

## THE ARRIVAL OF THE FIRST ARKWRIGHT MACHINE IN CATALONIA

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In early November 1789 two English machine-makers, John Waddle and Joseph Caldwell, arrived in Barcelona, carrying with them a model of Richard Arkwright's spinning machinery. They had reached the city from England by various, big stages. The first had been to France. It was there it seems likely that they had initially sought their fortunes before deciding to transfer to Spain, a good prospect for employment at that moment as it approached the peak of its eighteenth century prosperity. They discussed the move with the Spanish ambassador in Paris on July 12th 1788 and were provided with passports by him to travel to Madrid. In Madrid they were supported for a year by the Government while they proved their skills in spinning and carding cotton and machine-making<sup>1</sup>. In October the Conde de Floridablanca, first secretary of state, acceded to their desire to transfer to Barcelona. Explaining his decision to the Catalan Intendant, Juan Miguel de Indart, Floridablanca pointed out that as the state was already involved in two cotton manufactures, that of Avila, founded the previous year, and one in Madrid, it was not felt justifiable to sustain expenses in a third establishment. He invited the Intendant to make use of the machine-makers by placing them in some manufacturing concern which could then diffuse their skills<sup>2</sup>.

Indart duly made his preparations, instructing the city's Junta de Comercio to check immediately on the Englishmen's arrival whether their «*avilidad... en su ejercicio de hilar, y cardar algodón, y de hacer maquinas...excede a lo que aqui se ha adelantado*»<sup>3</sup>. This arrival was in early November: Waddle and Caldwell entered Barcelona laden with 120 kilograms of baggage, including their machine, and bringing with them too, already, a reputation for hard-dealing - «*los de su clase y nacion son por lo comun dificiles de contentar, y casi siempre desagradecidos*», the organizer of their trip from Madrid wrote adding that their travel expenses of 20 reales each a day had already been paid in case they should claim otherwise<sup>4</sup>. They were told on arrival to present themselves before the city's Junta de Comercio.

The presence of the two machine-makers in Madrid, for a year, at the very time that two of their compatriots, Thomas Milne and John Berry, were involved in the parallel enterprise of founding the Royal Manufacture of Avila, and then their sudden release for Barcelona,

1. Biblioteca de Catalunya (henceforth BC), Junta de Comercio (henceforth JC), legajo (henceforth leg), 23, number (henceforth no.) 19, f. 68, letter of Junta de Comercio to the Intendant.

2. Letter of Intendant Indart to the Junta de Comercio reporting on correspondence with Floridablanca, printed in F Torrella Niubó, *El modern resurgir textil de Barcelona (siglos XVIII y XIX)*, (Barcelona, 1961), p. 161.

3. BC, JC, Registro (henceforth reg.) 12, Acuerdos, 26 Oct. 1789.

4. BC, JC, leg 23, no.19, ff. 7-8.

requires brief comment. Milne and Berry had also arrived from France via the Spanish ambassador, arriving some months before Caldwell and Waddle, in early 1788. It is possible then that the introduction of Caldwell and Waddle represented an insurance policy on the part of the Spanish government in case Milne failed to develop the capacity to build Arkwright machinery in Madrid. As it turned out it took Milne a long time to perfect his machinery – approximately a year and a half– despite his having brought skilled workers with him and his final success probably owed a considerable amount to the contribution of a third machine-making unit operating in the capital since 1787 –that of Régnier (three of whose spinning, and one carding machine were transferred to Milne in May 1789): doubts thus over the viability of Milne’s enterprise were not probably misplaced. The success was achieved towards the end of 1789– at the same time that Caldwell and Waddle were released. It seems reasonable to argue, therefore, that there was a link between these two events – assured now of the viability of Milne’s machine-making, Floridablanca felt free to exercise largesse towards the Catalan industry. He mentions the existence already of two cotton manufactures, we have just noted –the second of these was in fact probably Milne’s machine making workshop where he had just completed the set of machinery. Machine making at Avila was only undertaken following this first achievement<sup>5</sup>.

