

Technical innovations at the service of cheaper labour in pre-industrial Europe. The Enlightened agenda to transform the gender division of labour in silk manufacturing.

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1. Introduction. A technological innovation for an strategic sector

In 1749, Jacques de Vaucanson patented his or *tour pour tirer la soie* or spindle for silk reeling. In that same year he presented his invention to the Academy of the Sciences in Paris, of which he was a member¹. Jacques de Vaucanson was born in Grenoble, France, in 1709, and died in Paris in 1782. In 1741 he had been appointed inspector of silk manufactures by Louis XV. He set about reorganizing the silk industry in France, in considerable difficulty at the time due to foreign competition. Given Vaucanson's position, his invention was intended to replace the traditional Piémontes method, and had an immediate impact upon the silk industry in France and all over Europe.

In the *Art de la Soie* volume of the *Encyclopédie* published by Diderot and d'Alambert², a good reflection of the technological level existing at the time in silk manufacturing, three spindles for "tirer la soie" were presented: the *tour de Piémont* (Fig. 1 and 2), the *tour d'Espagne* (Fig. 3) and the *tour de Mr. Vaucanson* (Fig. 4 and 5). The Vaucanson's mechanized spindle, improved on existing machines, guaranteed more cleanliness, a finer thread, and better quality silk, helping to produce a more competitive silk.

The impact of the Vaucanson spindle was not only due to its comparative advantages in front of former machines, but to the strategic importance of the silk industry for European producer countries. Silk was the most expensive textile, and, as a luxury commodity, the object of heavy industrial and trade interests.³ Silk producer countries, such as France, Spain and Italy, prohibited exports of raw silk (and in the case of France and Italy, exports of technology and qualified workers), as a means to develop their own manufactures, helped by heavy protectionist policies, while at the same time facing

* I thank Lourdes Benería, Cristina Borderías and Ruth Oldenziel, as well as Cirila Quintero, participant in session 14 of the XIV International Economic History Congress at Helsinki, for their helpful comments and suggestions on a first version of this paper. Paloma Sarasúa kindly helped me with some references difficult to find.

¹ "Adjoint mécanicien le 28 janvier 1746, associé mécanicien le 30 décembre 1757, pensionnaire mécanicien le 9 juin 1768." Jacques de Vaucanson is well known by historians of technology for his invention of what is regarded as the first automaton, with punch cards. This was subsequently perfected by Jacquard, the father of modern looms.

² The 17 volumes of articles of the *Encyclopédie ou Dictionnaire raisonné des Sciences, des Arts et des Métiers* were published between 1751 and 1765. The 11 volumes of illustrations issued from 1762 to 1772.

³ In Italy, "the most important and valuable manufacturing activity [was] the production and working of silk filaments and the weaving of silk fabrics. Silk was Italy's single most important export commodity in the eighteenth century" (Davis 1991: 87).

increasing competition from new producers such as England and Scotland, that had to import their raw silk.

Fig. 1. “The illustration represents the action of reeling the silk of the cocoons, and two girls occupied, the one at the crank (lever) of the spindle, the other one at the boiling pot. This operation is usually done in the months of June or July, when there is no need for a closed space as workshop thanks to the warm weather”.

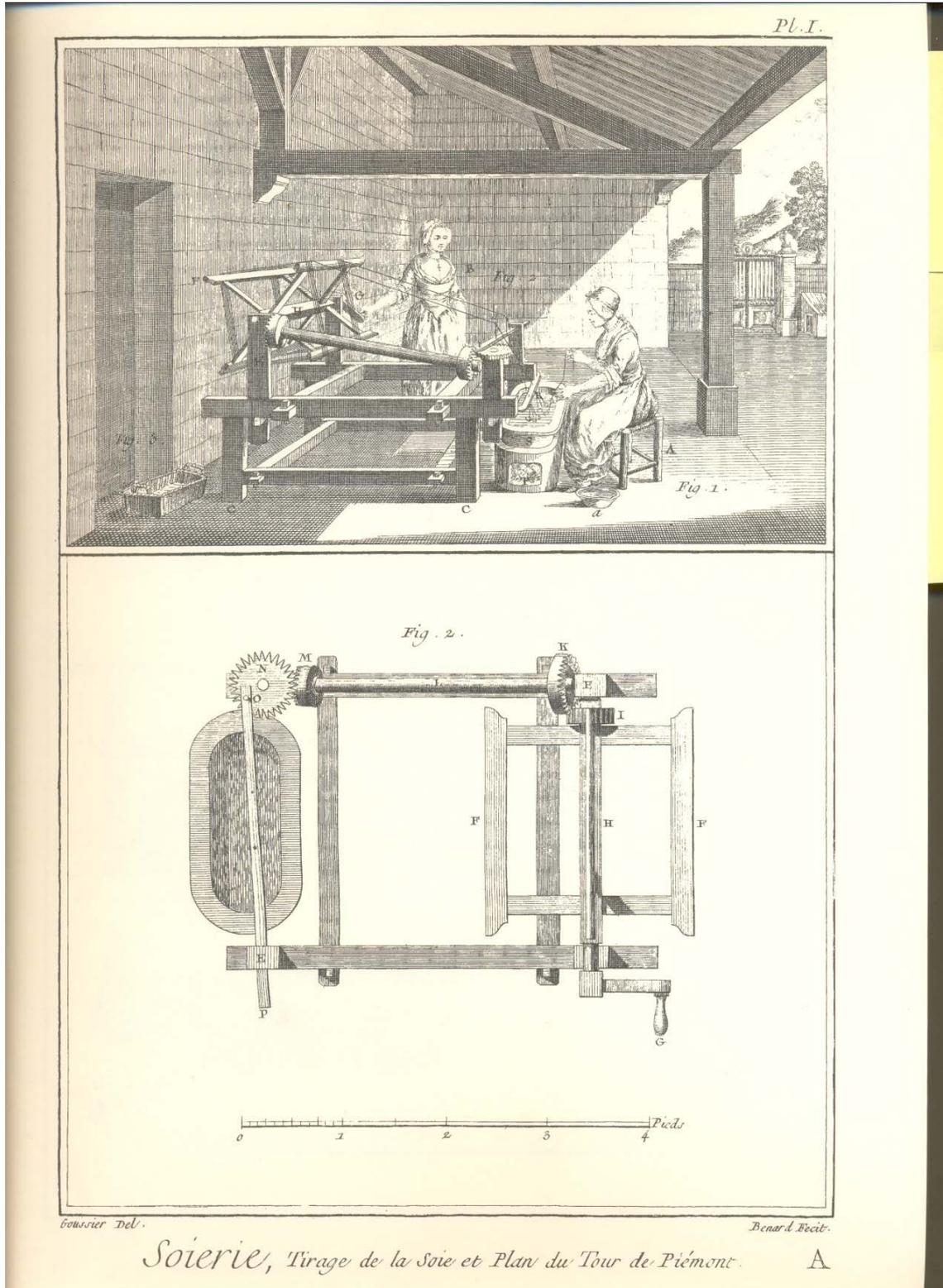
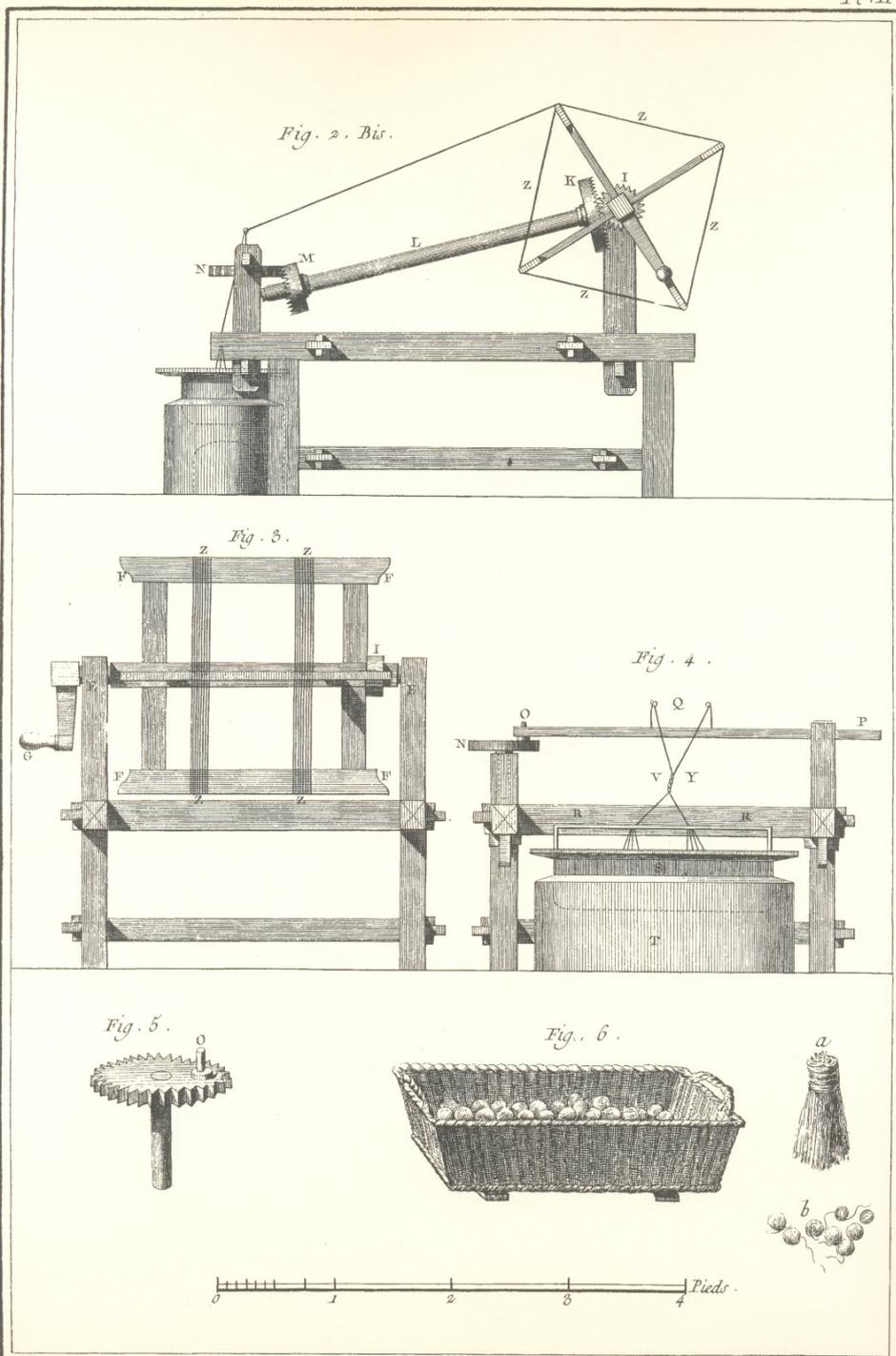


