MEGA URBAN TRANSPORT PROJECTS AND RISKS: WHAT PLANNING, FINANCING AND EVALUATION CAN BE LEARNED? THE CASE OF A PUBLIC PROJECT (MÉTÉOR, METRO LINE 14, PARIS, FRANCE).

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ABSTRACT

The planning, evaluation, financing and construction of mega urban transport infrastructures is characterised by considerable complexity and risks of a social, institutional, political, financial, technical and environmental nature. The aim of this article is to provide a critical assessment of the practices used by players during the planning and construction of the Météor automated metro line in Paris (France). This line is a public project. It is one of the highest performance lines on the Paris metro network. The article shows that the public decision-making process used for Météor can be compared with a closed system. This had consequences on the project results, including the impossibility of respecting the objective of reducing congestion on line A of the regional express network railway (RER) which is saturated as a result of high traffic levels. However, certain other objectives were attained. A critical analysis of the decision-making process and the planning, evaluation and financing practices used by the Météor decision-makers provides a series of conclusions and good practices applicable to public projects, closed public decision-making processes, project evaluations, transport planning and town planning, as well as the design and management of projects.

Keywords: planning, financing, evaluation, transport infrastructures, metro, France.

The planning, evaluation, financing and construction of mega urban transport infrastructures is characterised by considerable complexity and an occasionally high level of risk. The complexity can be linked to the technology used in the construction of the project (automated metro, bridge with a long span, etc.), the need to integrate the project into a restrictive urban environment (little available space, proximity of housing, etc.), the incorporation of the positions held by the large number of concerned parties, reducing environmental nuisances and the project's effects on health, respecting estimated costs, participating in economic development, greater accessibility, etc. This complexity is accompanied by a more or less large number of risks (Miller, Lessard, 2008).
The risks can be institutional. A new technical regulation may require that a project be modified for safety reasons. The risks can be political. Elections can see newly elected representatives coming into power who do not share the same transport policy as their predecessors. The risks can be social, linked to residents opposing the project. The project can find itself threatened by financial risks, natural risks (such as flooding during the works, etc.) or technical risks. The project can also generate environmental risks (pollution, health effects, etc).
The aim of this research is to establish a critical and comparative assessment of transport infrastructure planning, evaluation and financing practices. Depending on the national context in which they find themselves, these practices more or less take the risks and complexity of the projects into consideration. Thirty-three infrastructure projects in ten countries[1] are analysed in this research financed by the Volvo Research and Educational Foundation.
The article concentrates on the case of Météor, line 14 of the Paris metro (France). This 9.2 km long line was constructed between 1989 and 2007. It connects Saint-Lazare main line station, one of Paris' main railway stations, to the Olympiades metro station located to the south of the capital. The line was constructed under the authority of the Régie Autonome des Transports Parisiens – RATP (Paris transport authority), a public corporation that also operates the Paris bus and metro networks as well as part of the Réseau Express Régional – RER (regional express railway). Météor has the particularity of being the first wide gauge automated metro in the world. The absence of drivers makes for a highly flexible organisation of the transport offer as train sets can be added to adapt to the number of passengers without this having any repercussions on the time worked by drivers or the salary cost of the line.
The line can also easily be considered as an ecological infrastructure given that it is a public transport infrastructure. There are no noise nuisances as the line is underground, and vibrations are limited by the fact that the train sets run on tyres. There is no pollution because the metro uses electrical energy and, consequently, effects on health are very limited. Particular care has been taken to integrate the line into its urban environment, with exits incorporated into buildings or subject to particular architectural attention.
Météor is a public project. The decision for its construction was taken within a closed system comprising public financers (State, Ile-de-France region and City of Paris authorities which provided 80% of the financing) and a public corporation acting as a monopoly, the RATP[2], which initially imagined the project, managed its construction and now operates the network.
A public project often forms part of a specific project "culture". In certain cases, it can benefit from financing guaranteed by the government and, if the latter agrees, this can be used to absorb any additional costs. It can, within certain limits, also be exempted from profitability

[1] France, Grande-Bretagne, Hollande, Danemark, Allemagne, Suède, Etats-Unis, Hong-Kong, Australie, Japon.
[2] La RATP a financé 20 % du projet par des emprunts.

obligations, completion times, etc. It can also integrate various obligations imposed by the government, such as limitations to environmental nuisances and public service obligations (service levels, etc.). This "culture" can also influence the level of risk that those involved are prepared to take and their way of managing the project. The object of this article is to critically analyse the way in which a closed public decision-making system such as that used for Météor has or has not integrated the complexity and types of risks defined above.
The first part of the article analyses the decision-making process used for Météor by underlining the objectives of each of the financers and the closed system within which the public decision was taken.
The second part provides an assessment of the Météor results when compared with its Ile-de-France Region service objectives as well as its cost, completion time, traffic levels, service quality, etc. objectives.
The third part provides a critical analysis of the planning, financing and construction methods used for Météor and covers five themes: public projects, the closed public decision-making process, the global and regional planning of transport and town planning, evaluation, and the design and management of the project.

A PUBLIC DECISION-MAKING PROCESS COMPARABLE WITH A CLOSED SYSTEM

Choice of route resulting from competition between SNCF-RATP, services issues and multi-scale development

The multiplicity of service objectives for Météor was partially the result of the decision-making process that accompanied the project and which saw two competing public transport authorities with two different development challenges trying to impose their solution for resolving the saturation level reached on line A of the RER regional express network.
Line A had been constructed between 1969 and 1994 to provide links between the east and the west of the Ile-de-France region. It serves major Paris hubs such as Châtelet-les-Halles, the Gare de Lyon main line station, Auber and La Défense, a regional employment centre.
By 2000, Gare de Lyon main line station had become the most used station on the line (36 million passengers). This growth can be partially explained by the new line sections opened in the east and west suburbs and by the growing importance of the Défense employment centre located to the west of Paris and served by line A. Between 1998 and 2006, this business centre saw an additional 50,000 employees going there every day to work.
A study carried out in 2006 by the Etablissement Public d'Aménagement de la Défense revealed that 25% of employees came from Paris and 23% from the east of the region. These employees mainly used public transport and most travelled during rush hour periods.
Improvements made to the signalling on line A by RATP in the middle of the 1980s did not improve traffic movements. Studies looking at adapting fare levels were unsuccessful. Another solution had to be found.

The opposition of two public corporations (RATP and SNCF) in finding a solution to the oversaturation problem faced by line A

Having examined a number of different options (two-level trains, etc.), the RATP Development Department finalised a route (among several variants) using an automated metro that would start from Gare de Lyon, go through République metro station, Gare du Nord and Gare de l'Est, and end at Gare Saint-Lazare (Météor 2). The particular value of this

line lay in the fact that it connected four out of five of Paris' main line stations and that this would allow suburban users to avoid using line A.
SNCF did not like this route proposal. It wanted to replace the surface level suburban train sets by underground sets and thus free space on surface level for the future TGV Est high speed train sets (a long term project finally started up in 2007). SNCF proposed a project called SNCF Est that would join Marne-la-Vallée, Chelles and Tournan to Saint Lazare main line station. This resulted in the development of a highly political conflict between the two corporations.
Relations between SNCF and RATP managements were strained, especially because of the debates concerning the apportioning of traffic between the two projects[3]. In order to obtain public financing, the two corporations did not hesitate criticising the investment level of the other's project. SNCF, which had a large number of Ponts-et-Chaussées engineers, applied pressure on the Ministry of Transport where they were also well represented. RATP's CEO argued his case for Météor strongly to the Prime Minister whom he knew personally.
The first studies carried out by the Direction Régionale de l'Equipement de l'Ile-de-France (DREIF) in 1988 demonstrated that the route and the capacity of the SNCF Est (the future Eole) solution better met the objective of relieving the pressure on line A over the long term than the Météor 2 solution (Dufour, 1988 a)[4]. A second study showed it would be best to construct the SNCF solution first and then Météor afterwards (Dufour, 1988 b)[5].

