

“Mega Transport Projects planning, appraisal and delivery: A review of case study experiences and research findings”

WCTR special session 11-15 July , Lisbon, Portugal

**The Millau Viaduct (FRANCE)
Elisabeth CAMPAGNAC
LATTS**

The Millau viaduct presents different interests from the point of view of Mega Transport Projects planning, appraisal and delivery. We propose to focus this paper on four of them:

- A successful multi-purpose project: from technical innovation to territorial issues.
- The importance of context in decision making process: the turning points.
- The project as a risk treatment process
- The appraisal and evaluation face to new issues: the sustainable development.

Then we will conclude with the passage from a close to an open system, trying to clarify between specific context and generic lessons.

I. A SUCCESSFUL MUTI-PURPOSE PROJECT: From technical innovations to territorial issues.

If we consider that a mega urban project transport (MUTP) could be defined on the basis of the interdependence between different infrastructures and through its impact on territories, Millau viaduct is of specific interest to study the tension between technical innovations and territorial issues, in a multi purpose project.

1.1. A COUNTRY AND TOWN PLANNING MOTORWAY: The Millau Viaduct and the A 75

The Millau Viaduct has to be considered at first, as the missing piece of the A 75 (Clermont Ferrand-Montpellier). This motorway, also called “la Meridienne”, is a major axis of the Massif Central. The first objective was to open up this mountainous¹ and very sparsely populated area to create a large axis as a potential alternative to the Rhone valley corridor (quite saturated); and, at a larger scale, to supply an international major road to go from the North West of Europe to Spain and Mediterranean; But because this area in the centre of France was neither a densely populated nor a rich one, it could not be put on the agenda without a strong political will and an influential support. In fact, the project has been launched in 1975 by the President de la Republique, Valery Giscard d’Estaing,² who was for a long time elected as mayor and Parliament member by this region. The A 75 was included in the Massif central Road Plan (Plan routier du Massif Central) of 1975. It got the benefice of specific government finance commitments with the Schéma Directeur des Routes Nationales (SDRN) de 1988 et 1992. It was then registered as a “link ensuring the continuity of the road network” (LACRA)³. That means that there was a commitment for a **free motorway**, because justified for reasons of country development.

A.75, a political decision

So, the planning of this motorway got the benefice of a not classical procedure of planning for motorways. In fact, originally, the Plan routier du Massif Central or Plan “Giscard” did not forecast a motorway, but only the progressive passage of the national road RN 9 to 2x2 lines. The decision for a motorway rather than the simple widening of RN 9 has been taken par the Comite Interministeriel d’Aménagement du Territoire (CIAT) in 1987. It concerned at the same time other motorways: A 20 and

¹ The motorway A 75 has a lenght of 340 Km , including 250 Km of mountainous area with an average height of 700 m , culminating at 1.121 m au col des Issartets. It has to cross different valleys by several civil engineering structures. Most of them have a good and beautiful design , as a fruit of cooperation between engineers and architects.

² Valery Giscard d’Estaing was President de la Republique from 19 mai 1974-19 mai 1981

³ Liaison assurant la continuité du réseau autoroutier

A 89, from Lyon to Bordeaux, and RN 88, from Lyon to Toulouse. These infrastructures gave a wider national and European impact to A 75. All these road and motorways infrastructures are decisions concerning country and town planning (more precisely in French: *aménagement du territoire*) , that means political decisions, different compared with decisions of the Direction des Routes (Road Directions) inside the Ministry of Transport, considered as more “technical” and considering the roads mainly as “technical objects” contributing to traffic flux and safety regulation.

From opening up the Massif Central region to a credible alternative to the Rhone Valley

So, it is a little later that the project has been taken really in consideration by the Direction des Routes: some events occurred at the beginning of the 1990's in the Rhone Valley like climate events (severe drought in 1988 and 1990, then high pluviometrie with the dramatic flood in 1992) with bad management by the concessionary Autoroutes du Sud de la France (ASF) and the decontracted state services, that the interest for A 75 as an alternative to Rhone Valley motorway increased for the Direction des routes. The consciousness of the interest of A 75 in this search of alternative itinerary from north to south of Europe increased also at the same time . Its position and role in the European roads and motorways network has been re considered as well as A 61 (grenoble Sisteron) and A 20 (Toulouse- Espagne) .

Changing the expectations from “country and town planning”

So quickly, a lot of objectives concerning the territorial issues appeared with A 75. it was expected from this motorway :

- To promote the crossed regions in terms of economic et touristic development,
- To play as a main axis at the national scale,
- To offer an international axis from north- west of Europe towards Spain and Mediterranee.

The first lesson that we can draw from this first point about A 75 is that the objectives expected from this infrastructure became richer and richer all along this forty years between the launching of the project and nowadays. We can observe in particular, the swing in the term of “country and town planning” (*aménagement du territoire*): it meanted mainly at the beginning not to say reaching equal accessibility but at least opening up this underprivileged region; but it strived to mean more and more local economic development with the ambiguity about the scale where this development could be plaid and got, and also about the equality or inequality between the different territories in the crossed regions.

The second lesson that we can point out is that the A 75 being not connected yet to Beziers neither to Montpellier, it's difficult to check whether these different objectives have been reached or not. This length of time could be related to budget financing with its own constraints. At the end of 2009, the A 75 has been built until Pezenas, and it was expected that the missing 25 kms to Beziers will be built in the spring 2010. The issue of that is not only the completion of the whole motorway but also the connexion with the motorway A 9. As a local economic actor observed: *« It will be only at this moment that we could appreciate the role of A75 as a structuring actor of country and town planning and as a structuring actor of economic regeneration at the scale of a delicate territory »*. The challenge is important, considering that this motorway crosses the underprivileged parts of the department of Herault (Rodez, Decazeville etc.) or the most scarely populated parts with very few and weak urban concentration

1.2. THE MILLAU VIADUCT: A MULTI-PURPOSE « OUVRAGE D'ART ».

If we consider now the Millau Viaduct by itself as an “ouvrage d'art”, it appears that the planning, the design and the delivery of this civil engineering infrastructure pursues different objectives..