Fig. 2. Tour de Piedmont



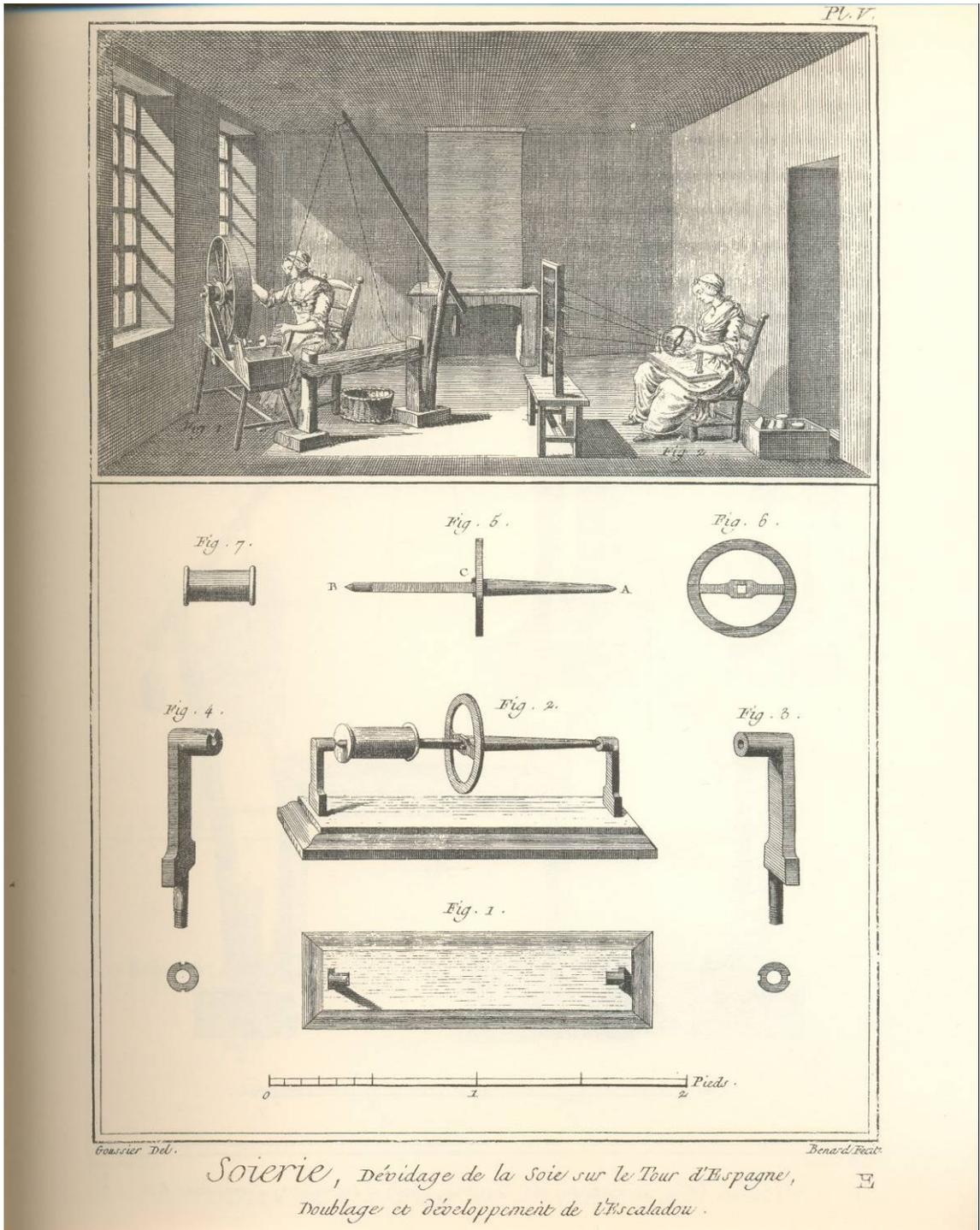
Goussier Del.

