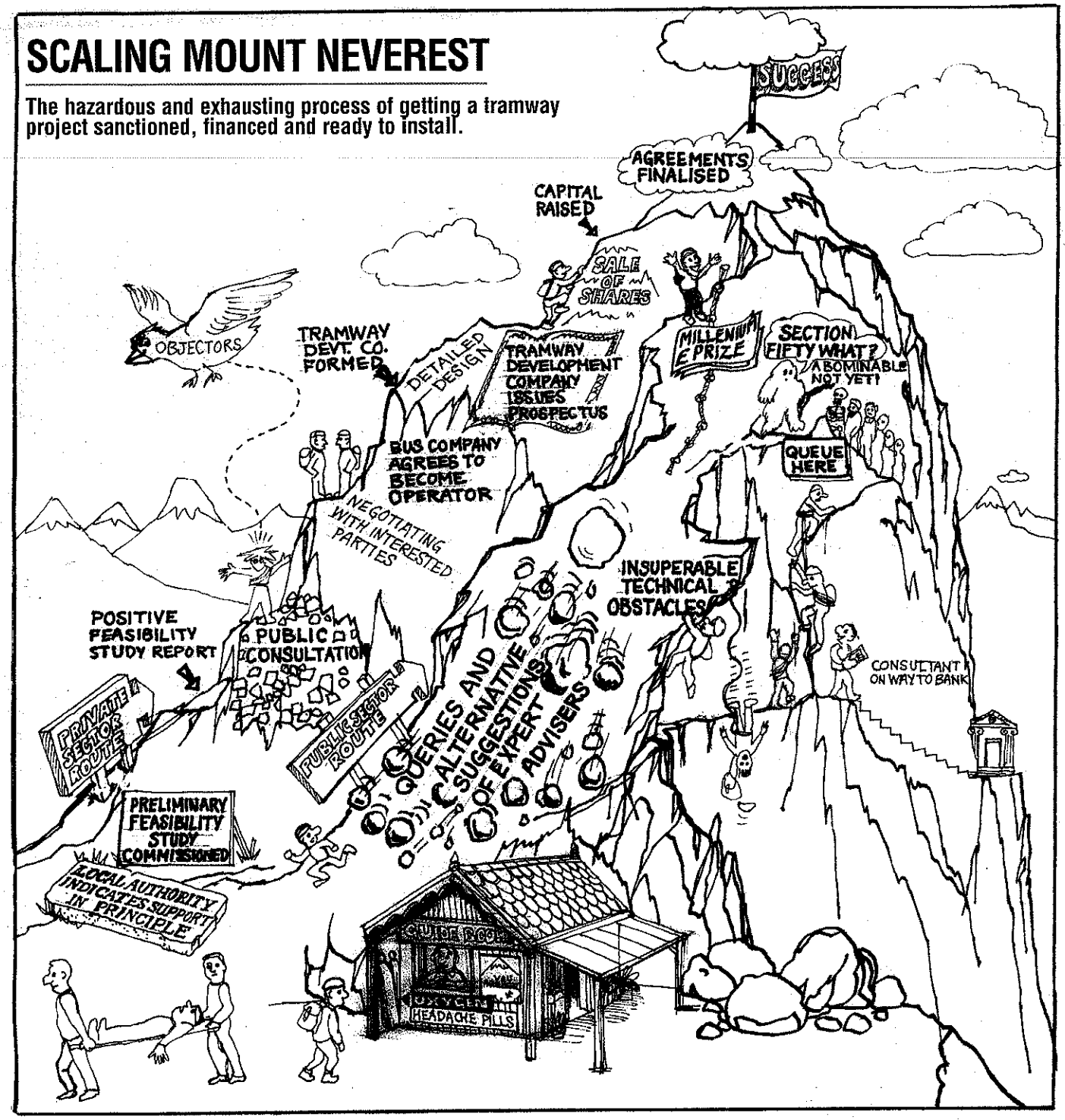
It works! So why complicate it? *UK Central Office of Information Film on the PPM Flywheel technology*



No. 9 passes Llanfair Caereinion signal box during trials and testing on the Welshpool & Llanfair Railway.