A part of them were in relationship with the construction of A 75: one of the output of the viaduct was to suppress the important summer traffic jam, the famous “bouchon de Millau” and to succeed.

Another goal was to be both a bypass to the city and a mean to develop the country and town in this area, to be a resource for the local development.

A third set of goals was to be an exceptional “ouvrage d'art” both in technical and in aesthetic terms, and at the same time competitive in comparison with other proposals.

A fourth set of objectives were more orientated towards the quality of the process, in such a way that the brief as well as the design, finance and build contribute to deliver the whole project, on time, on budget, and that the service operated was affordable for the users, economically profitable for the operator and in compliance with the quality specifications, including the contribution to the local development.

Each of these objectives doesn't concern the different actors or stakeholders in the same way. So is the case for the assessment of the success; the different actors we met insisted on different criteria to explain why and how the Millau Viaduct can be considered as a successful MUTP.

But their main conclusions were that the Viaduct was a success MUTP, for a reason or another one, or more generally for a combination of them.

In this part, we will focus only on these two last set of objectives : an exceptional ouvrage d'art which achieved most of its objectives .

From Normandy Bridge to Millau Viaduct: an exceptional ouvrage d'art...

As it is known, the Millau Viaduct, as a civil engineering infrastructure belongs to the same family than the Normandy Bridge: the family of bridges with multiple Cables –stayed Spans. Besides, its civil engineering structure has been originally designed by the same author, the French engineer Michel Virlogeux, before being improved and enhanced by the collaboration with Norman Foster & Partners, the British Architect office.

But one of its characteristics is that “is not only considered as *an exceptional piece of work from the technical perspective* but also comprises several innovations in terms of processes and procedures from the choice of the route, the design, the evaluation prior to the BOT contract- (a concession type) to the elaboration of the financing scheme and the negotiation process between the shortlisted private contractor and the public administration.”

The decision for location and the choice of design and civil engineering methods for the Millau Viaduct explain some of the technical challenges of this civil engineering structure. Civil engineering designer for the Millau Viaduct as well as for the Normandy Bridge, Michel Virlogeux explained in the interview that we made with him, but also in an article (M. Virlogeux 2001) the specific problems of bridges with Multiple cable –stayed Spans.

On the one hand they allow to be applied to long spans, and rapid progress has been made in span length in recent years:” *Cable –stayed bridges now compete with suspension bridges for spans between 700 and 1200, or even 1500m. The erection of the Normandy bridge was a major step in this field(Nevertheless) the Normandy bridge is no longer the longest cable –stayed span in the world. Since May 1999, the world record belongs to the Tatara bridge, Japan, a very elegant structure*”. As this author underlines, the cable stayed solutions can be both efficient and elegant.

On the other one, they are confronted with some constraints. “*The design of long span cable-stayed bridges is dominated by the resistance to turbulent wind dynamic effects and by aerodynamic stability. Streamlined box girders, inspired by the English suspension bridges and the Normandie bridge, constitute the best technical solutions to these problems*” (Virlogeux M. 2001, p.62 and 63) Another problem is the cable vibrations: “*Despite better understanding of the phenomena that produce such vibrations, one cannot consider the problem solved, as some points are still controversial. On the other hand, it is known how to master cable vibrations by different types of countermeasures*” (Virlogeux M. idem). Face to these constraints different solutions can be found. “*The best solution and the most elegant, is to distribute rigidity between the different structural members (the deck, piers and pylons) in order to balance bending effects produced by asymmetric live loads and to limit deflections.*” (Virlogeux M. idem p.70)

According to these previous considerations, the Millau Viaduct could seem very ambitious: it's about 2,5Km long, “from plateau to plateau” with the road passing 270m above the River Tarn.

It is made of steel with a maximum height of 343 metre on the top of the pylons. A Multiple Cable Stayed Spans structure was selected due to aesthetic considerations, giving prominence to a very light

deck and piers soaring up toward the sky. However, the Viaduc comprises seven piers, that is only seven points to lean on. Going further, the Millau Viaduct constitutes an exceptional bridge.⁴

... Which achieved most of its objectives.

What is notable with the Millau Viaduct is that it achieved most of its objectives. We will limit here to a set of three of them: achievement on time, on budget and on compliance with a set of specifications.

- This civil engineering infrastructure viaduct project has been completed on time and, better, with *one month in advance*.

The concession contract (with the conditions of contract) approved by decree of 8th October 2001 stipulates that the viaduct has to be brought into service *39 months* after the date of the official publication of the concession contract (10th October 2001), that means on *10th January 2005*.

The works ("first stone") started on 14th December 2001, and the opening of the Viaduct by the President of Republique (Jacques Chirac) occurred on 14th December 2004. The works last *38 months* at the total. The site was open by M. Jean Claude Gayssot (PC), as Ministry of transport under M. Lionel Jospin's government, on 14th December 2001 and delivered with M. de Robien (UDF), Ministry of transport under the M. Jean –Pierre Raffarin's government on 14th December 2004.

So the viaduct was delivered six years before the completion of A 75, as forecast for 2010.

- Th project was also completed within budget but in a different arrangement than forecast at the beginning.

.The project cost was € 320 Millions (equivalent to the FF 4 Billions of the Company's offer for the tender) and representing € 300 millions for the viaduct and € 20 billions for the toll station.and will operate *the concession during 75 years.*; it was financed by the concessionary society, the Company Eiffage du Viaduc de Millau.

