

"AN EYE FOR AN OPTICAL THEORY"

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"An eye for an optical theory" Innovations, economic organization and opticial instruments in the making

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(1) Focus on something "new"

The changing frame of innovation, in economic history, is puzzling. The story has been told many times: during the second half of the 18th c., in Paris as well as in London, guilds ceased, at first sight, to be relevent in terms of technical knowledg or improvement, while patent legislations gave to innovators individual rights to escape competition in the market economy. Christine MacLeod (1986) even stresses that patenting was a strategy to avoid guild searches and regulation. But is it that simple? In fact, Liliane Hilaire-Pérez (1994) describes in her thesis how being publicly an "innovator" was much of a strategy of actors embedded in social and economic insitutions. I use the optical trade in Paris and London, where most of the trade is made and most of technical progress, as an observatory of this embedness.

An symptomatic feature of this social embeddness of innovation is the expertise brought before the courts by plaintiffs and deffendants in cases of patent infringement: necessary, as, by legal definition, specifications have to be understable by men of the same trade, but not to the lay man, expertise gives much weight to men outside the legal sphere. And referring to the opinion of men able to understand specifications is much like referring to a court of men of the same trade. Another possible kind of expertise on optics is that of men educated in science: but an important drawback is that men of science manufacture ideas – that cannot be patented – not commercial goods. The third expertise possible is that of "technologists", well informed of "prior ars": if such professions do slowly appear (professors in technical schools, patent agents) during the 18th & 19th c., they cannot claim for a monopoly of expertise, as even the administrative or scientific knowledge of present-day technology was far from complete (Alder, 1998). The paper is about tree stories involving such expertises, their role, effectiveness... and mingling.

The former enumeration of three kind of expertise is by no means a definition, a classification or a typology. Of course, the problem of finding some expertise is part of an social history of "objectivity", as expertise is supposed to help judes to understand matter of facts (and of facta). But the issue addressed is the following: how much expertise and litigation can be used for an history of economic organization, in-between the "Guild age" and the market economy.

This implies stepping aside the classic account of history of technology (did Dollond really invented achromatism?), to look *by the side* experts and expertise.

(2) Looking at optical instruments industry by the side

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Attention will not be drawn on the achromatic glasse, nor on lorgnette-jummelle, but on craftsmen and merchants trying to get a share or holed on profits from selling such goods. Experts before the Court and strategies developed in pleadings as "expertise", themselves, will be studied as part of an economy: experts try to be this "eye" that can produce an optical theory – an "objective" eye –, that of plaintiffs... or defendants, whose pleadings are our main ressource. Better than reports of jurisprudence they describe this social embeddness of expertise and litigation i try to describe.

But there is more: expertise (judicial, administrative or professional), helping to trace or erase boundaries inside the economic organization (here: of the optical trade), should not be overweighed: expertise is, like law, a representation. So I try in that paper to understand expertise in its legal, social and economic context that helps understanding it. Besides, expertise doesnt hold a real and permanent authority. Therefore, expertise's importance must be understood in a broader context: that of politics inside a trade, and that of the State trying to construct an "expert" manufacture.

1. "Bravura in the Face of Grief": the resistible rise of a patentee before the trade. (Paris, 1824-1828).

My starting point will be the case of the "lorgnettes-jumelles" (ie binocular spyglasses), patented in 1825 by Lemière, one of the opticians located in the Palais-Royal, in the fashionable Paris. These binoculars were probably inspired by those patented a few months before, in Vienna, by Voigtländer – a famous optician who completed his training by a stay in London. The patent for importation and improvement of the "lorgnettes-jumelles" is hardly granted that a counterfeiter (formerly patented) is reported on May 10, 1825: the patented optician, Lemière, seizes two binoculars in his neighbor in the Palais Royal, Derepas, which, according to the expertise of three opticians, is condemned on August 26, 1825 to the confiscation, 400 francs of damages and the fine of the quarter.

