French Education in Science

and the Puzzle of Retardation, 1790-1840

Margaret C. Jacob
University of California
mjacob@history.ucla.edu

Resumo
Esse ensaio traça os altos e baixos da educação científica francesa de 1780 até 1840. Começa com a descoberta de que no departamento do norte, matemática e ciência foram descartadas do currículo universitário após 1815. A educação passou a ser papel da História cultural. No caso francês, temos outro exemplo de um fator cultural exercendo papel no desenvolvimento industrial e sua contribuição pra sua desaceleração. A chave para a compreensão desta um tanto bizarra reação ao saber científico está no fato da contrapartida católica frente à revolução francesa.
.

Palavras-chaves: *França; Restauração. Ciência*

Abstract
The essay traces the ups and downs of French scientific education from the 1780s to 1840. It began with the discovery that in the Department of the North mathematics and science dropped out of the curriculum of the colleges after 1815. Education belongs to cultural history and in the French case we have another example of a cultural factor playing into industrial development, and contributing to retardation. The key for understanding this rather bizarre reaction to scientific learning lies in the Catholic reaction to the French Revolution

Key words: *France; Restoration; Science*

Retardation is a mean word. Recently it has become impolite to apply it to people with disabilities or learning disorders, whatever their source. Perhaps national economies should also be exempt from such seemingly harsh judgment. Surely retardation in productivity can only be understood in relation to someone else's advance, and, of course, what we label as "retarded" may have seemed quite normal to contemporaries. How dare we arrogantly tumble into the past and pronounce a-historical judgment? Not least using the term conjures up the developed vs. the underdeveloped, and hence the chest-thumping of the West. Such is not the intention. For reasons of capital development and agricultural productivity, the area bounded by Great Britain, the Low Countries and France seemed, then and now, as the region in Europe most likely to advance economically and break out of the Malthusian trap. France did not, but only by comparison to England and Belgium. Economic historians who ignore culture have quantified the retardation onto its Procrustean bed; it is time for a new approach.

We dare to say "retarded" in relation to France in the first half of the nineteenth century precisely because the French living in the period were capable of making similar observations, even if they shied away from using the word when describing their anxieties about "our rival," England. It had become a mirror, and in it could be reflected French deficiencies. (NORMAND; MOLÉON, 1824, 47)[1] French observers sent by the government to Britain routinely remarked on how the English had vastly improved the use of coal in the manufacture of iron, thus they had achieved *"a marked superiority…over all other European countries."* The French engineer wanted *"to hope that France will not remain always foreign to this new source of prosperity."* (DUFRÉNOY; BEAUMONT, 1827, 353-54)[2] Aided by the hospitality of their engineering hosts, French engineers scurried about the coal fields of Britain making exact descriptions of the types and quantities of coal to be found in each. Competition did not preclude the fraternizing of men of science; lest we forget, there was still competition between rivals who saw themselves as directly comparable.

The custom of comparing relative progress between France and England was well in place by the second half of the eighteenth century. French spies routinely arrived in British towns and cities, prowling for information about innovations, or simply about the relative prices paid for things as varied as coal and cloth. Elaborate reports were then filed with the Ministry of the Interior in Paris where officials watched nervously for signs of the British having made advantageous improvements. When introducing a new invention, in this instance for improving the sheen on silk, the inventor proudly noted his many trips to England and *"the superiority of luster that the makers …[in England] apply to cottons, silk fabrics, and ribbons,"* and he proclaimed, the same luster can now be obtained in France, thanks to his invention.[3] He was rewarded with a fifteen year patent, free of charge. The inventor of a new pump for lifting water who claimed that he had spent many years studying *"mechanical objects"* assured the state that his pump delivered *"a greater force than the English steam engine."*[4]

Traffic in the direction of England to France also increased decade by decade, even into the revolutionary 1790s when British radicals like James Watt, Jr. - much to the annoyance of his father of steam engine fame - marched with the Jacobins through the streets of Paris. His po-

1 ***French accent marks not present in the original have not been added.***

2 *Report by MM. Dufrénoy and Élie de Beaumont on the manufacturing of iron as observed in different coal-rich areas.*

3 *Archives nationales, Paris [hereafter AN], F12 998, year 6, 9 vendredi, request by C. Bardel.*

4 *AN, F 12 997, dossier Laine and Varennes, 1792.*

litical ardor for French revolutionary politics did not prevent him from commenting extensively on factories and industrial processes observed, in one instance, in the cotton factories of Rouen. There he was surprised by the vast scale of the weaving operation of the Oberkampfs. Watt Jr., like the French themselves, had seen something important there. In the first decade of the new century, during the reign of Napoleon, French officials charged with inspecting the secondary schools of Rouen insisted that the education given be tailored to the needs of industry, particularly in the city that was the most industrially advanced in France.[5]

Perhaps the most curious and helpful observations made by the many British visitors to France in the 1780s come from the notes taken by none other than Watt's partner, the brilliant industrialist, Matthew Boulton (who was accompanied for all, or part, of the time by James Watt.)[6] They were guests of the French King and received contracts for work to be done at Versailles.[7] But other matters, largely to do with scientific education, preoccupied Boulton. In the 1780s, through his comparative eyes, we can see what a few years later the French revolutionaries saw and sought to correct by a new industrial and educational policy implemented by the mid-1790s. He made lists of all the mechanical and chemical arts, especially those found in France and not seen in England.[8] As it happens he was asking the very questions that a comparative historian would pose when trying to understand the cultural roots of French industrial retardation. Boulton had many motives, not least among them gaining access to a quantitative understanding of the energy used, and still needed, in various hydraulic projects where one of his steam engines might find a place.[9] He especially wanted to know how much it would cost to import coal from England and concluded that *"France ought to seek to work her coals and not depend on wood only."*

Perhaps Boulton and Watt were looking for men like themselves. Boulton wanted to know about "all publick meetings and schools for the promotion of human knowledge and arts."[10] Most helpfully for us, he made a list that included the Royal Academy of Sciences, the Society of Agriculture and Economical Arts, schools for millers, bakers, metallurgy, public medicine, surgery, design and painting, as well as chemistry, architecture (where drawing, geometry and mathematics were taught), the King's library, the Royal School of Hydrostatics, and a Lycée in the Palais Royale where twice a day lectures could be heard *"in all the sciences."* In addition there were ten different private lectures open every day and free. Boulton was looking for the Paris version of public science and he found it easily without the benefit of independent or unlicensed newspapers. The *Journal de Paris* regularly listed lectures in the city. In addition Boulton noted schools for the deaf, dumb and blind, for recreations like riding and fencing, and multiple near

5 Archives Departementales-Seine-Maritime, Rouen, MS 1T 579: Collèges et Lycées, Affaires générales au sujet des écoles secondaires; AN, Procès-verbal de la Visite des Ecoles Secondaire de la Ville de Rouen, "...et dans les maisons d'Education dont les directeurs avaient sollicité, pour l'an 12, le titre de l'Ecole Secondaire. Ils sont précédé à l'examen du mode d'enseignement suivi dans chacune, et ont interrogé les élèves depuis les premiers élémens du langue jusqu'au degré d'instruction le plus élevé qu'offre chaque pensionnat. Observations Générales...on a remarqué du Cn. Bricard, quelques élèves ont produit des dessins qui annoncent de véritable dispositions, et a cet égard on doit faire observer, qu'il est important de maintenir le gout du dessin dans une ville qui est la plus forte de l'Industrie française, tous les sujets de cette industrie ont de plus ou moin loins, le Dessin pour Caze (?), si l'art du Dessin se perfectionne, les machines se multipliant, les procédés acquière plus de simplicité, les ouvrages manuels plus de commodité et de gout, et l'industrie nationale obtient une meilleur concurrence dans les marchés étrangers."

6 Birmingham Central Library (hereafter BCL), UK, Papers of Matthew Boulton, MS 3782/12/107/14, 1786. Watt is there in January 1787 at Calais.

7 D1583/2/33 Letter, Boulton to Wilson regarding Baron Stein, and of work proposed for the King of France, 27 Jan 1787.

8 BCL, MS 3782/12/107/28, dated 1800, ff. 15-16, in this instance possibly a request he made to his French visitors, Mr. and Mrs. Gautier and de Luc.

9 BCL, MS 3782/12/108/49, 1786-87, f. 9 notes on the water supply of Paris with assistance from M. Deparceux, f. 18 on the cost of coal imported from Swansea or Newcastle, £1.3.0 per ton with extensive notes and measurements of the water works at Marly and Challiot.

10 Ibid., ff. 18-24.

university-level Colleges.[11]

Boulton discovered that all sorts of science could be found in the French capital (the provinces were a different matter), but what did this translate into, in terms of improved manufacturing? Again, Boulton made his lists. He found French inns to be inferior (in part because they did not serve tea), tables, chairs and pottery were inferior, and in general he determined that *"the riches of the country seem to be all applied to the use of the king."* Some of Boulton's observations were fairly stereotypical of English reactions to Gallic customs. But then Boulton got serious and found significant French superiority in jewelry, watches, clocks, vases (*"far superior,"*) wine, snuff boxes, fine silk and velvet, wooden shoes, bleaching of linen and silk, better presses for cutting, coining money, better rolling of lead pipes, and the superiority of just about all the artisanal goods coming from Lyons.(PEREZ, 2008, 232-263)[12] Boulton made an assessment of where he thought English superiority lay: optical, mathematical and philosophical instruments, coaches, chaises and all carriages, *"all useful things in iron, steel, doors, lathes, tables and drawers and tables."* In sum, the common people back home lived better and English life in general was more convenient with greater neatness and cleanliness in evidence. Watt, on the other hand, had nothing but praise for the quality of metal working used in French cylinders intended for the steam engine of Periers.[13]

Allowing for bias and provincialism in Boulton's assessments, what can we extract from them that hint at the industrial gaps that would open between France and England in the period after 1800? Boulton noted a gap in general prosperity that other observers of France had also recorded. He tells us about French artisanal superiority in a variety of consumer goods and time-keeping devices, and in linen and silk. When describing "cloth" – we may assume cotton and wool - Boulton put it in the plus column for England.[14] Add to the mix, means of transportation, iron and steel production and instruments to teach applied mechanics, and therein the English, he believed, excelled.

In the 1780s, through the eyes of Boulton can be seen what, but a few years later, the French revolutionaries saw and sought to correct by a new industrial and educational policy implemented by the mid-1790s. Curiously Boulton had also identified elements increasingly thought to be critically important for early industrial development: mechanical knowledge focused on application, machines made of iron and steel, productivity in coal extraction, improved transportation, a general prosperity that made surplus capital more readily available.[15]

The vision of both Boulton and Watt of what was needed for success in the business of power technology informed the education they insisted upon for their sons. Despite his own debt to artisanal practice, Watt demanded that they have an even more rigorous and formal scientific and mathematical education than was available to him - although it did include bookkeeping. Other contemporaries also observed that Fren-

11 BCL, MS 3782/12/108/49, ff. 32-33. For science in the French capital see essays by Michael R. Lynn and Lissa Roberts, in Bernadette Bensaude-Vincent and Christine Blondel, eds. Science and Spectacle in the European Enlightenment (Aldershot, UK: Ashgate, 2008), pp. 65-74, 129-140.

12 For some confirmation of what Boulton saw in Paris see André Guillerme, La naissance de l'industrie à Paris. Entre sueurs et vapeurs: 1780-1830 (Seyssel: Champ Vallon, 2007), pp.312-16.