What is notable in the Millau Viaduct is not only that it has been managed under the new regime of concession, the preference went to a candidate who didn't ask for financial contribution from the government and for those who present the more affordable fare for the car users when they use the viaduct. So, the competitive selection of concessionary has been made on financial criteria, like asking or not financial contribution from the government; concession duration and tolls level. At the same time it succeeded to be also quite profitable for the concessionary as investor, as contractor and as operator.

We will come back on those aspects below when we will examine the project management as a risks treatment.

- The project succeeded to to be delivered in compliance with the required specifications.

⁴ with the following characteristics (see :

- a length of 2 460 comprising:
 - o 6 spans of 342 metres long.
 - o 2 sided spans of of 204 metres long.
- 7 piers, P1 to P7:
 - o The heighest, named P2, measures 245 metre, that is 270metre above the Tarn River.
- 2 Abutments (C0 and C8)
- It required 85000 m3 of concrete.
- The steel deck is
 - o 32.05 metre large entailing:
 - a 2x2 lane highway with a 3 metre shoulder.
 - Wind screens to protect the vehicles.
 - o 4.20 metre thick
 - o And weights 36000 tones, in other words, 4 times the weight of the Eiffel Tower.

Source: Coste (2009)

Among the specifications defined in the conditions of contract, we can note:

- The specifications concerning the general conditions of the structure, including the *architectural, geometric and functional characteristics* (art. 3 of the conditions of contract). The Millau viaduct to be conceded is defined as “an exceptional civil engineering structure “, with multiple stays; the architecture as defined by the design team in a previous stage has to be respected. The characteristics of the toll barrier and its conditions of compatibility with the A 75 constraints interchange of Saint Germain, are also precisely defined
- The technical characteristics (calculation rules to apply , size, building material to use, technical prescriptions to respect for the piers foundations, for anti wind screen, the organisation of quality). It is précised by the concession contract that the viaduct has to be designed and built for an **use duration of 120 years** (when it is usually of 50 years in France)
- The rules of control for the realisation of the works. A specific Authority is created for that and it could be assisted by people of the architect agency: Norman Foster and Partners and by some other experts. .
- The rules of operating and the concessionary’s obligations about the continuity of circulation in good conditions of safety and commodity; the rules and measures in the field of police and security.
- The duties in matter of public services (compliance with the laws and rules regarding the free exercise of different public services (police, customs, firefighting, civil protection, health, protection of landscapes)
- The country and town development have been also included in the concession contract (see below)
- The involvement in projects which attract tourists is also expected from the concessionary in relationship with the local authorities. We will examine that point further below.

II. THE IMPORTANCE OF CONTEXT IN DECISION MAKING PROCESS: THE TURNING POINTS.

The second lesson which can be drawn from the Millau Viaduct is that this success is not the result of a linear decision making process, starting with a clear planning and objectives and ending with their achievement. The success is more due to an incremental process where the decisions have been taken step by step and which have been characterised by a lot of turning points. Paradoxally, these turning points, which appeared like new challenges or new objectives, seem to have been benefic to the project and appropriate to adapt it to an evolving context.

We could note the importance of the Directors of Roads (Ministry of Construction and transport) not only in the decision process, but also in the turning points decisions. Three Directors of roads have been involved in Millau Viaduct project from the beginning to the end :

Jean Berthier : involved in the choice of the route

Christian Leyrit : involved in new project objectives

Patrick Gandil : involved of the implementation of the concession contract, while the viaduct have been planned at the beginning as a free civil engineering structure.

We could illustrate the way in which the project success has been consolidated or reinforced by turning points in decision making through two examples.

2.1. Opening the Viaduct design to an international competition and the “marriage” between architects and engineers.

The Millau Viaduct was originally designed in the limit of the public administration and more specially among the Ministry of Construction and transport (Ministère de l’Equipement et des Transports). Face to the risks linked to the choice of the route and to the high problem of feasibility, the decision remained

in the Direction des Routes – at that time Jean Berthier- and the deconcentrated services. The Studies have been made by the SETRA (Service d'études techniques des Routes et autoroutes) conceptual design has been done by the engineer, Michel Virlogeux, inside the Setra, depending of Direction of Roads. Face to the technical problems and territorial issues, a specific structure, deconcentrated, but gathering different departments –that was new - the Arrondissement Interdépartemental des Ouvrages d'Art (AIOA), has been implemented in 1989 under Georges Gillet's direction. Its mission was to elaborate locally the bridges and tunnels projects and to ensure the expertise bring to the public client with the support of the whole technical support. So Setra was locally in relationship with the AIOA. It was this public organisation, with its too poles , central and deconcentrated (in the French meaning) which made all the studies needed for the choice of the trace. The direction des routes took the decision, first for the median option and secondly for the "high solution". If these choices represent many advantages in comparison with the other solutions, they put also serious questions of technical feasibility.⁵ The objective was to develop further the feasibility studies, on the basis of this choice.

A first turning point occurred when the Direction des Routes – where Christian Leyrit succeeded to Jean Berthier- decided to open the design of the Viaduct to designers (and engineers) competition. This decision was caused by the search of different solutions compared with this one elaborated by the administration (SETRA) and the will to pursue the feasibility studies for each of them.

This process has been managed in two steps in competition:

The first step took place in 1993-1994 to select new ideas and concepts. Design offices and architects were consulted separately. The aim was to improve the quality of design and to check the feasibility of the project. Five families of solutions have been selected after the first consultation.