Waddle and Caldwell were to spend nearly two years in Barcelona. In the central section of this paper I shall describe in some detail what is known of their experiences before using this description as a basis for making some general observations about technological diffusion in a conclusion.

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The two English «artistas» answered the summons to appear before Barcelona’s Junta de Comercio on November 11th 1789 in the company of an interpreter from the city’s «escuela de comercio». The interview, in front of the full committee of the Junta<sup>6</sup>, was a formal and, doubtless for the two English artisans, nerve-racking occasion. Asked about their skills they replied that «sabian cardar y hilar algodón por medio de una Maquina que trahen, que en esta hecha en grande podrian colocarse cerca de quatomil usos de los quales saldria un hilo tan perfecto como las muestras que presentaban». They were then shown a room in the Stock Exchange and asked whether it would be «proporcionado p<sup>a</sup> colocar la citada Maquina q<sup>e</sup> ellos trahen». On receiving an affirmative response they were instructed to set up their machine there «â fin de experimentar sus efectos» and also to draw up a calculation of «las utilidades y ventajas q<sup>e</sup> produzca d<sup>ha</sup> maquina» so that, assured of its viability, the Junta could proceed to «discurrir y providenciar el establecim<sup>to</sup> de una Maquina en grande por medio de una asociación». It would seem that a trial of the machine was then carried out in the Intendant’s presence<sup>7</sup>. Negotiating the terms under which they were to work proved difficult. The Junta wanted to lower the daily rate which they had been receiving from 20 to 15 reales. To this proposition Waddle and Caldwell «se resistieron por much tiempo» threatening to return to Madrid. The Junta, however, called their bluff «considerando...ser infundada d<sup>ha</sup> pretencion» – 15 reales it was to be!<sup>8</sup>.

In the course of December a further demonstration of the machinery took place, in the presence of Joaquim Roca Batlle, the spokesman to whom responsibility over the affair had been handed, and «sujetos practicos en la hilanza y ...fabricantes de mosulinas», in the rooms in which the English artisans were lodging. The experiment was carried out on the mini-

5. G Martín García, *La Industria Textil en Avila durante la etapa final del Antiguo Régimen: La Real Fábrica de Algodón*, (Avila, 1989), pp 218, 229, 241, 328, 344; A González Enciso, *Estado e industria en el siglo XVIII. La Fábrica de Guadalajara*, (Madrid, 1980), p 562.

6. The Junta de Comercio was presided over by the Intendant and composed of 12 members, a secretary and treasurer P Molas Ribalta, *Comerç i estructura social a Catalunya i València als segles XVII i XVIII*, (Barcelona, 1977), p 267.

7. Such a demonstration in front of the Intendant is mentioned in the report of Roca i Batlle, the vocal of the Junta delegated to handling the affair – BC, JC, leg. 23, reg. 19, ff 27-8, 17/12/89.

8. BC, JC, Reg. 12 Acuerdos, 11 Nov. 1789.

machine which they had brought with them- a small Arkwright machine with 6 spindles, powered by hand. In addition to carrying out the demonstration, the English artisans passed on information relating to the new technology - including estimates of the cost savings which would result from its use, details of the form in which it would be introduced into the Principality, its labour requirements and the costs involved. With respect to the first item, they provided a cost breakdown for spinning 100 lbs (English weight) of cotton showing a saving of some 70%. The other details, submitted in English by the artisans, were as follows:

### Cost and composition of assortments

1000 Spindles will cost £3 Sterling per spindle

10 Carding Machines	at	£72	£720
3 Drawing Machines		£50	£150
3 Roving Machines		£80	£240
18 Spinning Machines Containing 1000 spindles		£105 each	£1890
			£3000

