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LRT LINES IN FRENCH CITIES: ACCESSIBILITY VS. MODAL SHIFT? A PERFORMANCE-BASED ANALYSIS

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Session A4

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ABSTRACT

This paper summarizes finalized research concerning ten main French public transport networks including LRT lines: Le Mans, Marseille, Montpellier, Orléans, Reims, Valenciennes, Toulouse, Nancy, Caen and Clermont-Ferrand. This set associates single-line and more complex networks, classical tramways, LRT on tyres and « hybrid » systems (partially guided).

The performance of the network is based on (i) the profile of the lines (ramps, curves, etc.), (ii) the speed limits, (iii) and the degree of independence of LRT tracks *vis à vis* general road traffic (which can generate risk of conflicts and delays). Current travel times (and average commercial speed) are confronted to those announced in the projects. In most of the cases studied, average speeds are lower than expected (generally between 15 and 18 kph).

The aim of our research was to find out the reasons of the lower level of performance. Some of them are linked to the characteristics of the rolling stock chosen by the public transport authority: technical innovation can be deceiving. In most of the cases, the profile of the tracks generates a high level of constraints, with many curves and long sections of line at a reduced speed. This is especially the case of the first lines built: they have been designed in order to serve the maximal number of traffic-generators, as if they were the first and also the last line to be built. Changes of direction are frequent and straight lines, along which the rolling stock can run at its nominal speed, are rare. The financing mode, with incitations to serve « disadvantaged » quarters, can explain some diversions. In other cases, the new lines try to correct some past planning mistakes by serving remote service centres like hospitals, university campuses, etc.

As a first conclusion, the unsufficient level of performance can be explained by the fact that urban planning issues (including facade-to-facade re-shaping works) are of higher interest than transport ones during the project conception.

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Keywords: Light Rail Transit (LRT), lines, design, profile, speed

1. INTRODUCTION

Having almost completely disappeared from circulation, tramways began being reintroduced into French cities at the beginning of the 1980s. Of the 101 networks initially developed during the 19th century, only three isolated lines (Offner & Zembri, 1994) continued to exist in Marseille, Saint-Étienne and Lille. The revitalisation of the tramway in France has been translated by an approach radically different from that of the previous generation:
- complete separation from vehicle traffic,
- longer routes (up to 20 km) crossing through city centres and extending outwards to occasionally very distant districts,
- a desire to create an enhancing image based on the innovative design of the rolling stock, inventive street furniture and a choice of occasionally expensive floor finishes,
- an urbanism-transport interface translated by an in-depth reorganisation of traffic movements, the redefinition of the districts along the routes and track layouts reaching from facade to facade, a choice much more expensive than simply laying rails.

In certain cases, the chosen routes have been dictated by government funding programmes, particularly for opening up disadvantaged districts to the surrounding city (town upgrading national policy). In other cases, the creation of the network has been used to cross through areas that will be subject to future urbanisation, giving an immediate impression of pointless detours.

At the end of the day, the new generation French tramway gives the impression of being a luxury product (insofar as government funding is concerned) but which provides a low performance level due to the detours resulting from opportunities to open up specific districts or the desire to serve a maximum number of traffic generators and attractors. The tramway has also been a major issue in electoral campaigns and, as in Orléans in 2001, resulted in the defeat of local mayors. It continues to be the focal point of lively debate that has allowed academics to put their points of view (Carmona, 2001).

In technical terms, it must be admitted that in many cases, little additional time is gained when compared with the old bus system. There are at least two reasons for this:
- routes meander and often change direction. Straight lines have not been privileged and, as a result, distances are longer when compared with bus routes, a fact that counterbalances the increased speed of the tramway,
- speeds specified for the tramways are generally low and occasionally slower than those of buses on a comparable route. They can be affected by an insufficient level of priority at traffic light intersections.

There is very little scientific literature on the issue of tramway performance levels which appears to represent a “blind spot” of transport research[1]. Authors generally consider that

[1] There is no « proxy literature » counterbalancing the lack of scientific production. All the studies are carried out *ex ante* in optimistic terms, and *ex post* critical assessments, which would be interpreted as direct criticism of the elected people at the origin of the projects, are very rare. Our investigations have

transit speeds are satisfactory and sufficient enough to generate a changeover from bus to tram (Stambouli, 2007). However, potential risks of these speeds being reduced have been noted by Jean-Louis Maupu (2003). We wanted to look in greater detail at those linked to routes and the setting of speed limits and, to this end, initially examined ten networks: Nancy, Caen, Clermont-Ferrand, Le Mans, Reims, Montpellier, Marseille, Toulouse, Valenciennes and Orléans.

2. GENERALLY INNOVATIVE ROUTES

Bus networks in French cities are the descendants of tramway networks created between 1855 and 1911 and which reached their maximum level of development in the early 1920s. They were subsequently dismantled over the period from the 1920s through to the 1970s (Robert, 1974). The replacement of tramways by buses took place line by line. This resulted in the same routes being maintained through to the introduction of the "modern" tramway which often provided an opportunity to completely reorganise the network. Previous transformations had generally consisted in adding and extending routes to match expanding urbanisation or the perimeter being served (urban transport boundary or UTB).

