International Genevan business in the long run: from the greats fairs to the second industrial revolution

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The aim of this paper is to determine specifics caracteristics of the Genevan international business activities in the long run. Geneva has two sucessives chances whih connect this city to the international level of economic. Firstly, the greats fairs insert the city in the expanding commerce of the end of the Middle Ages and secondly the huguenot refuge which attracts kwow-how, capitals, working forces and elites who control the commercial networks to buy primary ressources and to sell manufactured products in Geneva to larges markets. In this last context, emerge the first jewels of the crown, one in textile industry with printed calicoes and a second on in metallic work with clocks industry. But since the middle of the 18th century, these jewels are threathened by the lust of the neighbouring state-nations which need to generate new economic ressources in order to resolve their fiscal crisis provokated by the costly wars of colonies. From this threat emerges in the last quarter of the 18th century the first sept of an long industrial transition that will drive Geneva from the preindustrial jewels to the new jewels of the second industrial revolution, in particular in hydroelectricity. The aim of this paper is also to rehabilitate important steps as the thermical graft between the 1830's and 1870's years which was forgotten by a selective memory mostly attached to celebrate hydroelectrical and mechanical firms leaded by medium sized firms with 100 to 400 employees and with capital of one to three millions of francs until the end of the First World War. We will also show that this long road to the second industrial revolution is undebtful to technological borrows, not only from advanced countries but also to other Swiss homologues as Zurich. This long industrial transition is also made of chaos provocated by political conflicts and precipitation to connect local and national dynamic in using the huges water ressources to the international dynamic supporting the large applications of electricity in world markets.

Geneva as commercial metropole (1350-1450): intermittent international activities

Geneva is an international commercial place for the exchanges of merchandises between the north and the south poles of the European economy between 1350 and 1450. The two poles connect the richness of two seas, the Mediterranean and the North sea. Geneva valorises his location factors, as a point of convergences fort many routes and valley.[1] Geneva was since the 12th century a relay which bringed the market on the road of the first greats fairs of Champagne. The decline of these fairs, provokated by the War of the Hundred years between France and England which devasts the north-west of France and the opening of a rival road by sea, profits to Geneva, which cans rest on a solid money: the Ducat of Savoy. In term of business activity, we can insist on the Genevan succursal of bank of Medicis that generates more benefices than the mother firm in Florence. But this kind of international business is made of intermintent activities, four times per annum. The economic elites formed by Italian, German and Swiss merchants do not settle in Geneva.[2]

This step, howewer important it was, is not an insurance to push cities of greats fairs to an international business activities in the long run. Numerous are the exemples which clearly show an opposite destiny. Thus, the town of Champagnes decline and Baucaire, another place of great foires is today a very little city. The second chance of Geneva is to have played a central role during the religious shism, considered by many economic historians as a important key to understand the future domination of the World by north-west European countries.[3]

Geneva as a manufactured center (years 1560 to years 1780): the settlement of international business

The *Rome protestante* attracts Latein culture refugees, mostly from France and Italy. This staedy-stream brings known-how, working forces, capital and elites who settle in the town by integrating high positions in academy and in the magistrature.[4] Keeping links with their area of origin, they constitute an important huguenot commercial network used to import raw material and export products manufactured in Geneva. This *Economie de Refuge* implicates two principal sectors: the textile industry and the activities of the *Fabrique* (jewels and

[1] Fernand Braudel, *Civilisation matérielle, économie et capitalisme, t. 3: Le temps du monde*, Paris, 1979, p. 74-113.
[2] See Jean-François Bergier, *Genève et l'économie européenne de la Renaissance*, Geneva, 1963.
[3] See David Landes, *Richesse et pauvreté des nations*, Paris, 2000, p. 234-242.
[4] The basis is Anne Marie Piuz and Liliane Mottu Weber, *L'économie genevoise de la Réforme à la fin de l'Ancien Régime (XVIe-XVIIIe siècles)*, Geneva, 1990, p. 385-648.

clocks industries). French and Italian refugees bring to Geneva silk, passementrie and gildings. The basis is made of the activities of dyeing that the merchants ordered during the time of the greats faires. The gilding occupies until 2 000 artisans in Geneva. As the studies of Anne-Marie Piuz has shown us, a female entrepreneur called Elisabeth Baulacre plays the first role in this activity.[5] But a political error is at the origin of its decadence. The Genevan elites sustain the French crown during the dynastic War of Succession in Spain. So the German states, opposed to French realm, close their markets to the Genevan gilding and the sector collapse in the turn of the 16th and the 17th centuries. The *Economie de Refuge* benefits also to the *Fabrique* sectors. The greats fairs have also bring a basis. Genevan jewellers founded not only their first market in the courts of Geneva and of the Duché of Savoy but also with the passages of rich merchants. The huguenot network pushes Geneva in the first step of a new globalisation era between 1650 until 1720.[6] Moreover the independant republic takes benefits in the long run without the costs to pay, for Geneva does not directly participate to the colonial wars. Thus calicoes and clock industries are well implanted in the international and commercial networks. Cotton comes from India and clocks industry is well implanted in mediterranean and in Asia.[7] In Constentinople, a Genevan colony of watches makers, installed under the protection of the French crown, constitues a advanced place to asian markets in Ottoman empire and Persia. The father of Jean-Jacques Rousseau was there for several years. The pilosoph writes "je fus le triste fruit du retour de mon père" (I was the sad result of the come back of my father to Geneva). Since the American War of Independance, the Genevan clocks find also markets in the Ameriques.[8] From this business emerges the merchants-bankers. The Genevan finance is well implanted in France and it hardly should be astonished if the Genevan Jacques Necker reaches twice the position of general manager of finances of the kingdom during the 1780's and the 1790's.

The first step in the long industrial transition (1776-until the crisis of the continental blockade)

In Geneva, a first step was overcomed in international business in the last third of the 18th Century. In opposition with the last period, Geneva is not any more a culturel and economic center of gravity. The news beneficiairies are the capitals of the two powerfulest state-nations: London and Paris. Thus Geneva has to establish links with these two new centers of gravity, London for his industrial advance and Paris for his famous scientists in chemestry and in physic. Industrial links are made in the wake of financial and scientific networks. It constitutes a first step in the industrial transition that leads from the preindustrial activities to the explosion of innovations of the second industrial revolution in mechanical industries (hydroelectricity, motorcars).