A second competition was organised in 1995-1996 between five teams of design offices and architects, each team being in charge of developing a project corresponding to one of these five families of solutions. The idea, then, was really to withdraw the design for public administration and to withdraw the possibility for it to compete in the framework of an international competition. Finally the jury selected the solution with multiple cable-stayed spans developed by a team composed with Sogelerg, Europe Etudes Gecti, Serf and the Architect Norman Foster. The engineer, Michel Virlogeux, who prepared in SETRA, the conceptual design of the Millau Viaduct in 1990-1991, left that society in 1995 to join this team. It ensures the continuity with the project and its enrichment with an architectural knowledge.

⁵ In the choice of the route, The deep valley of the Tarn river which lies within the Causses constitute a natural barrier particularly difficult to cross for a highway. From 1988, engineers and geologists looked at a way to reach Millau and ensuring the feasibility of the project at the same time. 4 options were considered from 1988 to 1989;

1. *Great East* : this option comprised two suspension bridges of 800 and 1000m span to cross the Tarn and the Dourbie Valley. However, this option did not provide access to Millau and residents mobilized for the protection of the Dourbie within an association called "saving the Dourbie Valley from the A75", so it did not receive any political support from local governments.
2. *RN9*: The second option consisted of approaching Millau from the North by its East boundary to cross the Tarn and then join the Larzac by going South. It provides a good access to Millau but implied several technical constraints and posed important safety issues; abrupt down hill were deemed dangerous for the freight traffic with a strong impact on the urban environment.
3. *Great West*: this option was the longest (12 additional kilometers compared to the others. It passed through the Cernon Valley and the traditional villages of Peyres and St Georges Luzencon with 4 bridges. Indeed, it did not provide access to Millau and also generated opposition from the villages.
4. *Median* option starts from the St Germain villages in the North, crossing the Tarn to join the Franc and then goes up towards the Larzac. Though it bypassed Millau, this solution was welcomed by local government and the mayor because it provides an easy link to the city and reduces the negative impacts of traffics jams and noises. Yet, the difficulties relied on the geological conditions at the right side of the Tarn. Finally , the technical feasibility of the route was confirmed by two experts: the geo-technician, Marc Panet and the geologist, Marcel Rat (LCPC)

2.2. Changing the decision from a free and public civil engineering infrastructure for a concession under new regime.

But ,while the project which has been developed until then in the context of a construction under public management – and as a free infrastructure for the users – the Ministry of Transport under Lionel Jospin government : jean Claude Gaysot announced to the press, on 20th May 1998, his decision to concede the viaduct. This choice represents a second major the **turning point** in the decision process.

This decision did not throw back the technical studies made by the groupement until August 1998 and checked by the SETRA. But it made necessary to start a new public enquiry with the application of the concession. This new enquiry gave place to a new Decision of Public Utility (DUP) on 23th November 1999. The administration wrote the conditions of contract, from legal and technical point of views, before launching the competition tender for concession at the European level. The call for candidates has been launched at the beginning of 2000, and the bids took place at the end of that year, with a call for application on 24th January .Four consortia replied to the tender, and Eiffage was finally chosen as concessionary.⁶ But it was necessary to expect the signature of the ordonnance of 28 March 2001 which modified the concession regime – to put it more in adequation with the European regulation – to sign the concession convention between the state and the Compagnie Eiffage du Viaduc de Millot. This convention has been signed by the Ministre de l'Equipement , M. Jean Claude Gaysot, and the Eiffage CEO, M. Jean François Roverato on 27th September 2001. It has been agreed by decree n° 2001-923 on 8 october 2001 taken by Lionel Jospin, Prime Minister.

The Millau Viaduc is the first civil engineering infrastructure to enter in the framework of the concession reform of 2001. It is financed by private funding ; the civil engineering structure remains state ownership while the expenses for the realisation and the infrastructure operating are at the concessionary as well as the income of the tolls . .

III. THE PROJECT AS A RISK TREATMENT PROCESS

The third lesson from the Millau Viaduc is the role plaid in the success of the project by the risk treatments.

The Millau Viaduct represent different types of risks, uncertainty and complexity : we will focus here on the way in which the partners , public and private , manage the risks during concession.

3.1.The management of risk by the private concessionary

As an entrepreneur, the concessionary could be defined as an economic actor who takes the risk and succeeded to reduce it. We could illustrate it through two kind of risks

The financial risk

One of the specificities of the Eiffage's bid was the choice of **self financing**. The Millau concession represents an investment of € 320 millions, totally supported by the private sector. The company didn't have recourse neither to government subsidies nor to bank loans.

-
- ⁶ the four candidates were :
 - the groupment Compagnie Eiffage du Viaduc de Millau (CEVM), with Eiffage acting for the other enterprises , in fact its subsidiaries, Eiffage construction and Eiffel
 - the groupment driven by the spanish group Dragados, with Skanska (Sweden) and bec et Bec (France) ;
 - the groupement Société du viaduc de Millau, including the french companies ASF, EGIS, GTM, Bouygues Travaux Publics, SGE, , CDC Projets, Tofinso and the italian company Autostrade ;
 - the groupment lead by Générale Routière, with Via GTI (France) et Cintra, Nesco, Acciona and Ferrovail Agroman (Espagne).