SCALING MOUNT NEVEREST

The hazardous and exhausting process of getting a tramway project sanctioned, financed and ready to install.



PRIVATE SECTOR FINANCE

John Parry

THERE HAS been consistency in over a dozen ULR feasibility studies carried out in British towns and cities between 1993-96. All indicated that a typical system, with up to 4 km of non-electrified track, usually costs under £2 million. Many are in the £1 million-£1.5 million range.

This is well within the kind of capital sum which can be raised by private share subscription supported by a strong business proposition. Rather than depend on public sector funding (increasingly scarce), the Parry promoters encourage creation of local Tramway Development Companies (TDCs). These will be formed around interest groups, particularly businesses which stand to gain from the tramway introduction in their area. Each TDC begins as a 'start up' enterprise financed out of seed funding from the interest group and small grants which may be available.

The next step is to bring in a competent operating company, typically an experienced local bus operator. Trams are unfamiliar beasts to most bus companies and here Multimodal Finance (MMF) takes a hand.

MMF will provide vehicles under special terms. Takers have an option of short leases and provision to 'get out' if all is not going to plan. With local authority backing and an experienced operator on board, and the viability of the system confirmed by a professional study (financed by TDC partners), the company can set out to raise capital. It can be used to install the track, stops and depot, and complete negotiations for planning permission and/or transport and works order, whichever is applicable. Meanwhile, the operator prepares to take delivery of trams for the service.

Successful capital raising naturally depends on a thoroughly sound business plan. This will be independently checked by financial advisers appointed specifically to safeguard interests of TDC shareholders. Then, the TDC converts itself into a 'mini Railtrack', earning its keep from access charges paid by the operator for use of the tramway, rents for kiosks, advertising, etc. It should provide a reasonable dividend on share capital and make shares eligible for listing on an alternative market (AIM or OFEX).

This gives TDC investors the option to convert investment back into cash or to continue to receive earnings — and no-one had to stand in any queue for public funds!

THE VITAL ROLE OF THE TRACKLAYING CONTRACTOR

Keith Gourlay

Scotland Track Renewals Company

THE REAPPEARANCE of British tramways means re-learning many old, forgotten skills and developing new ones to arrive at methods of permanent way design and construction which meet the changed circumstances of today. The Scotland TRC is responding to the challenges.

Quality of ride is as much a function of the type and standard of track as the vehicle's suspension. The two main features of a good riding track are obtaining correct longitudinal and transverse levels and achievement of correct alignment on straights, on transitions and on circular curves. It is all the more important with ultra light stock as it, by definition, has less inertia of its own to absorb effects of track irregularities. Experience of construction and maintenance of rail infrastructure is the key to understanding dynamic interaction of vehicle and track.

A preferential tramway installation contractor will have an understanding of the various possibilities for rail and trackbed specification and be able to match these to the demands of operation over a particular system.

Street running tramway construction poses particular problems, as the track must not only be suitable for the specified rail vehicles, but also withstand the substantial loads imposed on it by road vehicles. Good liaison with highway contractors is also necessary to leave a finished road surface which will please the most discriminating borough engineer.

Close co-operation with HM Railways Inspectorate and other regulatory bodies is needed. Approvals will be more straightforward for firms which have qualified for both the railway safety case and contractors' safety case, both of which the Scotland TRC is proud to have obtained.

The Scotland Track Renewals Company is one of the ULT grouping of organisations collaborating to bring about the introduction of the new ultra light tramway mode.

No. 8, consulting engineers JPM Parry Associates' 'mule', a testbed vehicle built to undertake monitored/instrumented trials of individual components. Here, it is set up for standard gauge tests to take place at Weymouth during 1996.

SUBURBAN APPLICATIONS

ULTRA LIGHT RAIL development has so far centred on the relatively small vehicle (35-70 passengers) suitable for car-free zones of town centres or for special purpose point-to-point applications, e.g. railway to bus station.

