

Economic Context and Early Management of the Saint-Étienne & Lyon Railway Company (1825-1835)*

By Michel Cotte ** and Ichiro Kobayashi***

Abstract : At the beginning of 1820s, Marc Seguin and his brothers started negotiations with French government for the construction of a railway line from the Saint-Étienne coal field to the Rhône valley and the city of Lyon. This railway is the first French railway using locomotives. Because there are few papers and publications on the history of this important railway, the writers have studied about the circumstances of the railway and the role of Marc Seguin. The originality of civil engineering works¹⁾ and the development of locomotives with tubular boiler²⁾ are already discussed.

This paper reexamines the Saint-Étienne & Lyon Railway Company from the view point of the economic context and management by investigating original documents of Marc Seguin and his colleagues. Major points discussed include: 1) Economic context leading to the railway and rate competition for the governmental concession, 2) Operation of locomotives and management of the company after the opening, 3) Advanced aspects of the railway.

1 - Introduction

The construction of the Saint-Étienne & Lyon Railway (Le Chemin de fer entre Saint-Étienne et Lyon) was to open up the coal field of Saint-Étienne toward the Rhône Valley and the city of Lyon. It followed another attempt of opening up toward the Loire Valley by the first French railway from Saint-Étienne to Andrézieux (1827). The design of the Saint-Étienne & Lyon line by the Seguin's company, during the winter 1826-1827, became an outstanding interest in civil engineering. For the first time, it gathered the main aspects of the modern standard of construction for a mountain railway line¹⁾: 1) general design of a line for fully locomotive traction, 2) constant gradient for long slopes (the most significant was 13.6 ‰ for 20 km), 3) large radius curves (not less than 500 m), and 4) systematic use of civil engineering structures including numerous tunnels (13 for 4 km length).

The aim of this paper is to overview the economic context and management of the Saint-Étienne & Lyon Railway. The paper discusses: 1) Economic context leading to the railway, 2) Rate competition for the governmental concession, 3) Partial opening in 1830 from Rive-de-Gier, to Givors, 4) Crisis of 1830-31, 5) Intensive use of the railway for the first years, and 6) Advanced aspects of the railway.

2 - Economic context leading to the railway project

From Saint-Étienne to the Loire or Rhône valleys, traditional transportation of coal was difficult during the early 1820s using mountain roads with carts powered by

horses. Mainly from Rive-de-Gier, the south-eastern part of the Loire coal field, the "Canal de Givors" had allowed a long tradition of exportation toward the Rhône. Canals were used since 1780; however, it was expensive for customers due to additional charges upon the basic rate granted by the State to the private canal companies. A great part of that coal was sold to manufactures in Givors, Vienne, and Lyon for domestic use in Lyon and to be exported via the Rhône river toward the south of France. From the end of the French Ancient Regime³⁾, heavy industrialization occurred in the Rhône Valley near Lyon based on coal works bearing many features of the 17th Century British industrial revolution. Factories using coal fuel were: lime furnaces (Lyon and Rhône valley), glass manufactures (Givors), but also the important industry of copper production and transformation (Lyon, Vienne). Ironworks were also set up in the Gier Valley and Lyon for second casting and forging. Frérejean, a private Company, tried to smelt iron by coke in its high furnace in Vienne (1817). Fig.1 shows a map of the Loire and Rhône region.

By the Loire river, Saint-Étienne coal was sold to the iron masters of Nivernais, such as Martin in Fourchambault, and to the Parisian market, by the "Canal de Briare"⁴⁾. The central and western area of the Loire coal field was the largest in France at that time. Workings consisted of craft industry by open-air mining, but it had very promising, large and numerous veins of good coal. The operating costs were significantly cheaper at Saint-Étienne, and for the Rive-de-Gier collieries, first signs of exhaustion had appeared. In 1825, the

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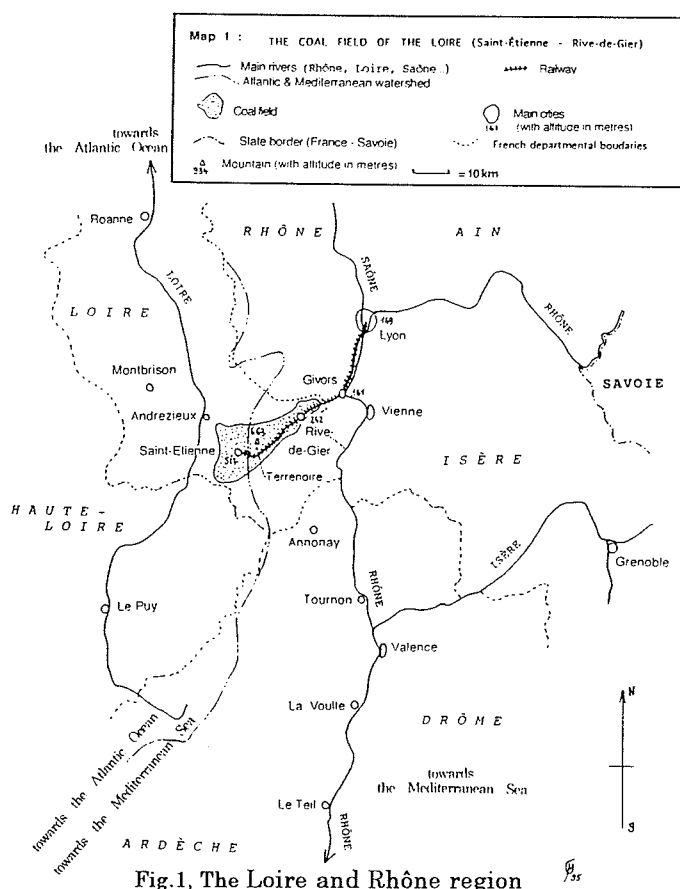


Fig.1, The Loire and Rhône region

importance of the Rive-de-Gier extraction remained first, mainly by the way of the canal de Givors. Table 1 shows coal destinations from the Rive-de-Gier and Saint-Étienne collieries in 1825. Table 2 shows prices of coal in Saint-Étienne, Gier Valley, and Lyon in 1827.