But the trade of lorgnettes-jumelles was probably too profitable: in december 1826, Lemierre complains again to the Juge de Paix about Derepas selling binocular. The experts choosen by Lemierre, Derepas and the judge, are not opticians but three "mechanics-jewellers": and their conclusions is quite opposite to those of the experts-opticians. Nevertheless, the judge again condemns Derepas on the sole ground of the 1825 expertise. Derepas, this time, appeals to the superior court. For the next two years, naming "good" experts is the core of litigation between Lemière and his counterfeiters. Especially after the opening of the trial between Lemière and Bautain, an optician also named as "jeweller-manufacturer of spyglasses", in february 1827: Bautain is in charge of the mecanic parts of the lorgnettes sold by Lemière.

1.1. Experts before the court: catalogue and battle of (technical) truth-tellers.

The first expertise is that of opticians of considerable fame and experience in the opticial trade. Two of them had been apprenticed in the corporation des miroitiers-lunetiers, and were related to members of that guild and to scientific instrument makers: for instance, Rochette jeune was a son (or nephew) of Gaspard Rochette, who was part of the ingénieurs du roi pour les instruments d'optique, mathématique et physique created in 1787, rewarded from the State for his scientific instruments in 1792. The third and the youngest one, Cauchoix, even if his family was not in trade (his father being avocat au Parlement de Paris), married the daughter of Gonichon, opticien du roi, himself son-in-law of Claude Paris, opticien du roi before him: both members of the corporation des miroitiers-lunetiers. During the French Revolution and the Napoleonic Era, our experts were awarded prizes and delivered telescopes and other instruments to the Army, the Navy and for the Chappe optical telegraph; their work was also acknowledged by the Académie des Sciences.

Therefore, choosing them as experts in 1825 is far from being controversial. As leading members of the optical trade, their knowledge about "prior ars" is able to tell the judge whether the patented binocular is new in trade or not. But did top-opticians really know? As a matter of fact, the second expertise of "mechanics-jewellers" shows the patented object cannot be understood as being of only one trade. Especially because Derepas added between the two tubes of the binocular a box instead of the three "barrettes" in Lemière's lorgnettes. The third case, opposing Lemière to his subcontractor, another "jeweller", demonstrates the production of binocular implies a coordination between different trades (and technical knowledge). As we will see later (Dollond's case), patent litigation is often related to partnerships which the patent overlived.

During the various trial opposing Lemière to Bautain, charged as a counterfeiter, most of the procedure is about finding good experts. It is interesting to note that no less than three successive body of expertise have been named by the juge de paix of the 7th district. But the more striking is the move to find experts with a more official status: the first expertise, in 1827, is that of Berthoud (choosen by Lemière), a scientific instrument and clockmaker as prestigious as Lerebours, of Gambey (choosen by Bautain), famous for his instruments made for the Observatoire, and Molard (choosen by the judge), director of the Conservatoire des Arts et Métiers, a former professor of applied geometry.

These new experts thinks differently from those of 1825. It must have caused some emabarassement, as the judge then call upon another body of experts: two scientists from the Académie des Sciences, Biot and Arago, and Lenoir, an even more prestigious instrument-maker (who trained Gambey). Theses experts cannot give any useful advice, as Arago refused to be expert, and Lenoir's death compromise completely the expertise. Therefore, in early 1828, three other experts are choosen: Gaspard Rochette, the retired but prestigious optician, Tremery, an engeneer from the Corps des Mines, and Armonville, secretary in the Conservatoire des Arts et Métiers. Rochette was choosen by Lemière, as it has been criticized on the behalf of Bautain... as Lemière was apprenticed to Gaspard Rochette. We dont know whether the judge named Tremery or Armonville, but it would confirm anyway this will of the judge to refer to an established authority out of the trade, the authority of experts serving the State.