the Chairman and General manager of Eiffage considered that self financing would be more interesting. This contractor had at that time a MBA cash flow of € 300 millions. So the price of € 400 millions to invest in 3 years (construction time) was congruent with the MBA cash flow.⁷ The other advantage of self financing was to avoid the conditions asked by the banks to cover the risk that they estimate. In the case of Millau, the bank probably would have valued the construction risk at a very high level (it was at that time the world record of the highest pier) as well as the receipts risk (strong uncertainty). So the Company's strategy was different: the idea was to go and see the banks after the construction phase, and to get then better conditions by the banks. That means that the company brought the whole financing on its own account, in "corporate". But at the same time, it reduced the risk and uncertainty on the traffic by a long duration of the concession. According to a general manager of Compagnie Eiffage du viaduc de Millau, this length of concession was due to accounting reasons: because the receipts are supposed to be higher at the end of the concession, it's important that the amortization will stay at a low level. On the other hand, this long duration has been accepted in counterpart of affordable levels of tolls. According to the general manager of Compagnie Eiffage du Viaduc de Millau, the better conditions got from the banks in comparison with a classical bank financing allowed to the company to propose more reasonable tolls in its bid. But the concessionary got to apply different tariffs according to seasonal traffic and types of vehicles. For instance the contract agreed that the toll level was 20% higher during the summer months. The tolls will be at € 6,1 (FF 40 at that time) for the cars in July and August, and € 4,6 (FF 30 on the rest of the year).

The idea for modulated tolls according to seasonal traffic was also a company's proposal. The argument was to calculate the time saving given by the viaduct in comparison of the traffic jam in the different times in the year. Then the tolls are higher in summer time, and lower in the rest of the year.⁸

In fact, the way to manage the financial risk was very profitable for the concessionary through three ways: the low interest rates that he got after the construction phase, the under estimation of the traffic by the public administration, and the opportunity taken by the concessionary to sell back some years after the construction phase, a part of his assets in the Compagnie Eiffage du Viaduc de Millau at the same price than the global investment that he brought, realising so a notable plus value.⁹

The construction risk : the option for a steel bridge construction

Another example of the risk treatment as factor of success could be given by the treatment of the construction risk, with its different issues about safety (in particular when working at height) or about technical or economic aspects. In the construction field, the major problem is the strength of the wind. It represents a major constraint during the phase of implementation of roadway according to the set construction method (pushing the roadway between two "piles" with a moment when the element is just dangling in space). Launching the implementation of the roadway (le lançage) needed to be sure to not

⁷ Nevertheless, as the global price for the investment was € 400 millions (compared to the initial FF 2 billions) the central government asked that the company will guarantee €300 millions on this amount in the case where it would be faulty. Eiffage had € 150 millions as proper and available funds. So, they negotiated with a bank (Natixis) to put this amount on a frozen account in exchange of a guarantee for €300 millions brought by the bank. Eiffage should use these guarantee at first and it would use its own funds in the bank for the second part of the site. This arrangement allowed to the company a low interest rate (0,37% a year) applied on the extra amount of €150 millions of guarantee brought by the bank.

⁸ In 2005, the tolls increased to 4,9€ for the cars (but 6,50 € in July and August)
7, 3€ for intermediate cars (9,7€ in summer)
17, 9€ for the trucks superior to 3,5 tons (all along the year)
3, 5 € for the motos.

⁹ Eiffage sold off 49% of the shares of the Company Eiffage of Millau viaduct to the Caisse des Depots et Consignations (CDC), a public group specialised in long run investments. Doing that needed an amendment to the concession contract; this amendment is got by a decree in Conseil d'Etat and it has been accepted because the buyer is the Caisse des Depôts. Otherwise the concession contract stipulates that Eiffage keep the majority of the part in the company of millau Viaduct.

The amount of this sale to CDC of 49% of the shares of the company for the viaduct is nearly equal to the total initial price paid by Eiffage. The sale has been made on the basis of € 770 millions, while the company have paid € 400 millions. Two years after the inauguration, the patrimonial value was at the double of the construction price.

getting a wind stronger than 60 or 80 Kms /h . It was a real site constraint and source of uncertainty, and the most delicate moment

To try to get this risk under control, the public engineering ran wind tunnel testings with different speeds.

Another kind of construction risks is due to other aspects. The exceptional technical characteristic of the Millau Viaduc came from the height of the piers (the higher is at 245 m and the higher pylone is at 340m) and from the system of load allocation (reprise des charges) of the roadway.

The Eiffage's answer was to opt for the "steel" solution, after an internal process where the two alternatives: prestressed concrete and steel, have been studied and compared; The "steel" solution appeared the best one from different points of view:

- safety: it allows to pre fabricated the elements on the ground and to reduce the work at height . So, only 4% of the working time would be done at the height of the viaduct above the river. That could explain, afterwards, that no fatal accident on the 2 millions of working hours occurred on site.

- economy : this solution was strongly supported by the industrial group Usinor Arcelor and by Francis Mer, the chief executive officer of this company since its privatisation in 1995, and President of the French Steel Federation. This support has been expressed in a commitment to give the guarantee of a fix price during the building time, if the steel solution will be adopted. One of the factor of economic uncertainty concerned the fluctuations of the steel price. Eiffage succeeded to sale back a part of steel at a good price after the end of site (the scaffolding). But the steel option needed to define rigorously the appropriate process to build the civil engineering structure. In fact, the Viaduct is oversized for the operated services because its size has been defined overall face to the construction constraints, in particular because the structure has to bear during this construction phase, more violent effects than after

- time: In terms of time, the choice of steel solutions plaid in favour of Eiffage, in spite of serious opposition to this alternative among some public engineers. During the bidding process, an internal innovation found by the Eiffel team (the design of a system to rise the steel towers on the roadway) allowed to reduce the initial time from 52 months to 42 ones. The engineer who found it knew since this moment that the steel option will win on the concrete one in the Eiffage decision. Then, time was a part of the negotiation between Eiffage and central government.