Since the 1815 treaties ending the Napoleonic wars, the dimension of France was reduced, and the Loire coal field remained the biggest of its kind in France known at that time⁷⁾. Mine engineers such as Beaunier and Gallois had important plans to instigate changes in the Saint-Étienne industrial landscape. Firstly, they gathered scattered private properties of the largest companies by an official concession policy. Secondly, their private projects in mines, ironworks, or steel factories were supported by some capitalists. Other contractors and civil engineers also had important projects in forge and high furnace for Saint-Étienne and surroundings like Terrenoire⁸⁾. All these plans were influenced by the British example of heavy industrialization relying upon coal and iron. After 1815, numerous French engineers tried fact finding trips to British Islands.

The question of transportation was a crucial point in the early 1820s, as a "bottle neck" to increase coal exportation and industrial awakening of the Saint-Étienne area. For example, the price of coal increased quickly along the road, with expensive costs when it reached the Rhône Valley. Road transports were difficult to operate and almost impossible to improve. Maintenance of public roads became a serious problem for "Ponts et Chaussées", not easy to solve in mountainous country. Such an argument led the French administration toward the acceptance of the "iron-way"

Table 1, Coal destinations from the Rive-de-Gier and Saint-Étienne collieries (1825)⁵⁾
(thousand metric tons)

coal destinations	coal from Rive-de-Gier	coal from Saint-Étienne
21 glass factories of the country	50	
to Lyon par road	34	25,5
to Lyon par waterways	108	
to the Loire river by road		100,5
to Givors and South of France (waterways)	130	
local consumption (ironworks mainly)	103	99
total	425	225

Table 2, Prices of coal in Saint-Étienne, Gier Valley, and Lyon (1827)⁶⁾
(in francs by hectoliter of 75-80 kg)

	First choice of coal	tiny coal
Saint-Étienne	0.70 to 1 f/hect	0.20 to 0.35 f/hect
Rive-de-Gier	1.60 f/hect	0.35 to 0.50 f/hect
Givors	[2 f/hect]	
Vienne	2.15 to 2.20 f/hect	
Lyon	2.50 to 3 f/hect	more than 1 f/hect

proposal by a private company despite its traditional monopoly upon the French transportation network. An important evolution occurred during the French Restoration⁹⁾, for a liberal policy in civil engineering works, involving concession of new canals to private companies. Proposals from Beaunier for the Loire railway, and from Seguin to reach the Rhône, were met with a good welcome in governmental spheres, especially from count de Villèle, the most "industrialist" First Minister of the Restoration.

More generally, transportation rates remained expensive in France due to geographic difficulties for canals and economic environment more diverse than that of the British.

3 - Rate competition for the governmental concession (1825-26)

In 1825, "Canal de Givors" was a private company, and merchants of coal made claims against its "transportation monopoly". Official inquiries of the early 1820s confirmed increases of canal rates following a rise in demand associated with the regional economic take-off. That started the Seguin project which was associated with the family of the physicist Jean-Baptiste Biot who was looking for an industrial position for his son, Edouard, a young "Polytechnician"¹⁰⁾. Furthermore, the

proposal focused on obtaining quickly the opening of the Saint-Étienne main coal field toward the Rhône Valley. Marc Seguin and his brothers clearly understood the great interest of a such line for the future heavy industrialization of the Lyon area and Saint-Étienne itself despite the tremendous geographical difficulties to set up the tracks and to operate traction¹¹). For Camille Seguin, brother of Marc and the economic and financial manager of the family firm, believed the team capable to built and control the railway transport would get the crown of "industrial principality". Of course he thought his family group was the best to do it !

Before the competition of the governmental concession, Camille studied accurately the cargo transportation along the road, canal, and railway at the entrance of Lyon city.

Except for special situations, such as the descent of the Rhône river, bias remained in France that it was not possible to decrease significantly the transportation rates. According to the monumental principles of "Ponts et

Chaussées", required in the French geographical context, building canals needed heavy investments. Thus the cargo transportation remained generally too limited to expect comfortable profits for capitalists, with low rates for customers, as it was in England. That seemed to be a permanent vicious circle (See Table 3).

The hope of a significant change in the economy of French transport did not occur with the first railway proposal of Beaunier, but rather with the second of Seguin's brothers. They popularized three or four new ideas about the Saint-Étienne & Lyon project:

- Decreasing the cost of transport will decrease drastically the price of coal at the place of use, leading to a strong development of transport, industry, and trade.

- A large development of the Saint-Etienne coal mines and industries depends upon low transport rates. - A break in rates is the best way to fight against monopolies of transport such as the "Canal of Givors".

- Similarities between the Saint-Étienne - Lyon context and the powerful industrial centers of England,

Table 3, Transport rates in the Saint-Étienne and Lyon regions around 1825¹²)
(centimes of franc for one metric ton moving one km)

<u>Road transport</u> of coal from Saint-Etienne to the Loire river from St-Étienne to Lyon All goods in the Rhône Valley	27 - 31 34 30 - 35
<u>Andrézieux railway</u> : coal other cargo	23,25 37,5
<u>Canal of Givors</u> : coal (concession) other cargo real rate including all charges	20 30 34 - 36
Cargo barges on the <u>Rhône river</u> ascent by traditional tow going down	19-20 5 - 7

Table 4, Exceptional rate overbid toward the governmental concession of the Saint-Étienne & Lyon Railway¹³)
(centimes of franc for one ton x kilometer)

1820 -1825	References for transport rate : road and Givors canal - coal on the Andrézieux line / other goods	30 à 35 c / t x km 23,25 / 37,5
December 1823	Proposed by Beaunier for a railway toward the Rhône	29
October 1824	Chamber of Arts and Manufactures of St-Chamond : - coal and heavy materials - grains, manufactured goods - cotton, silk...	18 25 40
April 1825	- sous-préfet of Saint-Étienne - préfet ¹⁴) of Loire - Marc Seguin	19 22,5 21,3
Summer 1825	Local newspapers of St-Étienne	20
27 October 1825	Writing proposal in official candidacy by and Seguin and Biot	coal : 23 other goods : 36
Winter 1825-26	Private discussions between Marc Seguin, J.B. Biot and Becquey, general director of "Ponts et Chaussées"	going down : 10 ascent : 15
February 1826	Official condition for submission : maximum and unique rate	15
27 March 1826	<i>Final competition for concession (unique rate) :</i> - Bérard & Co. - César de Lapanouse & Co. - Seguin brother, -Édouard Biot & Co.	— 14,7 13,5 9,8

such as Newcastle, show the great interest in railways with traction by steam locomotives.