This "authority" would be parallel to that who delivers patents. Though the administration does not check for the novelty or reality of the invention, it carefully examines the memoirs. For instance, Lemière did not obtained his patent for a lorgnette before giving drawings of his invention, joined to the specification. In early 1824, the "comité consultatif des arts et manufactures" also remarked that the invention of Bautain, submitted in november 1823, was quite similar to that patented by Monneret, a "tourneur en optique". As a matter of fact, academician and "technologists" from the Ministère or the Conservatoire des Arts et Métiers,

such as Molard himself are members of the very same comité: the second judicial experts about Bautain resemble the Comité consultatif. Therefore, the experts "off the trade" are not only "neutral" or "objective" because they cannot gain profit the judgement: but also because, as civil servant, professor or scientist, they belong to the State.

Such expertise only mirrors the importance of "savants" in the French Administration since Turgot, and magnified during the Revolution, when the State came to have an very strongly interventionnist politcy in the armament industry. But, before a civil court, the strategy of the patentee and of the counterfeiter is still important to choose the "better" expertise. And mobilizing both scientists and opticians is the succeeding strategy of Bautain

1.2. A trade of innovators? From friendship to partenership (and incorporation).

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(3) The patented inventor and the trade

Bautain, appealing after a first judgement that condemns him for being a counterfeiter of Lemière, has a two-fold strategy. In the one hand, as manufacturer of jumelles, he bonds himself to some opticians: he provide them with jumelles but guarantees to support all judicial cost; in doing so, he represents, at least legally, a part of the optical trade. He also unites his efforts with Derepas, as it can be told from their lawyers' pleadings. In the other hand, most of his efforts before the courts is about finding expertise that would oppose the first expertise and therefore give Lemière a bad name. Besides, Bautain improves greatly the binoculars sold to opticians, and combines new models to escape Lemière suing.

The first expertise is his own story, of a supposed partner in innovation: Bautain reminds he was patented in 1824 for a screw used in the binocular (but is the screw new to the trade?). In this prospect, it is very important to Bautain not to be seen as a worker, as Lemière tries to describe him ("son ouvrier"). Bautain tries to show he was in a partnership with Lemière, and so that he could have some rights over the patent. Conversely, Lemière displays his accountancy to demonstrate how much he paide for the work of his "worker". If the partnership cannot be proved, Lemière's answers confirm the patent resulted of at least three people: Lemière, Bautain who obtained the patent from the administration, and an "ingénieur-opticien", Magnien who made the drawings for the specification.

[A picture that cannot be shown even privately]

(4). It takes two to have one counterfeiter (at least)

On the other side, Bautain pays a few visits to astronomers of the Royal Observatory to produce a counter-expertise. Mathieu and Arago sign two certificates which admit that Lemiere's lorgnettes are not new in the trade. In fact, they just use an old 17th century treaty, already used by Derepas in 1825 without success. Bautain also pays much attention to other opticians.

First, he obtains a certificate from the self-named ingénieur Chevallier, in trade with the chemist Descroizilles, optician, scientific instrument maker and member of many sociétés savantes. This certificate says that a similar binocular "lorgnettes" was described in a book by Chevallier, published in 1806.

More important is that Bautain also obtains certificates from the first optician experts. Two of them can be looked as pretty vague but... though just signing certificate in favor of Bautain is already a move away from "expert" neutrality. But the certificate of the third expert-optician Cauchoix is boldly pro-Bautain: Cauchoix suddendly reminds the shop of his father—inlaw, when his wife inherited more than 20 years ago... and affirms a binocular was part of it, even though during the expertise he agreed to say it did not exist before Lemière.