The dynamic of the transition finds his basis in the threats which weigh on the preindustrial jewels of the crown. The beautiful behaviour of the Genevan printed calicoes and clock industries provoke the lust of the surroundings state-nations desirous to appropriate new finances in order to lead their costly and around the world colonial wars, as shown recently by an historian of the globalisation: Christopher Bayly.[9] Since the Seven years War from 1757 to 1763 which implicates England, France, Prussia, Russia and the Austrian empire, the French Kingdom is putting pressure on his boundaries, trying to generate new economic ressources. During the 1760's, the minister de Choiseul allied with the philosoph Voltaire, attempts to create a concurrent city at Versoix on banks of the lake Léman.[10] After having persecuted the printed calicoes manufacturer –revocation of the édit de Nantes in 1685- who were quite all huguenots from Languedoc and Vivarais, and consequently has created what we call the "Swiss monopoly", the French realm takes since 1759 a train of measurements to reinstall this prolific industry in his territory as supression of taxes on the entry of equipment in France. Later in 1785, the minister de Calonne prohibits the importation of Genevan printed calicoes. Moreover the Genevan government is paralysed by the idea that the French realm could impose taxes on the importation of clocks from Geneva. On his side, the emperor Joseph II is trying to attract Genevan cloak's makers in Constance.

According with what have be done in France and in England in the seventeenth century, the Genevan governement turns himself to his scientists and to his Academy. This context generates the Society of Arts, created in 1776 on the model of the londonian Society for the encouragment of Arts and Commerce.[11] The goal of this institution is to diversify the industrial sector. Among many activities oriented into the direction of innovation, new industrial experiments emerge during the 1780's. There is an attemp to copy the earthenware

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[5] Anne-Marie Piuz, «La fabrique de dorures d'Elisabeth Baulacre » dans Anne-Marie Piuz (éd.), *A Genève et autour de Genève aux XVIIe et XVIIIe siècles*, Lausanne, 1985, p. 166-183.

[6] Christopher Baily, *Naissance du monde moderne (1780-1914)*, Paris, 2007, p. 150.

[7] See Bouda Etemad, «Un horloger genevois à la Cour de Perse au XVIIe siècle» dans *Revue du Vieux Genève* (1985), p. 9-11 and Antony Babel, «L'horlogerie genevoise à Constantinople et dans le Levant du XVIe au XVIIe siècle» in *Etrennes genevoises*, (1927), p. 61-74.

[8] *Ibidem*, p. 67.

[9] Bayly, *op. cit.*, p. 155-162.

[10] Bénédict Frommel, *La Versoix, patrimoine hydraulique*, Geneva, 2005.

[11] See Jean-Daniel Candaux, René Sigrist «Saussure et la Société des arts» in René Sigrist (dir.), *H.-B. de Saussure (1740-1799). Un regard sur la terre*, Geneva, 2001, p. 431-451.

manufacture of Wedgwood in Geneva (1786-1796). Two of them are very cosmopolites. Ami Argand (1750-1803) wants to manufacture lamps of his invention in England for selling them on the continent, mostly in the French market. An artificial mineral water, which implicates the Genevan imigrant of a German State, Jakob Schweppe, and which have used the springboards of subsidiaries in London and in Paris in order to conquest national and colonial markets.

All this business encounters the turbulences generated by the Time of the revolutions, most particularly by the French Wars. Mineral water and the earthenware manufactures collapse in the 1790's. During these years, the manufacture of Argand was weak, but benefits from the annexation of Geneva to France between 1798 and 1813 in inserting the market's empires protected by the Continental blockade. Finally, the Argand manufacture do not cross forward the obstacle of the crisis of liquidation of the continental blockade.[12] The Genevan printed calicoes industry collapse in the 1830. Thus the industrial genevan texture is now monolithic which mean very dangerous.

The coals industry graft: the classical international transfer of technology from region to region

This step is important to relate because it plays an important role in the long industrial transition of Geneva. The selective memory has forgotten it, because it uses coal and not hydraulic resource and for the gas industry was considered as malthusian when electricity emerges and finally because it represents the old private companies in opposition with the new municipal services infrastructures.

This is a typical graft on the First industrial revolution with transfer of technology (coal equipment) from advanced region to a following region located in another country. For Geneva, the main clocks work are the parisian center of gravity, most particularly the Ecole centrale, and French coal of good quality imported from the mines of the Loire at Saint-Etienne by water way on the Rhone and by overland route per cart since the breaking bulk of Seyssel.

After the failures of the cosmopolites affairs, the novators activities of Geneva ared reoriented into the urban interests. By entering in the Swiss Confederation in 1815, Geneva is at this time the most important town, so it has to defend his prestige.[13] This town has nothing to await from its old elites, like the brothers Pictet, who were quite turned to French honors during the annexation of Geneva. It should consequently hardly be astonished if in fact other channels are initially put at contribution during the 1820's. There is a connexion between the cantonal engineer and polytechnician Guillaume-Henri Dufour (1787-1875) and the Seguin brothers by edifying the first european cable suspension bridge and wether this is an american diplomate, Edward Church (1779-1845), who introduces the steam boots on the lake of Geneva.[14] The orientation to the embellishment the city is given.