Government, administration, and local consultative chambers were easily convinced by such arguments. A quick change in the public opinion occurred too, as a sudden and idealistic view of the possibilities of railways. Inquiries and debates offered a fine landscape for a fast evolution in thinking until the final bid by sealed envelopes for the governmental concession. Finally, it was won by the Seguin brothers and E. Biot Company, with an incredible rate for that time 10 centimes for one ton moving one kilometer (See Table 4).

The attitude of Seguin for a very low transport rate was not very consistent before the official concession, yet they progressively forged their opinion by an accurate economic study of the possibilities of the railways in the Saint-Étienne and Rhône country. Undoubtedly, this region was very promising, but it became difficult to convince investors and bankers to bear the 10 millions francs capital for the Company, and 800,000 francs for the State, as a completion guarantee. Finally, an agreement was made for a limited joint stock company of about ten main shareholders as creators and first members of the board of directors. Hard discussions arose to divide up the future profits, between shareholders of "capital" (creators) and shareholders of "industry" (contractors : Seguin brothers and E. Biot). The importance of capital and low rates led the Seguin brothers to the acceptance of an annual guaranteed yield (4%) for shareholders, independent of the real annual profit and their priority under the real profits until 3%. Consequently, contractor's earnings would operate only if profits reach more than 7% ! Such a high guarantee by the Seguin's brothers was used to convince investors that low rates would create a large heavy transport effect. That was new thinking, and a challenge, about investment of capital in the French economic landscape of 1825-26. The debate also shows a high level of acceptance for a new transportation system by local elite, the bourgeoisie and aristocratic classes, and by the medium bank of Paris. At that time, only the Darlington line was in use as a public example of railway transportation and Seguin visited it during December 1825.

4 - The partial opening in 1830 from Rive-de-Gier to Givors

At the end of June 1830, the second section from the coal mine of "La grand Croix", a little above Rive-de-Gier, to Givors was completed. It consisted of 20 km with a gradient slope of 5.6‰. The choice to first finish the central part of the line was stressed by the technical need to experiment, as quickly as possible, with the method of coal going down by gravity power and ascent of empty, or low loaded wagons, by locomotive engines. The Perrache workshop had built a set of three units during the end of 1829 and the beginning of the year 1830²⁰. Track construction was completed during June 1830 followed by private trials of transport, mainly by Paul and Marc

Seguin. Relatively successful of trials lead them to open the section to the transport business on the first of July. Starting an immediate concurrence against the Givors canal and earning first incomes afforded another opportunity for the Company. A great effort was done to reach that partial opening of July 1830, leaving the two other sections largely unrealized¹⁵.

However, if the first limited public transport by gravity and steam locomotives were technically satisfactory, social agitation quickly disturbed the initial management of commercial transport. Mainly, the Rhône and canal dockers forbade the unloading of coal trains at Givors port. They certainly felt threatened by the new transportation with its automatic devices to unload the coal from wagons to boats. Thus, the board of the Canal probably influenced them against the railway. Furthermore, it was a troubled time in France, announcing the revolutionary days at the end of July 1830, followed by the fall of Bourbon's king, Charles X, and proclamation of the Constitutional Monarchy of Louis-Philippe, former duke d'Orléans. A general social agitation spread over the main French cities, especially among the traditional working class anxious about the increasing mechanization process in industry. On the one hand, it is a significant yet unknown example of the social agitation introducing the revolutionary days outside Paris ; on the other, it was an unlucky time for the initial opening of the Seguin's railway.

Social agitation pursued strongly during August. With intervention of the police, arrests of dockers, and military plan by the Seguin's brothers, tracks and trains were secured. Commercial transport was disturbed until October without significant outcomes. Lead by Paul, long negotiations started with the dockers. They reached a deal in the Fall : The company gave them a priority to employment, especially for the loading and unloading works, with a strong bonus for the unloading apparatus workers. Social change occurred before the railway was put to use¹⁶ ! Concurrently, the Seguin brother shrewdly introduced a special charge for unloading the coal wagons which drew no reaction from the Administration. This small event opened a breach in the official rate, as did the Givors canal some years prior !

October 1830 was the first significant month of a movement involving regular use of the Seguin stream locomotives with tubular boiler¹⁷. During the first months of 1831, the line operated with quickly increasing traffic. The three initial locomotives were enough for the ascent of 18 empty wagons trains three or four times a day. Soon helped by the n° 4. One was kept aside for assistance in case of mechanical failure. Gravitational descent was dangerous, and there were some big crashes during the first months. Seguin's staff slowly reached a better line of management, with smaller trains, bigger manual brakes, and permanent brake-workers on each of the three wagons.

At the end of October 1830, Seguin brothers examined immediately the crucial point of profit. They sent a report to the new Administration of King Louis-Philippe¹⁸, trying to show good traffic while producing a

small deficit, mainly owing to very low transport rates (See Table 5). They asserted that expenditures were 11.8 centimes for one ton moving one kilometer upper than the 9.8 centimes official rate. Thus, the question of maintenance costs remained premature, and income estimation for transport was very superficial and incomplete! Such early assessments were not very clear, led by its real purpose : to ask the new Administration for an exceptionally higher transport rate for the ten next years. The political context, involving a deep economic and financial crisis pushed the Seguin's brothers to do that, expecting governmental help as it had promised for firms meeting difficulties. Finally, they gained a

temporary increase of the rate for ten years, but only for the ascent : 12 centimes for one ton moving one kilometer from Givors to Rive-de-Gier, and 13 centimes from this city to Saint-Étienne¹⁹.