In february and august 1828 Derepas and Bautain eventually succeed and Lemière's patent is vacated. The striking importance of relationships between opticians and other manufacturers ("jewellers", "mechanics"), of specialization and subcontract (such as between Lemière and Bautain) is not antagonistic to some common interest. Of course, on can stress material interests: vacating the patent cut price of "jumelles" by five. But we can also take into account these expertises brought before the court, and the fact that tradesmen have not been excluded from expertise on the ground of "objectivity". Recognizing that expertise, as the courts do, reveal that in the 1820s, tradesmen still held much of the technical knowledge useful to understand it. And the many ties that are revealed during the case, between opticians, is also to be taken account. One explanation could be that, even twenty-five years after the abolition of guilds, their is still some cohesiveness between men of the same trade, inherited from the Old Régime Paris and its decentralized organization among most trades, described by M. Sonenscher and A. Thillay. The vacating of the patent helps to regulate intra-industry transaction costs,

prices and confidence between opticians; it denies a monopolistic rent to only one members, of medium status. All that looks much as a success of a guild.

So we now move into the 18th c. London, and its decaying guild system, to examine the famous Dollond's case. The case review is surprisingly similar to Lemiere's case, except for its ending.

[A picture that cannot be shown even privately]

(5). Dollond's case, very similar to Lemière's case

2. "The disposition of the linen": triumphs of Peter Dollond over the guild system? (London, 1763-1765)

This case is usually understood as "another sign of decay" of the London guild organization, and of the rise of an capitalist, individualistic organization (see MacLeod). But if so, how to account for the rule on the Spectacle Makers' Company of Peter Dollond after the patent expired? The Dollond's case will be looked up from an organizational point of view, and then we will examine quickly examine the "decay" of the Spectacle Makers' Company afterwards. The trial is not that of progress against archaism: for instance, while preparing to oppose Dollond's patent in the Privy Council, the SMC have decided to allow members of SMS to take as many apprentices as they want.

2.1. Inventors, their trade, and the guild institutionnal frame... beyond legal case report.

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(6). The invention is drafted, but who cares for the name of the inventor?

The story has been told many times, but the perspective here is not to put a name of the picture, ie to know who invented the "achromatic object-glass"; nor the importance of the Dollond precedent in Boulton & Watt's patent case. The problem is to know how guild system and patent system can both live along and conflict. The Spectacle Makers Company, in the 18th c. London, is the most important company in producting scientific instrument. This lead does not mean a monopoly as some instrument makers belong to other companies, or even some do not belong to any, enjoying important institutional patronage (such as James Short).

The litigation between Peter Dollond and opticians from the SMC begins in 1763, five years after his father's patent being granted. As a matter of fact, the litigation starts in the wake of a broken partnersphip between Dollond, foreign brother of the SMC, and Watkins, free of the Spectacle Makers' Company. Watkins paid the very expensive patent fees and the partnership allowed him to sell the patented object-glasses. The 1758 partnership also detailed how benefits would be spared divided between Dollond and Watkins: it was already four years ago that the son of the patentee had been admitted as a foreign brother to the Spectacle Makers' Company. The partnership broke up in 1763 because Peter Dollond wanted another way of

dividing the benefits. He paid Watkins £200 for his share of the partnership. Patent and guild do not yet seem been completely at odds.

Watkins continued to sell telescope with the patented object-glass, and was thus sued by Peter Dollond. Though Watkins proved achromtic lenses not to be a novelty, Lord Mansfield, Chief Justice of the King's Bench, stressed before the jury that the patentee was the first to sell achromatic glass to the Public – while the first inventor, a lawyer, just kept in his *scrutinoire*. However, if Watkins was found guilty by the jury, he was only to pay 1 sh. for damages, (and court cost up to 40 sh.), rather thant the £500 asked by Dollond. Lord Mansfield seemingly considered the specification to be sufficient to prove ("expertly?") the patent to be well-founded.

In autumn 1763, Watkins whose attendance to the Spectacle Makers' Court was very rare since his freedom in 1746 was elected Master of the Company. At that moment, Watkins was sued again by Dollond. Addison Smith, former apprentice to Watkins freed to the SMC the very same year was also sued: Smith also sold achromatic object glasses and was in a partnership with Watkins.