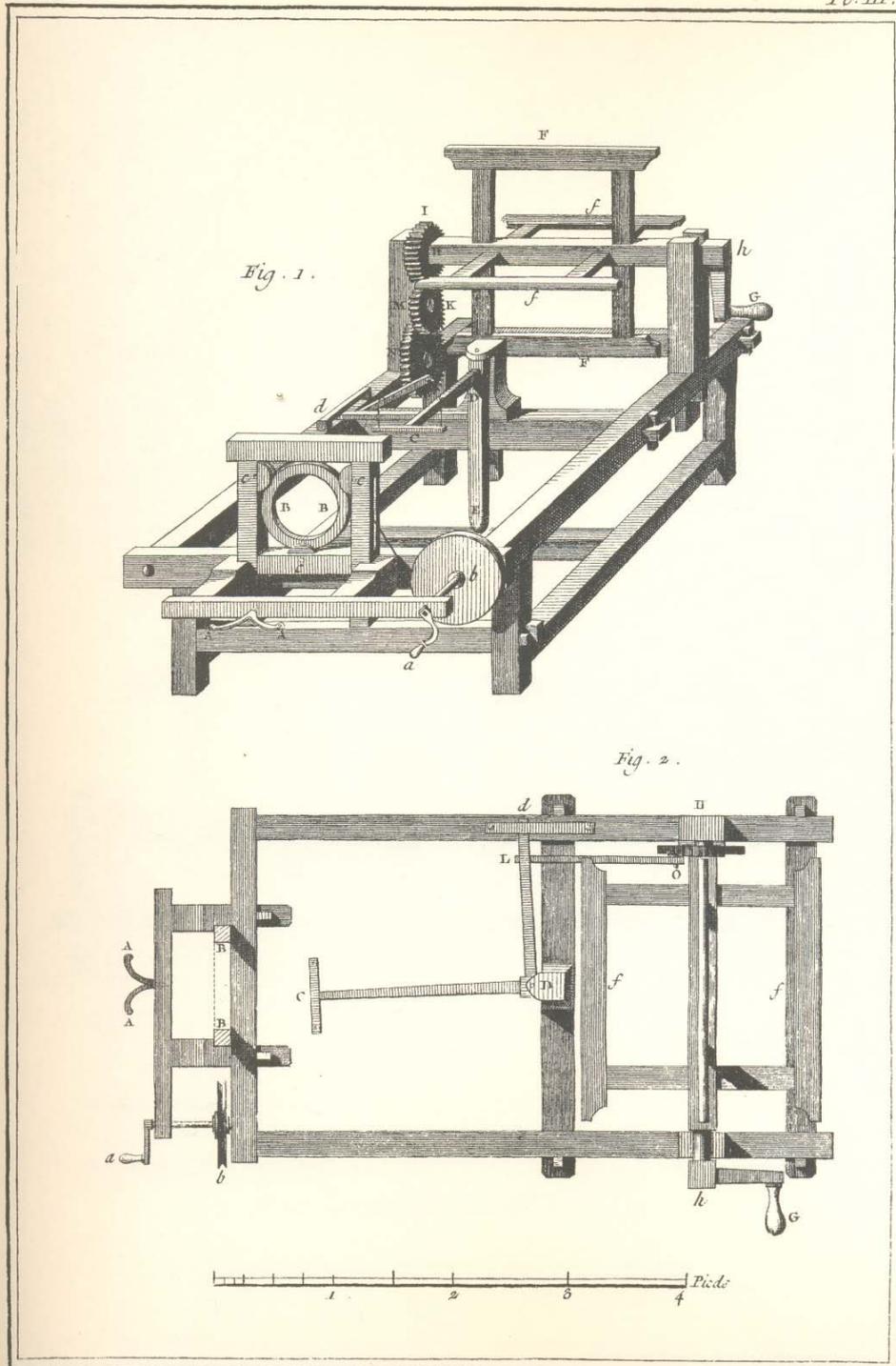
Benard Fecit.

Soierie, développements du Tour de Piedmont.

B.

Fig. 3. The Spanish Spindle.