To enter in a process of systematic assimilation of foreign technology, creation of added value in local condition and valorisation into external markets in the manner of the manufactures installed by the hughenots during the 16th, 17th and the begining of 18th centuries, Geneva must await on the entrance of one of the firsts europeans pionniers in industrial sciences, the Genevan Daniel Colladon (1802-1893).[15] Born in a family of the first French Refuge (16th), he tries above all a scientific career in physic at Paris, but he has to turn to the industrial applications. He is assistant professor in physic at the Ecole centrale des arts et manufactures created at Paris in 1828.[16] He teachs rational and geometrical mechanics and his special course dedicated to steam powered machines is famous. He returns in 1835 to Geneva to teach theorical and practical mechanic at the Academy of Geneva and to establish as consulting engineer, mostly in favor of Genevan new bankers well inserted in the Haute banque protestante at Paris.[17] However, he fails to impose an important water adduction that would have

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[12] On these experiences, see John Wolfe, *Brandy, Ballons, & Lamps. Ami Argand (1750-1803)*, Southern Illinois University, 1999; Michael Schroeder, *The Argand Burner. Its origin and development in France and in England (1780-1800)*, Odense, 1969; Bénédict Frommel, «Ami Argand (1750-1803). De la science à l'industrie» dans *Histoire et archéologie d'un site industriel*, Geneva, 1999; our study «La trajectoire internationale d'un innovateur-entrepreneur au siècle des Lumières: Ami Argand (1845-1803)» dans Michel Cotte (dir.), *Circulations techniques*, (2004), p. 95-110; René Sigrist, Didier Grange, *La Faïencerie des Pâquis*, Geneva, 1995; Douglas A. Simmons, *Schweppes. The first 200 years*, London, 1983.

[13] On the particular relationships between Geneva and Switzerland, see Marian Stepczynski (dir.) *Genève et la Suisse. Un mariage d'amour et de raison*, Genève, 1992 and Irène Hermann,

[14] Tom Frank Peters, *Transitions in engieering: Guillaume-Henri Dufour dans the early 19th century cable suspension bridge*, Basel and Boston, 1987; Felix Rivet, *La navigation à vapeur sur la Saône et le Rhône /1783-1863)*, Paris, 1962, p. 64-67.

[15] Daniel Colladon, *Souvenirs et mémoire: autobiographie*, Geneva, 1893.

[16] On the history of this school, see John Hubel Weiss, *The making of technological man. The social origins of French engineering education*, Cambridge-Massachussets, 1982 and some new elements in Jean-Pierre Williot, *Jules Petiet (1813-1871). Un grand ingénieur du XIXe siècle*, Paris, 2007, p. 41-76.

[17] See Nicolas Stoskopf, *Banquiers et financiers parisiens*, Paris, 2002, p. 81-86, 118-120, 272-273.

been leaded by a private company. The problem was in the second half of the 1830's to install a new pumping station in replacement of the old one edificated in 1708 by the French architect Jean Abeille.[18] The Genevan restaured government prefers clearly to stay in a water adduction inserted in a traditional process. Water is not privatised and the government continues to address itself to French system builder.

However Colladon is succesful in manufactured gas lighting industry (1843) thanks to a political change in favor of progress that rely on an alliance between liberal-conservators and radicals. His families links, since his marriage in 1837, with Genevan bankers gives him the chance to get the market. The builder of the network is one of his old student at Centrale. The affair is very successful thanks to the continous growthing of the private market and thanks to the continuous ameliorations of the technology based on Colladon visits to gas networks in France and in Great Britain. The local experience is valorised in Swiss and international markets during the beautiful years of growth during the 1860's. The international markets are open as newer. The *First industrial nation* and his direct follower, the France of Napoléon III, impose liberalism and transports of informations, merchandises and persons are more rapid and cheaper thanks to the telegraphic and railways services.

A Genevan gas holding created in 1861 imposes itself on important cities markets in France (Cannes, Marseille) and in Italy (Bologna ans Napels). The Genevan takes partly model on the on the britannical gas holdings borned in the mid-1820 to get markets in continental cities. The Genevan holding is partly a investment trust, with participation in gas companies in Munich and in Zurich and partly a vertically integrated financial company to develop old positions acquired in the international market. After negociations with Italian and French municipalities, the Genevan holding build extanding networks as it is the case in Naples and in Cannes. Genevan ingeneers belonging to the holdind are implicated in the expansion and in the exploitation of these positions. There is a connexion between the dynamisation of the cities provoked by connection with railways. As it is the case in Geneva, the connexion with the railway open a new era of urban growthing. The successfully renegociation of the terms of the gas concession in 1856 with the municipality of Geneva, two years before the connection with the railways, is a local experience which is replicated with success into the international markets.[19]

Colladon is also a the origin of another coal graft in heating industry. As it is the case with the gas industry, Colladon gives the principal orientations. The first technician of this affair, Louis-Frederic Staib (1812-1866) represents the third generation of locksmiths whom family has emigrated from the german state of Wurtemberg. Staib follows the new educational machine created by the Society of arts: Ecole industrielle which gives since 1830 bases in mathematic, geometry, mechanic, physic and chemistry in the morning and in the evening between the the time dedicated to apprenticeship; library with special books on industries and special lectures given by Colladon and the chemist Antoine Morin on the caloric values of different combustibles. To be precise, Colladon is charged in 1838 by the Genevan governement to investigate heating system for several public buildings. His choice is on the favor of a Perkins system that was just introduced in Zurich. Staib begins to work on this system in order to create a performing heating under the condition that it has to be spared of a combustible that has to be imported from France. As it is the case with gas industry, the target is to be present on a double markets: public and private. Colladon furnishs the two first, one for his colateral in 1839 -Guillaume Ginsing, owner of a nice contryside- and the other one for the Grand Conseil (legislativ assembly of Geneva) in 1843.[20] Other public buildings will follow as schools, churches and hospitals. According to the gas industry, the local experience is valorised on external markets in the 1860's. To achieve this goal, from 1861, the firm begins to be linked with graduates of the Ecole centrale. Jules Weibel, then Emile Briquet (1867) and Jules Feasch (1869-1872) became associate. They put money in this affair, 50 000 francs for the two first and more with the third because Feasch belongs to a rich family and connected to other rich families as the de Senarclens and the Necker. So the financing of the internationl expansion is assured. In this process, the heating firm obtains important markets in the German speaking part of Switzerland, under the duty of the first associate Weibel, and in Paris in the wake of the universal exhibition of 1867, the Genevan create a manufactured subsidiary. After the bombing of the subsidiary during the French-Prussian war of 1870/71, the Genevan firm turns to the Germanic

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[18] Alf. Bétant, *Puits, fontaines et machines hydrauliques de l'ancienne Genève*, Geneva, 1941, p. 51-105.