But the more intesting event is in 1764, a petition to the Privy Council, in order to vacate Dollond's patent. The SMC paid an attorney for writing and submitting the petition, who was signed by members of SMC and non-members. That petition prove the SMC admitted not to have by itself, jurisdiction over the litigation between members of the Company, even if the patent was a blow to many of its members. Besides, the petition is signed by instrument makers belonging to other companies. So it can be said, the petition argues on the ground of the interest and expertises of a trade (ie scientific instrument making) rather than on the behalf of the sole company.

Two signatures are mostly interesting: that of George Bass member of the court of assistants of the SMC and "The maker of the foresaid glass in the year 1733", and that of "Robert Rew who in 1755. Who in the year 1755 in formed Mr John Dollond of the construction of the compound object glass". The text itself tells much about the invention, manufacture and trade of some achromatic glasses before Dollond. The agument is four-fold: 1° the invention was not Dollond's, 2° a trade of achromatic telescopes existed before him, 3° the patent had to be vacated because Dollond was endangering a whole trade. The second arguement line was a response to Lord Mansfield and the third is a classic feature, from the 1624 Statute of Monopolies: that a patent should be voided if endangering the livelihood of tradesmen. The fourth argument is that the specification of the lenses is quite vague.

Dollond was clearly establishing an absolute monopoly. In early 1764, a order was issued to decide the case Dollond vs. Watkins & Smith by arbitration of James Short, a telescope-maker who did not belong to any company. Short decided that Dollond had to pay to Watkins for the

object-glass he still possessed "at the price that prevailed when they were made". This is a recognition that Dollond, as a monopolist, raised dramatically his prices. As a matter of fact, from 12 sh. according to the partnership for a 2ft-telescope, it soared to £2 and 2 shillings in 1766.

Again, in 1765, Dollond issued a bill of complaint before the Court of Chancery against five opticians: Watkins, Smith, but also Champneys, Stedman and Eastland, five opticians who signed the petition. The issues of these trial are not reported, except that againt Champneys who was condemned to pay £500. In 1767, Dollond even sued Pyefinch, in spite of their prior agreement. Pyefinch was condemned, and, in the same way that parisian lorgnettes makers, he was granted a patent a few years later for a "refractive telescope": the patent's use must have been to secure his situation against Dollond.

2.2. Who is afraid of the Spectacle Makers' Company's expertise?

The triumph of Dollond over his counterfeiters may be explained by a his institutional position. Before litigation with Watkins, and even before patenting, John Dollond's work to obtain achromatic lenses had been acknowledged by the Royal Society: he published letters in the *Philosophical Transcations* as early as 1753. In June 1758, just after the granting of the patent in, he demonstrates his achromatic object-glass before the Royal Society and obtains its most prestigious award: the Copley Medal. He was then made FRS in february 1761. Therefore, it cannot be said that Dollond did not revealed to the public sphere achromatic telescopes: a scientific examination, a scientific expertise of his telescope acclaimed his work.

The expertise the SMC tries to support is very different in nature. The story told in the petition and "answers" of deffendant to Dollond is much about the cooperation and subcontracting of opticians and "amateur de sciences", an expertise very different in nature: the first advertised achromatic telescope (not coming out of Dollond's shop) cannot be traced before 1759. While Dollond's discovery belongs to an institutionalized open knowledge such as the public demonstration or the patent specification attached to the only name of Dollond, the achromatic object-glass made in 1733 belongs to a different universe: that world of subcontracting and cooperative artisans whose shop was not only a place to display objects more or less standardized, but also a place for teaching and a place for meeting needs & ideas of amateurs and scientists, or even colleagues (See Bennett, on London shops visited by scientific tourist, and Brioist, 1998, on Harriot, "clearing houses" and the role of discussion in Inns)

Dollond's business plan is quite different: it suppose to exclude or dominate every other optician, except if he accepts to pay a substantial fee. His shop mostly rely on only one specialized and patented product. The idea is that, though Dollond's success rest on the circulation of scientific knowledge (especially the idea that Dollond know how to make the best

telescope...), is not mirrored by a circulation of Dollond knowledge and production in-between opticians. James Short could be an exemple of a similar business organization: though being a FRS, and part of the scientific world, he refused to reveal his grinding methods until his death (he described them in a sealed envelope given to the Royal Society).