After the first managerial exercising, another report for shareholders afforded a better view on the expenditures and incomes for the second part of 1831 (See Table 6). Maintenance of locomotives remained a difficult task following an important increase demands. Financial result must be criticized to be understanding : Facing the shareholders, purposes of the report were not the same than before the government ! Maintenance costs for the line and rolling-stock were probably

Table 5, Results of the first operational period (July 1830 - October 1831)²⁰

<u>Traffic</u>	<u>going down</u>	<u>ascent</u>
1- July 1830 - 30 April 1831 (10 months)	71 927 t (average : 7 193 t/ month)	1 449 t (average : 145 t/ month)
[1- May - 30 October] 1831 (6 months)	62 553 t (average : 10 425 t/ month)	4 677 t (average : 780 t/ month)
<u>Financial Results</u> from 30 June 1830 to 31 October 1831, Board of directors assess the capital used for the 2d section to 4 millions francs	<u>railway :</u> incomes expenditures railway profit profit of the <u>La Mulatière Bridge</u> total profits guaranteed interest 4 % for 4 Mf : benefit	315 010 f 191 448 f 123 562 f 75 254 f 198 816 f 160 000 f 38 816 f

Table 6, Results of the second operational period (November 1831 - October 1832)²¹

	<u>going down</u>	<u>ascent</u>
	153 017 t (average : 12 751 t/month)	12 060 t (average : 1 005 t/month)
<u>Incomes</u> : cargo transport	382 057 f	23 171 f
passengers		66 690 f
Total		477 555 f
<u>Expenditures</u> (coast, maintenance and administration)		247 987 f
<u>Profits</u> : Railway		229 588 f
Bridge of la Mulatière and financial yield		105 432 f
Total profit		335 000 f
<u>Sharing of profit</u> :		
- Guaranteed interest 4%		118 862 f
- Priority benefit of shareholders		160 960 f
- Exceptional benefit (50% for Seguin & Biot)		55 178 f

minimized. Exceptional works like embankment reinforcement or tunnel repair were not included, shifting to the capital account for construction. That was clearly underestimated for the second section at four million francs. It was more expensive to build, and the first question for the Company was how to get money to complete the first and third sections. The toll of "pont de la Mulatière", linking Perrache to the western part of Lyon, supporting the royal road toward the Saint-Étienne country and the future railway, bore an interesting supplement for incomes. The second operational period showed a new presentation, which emphasized the financial features of Seguin's management methods - those expected by the shareholders ! Cost of maintenance was exceptionally low for the same reasons as in the former period and because the line was new and without need of important repairs. Benefits seemed very nice and very promising for the next general opening of the line. Despite some weaknesses, the two results of the partial opening from Rive-de-Gier to Givors appeared hopeful because :

- First, traffic increased regularly and challenge against canal de Givors was overcoming. And the ascent traffic rose and bore an appreciated complementary income.

- Second, powering by locomotives became technically credible for the ascent trains on the 5.6 % slope, and not too expensive even with the new rate of 12 centimes for one ton per kilometer. They operated the cargo traffic on demand without horses from Rive-de-Gier to La Grand Croix.

- Third, management for the descent by gravity improved, and came under better control. It bore an essential guarantee for the future to earn money with the tremendous coal traffic they expected from Saint-Étienne.

- Fourth, and not the least interesting item of satisfaction, as passenger traffic rose, not forecast in the project, under the impulsion of demand and quickly managed by the Seguin's brothers, with construction of passenger cars. That was very interesting because out of the concession rate with the government : not allowed but not forbidden ! They asked immediately a passenger rate lined up on stagecoaches. That meant comfortable incomes on close future...

5 - External and internal crisis of 1830-31, it's consequences

Expenditures for purchasing lands and for the line construction increased very quickly during the years 1828 and 1829. Rapid exhaustion of capital led to difficulties; e.g., during 1829, the Company call for anticipated payments of shares. Finally, the board chose a partial completion to get necessary incomes to pay the guaranteed interest²².

As early as February, before the events of the "July revolution", a special committee of the board studied the financial situation and proposed an exceptional meeting of the shareholders, which happened in April, for an

immediate capital increase of 750,000 francs. The ordinary meeting of December did so again for 250,000 francs. But it was the end of legal possibilities allowed by the statutes of the Company. It was not possible to raise more than 11 million in capital.

A financial and economic crisis followed the social and politic crisis of the Summer of 1830, threatening strongly the Company and the Seguin themselves. It was a typical credit crisis : cash held by firms was exhausted and traditional networks for cash credit and loans had failed. Individual investors and banks, indeed not very numerous and not very powerful during that time in France, were worried by pursuing of social events. Even discount for commercial paper was drastically reduced. During the fall of 1830, without capital and cash, the Company was forced to stop the workplaces along the two final sections.

Seguin's affairs were very complex at that time, featuring the high speed of money being transferred from one affair to another with numerous settlement dates. Such a financial circle was fueled by a network of credit by individual investors and wealthy friends. When it stopped suddenly, the future of Seguin's firms was seriously threatened. These affairs mainly surrounded the railway, as speculations highly managed by the familial strategist Camille Seguin. For him, numerous peripheral affairs within a limited number of financial partners outside the "inquisitorial" board of the Company but under strict family control, must afforded outstanding benefits for the brothers, more than the railway itself !

They bought by themselves lands surrounding the railway stations, in hope to get control of commercial activities near the line. Nevertheless, that attitude toward a private land-owning followed a clear giving up by the board of the Company, which refused at many times the Seguin proposal for that²³. Another field of the Seguin's affairs were some great commercial and industrial projects strongly linked with the railway involving contracts with local councils and companies within a limited number of wealthy local investors, sometime the councilors themselves ! The most important, and most famous, was the "Perrache project" (See Fig.2) which involved various preliminary aspects of space management for industry and trade. The Seguin's Perrache project was featured by a contract with the Lyon council for a flood control site close to the center of the city, a strategic place at the end of the tracks. Projects included a commercial station for the railway line, dredging of an inland port linking the rivers Saone and Rhône, embankment for public streets, and draining and reclamation for lands sold by the city to the Seguin's where they had to implement industries... Station and port surface reached close from 14 hectares and industrial lands close from 15 hectares. Like a puzzle game, the Perrache projects exactly completed the construction of the Railway : tracks inside peninsula and "La Mulatière" bridge. Otherwise, a similar project arose at Givors (See Fig.3), with an inland port beside the Rhône and industrial lands (around 20 hectares shared