[19] See our studies: p. 77-78. Serge Paquier, Olivier Perroux, «De la compagnie privée à l'entreprise municipale. L'exemple genevois (1844-1930)» in Serge Paquier, Jean-Pierre Williot (dir.), *L'industrie du gaz en Europe aux XIXe et XXe siècles. L'innovation entre marchés privés et collectivités publiques*, Bruxelles, Berne, Berlin, Francfort am Main, New York, Oxford, Vienna, 2005, p. 295-317 and our study «Swiss holding companies from the Mid-nineteenth Century to the Early 1930's: the Forerunners and Subsequent Waves of Creations" in *Financial history review*, vol. 8, part 2 (October 2001), p. 163-182.

[20] «Discours de M. Alphonse de Candolle, président de la Société des arts prononcé dans la séance générale de la Société et des trois classes, le 23 mai 1867» in *Bulletin de la Classe d'industrie et de commerce de la Société des arts*, Geneva, 88 (1867), p. 4-8.

empires, in South of Germany and in Austria. But the experience was not so interesting and the firm returns in the 1880's to the French market.

A very important step for the firm and for the industrial transition of Geneva, is the new orientation given to innovation. This movement begins in the thermical phase unless it will play the biggest role during the conversion of Genevan firm to hydromecanic as we will demonstrate it later. First we develop the innovation process during the thermical phase. It consists to connect the firm furnishing equipment to Swiss schools of engineers. The Ecole spéciale at Lausanne was founded in 1853 and the Ecole polytechnique fédérale de Zurich (EPFZ) in 1854. The Genevan heating firm has employed Paul Piccard, graduate of the EPFZ, to reinforce his presence in Paris at the end of the 1860's. But in 1869 he is elected professor of mechanic at the engineers school in Lausanne. In this position, he creates technology that could be produce by the Genevan heating firm soon installed in international markets. With the help of the associate Weibel, the firm installs salt and sugar distillation equipment. But this process of innovation is difficult because of the long distance. It is costly and wearying to applicate these new technologies in move back areas of the Austrian empire as Ebensee and Pohrlitz. Moreover, the industrial futur is linked not any more with thermical equipment that use coal that should be imported with bad consequences on the independancy of Switzerland, but with hydromecanical equipment that use national an abondant hydraulic resources.[21] But the first mechanism is loaded.

The creation of a national dynamic (1858-years 1880)

The integration of the Swiss cantons into a federal state-nation go a step further after the Civilian War in the autumn 1847 which opposes the sescesionists and conservator cantons bounded into the Sonderbund league against the liberal and radical cantons. After the victory of the latters, the creation in 1848 of the Swiss Confederation contributes to make fall the internal barriers. The internal taxes are abolished and national infrastructure services, telegraph and railways, are established. Moreover, it contributes to awake the consciences in the direction to share same the problems, not only risks provokated by the rising power of Prussia, but for the industrialists still and especially energy dependence of an industry which starts to consume imported coal. Consequently to link the average formed commun runs of the high schools of engineers created in the mid 1850's, the suppliers of equipment and the creators of networks to domesticate and extract the maximum of the rivers and the rivers which rely the various parts of the country. This constitutes a patriotic program which will take the form of technological loans from advanced city to anothe advanced city, mostly from Zurich to Geneva.

The spread of the railways in Switzerland, by bringing cheap coal of quality from mines located in France (Mines de la Loire à Saint-Etienne, Charbonnages du Nord) and in South Germany (Sarre, Ruhr) generate an new type of problems in Switzerland: the dependancy of external combustible. Before, Switzerland, except Geneva and perhaps Bâle, was using national wood, peat and coal which was located in many little veins not more profound than 30 to 50 centimers for particular reasons imposed by the Swiss geology. The formation of the Alps has crushed the veins. This context does not permit to use Swiss coal at large scale and the national producers that were looking to new markets linked to the first wawe of industrialisation, in particular with the spread of steam boats on Swiss lakes since the 1820's, become disillusioned.[22]

The problem is the rising price of the coal in the 1850's. In a unpublished note, dated from 1858, so just before the beginnings of the Swiss railways sounds the alarm.[23] Colladon estimates that the prices of coal is growthing up in all Europe. By using statistics dedicated to the Department of the Rhône (France), he shows that the price of the "black diamond" is two third higher than the middle basis constitued on the 1800-1850 years. The Genevan engineer indicates that it is now the time to use the huges reserves of cheap energy contained in the rivers. A new technological system has to be created, particularly new efficient and cheap secondar water motors. Moreover, the problem of low water should be also be resolved. In fact the service to create should be regular and not unregular a it is the case with the traditional process (mill, and using energy on site). This new vision constitutes an technical challenge. Colladon also indicates the best places to begin with this process: spaces located after the regulating passage of the rivers in important lakes. It means Geneva (Rhône), Schaffhouse (Rhin) and Zurich (Limmat).

According to other networks public industries, pionniers of technical services begin with a transposition of technology created in industrial firms to public areas. The Swiss creators begin with the couple hydraulic turbines and teledynamic cable used in the textile industry. Two teledynamics central stations are erected, the

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[21] On the base on letters of Jules Weibel to his family, Jules Weibel, Lettres à sa famille, 3 vol., ronéo, Geneva, 2003. A selection of these letters, Jules Weibel, *Portrait d'un industriel. Lettres à sa famille (1857-1886),* will be published in September 2007. We are grateful to his descendant Luc Weibel. We have completed this letters by researches in the notarial archives at the Archives d'Etat de Genève.

[22] Paul Louis Pelet et Daniel Marek «Charbon» dans *Dictionnaire historique de la Suisse*, version électronique du 11.2.2005, www.dhs.ch.

[23] Bibliothèque de Genève, salle des manuscrits, Ms 3758: Notes et considérations générales sur l'utilisation de la puissance motrice des rivières et des fleuves, Geneva, 1858.

first one in Schaffhausen between 1863 and 1866 (600 hundred hp) and the second one in Fribourg at the end of the 1860's.[24] System builders go further with more evoluted fluids systems: compressed air and pressure water in Zurich and Geneva as we will show it.