The introduction of the tramway also generated a hierarchy of lines. The new "heavy" lines were protected from vehicle traffic and profited from an increased transit speed, greater regularity and a better passenger carrying capacity. Tramway sets are able to carry 170 to 300 passengers as against 90 to 140 for buses. Tram services are more frequent than those provided by buses. This has led to the temptation of creating bus connections at various points along the tram line to avoid sharing the same route.

It is therefore interesting to compare the new networks with those that they replaced. We shall show that the differences essentially lie in the adoption of routes that are not so obvious or as straight as in the past, a factor that can be explained by modified service objectives, themselves occasionally dictated by urban development or redevelopment objectives.

2.1. From tramways… to tramways, via buses

The first French tramway networks followed the main roads and made few detours. For example, line A of the Tours tramway (in 1930) was completely straight between its terminus on Place de la Tranchée to the north and the Barrière de Grammont terminus to the south (4 km). Lines intersected one another at one or more points in central districts, such as the Place du Martroi in Orléans or Place Jean-Jaurès and Place des Halles in Tours. Where the layout of historic city centres (particularly narrow or winding streets) made it impossible for tramways to pass through, as in the case of Clermont-Ferrand, they were organised to loop around the

been funded by some operators, through a procedure of « expertise of new technologies » established by Labour Law, which can be requested by any Joint production committee (*comité d'entreprise*).

centre. However, they did not serve locations at any great distance from the dense central districts. In this sense, they were very different from today's tramway layouts.

When the initial tramway networks were converted into bus routes, these simply used the existing routes. This approach can be clearly seen in the recent work carried out in Le Mans by Adelaïde de Ketelaere (2010 & 2012). Subsequently, the considerable expansion of conurbations that took place as from the 1960s initially saw the existing lines being extended. This was followed by the creation of lines providing a better service to the city outskirts. The routes previously followed by the tramways became joint sections with several lines organised into groups.
When "modern" tramways were introduced in the early 1980s, cities were not as compact as they had been 30 years earlier. In addition, poles of attraction had been placed on the outskirts: new university campuses, hospitals and business parks as well as shopping and leisure centres. Dense residential housing block districts had also been built. It was therefore necessary to take into consideration these new poles which were occasionally separated from the rest of the city by green spaces that had not yet been built up. This resulted in much longer lines that could have been straighter (figure 1).