Inside Eiffage, the choice could be justified by the presence of a steel construction society, Eiffel, among the group's subsidiaries : Eiffel, previously named CFEM (Compagnie Francaise d'Entreprises Metalliques) was the result of a grouping of different steel construction companies , including the ancient "ateliers de Gustave Eiffel". The choice could be justified too by the experience of another Eiffage subsidiary, Quillery, on the Normandy bridge. So the study of the steel alternative has been put in charge of teams from Quillery. A more general principle retained in the decision making was to do everything in house as far as possible. In house meaning the contractor company (Eiffage) and all its subsidiary; eiffage TP for concrete, Forclum for electricity; Eiffel for the metal structure and the weld, Apia for coating. The only part of the viaduct which has been subcontracted was the stays; they have been subcontracted to Freyssinet.

They gave the demonstration that this constructive choice should be more efficient in terms of time, cost, safety and working conditions. According to the Eiffage President and managing director, this option for steel bridge was also justified by the length of the span (330 m). Even if it was a bone of contention with some engineers of the corps of Ponts et Chaussee, it was for him an obvious fact.

But the choice of steel has boosted also the objectives in term of time and costs for the project itself. Nevertheless a lot of incidents or events during the construction phase were due to the steel option, making evidence that reduction of risks could generate other risks

3.2. The management of risk by the granting authority

Afterwards on the Millau viaduct, the risk for the granting authority appears less located on the non project completion within budget, than on the rapid and unforecast increase of the receipts, mainly due to the capacity of this infrastructure to attract more traffic than forecast.

The clause of Rendez vous

In the case of Millau, the contract reveals a compromise: on the one hand, concession duration is exceptionally long: **78 years** (3 years for building, and 75 years for commercial operation) but with a forecast **rendez vous after 42 years** after opening the commercial operation: in the case where the concessionary's incomes have been sufficient to reimburse the financing, (the government could take back the Viaducts and operate it before the deadline of 78 years. It is a clause of "revision in case of coming back to better fortune"); Otherwise, the concession will be applied until the end, that means until 2079. Nevertheless, the concedant can ask the end of the concession as soon as the addition of real turn overs converted to current value(November 2000 value) at the rate of 8% will be equal of superior to **€ 375 millions** .

Missions of expertise and control.

Another aspect to manage the technical risks after the concession contract has been signed was the creation of the **Mission of controle** on Millau Viaduct ; there were two missions for the viaduct, the first one was a mission of expertise to evaluate the feasibility of the project (at that time, the project was planned as a public one); the second one was the mission of controle. Both of them have been submitted to a experts commission, whose the chairman was M.Jean François Coste

But the post contractual phasis could be at the origine of other types of RUC, in particular those related to the agent's opportunism, according the theory of Agency, or the theories related to the economics of contracts.

According to the Chairman of the Mission of control, the government has more power to act on concessionary than on the public roads. For instance, after the fire in the Mont Blanc Tunnel, to bring the tunnels in safety has been quicker in the case of conceded motorways rather than on public motorways because it's more difficult to get public funding in time. While on the conceded motorways the granting authority could require different measures from the concessionary and impose him to repair in case of failure.

In addition, there is a "**reputation effect**". Many examples could be mobilised in the case of the Millau Viaduct . We could note one as example. It is about the toll barriers, in the operation step. It was operated normally with a define number of lines and these ones could be enlarged when necessary. But on the first summer after bringing the viaduct into service, traffic was so dense that the granting authority obliged the concessionary to open other lines and to put additional employees. The concessionary did it, by this "reputation effect".

IV . THE APPRAISAL AND EVALUATION FACE TO NEW ISSUES: THE SUSTAINABLE DEVELOPMENT.

The main lessons that we could take from the Millau Viaduct case study, regarding the sustainable development challenges are the following ones :

- Even if the reference to these challenges didn't exist at the beginning of the project, they have been taken in consideration afterwards, through different considerations: the landscape motorway, the will from the designer, specially Norman and Foster team, to impose specifications about the improvement of the Mutp inscription in the landscape and natural environment.
- The success or failure of the Millau Viaduct regarding the sustainable development has also to be appreciated around the special item which is the local development and the country and town planning of an underprivileged region. The result is here more mitigated: at one of the hand, there were benefit consequences on local economy; on the other hand, some observers feel that the occasion to make something exceptional has been missed , because the games of local actors.
- The country and town planning hadn't be at the measure of the MUTPs but remained (empetree) in the games of local actors with as results a lot of dispersed and banal actions, despite of the active local initiative taken at the previous stages.

- The role of the government could be also appreciated in different ways; at on the one hand , it plaid a quite important role to promote the sustainable challenges, in particular through the direction of roads. For instance, the central administration (Direction of the roads) tried to associate closely the local representants (not only the elected ones but also those involved in local economic activities) to the concession process; the decision was motivated by the opposition to the principle of toll from most of the local actors.

It has also a quite important regulator role through the requirements addressed to the concessionary regarding the green treatment of the viaduct (concerning la remise en état des sols, la vegetation,) but also the services supplied the users and accompanying the tourist development. A lot of these requirements have been included in the concession contract.

But on another hand, the government missed the appreciation of the impact of the Viaduct on the tourism ; the Viaduc success has been underestimated.

In this part, we will focus on three points :

- The emergence of “landscape motorway” and its status between environmental concerns and territorial management ;

- The increasing concern of territories and the questions put to appraisal and evaluation.

- The search of an appropriate governance to support and manage the effects of the MUTP

4.1. Millau as a turning point : A landscape motorway as a new objective

The objective to promote both the Millau Viaduct and the A 75 as transport infrastructure more compatible with the environment has been supported by *Christian Leyrit*, Directeur des routes from 1989 to 1999.

Even if the local opposition to the project for environmental reasons did not take the same force than in other places, the idea to think the A 75 as a “landscape motorway” didn’t emerge totally independantly of this worry. It appeared as the fruit of different circumstances but also of different issues.