[3] The traffic level on line A transferred to Météor or Eole determined the time saving generated by each project, being one of the key elements in calculating the socio-economic profitability.
[4] Six solutions were proposed in the first study, all developed by in-situ operators (SNCF and RATP).
The SNCF Est line would remain in parallel with line A and serve the same stations as line A between Val-de-Fontenay and Torcy. No allusion to a route called Météor 1 is made in this study.
[5] On first view, the projects were fairly similar to those of the first study and could be combined.

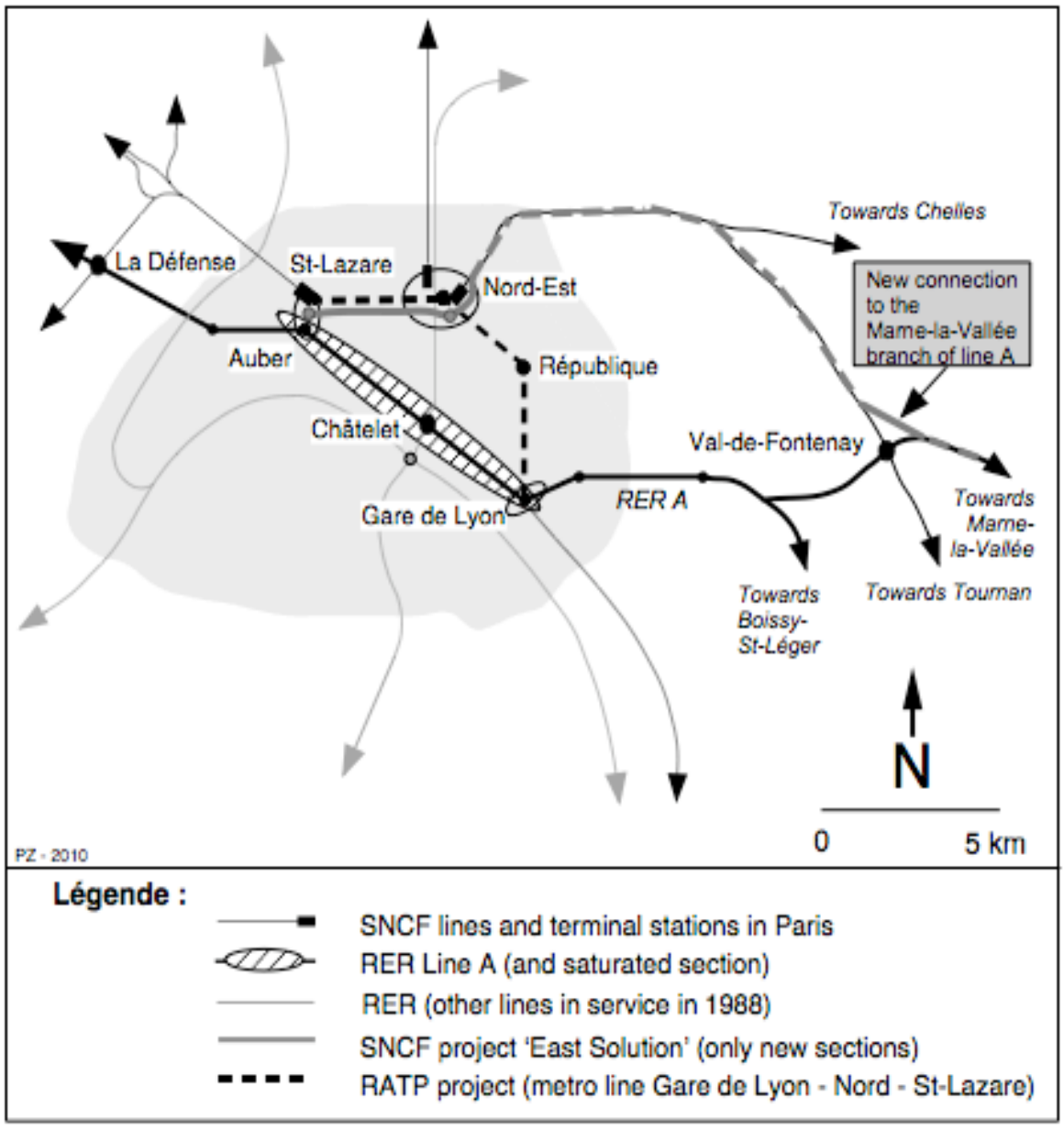


Figure 1: SNCF Est and Météor projects (1988)

RATP rapidly realised that the SNCF project was liable to receive public funding that the route taken via the Gare du Nord and the Gare de l'Est in the SNCF solution would need to be taken into account in the route taken by Météor. Consequently, the route was changed. It followed RER A between Gare de Lyon and Châtelet with two new objectives in addition to the problem of the oversaturation of line A: to join up with the saturated line 13 to the north and provide a service for southern Paris with a connection to line 7 while also abandoning the service to the Gare du Nord and the Gare de l'Est. A connection to Orly airport to the south was also programmed in the Ile-de-France Region master programme in 1994. This connection forms part of the current Grand Huit[6] programme in Paris' second suburban ring.

[6] This figure of eight shaped automated line was to have connected to Météor and serviced Chelles, Créteil, Orly, Massy, Versailles, La Défense et la Plaine Saint-Denis.

Clash between the development challenges facing the Ile-de-France and those facing Paris

Initially, the Paris City authorities showed no preference for either Eole or Météor. In 1987, the approach taken by elected representatives essentially concerned relieving the oversaturation on line A and providing a service for south-eastern Paris. The city authorities wanted to create a pole that would create a regional balance and act as a counterweight to La Défense which had the highest population of employees in Europe. Creating a junction between Météor and lines 7 and 13 would be a plus factor in achieving this balance. The city authorities backed this project without which there would be no metro service for the 150 hectares to be urbanised in south-eastern Paris, but without denying the attributes of Eole. But RATP did not always find it easy to convince the mayors of Paris' arrondissements concerned by the route who were worried by the nuisances that would be generated by the sheer extent of the future works and who were occasionally hostile to the construction of surface access points.
The Ile-de-France Region was not particularly convinced by the arguments put forward by the City of Paris authorities concerning the value of creating this employment hub (even though the President of the Regional Council and the Mayor of Paris belonged to the same political party, the Rassemblement pour la République). The Region saw this hub on the scale of the city and did not consider it to be a financing priority. It was not particularly concerned by the service provided by Météor given that Eole was a regional project creating a link between the suburbs and the city centre.
The State on the other hand gave greater support to the Mayor of Paris and his project for developing the south-eastern districts given Paris' importance as the capital city and an international showcase for the country's technological expertise. The State had also chosen to build the new National Library in this area as well as the new Ministry of Finances in the nearby Bercy district. Nonetheless, the State was torn between Eole and Météor because they both depended on public corporations. In addition, the delicate social climate existing within RATP required that employees needed to be able to become involved in a far-reaching project.
Finally, the decision to construct both Eole and Météor was taken by the Prime Minister on 7 February 1989. RATP's CEO interceded at the very last moment with him to go ahead with the Météor project. The 1989-1993 State-Region planning contract (Contrat de Plan Etat-Région) saw € 230 millions being earmarked for the connection between Gare du Nord main line station and Châtelet-les-Halles by RER line D, and the same amount for Eole and Météor. These sums were totally insufficient given the final cost of the projects (€1.35 billion for Météor and €1.5 billion for Eole). Over time, this situation considerably handicapped the construction of the three projects and demonstrated that the political powers had not really made a choice between them. It should also be noted that the studies carried out to reduce the saturation level of line A did not particularly examine the value of the junction of RER line D between Gare de Lyon and Châtelet, despite the fact that this had been programmed since 1976. The power of the SNCF and RATP corporations and their respective projects was vital in the decision-making process and the final choices made.
The financers, particularly RATP and the City of Paris authorities, added other objectives in addition to reducing the passenger load on line A of the RER as the various project variants were developed. This had the effect of changing Météor's final route and partially assimilating it into the metro network. However, this geographical enlargement of the service objectives, when taken against the problem of line A, fairly rapidly saw consensus being reached by the partners. It is worthwhile underling the short amount of time (two years) between the first studies in 1987 and the decision to construct the two projects in February 1989.