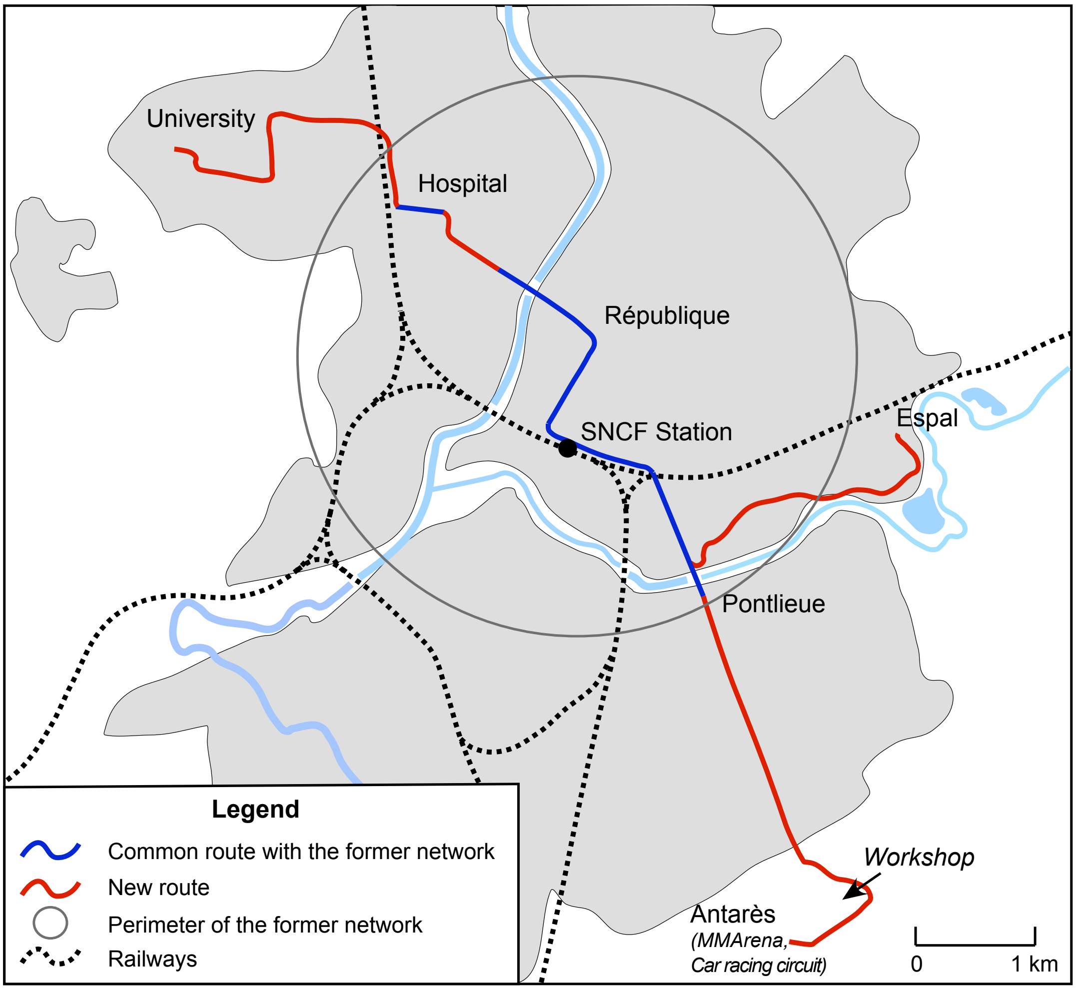

Figure 1 – The difference of scale between the former and the "modern" tramway network in Le Mans

2.2. The importance of a policy aiming to improve the status of underprivileged districts

Almost all the first lines of the new networks were designed to serve underprivileged high-rise apartment block districts. La Paillade in Montpellier, Hautepierre in Strasbourg, La Source in Orléans, Les Caillols in Marseille and Croix-Rouge and Orgeval in Reims were provided with tramway access from the outset. These choices can be justified by a car ownership among the residents lower than the average, resulting in difficulties in accessing jobs that are generally at a considerable distance. The socio-economic development of these districts had since the early 1980s been very unfavourable as a result of the most well-off populations, encouraged by State aid, leaving the district to buy their first home. These people were replaced by poorer households housed where units were made available by the social housing agencies owning most of these districts. This subsequently resulted in the launch of policies aimed at preventing the progressive isolation of these districts and allowing their working populations to travel to their jobs in the best possible conditions. These measures are grouped together under the general term of Urban Renewal Policies.

These policies were introduced as from 1984. The development of high performance public transport networks serving "sensitive" districts in order to open them up and incorporate them into the surrounding urban fabric rapidly became a priority. Financing was proposed to city administrators to encourage them to direct their tramway lines towards districts subject to Urban Renewal Policies. In addition to opening up the districts, the tramway works also included the renovation of public spaces crossed by the new infrastructures and overall improvements made to the districts, contributing to reinforcing a sense of pride among the residents as well as attracting activities and services.

The promised additional financing profited most cities having developed a light rail transit (LRT) system. The city of Clermont-Ferrand, for example, received €30 million from the State to extend its line A through to a district with an urban Upgrading Policy status.

2.3. Generalized accessibility? The risks of trying too hard to provide access

The impression that might be felt by an uninformed observer is that the designers of the first lines built in a given city considered that no other lines would subsequently be built and that they had to serve all traffic generators and attractors in vast sectors. Objectively, it can be seen that the lines do not – as did their predecessors – adopt straight routes that closely followed the major axes converging on the city centres. The case of Montpellier is highly representative of this approach, which combines radial routes (from the centre to the outskirts) and a route looping around the city. The first line links the Odysseum shopping and leisure centre (in the eastern suburbs of the city) to the Paillade district (at the opposite) via the railway station and the Place de la Comédie, the city's emblematic centre. On its eastern side, the line makes a detour to serve the new Antigone – Port Marianne district which is also home to the Regional Council and the Conurbation Committee (*Communauté d'Agglomération*). Following a particularly winding route through the station district, the line then skirts the historic centre to the east and north before reaching the north-western universities district and teaching hospitals. It then separates from the dominantly radial road routes to make a detour towards the south-east which allows it to enter the Paillade district and reach its terminus there at the Mosson stadium. As a result, the main facilities located in the north-west segment of Montpellier are served by a single line which would otherwise have needed to be served by three separate bus lines following direct radial routes (figure 2). As we shall subsequently see, this also has certain consequences on the length of travel time from one end to the other of the line.