### Specification of labour requirements for assortment

To pick the Dirt from the Cotton	9 Women
To attend the Carding Machine	10 Boys
1 Master Ditto	1
Drawing Machines	9
for the Roving Machines	12 girls
Ditto for the spinning Machines	30 girls or Boys
D° 2 Masters	2
To reel the yarn after spun	10
To weigh the yarn and make it up for sale 1 Man and 2 Boys	3
To Clean the Machines etc. 1 Man and 4 boys	5
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The spokesman from the Junta de Comercio was convinced by the demonstration and the accompanying documentation, reporting back to the Intendant that the English workers had demonstrated an «avilidad ... de sacar por medio de la Maquina q<sup>e</sup> han manifestado el Algodon hilado, y torcido con mayor finura, y mucho menor coste del q<sup>e</sup> tiene hilado y texido por los medios regulares». But though the advantages of the new processes had been demonstrated the manner of attaining their introduction to the city was proving difficult to resolve - he stated in his report that he had «pulsado varios fabricantes» - in view of a loss of confidence in the future of the sector following the recent removal of tariffs on the import of Asian textiles from the Philippines. In view of the cotton manufacturers' reluctance to adopt the machinery for this reason Roca questioned if some merchants might not be induced to invest in it. Whatever happened, he urged, it was essential to ensure that the machines should be «plantificadas...y manifestadas al publico las ventajas que producen premiando a d<sup>hos</sup> Artistas Ingleses»<sup>9</sup>.

9. BC, JC, Reg. Acuerdos, 17 Dec. 1789 and leg, 23, no. 19, f. 11, instruction to committee members of JC, f. 13, calculation of spinning savings, ff. 14-15, make-up and labour requirements of assortments, ff. 27-8, report of spokesman of JC on experiment. On the concerns of the Catalan industry about the removal of protection on cotton production as a consequence of a 1789 concession to the Philippines Company to import cloth from Asia see BC, JC, leg. 51, no. 20, fo. 2, 16 June 1790.

Following Roca's favourable report, three other spokesmen of the Junta were ordered to join him in taking the necessary steps to form a project to introduce the new machinery and thus both benefit «el Estado» and «el Publico» and also provide «el competente acomodo y premio para dhos artistas». A preliminary to achieving this, this group decided, was the carrying out of a public demonstration of the machine in front of the city's muslin manufacturers. This time, the demonstration was a more thorough one, the little machine being used for an hour at a time on three different qualities of American cotton. What are referred to as «los experimentos» undertaken with the new machinery were recorded with due scientific precision and the following calculations were drawn up to demonstrate the cost advantages which would accrue from their adoption to supplement the earlier estimates provided by the English workers:

«Calculo prudencial sobre el beneficio que ha de resultar al establecimiento de unas Maquinas que se propone Plantificar por movimiento de Agua para cardar e Hilar Algodones, hilando de una vez Mil hilos, en consecuencia de tres experimentos que se han hecho con las maquinas de los Ingleses, qe hilan solos seis hilos de una vez, saver:»

### Capital costs

Cost of machinery according to English artisans	18,000 pesos
Cost of land and buildings for machinery	<u>8,000 libras</u>
Total cost of land and machinery	33,200 libras
Interest on this sum at 6%	1,992 libras

### Running costs and raw materials of equipment per day, calculated on the basis of a 280 day working year

libras	sols denarios		
Daily cost of equipment and building on basis of 280 day working year	7	2	3
2000 libras for maintenance and «recomposition» of machinery on basis of 280 day working year	7	2	10
400 libras a year for maintenance of a man and horse to transport cottons	1	8	7
For 100 days work for men and women at 10 sols	50		
For subsistence of English artisans	6		
For 93 lbs of raw cotton which are needed to spin 69 lbs, 8 ounces 12 ardamas, 32 granos which it is calculated 1000 spindles produce in virtue of experiments done on the three qualities of cotton	39	10	6
Salaries of one or more directores and other employees or dependants need in the «House of Direction» in Barcelona rent of this house and other unanticipated expenses, 4000 libras	14	5	9
<b>total</b>	<b>125</b>	<b>9</b>	<b>11</b>
costs per lb of cotton	1	16	
market price of cotton	2	12	6
profit per lb		16	6