Geneva begin to stay beyond this wave of creation because unlike the north east of Switzerland which is implicated since the 1800's in the mechanisation of cottons-spinning, the dispersed clock industry does not need mechanical energy. Edouard Lullin, one of these Genevan enginners graduated from parisian engineers schools –the Ecole des ponts et chaussées- and member of patrician families, fails to furnish a water wheel destined to the extension of the capacity of the pumped storage power station. According to dynamic of Geneva in the long run, the town will recover by borrowing.

In fact during the 1860's, the most relevant progress in distribution of driving forces is made in Zurich by an engineer belonging to the patricians families of the town, enriched in textile, but oriented by certain of his members to left political parties. So in opposition with the Genevan case, this engineer can gather together and go further with building a modern Zurich with network industries. Graduate of a Berlin academy, Arnold Bürkli (1833-1894) is municipal engineer of Zurich since 1860. According to his biographer, he passess on the town from the Middle Ages to Modernity.[25] He built new aera dedicated to finance and railways and solves the cloaks. This is in this last context that he is confronted to water adduction. The distribution of driving force should be linked with the new high pressure system. English and French applications of high pressured system to material handlings in ports and railways stations give an orientation. In Liverpool, driving force and water adduction is combined in a same high pressure system. But Switzerland has to create a secondar motor that could be used by urban craftsmen.

Zurich borrows technic from the railways industry, most particularly the steam motor. An engineer of Zurich, Albert Schmid (1847-1915) EPFZ graduate, creates in 1869 in a municipal competition a piston engine to connect on the municipal high water pressure system. Schmid is in possession of the two basis requiered in this kind of technical creation, one with his early stage in the hydromechanical firm established in Zurich, Escher, Wyss & Cie, and second a complete experience acquired in the railways industry. He performs another stage at Sulzer, a reputated firm which produces steam engines and based on the industrial town of Winterthur close Zurich and joins the Schweizerische Nordostbahn where he is dealing with construction of locomotives. He drives locomotives in England, Russland and in Austria. It is important to stress that the creation of the piston water engine implicates the ateliers of the Ecole polytechnique fédérale de Zurich.[26]

After the war of 1870/71 between France and Prussia, the cost of imported coal is growthing up. The price of the imported Sarre coal is in the first of December 1873 230% higher than the price in the first of May 1869. In consequence Switzerland fears for the independance of his industry.[27] These are new factors that incitate to use the national water ressources and Geneva from this point of view is very late. Statistics established to present the water power in Switzerland for the exhibition of Philadephia in 1875 show that the canton of Geneva is located in penultimate position with only 500 hp.[28]

The importation of the zurcher model is graduate. Theodore Turrettini (1845-1916), belongs to the new generation of graduates engineers in the Swiss school of Lausanne or Zurich and he is a member of a well know patrician family originated from the first Italian refuge (16th century). He is looking since 1870 to developp the machine sector of a firm, the Société genevoise d'instruments de physique, oriented since 1856 by rich local scientist to the unbenefit manufacture of physical instruments.[29] This new generation of engineers is more oriented to the national interest and the edification of a new technical system which could use the huges and cheap water ressources, than the Centraliens as Colladon, Briquet and Weibel who are turned to industries that use coal. Turrettini begins to manufacture the Schmid motor under license which are to be connected to the municipal high pressure water sytem. After this technical transplant, this is the managing model which it is grafted from Zurich to Geneva: the municipalisation. For the municipal engineer Arnold Bürkli, the municipalisation of the water was so evident that it is no question neither to disscussed it or to defend it.[30]

Between 1878 and 1882, a war is engaged for the battle of the Forces motrices du Rhône.[31] The goal is to obtain a hundred years monopoly for the using of the Rhône. The struggle is technical, political and

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[24] See our study, *Histoire de l'électricité en Suisse. La dynamique d'un petit pays européen (1875-1939)*, vol. 1, Geneva, 1998, p. 303-331.

[25] Walter Baumann, *Arnold Bürkli, Aufbruch in eine neue Zeit*, Meilen, 1994.

[26] «Albert Schmid » in *Schweizerische Bauzeitung*, 65 (1915), p. 42-43.

[27] «Der Kohlenmarkt in 1875» in *Die Eisenbahn/Le chemin de fer*, 5 (1876), p. 55-56 et 62.

[28] W. Weissenbach, "Die Wassormotoren der Schweiz. Für die international Ausstellung in Philadelphia" in *Die Eisenbah/Le chemin de fer*, 4 (1876), p. 8-11.

[29] See the economic results in *Au cours de 80 années (1862-1942)*, Geneva, 1942, p. 82.

[30] As he wrote it in one of his articles dedicated to water adduction, Arnold Bürkli, «Wasserversorgung der Stadt Zürich» in *Polytechnische Zeitschrift*, 14 (1869), p. 121-123.

[31] Paquier, *Histoire de l'électricité op.cit.*, 1, p. 376-382.

managerial. On one side, the radical sustain a teledynamic solution and in the other side, the liberal-conservators purpose the high pressure water system. To win, the liberal-conservators go further with the municipalisation and the radical a private company. By arguing that the national ressource should be in the hands of foreigner financiers, the municipalisation wins. The project is a model of integration of local dynamic in the creation of services infrastructure and national dynamic. The zürcher manufacturer of hydraulic turbines Escher, Wyss & Cie linked to the capacities of the Genevan liberal-conservators to create technical services are essential pieces of the high pressured water network. Following the direction given by Colladon in 1858, the Genevan heating firm is turning to the creation of a new seconder motor. Two associates, Jules Faesch in the firm since 1872 and the ex-professor Paul Piccard who quits his academic position at Lausanne to return to the Genevan firm to create in 1886 a performing reception hydromecanic motor, the Faesch-Piccard turbine, to be connected on the new high pressured water system (Coulouvrenière).

This is an integration of local dynamic which benefits of the *cross fertilisation* process combined with a national dynamic made of independance energy policies. The latter implicates engineers schools, furnisher of equipment and creators of networks and national transfer of technology and a new style of managment. What it is very interesting in term of sustained technical and economic development, is that the step of high pressure water does not implicate a suboptimal choice that has could be driven for a long time. In fact the elaborated high water pressure system is considered in the leading towns of Switzerland as Geneva and Zurich as stepping stone to pass on a new and powerful technology. It is not only question of of a bigger energical potential with larger application to traction, lighting and electrochimestry, but also to benefit of valorisation in international markets. The point is now to understand how the national dynamic made of high pressure water has been linked with the international dynamic in electrical energy.