Firstly, it appeared quite simultaneously with the choice of the “routes” . This new concept of “landscape motorway” emerged, not to say under associations pressure, but in a time of negotiations and as the sign of an increasing worry to take in account the territory issues and to get the local representants’ support to the project. Changing the image of the motorway for something valuating the landscape was a quite strategic decision for agood governance of the project relationships between central government and local authorities.

Secondly, the creation of a college of environment and landscape experts allowed to gather different skills and competencies around the Direction of roads and the landscapiste Bernard Lassus . A part of this skilled people coming from academic world (historians, geographers and philosopher).The idea was to recognize that there are more and more problems with the choice of routes and that it was better to integrate this data and to change the image of the route. Promoting this idea could be a way to manage a sensible areas such as Millau , close to the larzac Plateau.

Thirdly, the consequence of that was also to consider that most of the difficulties met in general with the routes were due to the fact that the projects were designed essentially from technical points of views. So it appeared decisive to underline that the technical administration and central government were ready to promote other criteria to evaluate the mega projects. That means a will to show a breakdown with the solely dominant technical criteria.

A new device has been created with the “1% *landscape and development*” (circular ° 96-19 of 12 December 1995, concerning the policy of 1% landscape and developpement. See below 2.1. the regulatory role plaid by central government). It meant that the Central government could invest 1% of the construction cost of the civil engineering work for landscape, under the condition that the local authority invest also 1%. This device has been experimented for the first time on A75 (Clermont – Ferrand- Béziers) and on A 20 (Vierzon –Montauban via Limoges)

Fourthly, this turning point about the motorway image has been strongly supported by the Direction of the roads through media communications. There have been a real strategy in this way, with an expected effect which was to give a new legitimacy to MUTP near the local population. It has been

popularised by this sentence: “*Discovering the landscape has become a route choice factor*” The main idea was to no more consider the roads and motorway as engineering objects but as a cultural one.

4.2. The increasing concern of territories and the questions put to appraisal and evaluation.

As we noted at the beginning of this paper, one of the criteria of the success of a MUTP is its impact on the territorial issues. In fact there are many issues and the case of Millau underline how difficult it is to appraise and evaluate them. We could give some examples

Economic impact and business parks

Millau and A 75 participated of “country and town development motorway”, that mean that there are an interchange at every 8 kms. One of the challenges for the local authorities was to avoid the multiplication of small business parks and that everybody makes “*its own cooking on its own stove*”.

An early initiative has been taken by the Departement¹⁰ (Aveyron) to organise, before the completion of the motorway, a cooperation between the local authorities and the chamber of commerce for more local concertation and planned initiatives. The result was the creation of a mixed association (syndicat mixte), with Bernard Sellier as President. One of the tasks was also to think about some solidarity criteria (economic and fiscal). The result was the plan of only two business parks and the payment of a part of taxes to the mixed association which reallocates it between the local authorities. One business parks has been created at Severac le Chateau (50 ha) in 1998, with the benefice of the junction between A 75 and RN 88 (axis Lyon-Toulouse) and another one “La Cavalerie” (50 ha) in the south of Millau some time afterwards. In this case, the local political and economic actors have anticipated on the arrival of motorway. But the real starting up of these areas occurred with the Viaduct achievement: some enterprises established themselves there and the extension of these 2 business parks has been planned with 15 ha in La Cavalerie and 35 in Severac le Chateau. With the achievement of A 75 there is a new perspective for itineraries and the possible link it allows between North west of Europe and Spain- for instance, it is the shorter route between the harbours like Rotterdam and Barcelone. This explains that the business parks located at Severac le Chateau **for the logistic societies** (in addition of the present furniture firms) ; this movement takes place in an environment where the economics of transport is changing (for instance , transport tariffs are calculated until the way out of motorways. Each additional distance is in extra price.

With the opening of the viaduct, there has been a third business park in the North of Millau, where some local firms, previously established in Millau, moved, including the firms of traditional industry (globe) like tanneries. The most important of them left the core of the city for more access facilities on the plateau, even if there is no the river water like in the city. One challenge of the local actors and institutions is to succeed to create an appropriate environment (housing, training etc.) to welcome the new firms coming there

The tourism development : an unexpected success

Another real impact of the viaduct is the very quick and massive development of tourism. A lot of interlocutors told us modestly that this large success was due to the fact that on the D Day of inauguration on 14th December 2004, no special event occurred in France or in the world; so the TV news could spend 15 mn on the Millau event, making it suddenly very famous. As an observer noticed, the extent of success of this infrastructure on the public has been deeply underestimated neither by the central government (direction des routes), nor by Eiffage. And yet, already during the construction site, thousands of people came to see the site in progress. In 2005, the flux of tourists was growing: the Millau viaduct appeared like the most visited area in the region Midi Pyrenees, just after Lourdes.

The gap between the public enthusiasm and the institutions and actors moderation regarding the attractive quality of the viaduct was represented by the case of the rest area of Brocujouls ; It was designed at the beginning like an ordinary rest area with a minimum set of services. But it became quickly very used because of the beauty of the point of view. So, this rest area has to be equipped and

¹⁰ The department is one kind of local authorities, larger than the cities and smaller than the regions.

converted to answer to this success. An agreement has been signed afterwards between the central government and the Departement to get a right on the land and to convert a barn and an old farm to welcome new services in it (catering, shops, including one for valuing the tourist wealth of the region). Therefore the rest area became, at its turn, an object of tourist visit. All this has been made after the achievement of the viaduct, it has not be planned before at all.