13 http://www.cornish-mining.org.uk/story/boulton_watt/volume2.htm, MS D1583/2/31, Letter, Ann Watt to Wilson, January 9, 1787, "I had the pleasure of receiving your of the 5th this morning inclosing the account for Dec[embe]r which is sent to Mr. Pearson I am very sorry to hear of the three Engines you mention as it may be the cause of some quarreling but the Cornish gen[tleme]n need give themselves no trouble to prevent Engines being sent out of the Kingdom Mr. Watt wrote me that he saw Cylinders cast & bored by Mr. Perrier better done than any of Mr. Wilkinson's & that all the noise that was made about the tool bill was to no purpose for he was sorry to say that many of our Artists might learn from France more than the French now can learn of us that their late improvements were immense."

14 BCL, MS 3782/12/108/49, f. 36. This notebook contains these crucially important comparisons.

15 For a detailed treatment of these factors and many more, see Joel Mokyr, The Enlightened Economy. An Economic History of Britain 1700-1850 (New Haven, CT., Yale University Press, 2009).

ch education needed to be turned in the service of *"national industry, education in the arts and crafts"* as was the case among France's competitors. A petition by Parisian citizens went on to call for education in descriptive and applied geometry, physical and chemical experiments and elementary machinery. (GREVET, 2001, 300)[16]

The Parisians were on to something. With the French Revolution came a new generation of leaders who were convinced that France lagged behind Britain, a situation that had to be corrected. By the 1790s these leaders of the new regime – reacting against what they believed was a clerically induced backwardness - embraced with enthusiasm the Baconian vision of learning intended for industrial application. They wanted industrial development, and the mechanical arts were at the center of their vision.[17] In 1791 a new system for awarding patents was instituted and within the next few years inventors of everything - a new system for navigating canals (by the American Robert Fulton), building better pianos, reducing the cost of printing school books, and improving the speed of ships - applied for patent protection. The ministers charged with their issue had a background in science such that they could assess, according to *"the theory of affinities,"* if the patentee's chemical process would indeed produce *"soda and sulphate of soda."* The chemist Berthollet assessed the viability of the application. The applicant argued plausibly that national benefits in such production would follow and eliminate French dependence on British imports such as Epsom salts.[18] Yet the new patenting law benefitted a class of men who could afford the fifteen hundred livres needed to secure a patent for fifteen years.

The new system of awarding patents or *brevets* meant that the inventor's device did not have to pass a formal test organized by the academicians. From the 1790s the ministers of state responsible for granting patents still needed to understand what principles had been applied in the new technology. They received in detail a description of what sort of technical knowledge of mechanics or chemistry had enabled the inventor to create his device. Where such knowledge had been used, patent applicants spelled it out in some detail as a part of the application: *"the physical principles of this invention reside in the general law of hydrostatics."* [19] Sometimes inventors made it clear that they did not know the physical or chemical principles at work in their process. Well into the 1820s the French government awarded prizes at public expositions for innovations that ranged from a new model of a steam engine for use in a Saint-Quentin factory to improvements in solid colors for cottons. (NORMAND; MOLÉON, 1824, 25-35)

Education in science did not insure employment in industry. In 1808 the *Manuel du négociant* listed sixty-four "mechanists and machinists" at work in Paris. By contrast there were 400 government-employed engineers of bridges and roads and hundreds of others occupied by the state in artillery, the overseeing of fortifications, mines, geography, and the marine. (GUILLERME, 2007, 317-18)[20] Nevertheless real efforts were being made to inculcate knowledge suitable for industry. In 1808 at the Conservatoire

16 Quoted from the Parliamentary Archives, vol. 64, pp. 233-39

17 "Ces arts, que l'idiome de l'ancien régime avait cru avilir en les nommant arts mécaniques, ces arts abandonnés longtemps à l'instinct et à la routine, sont pourtant susceptibles d'une étude profonde et d'un progrès illimité. Bacon regardait leur histoire comme une branche principale de la philosophie. Diderot souhaitait qu'ils eussent leur académie; mais que le despotisme était loin d'exaucer son voeur qu'il était loin de le comprendre il n'envisageait dans les arts que des esclaves d'un vain luxe, et non des instruments du bonheur social." Found in François de Neufchâteau, Circulaire aux Administration centrales de Départements et Commissaires du Directoire exécutif près de ces Administrations, 9 Fructidor, Year VI, located in AN, MSS F12 985.

18 AN, F12 997, "Memoire" of M. Carny, May, 1789.

19 Cited from a patent mémoire by one Schmidt from 1799 in Jérôme Baudry "La technique et le politique: la constitution du régime de brevets moderne pendant la Révolution (1791-1803)" M.A. thesis, École des Hautes Etudes en Sciences Sociales, Paris, 2008-09. Kindly brought to my attention by the author. He has mined the 215 brevet applications found at the Institute National de la Propriété Industrielle, Paris.

20 For the new patents see AN, F12 998. See the brevet awarded on 24 Messidor, year 7 to Henry-Joseph Girard, Paris, for a new machine to increase the speed of boats, complete with mathematical explanation.

des arts et métiers, the main training school in applied mechanics, leading industrialists such as the cotton manufacturer, Milne, were employed as "*chief of the practical school de filature*" and he was joined by skilled machine makers like J. Montgolfier of ballooning fame. All mention of machines and application disappeared from the faculty positions by January 1816. Application reappeared in 1821 when the conservatory hired three professors in "*chemistry applied to the arts, mechanics applied to the arts, and industrial economy*" and they are paid more than the professors of geometry and design.[21]

French Education in Science after 1789

Despite the elitism of the patent fee, the post-1789 goal for industrial progress had an egalitarian tendency. By 1792 visionaries like Marquis de Condorcet, now in positions of authority in government, proposed the reorganization of traditional secondary education and placed the mechanical arts and the practical elements of commerce front and center in the curriculum of the secondary schools. (BACZKO, 2000)[22] He even believed that all new science–oriented faculties could be found to staff his grand experiment in progressive education intended to create a new democratic citizen. Increasingly in the 1790s a working assumption held sway: English industrial prowess depended upon their superior machines, and education in physics, mechanics, and mathematics would promote innovation.[23]

Amid all of their jealous looking-over-the-shoulder Boulton was one of the few commentators, either French or English, who mentioned the state of mathematical and scientific education in either place. In this regard there is growing evidence suggesting that the British were further ahead in such education by the middle of the eighteenth century.[24] Whatever the case then, after 1789, the French reformers and revolutionaries brought to power made education a corner stone of the new mindset they hoped to create. At the center of the educational reforms lay the new *écoles centrales* established in every province with teachers drawn mostly from the laity. This bold experiment - undertaken in 1795 amid enormous financial and military distress - laid great emphasis on the teaching of mathematics and science aimed at application. Zealous for the success of the new secondary school curriculum, teachers from all over the country wrote to Paris to complain that they did not have the demonstration instruments they needed to teach the application of mechanics to real bodies in time and space. Yet they persevered. A similar curriculum that stressed mathematics and physics was put in place for the training of all engineers.

By 1802 the curriculum of the French secondary schools had expanded to include Euclidian geometry, works by Descartes and especially Newton and the major Newtonians.[25] Very little was added to the scientific reading list until the 1830s, although as we are about to see, gradually much was subtracted. During the reign of Napoleon the commitment remained to teach workers of every kind to calculate and to *"know*

21 AN, F 1b I, 34, salaries and employees listed for 1808-09, among other dates. Milne's name no longer appears after September 1814. For January 1816 list of faculty and salaries see No. 41. Gaultier, the professor of Geometry, remained. A position appears for "Du dessin de la Mécanique." Salaries, with the exception of the director, are now lower than those before 1815. The new professors are Clement, Dupin and Say.

22 Condorcet, Rapport et projet de décret sur l'organization générale de l'instruction publique (avril 1792-décembre 1792,) p. 221.

23 AN, F/14/4250 1805 Statistique minéralogique du Département du Leman..., entire discussion of all mining of every substance; machines never mentioned. Written by Lelivec, Engineer of the mines; Mémoire sur les Mines de houille et le commerce de...Jemappes.... Competition with England cited as critically important (year 10); their coal is superior and accounts for their preeminence particularly from the produce of Northumberland; the coals of Jemappes are comparable "the work of exploitation in England has the advantage over those of this department ... because of the conduct of the operation and the perfection of the machines they employ." Their machines for extraction are more complex than ours (they are also near the sea); we need to develop our navigation system to compete.

24 http://www.cardiff.ac.uk/carbs/research/working papers/accounting_finance/A2009_2.pdf

25 AN, F 17 1559, "Liste des ouvrages …approuves de 1802-1830," in 1802 works by Newton and Newtonians such as Keill, Gregory and Maclaurin, also Daniel Bernoulli, Euler, s'Gravesande, LaGrange, Cassini, Monge, Camus, Desaguliers, Musschenbrock, Haûy, among others.

descriptive geometry and … the notions of physics and chemistry [and] to study the mechanism of machines."[26]

The minister in charge of overseeing public instruction received reports from England about its educational system, and was informed that while French penmanship excelled, the teaching of mathematics *"has acquired the greatest perfection with the English."* The ability to use arithmetic and algebra can even be seen among porters and valets in London, the report concluded. All this comparative information assisted in the establishment of the elite lycées, a national system of superior secondary education that gave serious attention to science and mathematics including a *"professor of applied mechanics for the arts and crafts and technology."*[27] Note that a minority of boys and even fewer girls (in any country) engaged in secondary education in this period, and in 1802 when the lycées replaced the ecoles centrales they were meant to educate a mere 6400 pupils.

The Napoleonic administrators had figured out what anecdotal evidence confirms. If a young man was going to make a career in industry, and particularly in the application of machinery and its maintenance, in his youth he had to receive education in geometry and algebra, in basic mechanics of a Newtonian sort, and of course he had to be literate and numerate. Many British young men, like James Watt, or the cotton barons, M'Connel and Kennedy, received such an education when they were apprentices, also, as in the case of the linen manufacturer in Leeds, John Marshall, through self-education. Indeed fully two-thirds of inventors and improvers found in the eighteenth century had been apprenticed. The content of an apprenticeship is nearly impossible to reconstruct. Similarly British education, unlike French, was entirely decentralized, and only a school-by-school search can tell us what was actually being taught. Where we know particular school systems, in the case of those run by Quakers, we can establish linkages between the teaching of natural philosophy and mathematics and careers in industry.[28]

Neither apprenticeship, nor scientific lecturing, was commonplace in France, and there certainly were no Quakers to speak of. As a result the curriculum of the secondary schools became increasingly important for a mechanical education suitable for industry. The post 1789 French administrators sought to maintain that secular orientation and hence they were also clear on another vexed subject. The new secondary schools were not to be in the business of teaching religion. That prohibition would be lifted during the reaction that came in the years after 1815 and the restoration of monarchy and church.[29]

With the restoration in 1815 the secular authorities continued the rhetoric of being committed to the Baconian ideal of utility. They also put in place the Royal Institute where scientists, among other *savants*, gathered and coveted the distinction of membership. Contemporaries believed the Institute had come to *"realize the thought of the celebrated Bacon."*[30] After the Napoleonic wars praise for Baconianism did not,

26 Exposé de la situation de l'Empire Français. 1806 et 1807 .Paris : Imperial Printer, 1807, p. 18. A similar claim is made in the exposé of 1809.