In fact, electricity begins to be connected with the new electrical energy on national basis in the Zurcher milieu of engineers during the mid-1870's. As it is the case for the creation of the water engine by Schmid, another engineer graduated of EPFZ, Emil Bürgin (1848-1933) borned in Basel,[32] benefites also of the double basis made of stages in hydromechanical firms, -Socin & Wick in Basel- and in the construction of steamed locomotives. His international experience is stronger than these of Schmid. Bürgin was thus in a parisian factory of locomotives (Claparède in Saint-Denis), follows the courses given in the evening at the Conservatoire national des arts et métiers and fonctionned as a machinist on steam boats from the Compagnie générale transatlantique joining New York. When he comes back to Switzerland, he has the chance, according to him, to be directed in the construction of locomotivs by Charles Brown sr at the Schweizerische Lokomotiv-und Maschinen Fabrik (SLM).

This is by adapting the railway system to the strong slopes at the Uetliberg, close to Zurich, which pushes him to electricity, which was called at this moment electromagnetism. This solution provokes good results in obtaining more adherence.[33] But as it was not possible to generate enough energy, he has to investigate the dynamoes. Begining with the dynamo Gramme, the only one which is inserted into a industrial process –they replace batteries used for electrochimic production of silvering and gilding at Christofle factory in Paris-, Bürgin brings any modifications and creates his own dynamo.[34] All this with the help given by the municipal engineer Bürkli and the creator of water engine Schmid. The latter lets to him use its manufacture of motor engines and the first purposes him a room connected with water under pressure. But the zurcher dynamic is coming to an end because of the precoce illness and death of Bürkli between 1891 and 1894. This is the Genevan place which will take the relay for important advances in hydroelectricity.

The Société genevoise d'instruments de physique (SIP), seems to be the best place to manufacture the Bürgin dynamoes. As said before, Turrettini is looking for new products to develop his machine sector and he was initiated to electrical generators, when he accomplished a stage at Siemens in Berlin. So the Genevan dispose of a good basis to go further and the transport of electricity is seen as the national level to be very important, but everything is still to make. Moreover, Bürgin opens the door of the United States for Geneva. Unlike the official version given in the Genevan sources, Bürgin is not a simple technician in the SIP as foreman, but he is engineer at the society des brevets Raoul Pictet, which has bring to the SIP the goose that lays the golden eggs with machines which produce cold. He joins twice the United States for the account of Raoul Pictet & Cie, once in 1876 to present the cold machines at the exhibition of Philadelphia and twice in 1877 for installing a ice machine in New York, a plant which was ligthed by Bürgin dynamoes.

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[32] «Emil Bürgin» in *Schweizerische Bauzeitung*, 102 (1933), p. 191-192.

[33] See "Vermehrung der Adhäsion der Locomotivetriebräder durch Anwendung des Electromagnetismus" in *Die Eisenbahn/Le chemin de fer*, 11 et 13 (1874).

[34] C. Hirzel-Gysi, "Electrodynamische Maschine von ingenieur Emil Bürgin" in *Die Eisenbahn/Le chemin de fer*, 5 (1876), p. 57-58.

The connection between national and international dynamics (1880-1914)

In two years, in 1881 and 1882, electricity becomes a technology which is displayed in the international ladder, in the same way of the blossoming of technologies of the first industrialisation in world fairs during the 1850s until the 1870's. The exhibition of Paris in 1881 which sees the Edison's lighting system triumphing with a lot of advertising,[35] gives kickoff in a quick progress in electrical illumination of urban spaces. The second, in Munich (1882), opens perspectives for the transport of electricity. The French Marcel Deprez (1843-1918), professor at the national Conservatory of arts try to transport electricity on a long distance: 57 kilometers. Even wether this essay ends in a failure,[36] it represents an opportunity in a strategic domain for Switzerland. The kickoff given by Edison makes possible to create special firms in the new field of electricity by generating enough cash and the Munich exhibition offers new perspectives of development.

In Geneva, where the electrical sector is precoce thanks to the fabrication of Bürgin dynamoes, there are important changes. The engineer Bürgin and the SIP apprentice René Thury (1860-1938) move to special electromecanical firms. Bürgin returns to his native Basel where he creates in 1881 his own firm. He is soon joined by a industrial of textile, Robert Alioth, graduated of the engineers school of Lausanne. The two Basler cooperate with firms in London, where Edison has presented in 1882 his system of lighting. Bürgin has prepared the field by manufacturing his dynamo in the firm of Robert Crompton. The aim was to impose to english and and their colonies markets. But the firm encounters difficulties to generate enough cash for the two owners. The multiple interests of a independant innovator as Bürgin contributes also to his decision to let Alioth alone managing the basler electromecanical firm. Bürgin asks only 20 percent of the benefices that will be generated by the firm. And go further with other innovations as ice manufacture and hydromecanic in Basel.

René Thury who has carried on a stage of six months in the Edison's laboratory in Menlo Park, close to New York, during the winter 1880/1881, so just before the commercial opening of Edison at the parisian exhibition, can not afford to create his own firm. He is indedd the eleven son of a professor of botanic at the Academy of Geneva (Marc Thury). The father, issued from the middle class of the canton of Vaud, do not possess a fortune and he is not graduate of a ingineer's school. The best he can do is to join a little Genevan firm activ in low currents as buzzer for hotel, belonging to Vaudois (de Meuron & Cuénod). In this position, Thury develops considerably the firm based on his knowledges acquired in the Edisons laboratory. The firm is soon well implanted in many markets, in Switzerland and in Latein countries, mostly France, Italy and Spain. Further more, Thury orients the firm to new segments of market with huge potentiel of development like the traction on strong slopes linked withe the growthing tourism industry. The Genevan firm participates also to the opening of a new market, by furnishing powerful generators to erect in 1889/90 the first european electrochemical plant at Vallorbe (canton of Vaud). This is the result of a international cooperation between French and Swiss engineers.[37]