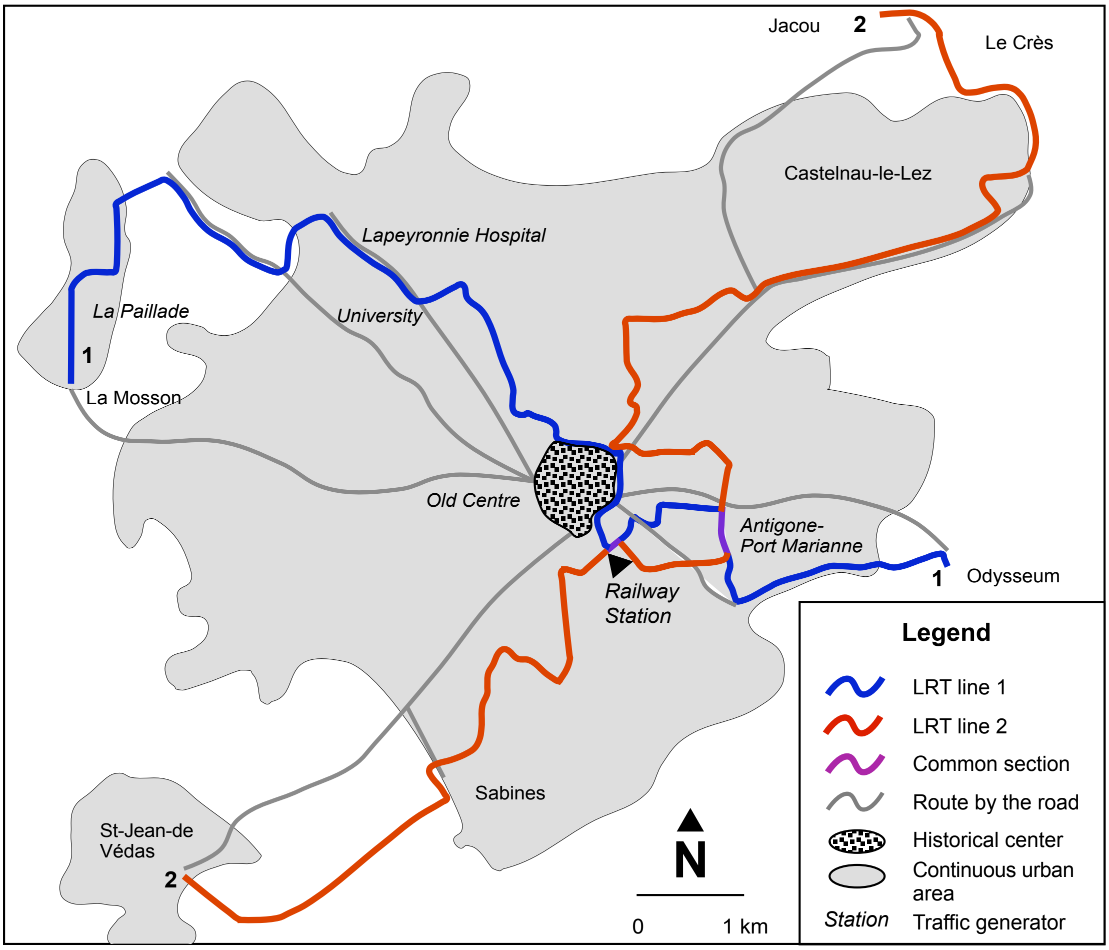

Figure 2 : Comparison between direct road routes and the routes taken by the two Montpellier LRT lines (before april 2012).

In addition to the aim of serving a maximum number of traffic-generating poles, there is also occasionally the intention of passing through sectors of the city that will be undergoing development but which, at the time that the LRT was built, had not yet been urbanised. This option, taken for the first time in Orléans in 2000 (Archambault, 1995) was initially very highly criticised given that the line passes through orchards and wasteland over a distance of almost two kilometers between Olivet and the university of Orléans (La Source campus). The detour when compared with a straight route is considerable and has substantial effects on travel times (Figure 3). Subsequently, Montpellier also took a gamble with its second line, passing through rural sectors between Les Sabines and Saint-Jean de Védas (to the south-west) and between Castelnau-le-Lez and Jacou (to the north-east). This is the same for the new line 3 (opened in 2012), joining Montpellier to the Mediterranean Coast (Pérols) and to the peripheral town of Lattes through the countryside. The first LRT line in Reims, opened in April 2011, has a branch line leading to the Champagne-Ardenne TGV station which is located outside the city. For over half its length (1.4 km), this branch passes through a future urbanisation zone (Bezannes designated development area) and two locations have been earmarked for future intermediate tram stops. This branch line is currently mainly used by people going to or coming from the TGV (high speed train) station. However, these passengers also have the choice of taking regional trains to the city centre that are faster than the tramways. Consequently, passenger traffic levels risk being very low until this sector has been fully urbanised.