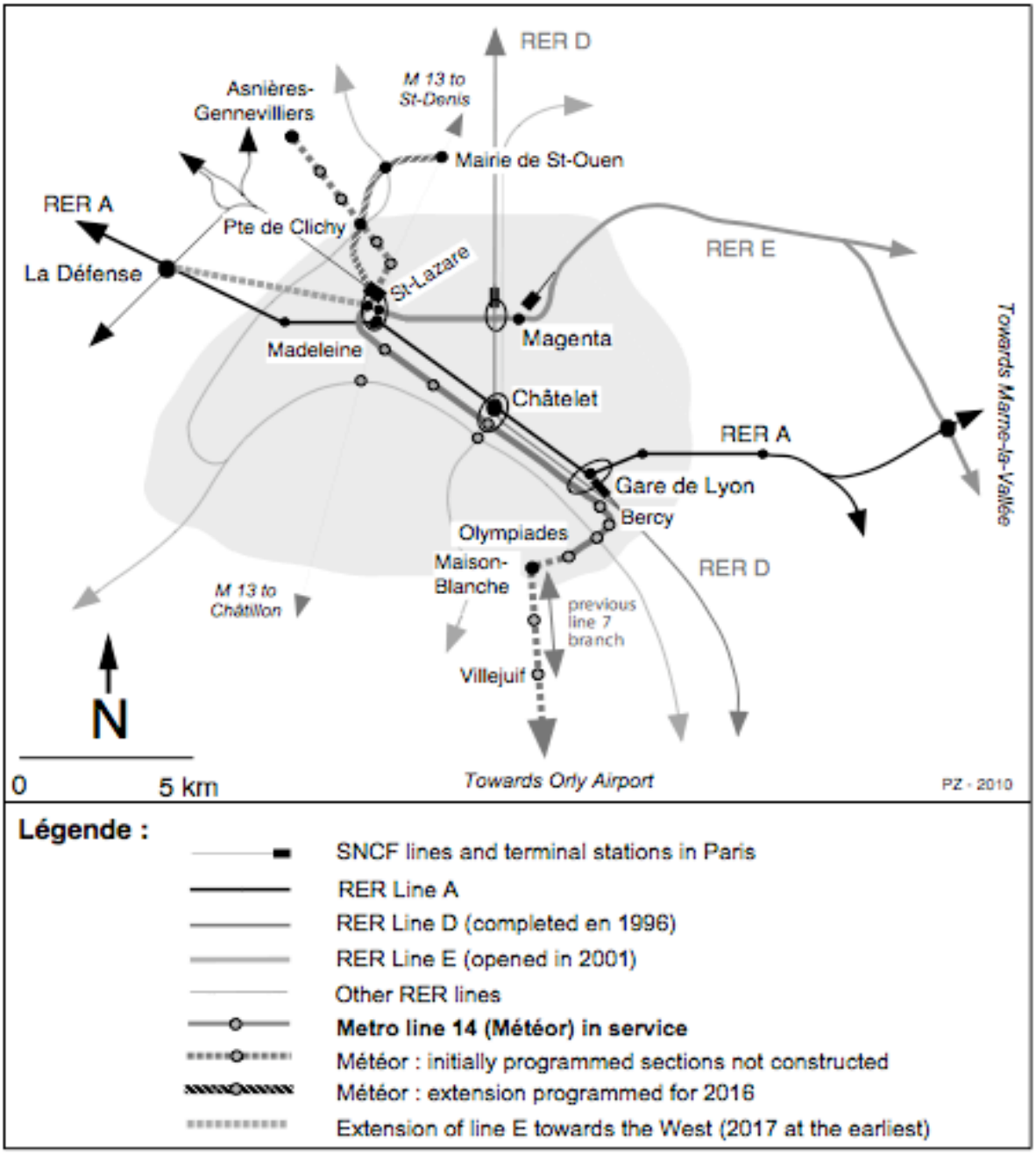


Figure 2: The final routes taken by Météor and Eole

Météor's final route did not go as far as La Défense, a solution that could have reduced passenger levels on line A.

A specific financial package involving the State, the Region, the City of Paris authorities, the Paris Transport Authority (Syndicat des Transports Parisiens) and RATP.

Traditionally, financing for the operation of transport systems was (prior to the construction of Météor) provide by the City of Paris authorities, the State, the Paris transport authority

(Syndicat des Transports Parisiens – STP)[7], with the Region financing the infrastructures and RATP the rolling stock. The State and the Region initially considered that Météor met the needs of a local problem and that it was not necessarily up to them to finance the system. RATP had considerable difficulties in obtaining participation from the City authorities because Météor was not a standard project. This led to negotiations between the City authorities and RATP, with the latter strongly backing Météor[8]. Finally, the City authorities provided a €68 million participation in recognition of the project's value in servicing the new south-eastern districts and the difficulty in obtaining financing for the works.

The challenge represented by Météor subsequently modified long-term financing practices, as can be seen in the City's current partial financing of the investments into the T3 and Maréchaux tramways.

Despite the Prime Minister's decision to construct Météor and Eole and the € 230 millions contribution to the State-Region Planning Contract (Contrat de Plan Etat Région), the project continued to suffer from financing difficulties and this finally saw Météor being segmented into three phases. This measure had the effect of prolonging construction works (19 years were needed to build nine stations). It also resulted in ten years of difficult negotiations during the 1990s between RATP and its financial partners to find the funds needed to finance the last two phases (up to Olympiades in the south and Saint-Lazare in the north). The Region had particular difficulties in financing Météor as it was also financing Eole and simultaneously suffering from a considerable reduction in income between 1993 and 1996 due to the fall in the office property market. It hesitated in continuing the construction of the project before letting itself be convinced by RATP that it would be more expensive to stop the works than to continue them. Stopping the works would have meant compensating the contractors, ensuring the safety of the work sites, lowering the tunnel borer, etc. The hybrid financial partnership was renewed with the construction of the Olympiades station. However, a proportion of the Region's representatives continued to believe that the construction of this station was a particularly Parisian problem and ought to be financed by the City authorities. The latter hesitated but was in a difficult position to refuse given that it had financed phase 1 between Madeleine and Bibliothèque-François-Mitterrand.