27 AN, MS 29 AP 75, the private papers of Roederer, ff. 395-99, see article 12. See f. 619 for the structure of the lessons in physics and its application and f. 666 on the suppression of the ecoles.

28 Friends Library, Euston Road, London, MS note book for good penmanship of William Sturge 1797, Ackworth School, MS Box G 1/5/1-2; and for the correlation between attendance at Ackworth and a career in industry see Edward Milligan, Biographical Dictionary of British Quakers in Commerce and Industry, 1775-1920, (York, UK: Sessions Book Trust, 2007) pp. 552-555 for students at Ackworth from 1779. For a similar curriculum see Minute book of Joseph Sam's School, 1809-1828, at Darlington, County Durham, MS vol. S.25. On apprentices see http://www.nber.org/papers/w16993.pdf where is found NBER WORKING PAPER SERIES, Ralf Meisenzahl and Joel Mokyr, "The Rate and Direction of Invention in the British Industrial Revolution. Incentives and Institutions," National Bureau of Economic Research, 1050 Massachusetts Avenue, Cambridge, MA 02138, April 2011.

29 Discours prononcé par Roederer, Orateur du Gouvernement sur le projet de loi relative à l'Instruction publique…11 floréal an 10; 1 mai 1802, pp. 12-14. Found at f. 681, AN, 29 AP 75.

30 Mémorial universel de l'industrie française. Paris: Didot, 1821, p. 497.

however, absolve the English of their failings. The French said that, unlike their English counterparts, they innovate *"for the entire world"* while the English *"are jealous and envious."* French critics complained that some people think that everything coming from across the Channel must be wonderful and are possessed of a foolish *"Anglomania."* (NORMAND; MOLEÓN, 1824, 48-51) The more the English aspire to supremacy, some said, the more the French realize that all their achievements originate with the flight of French Protestants after 1685 when Louis XIV revoked their religious liberty. The French, went the complaint, had already initiated those industries from which the English now benefit. The moral of the story of French industry consisted in never ceasing to contest the preeminence of England in this *"war of industry."*

But gaps remained. In 1818 the Parisian Conservatory charged with the task of maintaining state of the art mechanical devices possessed sophisticated batteries coming from the work of Volta, machines of every sort for spinning and weaving cotton as well as many other textiles, pneumatic machines, hydraulic ones, multiple measuring devices, but curiously and tellingly, not a single steam engine which, had it been state of the art, would have been made by Watt or modeled on his design. (CHRISTIAN, 1818) When in 1822-23 an engineer appeared in Paris with the ability to build steam engines they were praised for being able *"to rival those of England."*[31] The neglect in teaching applied mechanics at the main Parisian engineering school may very well have contributed to the malaise into which French mechanical applications appears to have fallen. Certainly in 1830, when educational reform was everywhere discussed, the absence of interest in application at the engineering school figured high on the list of what needed to be addressed. Now, state of the art instruction was to be based upon manuals on English mechanics.[32]

The gap in the application of steam was one of the prime reasons why French commentators said that *"the imagination is confounded when contemplating the astonishing impact made on English industry by the genius in mechanics."* (CHAMBER OF COMMERCE, 1825, 10)[33] Perhaps predictably, from 1818 to 1823 over twenty treatises on industrial mechanics poured from the French presses. In the same period an estimated six thousand English mechanicians, artisans, mill-wrights, and master engineers were lured to France. In the 1830s the tri-weekly newspaper, *L 'Europe industrielle*, regularly reported on the number of steam engines and horsepower at work in Birmingham, or the state of English canal building and railroad construction. Generally it also kept its eye on other European countries and their relative industrial progress. (GUILLERME, 2007, 321-22) Something else, not simply the high cost of labor or the absence of coal, had to be at work in the puzzle of French industrial retardation.

The Contrast with Belgium

Once the French revolutionaries captured the territory, schools in the area known as the Austrian Netherlands (Belgium) had imposed upon them a similar curriculum, rich in natural history, mathematics, physics and chemistry. In

31 This is Bresson fils; see Charles Malo, Bazar Parisien, ou tableau raisonné de l'industrie (Paris: au bureau du Bazar, 1822-23), pp. 66-67.

32 AN, F 14 11057, "Note sur l'organisation de l'Ecole des Ponts et Chaussées par M. Navier, ingénieur en chef Septembre 1830, Rapport sur le cours de Mécanique appliquée de l'ecole des Ponts et Chaussées, L'ingénieur en chef soussigné a commencé à faire les leçons de mécanique appliqué en 1819. M. Eisenman n'ayant rien écris sur cette matière, on ne peut dire en quoi consistait l'instruction dans il était chargé avant cette époque. Les Ingénieurs qui cherchent dans leurs souvenirs quelques traces de cette instruction n'en retrouvent presque aucune…. Enfin il serait indispensibles de le procurer une ou deux des meilleures encyclopédies anglaises, qui sont des sources précieuses d'instruction. Ces ouvrages existent à la Bibliothèque de l'institut, et l'expérience vous apprend chaque jour qu'il est impossible quand on en est privé de l'occuper conversablement des sciences et des arts, et d'en suivre les progrès. Il est inutile d'ajouter qu'outre ces collections, il faudrait que la bibliothèque peut avoir les ouvrages utiles qui paraissent journellement."

33 from the preliminary discourse introducing the translation.

Liège, one of the industrial centers of early nineteenth century Belgium, the teacher of physics and chemistry was instructed to pay particular attention to the machines and manufactures of the Department, and both the theoretical and practical aspects of simple and double-action fire engines. The newly created Department was sent significant equipment for teaching physics and chemistry, everything from devices to measure the impenetrability of air, to levers, weights, a hydrostatic balance for measuring specific gravities, inclined planes and pulleys, a machine to demonstrate the effects of gravity, even a small carriage that moves by the force of steam. Some of this equipment had been seized from the French homes of fleeing nobility and clergy. The text books employed were also state of the art, and in some cases taught physics for engineers. The Parisian minister made it clear that the instruments would augment *"the powerful influence that the progress of physics and chemistry must have on the prosperity of the Republic."*[34] In the humanities in 1812-13 the emphasis lay on the classics, French literature, and devotion to God, King and Country, by which was meant Napoleon and France.[35] Despite the chauvinism, the French overseers in Belgium had assisted in laying a firm foundation in scientific education. After 1815 it was up to the newly liberated Belgians to continue or neglect it.

When in 1815 the Kingdom of the Low Countries was formed, the religious orders returned in force, but the Dutch king's ministers remained in charge of education. Belgium became part of a newly created kingdom. Indeed when they found deficiencies in the teaching of science relevant to a region, such as mineralogy in iron and coal regions, the Dutch administrators moved to correct it. The lycée was replaced by the Royal College and a gymnasium, and the curriculum found in the schools continued to include mathematics, physics and chemistry well into the late 1820s. By that decade the University of Liège offered a long and complex course in mineralogy, botany, physics with attention to machines and metallurgy.[36] In 1817 the ministry insisted that at Mons a course in mineralogy was needed because of the rich iron and coal deposits that lay in its region.[37] As early as 1822 the normal school in Mons offered yearly a short course on steam. By 1833, after Belgian Revolution of 1830 that created the modern state, industrial schools were established in Liège and Ghent. Mathematics and science, especially applied science, took pride of place.[38] By then those Belgian cities were universally recognized as major centers for mining and the new industrial production of cotton cloth.

From the 1790s onward in Belgium we find a straight line of development that runs from the schools introduced by the French revolutionaries to education in a truly industrial era. As early as the 1790s the French invaders believed that in order to promote well-being, "*a new manner of existing depends over all on the flourishing state of …manufacturing and commerce, it is urgent"* that the sciences be cultivated.[39] After 1815 the Dutch administrators who took over the country maintained that commitment and most important, retained complete control over

34 Archives d'état, Liège (AEL), Fonds Français Préfecture, inv. Nr 448 from the Year 9, and 449-4.

35 AN AB XIX 514, "Cahier de devoir de H.F. Jaubert, a Lycée de Liège."

36 Archives nationales, Paris, F 17 1344/23, archives for the écoles centrales of Liège for the year 10 and Archives de état, Liège (AEL), Fonds Français Préfecture, inv. # 448, p. 22. For expenditures on books see Inv. #449-4 to 449-11. For the period after 1815 see Archives de état, Liège, Fonds Hollandais, inv. Nr. 277, 880 for the religious orders, and 889 for prizes in mathematics. For the courses in 1817, ARA, Biza, 2.04.01, inv nr 3993, and mathematics are introduced in the education of girls; see ARA, Binnenlandse Zaken (1813-1864) 2.04.01 inv. Nr 3992. For the university see the University of Liège, General Library, MSS 1310, 6164, 2038, 4028-29, 4035, 4037, and 4050-51.

37 Algemeen Rijksarchief, The Hague (ARA), Archief van Binnenlandse Zaken. I796-18I3. (BZ). 2.04.01, inv. Nr 4000, October 1815-31 March 1818, letter of January 9, 1817.

38 Bibliothèque Léon Graulich, University of Liège, 23323 B for the society formed to promote the arts and sciences; Stads Archief, Ghent, U, inventaris nr. 1424 to 1427; for the course on steam see Archives d'état, Mons, Fonds Française et Hollandais, Province Hainaut, inv. Nr 756.

39 AEL, Fonds Française Préfecture, Inv. Nr 448 education.

Whether in France, or the French-controlled Low Countries, during the era of Napoleon (1800-1815) the emphasis on mathematical training and applied science remained high on the list of what the central government wanted for education. (BACZKO, 2000, 464)[40] In 1815 with the loss of Belgium, and the French Restoration of hereditary monarchy and Church, the commitment of the central authorities remained, at least in principle, to the teaching of science and mathematics in the secondary schools.[41] Yet clearly in many places in France, unlike Belgium, that commitment was being honored more in the breech than the execution.[42] By the 1840s French educators travelled to Belgium to observe their schools and universities.[43]

French Education in Science and Mathematics after 1815

Late in the reign of Napoleon a reformer within the Ministry that oversaw religion penned an angry treatise on the state of religion and the clergy in France. Everything from celibacy to the education they received warranted reform, and the author noted in passing that among clerical failings stood the complete refusal to undertake study in *"les sciences mathematiques et physiques."* By comparison to the *"rapid march of all the sciences, the general perfection of their methods, theology has remained stationary."*[44] Even allowing for bias, there is little evidence to contradict this anonymous assessment of clerical education at the opening of the nineteenth century.