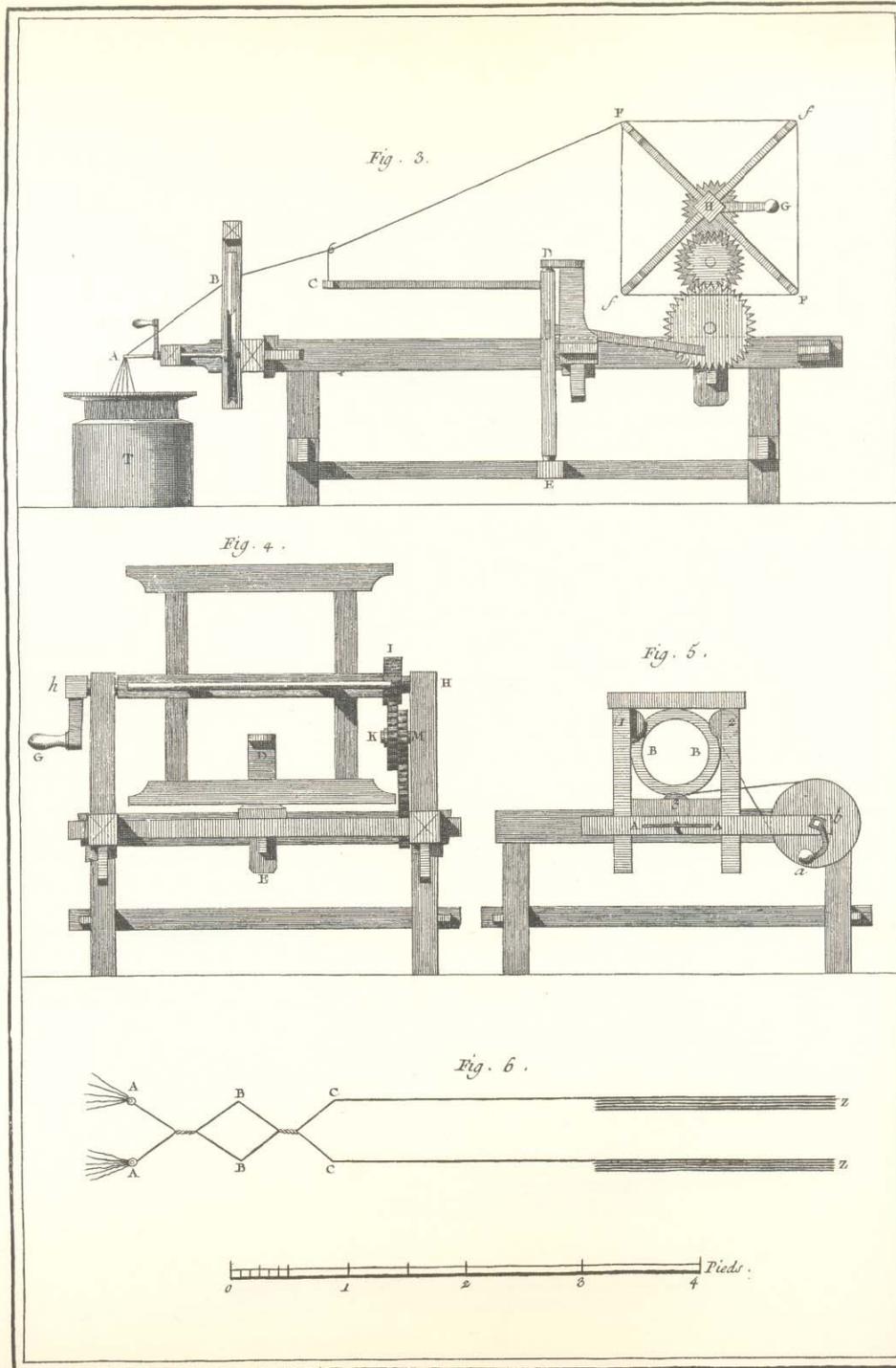


Goussier Del.

Bonard Fecit.

Soierie, Tour de M. de Vaucanson

Fig. 4. Silk making. Spindle of Mr. Vaucanson.



Goussier Del.

Bonard. Fecit

Soierie, Développemens du Tour de M^r. de Vaucanson.

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Fig. 5. Developments of Mr. Vaucanson's Spindle.

In this paper I analyze the introduction of this innovation in Spain, particularly in the main productive area, the region of Valencia, in the second half of the 18th century. I describe how the Enlightened reformist government intensely promoted its adoption, the main advantage in relation to former spindles being (according to the official discourse) that it could be handled by women, given that less physical effort was needed. Despite the fact that after some decades of uninterrupted financial and political efforts the diffusion achieved by the Vaucanson spindle was very limited, the interest of this case is that it fitted perfectly with the labor agenda of the Enlightened reformists: to increase women's labour force participation for two reasons: (a) because women's lower wages would lower productive costs and increase Spanish industrial competitiveness; and (b) because women's entrance in manufacturing would permit men's labour to be 'reallocated' into agriculture, public works and the armies.

2. The reeling of silk as a put out activity

The silk filament was first made into cloth in Ancient China; production of raw silk and later its weaving was introduced in Spain and Italy by the Arabs in the 8th century, where guilds of silk weavers existed in the early Middle Ages. The weaving of silk was then rapidly introduced to France, and to England in the 17th century when the Huguenots from France established.

The silk industry was based upon a complex integrated manufacturing cycle. The first stage, called sericulture, consisted upon the production of raw silk thread, unwinding (or "reeling") filaments of silk by hand from the cocoons produced by the larvae of silk moths. Cocoons were raised from silk worms tended by families that fed them fresh mulberry leaves. When they were mature, the cocoons were placed into very hot water to soften the sticky gum that holds the filament together. The ends of the filament is found and is then unwound. This process is called reeling. The silk filament was then put on to large reels, or swifts. Unlike cotton or wool, silk is not spun but twisted. Hence the term throwing rather than spinning. Throwing involves the revolving of two sets of bobbins at different, carefully adjusted, speeds.

The first stages of the production process took place in the countryside, as a seasonal activity: peasant women harvested the leaves of the mulberry trees from family mulberry orchards, feed the cocoons and prepared the silk filament. These preparatory stages constituted the basis of the entire silk industry, since the quality, resistance and shape of the thread obtained determined the quality of the yarn later produced. This is also explains why most technical innovations developed and eventually adopted by the silk industry referred to these preparatory stages. The rest of the stages (twisting, weaving, and dyeing), took place in the city, either in workshops under the guilds' control (such as the weaving and dyeing) or at home by women, such the twisting and the second reeling.

Although the recollection of the mulberry leaves and the rise of the cocoons had to be done at the farm, nothing prevented the reeling of the silk from moving to the city. This never occurred, though. For peasant economies silk was a totally commercial production, and thus an essential source of cash for small landholders. According to Ortells, in 1783 in the area of Valencia "most of the silk crop had to be woven by mid-June, because the rent had to be paid by Saint John (23 of June), and landholders need

to sell the silk in order to get the cash to pay the rent.” As it will be seen later, the heavily seasonal character of the crop conditioned the entire silk business, and particularly the organization of labour around the year, and accounted to a large extent for the decisions taken by the peasant-producers on the techniques and machines used.

State policies acknowledged this crucial role protecting its status of rural industry. Among the protective measures of the silk sector enacted by the State in the 18th century, the prohibition to sell the cocoon intended to guarantee the benefits of added value for farmers: “so that the farmer, with the industry of his Family, perceives the utility of the thread (...) It is forbidden the purchase of the cocoon, so that the Farmer, with his family’s industry, collects the utility of the yarn.” (Ortells, 1783, *Disertación*: 5, 7).⁴

This division of labour between town and country reflected in the two main figures in the silk business: the *Labrador cosechero* (Farmer collector of silk) and the *Comprador fabricante* (buyer manufacturer). The later purchased the silk thread in the countryside, and took it to the city to finish the process.

3. The introduction from top to bottom of the Vaucanson spindle in Spain

All over Europe, the second half of the 18th century witnessed the massive intervention of the State in the regulation of economic activity. In the context of deep changes in the trade positions of European countries, with Spain losing its economic and political power in front of the new powers, the Enlightened reformist governments identified, through writings, legislation and the support of private and public institutions, the expansion of the manufacturing activity as a central economic and political goal. Increase of industrial output meant a diminution of the serious trade deficit (with growing consumption of luxury goods being mainly satisfied with imports).⁵

The writings of Enlightened reformers became a powerful instrument of economic policy in the final decades of the 18th century. Thanks to the financial and political support of the State, they printed and diffuse their works, obliged schools and priests to read and transmit their ideas, and to act upon them. Very aware of the advances taking place in Britain, France and the Low Countries, and of the fact that foreign manufactures were preferred to the national ones for their quality and design, king Carlos III and his counsellors decided to set the basis for a process of industrial modernization, even changing traditional policies such as rejecting foreign influences. Spanish Enlightened governments became enthusiastic advocates of foreign methods,

⁴ This was probable the norm around Europe, with the apparent exception of Bologna. “In Bologna, silk twisting had been carried out since the fifteenth century in what can only be described as factories, but elsewhere silk reeling and throwing was largely a domestic and decentralized activity” (Davis, 1991: 88).

⁵ These words on Italy could very well define Spain: “The need to adopt and to adapt to the new technologies that were being developed elsewhere was certainly perceived to be a major problem by contemporaries, and from the mid-eighteenth onwards there were many Italians who saw the persistence of archaic techniques and methods of production as a primary reason for the failure to emulate the industrial expansion pioneered by the economies of north-western Europe” (Davis, 1991: 83).

manufacturers, technicians and technology. By importing them, they believed that the ‘problem was solved’ and Spain could catch up with European industrial powers.