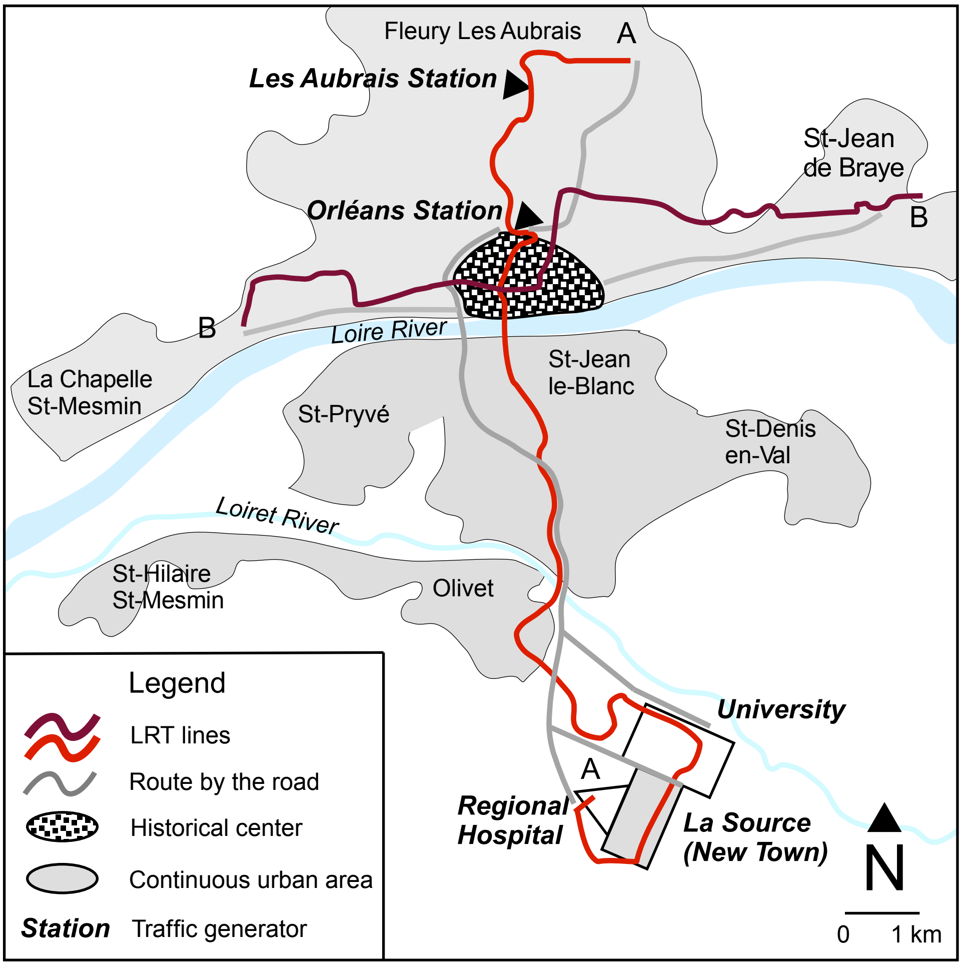

Figure 3 : Comparison between direct road and LRT routes in Orléans

The opposite process can also occur with the LRT when it does not serve a city amenity judged to be vital, such as the central station. This is what took place in Clermont-Ferrand. The first LRT line, generally laid out from north to south, skirts the historic centre by the west despite the train station being located to the east. It should be noted that the previous network took the same approach and that the station was only served by a dead-end branch line. Opposition to the proposed route was such that the matter went to the Council of State (the highest French administrative court) which decided in favour of the route proposed by the conurbation committee (*Communauté d'Agglomération*), given that no law imposed that the station should be served by the tramway!

3. WINDING ROUTES, AND A LARGE VARIETY OF SPEED LIMITS

In this section, our analysis focuses on the routes themselves. Given the multiplicity of tasks carried out by the LRT, they are characterised by a large number of changes in direction and by the use of secondary roadways that are narrower and less straight that the main roads usually followed by the tramway. There are also routes on the city outskirts that are completely independent from roadways and which transform the tramway into a type of suburban railway, permitting increases in the average speeds calculated over all routes. Having said that, those that go fastest towards the ends of the lines are not necessarily those that are most frequent.

3.1. The main characteristics of the lines being studied

Changes in direction in the city outskirts and routes through the central districts are translated by tight curves that slow the tramway down to speeds much lower than those attained on straight lines. Other factors can also come into play, such as the winding nature of the routes taken by the LRT, the number of road crossings over the reserved site, the opening of the LRT platform to pedestrians (in historic city centres), etc. In the case of Reims, a precautionary principle that the owner imposed on itself (until now, no other network had inflicted this type of constraint on itself), calls for drivers to reduce their speed by 10 kph at all intersections, even when the route is straight! We can observe the same principle along the brand new line B in Orléans (opened in june 2012) : the speed is reduced to 30 kph[2] at all intersections (picture 1). We shall subsequently see that this means a large number speed limit changes that drivers are unable to respect.

[2] And to 25 kph during the three first months of operation (picture 1 has been taken during this period)

Picture 1: reduced speed across intersections : an illustration along the new line B in Orléans. Another signpost at the rear shows a higher speed limit for the next section of the line (40 kph) (author: P. Zembri)

Generally speaking, the speeds attained towards the ends of the lines in city outskirts are much higher than those imposed in central districts. Most recent LRT reach 70 kph, especially when the lines travel through low density areas. On the other hand, routes through densely populated areas can see strict speed limits being imposed: 20 kph in general in pedestrianised zones, 30 to 50 kph along main routes. The accumulation of reduced speeds has a considerable effect on travel times.

There are numerous changes in direction, even though their frequency changes from one network to another. In the case of Reims, there is a change in direction every 658 metres on average, of which ten with an angle greater than 45 degrees. On line A of the Orléans LRT, there are 24 bends over the 18 km route, being an average of a bend every 750 m. On line 2 of the Montpellier LRT, there are 24 changes in direction over the 19.8 km route. While standard tramways have a minimum turning radius of 20 meters, the tramways running on tyres used in Nancy, Caen and Clermont-Ferrand can turn on a tighter radius: 10.5 m for the Translohr and 12 m for the GLT (Guided Light Transit) (data provided by manufacturers). Network designers were quick to impose curves based on the presumed tramway performance levels. In the case of Nancy, the GLT has a tendency to detach itself from its rail due to the overly low pressure exerted by the guiding system: following several derailment incidents, the only solution found was to limit the speed on bends to a derisory 5 kph. By pushing a system to its limits, there is a considerable reduction in real performance levels. Standard tramways also take bends at the limits of their performance capacity, resulting in speeds being reduced to 10 or 15 kph.