In 1812 when the church was directed by the university to consolidate its ecclesiastical secondary schools and to put them in towns where their students could take courses at a lycée or college, Cardinal Joseph Fesch, Archbishop

40 For primary sources see Archives Departmentales, Seine-Maritime 1T 579: Collèges et Lycées, Affaires générales au sujet des écoles secondaires, An XI-1810, Arrêté Portant règlement pour les Écoles secondaires communales de Saint-Cloud, le 19 Vendémiaire, an 12 de la République....(6) Dans la 6e on enseignera l'arithmétique jusqu'aux fractions décimales exclusivement, et les élémens de l'historie naturelle. Dans la 5e le reste de l'arithmétique, les premiers élémens de physique, et quelques propositions de géométrie nécessaires pour la pratique des opérations plus faciles du toisé et de l'arpentage….S'il y a sept Professeurs, le septième fera les 2e et 1er classes de mathématiques. Dans la 2e on enseignera les élémens d'algèbre et ceux de chimie; Dans la 1er la trigonométrie, l'application de l'algèbre à la géométrie, les élémens de minéralogie; on y joindra les principes généraux de physique, de l'équilibre des fluides, et quelques notions d'électricité, et magnétisme. S'il y a huit Professeurs, l'enseignement sera en tout semblable à celui des lycées....Le Ministre de l'intérieur, signé Chantal. Cf. AD-Seine-Maritime 1T 1641: Correspondence a propos de établissements, Lycée de Rouen; Correspondence...tableau horaires de classes...sciences physiques, mars 1810; "Monsieur le Proviseur, J'ai l'honneur de vous adresser le tableau des livres élémentaires que j'ai cru servir mettre entre les mains des élèves auxquels je suis chargé ?? les Sciences physiques…. Les Physique de Haüy est le meilleur livre élémentaire que le Professeur a cru pouvoir mettre entre les mains des élèves. S'gravensend (sic), Desaguliers, Mariotte, Mussenbrock, Voller Seroni les auteurs que le Professeurs consultera particulièrement pour étendre sera implications et agrandir les idées des élèves. L'expérience précédence ou suivra la théorie autant que l'état actuel des appareils qui malheursement laisse beaucoup a désire, pourra le permettre." CF. AD-Seine-Maritime, 1T 573: Enseignement Secondaire, École Secondaire, Affaires Générales relatifs à l'administration et á l'enseignement, an VII – X, Arrivé le 19 Vendôme an 8, Cours de l'École Centrale pour l'an VIII, Administration Centrale du Département de la Seine Inférieure, a Ses Citoyens....C'est ici le lieu, Citoyens, de remettre sous vos yeux, l'organisation sage des Institutions républicaines et l'analyse des divers genres d'Instruction que l'on trouve dans l'École centrale, complètement organisée dans ce Département, d'après la loi du 5 Brumaire, an IV...L'École centrale de ce Département contient neuf Cours, Celui de Dessin; Celui d'Historie naturelle; Celui de Langues anciennes; Celui de Mathématiques; Celui de Physique et de Chymie expérimentale; Celui de Grammaire générale; Celui de Belles-Lettres; Celui d'Histoire; Celui de Législation.

41 AD-Seine-Maritime, MS 1T 862: Fonds de l'Académie, Correspondence au recteur, 1808-1822, Université de France, Statut Portant Réglement sur la discipline et les études des lycées et des collèges; Procès-verbal de la séance du 25 septembre 1821; Liste des Livres adoptés par Le Conseil Royal de L'Instruction Publique, Pour l'Année Scolaire de 1821-1822; (6) Arithmétique de Bezout, ou de MM. Lecroix, Bourdon ou Reynaud; Géométrie de M. Legendre ou de M. Lacroix; Algèbre de M. Bourdon, ou de M. Reynaud; ou Algèbre de M. Lacroix, avec le complément; Résolution des équations numériques, de M. Lagrange. Statique de M. Poinsot. Application de l'algèbre à la géométrie, d'après les Traités de MM. Lacroix, Poullet de Lisle, Reynaud; ou d'après le Traité des courbes du 2e degré, de M. Biot. Abrège d'astronomie de M. Delambre ou Astronomie physique de M. Biot. Physique, Les ouvrages de MM. Haüy, Biot, Beudant; Chimie, Les ouvrages de MM. Thénard, Thompson.

42 AD-Seine-Maritime, 1T 1656: Correspondence à propos des établissements, Lycée de Rouen...organisation d'un cours d'instruction commerciale..., 1826-1828, Université de France, Extrait du Registre des Délibérations du Conseil royal de l'Instruction publique; Procès-verbal de la séance du 16 septembre 1826....Vu le Statut du 4 septembre 1821; Vu les rapports des Inspecteurs généraux des études et les observations des Recteurs et de Proviseurs; Considérant que les dispositions du susdit statut relatives à l'enseignement des sciences physiques et mathématiques et de l'histoire n'ont obentu jusqu'a présent que des résultats incomplète. Cf. AD-Seine-Maritime, IT 864: Fonds de l'Académie, Instruction ministérielles et correspondance diverse adressées au recteur, 1819-1822, Commission de l'Instruction Publique … Paris, le 30 novembre 1819, "Monsieur le Recteur, la Commission a senti la nécessité de donner dans tous les Collèges Royaux, une direction fixé et un forme aux cours de sciences physiques, qui malgré le zèle et le talent de Professeurs, n'ont eu jusqu'à ce jour faute de d'unité, que des résultats incomplètes."

43 AN F 17 8838, folder labeled Paris, first document on education in arrondisements 4 to 9 Pension Verdot.

44 AN, Paris, MS f 19 326, "Mémoire sur l'Etat de la Religion & du clergé en France," document unnumbered, 65 ff, f. 21-23 "pour les sciences mathématiques & physiques il n'est pas du tout question." It is undated but placed in the files with documents from 1812, followed by documents from 1808.

of Lyon, took umbrage at the imposition. When at the height of his power Fesch had persuaded the Pope to come to Paris and crown Napoleon as emperor. Despite receiving many honors by 1812 Fesch had felt the cold chill that came from Napoleon's growing disputes with the papacy. Fesch had little to lose when he wrote to the Grand Master of the University and the Ministry of Cults to inform them that philosophy undertaken by students possibly destined for the priesthood had to be under the oversight of a bishop.

When it came to the physics taught in the French secondary schools the archbishop bitterly complained that he would not even speak about physics, in a century where it has been used to efface the name of the Creator and his works and *"the observation of nature serves to destroy revealed Religion; it has never been more essential than today to allow the Bishop to direct the study of physics …to protect the students of the Sanctuary from an insidious philosophy that would oppose the religion of Jesus Christ, the human traditions and same elements of the world."*[45] Everything about the post-1789 world that the church hated came from the philosophes and their slavish devotion to scientific learning with its materialist tendencies.

Archbishop Fesch spoke for the Church and its attitude toward science. But such views did not stop the Napoleonic administrators in their quest to add secular elements to the education offered in the ecclesiastical secondary schools. After 1812 the reorganization led to the closing of a number of ecclesiastical secondary schools, or their removal to more remote towns where there was no college or lycée. The University wanted to give the clergy knowledge of the human sciences so that they might better understand "the actual state of society… [and] acquire the right to speak with knowledge of the cause that made the glory of the century and forcefully leave behind the abuse of science."[46] Yet despite being nearer to training in science or mathematics, little evidence exists that the training of priests paid any more attention to subjects other than philosophy, theology and the humanities. Certainly in 1828, when assessing the need for special new schools for more and better educated priests, no mention is made of mathematics or science in a proposal to improve the curriculum.[47] Eleven years later the superior of the College of Saint-Joseph in Lille proclaimed *"we are resisting with all our strength the forces that are precipitating the University in the direction of the almost exclusive study of the natural sciences, and we are faithful, as far as is possible, to the old traditions of the Schools."*[48] Arguably the whole of the nineteenth century witnessed constant strife between liberal secularists and the Catholic clergy over who would control French education whether primary or secondary.

The strife began during the reign of Napoleon and was only exacerbated with the restoration of the monarchy and church in 1815. It brought a renewed emphasis on religious

45 AN 19 4062, letter of 10 January 1812. And for his response to individual cases of possible closure see his letter of 10 December 1811 in AN F 19 4062 and the response, where Fesch is told that the decree does not permit any exceptions, 23 December 1811; the same letter of 10 January 1812 is also sent to the Ministry of Cults, "Je ne parle point de l'étude de la physiques dans un Siècle où on semble prendre à tache d'effacer le nome du Créateur de dessus ses ouvres et de se servir de l'observation de la nature pour détruire la Religion révélé: il n'a jamais été plus essential qu'aujourd'hui de laisser aux Evêque la direction de l'étude de la physique, affine qui suivant le precept de l'Apôtre ils puissant prémunir les Elèves du Sanctuaire d'une philosophie insidieuse qui voudrait oppose á la Religion de Jésus Christ, les traditions humaines et les éléments même du monde . Videte ne quis vos decipiate per philosophiam et inanem fallaciam secundium traditionem hominum, secundium elementa mundi, et non secundium Christum." Underlining in the original. Such sentiments could also be found among British right-wing Tories: Thomas Whiting, Mathematical, Geometrical, and Philosophical Delights...A Eulogium on the Newtonian Philosophy (London: T.N. Longman, 1798), p.19, "the Democratic school would make us believe, that particles, of inert, matter, from their most chaotic state, could dance, into form and order...."

46 AN F 19 4062, letter of response to Fesch, from the Grand Master of the Imperial University, 23 January 1812.

47 AN, MS F 19 326, "Rapport de l'évêque de Beauvais (Mgr. Feutrier) Mre. des affaires ecclésiastiques au Roi, 16 juin 1828." On the reorganization see AN F 19 4062, "Université Impériale. Etat des ecoles secondaires ecclésiastiques actuellement existantes."

48 Quoted from the archives of the Institution libre du Sacré-Coeur, Tourcoing, in Robert Gildea, Education in Provincial France 1800-1914 (Oxford, UK, Clarendon Press, 1983), p. 195.

instruction and the moral probity of French students, while the clergy were returned to their preeminent place in primary school education.[49] French clerically controlled schools in the eighteenth century had a spotty, but real concern for technical education; in 1815, after a generation of secularization and anticlericalism, when the clergy returned, they threw their considerable educational zeal in the direction of re-Christianization. (PRÉVOT, 1964, 87-100) The new Restoration government embodied a profound reaction against what it regarded as the excesses of the French Revolution, and education now had to be reformed. *"Religion and love of the King must be made the base of education,"* inculcated without ceasing, and state inspections in every district were to report back to the Ministry of the Interior that all children in primary schools received religious and moral instruction.

Even when in the service of religious piety, the system of state inspectors inherited from Napoleon did not set well with the Church. Given that the Rectors of the Academies were in charge of overseeing all aspects of education, the Archbishop of Paris pointedly informed the king, *"that anywhere the rector of the academy will be an irreligious man; your people will be without religion."* The entire discussion of the academies that regionally oversaw secondary education was framed within the context of what the Archbishop saw as the excesses of the French Revolution when *"the rights of man became the universal catechism."* In 1818 a test of religious probity was imposed, a certificate of morality and the profession of the Catholic religion were required of all primary school teachers.[50]As late as the 1840s even royalist men of science, such as the mathematician, A. Cauchy wrote off the entire eighteenth century as *"the source of calamities without number…the abuse of talent and science."*[51]

Position papers circulating in the Ministry of Ecclesiastical Affairs around 1815 decried how - for a generation - education had breed license and passion. Only a return to teaching morality, respect for king and God, and not least the history of France, will free the young from *"the vices of the revolution."*[52] In secondary schools the pupils were to be instructed on the abuses introduced by the enlightened *"l'esprit philosophique."*[53] Needless to say, all the works by the philosophes were off their reading lists. In addition the post-1815 ministers charged with overseeing education were vigilant that books inspiring *"in the children of the inferior classes the sentiments of animosity toward the more elevated classes"* also be banned.[54]

The school inspections from 1817 to 1820 tell an important story about the lack of scientific education in the French secondary schools. At the Academy in Clermont-Ferrand, the Academy at Metz, at Pau, at the relatively new colleges in Corsica, in the north at Caen (where mathematics was taught) the inspectors evince little, if any interest in the teaching of either physics or chemistry – even, as in Metz, where the faculty possessed one teacher of physics. At least in Lyon the academy had a zealous teacher of physics who had no instruments, no minerals, plants or acids. No such instructor appears in the documentation about Marseilles where none of the professors have time for, or

49 Archives Departmentales, Seine-Maritime, MS 1T 873: Fonds de l'Académie, Administration générale, Lettres ministérielles au recteurs au sujet du personnel, 1823-1826; see letters for 1826 to, and from Paris, Ministère des Affaires ecclésiastiques et de l'Instruction publique.