The commercial opening of Edison in Paris has also an important impact in firms located in the industrial towns located in the region of Zurich. The applications of the new energy offer opportunities to diversifiy, because their principal products were slowing by the Great Depression. SLM and Maschinen Fabrik Oerlikon enter in these news markets in acquiring licenced from French and Belgian firms. The Brown dynasty is playing an important role in this process.[38]

The connection between national and international dynamics will know his higher moment in the new commercial opening provokates in 1891 at the exhibition of Francfort and at this time the Swiss will directly participate to it. This is clearly one of the biggest international technical success for the Swiss industry. It is the result of a connection between national and international dynamics. As noticed before, since 1875 many hopes sustain the electromecanical solution to use the national hydraulic forces. The departure is modest and the efforts are put on two directions. One is to use the jump of exhibitions for which Swiss firms erects provisotory infrastructure. The first national exhibition of Zurich in 1883 implicates scientifics, as the professor of physic at the polytechnical engineers school of Zurich, Heinrich-Friederich Weber who for the anecdot teachs to Albert Einstein. But nothing was spectacular. Second is the realisation of permanent transport dedicated to customer.

The Genevan firm realises the first transport of this kind in Bienne where 30 cv are transported on 1 200 meters.[39] The Maschinen Fabrik Oerlikon under the direction of the young Charles Eugen Lancelot Brown

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[35] See Robert Fox, «Thomas Edison's Campaign: Incadescent Lighting and the Hidden face of Technology Transfer» dans *Annals of Science*, 53 (1996), p. 157-193.

[36] Thomas Parke Hughes, *Networks of Power. Electrification in Western Society (1880-1930)*, London and Baltimore, 1983, p. 335.

[37] See Association amicale des anciens élèves de l'Electro-chimie (ed.), *Mémorial de la Société d'électro-chimie (1889-1966)*, Lyon, 1991.

[38] See our study, "L'industrie suisse des machines pendant la Grande dépression de la fin du XIXe siècle" in Pierre Lanthier, Hubert Watelet (ed.), *Private Enterprise during Economic Crisis. Tactics and Strategies*, , New York, Ottawa, Toronto, 1997, p. 67-83.

[39] *Schweizerische Bauzeitung*, 3 (1884), p. 84.

realises the transport of 20 to 30 cv between Soleure and Kriegstetten on 8 kilometers with an important output of 75%.[40] The strengh of the young Charles Brown is to be mobile in his applicated researches. After his success of Soleure with direct current, he decided to investigate the alternating current which will be successful in the long term. The Brown researches and his presence at Soho where important path was made in high voltage system gives enough confiance to the organisator of the exhibition of Francfort, the Bavarian Oskar von Miller. During this exhibition at Francfort, a power of a hundred CV is transferred on 177 kilometers with an average tension of 8 000 Volts. The average output of 70% pushes away the other technical systems (pressured water, compressed air and cables).[41] Geneva is far behind.

Hunting market strategies: the chaos of the Compagnie de l'industrie électrique

As it is the case after the commercial opening of Edison, the technical opening of Francfort changes deal in Geneva.[42] The firm of Thury which at this period show a big potential of growth is acquired in 1891 by the Genevan Edison company (Société d'appareillage électrique) which was formed in 1883 to install and exploits the first electrical lighting network of Geneva. But again political conflicts play an important role. Turrettini for fear the radical ennemy reproaches him that the Edison company of which he is the president orders equipment to the SIP of which he is the director, lets the door open to others. Consequently, a banker linked with the radical party, John d' Everstag, infiltrates the Genevan Edison company.

Arrived at the top of the new firm Compagnie de l'industrie électrique with 300 to 400 and employees and a capital of 2 millions of francs, d'Everstag applicates the hunting market strategy, on the basis of the principle which the place is with the come first. The firm establishes manufacturing subsidiaries between 1891 and 1893. The italian choice on Genoa (Gênes) depends on an important infrastructure of ligthing and driven forces installed by Thury at the end of the 1880s years. In Paris, the establishing of a subsidiary at Ivry is the consequence of an important command. But the general failure of this firm causes soon the end of the subsidiairies. Technical choice and failure in the managment causes this desaster. Firstly, Thury chooses the direct current, and secondly, he wants to create everything himself and valorised it with licenses. As the markets want alternating current equipment, Thury creates it, estimating that for the little and middle distance, this was an acceptable solution, but was always seeing a "future" position of monopoly in the long distance.

But Thury fails with alternating system in the mid 1890's and it creates new turbulences in the Genevan firm. As a result, the firm is close to the collapse in 1899. A new team is installed, directors were fired, but the president d'Everstag and Thury stay in the firm. The new strategy was organised in order to use the installation for manufacturing cars. The cash that will be generated will be used to pay the passiv and to wait until demonstration should be made that the direct current system will win. But the technical choice of the municipality of Zurich (1908) in favor of the alernative system for transporting his current from the alpin plant localised in Albula (canton of Grisons) puts an end to the Genevan hopes. The Genevan firm is surviving until the new opportunity given by the fabrication of ammution during the First World War. But the solution is coming from the the federal scale. The Chemins de fer fédéraux, which folowing the energectic crisis of the First World War decides to introduce the electrical traction, offers a solution in the long run. The idea was to save the Genevan factory in order to avoid a collusion of the two leaders of the industrial area of Zurich, Ateliers de construction Oerlikon and Brown, Boveri & Cie, that could impose excessives prices for their equipment. The history of this firm, based on arhivs, demonstrates that the enter of Geneva into the mechanical industry was difficult. As we have seen it, technical, management and strategies were not adapted. It is truth that political conflict in Geneva has played an important role in these successives collapses. We know that d'Everstag has hurted the libéral-conservators milieu by purposing to purchase the jewel of the Crown made of the genevan gas empire: Cannes. The fundamental question is: is it possible to succeed in high technological business without the liberal conservator milieu? It seems to be difficult at this time.