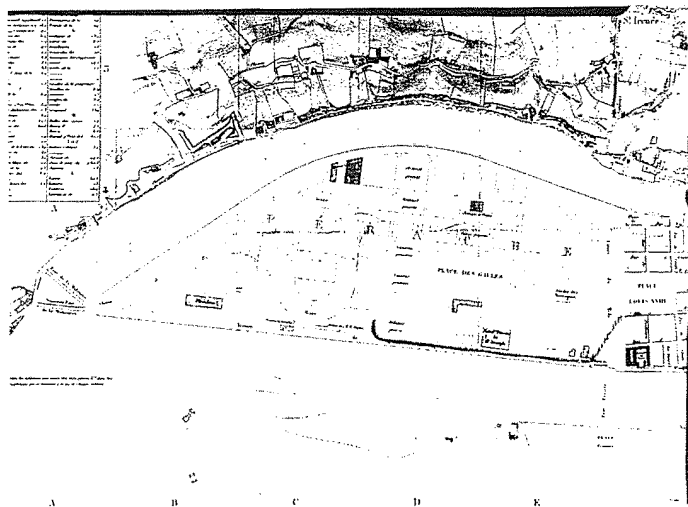


Fig. 2, Plan of the Perrache project around 1830 (D.A.A. 41J)

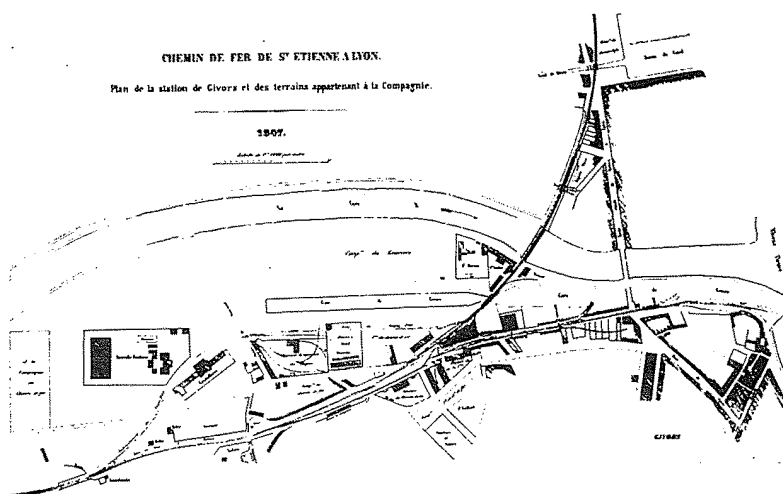


Fig. 3, Plan of the Givors railway station in 1847, with port and industrial zone (D.A.A. 41J)

with other landowners) and one other more commercial project at the Saint-Étienne terminus (about 5 hectares). Seguin's brothers also bought shares in coal mines, sometime secretly or by servant partners²⁴.

A suspicious atmosphere progressively arose inside the Company, fed by the Seguin speculations, but also by the struggle to get control of the construction accounts. Furthermore, it laid controversy upon the management for the direction of the Company after its full completion. That situation involved two main parties : the Seguin brothers as contractor and also as first manager of the partial opening, facing the majority of the powerful investors leading the board, i.e. Henri Boulard, Laurent Garcias. Nevertheless, the board was not unanimous, and a kind of "third party" arose with a critical point of view about the Seguin's private speculations but helping them with industrial and technical goals. The Seguin's party hoped in the designation of Marc as Director of the Company, with full financial control and management of the line, traction and maintenance, and commerce. The board control party wished to promote Mr. Baronnet as general Director ; he was the Parisian director of the Company accounts under the direct orders of the board.

As an outsider, Edouard Biot and his family clan intrigued, hoping to be the compromise solution²⁵.

The 1830-31 crisis really threatened the life of the Railway Company and the Seguin's affairs. This gave rise to attempts to develop remedial solutions which were evidenced on three occasions: That happened in three times.

- Firstly, the land question was solved, by a drastic proposal imposed by Marc Seguin to his family group in January 1831 : they offered to sell their fully land speculations to the Company, for their buying prices increased only by of implemented works. In July 1831, the board agreed on the land deal, soon confirmed by an exceptional shareholders meeting²⁶.

- Secondly, the financial crisis was overcome by a courageous decision of the board, ratified by meetings of shareholders on February, August and December 1831. The Company resorted to loans by public bonds with a 6% guaranteed interest with 2.2 million to complete the railway construction, raising 3 million after the land deal. The debt contracted by the Company to the Seguin brothers was converted to bonds. Work for completing the two final sections started again, reaching an high

pace during the Summer of 1831. The new capital of 14 million was fully completed in December 1832, and the line was completed in February 1833²⁷⁾.

Thirdly, the designation of the Director for the general opening, turned in favor of Marc Seguin, after many discussions and events. The board control party imposed a trying of direction of the partial opening by Baronnet during the Fall of 1831. That attempt was a clear setback, showing the skillfulness of the Seguin brothers not only for construction but also for management. A strong debate arose about the traction : by locomotives or by horses? The board control party supported horses, mainly for financial facts as we have seen. In 1832, however, the board changed progressively its opinion, influenced by the Seguin's economic arguments following goods line management outcomes. Edouard Biot looked like a pale personality compared to the exceptional character of Marc Seguin.

6 - Intensive use of the first years

The general opening of the line, from Perrache in Lyon to Saint-Étienne happened as two events : first for the lucrative passenger traffic on 20 December 1832 and second for heavy transport on 25 February 1833.

Quickly, demand of coal transport from Saint-Étienne to the Rhône Valley reached a tremendous level, overcoming the theoretical maximum of the line, 300 000 metric tons a year. It was the top that Seguin expected, leading to exceptional success on the one hand and to many difficulties on the other. The first fully exercising, showed good, regularly increasing, annual outcomes mainly as a result of the coal business. Fig.4 shows annual heavy goods transported by the early Saint-Étienne & Lyon from 1833 to 1837. The rolling stock of wagons started with more than 800, reaching 1100 by the end of 1833. Descending trains were powered only by gravity from Saint-Étienne to Givors. It involved around nine or ten loaded wagons, not more, carrying three metric tons of coal each. The descent was controlled by three or four men with manual brakes, as experimented on the second section during the partial opening.

Incomes by the coal descent were completed by passenger transport, with two regular trains each day going down, and two coming back up (See Fig.5 and Fig.6). For regularity and passenger comfort during not less than four kilometers of tunnel, horses were used for power, managed by located relays. Traditional road transport yielded in favor of the railway which had the advantage of the iron tracks during winter or rainy days in moderate mountain terrain. Purposes assigned by Seguin to such transport were very sound : not very speedy but with regular schedules and for the same rate as stagecoaches. Situation became quickly unequal !