50 Archives historiques de diocese de Paris, 4 rue de L'Asile Popincourt, Paris 11, letter of 1816, n.d. addressed to "Sire." For the certificates see AN F/17/10172/180, letter of 17 April 1818 from the rector of the Academy of Lyon.

51 A. Cauchy, "Sur la recherché de la vérité," Bulletin de l'Institut Catholique, second installment, April 14, 1842, p. 21. Reference kindly supplied by Amir Alexander.

52 AN, MS F 19 326, ff. 425-430.

53 Archives nationales, Paris, F17 11752, Commission de l'instruction publique, 27 juin 1816. On the approval of books hostile to the Enlightenment see "Liste générale des ouvrages qui ont été adoptés…. pour l'usage des Collèges…depuis 1802" # 258 a work by de Portalis.

54 AN, F 17 23396, book # 244, "Commission charge de la révision des livres," 1831.

interest in mathematics. The Academy at Toulouse insisted that it must have mathematics and science in part because of the local medical school, and saw to it that physics and chemistry were taught in the early 1820s. It also taught pure and applied mathematics and lacked only someone sufficiently qualified to occupy the chair of physics. At Dijon physics was promoted at the academy but at the College Royal (the colleges were roughly on the level of lycées) the chairs of physics and mathematics were vacant but the subjects were nonetheless taught. Rectors of the academies instructed that physics and chemistry be taught in the commercial towns and cities, but it is unclear if anyone followed their instructions.[55]

Although the inspector's report of the circumstances into which scientific education had fallen was clear, there was no real interest in anything other than the religious devotion of the students and the state of the humanities. One exception can be seen in the reports of A-M Ampère who decried the condition of science into which the academy at Dijon had fallen but praised the situation at Caen. The inspectors, however, evince no burning love of the clergy, and are first and foremost out to have them submit to the will of the University, the administrative body (not a teaching institution) charged with the task of overseeing primary and secondary education for the nation. Devotion to religion was all part of order and obedience.[56]

In 1818 a popular work, receiving the prize for the best book from the *Société pour l' instruction élémentaire,* presented a young man, a small-time buyer and seller of goods, who travels about the country-side, accompanied by a priest, and sheds light and joy wherever he goes. He praises religion and the king – many times – and extols the merits of everything from mutual education (where children teach one another), the national guard, the payment of taxes and the metric system, to vaccination. Primly he preaches against the insolence of servants toward their masters, the perils of over-eating and drinking, and the indolence and laziness of the locals. He ends by proclaiming that a general prosperity will come, and that all men must dedicate themselves to France. In this way they will demonstrate to other nations their superiority. (JUSSIEU, 1918)

The prize book went through multiple editions over the next fifty or more years. Yet the enduring smugness of the little boy, Simon, belied an under- the- surface anxiety. The French authorities nervously looked at instructional methods in Holland and England and sought to imitate them. Students were mutually to instruct one another, in imitation of the method known as Lancastrian; reading, writing and arithmetic remained at the core of primary education, but the local curé and a committee of the district were to maintain *"the order of morals and religious instruction."* Protestants and Jews had to be educated separately. Conservative clerics bitterly opposed mutual instruction regarding it as a subversion of priestly authority. Even in 1816 when the method was new and introduced by some Christian Brothers the leadership of the Church viewed it with suspicion and eventually it largely disappeared from the schools.[57]

55 AN F 17 6809/1, ff. 189-355, ad f. 356 for the conditions at Lyon; f. 327 for mathematics at Marseilles; f. 378 for Toulouse, report of 14 July 1817; Dijon f. 163 but placed after f 210 and between f. 209 which are out of order. For Toulouse see F 17 6810, f. 493 filed out of order and dated 1823. For the near absence of scientific education in the colleges of the Côte d'Or, see ff. 165 with mathematics present in about half of the schools. The majority of the faculty was by far laity. See Archives Departmentales, Seine-Maritime, IT 864: Fonds de l'Académie, Instruction ministérielles et correspondance diverse adressées au recteur, 1819-1822, Commission de l'Instruction Publique, Division du Personnel, Bureau de Coll. Roy, Paris, le 30 novembre 1819 Monsieur le Recteur, la Commission a senti la nécessité de donner dans tous les Collèges Royaux, une direction fixé et un forme aux cours de sciences physiques, qui malgré le zèle et le talent de Professeurs, n'ont eu jusque à ce jour faute de d'unité, que des résultats incomplètes.

56 AN 17 6809/1, f. 406. Ampère insists that the physics course must be experimental. His report on Caen is in AN F 17 6810, 16 June 1829. See AN F 17 6810 for the instructions to the inspectors of studies, 1823 where there is no mention of science.

57 AN F 17 23396, Enseignement mutuel, Ecole des Lisieux, 7 November, 1819. See the correspondence of the Archbishop of Paris for 1816, Archives historiques de diocese de Paris, Paris 9, letter of 9 February

In general the restored Catholic Church could only have been pleased, despite the persistent complaining of its ultra royalist right-wing. The state subsidized novitiates for the training of orders of Christian brothers, while religious books were being diligently distributed in the re-Christianized schools. [58] In the further reaction of 1822, when the nobleman and bishop of Paris, Denis Frayssinous, became Grand Master of the University that oversaw all public education, he made it clear that pupils must have *"their eyes on sacred objects; that are the true way to give them religious habits."*[59] As early as 1808, when new guidelines were issued for education he believed *"in the uniformity of education, the fidelity to the Emperor and that … the pupils be attached* *__to their Religion…education will be based on the precepts of the Catholic Church.__"* [60] Therein lay his single-minded concern.

In multiple orations, many centered on the horrors of the French Revolution, Bishop Frayssinous made clear his belief that the *philosophes* of the eighteenth century had planted the seeds of revolution. They had exaggerated the advantages of the sciences, letters and arts - all became more commonplace than ever before. Their popularity coincided with the revolution, one of the greatest calamities that ever afflicted the earth. (FRAYSSINOUS, 1843, 39-40)[61] While the good bishop could acknowledge the achievements of science, he did so only as an after-thought. (FRAYSSINOUS, 601) Given his attitude toward secular learning and the French Revolution, we cannot be surprised when we observe the downward course of scientific and technical education after the Restoration. Indeed, after police reports about it in 1826, the Royal Academic Society of the Sciences, an originally non-royal and republican body, was prohibited, and its members left to protest that they had never spoken a word about "politics or religion."[62]

At the same time and at the height of the reaction, the police spied on the free and public lectures given by Parisian professors at the *Conservatoire des arts et métiers* and found that they contained eulogies *"to liberty and equality…and that a King is more often an ignorant and unjust man."* Among the greatest offenders, M. Dupin, a teacher of geometry and applied mechanics, also had accomplices teaching literature, chemistry and economics, when, the police said, they were not teaching sedition. When Dupin lectured the amphitheatre was packed by attentive young men preparing for careers in manufacturing, commerce and students of mathematics – or so the spies reported. Particular surveillance had also to be placed on the courses in chemistry and industrial economy. Perhaps all learning intended for industrial development had become inherently suspect. Certainly such applied instruction was described as consistently anti-monarchical and irreligious. In the mind of the police authorities such liberal groups sought *"to exploit all types of industry, all human knowledge in the interest of the revolution."* The three great *"powers of modern time…the financial aristocracy, the scientific and the industrial"* will prepare the triumph of a new liberal and revolutionary order.[63] In addition industrialists and merchants,

1816 from Archbishop Alex. Ang. Duke de Reims to Comte de Vaublanc, Minister of the Interior.

58 Ibid., Paris 6 janvier 1820, "Rapport" presented to the secretary of state for the ministry of the interior on religious books being distributed in the schools. Cf., the entire folder, F17 12451 for the payment of expenses for educating the Brothers of Christian Doctrine and the Brothers of Christian Schools.

59 Circulaire de Mgr Frayssinous, June 1822; BFM, Fol-R Pièce-205.

60 AN, AB xix 514, letter of 3 8bre 1818, underlining in the original.

61 For a secondary work that contains the same sentiments see Alexis Chevalier, Les frères des écoles chrétiennes: et l'enseignement primaire après la révolution, 1787-1830 (Paris: Libraire Poussielgne Frères, 1887).

62 AN, F 17 3038, pamphlet dated 27 December 1826, "Les membres de la commission administrative, charge de réclamer après du Ministre de l'intérieur, contre son arête du 31 janvier 1826…." For the reports see F 7 6689, from the Prefecture of police to the Ministry of the Interior, 30 January 1826, it had become associated with certain Masonic lodges.

63 AN, F 7 6965, #12,391 Paris 14 January 1825, to the prefect of Police. There is particular concern over M. Dupin. For his teaching of geometry and applied mechanics see first item in this dossier dated 13 October 1828. For Clement teaching chemistry and Say on the industrial economy see #12, 391, Paris, 17 December 1824, labeled confidential; #12391 on filled lecture halls. See # 12, 395 for a teacher of mathematics with liberal opinions, and May 4, 1827 for liberals meeting in the room at least in Rouen, had become suspect because of *"the violence of the revolutionary opinion."* This premier industrial city, according to the police, had become *"the theatre of intrigue."* It was also the case that certain industrialists forged ties with secret societies of liberals in search of a way to return to the principles of the French Revolution. An air of liberal conspiracy hung over the 1820s. (NEELY, 1991)[64]

Such police reports fed the extreme reaction in that decade. Then and thereafter, during the first half of the nineteenth century, the Church engaged in a massive, encyclopedic effort to undo the damage done by Diderot and the philosophes and to create its antidote, *"une science catholique."* (DORD-CROUSLÉ, 2009, 177-210) This French Catholic reaction to the culture of the Enlightenment, given the role of the clergy in primary and secondary education, had consequences for the training of a new generation of engineers and industrialists. Certainly in 1830 when another revolution brought in a more liberal monarch, clerical supporters thought that during the last fifteen years the bishops had followed an *"absurd theology," and "one of them had told me it is dangerous that the people would be instructed…."* They are better off working the soil or pursuing a craft - for the laity that is enough.[65]

After the Revolution of 1830 the state changed the agenda for public education, and while religion remained important, school inspectors were told to pay particular attention *"to the diverse parts of commercial and industrial"* education, to this necessity of our age.[66] But the damage, arguably, had been done. The change in direction came after nearly twenty years – a generation of young people being educated – when the educational ideals of the French Revolution were systematically undermined. In 1831 inspectors reported that *"the colleges had fallen under the empire of the clergy"* and urged that at least one inspector always be a mathematician. That said, the record should also show that in some colleges, Montpellier and Caen for example, a high degree of scientific education could be found by the late 1828s while in places like Grenoble where mathematics and chemistry were needed for mining and commerce the courses were available. By very late in the 1820s the University had begun inspections specifically aimed at the state of the sciences in the various academies and colleges. Some of the pressure for scientific teaching may have come from the general public that crowded around open windows and doors to hear the courses on physics and chemistry.[67]

Science in the Industrial Heartland: The Department of the North

If we take the department of the North and the area around Calais, close to what was (then and now) Belgium, it is possible to obser-

of a Masonic lodge; #12394 for another "venerable" of a lodge. See also AN F 76915 letter of 8 March 1826, in # 8351 on a literary society in Paris, L'Athènée. For a memoire that ties all these projects, science, industry and finance, the conservatory, the lectures of Dupin, under the banner of revolution and liberalism see Prefecture de police, Paris 26 mar 1825, in AN F 7 6689/23 and in the same box, 26 March 1825.