Conversely, the defeated opticians' petition demonstrate a will to show a collective knowledge of a "prior ars", a previous invention, in a collective and open knowledge: rather than the name of Chester Moor Hall, or that of George Bass. Though we cannot account this text for plain and exhaustive truth, it might be paralleled to the memoirs defending Bautain, appealing to the opinion of tradesmen. Patenting favorize a way of capitalizing, in one's business, more than knowledge. As a matter of fact, Dollond move after most of the trials, in 1766, out of the area where most of high-skilled instrument makers were neighbouring to an area of less skilled members of SMC, mostly specialized in spectacles making.

At the end of the 14 years of patent duration, Dollond remembered he was a foreign brother of the SMC. More than this: "he started to attend guild meeting regularly, became a membert of the court of assistants and rarely missed a meeting for the rest of his life". He was master of the SMC in 1774, 1778 and 1779. As a matter of fact, the Dollond family continued to play a major role in the government of the SMC for about 100 years. It was not completely disinterested.

For example, his influence over the Company is quite obvious when, Dollond being master in 1774, Watkins and Scarlett were sent accounting of their overdue quarterage since their last attendance in 1764. In 1781, Dollond serving again as master, the Court decided to consult (and paid) a sollicitor before suing Watkins (who died before legal action could be taken). Conversely, most of optcians who opposed Dollond in the 1760's ceased to attend the court after 1774.

But does the defeat of opticians against Dollond make the SMC a purely "decorative" body with no authority? A petition to the Parliament prepared in 1817-1818, against a bill that would give to clockmakers a monopoly on sun-dials is revealing that the SMC is still a place and an institution when trade interest can be discussed; and a legitimate place for expertise too, as the petition seemingly succeeded. One could compare the SMC to one the "Chambre de Métier" that were created in mid-19th Paris. My point is not to say that guilds somehow survives the 18th century, but that the transition of London optical industry to a purely "individualistic" market economy is not finished yet (if ever is to be...).

3. "Chasing sheep is best left to shepherds": scientists, engineers and artisans as experts in the French search for military optics (Paris, 1795-1811).

The "manufature nationale des lunettes achromatiques" and the many incentives to the optical manufacture during the French Revolution and the Napoleonic era illustres a technological policy rooted in the last decades of the Ancien Régime (see Skornicki, Brian, Gillispied, etc.). Acting as experts, scientists are regularly commissioned to review inventions, new manufactures and their production. But experts do not act only to evaluate and to improve the production: they role about optical making is not only to choose the best opticians or the best methods, but also to try to foster improvement for the whole trade, of scientific and military interest. Through expertise, the State's policy not try to reveal to the Public some "secrets de fabriques" or improvements. Technical knowledge is not only at stake: other constraints (prices, scale of production) are also important. The optical industry, like the gun industry which technical and organizational story has been explored by Ken Alder, seems to have escaped away from a scientific project of a rationalized and centralized manufacture. One must not be blind to the efforts of opticians themselves by a intense, and polymorphic expertise activity.

[A picture that cannot be shown even privately]

(7). From history of invention to history of experts about innovation?

3.1. Engineering the french optical revolution.

The Revolution not only destroyed the Old Régime but also accelerated the changes in relationships between men of practice to institutional knowledge: the Académie was suppressed for a few years, and artisans, promoted to the name of "artists". One most obvious example is that of Carochez, "artiste" to the Bureau des Longitudes. His functions was not only to repair and make instruments for the Bureau, in the Observatory, but also to give his point of view on instruments to be purchased, as a man of pratice.