- In the same manner, the government has been surprised by the quick and full success of the viaduct near the car drivers. At the operating day, the forecast traffic was 10.000 cars a day including 10% of trucks, and 25.000 cars in summer. The forecast rate of growth was 3% a year on 15 days. The initial size for the barriers was calculated on a maximum of 28.000 cars a day, without slowing down. In 2005 and 2006, about 4.300.000 cars used the viaduct, i.e an average of 12.000 cars a day. After the peak rush of 50.018 cars a day on 31st July 2005 generating more than 12Kms of traffic Jam, Eiffage was asked to build four new lines, in addition of the previous 14 ones. These new lines have been operated in 2006. Then there have been 4.532.485 cars in 2007, 4.670.449 in 2008. On 3th October 2009, the 22 millionth car has been registered. (source: La Depeche ; [http:// www. Ladepeche.fr](http://www.Ladepeche.fr))

4.3.. In search of an appropriate governance to support and manage the effects of the MUTP

Face to this unexpected success, one of the lesson that some actors brang out of this experience is the absence of a real accompaniment to get larger benefices of this infrastructure. Except at the beginning in some fields like the previous creation of the mixed association, the impression is that “*there is no pilot in the plane*” to manage at the local level an event appropriate to the build of this “grand ouvrage”.

This remark could be applied to the relationship between central government and the private company as well as to the relationship between the different local authorities.

The relationships between local authorities or the key question of the pertinent territory

Another issue from the point of view of the management of the MUTP's effects is the identification of the pertinent territory. As an observer noted : “the name of the viaduct is the Millau viaduct” but this name could have been really “ the Aveyron Viaduct” , like the “Normandy bridge”; one part of the reasons is in the different attitudes adopted by the Millau Mayor, on one hand , M. Jacques Godfrain, and the president of the general council of the Aveyron Departement , Jean Puech, on the other hand, about the passage of the viaduct under concession. While they belong both of them to the political party (UMP) and has been both ministers, the first one accepted the principle of a concession, the second one refused it as in contradiction with the first design of the MUTP as a free one. This refusal got him marginalised while the Millau Mayor got some legitimacy. The President of the General council tried afterwards to be back involved in the local management about the viaduct : it got that the AOT (Autorisation d'Occupation Temporaire, temporary occupation permit) for the rest area has been signed by the Departement.

In fact, according to an observer, there has been a gap between the construction of an exceptional MUTP, the Millau Viaduct, very famous for the public, and the capacity limits of most of the political local actors to reply by a same exceptional country and town planning at a pertinent scale. Very clearly, the response of the local authorities was not at the measure of the project , each of them tried to getting the benefits for itself without any consideration of the pertinent territory to manage the Viaduct effects and specially the tourist development.

Except the previous experience of the mixed association which tried to support and manage the economic impact on a large area, for the business parks, there hasn't been afterwards any more similar movement to anticipate the Viaduct effects. The conflict between the Millau Mayor and the President of the General Council contributed to marginalise too the mixed association. The Millau Mayor continues to create and animate another association “ La Meridienne” which gather many local authorities around the A 75 from Clermont-Ferrand to Beziers

In the relationship between Central government and private company.

There is a gap between the important role plaid by the public administration and central government to regulate the design and operate of the viaduct through the concession contract, and some failure or lack of foresight to forecast and manage its effects.

CONCLUSION

This last arguments means that the main conclusions that we can draw from this case study could be both.

The first one is that, through the project history of the millau Viaduct, we could read, concerning the planning, appraisal and delivery of major project transports, the passage from a "close" system (mainly dominated by the public sector and the engineering culture) to a more open system characterised by a greater diversity of stakeholders , interests and social values.

The second one is that this evolution asks to be analysed not only in the framework of the only transport project infrastructure (with its world of actors) but also put in relationship with the emergency and increasing of territorial issues. In this case, it is not only the passage from a close to a more open system which is relevant in the analysis , but the way of social regulation of the whole system of actors: those involved in the transport project system planning and delivery as well as those involved in the management of territorial issues, those acting at the national scale an those acting at the local one , and the way in which the articulation between the different levels is redefined.

Bibliography (elements) :

CEVM (?) *Historique d'un projet né en 1987. Quelques étapes significatives d'un grand viaduc à Millau.* Unpublished document.

Coste J-F (2009) *The Millau Viaduc*, Royal Aeronautical Society, 20th October 2009.

Coste J-F (2005) *Le viaduct de Millau: la creation d'un haut lieu.* PCM Décembre 2005

Coste J-F (2005) *La mission des experts du Millau Viaduct* . Unpublished document .

Coste J-F (2006) *The Millau Viaduc*, Presentation at French Economic Mission in Ankara/Turkey.

EIB (2008) *Project Finance magazine applauds record number of EIB projects in 2007*, / <http://www.eib.europa.eu/about/press/2008/2008-018-project-finance-magazine-applauds-record-number-of-eib-projects-in-2007.htm>

Gillet, G & Mutel, JF *Millau Viaduct , de l'idée d'un pont à sa mise en service* <http://www.mtq.gouv.qc.ca/portal/page/portal/Librairie/Publications/fr/minist...> [pdf] (1972 ko) (17/02/2010)

Godfrain J. (2004) *Millau Viaduct, an exceptional stepping stone for the economic future of the south of Aveyron* , Ponts Métalliques 2004 pp.8-11:

Legrand, M (2002) *La concession du Millau Viaduct* . PCM Décembre 2002.

Ministere de l'Equipement (2004) « Le Millau Viaduct , un ouvrage exceptionnel initié par le Ministère de l'Equipement » Dossier de presse. http://www.environnement.gouv.fr/IMG/pdf/millau_cle148b14.pdf (17/02/2010)

Virlogeux M. *Bridges with Multiple cable-stayed spans* Structural Engineering International 1/2001, published by the International Association for Bridge and Structural engineering, Zurich, Switzerland