Trying to get the advantage of the exceptional and time limited increasing of the official rate, from Givors to Saint-Étienne, Seguin slowly improved the commercial ascent of loaded wagons. Starting around 1500 tons each month in 1833, it reached more than 5000 tons during the early part of 1835. A contribution to the total income

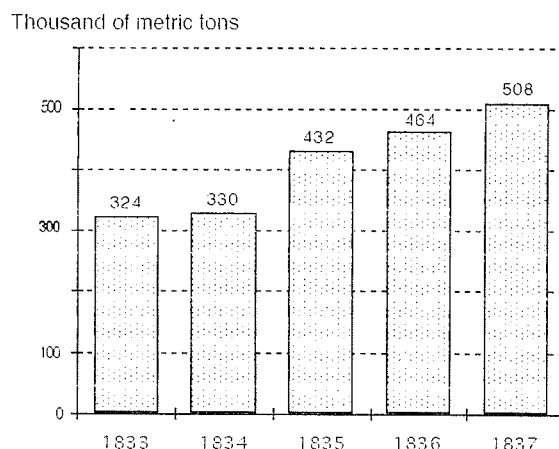


Fig. 4, Annual heavy goods transported by the early Saint-Étienne & Lyon²⁸⁾

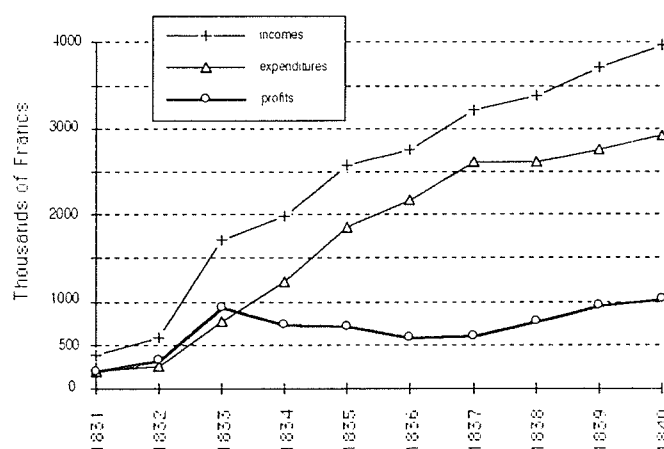


Fig.5, Incomes, expenditures and profits during the first ten years of the St-Étienne & Lyon Railway Co.²⁹⁾

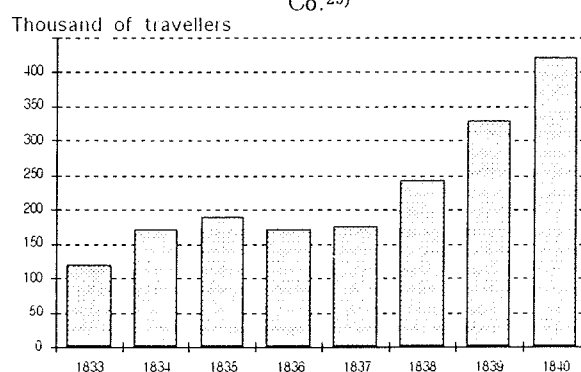


Fig.6, Passengers of the Saint-Étienne & Lyon³⁰⁾

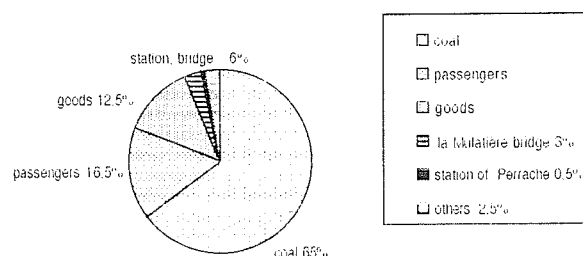


Fig.7, Incomes structure for the St-Étienne & Lyon, in the year 1836³¹⁾

became significant. Wagons carried construction materials (lime, sand, bricks...), industrial material (iron pigs, machines...), and manufactured goods (See Fig.7).

Such intensive heavy traffic at the earliest time of the public railways gave rise to an array of difficulties : technical, managerial, commercial, social, administrative, and even judicial !

Technical questions generated by such heavy traffic were numerous in light of the recent History of the Company. We have seen the serious consequences of the crisis of 1830-1831. One was the stop in locomotive construction, by lack of capital and by choice of an influential part of the board. When the general opening happened, there was only four locomotives, capable of only three or four ascents each from Givors to Rive-de-Gier. In 1834, Seguin estimated the locomotive minimal need to be not less than 30 units for the general traffic along the full line³². Mixed traction with numerous rented horses and locomotives were managed, focusing on the use of steam machines on the nearly horizontal section from Lyon to Givors. At the end of 1832, following the board evolution in favor of the Seguin's options, the workshop of Perrache again started locomotive construction and improved a little on the first set. However, performances of the Seguin's locomotives remained insufficient. Despite the tubular boiler and the four wheel drive, they were unable to power a train of 20 empty wagons up the 20 kilometers slope of 13.6 per 1000 from Rive-de-Gier to Saint-Étienne. On the other hand, reliability of the machines and skillfulness of the mechanics improved, but not enough to maintain the full range of machines in use. Serious breakdowns happened occasionally on the line which disrupted traffic. Workers had to lift machines out of the tracks by manual means. Moreover, breakdowns during the descent by gravity were not rare, indeed a dangerous method if the wagon brakes failed, if a brake-men was inattentive, or if a rail had moved out of line³³.

The intensive use of the line imposed a tremendous challenge to organize trains. Even if the line normally had a double track, it became a single track inside the three main tunnels (Terrenoire, Couzon and la Mulatière), thus producing some traffic "bottle necks". During Summer 1833, the station of Rive-de-Gier had to control the following daily traffic :

- ascent : 20 to 22 trains of empty wagons, 7 to 8 loaded, 2 passenger trains;
- going-down : 52 to 58 loaded trains, 2 passenger trains³⁴.