The intervention and reform of silk manufactures was a central piece of this general plan of modernization of industrial activity. In the second half of the 18th century silk manufacture in Spain was of growing importance, particularly in a few areas where the complex integrated structure of the sector was more developed, although production of the raw material, cocoon, was extended by most of Central, South and Mediterranean Spain, where the climate was adequate. Its importance became strategic, given that the demand of luxury goods was expanding faster than the general demand for goods, and that silk was the preferred textile of the aristocracy, the Court and the Church to dress and to cover the walls and furniture of their palaces. Lyon and other silk centers in Italy and France had become strong producers, centers of technological innovations, and the origin of most of the expensive imports. But at the same time, increasing foreign and internal demand and rising prices worsened the structural problems of the sector, lowering the quality of the product, and paving the way for an industrial and commercial crisis already visible in the 1780’s.

In the main center of raw silk production in Spain, the region around of Valencia, production figures followed approximately this tendency:

Table 1. Silk production in the region of Valencia in the second half of the 18th century (in pounds)

1762	1770	1784	1791	1799	1810
1.150.000	2.000.000	1.500.000	701.603	560.293	557.264

Source: Martínez Santos, 1984: 93.

These figures are in agreement with figures provided by contemporaries: “It is commonly judged that, according to a prudential calculation, this Kingdom [Valencia] produces every year a million and a half pounds of Silk”, wrote in 1783 the parish priest Ortells (1783: 7), gathering the figure provided by the famous Enlightened botanic from Valencia Antonio José Cavanilles⁶. According to recent calculations using as a source the Guild’s official market of the city of Valencia, at least 400,000 pounds of silk prepared in the countryside were every year taken to the city and sold there, as an average, before the crisis that started in 1810 (Franch, 1990: 279).

In this context, references to the ‘Vaucanson spindle’ began to be found. The adoption of the *tornos de Vaucanson*, also defined as ‘modern spindles’, and the subsequent rejection of the traditional spindles, now defined as ‘old’, became the subject of publications, prizes, and campaigns of local and national reformers. In the following years a campaign to promote the new method was launched by the government, the societies of the enlightened, local institutions, and the Church (very interested in

⁶ *Observaciones sobre la historia natural, geografía, agricultura, población y frutos del Reyno de Valencia*, 1795.

promoting economic growth, as she was still collecting the decimal tax on output). Books and booklets were published praising the new invention, prizes were offered and granted; and members of the government, as well as civil and religious institutions, became involved in the diffusion of this technical innovation.

The first step took place in 1769, when Monsieur Reboul and his son were granted by king Carlos III a privilege to introduce in Spain the spinning of the silk “according to the invention of the famous machine maker Monsieur Vaucanson”. In partnership with another Frenchman, Joseph Lapayese, the Rebouls established the new factory, equipped with Vaucanson spindles, in Vinalesa, a league from the city of Valencia, one of the traditional centers of silk production in Spain since the Middle Ages, and still flourishing at the time. Despite the many problems, the factory consolidated and production passed from the 363 pounds produced in the first year to 2,615 in 1777. Lapayese remained in the direction of the factory when the Rebouls left. He published in 1779 the famous *El arte de hilar...según el método de Mr. Vaucanson [The art of spinning...according to the method of Mr. Vaucanson]*, where he presented the *Vaucanson a la Española*, a Vaucanson spindle modified by his young partner Toulot and himself, in order to solve the problems that had appeared. The book was soon to become the official statement on the right technology to be used in silk spinning.⁷

This initiative was followed by the government with the greatest interest. The minister of Finance, Miguel de Muzquiz, who had a property in the nearby of Sueca, a few kilometres from the city of Valencia, was going to become heavily involved in the project as well. In 1773, Muzquiz ordered the silk of his harvest to be reeled with four Vaucanson *tornos* established under the supervision of Reboul.

We have a detailed account of this story thanks to the work written in 1780 by the priest Francisco Ortells y Gombau, who witnessed the experience while in charge of the parish of Sueca. Published in 1783, the *Disertación descriptiva de la hilaza de la seda, según el antiguo modo de hilar, y el nuevo llamado de Vaucanson*⁸ was printed by order of the *Real Junta particular de Comercio y Agricultura*, heavily implicated in the diffusion of the new method. According to the priest, “wishing his Excellence that this new invention was perfected with no loss for the farmers, collectors and Industrials, according to the pious intentions of His Majesty, and in advance of the Silk Factories of this kingdom”.

Both the Valencia and the national Boards of Trade and Agriculture became enthusiastic defenders of the new *torno*, offering prizes to silk manufacturers and distributing Vaucanson spindles for free. The bishop of Valencia offered a prize for the best dissertation describing the two ways of spinning the silk, “with a practical and clear instruction so that the farmer can adjust and use the Vaucanson spindle in his barrack, occupying less soil than the old one” (Ortells: 14). This is the origin of Ortells’ book.

⁷ *Tratado del arte de hilar, devanar, doblar y torcer las sedas, según el método de Mr. Vaucanson...con los progresos de la fábrica de Vinalesa, en el reyno de Valencia...por D. Josef de Lapayese, Madrid, 1779.*

⁸ [Descriptive dissertation on the spinning of the silk, according to the old method of spinning, and the new one, called of Vaucanson. Dr. D. Francisco Ortells y Gombau, priest in the parish of Foyos, wrote it].

The main advantages of the Vaucanson spindle, as exposed in the writings by Lapayese and Ortells, were:

1. Greater cleanliness. In the old spindles, needles were glass made and (from the large pot in which the cocoons boiled to the distaff for spinning) had three large holes, through which many impurities and parts of the silk worm passed. In the Vaucanson spindle, the needle had 'very subtle holes', and so only the pure thread passed through. This was important for the manufacturers who bought the thread, because the perfection of the following stages (reeling, twisting and dyeing), and particularly the possibility of the thread to break, depended to a large extent of the quality of the thread, and impurities made it weaker.
2. Greater uniformity and beauty of the thread. The usual fraud of adding oil to the silk filament to make it heavier was diffculted by the much smaller holes.
3. Double crossing (or 'double cross') of the fibres before arriving to the reel, "doubtless the main advantage" of the Vaucanson spindle.
4. Opening up manufacturing to women in order to reduce production costs.

Given the apparent technical advantages of the new spindle, and the heavy institutional support to its adoption, a rapid and massive abandonment of the old technology would have been expected. But this was not the case. In 1789, twenty years after king Carlos III granted the Frenchman Reboul the privilege to introduce in Spain "the invention of the famous machine maker Monsieur Vocanson", the official balance of the effort suggests a clear failure. In that year the government discussed the possibility of implementing a regulation to impose the Vaucanson spindle as the only authorized mechanism to reel silk. This was finally rejected by the national Board, in a reasoned report written by Jovellanos, a famous Enlightened reformer, and then minister.⁹ Yet in Valencia, the Board of Trade did approve the project, although the available evidence suggests that this had no real impact on the sector.