This is in response to what is seen as the most pressing public demand, affordable transport for the town centre which is as environmentally friendly as modern technology allows. ULR fulfils this function by emission-free propulsion, non-threatening 'people-friendly' size, predictable path and absence, in some versions, of the visual clutter of overhead wires and elaborate safety paraphernalia.

ULR is expected to be highly attractive to local authorities not only because of these primary advantages, but also a host of planning problems which it could alleviate or solve. Pedestrian (or 'pedestrian-preferred') zones in town centres have been popular and good for business but they are limited in size to modest walking range from the nearest car park. ULR allows pedestrian zones to be greatly enlarged and enforced walking distances reduced, especially if the tram tours the edge-of-town car park dropping passengers on request a few yards from their cars. When motor traffic is excluded from the enlarged centre, there is a potentially enormous 'no-car dividend.' Acres of space and buildings once sacrificed to moving and stationery cars find other uses, more attractive and profitable.

While for town centre applications ULR is likely to be chosen mainly for its environmental features, there will be others where its modest cost will be the prime consideration. One possibility, now under study by BR Research and others, is for what might be called an 'appropriate capacity service.' Many ex-BR branch lines and feeder services have a problem matching viable service frequency with customer requirements.

With conventional rolling stock, the minimum economic load factor restricts service to peak times or very long intervals. A lower cost, lower capacity vehicle allows service intervals to be shortened, e.g. from four per day to once or twice per hour. Experience shows a frequent and regular service will develop a whole new travel market, as well as bring back customers lost to rail for years. ULR is seen as the solution, albeit probably in a more substantial version. Early applications will no doubt be on existing rail spurs. Spurs could be extended to run from the railway station through streets into town centres. Assuming the formula is successful, new vicinal ULR systems will spring up, linking towns as railways used to do, sometimes using trackbed abandoned for 40 years.

A different but possibly very large ULR market probably exists in rapidly expanding cities of the developing world. Many countries have cheap hydro-electricity, often with grossly under-used capacity, while their transport needs are entirely met by imported buses, cars and oil. Poor roads and scarcity of mechanical skills make buses expensive to maintain and relatively short-lived, resulting in high costs and high or subsidised fares.

ULR would use fuel which is both local and renewable, while local content of rolling stock could be quite high. Versions would be relatively large, with no frills, and give full scope to local coach-building skills. And the low fares charged would enhance labour mobility and stimulate the economy, just as cheap travel by electric tram facilitated the European industrial revolution a century ago.

ULR POTENTIAL IN AUSTRALIA AND NZ

Dave Gamble, LRTA

ALTHOUGH PARRY People Movers of Cradley Heath has done nothing so far to promote its newly-developed ULT system outside the UK, keen readers of *Light Rail & Modern Tramway* 'down under' have made their way to the Parry premises and are now generating serious enthusiasm for the system in New Zealand and Australia.

The policy environment is extremely favourable, since both countries place a high value on environmental quality and, despite highly car-dependent populations, both are grasping the problem of cars in cities more pro-actively than city authorities in other parts of the world. Australia even has a 'Better Cities' programme which channels funds to important city improvements, such as A$13 million recently to the Ultimo/Pyrmont light railway in Sydney now under construction.

In New Zealand, the Parry People Mover transit system is now under serious consideration in Auckland, Wellington and Queenstown. Auckland and Wellington both have waterfront developments where transport systems of minimal environmental impact are required.

Queenstown is a four-season holiday location which expects a massive increase in tourist visitors over the next decade and is determined not to allow motor traffic to spoil the clear lake and mountain ambience which is its principal asset.

New Zealand promoters of the Parry system have now moved on to present the system to the Premier of New South Wales. Although the major city of Sydney has recently commissioned a very highly specified conventional light railway, there are many authorities for cheaper short-range systems, and the city authorities are definitely rail-minded.

Still only an image, but committed soon to achieve realisation — a photo-montage of the proposed ULT70 in a shopping street.