Others, like Rochette, Grateloup or Putois, were rewarded for some masterpiece submitted to a specialized committee. In fact, the procedure is similar to that which existed, before 1789, as described in Hilaire Pérez thesis. Its aim was to enhance the merit of the best individuals from a trade useful to science, not to look after the organization of a trade. The selected elite, beside, was also similar to that of the Ingénieurs du roi pour les instruments

d'optique, de mathématique et de physique, that was created in 1787 against the guild system, only to help the scientific community to obtain better instruments more easily.

But the war and the Chappe telegraph paved the way for another relationship between the State, the scientist and men of the optical trade. As soon as vendémiaire An II, a Ponts-et-Chaussées engineer, seemingly trained in optical instruments, Fréminville submitted to the Comité de Salut Public his project to create a national manufacture of achromatic telescopes. At this moment, not only was France in war with Britain, but Britain was lacking of flint-glass able to produce good lenses. So Fréminville planned to manufacture flint-glass and achromatic telescopes from the grinding of the many *cristaux* the State seized from *émigrés* properties. He also proposed to experiment new methods for making flint-glass: the aim of the manufacture was to produce achromatic telescope for the navy, the army and the new Chappe telescope.

The project was accepted and financially supported by the Comité de Salut Public. His établissement was regularly scrutinized by college of experts on behals of the Comité de Salut Public or other specialized committee, of which the astronomer Delambre, former member of the Académie des Science was always a leading, and quite supportive member. The manufacture suffered from labor shortage – Fréminville had to seek the help of the Comité de Salut Public to get two of his workers *requisitionnés* back into his manufacture – and raw materials shortages. In Year IV, it seems that the part of the manufacture producing flint-glass had been separated from that of telescope and directed by Besson and Catoire. Besson was a former conventionnel, and, formerly, a member of two committees that scrutinized Fréminville's manufacture.

In 1797, the manufacture of flint-glass, then directed by O'Reilly who later created the Annales des Arts et Manufactures, submitted a piece of flint-glass that Carochez tried and found able to make good achromatic lenses: therefore, acting as a expertise body, the Bureau des Longitudes gave a favourable report. In the same time, Fréminville who had been charged by the Navy to improve every telescope or longues-vues by the "dépôt de la Marine", and worked also for the Chappe telegraph, and possibly for the Army. But did the success of the expert manufacture of Fréminville, constantly scrutinize by expert savants made men of the optical trade, "opticiens" or "lunetiers", completely useless? that parisian trade that Cassini described as so miserable compared to the londonian instrument makers?

2. 2. "Here, there... and back again": expert manufacture or experts and manfacture

Of course, the answer of experts committed in Messidor, An IX, by the navy to compare the achromatic telescopes of Fréminville and Lerebours is not straight-forward. Comparing two telescopes of each optician, they concluded Lerebours produced sometimes a better objective lense was Freminville's, but Freminville's ocular were always better than Lerebours'. Therefore, if Fréminville seemingly produced the better telescope,

« ...néanmoins pour les progrès de l'art, la Commission pense qu'il serait avantageux d'établir pendant quelques tems une espece de concurrence entre ces deux artistes, en accordant à chacun une fourniture proportionnée aux besoins du service et à leurs talents réciproques. La Commission se chargera volontiers de rendre compte au Ministre, d'après la vérification et l'examen qu'elle fera de chaque lunette, du mérite des fournitures qui seront faites. Elle entretiendra par ce moyen entre ces deux artistes une émulation qui ne peut tendre qu'au bien du service, et aux progrès de l'optique. »

This must be understood in two ways: first, the expert committee, made of scientist who made a career in the various Revolutionary expert committees (such Hassenfratz, Méchin), see itself has a tool for improvement of industry: this is hardly suprising after ten years of a government that had been much that of committees and experts reporting. The fact the reports goes way beyond the simple choice between telescopes from different makers reveals the expert's counsciouseness of their role in the Minister's decision.