64 In particular chapter 7 and Gilles Malandain, L'introuvable complot. Attentat enquête et rumeur dans la France de la Restauration (Paris: EHESS, 2011). See also AN F 7 6689/ 26, letter of 8 January 1821 from Prefecture de la Seine-Inférieure, about the secret Society of Reformers. There are reports in the dossier from various cities, Calvados, Marseille, Besançon, including a report on the Masonic lodges in Paris, 1 June 1825 from the Prefecture of the Police, and one from Poitiers on a society "prétendue maçonnique." In the same box, ff. 307-319, information about a Masonic group with the name of Misaim, 8 8bre 1822, from Montpellier, also Paris 7 May 1825, f. 503-22; 362; much of this box is devoted to this group. On freemasonry in the politics of the Restoration see Alan B Spitzer, Old Hatreds and Young Hopes. The French Carbonari against the Bourbon Restoration (Cambridge, MA: Harvard University Press, 1971), pp. 219-24. The link between industrialists and the Charbonnerie is made in Joel-Noël Tardy, "Le flambeau et le poignard. Les contradictions de l'organization clandestine des libéraux français, 1821-1827," Revue d'histoire moderne & contemporaine, vol. 57-1, 2010, p. 73.

65 AN F 19, 860, Poulard, the bishop of Autun to the Minister of Public Instruction and Religion, not dated, but from 1830 as seen by the other letters in the dossier.

66 AN F 17 6810, f. 224, "Instructions à M.M. les Inspecteurs géneréraux …de 1832."

67 For the academy at Montpellier, see AN F 17 6810, f. 416 report on the faculty of science, 22 July 1828; same box f 549 for Grenoble, 1826; for Toulouse, 1827, f. 450 where chemistry for industrial arts is taught as is physics which has a following among young army officers; f. 263, 1831 on the academy at Rennes and the need for a mathematician; the crowds can be found in 1830 in Toulouse, f. 290, 25 July 1830 .

ve the revolutionary curriculum at its birth after 1789-- and at its eventual demise after 1815. The North is not just any province from the perspective of industrial development. Just south of the department of Jemappes, seized from the Austrians in 1795, this northern region of France was its most populous, had access to Belgian and French coal, and its engineers could witness the advanced state of machine technology found at the Austrian/Belgian coal mines. By contrast, at the famous French mine owned by the Anzin Company, Newcomen engines had been installed late in the eighteenth century but little was done to maintain them in good working order.[68]

After 1795 the schooling for French students aged at least fourteen in the department of the North paid a new attention to mathematics, especially as it applied to actual bodies. Even the calculus was introduced although scientific instruction came more slowly.[69]In 1795 the decree went out throughout the department that the new schools were to have four new classrooms, each for mathematics, physics, chemistry and natural history.[70] The following year further uniformity was added to the science curriculum and the professors were instructed about the order in which the science topics should be taught.[71] The directives coming out of Paris remained completely silent on the subject of religious education or the traditional classical education, although by 1807 the Ministry of the Interior demanded that the lay faculty not spend its time teaching the catechism devoted, as it was, to dogma. Much to the annoyance of the local ecclesiastics, that was to be done by priests in a separate place outside of the school. All secondary schools were to follow the directive. Undeterred by the law, the clergy in the Department struck back and took to ringing church bells and holding public processions.[72] As in many other places in revolutionary France, the practice of religion had become deeply vexed.

The secondary school curriculum could also be easily filled with other secular subjects. By 1800 schools in Lille, as well as Namur (it now within a department of France) had added electricity, gases and air pressure to the curriculum.[73] In less than ten years the city of Lille demanded a public course in physics with salaries and instruments for demonstrations paid for by the Ministry of the Interior.[74] By the 1820s its industrial prowess was honored during a royal visit in 1827.[75]

But after 1815 something happened to scientific education in the secondary schools of the Department of the North. In most cases mathematical instruction continued, but physical and chemical science largely disappeared. In 1816 physics was still being taught at the College Royal but only four students elected to take it. The curriculum had returned to being overwhel-

68 Reed G. Geiger, The Anzin Coal Company. Big Business in the Early Stages of the French Industrial Revolution (Newark, DE: University of Delaware Press, 1974), pp. 58, 86-87.

69 Archives Departmentales du Nord (ADN), Lille, Séries L 4840, printed circular, Programme d'exercices publics, qui auront lieu a le école centrale du département du nord, établie a Lille, les 28 et 29 Fructidor, an VI de al République, (Lille, chez Jacquez). Cf. AN F 19 456, Cambrai , 19 janvier 1807, the secondary school in Cambrai had two professors of mathematics out of five faculty. See also Nicole Hulin, "La place des sciences naturelles au sein de l'enseignement scientifique au XIXe siècle/The place of natural science within the 19th-century science curriculum." Revue d'histoire des sciences, 1998, Tome 51 n°4. pp. 409-434.

70 Ibid., Séries L 4840, Extrait des registres du comite d'instruction publique, règlement de police pour les ecoles centrales…8 ventôse, l'an 3 de la république; circular printed at Douai.

71 Ibid., Extrait des registres des délibérations de l'administration centrale du Department de la Moselle, 25 Prairial 4th year… (1796). Here the guidelines call for math and physics and experimental chemistry; article 5 "la physique sera enseignée pendant les sept premiers mois de l'année, et la chimie, pendant les cinq autres. Le professeur enseignera la première science dans l'ordre suivant, propriétés des corps, mouvement, statique, hydrostatique… feu, lumière électricité…."This circular is printed in Metz and to be sent to the Department of the North. See also Avis du jury d'instruction nomme…pour la formation de l'ecole centrale de Maubeuge.

72 Lille, Series L 4840. For annoyance see letter of 10 February 1807 to the Minister of the Interior, 9 February 1807.

73 Programme d'exercices publics, qui auront lieu a l'ecole centrale… Lille, year 8 p. 6 where gases and air pressure is being taught, also electricity. For teaching the catechism outside the school see AN, F 19 456, Cambrai, 19 January 1807, from the prefect of the department of the north.

74 ADN, Lille, Box 1 T /19/1-4 minister of interior in 1809 has received a request to set up a free course in experimental physics and giving money for salary and instruments; course of chemistry in place in the 1820s

75 [Anon.] Relation du séjour du Roi a Lille…Le 7 et 8 Septembre 1827 (Lille; Reboux-Leroy), pp. 47-51; 95-100.

mingly classical.[76] In 1822 at the College de Cambrai, mathematics, including geometry, was being taught, but not physics or mechanics. In 1822 the College d' Armentieres was teaching neither mathematics nor science but the following year the college instituted the teaching of arithmetic, the metric system, and the fundamentals of algebra. So too the College du Quesnoy in 1823 taught neither math nor science. The College de Tourcoing taught commercial arithmetic; College de Baillaud and the College de Lille offered mathematics only. In 1824 at the College de Valenciennes the inspector complained that the math exercises and problems were all too easy. In 1822 the inspection of the secondary schools in the region overseen by the Academy of Douai found geometry - but no science. By 1840 the situation with physics in the secondary schools under the direction of the Academy had changed somewhat and at least one possessed a *"cabinet de physique"* and the teaching was under the direction of a layman. In other places it still left much to be desired.[77]

In addition the ecclesiastical secondary schools – for young men who might become priests - displayed neglect for science, thus suggesting that if their graduates became clergy and went into teaching they would be forced to stay away from those subjects or work awfully hard to catch up. If one of them then went on to the seminary in the region he would have received little help. A letter of 1828 to the Ministry of Education reported that the seminary in Cambrai also taught neither mathematics nor science.[78] These deficiencies were noted by liberal critics who were convinced that the teaching of mathematics and mechanics, particularly in the North, would result in further industrial development and wealth for the state. (DUPIN, 1826, 25-57)

The department of the North should not be uniquely faulted. If we take the department of the Eure in Normandy, its secondary schools also overseen by the Imperial University and the Academy of Rouen, the situation appears not very different. Rouen was of course a major center for the production of cotton cloth, and from the 1790s onward we can document a concentrated interest in the acquisition of steam engines.[79] Even before 1815 its colleges by and large taught mathematics but very little science. Exceptions were duly noted in the reports to the Academy. At the college of Evreux, the principal "was professor of mathematics at the *l'ecole central*, and as a result many of his students have gone on to attend *l'ecole polytechnique*." Throughout the country, the *ecoles centrales* had been abandoned in 1802 and renamed as secondary schools known as *lycées*. In 1814 a teacher at one of them in Rennes requested that he be allowed to set up a course of instruction in mechanics and the local principal wrote to ask if it would be permitted under the laws and statutes of the University. We do not know what answer he received although the principal noted that it would be more suitable for persons of an advanced age. At Toulouse the academicians taught a significant number of students; they received instruction in mathematics but not in science.[80] Only in 1826 did the royal council on public instruction, now a part of the Ministry of Ecclesiastical Affairs, mandate that more complex mathematics and physics be taught in the colleges. It is not clear that much changed in the wake of that decree. It had been preceded by one of 1821 that had little

76 ADN, MS 2 T 1712 Rapport on the College Royal of 1816.

77 AN F 17 8838, letter of 5 February 1840 from the inspector Vincent to the Inspection extraordinaire des Institutions et pensions on the school of the abbé Haffreingue in Boulogne sur Mer, in folder labeled Douai. In this region a number of students also took lessons at the College Royal. See also in same place, "Exposé sommaire de la situation des établissements privés d'instruction secondaire du ressort de l'Académie de Douai."

78 All these examples are drawn from ADN, MS 1 T /19/1-4 ; AN F17 10384, letter of 20 September 1823 from Douai to the Grand Master of the University on the suppression of "clandestine" primary schools and the new ones now authorized by the state.