A low radius curve linked to the roadway configuration may exceptionally be tolerated. However, it is not easy to accept that these curves be multiplied given the resulting increased travel time and the greater wear imposed on the rolling stock which is regularly pushed to its limits.

3.2. Three representative networks: Orléans, Montpellier and Reims

These three networks share similar characteristics: the lines pass through different types of urban environments that range from roads and pedestrianised squares in the city centre through to sites that have not yet been urbanised in outskirts that are occasionally at a great distance from the centre, passing through outlying high-rise housing districts and shopping centres. They have at least two lines.

In all three cases, the lines lead out from the dense urban zone and cross almost empty territories, with fewer stops and good technical characteristics. In the first two cases, the lines cross future urbanisation zones where the passage of the tramway is intended to form part of a sustainable urban development logic. In the case of Montpellier, the tramway serves outlying districts (Saint-Jean de Védas and Jacou), crossing non-urbanised spaces which will not necessarily be subject to development.

The lines are of different lengths: those in Reims are the shortest (9.5 km and 6.9 km respectively) and have a 3.5 km long joint section. The two lines in Montpellier were 15.2 km long (line 1) and 19.8 km (line 2) before april 2012[3]. The first Orléans line (A) is 18 km long. The second one (B), recently opened, is 11,5 km long.

[3] A major change in the structure of the network has occurred in april 2012, with two new lines (3 and 4) and the re-routing of line 2 across the city center (along line 1 between the central station and the Corum). Line 4 is a nearly-completed circle line around the historical center.

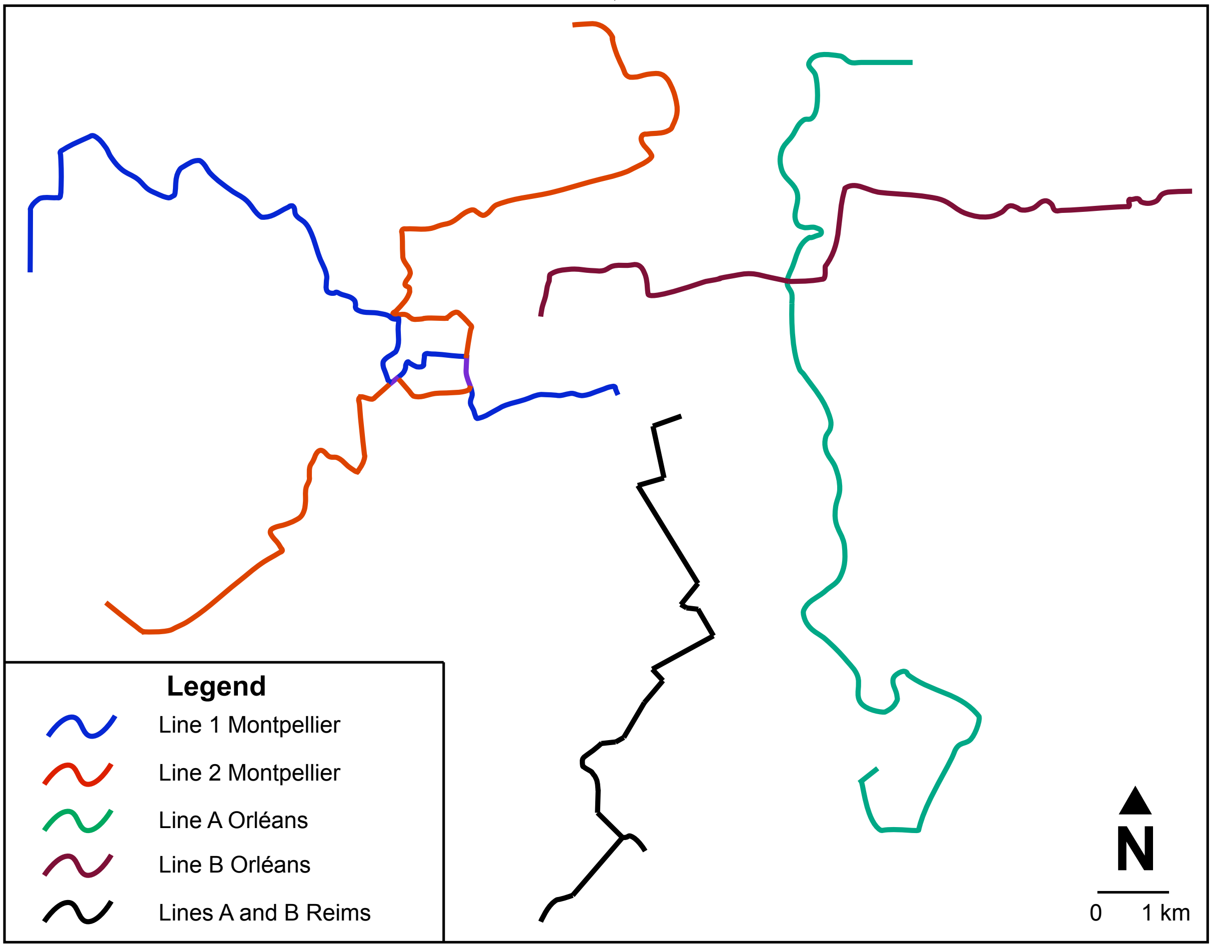

Figure 4 : Routes taken by LRT lines for the three networks being studied (at the same scale)

Figure 4 demonstrates that in all three cases, the routes are fairly tortuous, leading one to believe that the highest speeds (greater than or equal to 50 kph) will only be authorised over 40 to 60% of the total length. In practice (Table 1), high speeds are only obtained over 51% of the route in Reims. What is surprising in this example is the considerable number of imposed speed limits: ten in all over 101 sections! Fortunately, these frequencies are not to be found on the two other networks.