But what is more important here is that on occasion of this debate a balance was made on the more than 20 years of attempts to introduce the Vaucanson *tornos* in the region of Valencia. The results were quite poor: asked for the amount of silk produced by the Vaucanson spindles, one witness told the Board in Valencia that the factory of Lapayese produced 4.000 or 5,000 pounds per year; 1,000 or 1,500 were produced by the factory maintained by the Guilds; Manuel Francisco de la Torre produced 600 pounds, "and may be some other could declare fifty or one hundred pounds" more. Less than 8.000 pounds out of a regional output of between 400,000 and 1.500.000 pounds of silk (see Table 1), was really a very modest result after more than 20 years and the amounts of money spent (Martínez Santos, 1981: 195), and suggest that the actual diffusion of the Vaucanson spindles was very limited.

Why were farmers so reluctant to adopt the Vaucanson *tornos* if these were such an improvement in relation to former spindles? It seems that they were not as clearly advantageous. Let see what the minister Jovellanos says in his report against the possibility of imposing by decree the Vaucanson *tornos*. Jovellanos was a firm believer in the benefits of free trade, and his opinions were always in favour of deregulation:

⁹ "Informe extendido en la Junta de Comercio y Moneda sobre sustituir un nuevo método para la hilanza de seda" [*Report issued by the Committee of Trade and Currency on replacing a new method for the spinning of the silk*], Gaspar Melchor de Jovellanos, *Obras* (1950), pp. 67-70.

whilst acknowledging problems in silk manufacturing (frauds, increasing competition on the part of England, and particularly France, “whose manufactures of silk are currently the object of our envy”), new regulations and prohibitions were never the solution for Jovellanos. Only personal benefit on the part of farmers and consumers (Smith’s “invisible hand”) could guarantee the adoption of a new machine or artefact.

Jovellanos began by pointing out to the important financial and political support already granted by the State to this invention. The “method invented by Vaucouson in 1750, introduced in Valencia by Mr. Roboull in 1759, and perfected the machine by Francisco Toullot, has achieved all the protection that could have wished from the Government.” The first obligation of the Government, “to diffuse the lights”, has already been accomplished.¹⁰ The work of Lapayese “has been so generously protected, despite being so scarcely propagated until this day”. Yet the feeble results came as no surprise to Jovellanos. Farmers’ scarce enthusiasm for the new spindles was explained because the old ones were “cheaper, easier to fix up, handier to use, more rapid and above all better known”. Besides, continued Jovellanos, the bad quality of the silk thread obtained with the old method was more due to the conditions under which silk reeling took place in the countryside, than to the *torno* used.

By all accounts, in fact, the new method had also its disadvantages: Vaucanson spindles were more expensive, more difficult to fix up in case of breakings, and consumed much more raw silk. Higher costs of production were expected to be compensated by the higher benefits obtained due to the greater quality of the silk produced. But this greater quality of the silk reeled had been obtained *in factories*, where workers were closely surveyed and a standard of quality higher than in domestic workshops was established.

Given that the new *tornos* did not seem to be a better technique for small silk producers, the question, then, was not why were farmers reluctant to adopt them, but why had the Vaucanson spindles been presented by the Enlightened reformers and governments as such a convenient technological innovation. To respond to this question we now must turn to the organization of labour, and most in particular to the gender division of labour.

4. A new spindle to change the gender division of labour in the silk industry.

As in most other industrial activities, one of the most characteristic features of silk manufacturing was the strict gender division of labour existing in the sector. Women took care of the silkworms, collected the fresh mulberry leaves and fed the cocoons, always trying to keep a stable temperature.

“Peasant women around the kingdom take an immense work in the rise of the silk worms: they do not eat not sleep with calm until seeing the recollection concluded, and each quality of cocoons separated; and at the

¹⁰ “Having being published the art of spinning the silk by don Miguel Gerónimo Suárez, the one by don José de la Payese, the one by don José Antonio Valcárcel, an instruction formed by Mr. Roboull and translated by the same Valcárcel, and other little treaty by the priest of Foyos, that is an abbreviation of the method of la Payese”. All quotes are from the Report, in Jovellanos, *Obras*, p. 69.

moment of taking out the cocoon this is taken from their hands so that men can perfection it, as if they were not able to spin he silk, or as if Men had not at the same time that employ themselves in the spinning other tasks that women can not do.” (Ortells, 1783: 40-141).

Women were also in charge of classifying the cocoons, a task requiring a great deal of expertise to identify by their aspect the higher quality silk producers, separating them from the defective, etc. According to Ortells, men were in charge of the reeling of the silk in most places. “With the exception of the villages around the city of Valencia, nowhere women reel the Silk...only men understand the reeling of the silk...there are male Reelers extremely skillful and intelligent in the Art” (Ortells, 1783: 135). This argument that nowhere women spin the silk was not true. Ortells himself mentions “the exception of the villages around the city of Valencia” and in the first pages of the book mentions that “male and female spinners” were obliged to pass an examination.¹¹

Furthermore, we have abundant evidences of women reeling silk in places in Spain other than Valencia. In Talavera de la Reina, province of Toledo, near Madrid, a later famous royal factory was created in 1748 under the direction of the lyonnaise Jean Ruliere and financed by the king Fernando VI. Specialized in velvet silk and golden and silver yarns, and catering mainly royal and noble families in Madrid, and the Church, the factory employed around 1,000 workers, of which between 20 and 25 per cent were silk spinners, all of them women, including masters and apprentices.¹²

In any case, in the region of Valencia men were the ones mostly winding and reeling the silk. This was the key point of the arguments, since the new spindle was presented as necessarily worked by women (since it was a lighter artefact), which means that its introduction would carried out a radical change in the existing division of labour. This was seen by Ortells as both the main advantage of the new spindle and the main obstacle to its adoption.

The minister Jovellanos himself, in his report of 1789 refusing to accept further protection for the *tornos de Vaucanson*, accepted, nevertheless, the establishment of public schools for learning the spinning of the silk, “for women and girls, according to the Vaucanson’s method”, as well as the distribution of prizes and spindles to the best disciple girls, and “to the farmers in which household a wife or daughter knows how to spin with the new method”. This distribution of helps, recommended by Jovellanos to the government as the solution to the problems of the sector, “will have the following advantages: firstly, it will diffund the new method and its advantages...secondly *it will concentrate the art of reeling the silk in women, subtly banishing the male spinners, and with them their old spindles*; and thirdly it will introduce the use of the spindle in the sharecropper families, and once settled in them together with the method to use it, it will pass traditionally from one generation to another.” (my italics).

¹¹ “It is ordained the exam of Male and female Spinners, so that only those who understand it with practice enough work in the Silk Trade” (Ortells, 1783, *Disertación*: 5, 7).

¹² Peñalver Ramos, 2000. The preparation of the silk thread was done by women in other countries: in Italy winders were women, “who nearly always worked outside the town” (Massa Piergiovanni, 1993: 548), but spinners, weavers and dyers were men, or their female relatives.

The fact that the new spindle permitted women to perform a task previously done by men appears as its main advantage. Why was this, according to its defenders, so important?

The silk industry had developed in the region of Valencia to provide raw material for other silk manufacturing regions, such as Toledo or Granada. But by the 18th century these centers were declining, whilst Valencia had become the main silk producer area. The importance of the local growth of mulberry trees, and the increasing production of raw silk, eventually led to the development of a local industry to process it.