Secondly, the Fréminville manufacture, whatever its merits and the State support, did not produce something that is out of reach of private industry. In fact, in 1809-1810, when Le Creusot manufacture delivered flint-glass to parisian opticians and gave to the Ministère de l'Intérieur the name and quantities for each optician, the expert manufacture of Fréminville hardy seems different from the other top five opticians who bought over 10 kg. But while Lerebours bought more than 82 kg, and Jecker over 50 kg. This is a hint that optical trade in Paris mainly rely on the private industry mostly dominated by men trained and established while guilds still existed: this does not mean Fréminville did not have a role in its improvements, though difficult to understand. It may be that he merely cooperated with the existing trade: we know that the to-be famous Louis-Vincent Chevalier was one of his subcontractor, working as a *chambrelan*, in the very first years of the 19th century. Therefore, the production of Fréminville "manufacture" was not as centralized as his first projects and the experts' accounting report suggests.

[A picture that cannot be shown even privately]

(8). "Chasing sheeps is better left to shepherds" (and optics to opticians).

An example of the persistence of industry developing not from the sole the State's sole impetus is Jecker's manufacture was probably the biggest and was also important because it appeared to members of the Académie des Sciences to be a paramount of rational organization

of production through the division of labour. Two comments must be made: first, the technical knowledge of Jecker was only the result of his own training and travels to two major capital cities: Paris, and London from 1784 to 1794. It is in London that Jecker learned from Ramsden (Peter Dollond brother-in-law) much of what made him able to construct a dividing engine in Paris, and also organizing a manufacture according to division of labor. So, what was the expertise for ? It was not to collect technical knowledge, as it can read from the report of he committee of academicians visiting Jecker's manufacture and examing a new divinding engine:

« Aucune machine connue ne présente autant de difficultés d'exécution, et n'exige plus de soin et de plus d'adresse. Vos commissaires n'ont pas jugé nécessaire de prendre connaissance du procédé employé par l'artiste, pour diviser primitivement cette plate-forme, et encore moins de le discuter. »

This report, made in 1812, is telling: experts from the Académie do not suppose that their role is to understand and publicize technical knowledge. They just acknowledge the result of Jecker's talent and whose secrets are inside the realm of manufacture and workmanship; the scientific instrument industrialist can have its own experts, and his *secrets* could be kept secret. The Revolution and Napoleonic Era therefore is an interesting moment, if we examine the relationship between trade and science through the scope of science. But the interest of scientist, if especially important, must not make us believe there was more than a will to influence and to foster an industry (the optical industry) that looked so near the scientist's world.

But expertise in instrument making industry was kept (until 1853) inside the Navy, who choosed to maintain some "ateliers de boussole" in its main ports. They were in charge of making and repairing nautical instruments. The want to keep a hold on ready-to-use technical knowledge explains a choice which is not only inspired by technical or economical efficiency.

To sum up, the various expertise on the optical trade can have a common use: experts help to trace boundaries between fields where rules cannot be the same: between trade (guilds litigation) or between tradesmen (patent infringment), between the scientific world and that of trade, between scientific use of optics and military needs. Expertise, rather than an way to adaptat of abstract law or principles to "real matters" through the eyes of "specialists", is a moment for heteronomy. And it is a very political moment to achieve a career in the optical trade, as it determine the ability to be present in other spheres: experts decided whether Bautain was an innovator or a counterfeiter; londonian opticians tried to find an expertise that would put an end to Dollond's monopoly, that would put him in the "normal" trade; experts decided Fréminville could be supported by the State; and experts from the navy eventually abandoned their own instrument makers to go back to the private parisian optical industry.

Beyond law itself or the politics of innovation, economic organization is at stake: expertise is not only a somewhat authoritative information on technology, but also in itself, an useful way to describe what is the link between manufacturers and between science, scientists

and trade; but a look on expertise itself tells as much on other links out of limited scope of a given expertise. The principle of expertise is to be reported to a society, a scientists' society... or another social frame.