In addition, the State and the Region did not want to finance the project's extension beyond Olympiades, a measure that, by definition, cancelled the junction with line 7 and Orly airport. In addition, the financing at the time was not available to finance the junction with line 13 beyond Saint-Lazare[9]. The consensus between the partners slowly began to crumble due to the lack of finance.

METEOR IS A PROJECT THAT DID NOT ACHIEVE ALL ITS OBJECTIVES

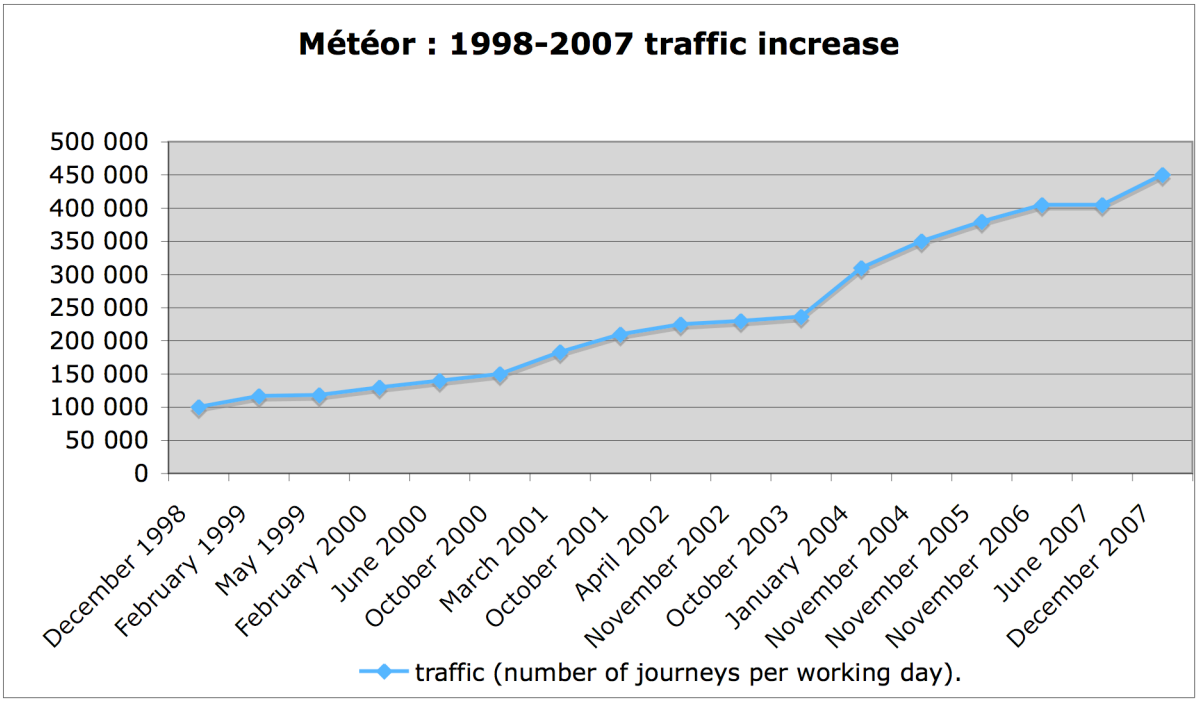
Relieving overcrowding on line A of the RER (regional express train network)

The prime objective developed by elected representatives to justify the construction of Météor was the provision of an alternative line for passengers using the congested line A of the regional express train network crossing through Paris from east to west.

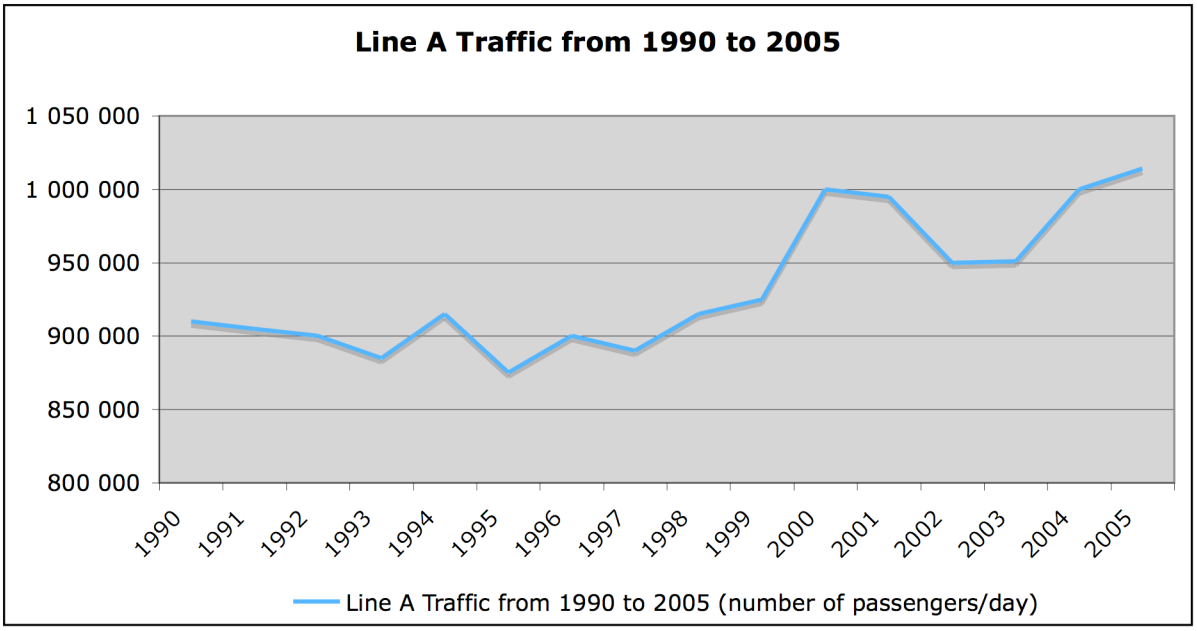
[7] Which is also The Ile-de-France transport organisation authority.

[8] Météor was the first large project undertaken by RATP since the construction of the regional express network. It was also a corporate project that RATP's CEO used to mobilise employees. Finally, it represented a technical, commercial and image development challenge for RATP.

[9] This connection is currently at project phase.



Source: RATP, DGA transport 8th April 2008.
Graph: G. Zembri



Source: RATP, DGA transport, 8th April 2008
Graph: G. Zembri

Traffic forecasts for RER line A made in 1990 anticipated between 63,000 and 65,000 passengers/hour in 1998 between Gare de Lyon station and Auber station. Météor traffic forecasts made in 1991 anticipated 96 million passengers a year by 1998. 1990 traffic forecasts indicated that 27,000 passengers/hour using Châtelet station and Auber station (line A of the RER) would transfer to Météor. Traffic on line A increased considerably between 1990 (910,000 passengers/day) and 2005 (1,010,000 passengers/day).
The statement of public utility file forecast that between Auber station and Châtelet station, there would be a transfer of 12,000 passengers/hour from RER A line to Météor. The noted

transfer was in fact 4,500 passengers/hour during peak periods, a number well below that forecast.
According to these figures, Météor's first objective has not been met, but the line is nevertheless useful. It should be noted that traffic on line A of the regional express train network would have been 62,000 passengers/hour during peak periods in 2002 without Météor, and without the two other projects (line E and line D) that were supposed to take the pressure off this line, which carries far more people than the maximum capacity of 54,000 passengers/hour (source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007).