The demonstration had thus been a successful one, justifying taking the matter further with the English artisans. Difficulties in their respect however were encountered in agreeing on terms: it is clear that bargaining was hard - «se les ha instado varias vezes y siempre han

permanecido a lo mismo», the four spokesmen noted on one stage of the discussions. Threedifferent propositions were considered - the first was that they should be paid a daily fee of 30 reales each for life and the right to a 1/3 of the machinery which they built for their own use, in a second they were to receive the same fees but to be paid 1000 pounds sterling in lieu of receiving the machinery and in the third the conditions were as for the first but with a ten year limit on the fees and on the share of the machinery built and a reduction to a 1/5 in the size of this share. The original versions in English of the first and third proposals are to be found in the archives of Barcelona's Junta de Comercio as follows. There is a significant

### **Waddle and Caldwell's 1st terms for the introduction of Arkwright's technology**

«We propose to be supply'd with Proper Persons Money and all necessary Materials to erect a house for Carding, Drawing, Roving and Spinning Machines Containing 1000 Spindles Drove by Water or as many more as may be found necessary to supply this country with Cotton Yarn.

We being first secured to have betwixt us one third part or share of all the Machines of the aforementioned sort that shall be erected in this Country, as we will give all the Necessary Direction and assistance in our power to perfect the same. Also to allow each of us 30 Rs vn per day during our lives»

### **Waddle and Caldwell's 3rd set of terms**

«We propose as at first to instruct the people of this Country to Erect Machines for Carding Refining and spinning Cotton also to instruct them in the art of conducting the said Machines to the utmost of our powers to bring the said Fabric to perfection, and we expect to Receive for our support 30 Rs. Vn. each for our support for the term of ten years, also for our Gratification a fifth part Share and interest of the Machines that may be erected not less than one thousand Spindles and of as many more as they shall think proper during the time of ten years, the aforesaid fifth part or share is to be our own property»

change of wording between the two proposals as well as change in the terms offered. As can be seen whereas in the first proposal the emphasis is on Waddle and Caldwell playing an entrepreneurial role in creating a «house for carding....», in the second emphasized is the role of instructing Catalans in machine-making and the use of machinery<sup>10</sup>.

In fact the formula finally adopted appears to have represented a reversion to a variation on the second proposition. This is revealed by the contract which was drawn up two days after the spokesmen had filed their report to establish a commercial company to last for ten years to exploit the machinery. At the bottom of the draft of the document which was shown to them, Waddle and Caldwell added that they «consent to the abover Article except that we will be entitled to one thousand pound share of the said Machinery, instead of 1/5 part of the profits» adding that the «£1000 part or share is to be Considered as our Gratification for teaching and instructing thepeople that is necessary to be employed in the said fabric in all our secrets that is Necessary to bring the said fabric to perfection»<sup>11</sup>.

A condition of the forming of the company was that it should be given a monopoly in the use of the new machinery for ten years and that the rumour of the repeal of the legislation permitting Phillipine imports of cotton cloth should be confirmed: the existence of these conditions, and the news of the successful public demonstration of interest in the machinery, served finally to arouse the interest of the industry in the project. Within a week fifty four

10. BC, JC, leg 23, no. 19, f. 12, estimates on costs; f. 20, terms offered by English; ff. 23-4, demonstration in front of muslin weavers.