Another aspect of management was the difficult task of maintenance of the big embankments upon which rails had a tendency to move out of place. They moved also under the loads exerted by trains, mainly during the descent. To solve these difficult questions of mechanical breakdowns and tracks under repair, facing an intensive traffic, trains in one direction were grouped simultaneously on the two tracks. Dangerous descents were performed during the day and climbing during the night. Furthermore traffic moved seven days a week. Of course, traveler trains had permanent priority and, if

necessary, changed track to avoid to stop. Exclusive up line and down line was imposed by the Administration not before the end of 1838³⁵.

Importance of maintenance and repairs and the first need of change to a stronger rail, charged the financial accounts of the Company. Despite a regular increase of coal traffic and of total incomes for the line, profit decreased during the years 1834-37. A virulent campaign against passenger transport, emphasizing its dangers significantly reducing incomes. Interests of bonds also affected the profit of the Company, which once again resorted to new bonds during the years 1834 - 1835. The total amount of loans, about 4.7 million francs, increased financial charges significantly .

Transport demand by merchants and miners avid to buy and to sell the cheap, good coal of Saint-Étienne had been very important. Certainly, they did not pay attention to the technical and managerial difficulties of the Company. They were sure that Seguin must have a lot of empty wagons when and where they wanted. And if it was not possible, they were also sure that the Company had pernicious behavior with favorites, especially the allies of Seguin in coal mines affairs ! Indeed some very complicated complaints to the government arose under the accusation of monopoly, a major fault in French thinking at that time³⁶. With a secret pleasure, the Administration took such opportunity to ordered an official inquiry about the practices of the Seguin management of the railway³⁷, and to decree police acts to get control upon the private company and the new public transportation³⁸.

7 - Advanced aspects of the Saint-Étienne & Lyon Railway

High traffic on the Saint-Étienne & Lyon Railway arose among a lot of technical and managerial difficulties during the 1830s. However, that happened mainly because it was an outstanding and immediate success exceeding the expectations of the creators. The upper limit of cargo transport was immediately reached in the year of the general opening (1833). That surprised the Seguin's brothers despite their initial economic reflections about links between the cheap rate for coal transport and the industrial awakening. It was the first time when such an idea was put to use in France, a country where transportation remained expensive due to geographical difficulties inside a vast country and a large but diffuse pre-industrialization scattered among numerous regions. The Seguin's proposal for a concession rate of 9.8 centimes to move one metric one kilometer was very low and it impacted French economic history as a sign of the entrance of the "Industrial Revolution" following the British model. Furthermore, significant passenger traffic arose with the partial opening of the second section (1830) and was immediately developed by the Seguin brothers as a good income opportunity.

Maintenance of tracks and embankments was a difficult task, due to heavy transport and continuous

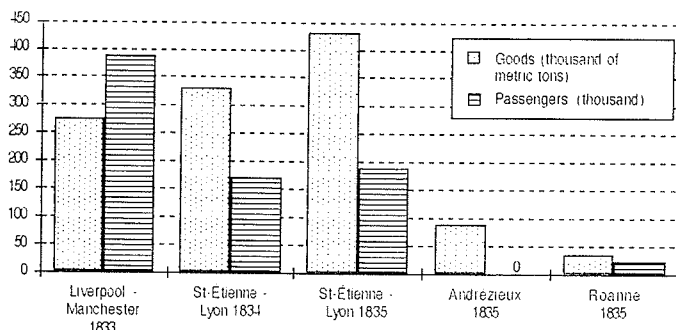


Fig. 8, Comparison of traffic between the St-Étienne & Lyon Co. and other contemporary lines³⁹⁾

train operation on the line, day and night, seven days a week. It was immediately obvious that full traction by steam locomotives was not possible, first by lack of locomotive engines, construction of which was stopped by the financial crisis of 1830-31 and the internal difficulties of the Company. Second, locomotives could not climb up under regular commercial usage along the hard 13.6‰ slope on the 20 kilometers from Rive-de-Gier to the Terrenoire tunnel. Third, long and narrow tunnels forbade the use of Seguin's pioneer locomotives for passenger traffic, because they produced a lot of black smoke and grit. A melting use of powers was the rule on the Saint-Étienne & Lyon Railway, with the use of gravity going down from Saint-Étienne to Rive-de-Gier and Givors and with the ascent return mainly by horses and with full locomotive traction on the Givors - Lyon section as early as 1834-35. Thus, costs of locomotive traction and maintenance quickly trended to decrease for the regular heavy transport and that eventually led the Company toward a fully steam locomotive traction policy.

Comparison with other contemporary railway lines of Fig.8 shows very clearly the high level of traffic immediately reached by the Saint-Étienne & Lyon Railway. Facing the other lines of the Loire network, there is no doubt that a deep gap arose in traffics. Ratio was 5/1 with the Andrézieux Co. (opening 1827) and 10/1 with the Roanne Co. (opening 1833). That justified the two economic ideas which underlay the Seguin's gamble on the line : first, the large decrease of the rate created an immediate heavy transport ; second, despite the exceptional geographical difficulties, the railway line toward the Rhône Valley was more profitable for coal trade and industrial development than the Loire Valley.

The only competition that was able to face the Saint-Étienne & Lyon traffic was in England, the mythic Liverpool & Manchester (opened in 1830). For cargo traffic, the French line was similar and even superior in loads than the famous British line with probably the worlds best performance for cargo tons moved each year from 1833 to 1848. Otherwise, and despite an exceptional and unique traffic for passengers in France during that time, its ratio was less than 1/2 for that. The Saint-Étienne & Lyon remained a specialized line for coal

transport, keeping the first generation touch of the opening up railways for coal fields : 65% of incomes from coal transport, 16.5% for passengers, and 12.5% for general goods (year 1836)⁴⁰⁾. Other important differences must be noticed with the Liverpool & Manchester. The British line was the first "modern line", with exclusive locomotive traction and a more varied incomes structure : 54% for passengers, 43 % for general goods, and only 3% for coal. Another aspect for comparison was in the income value itself, the ratio is more than 2/1 against the British line, because its rates of transport were more favorable for general goods and still more for passengers, indeed a very high price was paid by numerous wealthy travelers attracted by the new speedy transportation. Nevertheless, the financial ratio comparing incomes and capital became similar between the French and the British companies⁴¹⁾.