Table 1 – Frequency and average length of speed limit zones by set speeds on the two LRT lines in Reims (southbound, situation on 25 November 2010).

Applicable set speeds (kph)	Number of zones	Cumulated length (m)	Average length (m)
15	13	950	73
20	5	820	164
25	8	670	84
30	9	610	68
35	2	280	140
40	30	2160	72
50	28	4360	155
55	1	80	80
60	4	600	150
70	1	680	680

It is worthwhile establishing a parallel between the authorised speeds and the urban context of tramway lines, based on the principle that the densest contexts are those where passenger traffic will be highest. However, as we shall see, it is at the ends of the lines, in a periurban environment that speeds are highest. This makes it possible to estimate the average speed while taking the lower speeds of the central zones into consideration.

Line 2 in Montpellier (Saint-Jean de Védas – Jacou) provides a representative example of this configuration given that it includes long sections in semi-rural settings which are crossed at 70 kph with much greater distances between stops. These sections are only covered by one out of two tramways as intermediary terminuses have been created in Sabines and Sablassou. As a result, lines are single track, with passings possible at most stations. Between Sabines and the entry to Saint-Jean de Védas, line 2 picks up the route of a railway line forming part of the national network but which has been closed to all standard rail traffic (picture 2). Between Sablassou and the north-eastern terminus of Jacou, the route is completely separated from the roadway but does not pick up a former railway line (picture 3).

Picture 2 : View of line 2 of the Montpellier tramway on a former railway line section between Les Sabines and St-Jean de Védas (Author: Pierre Zembri)

Picture 3: Independent route followed by line 2 of the Montpellier LRT between Sablassou and Jacou (Author: Pierre Zembri)

On the other hand, in the city centre, speeds are lower with a particularly winding section around the Corum conference centre and the SNCF station where speeds are reduced to 20 and even 10 kph.

The same type of organisation can be seen on the Orléans network. Line A links the centre of Orléans to the La Source satellite town, home to the city's university, public housing districts, businesses and a major regional general hospital. It crosses two rural sectors where travel speeds can be higher (picture 4), partially running alongside an express highway. However, it takes a fairly indirect route which, as we shall subsequently see, makes it much less efficient when compared with the former bus service.

In the case of Reims, line B, linking the central station to the TGV station, crosses the future Bezannes urban development area along a single track. It is only along this section that the trams can travel at 70 kph, but there are few passengers currently using this route. However, the speeds travelled over parts of the route crossing the central districts are much lower.

Picture 4 : line A of the Orléans tramway between Orléans and La Source in a sector of the Olivet municipality that has not yet been urbanised (photo: Pierre Zembri)

4. THE DANGERS OF AN OVERLY GLOBAL APPROACH TO TRANSIT SPEEDS

The posting of a global transit speed per line and even for all tramway lines serving a given city is liable to mislead decision-makers and users while simultaneously placing a high level of pressure on drivers to ensure that travel times are respected. We shall explain this situation by basing ourselves on a number of examples where we have been able to acquire detailed information.

4.1. Definition and display

The transit speed is defined as the average speed calculated from terminus to terminus, taking into consideration the stops and consequences of all problems encountered along the route (congestion, defective traffic lights, exceptional passenger traffic, etc.).

The speeds announced during the project phases are fairly uniform: around 20 kph. The real speeds noted subsequent to the start-up of the service are more varied: between 16.7 kph (Nantes, line 3) and 22.2 kph (Nantes, line 1) (Stambouli, 2007). Jacques Stambouli asserts that even though slightly lower than the announced performance levels, these speeds are completely compatible with those of an equivalent distance covered by car. But is it reasonable to discuss equivalent distances given the divergences from straight lines noted earlier in this article?

Also, and as we shall subsequently see, the global transit speed is misleading as it can mask considerable disparities. In addition, it is not a relevant indicator in assessing the performance of LRT lines inasmuch as passengers are particularly concerned by real point-to-point travel times. Finally, the transit speed provides the operator with a basis for setting timetables and schedules. The policy objective, even though unrealistic, becomes the threshold below which financial penalties can be applied, with consequences on the working conditions of the drivers that are best not mentioned.

4.2. Calculated speeds and travel time appreciations

To quote Jean-Louis Maupu (2003), "*the line does not go where the passenger expects*. (…) *A sinuous line can become a well-filled merry-go-round, but is that really the aim?*" It is necessary to further examine this paradox which reveals that, despite fairly mediocre real performance levels, the tramway service is widely used by the public.