Serving the new 13th arrondissement districts and the Bercy districts

The second objective was to serve the new districts to be built in the 13th arrondissement in southern Paris (ZAC de Bercy, ZAC Corbineau-Lachambeaudie, POPB and Bibliothèque de France) and the Bercy district. This second objective has been met. However, the urban regeneration objectives announced by the City of Paris authorities for these districts (which were initially independent from the construction of Météor) have not been fully attained. While 2,886 houses, 153,000 m² of apartments and 611,000 m² of offices have already been constructed, there remain 366,500 m² of houses and 452,000 m² of offices that have not yet been built.
No studies analysing the impact of Météor on the number of jobs in these districts have yet been carried out[10]

Relieving the pressure on line 13 of the metro system

It was initially intended that Météor be connected to the Asnières Gennevillliers branch of metro line 13 in northern Paris which is particularly overcrowded.
To date, this connection has not been subject to studies or provided with any financing. Other solutions are also being envisaged to resolve the crowding problem on line 13.

Costs

Figures are only available for Météor phases 1 and 2.

Infrastructure investment costs

In millions of euros at 2003 values	Statement of public utility -SPU (1993) (1)	Preliminary design (1994)	Works	Divergence/SPU (2)	*Divergence/ Preliminary design*
Infrastructure investment costs	1101	1089	1186	8 %	*8 %*

[10] Sources:
http://www.parisrivegauche.com
http://www.semaest.fr

1 – The cost given by the first statement of public utility in 1990 was €707 M (2003). The cost given by the second statement of public utility in 1993 was €1,101 M (2003).
2- The divergence from the first statement of public utility represents 68 %.
Source: RATP, DGA transport 8th April 2008.
Source: report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

The difference between the construction costs and the costs given in the first statement of public utility in 1990 is 68%. This increase was due to improvements required by the Syndicat des Transports Parisiens (Paris public transport executive authority) following recommendations made by the Direction Régionale de l'Equipement (regional planning department), changes to safety measures following further in-depth studies and the incorporation of additional construction difficulties (source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007).
The 68% increase in these costs is greater than that of two other major projects carried out at the same time: RER line E saw a 44% increase in costs and the interconnection of RER line D saw a 7% increase in construction works over the figure given in the statement of public utility.
The final cost difference between the construction and the second statement of public utility published in 1993 was 8%. This was because the more detailed studies carried out for this statement led to better cost control.

Rolling stock investment costs

In millions of euros at 2003 values	Statement of public utility-SPU (1993)	Preliminary design	Construction	Divergence/SPU	*Divergence/ preliminary design*
Rolling stock investment costs	124	124	133	7 %	*7 %*

Source: RATP, DGA transport 8th April 2008.
Source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007).

This increase was due to the increased cost of train sets.

Operational and maintenance costs

In millions of euros at 2003 values	Statement of public utility-SPU (1993)	Construction	*Divergence /SPU*
Operational and maintenance costs: total	10.8	20.6	*91 %*
Operation of the line	3.07	12.17	*296 %*
Energy	3.14	1.49	*-53 %*
Rolling stock maintenance	2.08	2.66	*28 %*
Maintenance of fixed installations	*2.51*	*4.29*	*71 %*

Source: RATP, DGA transport 8th April 2008.

Source: report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

The increase in these costs was due to the cost of personnel (fraud control, humanisation of the network) and the maintenance of fixed installations. These costs reduced the profitability of the operation.

Deadlines

Provisional start-up date (statement of public utility)	Real date	Delay in start-up
Phase 1 Bibliothèque F. Mitterrand-Madeleine June 1987	October 1998	15 months
Phase 2 Madeleine-Saint Lazare June 1998	December 2003	5 years and 6 months

Source: RATP, DGA transport 8th April 2008.
Source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

The delays to phase 1 were due to natural hazards (flooding of the river Seine during the winter of 1993-1994, geological problems on the workshop zone site near Olympiades station and next to the river Seine), delays in the provision of works authorisations from local mayors, the restriction to daytime-only working hours to avoid disturbing local residents, the action of a local resident against the Châtelet statement of public utility in 1991, contractor bankruptcies, etc. Delays to phase 2 were due to financing difficulties encountered by the partners who decided to halt the Madeleine project and delay the construction of the Madeleine-Saint-Lazare section.

Global Traffic

Annual traffic on the line (in millions of passengers)

	Statement of public utility	Subsequent studies 1	Subsequent studies 2
Bibliothèque F. Mitterrand-Madeleine	40	33 (1)	
Bibliothèque F. Mitterrand-Saint Lazare	96	89.5 (2)	98.2 (3)

1- first full year of activity (1999).
2- first full year of activity (2004).
3- 2005.
Source: report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

Traffic forecasts were met as from the opening of the first two sections of the line (being eight out of nine stations) and the connection of the line to Saint-Lazare main line station which provided a substantial amount of traffic.

New traffic levels (in % of total traffic)

Road traffic transferred to Météor		Induced traffic	
Statement of public utility	Subsequent studies	Statement of public utility	Subsequent studies
4.5%	2.6%	3%	1.4%

Source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

Météor did not attain the forecast traffic objectives. One of the reasons being that the northern part of the line is located in a zone already well-equipped with metro lines providing an alternative to Météor.

Time savings

Time saving represents an important parameter for evaluating urban transport projects such as Météor.

Time saved for all passengers (statement of public utility)	Estimated time saved as evaluated through a passenger survey.	Difference
5.1 mn	8.5 mn	+ 67 %

Source: Report on the LOTI assessments for RER D, RER E and metro line 14, report issued by the Conseil Général des Ponts et Chaussées, June 2007.

The evaluated time saved by passengers is clearly greater than the forecast time saved. However, it should be noted that passengers occasionally tend to overestimate the time they have saved[11].
The time saved by all passengers of the new infrastructure is called generalised time and is used in the statement of public utility file. It is calculated on the basis of the time taken for the trip, the time spent waiting and transferring, weighted to take the tediousness of the transfer into consideration.
The estimated time saved was stated by passengers during a survey.
However, this evaluation encountered methodological problems (which are not developed in this paper).

Service Quality

A survey carried out on the Régie Autonome des Transports Parisiens (RATP-Paris metro authority) in 2008 gave the following results :

[11] Segonne (Cécile), Choix d'itinéraires et péage urbain. Le cas du tunnel Prado Carénage, à Marseille, *RTS*, vol. 71, April – June 2001, pp. 3-21.

Criteria	Rate of satisfied users Entire Paris metro system	Rate of satisfied users Météor
Time waiting for trains	98.9 %	99.8 %
Buying at distributors	95.6 %	94.3 %
Cleanness of stations	89.7 %	93.4 %
Cleanness of train sets	92.1 %	100 %
Reception at the ticket office	88 %	93.8 %
Comfort of train sets during peak periods	92.6 %	100 %
Comfort of train sets during off-peak periods/night	86.6 %	100 %
Fraud	4.3 %	2 %

Source: RATP, DGA transport 8th April 2008.

The Météor results are better (with the exception of buying at distributors) than the other Paris metro lines. This is explained by the greater number of customer assistance agents available to passengers, both on trains and in stations. The line is also subject to a systematic cleaning policy and provided with anti-graffiti finishes. Finally, the driverless system ensures a very punctual service and a smooth ride. These two aspects are interpreted as very high comfort level factors by passengers.