8 - Conclusions

The Saint-Étienne & Lyon Company showed us an exceptional case study in the birth of railway management with an array of technical and managerial challenges. Main advanced aspects are summarized as follows:

- 1) The cost of transport for merchandises was exceptionally low, less than 50%, in comparison with that of road transport or canal transport.
- 2) The Saint-Étienne & Lyon railway remained a specialized line for coal transport. And it exceeded the Liverpool & Manchester in the volume of goods transport.
- 3) Marc Seguin's industrial projects were strongly linked with the railway, such as Perrach project with a terminal station, an inland port connecting to the rivers Saone and Rhône, and an industrial area, and Givors project with an inland port beside the Rhône and an industrial area.

The Saint-Étienne & Lyon Company also showed the importance of early development in world railways, with some major lines and regional networks outside of England, in that case fully managed by French civil engineers. Undoubtedly, the technical center for railway and steam locomotive innovation remained inside the British Islands during the 1820s and 1830s, built upon the exceptional skillfulness in ironworks. Nevertheless, that was not exclusive. Diffusion of technology moved quickly from England toward Continental Europe and there were also reverse influences including major innovations. Some outstanding experiments in railway construction and management happened outside England during that time, such as with the Saint-Étienne & Lyon Company.

Acknowledgment

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Notes

- 1) M. Cotte & I. Kobayashi, "The first French Railways of Saint-Étienne (1823-1833)", *Historical Studies in Civil Engineering*, n° 16, J.S.C.E., 1996, p. 105-116.
- 2) I. Kobayashi & M. Cotte, "The locomotives of the Saint-Étienne & Lyon Railway...", *Historical Studies in Civil Engineering*, n° 17, J.S.C.E., 1997, p. 101-110.
- 3) The years before the French Revolution, under the king Louis XVI.
- 4) The first summit level canal, achieved for the supply of Paris in 1642.
- 5) Seguin frères et E. Biot, *Compte rendu aux actionnaires du chemin de fer de Saint-Étienne à Lyon*, 1826, p. 35-41.
- 6) D.A.A. 41J/76, letter of 10 January 1827; 41J/109-1, writings for the share-holders assembly of 1828; 41J 212-1, Richard Lioud report, 1828; 41J/55, "Mémoire en réponse aux attaques... par le Conseil d'administration de la Cie", 1836, p. 25.
- 7) After 1850, the Nord and Pas-de-Calais coal field became the first in France.
- 8) This French name means : the black earth.
- 9) The comeback of the Bourbons, with kings Louis XVIII (1815-1824) and Charles X (1824-1830).
- 10) Issued from the French School "École polytechnique".
- 11) See note 3.
- 12) Michel Cotte, *Innovation et transfert de technologies, le cas des entreprises de Marc Seguin*, Thesis, EHESS Paris, 1995, chapters 4 and 17.
- 13) A.N. F 9030 and 9031; *Bulletin d'Industrie... de l'arrondissement de Saint-Étienne*, 3-4, juillet août 1825, p. 180-187; Private archives, *Historique du chemin de fer de Saint-Étienne à Lyon*, 12 mai 1836, f° 6-7; [Marc Seguin] *Observations sur le projet d'établir une route en fer...* [April 1825].
- 14) "Préfet" or "sous-préfet" are the official representatives of the government inside each French department or district. Still today, department is the intermediate administrative territory, with a Chamber of elected representatives, between local council and government; example : Loire, Ardèche... District is a subdivision of the department; example "sous-prefecture" of Saint-Étienne (in 1825), of Tournon (still today)...
- 15) D.A.A., 41J 194, Seguin's correspondence of June and July 1830.
- 16) D.A.A., 41J 194, 195, from July to November 1830.
- 17) See note n° 15.
- 18) National Archives (France), F14 9031, "Mémoire sur la nécessité d'augmenter à la remonte... le tarif du chemin de fer de Saint-Étienne à Lyon", [novembre 1830], ms..
- 19) Ordonnance royale du 16 septembre 1831.
- 20) D.A.A., 41J 221, account of the first exercising.
- 21) D.A.A., 41J 55, "Rapport... présenté à l'assemblée générale du 20 décembre 1832".
- 22) D.A.A., 41J 200, meeting journals of the board; 41J 307, Transactions of the of shareholders meetings.
- 23) D.A.A., 41J 55 and 307, transactions of the shareholder meetings .
- 24) D.A.A., 41J 221, "Traité...", July 1831.
- 25) D.A.A., 41J 196, correspondence of 1831.
- 26) D.A.A., 41J 55, exceptional shareholder meeting of August 1831.
- 27) D.A.A., 41J 307, *mentioned*.
- 28) National Archives, F9030, demande file for a loan to the government, 5 February 1838, "Mémoire explicatif".
- 29) *Statuts de la compagnie du chemin de fer de Saint-Étienne à Lyon*, 1847, p. 109 et sq..
- 30) National Archives, F9031, "Récapitulation générale des recettes annuelles".
- 31) D.A.A., 41J 221, chart for a recapitulation of results, litho, 1847.
- 32) D.A.A., 41J 55, letter to "Messieurs les membres du Comité d'exploitation...", October 1834, litho. 12 p..
- 33) D.A.A., 41J 221, correspondence, for example letter of Vautro, 29 June 1833.
- 34) D.A.A., 41J 55, "Rapport de M. Seguin... 5 juillet 1833", p. 21-22.
- 35) National Archives, F14 9031, "Règlement de police" Décision of the Loire prefect, on 17 Decembre 1838.
- 36) National Archives, F14 9030, file "Plaintes d'exploitants", i.e. letter of Bréchnignac, 8 August 1833.
- 37) M. Smith, *Lois européennes et américaines sur les chemin de fer...*, St-Étienne 1837.
- 38) National Archives, F14 9031, File "Règlements de police".
- 39) *Annales des Ponts et Chaussées*, 1834, 1° semestre, cité; Annexe 25-A; M. Smith, *Lois Européennes et américaines sur les chemins de fer...*, 1837, "Tableau des mouvements des chemins de fer de la Loire"; *A.P.C.* cité, 1834, 1° semestre.
- 40) 6% of incomes came from other : bridge of La Mulatière, station of Perrache, financial yields.
- 41) For this railway comparison during early 1830s : Michel Cotte, *thesis mentioned*, p. 879-890.