WEYMOUTH IN WAITING

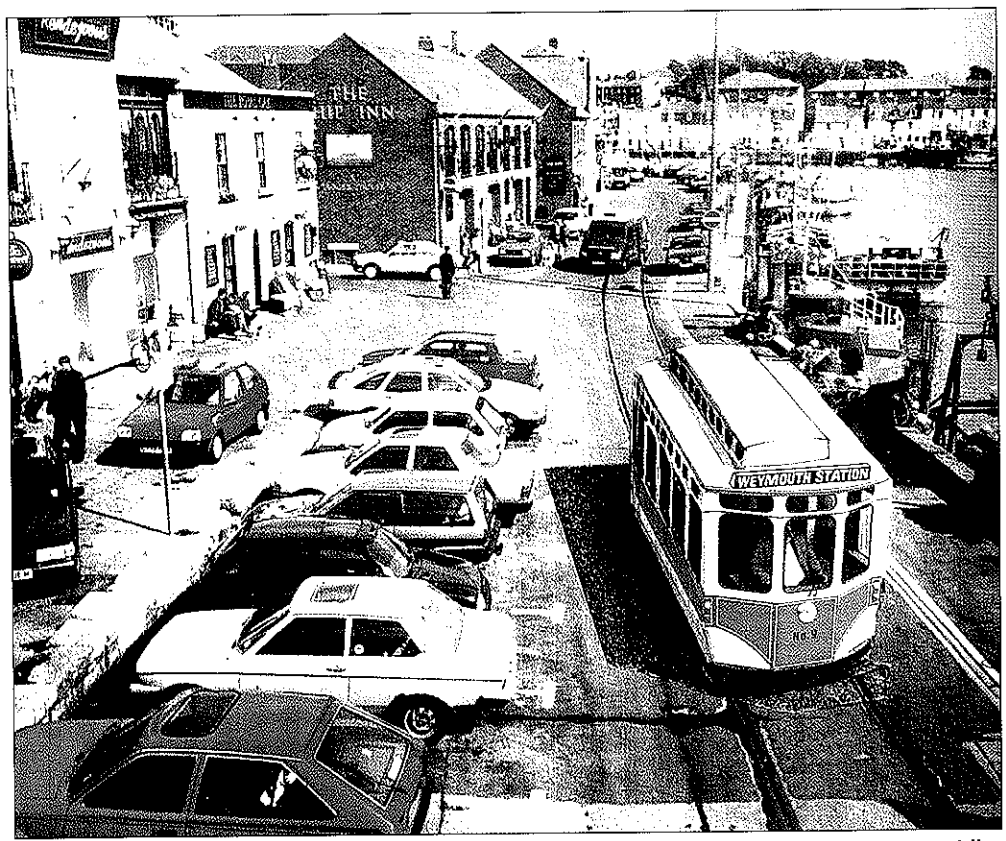
John Sherlock

THE POPULAR seaside resort of Weymouth in South Dorset may see the first public service operation of a PPM light tram if current plans to operate a service between the town's station and the seafront area on the existing Quay Tramway are carried out. The Quay Tramway, opened in 1865 as part of the Great Western Railway to carry freight from the town's station, is approximately a mile and a half of street running track. Although now only used for infrequent special trains, in the past it carried passenger services, including boat trains, to connect with ferry services.

Faced with growing public demands to 'do something about the tramway', Weymouth & Portland Borough Council had to make the decision whether to press for the removal of the track, or to make use of this valuable public transport asset. It decided on the latter, and after carrying out an investigation into the availability of suitable vehicles has decided that a Parry People Mover light tram, with its attributes of nil-emission operation, appropriate size and relatively low capital and operation costs is the most feasible option.

A heritage-styled PPM vehicle will be a visitor attraction in its own right, and serve a valuable public transport function by connecting the railway station and car parking with the ferry terminal and sea front areas.

Although some changes will have to be made to road traffic controls, WPBC is confident that the tramway can operate without causing disruption to traffic flows within the town. Detailed plans are being made of traffic signals and other measures required for safe operation, under discussion with the Railways Inspectorate.



How street car styling would fit into a South Coast harbour scene. Only cars seem out of place!