Conclusion

In overall terms, Météor is a success despite certain tribulations (actions against the statement of public utility in 1991, construction problems and segmentation of the site into three phases). Among the **positive points**, the following are worth underlining.
The underground line generates few nuisances. Vibration caused by the passage of the trains is considerably reduced by equipping the train sets with tyres. Electric traction ensures that no direct pollution is caused. The infrastructure is well maintained and cleaned (it is a showcase line for the Paris metro authorities).
The quality of the service is highly satisfactory (resulting in line 1 of the Paris metro now being programmed for a changeover to driverless trains).
The time that passengers feel has been saved (within the framework of methodological limits which have already been underlined) remains positive and overall traffic (excluding new traffic) matches forecasts.
Investments have almost respected forecasts (divergence between construction and the preliminary design of 8% for infrastructures and 7% for rolling stock). This result was obtained following the in-depth studies brought about by the annulment of the first statement of public utility.
The existing districts and the new 13th arrondissement districts were served in accordance with the initial scheme.

The following should be noted among the **negative points**:
The doubling of operational costs, due to the changing context (increased personnel costs, etc.).
The time taken to complete phases 1 and 2 were particularly long: phase 1 was delayed by 15 months and phase 2 by five and half years.
The traffic transfer from line A of the regional express train network did not match forecasts.
The traffic transfer from line 13 of the metro did not take place because Météor stops at Saint Lazare station without going on to Asnières-Gennevilliers.

WHAT LESSONS CAN BE DRAWN FROM THE METEOR DECISION-MAKING PROCESS IN TERMS OF THE PLANNING, FINANCING AND EVALUATION OF MEGA URBAN TRANSPORT PROJECTS?

Public project

The programming of public financing was considered as a guarantee that RATP, the project authority would see through the project, despite the additional costs.

Increasing demands from the Paris transport authority in terms of the safety of the automated systems, the desire of RATP's CEO to have fairly luxurious stations, the updating of costs and the incorporation of costs that had been forgotten during the first studies led to a 68% increase in the cost of the project between the first statement of public utility (DUP) in 1990 and the second in 1993.
Although these additional costs did not discourage the public financers, they did contribute to their decision to segment the construction of the project. As from the moment that the project was programmed, there was a certain guarantee of financing even though the project authority, RATP, had to convince the elected representatives to continue the financing over the three phases.
It would appear that there was little interest of the project authority in the positive or negative changes to the economic context or financial risks over the two decades required to plan and construct Météor. The context of the public financing of the project and the relative economic positive growth that existed towards the end of the 1980s might well explain the reduced involvement of the project authority and the public authority in this financial issue.
This approach has now virtually disappeared and is replaced by a far stricter control of forecast costs by public financers, accompanied by a system of penalties applied if costs are exceeded. It would be worthwhile integrating the financial risk to which the public budget is exposed in the profitability calculations.
The lack of funds led to the project being segmented and generated delays because the project authority had to negotiate the financing with the public partners for each phase. However, the advantage of this type of public multi-partner financing (State, Region Ile-de-France, City of Paris, RATP) is that if one financer defaults, the others can take its place.

Segmentation

The segmentation of the project into three phases made it possible to find financing for the project, but spread over time. This avoided blockages during the construction of the project but did not avoid negotiations between RATP and other financers for the mobilisation of funds for phases 2 and 3, because of project's cost overrun. The inconvenience was that the project was not much used prior to the completion of phases 2 and 3 creating the connection between Saint-Lazare main line station (a major Paris transport hub) and the Olympiades station. Prior to the completion of phases 2 and 3, the project did not attain its traffic forecasts and required socio-economic profitability level. The segmentation was also accompanied by additional costs resulting from the underground works (ensuring the safety of sites during works stoppages, etc.). Consequently, constructing Météor in a single phase would have been cheaper.
If one looks at other projects such as the A89 or A35 motorways in France, it can be seen that segmentation can also be used to provide a project with legitimacy. The A89 and A35

were segmented into 10 to 20 km long sections to accelerate construction works there where public opposition was not too strong. But this led to hybrid infrastructures with sections having motorway characteristics (2 x 2 lanes with a central median strip, grade separated intersections, etc.) as well as sections with standard road characteristics.
Project segmentation is strategic in the case of public projects if there is an opposition to the project or a financing problem and allows these two risks to be covered. However, private project managers prefer avoiding segmentation because of uncertainties concerning accompanying additional costs and extended completion times. These project managers need to have a detailed understanding of all risks associated with a project prior to its commencement and to know in advance how these risks can be controlled.

By the time of the second public utility statement (DUP) in 1993, a clear anticipation of the required studies led to a satisfactory estimation of costs

Costs were only 8% higher than those forecast, being a reasonable divergence. This was due to the considerable additional studies that took place between the 1990 public utility statement and that of 1993. It is worth underlining here that there should have been a certain transparency regarding these costs as from the very first studies.
We can underline that an in-depth analysis of the project and the use of updated costs provided a more precise estimate and respect of the project's estimated costs. The complaint made during the public inquiry that led to a revision of the first studies in 1993 was a key moment in the project and made it possible to obtain this result. But, generally speaking, cost estimates should be as accurate as possible, including when within the framework of public financing.

An innovative project and a public corporation

RATP organised a multi-skill project team to adapt the management of the project and the construction of the automatic systems to the context of uncertainty and innovation that is characteristic of this type of project. The approach was highly successful.
The resistance to the automation of the line came from the drivers working for RATP (project authority for the future Météor line and operator of the Paris metro) who were concerned that they would lose their jobs. The delay was also due to the 68% cost increase between 1990 and 1993 (the Paris transport authority - Syndicat des Transports Parisiens – required the application of additional safety standards for the automated systems). RATP also demanded additional fine-tuning of the automated systems from the manufacturer and this delayed the project by two years. Competition with Eole also slowed down the construction of Météor.
Anticipation (RATP negotiations with driver unions upstream from the public decision), flexibility (RATP's modification of Météor's route to take the Eole project into consideration), RATP's lobbying (particularly for obtaining approval from the Prime Minister) and detailed monitoring of the system's fine-tuning (RATP pressure on the manufacturer to improve the reliability of the system while remaining within a cost envelope) overcame these stumbling blocks.
It is worth underlining that this level of resistance was limited by the considerable involvement of RATP in the project for which this was the first major project since the construction of the Ile-de-France regional express network (RER). The innovative nature of the project was seen by the corporation and it's CEO as an asset rather than a source of blockages within this particular context where the financial risks were fundamentally assumed by public financers.
A private project authority assumes the uncertainties linked to technical innovation if all the research has been carried out prior to the construction of the project and if all the risks have

been eliminated. If this not be the case, the project authority cannot take the financial risk of carrying out the project.

Closed public decision-making system

The political decision to construct Météor and the competing Eole project did not reduce overcrowding on line A of the RER. The decision was taken by the Prime Minister within the framework of a closed public system, with the two projects proposed by the two public corporations. SNCF (the French railway authority) lobbied the Minister of Transport and RATP (Paris transport authority) lobbied the Prime Minister to obtain public authorisation for the construction of their projects.
It is worthwhile underlining the combination of interests of the players forming part of the public decision-making process. RATP, a public corporation, wanted to see the construction of Météor, considering it to be a showcase for the corporation's technical know-how. The State backed the project as the automation technology could potentially be exported and profit the French gross domestic product as well as serve the François-Mitterrand National Library. The Region was against Météor as it considered it to be a Parisian project.
The decision-making system operated within a closed circuit and was conducted in a manner intended to avoid penalising either of the public corporations given that each wished to see its project become a reality. As a result, the Météor route had to adapt to the one laid out for Eole.
It would have been sensible to continue Météor up to La Défense, which has a very important traffic, and to connect to the Gare du Nord and Gare de l'Est main line stations. This context partially explains Météor's failure to reduce the passenger load on line A. The closed system also raises the question of the responsibility of public sector players in making the right decision.