79 AN F12 997, Dossier # 73, from the Department de La Seine-inférieure, for many applications to patent steam engines.

80 AN F17 8837, folio size dossier "Université Impériale, Académie de Toulouse, Department de la haute Garonne, Etat des chefs d'establissment…," c. 1820.

or no effect and in 1828 the ministry noted "the repugnance of the students" for mathematical studies. The following year the university demanded that each academy report on the morals, religion and politics of every faculty member. In sum, from 1805 to 1826 where physics was taught at all, it was given as a single, very general course in the lycées.[81]

Paris and Elsewhere

In the mid 1830s the university was still struggling with the professors in Paris to take up the teaching of mathematics in its complexity. They may have been unwittingly assisted by a new school established to teach *"English youth apparently from industrial families"* intended to occupy places in industry. Living languages, as opposed to Latin, history, geography, physics, chemistry and mathematics were the main focus of the school. There was also an emphasis on application. Around the same time in Paris students could also attend *"an industrial institution"* and it appears to be recently established.[82] At the Royal College of Saint Louis in Paris students wanting to make their way to the polytechnic gravitated to a particular professor. Indeed it would seem that by the late 1830s the students are now eager to receive the best possible education for a scientific or engineering career.[83] Predictably the professors of physics were demanding an end to their *"shocking inequality"* and requesting equal pay and status with those in the humanities.[84] Also in this decade natural history and chemistry were introduced into the curriculum. In 1838-40 the list of books upon which the pupils were to be examined included the ancient classics, mathematics, from arithmetic to trigonometry, plenty of geography and history, but next to nothing in physics and chemistry. Yet the 1830s reveal a watershed and in the provincial colleges extra funds had to be allocated to augment the cabinet of physics and the chemistry laboratory.[85]

By 1842 students in the 4th to 9th districts of central Paris could receive their scientific education by also attending the College Royal or by going to one of a number of secondary schools dedicated to the sciences and functioning as a pathway to the *École Central des Arts et Manufactures.* By this date it became possible to chose a course of education for *"professions properly described as industrial"* although not many students chose it, and it was predominantly scientific. In such schools students learned also about the design of machines, but in general the inspectors took a dim view of their morals and behavior. Two schools were evidently dedicated to the study of commerce and elementary industry. Graduates were able to apply to the *École polytechnique* or one of the special schools that emphasized practical application. All could avail themselves of instruction at one of colleges in the vicinity such as the College St. Louis.[86]

In 1840 national examiners specifically in mathematics and science were appointed, and

81 See the dossier assembled under 9 June 1829 from the Ministry of Public Instruction to all the rectors; AN F 17 8858. See Nicole Hulin, "Le problème de physique aux xix e et xxe siècles," in Pierre Caspard, ed Travaux d'élèves pour une histoire des performances scolaires et de leur évaluation XIXe-xxe siècles, no 54, 1992, pp. 48-49.

82 AN F17/6894, dated September 1826; F17 6894, letter dated 20 November 1828; see in the same box letter of 8 October 1833 on Paris. For the school for English pupils see AN F 17 8838, school of M. Houseal, described in letter of 14 May 1833; and under Mr. Gignoux see mention of the industrial institution in the same letter.

83 AN, F17 8837, folder labeled "Collèges, Institutions, et Pensions 1812-1813," within that report labeled "Rapport sur les établissements d'instruction publique du Dept. de l'Eure pour l'année 1811." The entire box is relevant. See AN f 17 6894, letter of 19 November 1838 from the College to the inspector general.

84 AN F17, 6894, letter of 16 August 1839 signed by the professors and addressed to the Ministry. For "shocking inequality" see letter of 2 May 1742 from Paris to the Ministry.

85 AN F 17 8838, rector of the Academy of Angers, 21 December 1835.

86 AN, F/17/1557, "Liste de MM les Examinateurs des Livres Classiques," the first list of 1840 containing no books in physics or chemistry, but the second list "presented for university adoption" introduced only in 1839, Deguin, Cours Élémentaire de Physique, 2nd edition, and Pierre Isidore, Exercises sur la physique. Later in the same year Olivier, Mécanique usuelle and Pinaud, Programme d'un cours Élémentaire de Physique were suggested. In 1840 chemistry made its appearance in a work by Burnouf. For the behavior of students in the school dedicated to the sciences see F 17 8838, entire folder (40 ff) about Paris, report of November 1842; not least, the science students smoked. For the school dedicated to commerce and industry see Pension Chalamet and it cost 25 fr. a month. For education suited to the industrial professions see F 17 8838, letter of 9 December on the 10th and 11th arrondisements.

throughout the 1840s books in every field became more numerous and more sophisticated. Assessing the condition of primary and secondary education in 1840 inspectors still found the greatest weaknesses to be in the fields of mathematics and the sciences. A survey of the Department of the Vosges found that *"various notions in physics and chemistry are badly taught."* At a school for boys 8 to 15 in Colmar natural history, physics and chemistry were not taught at all. At another school in the district mathematics, as well as physics and chemistry were taught *"as [far as] possible without instruments or laboratory."* The inspector noted the need to improve the education in *"physical and industrial sciences"* and that in manufacturing towns more scientific and less literary education had been attempted. When reporting on a school run the Brothers of the Christian Retreat, the inspectors found that, while the instruction followed *"le mode universitaire,"* the exception appeared in the total neglect of the sciences. In Rouen by 1840 students in need of courses in mathematics and science received them at the local college.[87]In the 1850s the Paris lycée requested that mechanics become mandated in the curriculum as it was directly relevant to *"the industrial life."* The race was on to find, and buy, the necessary machines for an education in mechanics.[88]

Rightfully we may ask, what happened to the scientific education of the generation between 1810 and 1840? If we assume that a set of discrete decisions, made as always within the limits imposed by budgetary constraints, downgraded math and science and favored religious and classical subjects, then it is possible to postulate a cause. Not everyone approved of the educational innovation that came with the French Revolution. The Church initiated a clerically led assault against a secular educational establishment that, it claimed, valued moral instruction less than the culture of the sciences.[89]

As early as 1815 the restored monarchy initiated a renewed emphasis upon Catholic religious instruction and the clergy got the right to oversee all Catholic religious instruction in the schools. Both primary and secondary schools saw an influx of clerical educators. By 1824 the Ministry of Ecclesiastical Affairs and Instruction had an overall budget of 25 million francs a year for clerical salaries versus one of 1.8 million for the staffing of the royal colleges and the primary schools. Even if we assume that only a small portion of the first actually taught, and every one of the second were lay, the ratio is a remarkable one.[90]

Although overall civilian control through the Ministry of the Interior was maintained, the clergy were directly involved in curricular oversight. If the Church had had its way, the clergy would have had their power-sharing further enhanced by royal decree. As even one of the liberal leaders of primary school education put it, *"the foundation of instruction with us as in all Christian schools is religious morality."*[91] There were ideological nuances in the Catholic vision of education but no faction embraced science wholeheartedly. Note, however, as late as the 1820s, inspectors of localities all over the country reported to their academies that clandes-

87 AN F 17 8838, Rector of the University of France to the Ministry of Public Instruction, 30 January 1840; letter of 20 February 1840 from Strasbourg from the inspector discussing a school in the arrondisement of Colmar; letter of 19 February 1840 discussing the absence of the laboratory; for education under the brothers see letter of 1840 (without month or date), Academy of Aix, concerning Sainte Croix. For Rouen see AN F 17 8838, letter of 10 January 1840 to the Academy of Rouen from the rector (at bottom of box).

88 Ibid., letter of 16 March 1857 to the head of the Ministry of Public Instruction.

89 L' ami de la religion et du roi, Sur l éducation publique et sur les lycées, pp. 1-5, vol. 5, 1814.

90 For a summary of this legislation see M. Chatillon, Almanach du clergé de France (Paris: Guyot, 1824), pp. 525-39. For salaries see first dossier, AN F 19 1340 A.

91 See the appeal of 1828 from the minister, the secretary of state for public instruction, to increase the role of the local bishops in the committees that oversee the instruction of children, Journal d Éducation, no. vii, Avril, 1828, pp. 181-86; the quote comes from an oration by the titular head of the society for mutual education, p. 383, same journal, August, 1828.

tine primary schools continued to exist. They were deemed to be irreligious, and their existence suggests that not every family endorsed the project of re-Christianization.[92]

Re-Christianization

Revived Catholicism had zealous and impassioned advocates. At one extreme the ultra-royalist supporters of king and church believed that the previous century had rendered multiple injustices against educational institutions, all in the name of *"what called itself philosophy."*[93] The suspicions roused by enlightened philosophies extended all the way to science itself. Materialism lurked in those precincts, and science had fostered its rise. The ultra- royalists believed it impossible *"to open a book of science without finding there the principles subversive of all religion, all morality, education, and instead of being a benefit, it has become a true danger.*" Societies that exist *"with erroneous systems in chemistry or in physics"* exhibit a form of moral corruption; science can be ignored, *"a people are able to attain a very high degree of civilization without knowing the true causes of gravitation."*[94]

Such anti-science ideas circulated widely. A liberal satire aimed against the ultra royalist assault on science – one that came to the attention of the police – put words in the mouth of the inspector of public education in Marseille that *"physics, mathematics, chemistry, finally, all the sciences that you are taught are only pernicious to the sociability of men. Our King has no need of savants, he wants monarchist and religious men - oh I made a mistake, religious and monarchical men."* The authorities found the satire particularly sinister because it insinuated that all students would be treated like seminarians and their *"classes in mathematics, physics and chemistry would be suppressed."* [95] Parents would justifiably be alarmed. Curiously the actual speech, which survives, said nothing about seminarians nor science; the authorities made the linkage and in the process tell us what other sources asserted, that science had no place in a clerical education. When the inspector, the abbé Eliçagaray made his way to the medical college at Montpellier and began to lecture on the virtues and orders of the government, some students started to murmur - much to the annoyance of the abbé.

When lecturing to the professors and students at Royal College in Marseille, the archives tell us that in fact the inspector had said nothing about science. Instead he ignored all secular subjects in the interest of insisting that first and foremost the collegians needed to realize that *"politics and religion can never be separated."* Liberals are rebels, factious, revolutionary and Jacobin. Furthermore, he did say, *"we have no need of savans…we want subjects faithful and devout. Make savans if you want; it is your affair, but have all the men [possess] a royalism pure and ardent."*[96] The satire had put into print words that the abbé had not said – but it captured sentiments that had been implied.

Reactionary forces had become deeply involved in the educational system and they were in open revolt against the Enlightenment and its errant step-children, science and the French Revolution. They were convinced that a philosophical education, as found in England, must be a liberal one.[97] In the post-1815 ideological wars it would appear that in some places science and mathematics suffered co-lateral damage. If the

92 AN, F17 10384, reports on primary schools during the early 1820s.
93 La Foudre, 15 October 1823, p. 54. In the following year this journal is bought up secretly by the moderate right-wing government.
94 Ibid, #48, n.d., but 1822-23, pp. 6-7.
95 AN F 7, 6915, #8314, printed journal, Le Caducée, dated 18 June 1821, supposedly spoken by the inspector on his first visit to the college in Marseille. For the letter describing the damage done, see Marseille le 23 June 1821 from the Prefect of Bouches-du-Rhône.
96 AN F 7 6915, #8310, "Discours de Mr Eliçagaray aux Professeurs du Collège Royal de Marseille."
97 La Foudre, Ibid, # 42, 1821, p. 415.

national granting of doctorates in science and mathematics may be taken as indicative, in the period from 1811 to 1816 eleven highest degrees were awarded, and the situation remained at one or two a year until the 1830s.[98]

One removed from the extreme fostered by the ultra-royalists, less radical royalists displayed little overt hostility toward science per se, but they also evinced not even a passing interest in its advance or its application. The Enlightenment did not get off as lightly. The hostility toward *"le siècle des lumiéres"* found among ultra conservatives also prevailed among the less radical conservatives, suggesting one reason why they displayed so little interest in matters scientific or, for that matter, industrial. The leading right-wing daily of the 1820s looked upon English affairs and saw only disorder, worker unrest, and the abuses of child labor - nothing of an industrial or economic nature penetrated its gaze. Nor were scientific lectures in Paris advertised in most of its pages.[99]

Yet more moderate conservatives followed the science of the day and reported on it in the pages of their daily newspaper. They recommended books on astronomy and urged parents and teachers to present them to their children and students, to call attention to *"the universal providence that reigns in the world."* [100] But Restoration Catholic ambivalence toward science meant that when a new professor of medicine gave his inaugural address he had to assure his audience that doubt about the truths of religion is not the fault of science but rather of *"faux savoir"* which judges without actually knowing.[101] Even at the Royal University, charged with overseeing education throughout the country, the topic of science in relation to religion produced nervousness. Just a few years earlier in 1820, at a time of student unrest, moderate conservatives thought the university professors were responsible for *"the atheism that hides itself in our schools under the veil of indifference."*[102] Similar sentiments prevailed in Catholic circles well into the 1850s.