The unwinding and preparation of the silk thread was a very seasonal activity. Mulberry leaves were collected in the second half of May, and from that date onwards, a rapid period of preparation and commercialization began: almost 70 per cent of total sales of silk in Valencia took place every year in the period between June and August. "This was no doubt due to the entrance into the market of the small collectors, who needed to rapidly sell their reduced production in order to face the more immediate charges affecting their holdings. Only in the months more distant from the recollection season the large producers and speculators, who benefit from higher prices, entered into action" (Franch, 1990: 278). It is likely that a gender division of labour developed here by which women tended and cared for the cocoons whilst men unwinded and reeled the silk, very fast and using heavy machines, which allowed them to end the job in a few weeks.

What was the problem with this? First, the quality of the silk thread was poor. Rapidity was much more important than quality of the product, and fraud was widespread. As in most put out manufactures, there was very little room for control of the manufacturing process at home, and the result was, according to contemporary reformers, bad quality thread: dirty and oily because (although it was strictly forbidden), oil was put into the process to facilitate the separation of the filament and make the thread heavier. This aroused increasing complaints from the merchant manufacturers and was thought to be a cause of low competitiveness. A greater quality of the silk produced was, according to its defenders, one of the main advantages of the new spindles.

A second reason linked the new machine with a change in the gender division of labour. In the silk industry, the unwinding and reeling of the silk was men's task, and this meant a scarce supply of male labour for other tasks, that is, increasing wages and higher labour costs. Since the Middle Ages and as a result of the agricultural techniques practised by the Muslims, the region of Valencia was an area of irrigated agriculture. In the 18th century, increasing demand for food by urban and export markets was followed by the expansion of the irrigated land, among other crops with mulberry trees, and created one of Spain's most dynamic agricultural economies. Yet as the priest Ortells pointed out, and contemporaries were well aware of, in regions with irrigation the demand for (mostly male) labour was much higher. Precisely because silk production had developed in regions of irrigated agriculture (because mulberry trees demanded water) the problem of high wages and scarce supply of male labour was more acute here. Supply of male labour was insufficient to meet the demand in these regions, and high wages were the consequence. On the other hand, while the government was aware of the need to increase industrial and commercial competitiveness, intensification of textile industries was not possible with highly paid, guilded male workers. Women and children would allow for lower production costs and greater benefits.

In this context, the *tornos* de Vaucanson, worked by women, appeared as a helpful mechanism in the attempt to redefine the gender division of labour. If men would return to agriculture, and women and girls would take over the spinning of the silk, both agricultural and industrial prices would lower, and silk manufactures would gain competitiveness in urban and foreign markets. The enthusiastic defence by the State of the new technology must be understood within the context of the Enlightened agenda to reshape the gender division of labor.

5. The Enlightened agenda to reshape the gender division of labour as a policy for economic growth.

In 1774, fourteen years before the priest Ortells wrote his passionate defence of the Vaucanson tour, the most influential reformer and politician of the second half of the 18th century, Pedro Rodríguez de Campomanes (1723-1802), published his *Discurso sobre el fomento de la industria popular*. The impact of this work was exceptional. Hoping to use it as a privileged instrument to divulge the 'lights', 30,000 copies were printed at the expenses of the State, and king Carlos III ordered their distribution to every society, reformist group, town and parish priest in Spain and in the American territories. Intended as a bible of economic reform for impoverished Spain, the *Industria popular*, as it was popularly known, advocated rural manufactures as the best strategy for the country's economic recovery. Rural manufactures would allow for the population to combine agriculture and industry, would solve the problem of seasonal agricultural unemployment, prevent migration to the cities (and thus political unrest) and keep industrial wages low. Domestic industry, and not urban factories, was the solution to the lack of industrial growth.

One of the most interesting points of Campomanes' model was his conviction that an *adequate* gender division of labour was crucial for economic development. And that, on the contrary, the fact that the existing gender division of labour in Spain was a wrong one was one of the main causes accounting for the country's economic and social backwardness. According to the social structure of Ancient Regime societies, in which nobility, clergy and people (to whom members belonged by born) had very different social rights and duties, the foundation of 18th century economic thought on the division of labour was the conviction that social groups had a natural origin (they were defined by Nature, in turn created by God). To each group corresponded a different a function, and thus social differences were nothing more than the expressions of naturally (godly) determined different places.

The division between women and men, defined as two different species, with radically different intellectual and physical capacities, legal rights and economic functions, was also fundamental for the economic organization of society. Women and men were born different, and governments had to ensure that this natural order was respected and maintained. As often has been pointed out, there was however a deep a contradiccion in the fact that gender differences were always described as natural or God-created (in any case, pre-social), when at the same time so many mechanisms and efforts were developed to ensure that gender differences were created, learned, and imposed. Many examples show how governments and the Church inspired, implemented and continuously reinforced this policy: one was the educational system; another, the internal organization of workhouses for the poor, where girls were taught the necessary

abilities to become good wives or servants, whilst boys were taught the jobs demanded by guilds or sent to the public works or to the Army.

According to Campomanes, female labour had to be employed in manufactures and domestic services, whilst men should be employed in the Army, public works and agriculture.

“Women from 15 to 20 years old can be taught at the expenses of the State many exercises that are now occupied by men with damage of the society, such as cooks, hairdressers y certain works of passementerie, forming in this way servant girls of good morals, well instructed in the Christian doctrine and (...) In this way it will cease the indecency that men comb women’s hair, it will diminish the number of male Cooks, and many other trades that in themselves are womanish and improper of men will be restituted to the sex to whom they belong.”¹³

It was not simply by moral convenience. Wages played a major role. Prices of both agricultural and industrial commodities had been rising for the entire century, with the subsequent social unrest, that was becoming a real political menace. For Enlightened reformers, the reason of increasing agricultural wages was the scarce supply of men, caused by their preference to work in manufactures, in domestic service under the protection of a noble family, that is, in ‘light’ works more proper of women (Sarasúa, 2005)¹⁴. The constant flow of poor men and women to the cities, while at the same time (as foreign and national travellers noted) the countryside was abandoned and agricultural production was incapable to feed the population, was seen as a central problem to solve. Men should be taken out of textile manufactures. Campomanes had already identified the problem when discussing in 1778 why textiles produced in Madrid were so expensive. “A weaver of ordinary cloth makes more than 10 reales per day”, which is caused “for two reasons: the short number of weavers, who have their clients imploring them, and the prices of the fabrics rised”, and the fact “that this operation is performed by men”, for which there is no reason, because in Northern Spain “women are the ones who weave the cloth”. Men should, then, be replaced by women, because these

“will be happy to make five reales per day instead of 10, now paid to the male weavers. I must insist that the public administration is obliged to to employ women in this and similar works, and the way to achieve it is teaching girls and no men.”

In fact, the first battle of this war was to be fought against the guilds, which excluded women from the manufactures of luxury goods. Despite repeated admonitions, the

¹³ Campomanes, *Las cinco clases de pobres* [The five classes of Poor people], 1778.