Delays as a consequence of the political non-choice between the two competing projects of the two public corporations

The question of the choice of political decision-maker was vital. The competition between Eole and Météor placed the Prime Minister in the delicate position of having to choose between the two large public corporations, despite the fact that the studies carried out concluded that Eole should be considered the priority project. Despite their different cultures, the idea of a single project to be developed by these two corporations might have resulted in other projects able to meet the objective of taking the passenger load off line A. These would have seen the light of day within the framework of general interest projects financed by public funds. What actually took place was that there was a competition (but without calls for bids and without any real competition) between two hermetic public systems, each seeking to ensure the success of their project.
In 1989, the Prime Minister decided that the two projects should be constructed concurrently. This non-choice generated a financial risk and the Region found itself unable to finance another transport project for the following ten years, despite the fact that other needs had to be met. Météor had its two ends severed which meant that it could no longer be extended to join up with metro line 7 to the south or to reduce passenger levels on line 13 to the north. The construction of Météor also had to be segmented into three phases which meant that the works took longer (19 years for nine stations). Each phase also suffered from delays (15 months for phase 1 and five and a half months for phase 2).

Highly flexible project planning unable to satisfy the initial objectives

The project authority adapted to changes but did not formalise them within the framework of a strategic approach. The project authority adapted the design and the construction of the project as and when necessary by, for example, changing the route to take into consideration the competition of the Eole project, negotiating with elected representatives to acquire the financing for each phase once the additional costs were known, negotiating with local residents disturbed by the works, and by adapting the technical project to new regulations concerning automated systems, a factor that also resulted in additional costs.
The construction of Météor depended on agreement being reached between the State, the Region and the City of Paris authorities. Each progressively accepted to finance the project on condition that it served the areas that particularly concerned them. This influenced (in the same way as the competition represented by the Eole project) the route taken by Météor which finally was not able to take the passenger load off line A of the RER as had initially been proposed.
The financing problems faced by the partners, who also had to finance the competing Eole project, meant that Météor was no longer able to connect with line 7 of the metro or reduce passenger congestion on line 13. The segmentation of the project into three phases as a result of the same financial constraints meant that the project was only able to achieve its socio-economic profitability as from the completion of the second phase (in 2003).
Experience feedback demonstrates that planning methods must be flexible to be able to adapt to change, especially economic change. This flexibility will allow the project to attain its objectives on condition that it has clearly been incorporated from the outset and that the project financers and partners are in agreement and will not change their minds. The public decision must also be clearly expressed to meet the initially stated objectives. If not, the projects will find themselves independently and objectively refused.
The Météor project demonstrates that flexibility in planning, when seen in the light of the large number of interests of the various public financers, has its limits. The project did not meet its initial objective of reducing passenger congestion on line A. In this particular case, the setting of an action framework might have been envisaged, but this would have implied distributing the financing between financers on the basis of to what degree their respective interests were met, an approach occasionally used for certain French projects.
The RATP, a public corporation, adapted to these political and statutory changes that either accelerated or delayed the project. As this was a corporate project, RATP wanted to complete it despite the risks involved in public financing. One hypothesis that bears checking is that the adaptation effort made by public corporations could be greater given that they are less constrained by the need to respect completion times and costs than private contractors, and that consequently, it is easier for public financers to make modifications to public projects than it is for private financer to modify private projects.

The need for consultation

Consultation covers the social risks present in the programming and construction of transport infrastructure projects.
While there was no major public opposition to the project, there was nevertheless a claim made against the 1990 public utility statement and complaints from local residents during the works. The context within which Météor was constructed was not one of the population being opposed to a transport project, as was subsequently the case for certain French motorway projects. The project authority did not consult with local residents before the public utility inquiry simply because this was not an obligatory measure at the time.
Experience feedback demonstrates that associating local residents to the project prior to the beginning of works is important in avoiding complaints and claims being made during the works. The experience of other projects has also shown that consultation with local residents

on the relevance of a given project or an alternative project should be carried out as early as possible and, in any case, prior to the beginning of studies. Some believe that it should take place prior to the project being incorporated into a specific programme or master plan.
The need for local residents to have confidence defines itself in a specific manner. They should be able to understand the technical documents presented to them by the project authority within the framework of consultations (which did not take place for Météor but has been applied for other projects in France). The project authority is responsible for making the studies available to all and must not omit any information that might reduce transparency. In addition, too many technical details risks making the debate too technical, resulting in local residents losing confidence. The degree of transparency needs to be adapted to each particular case.

Transparency

A closed public decision-making system, such as that used for Météor, did not provide transparency concerning the project. RATP submitted costs to the public decision-maker that were lower than those of the real costs. Revealed by the press, the increased cost of subsequent studies generated criticism concerning the project. These was no consultation with local residents concerning the project and this resulted in worries, an appeal made against the public interest statement and a 15 month delay for phase 1. Experience feedback also reveals that RATP's lack of transparency concerning the estimated cost of the project generated additional costs that subsequently partly justified the segmentation of the project. This lack of transparency meant that the public decision-maker was not in a position to make an objective choice between the competing Météor and Eole projects.

Regional and global transport and town planning plan

Telescoping of objectives held by public decision-makers and financers

The first aim of Météor was to reduce the passenger load on line A of the regional express network (RER). Other objectives were added because each public decision-maker and financer (State, Ile-de-France region, City of Paris authority) sought to adapt Météor to its own particular needs. There was a main regional objective, being to reduce the passenger load on line A of the RER, as well as local objectives added over time (service the new districts in Paris' 13th arrondissement, ensure a connection with line 7 of the metro in southern Paris and reduce the passenger load on line 13 of the metro to the north of the capital). For the Region, Météor represented a local project that did not meet its regional objectives. On the other hand, the State and the City of Paris authority supported the project. There was also the difficulty of getting all the financers to agree to the Météor project given that a competing project, Eole, was being proposed at the same time by SNCF. As a result, the route taken by Météor was modified to meet the interests of the financers and to be complementary to Eole.
The divergent objectives of the financers meant that Météor could not achieve its main goal of reducing overcrowding on line A of the RER.

The absence of global planning for transport systems and town planning on the scale of the Ile-de-France Region

During the 1980s, the1990s and the 2000s, there was no planning including both transport systems and town planning on the scale of the Ile-de-France Region. The eastern part of the

Region was characterised by a very high housing density while, to the west, there was a considerable office density. This situation led to very high levels of passenger movements on line A of the RER between the east and west of the Region. A planning programme encouraging a greater mix of urban functions to the east and west of the Region would have made it easier for Météor to reduce the passenger load on line A of the RER.
The current plan is to build an additional 280,000 m² of offices in La Défense and extend line E of the RER, in addition to line A, to improve access. However, this will not change the number of passengers travelling between the east and west of the Region.

Developing a global and regional town planning and transport plan

This approach is useful within the framework of applying principles linked to sustainable development. Planning on a global and regional level for a metropolis (or on other scales) makes it possible to set clear transport and town planning development objectives that the various projects are intended to help achieve. Combining urban planning and transport networks can also lead to the creation of mixed urban function hubs that can contribute to reducing travel movements and distances covered.