The 1820s were precarious for the educational fortunes of French science, and in this intimidating environment anonymous critics decried its avoidance and the penchant for Aquinas and scholasticism found among the clergy.[103] In the period from 1809 into the 1840s the books approved for use in the secondary school curriculum featured basic physics, and only in the 1830s turned toward industrial application.[104] By that decade when the political wind shifted somewhat toward the left, school reform was once again on the agenda. A new society founded in Paris in 1831 offered a renewed educational agenda that called for physical and moral education to be sure, but also "scientifique et industrielle" education.[105] Only in the 1830s do we find curricula and books introduced in French primary schools that addressed geometry and applied mechanics.[106] By that decade mature industrial leaders of the new generation, particularly if educated in the region of the north, lacked a basic familiarity with applied mechanics. It is reasonable to argue that knowledge not present has consequences for industrial development.

In 1843 one of the largest cotton manufacturers in the Department of the North decided

98 AN F17 5577 for the years from 1811 to the 1860s where the numbers steadily increased decade by decade.

99 For example see Le Drapeau Blanc, 30 June 1819, # 15, and inter alia for the period 1819-1828. On 16 November 1819 # 154, and #158 a notice appears for 'the spectacle of experimental and amusing physics' by M. Rossi.

100 La Quotidienne, 4 January 1823, no. 4, p. 4; 9 January, 1823, no. 9, p. 4.

101 Ibid. , 11 March 1823, # 70, p. 2

102 Ibid, 1 July 1820, # 183, p. 4.

103 [Par un Professeur] Nouveau plan d'éducation, épitre adressée a tous les membres du corps enseignant et aux pères de famille (Paris: chez tous les marchands de nouveautés, 1828).

104 AN 17 1559, "Liste générale des livres qui on l'été autorisés pour l'enseignement des sciences…", from 1809-1845.

105 AN, F17 3038 dossier "Société des Méthodes d'enseignement."

106 AN F17 1559, ff. 36-41; "Liste des ouvrages...", dated 1843, f. 43 one work dates from 1828 and concerns the application of geometry to industry.

to modernize his factory and introduce state of the art equipment. Mr. Motte of Motte, Bossuet et Cie. arranged to have all the equipment shipped from Britain and installed by English workers, and more to the point, he bragged that they did all of this, despite import taxes, cheaper than if he had used French equipment and workers.[107] We know that British workers were not underpaid relative to their French counterparts. What the cost differential reveals is the relative scarcity of equipment and skilled French workers relative to what could be obtained in Britain at less the cost, even with shipping of men, machines and import taxes taken into account. A critical mass of skill, of mechanical knowledge and know-how, made a difference. It created a knowledge gap in available power technology between Britain and the rest of the world, for which French industry, somewhat unfairly, has had to carry the burden of proof. The gap would only be closed in the half century after 1850 and then slowly.

The evidence continues to mount that the era of the Industrial Revolution also witnessed the first industrially based knowledge economy in the world. No single causal explanation should be advanced for why parts of Western Europe, then America, industrialized first. For decades economic history has been written as if culture and knowledge were irrelevant. All that matters, economic historians claimed, were high wages or low fuel costs, or secure titles to land, low taxation - but now belatedly, a few people are adding scientific culture to the mix. Surely the point here is that it all mattered.[108] *Homo economicus* possessed in some places, and not others, certain cultural components which could be used to an industrial advantage. French industrial retardation had many roots, to be sure, but deficiencies in scientific education for boys (the situation was even worse for girls) must now be added to the story. That said, the French must be given their due. In the area of chemical dying and bleaching of fabrics, they led the way and in the process carved out an area of expertise that would make French fashion the envy of the world.[109] The last word: developing countries ignore education at their peril.

107 Archives de le Monde du Travail, Roubaix, MS 1988007-0016 Motte MSS, a memoire of 1943 by Gaston Motte says that his grandfather introduced equipment of English origin in 1843. There is a report is by Kuhmann, and given to the Jury départemental du Nord, found in folder labeled 1830-1845; "l'ateliers de construction tous les métiers sans exception sont venus de l'Angleterre, la levée de la prohibition a la sortie avant permis aux constructeurs anglais…en France a des prix bien inferieurs a ceux auxquels nous pouvons construire" typed script toward bottom of the box. For an overview of cotton manufacturing in the region see Mohamed Kasdi and Frederic Ghesquier Krajewski, "L'industrie textile entre campagnes et villes. Deux filières textiles en Flandres du xviii siècle au milieu du XIXe siècle," Revue du Nord, no. 375-76, 2008, pp. 497-530. Between 1805 and 1843 12% of all cotton manufactures in the country came from this department. The centers were Lille, Roubaix, and Tourcoing (p.515).

108 Here let me endorse the sentiments found in Joyce Appleby, The Relentless Revolution. A History of Capitalism (New York: W.W. Norton, 2010), pp. 155-162. For a refreshing approach to the problem of French retardation see Morgan Kelly, Joel Mokyr, Cormac Gráda, "Precocious Albion: Factor Prices, Technological Change and the British Industrial Revolution," unpublished paper, circulated UCLA May 6 2011.

109 Guillerme, La naissance , pp. 343-75.

Bibliography

Primary Sources (manuscript)

Algemeen Rijksarchief, The Hague (ARA), Archief van Binnenlandse Zaken. I796-18I3.

Archives départementales, Lille

Archives d'état, Liège (AEL), Fonds Français Préfecture

Archives d'état, Liège, Fonds Hollandais,

Archives d'état, Mons, Fonds Française et Hollandais, Province Hainaut

Archives Departmentales, Seine-Maritime 1T 579: Collèges et Lycées, Rouen ; 1T 573: Enseignement Secondaire, École Secondaire, Affaires Générales relatifs à l'administration et á l'enseignement, an VII – X, Arrivé le 19 Vendôme an 8 ; MS 1T 862: Fonds de l'Académie

Archives historiques de diocèse de Paris, 4 rue de L'Asile Popincourt, Paris, 11

Archives du Monde du Travail, Roubaix, MS 1988007-0016

Archives nationales, Paris, MSS AB xix 514, séries F7, F12, F1b, F14, F17, F19, MS 29 AP 75,

Birmingham Central Library, UK, Papers of Matthew Boulton and James Watt

Electronic archives: http://www.cornish-mining.org.uk/story/boulton_watt/volume2.htm

Friends Library, Euston Road, London, MS William Sturge 1797, Ackworth School, MS Box G 1/5/1-2

University of Liège, General Library, MSS

Printed:

Annales des mines, second séries (Paris: Treuttel et Wurtz, 1827)

Chambre of Commerce, Enquête faite par ordre du Parlement d'Angleterre pour constater les progrès de l'industrie en France (Paris: Boudouin, 1825)

M. Chatillon, Almanach du clergé de France (Paris: Guyot, 1824)

Charles Dupin, Effets des l'enseignement populaire de la lecture, de l'écriture et de l'arithmétique, de la géométrie et de la mécanique … (Paris; Bachelier, 1826)

Exposé de la situation de l'Empire Français. 1806 et 1807 (Paris, Imperial Printer, 1807)

La Foudre, 1820s

L.P. de Jussieu, Simon de Nantua, ou le Marchand Forain (Paris: chez L. Colas, 1818)

L. Le Normand and J.G. V de Moléon, Description des expositions des produits de l'industrie française, faites a Paris depuis leur Origine jusqu'a celle de 1819 inclusivement (Paris: Bachelier, 1824).

Thomas Whiting, Mathematical, Geometrical, and Philosophical Delights...A Eulogium on the Newtonian Philosophy (London: T.N. Longman, 1798).

Secondary Sources

Lise Andries, éd. La Construction des savoirs XVIIIe –XIXe siècles (Lyon: Presses Universitaires, 2009)

Joyce Appleby, The Relentless Revolution. A History of Capitalism (New York: W.W. Norton, 2010)

Jérôme Baudry "La technique et le politique: la constitution du régime de brevets moderne pendant la Révolution (1791-1803)" M.A. thesis, École des Hautes Etudes en Sciences Sociales, Paris, 2008-09.

B. Baczko, éd. Une Éducation pour la Démocratie. Textes et projets de l'époque révolutionnaire (Geneva: Droz, 2000).

Alexis Chevalier, Les frères des écoles chrétiennes: et l'enseignement primaire après la révolution, 1787-1830 (Paris: Libraire Poussielgne Frères, 1887)

Electronic essays: http://www.cardiff.ac.uk/carbs/research/

working papers/accounting_finance/A2009_2.pdf

Bernadette Bensaude-Vincent and Christine Blondel, eds. Science and Spectacle in the European Enlightenment (Aldershot, UK: Ashgate, 2008)

S.R. Epstein and Maarten Prak, eds., Guilds, Innovation and the European Economy, 1400-1800 (Cambridge UK, Cambridge University Press, 2008).

Robert Gildea, Education in Provincial France 1800-1914 (Oxford, UK, Clarendon Press, 1983)

André Guillerme, La naissance de l'industrie à Paris. Entre sueurs et vapeurs: 1780-1830 (Seyssel: Champ Vallon, 2007)

René Grevet, L'avènement de l'école contemporaine en France, 1789-1835 (Villeneuve –d'Ascq [Nord]: Presses universitaires du Septentrion, 2001)

Mohamed Kasdi and Fréderic Ghesquier Krajewski, “L’industrie textile entre campagnes et villes. Deux filières textiles en Flandres du xviii siècle au milieu du XIXe siècle,” Revue du Nord, no. 375-76, 2008

Charles Malo, Bazar Parisien, ou tableau raisonné de l’industrie (Paris: au bureau du Bazar, 1822-23)

Mémorial universel de l’industrie française (Paris: Didot, 1821),

Edward Milligan, Biographical Dictionary of British Quakers in Commerce and Industry, 1775-1920, (York, UK: Sessions Book Trust, 2007)

Gilles Malandain, L’introuvable complot. Attentat enquête et rumeur dans la France de la Restauration (Paris: EHESS, 2011)

Joel Mokyr, The Enlightened Economy. An Economic History of Britain 1700-1850 (New Haven, CT., Yale University Press, 2009)

Sylia Neely, Lafayette and the Liberal Ideal 1814-1824. Politics and Conspiracy in the Age of Reaction (Carbondale, IL: Southern Illinois University Press, 1991)

Prévot, André, L’Enseignement Technique chez les Frères des Écoles Chrétiennes au XVIII e et aux XIXe siècles (Paris; Ligel, 1964)

Alan B Spitzer, Old Hatreds and Young Hopes. The French Carbonari against the Bourbon Restoration (Cambridge, MA: Harvard University Press, 1971)

Joel-Noël Tardy, “Le flambeau et le poignard. Les contradictions de l’organization clandestine des libéraux français, 1821-1827,” Revue d’histoire moderne & contemporaine, vol. 57-1, 2010