In the case of Montpellier, we have earlier seen that the routes taken by the LRT are much longer inasmuch as they combine several links that were previously covered by separate bus lines running along more direct routes. We have tried to draw a comparison between the distances covered by the tramway and those covered by a direct road route. As shown in table 2, the tramway is always slower despite the fact that road traffic has to skirt the historic city centre.

Table 2: Comparison between LRT distances and distances by cars taking the most direct routes (calculations made using IGN cartographic data). Situation before april 2012.

	Road (m)	Tramway (m)	Difference (m)	Difference (%)
Railway Station - St-Jean de Védas	4900	7090	2190	44.69%
Railway Station - Sabines	3000	4080	1080	36.00%
Railway Station - Odysseum	3500	5870	2370	67.71%
Railway Station - Sablassou	6000	8700	2700	45.00%
Railway Station - Jacou	7500	12710	5210	69.47%
Railway Station - Euromédecine	5440	6790	1350	24.82%
Railway Station - Mosson	5070	9330	4260	84.02%
Railway Station - University	3700	4350	650	17.57%

The Station – Jacou route takes 35 minutes by tramway, while the 7,500 metre road journey takes 26.5 minutes at an average speed of 17 kph, being 24.3 % less time, a factor that is very important for a city of this size. The Station – Saint-Jean-de-Vedas route takes 21 minutes by tramway as opposed to 17.3 minutes by road (17.6 % less time). In both cases, the high speed of the tramway in the outskirts of the city allows it to reduce the time differential when compared with a road journey (the distances are respectively longer by 69.47 % and 44.69 %). For more tortuous routes such as that between the Station and Mosson, the tramway takes almost twice as long as a road vehicle travelling at 17 kph (31 minutes as opposed to 17.8 minutes).

In the case of Orléans, the situation is comparable for links between the central districts and the La Source district, although it is worthwhile specifically mentioning the access to the regional hospital which is served following a considerable detour via the university campus. By road, the district is 11 km from the station (representing a 17 minute journey). By

tramway, the travel time is 35 minutes. The university campus itself can be reached in 28 minutes by tramway from the central station (a route used by a large number of students). This travel time is very similar to that previously taken by buses prior to the introduction of the tramway. By road, the 11 kilometres take 20 minutes (being 28.5% less time).
In these two cited cases, the high speeds over a part of the route partially but not completely compensate the increased distance. The result is insufficient point-to-point performance levels despite the fact that the transit speeds given in the official schedules are fairly high (21.6 kph for line A in Orléans, 21.2 kph for line 2 in Montpellier). It goes without saying that there are more passengers over the most direct parts of the lines.

4.3. Imposed speeds and driving conditions

In practice, the transit speeds announced at the time that the projects were presented have rarely been those measured once the lines have become operational. The difference can be explained by a faulty organisation of priorities on intersections and by modifications made during the project to the speed limits set over the various sections. It is up to the drivers to remain as close as possible to the announced performance levels, no matter what the driving condition or tramway frequencies.
However, a lot of unexpected events can occur along a route: vehicles immobilised on the tramway site, crowds of pedestrians in town centre shopping streets, traffic light breakdowns, etc. In addition, the schedules integrate stop times in stations that cannot always be respected during peak times. This can be further aggravated by the positioning of ticket validation machines inside the tramways next to the doors. Certain networks, such as the one in Strasbourg, have chosen to place the validation machines on the platforms rather than in the tramways, but this is far from a standard approach. Whatever the nature of the encountered problems, it is up to the drivers to, as far as possible, catch up the accumulated delays to avoid the operators suffering penalties for not respecting schedules. This can take the form of briefer stops at the terminus or driving behaviour that does not take passenger comfort into consideration.
The pressure has become such on certain networks that strikes have been generated by problems concerning the respect of the imposed timetables. This was the case on line T3 of the Paris network following a managerial decision to increase the transit speed on the line without any modifications to operating conditions.

5. CONCLUSIONS

The performances of French LRT can be seen to be paradoxical: relatively high transit speeds along routes longer than those taken in the past by buses. At the end of the day, point-to-point travel times (particularly from the end of the line to the historic city centre and the station) are disappointing. The routes deviate considerably from the most obvious straight lines and the detours dictated by the need to serve the largest possible proportion of population and jobs have the effect of reducing the efficiency of the system. As a result, the filling of tramways is very satisfactory in the central area, there where detours have least negative effect, but much less so over the rest of the route.

The required detours are also a source of constraints for the rolling stock which is often pushed to its limits, especially where curve radiuses are concerned. Systems on tyres (GLT, Translohr) are those most exposed to this problem. The accumulation of curves and the associated speed limits multiply the moments at which the tramways travel at below the nominal speed, resulting in drivers having less leeway given that they have to respect overly restrictive timetables.

It is easy to understand that local decision-makers wanted the LRTs, attractive urban objects and symbols of modernity and urban renewal, to be as visible as possible to the greatest number of people as from the opening of the first line. However, the LRT's urban function has taken precedence over its transport function, to the detriment of speed performance levels. While a network such as the one to be found in Montpellier is planned to develop to form a wider-ranging mesh, a solution that will permit the exchange of sections between lines and, in the long term, introduce more direct routes, it is not at all sure that this movement will be generalised across the country..

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