Evaluation

Take risks into account in evaluation of public projects doesn't question the validity of standard socio-economic profitability criteria (time savings, etc). The experience of Météor and other projects in France shows that it would be better to complete this method using sustainable development criteria which could limit risks and could be as follows:
- Accurately measure the impact of the generalised move from car transport to public transport (optimised travel time, traffic volume, carbon balance, etc.). The level of CO2 discharges should be fine-tuned. This would provide an understanding of the project's forecast traffic levels and permit CO2 discharges to be calculated.
- Integrate the problems of urban development (urban spread; the role played by transport in the restructuring of districts undergoing change).
- Integrate the limited capacity of public financing into the methods and better study financial risks. This would reinforce the financial transparency of the project.
- integrate other criteria like traffic barrier effect, network effect into evaluations, a measure permitting a more detailed evaluation of the spatial equity of access services.

Project design and management

Anticipation-based risk management

Anticipation is a key factor in the success of a project. It was important to pick out and define the constraints from the outset – prior to the design of the project – to avoid any later malfunctions. These constraints concerned costs, geological problems[12], etc.
It was also necessary to take into consideration the initial service and traffic objectives to ensure that the infrastructure was sufficiently dimensioned while also being able to absorb the increased capacities defined by various traffic growth hypotheses.
The project's sustainability also had to be defined in advance during the design phase: choice of sustainable materials, maintenance and cleaning costs, etc.
The project's urban insertion also needed to be anticipated. It was necessary that the infrastructure serve all the required districts and that its nuisances be limited (visual nuisance, noise nuisance, pollution). The insertion also had to make itself felt during the works which were organised to cause as few nuisances as possible to local residents. This meant avoiding night work, preventing site areas spreading onto the public highway, replacing damaged trees, landscaped areas, etc.; all factors favouring the acceptance of the project by those living nearby.

Connection of Météor to other transport infrastructures

The connection of Météor to the other metro lines and the main line railways was an important point in the conception of the project which was intended to improve accessibility for Paris residents and those living in the suburbs commuting to work every day. Generally speaking, connections and interconnections between public transport lines are important both to ease the transfer of private car traffic to public transport and to limit environmental risks (CO2 discharges, greenhouse effect, urban spread, etc.) linked to the multiplication of transport infrastructures.

Urban projects related to Météor

Most of the urban projects related to Météor (development of housing and offices in the 13th arrondissement districts) were carried out at the same time as Météor with a resulting urban homogeneity in the new districts. The additional traffic generated by these districts also contributed to Météor achieving its traffic forecasts. From an economic point of view, new jobs were created in these districts which increased in value thanks to the quality of the new building works, the construction of Météor and the presence of major public amenities (François-Mitterrand national library). The coordination of the works concerning Météor and the ZAC (designated development area), carried out respectively by RATP and the joint venture responsible for the new districts, significantly contributed to the successful management of the projects.

[12] In the case of Météor, RATP had an excellent understanding of the Parisian subsoil. The geological risks did not change as the project developed. There was a coherence between the risks evaluated at the time the decision was taken to go ahead with the project and those that might subsequently be encountered.

Completion times.

Design and construction completion times must be defined from the outset. It is necessary to integrate the risks of unsuccessful calls for bids and the delays suffered by subcontractors whose works are complex and depend on the completion of works by other trade sections. Critical paths in the process must be noted alongside the key dates to be respected in the design and construction phases. Where required, safety margins must be incorporated.

Project team

Météor is a complex project as it involves several public decision-making levels (State, Ile-de-France Region, City of Paris) and because it uses an innovative driverless system. It is also risky for the last reason.
The complex management of the planning and construction of the project took place within RATP and was carried out by a project team. Organised for the Météor project by RATP, this cross-disciplinary team grouped together the functions of project authority and project manager. It was under the responsibility of senior management and had considerable internal powers. The project team had authority over those responsible for the various project components who remained accountable for their particular sectors: project leader, coordinators, engineers, design and construction teams. The reduction in the number of hierarchical levels within the company's new organisation favoured the decentralisation of decision-making and resulted in the sharing of responsibilities. The organisation incorporated all required skills, especially those needed for automatic systems and safety, being elements representing a high proportion of the project's risks.
To optimise the chances of the project's success, the project team also integrated the operators. This was to incorporate the project's operational constraints into the technical driverless train solution (traffic control constraints, inclusion of operational risks, etc.). This type of organisation was judged by RATP to be very useful in carrying out the project

CONCLUSION

The Météor project allows three main conclusions to be drawn:

(i) The closed decision-making system used for the period during which Météor was being planned became a more open system during its construction. The closed system corresponded to a public decision-making process taking place within a context where there was no competition and exclusively concerned the State, the Region, the City of Paris authorities and RATP, a public corporation acting as a monopoly. The close relations between RATP's CEO and the Prime Minister also played an important role in this closed decision-making system.
The more open system used for the construction of Météor could be defined as the association of several very different skill sectors (finalising of the automated systems, operation of the metro network, civil engineering for the tunnel boring, etc.) working within a project team set up by RATP. The latter coordinated the work of each private subcontractor chosen by calls for bids and maintained links with local elected representatives to manage the nuisances linked to the works. This practice was based on Anglo-Saxon managerial methods used for private sector projects.
In parallel, the Météor project revealed the increasingly vital need for the project authority to consult with local residents prior to the public inquiry, a measure that also called for the opening of the closed public decision-making system. This changeover from a closed system

to an open system has become generalised and is being used for other projects in France, both for project management methods and for the incorporation of a much wider consultation with the public. This is the result of the circular dated 15 December 1992 concerning the management of major infrastructures projects, law no. 95-101 dated 2 February 1995 and the framework instruction dated 27 May 2005.

(ii) However, this change does not mean that the public authorities have a reduced level of importance in the decision-making process. The State, especially in France with its above-mentioned laws governing the democratisation of consultation, now plays more of a mediating role in managing the social risks of a project and ensuring the confidence of the public. This reassures private project authorities and allows them to eliminate this risk factor. In France, the State is also becoming a regulator in limiting environmental risks by setting reference standards concerning pollution. Finally, local authorities can also act as regulators by defining a programme that combines a greater number of jobs and housing within an urban conurbation to limit travel movement, a measure that simultaneously has the effect of increasing urban density.

(iii) The level of risk-taking proved to be highly specific in the case of Météor given that it was a project financially backed by the government. This differs from a private project where there is a need to respect completion time criteria and strict returns on investment.
The Météor project reveals that risk-taking linked to innovation can be greater within the scope of a public project. The public authorities decided to finance an innovative showcase project with Météor, the first wide gauge automated metro in the world, despite the risks of delays and additional costs linked to the development and fine tuning of the automatic systems that only public financing could assume.
Generally speaking, a private project authority seeks to eliminate as many risks as possible that might influence the cost of the project. These include any political, social or financial risks that might arise prior to the construction of the project. The Météor decision-makers chose to adapt the project to these risks during the planning and construction phases (resulting in a certain number of objectives not being met) by choosing to segment it despite the additional costs that this represented. It can justifiably be argued that a private project authority would not have chosen this option without financial compensation. It is nevertheless important to underline the need for these public projects to integrate the financial risk as from the conception of the project by making cost estimates that are as reliable as possible. This provides a reliable base for the public decision to be made.

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