The success of a international niche: Gardy

The success of a another electrical firm argue in favor of the power of the liberal-conservator milieu. The founders of Gardy, are two Genevan engineers who were only graduated from secondary lewel (Technikum with two years of study for 14 years old stundents and not Polytechnic with three years of cours at academic level). Their learn the practical field under the patronage of Theodore Turrettini, like in 1873 at the Vienna universal exhibition. One, Auguste Gardy, is a son of a Genevan graduated in Centrale and the other one, Emile Sechehaye, is a son of a Genevan mechanist. The two fathers failed to diversify the Genevan industry with

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[40] *Schweizerische Bauzeitung*, 8 (1886), p. 156-158; 9 (1887), p. 27; 10 (1887), p. 47-48. William Cawthorne Unwin, *On the development and transmission of power from central station*, London, 1894. 264.

[41] *Offizieler Bericht über die International Elektrotechnische Ausstellung in Frankfurt am Main 1891. Band II: Arbeiten der Prüfung-Kommission in deren Auftrag*, Francfort-sur-le-Main, 1894, p. 361.

[42] The basis is formed by our study on archives of the firm in the Municipal Archives of Geneva. We are grateful at his directors Micheline Tripet and Didier Granges. See Paquier, *Histoire de l'électricité op.cit.*, II, p. 606-633.

innovatives activities during the nices years of growth 1850-1860's. The two sons, begin to investigate electrical generators. But surely according to the good councils of of Turrettini, who is conscious was of the potential of berliner manufactures as Siemens, the two founders choose to settle in the niche of apparatus isolated in earthenware.

The firm firstly (1891) establishes at La Plaine, a preindustrial aera dotated with hydromechanical force which was dynamised by the edification on the railways line from Geneva to Lyon. It was easy to recrute workers coming from the boundaries from French and Genevan villages. Facing an important growth, the firm moves to the new periphery of Geneva, in Jonction where the river Arve throws itself in the Rhône. In opposition with the generalist Compagnie de l'industrie électrique, the firm is successful in prestigious markets, like this of the Parisian Metro. As a result the firm establishes numerous subsidiaries in France, Belgium, Spain and even in Latein America before the First World War.[43]

The manufacture of hydraulic turbines: a middle success

Another trajectory of industrial firm, the manufacture of hydraulic turbines Piccard, Pictet & Cie, is going in the sense of the myth of succes history jewel of Crown. As written upper, this firm is supported by the liberal-conservator milieu. We have mentioned the transition from fluids in conduits into mechanical industry was the result of borrowing technology from Zurich and the implication of the professor of mechanic Paul Piccard. This is a result of movement engaged from receptor hydromecanic motors to prime movers turbines. The success in the hydraulic turbines is determined by the transplantation of the servo-moteur used for the Faesch-Piccard receptor motor which give a regular movement to the prime motor in fact the hydraulic turbines which need an absolute regular movement to move the electrical generators. Unfortunately, the archives of this firm were destroyed when the foreholder Ateliers des Charmilles was acquiered in 1980 by the firm Galley. So it is difficult to get out of a succes story. We do not know how this firm has managed to enter in the turbine prime motor water business, with acquisisition of licenses (Kaplan, Francis, Pelton) or by internal creations? We do not know also about the economics results. We can suppose that the early death of the associate Jules Faesch in 1895 pushes the firm in trouble for financing his expansion in national and international markets. The solution is founded with the entrance of a new associate well placed in the liberal conservator families: Lucien Pictet. He is the son of the well known Genevan banker Ernest Pictet and brings money into the firm. The studies on our collegue Anne Dalmasso from the university of Grenoble show also that the success was not always present, more precisely in matter of expansion into the French market. The Genevan firm begin to create a subsidiary in Grenoble, but this aim fails.

But the presence of the liberal-conservator into this firm which encouters success does not mean tot have concluded an insurance againts the industrial risks and false strategies. If we know little about this firm from 1896 until the end of the First World War, a file in the Cantonal archives[44] demonstrates the reasons of his collapse during the economic crisis provoked by the reconversion of the war economy to the peaceful times in the early 1920's. During the First World War, Genevan industries have produced ammunitions, mostly for France. As far as I am informed, the associate Lucien Pictet had good relations with the French minister of armenent Albert Thomas. We suggest that these priviligied links places the Genevan industrial firms in a dynamic and profitable market. Thanks to this files, we know that Piccard, Pictet & Cie was trying to agglomerate the principal industrial factories in the French speaking part of Switzerland. The aim was to create a pool that could compete with the Swiss german industry that was bigger partly because it began sooner –since the 1800's years with the mechanisation of the spinning factories- in the mechanical machineries Piccard, Pictet & Cie begins during the War to buy important shares in the capital of industrials firms like Compagnie de l'industrie électrique, Motosacoche, Gardy, Societé genevoise d'instruments de physique, Ateliers de constructions mécaniques Vevey and so on. When the rates begin to sink during the 1920's years of crisis, Piccard, Pictet & Cie could not go further without a financial collapse. Lucien Pictet seems to have also favored relationships with the federal administration in Bern which can explain why the genevan firm did not pay taxes on the production of ammunition during the war, but has suddenly to pay enourmous taxes. An least but not last, the cars sector is weakened by a bad technical choice. Thus, the old associate Paul Piccard can say that he was against the diversification in the manufacturing of cars vehicles. So appears the bad image of a Lucien Pictet play boy who failed in his studies at the Federal polytechnical school of Zurich and show off in the cars manufactured in his firm. He has to quit Geneva and flew to France. So being in the conservator-liberal milieu does not mean to avoid financial collapse.

On his side, Théodore Turrettini limits himself to make manufacture at his SIP electric meters while being distinguished in building between 1893 and 1896 the first european low pressure hydroelectrical and polyphased plant. For this, he concentrates the three dynamics interpenetrated during the 1890's on the Genevan space: local with crossfertilisation, national with large use of water and international by applicating the electrical

[43] From the *Annual reports* in Bibliothèque de Genève.
[44] Archives d'Etat de Genève, file faillite Piccard, Pictet & Cie.

energy. He valorises this experience in a holding created in Geneva (1898, Franco-suisse pour l'industrie électrique). In this way, he does not only prolong the activity of Colladon by adapting his coal user networks at the new era of the hydroelectricity, but still and espacially prolongs the industrial activities of the refuges elites by bringing new know how from the exterior, by adding value in local condition and by valorising it into Swiss and international markets. On these basis we can see long run caracteristics in the international business of Geneva.