¹⁴ In fact, tasks defined as ‘feminine’ were not the physically light jobs. For instance, laundry, which was recognized even by the contemporaries as the hardest of all ‘trades’, was always done by women, both as part of their domestic duties and as a professional activity (Sarasúa, 2003). Probably other factors played a role here: laundry was mostly privately done (women did not have to share the public space with men to do it); was very poorly paid; had absolutely no social prestige; and lacked a guild tradition.

Guild of Silk Cord-makers of the city of Valencia made the government furious in 1779, for its resistance to accept that girls be taught the trade.

“Having my Council noticed how harmful it was for the fomentation of industry...the exclusions established by some of their Ordinances of women from the works which are more proper and suitable to their sex than to men’s, who for their robustness and strength seemed more convenient to be applicable to agriculture, the armies and navy; and having present the fact that the Guild of Silk Cord-makers, Passementerie and Button Makers of the City of Valencia has pretended to prevent that a School to teach the Girls all the relative to the industry of cord-making be established, as it was projected by the Sociedad Económica de Amigos del País of that said City...We order: that with no pretext you prevent, obstacle, or by the guilds or other people be prevented or hindered, the teaching to women and girls of all those works and artifacts that are proper of their sex, and that they can freely sell, by themselves or on their own account, the manufactures they make.”¹⁵

Both for political reasons (increasing urban population was seen as a serious danger of political unrest since the 1766 revolt against Carlos III, later reinforced by the 1789 Revolution in France) and for economic reasons, the Enlightened reformers attempted to stop the flow of population to the cities. Their ideal of economic and social unit was the rural agricultural/industrial family: families living in small holdings, with men working (mainly) on the fields and women (mainly) on the looms; families self-regulating their supply of labour according to the seasonal needs of the demand; men and women living on very low wages thanks to their high degree of self-sufficiency (orchards...).

Silk manufacture was a very labour-intensive industry and, despite the high cost of the raw materials and machines, wages accounted for a high percentage of total costs.¹⁶ This explains the interest in reducing labour costs, and replacing male by female labour was the simplest and easiest way of reducing them. Average daily wage for unskilled male workers was, according to Campomanes, 4 or 4’5 *reales*, while by working at the looms at home, women and girls could make 1 or 1’5 *reales* per day (Sarasúa, 2004: 185). Manufacturers and merchants themselves were doing the same in other European countries in the face of increasing foreign competition. In the Bologna ‘silk district’ studied by Poni, while the sector of dyed silks entered in crisis, white silks remained competitive “partly through agreements among manufacturers and also by taking on women and children as workers in order to reduce costs” (Massa Piergiovanni, 1993: 559).

¹⁵ *Real Cedula of 12 of January, 1779 by which is ordered that with no pretext be prohibited or obstructed, by the Guilds of these Kingdoms or other persons, the teaching to women and girls of all those works and artifacts that are proper of their sex, despite the regulations that in their Ordinances may the Masters of the respective Guilds have.* The fact that guilds continued to obstruct the entrance of women in a number of trades was one of the main reasons after the dissolution of the guilds that European governments implemented since the last decades of the 18th century.

¹⁶ In Italy, for instance, 30-35 per cent of the total production costs, although the biggest part was to weavers (Massa Piergiovanni, 1993: 546-547).

CONCLUSIONS

This paper has described the adoption of a technical innovation in the second half of the 18th century, when European societies were becoming increasingly aware of the importance of modern, 'advanced' technology to increase industrial competitiveness. Because the State was strongly implicated in this process, a very articulate and strong discourse was constructed and diffused around these innovations, and the State itself, together with Enlightened reformers, became the main agent responsible for the transfer of both technology and qualified workers from foreign countries.

Adoption of technical innovations can not be separated from its effects upon the existing labour organization. This can even be the main reason accounting for the failure or success of the process of adoption of an innovation, be this organizational or technical. Workers reacted in front of innovations, to the point of ensuring their success or making impossible their introduction. In 18th century Europe, the gender division of labour was strict, and every agricultural, industrial or services activity was labelled masculine or feminine (although labels often had opposite meanings in different place). Furthermore, regulations and prohibitions heavily restricted women's access to education and paid occupations. Labour policies oscillated between the need for a massive mobilization of the labour force to expand the supply of labour and thus to increase industrial competitiveness, and the need to maintain a family structure based upon the unpaid work of women and girls, and perceived as basic for social stability. In such context, contemporaries were very aware of the strong impact of technical innovations (both machines and tools, and systems of organizing the work) upon the existing gender division of labour.

By using as a case study the introduction in Spain of the Vaucanson spindle for silk reeling, massively supported by the State since the 1770's, it has been possible to see (a) how a technical innovation was introduced as 'male' or 'female'; (b) that the fact that the new tool changed the traditional gender definition of the task was not relevant, which confirms that the gender identification of tasks is a social (re)construction; (c) how the fact that the new machine implied a redefinition of the gender division of silk reeling was seen as its main advantage by its defensors; and (d) that the main argument of the advocates of women's greater participation in manufactures was the much lower wages paid to them. Only this justified women's paid work.

According to contemporaries, there were two main advantages in silk reeling performed by women with the new Vaucanson spindles. The first one, at the microeconomic level, was to lower labour costs. The feminization of a formerly male task, such as silk reeling, had an important impact on costs for the manufacturer, because women were paid much less. Although defenders of the new invention mentioned other advantages related to the better quality of the produce as well, the final and more decisive argument to adopt it was women's lower wages. The second advantage was at the macroeconomic level. The new spindles could be handled by women, and this was consistent with the policy of reshaping the gender division of labour, facilitating women's work in manufactures and men's work in agriculture, public works and the armies. In short, the advantages of the model defended by Campomanes (employing women and girls in domestic manufactures) were: (a) to make industrial commodities cheaper, while at the same time (b) ensuring an abundant supply of male labour in agriculture (and as a

result, cheaper agricultural products), and (c) guaranteeing women's paid work compatible with their domestic obligations.

It can be concluded, in the first place, that as the gender division of labor is a cultural construction, the identification of certain tasks, and particularly of the use of certain techniques, tools, devices or machines, as 'masculine' or 'feminine', has constantly changed over time and between countries or regions. In fact, the same opinion-makers (politicians, reformers, technicians) who defined as masculine or feminine certain tasks, or prohibited women to perform certain jobs, or to enter certain occupations, were ready to use the opposite arguments if this was convenient for their interests. This also shows that the usual arguments justifying men's monopoly of certain jobs because of their greater physical strength were easily forgotten were other interests were at stake.

The second conclusion is the decisive role played by wage differentials in the constant redefinition of the gender division of labour. Women's lower wages permitted greater benefits, particularly in labour-intensive sectors. This of course has historically not sufficed to guarantee the hiring of women's labour. In the 19th and 20th centuries, powerful counter-mechanisms, such as unions and labour laws favouring men (mostly passed as a result of pressure from male unions) acted against the hiring of female cheaper workers (Sarasúa and Gálvez, 2003). But in the late 18th century, the State was determined, despite the resistances, to reallocate both female and male labour in the benefit of economic development. Women's place was domestic manufactures. They produced goods at a much lower cost there, whilst at the same time working for free for their family and household. To the extent to which they helped this project, technological innovations were enthusiastically supported by the State.

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