11. Condiciones y pactos, signed 23/1/1790, BC, JC, leg 23, no 19, ff 25-6.

calico-printers met to consider the founding the company. A third set of figures had been drawn up to publicize the advantages of the venture: it demonstrated the «Beneficio que ha de resultar a la Compa General que se propone establecer en Barcelona de capital 50,000 pesos [c. 70,000 libras] para la Plantificacion de unas Maquinas de cardar e Hilar de Algodones por medio de dos Artistas Ingleses al solo objeto de fomentar en esta Provincia la hilanza de Algodones». The sum was to include 24,000 pesos for the cost of the machinery and 26,000 for the purchase of cotton and other expenses. Interestingly the English craftsmen based their calculation of the cost of machinery on the «wage rates in Madrid» - a sign that their activities there had proceeded beyond the demonstration of their model. The calculations for profit were based on the figures resulting from the January 21st demonstration, however it was added that the potential for profit was still greater than had been estimated then, the English artisans having provided assurance that «con el movimiento de agua mucho mas rapido y mas igual que con la mano, hilaran 114 libras catalanas» in the day (nearly double the amount of the previous estimates). The 70,000 libras, or 50,000 pesos, were to be financed by the issuing of 100 500 peseta shares and these found a ready market - 60 were snapped up immediately at the meeting. The extent of interest in the enterprise is further illustrated by the holding of a second meeting four days later which was attended by a further twenty printers<sup>12</sup>.

In the course of these meetings concerning the company, however, a contrary viewpoint to that of the manufacturers concerning this monopolistic manner of introducing the machinery had emerged among the committee of the Junta de Comercio. Its holder was one Mateu Civil, a merchant from a cloth-making background, and on the same day as the second meeting of calico-printers he put forward an alternative method for achieving the introduction of the English artisans' machinery<sup>13</sup>. This involved the imposing of a form of a tax on all those with interests in spinning in Catalonia - he reckoned some 120 manufactures were in this position - to provide the some 41,900 reales (or slightly under 4000 libras) which he calculated was the annual cost necessary to purchase the Englishmen's skills and then to make the skills and the machinery generally available with instruction in its use open to everyone «por ser lo que conviene a su fomento y no solo el algodón si también del cañamo y Lino». On the calico-printers' proposal for a company with a monopoly for ten years he commented: «no conviene y lo tengo por perjudicial para el objeto de que se trata, quando este fuese de mayor importancia y riesgado podría convenir en cuyos casos no estamos por lo que no deve privarse el publico por diez años de un bien que puede disfrutar por el medio propuesto»<sup>14</sup>.

The disagreement, it is evident, was the occasion for heated discussion and debate. Some traces of it have been left in the documentation. The Directors of the city's Royal Spinning Company claimed that the adoption of the Junta's spokesman's project «no les facilitaria, antes bien podría estorvarles»<sup>15</sup>. The group of Civil's colleagues on the Junta de Comercio who had been involved in promoting the spinning project at an earlier stage was more subtle in its distancing itself from his proposal: «opinamos ser el mas sólido y laudable», they noted, «si se hallase quien lo abrasase pues que podría mas pronto propagarse al Publico la habilidad de dichos Ilados». On the other hand they advised checking on the 25 to 30 manufacturers whom Civil claimed supported his project for their own sounding out of manufacturers' opinion about such a project had not suggested that it would be favoured - «podría V.S.», they warned the secretary of the Junta, «verse con el chasco de no hallar quien lo abrasase»<sup>16</sup>.

In view of the at best lukewarm reaction to his first proposal, Civil, on February 11th, put forward another. This, this time, involved the Junta itself financing the purchase, and

12. BC, JC, reg. 12, Acuerdos de 28 Jan. & 1 Feb. 1790; leg 23, no 19, f 22, estimates re profits; ff 25-6, «conditions and pacts» concerning monopoly and Philippines company; ff 35-6, project for society.

13. Molas Ribalta, *Comerc*, pp 158, 281.

14. BC, JC, leg. 23, no. 19, f 39, «Proyecto para conseguirse con prontitud quanto an ofrecido los dos Ingleses».

15. BC, JC, leg. 23, no 19, f 29, recurso to the intendant, 4 Feb. 1790.

16. BC, JC, leg 23, no 19, f 32

manufacture, of the new technology and thus controlling the diffusion process. If the Junta felt that the financial commitment that was involved was too great, then, the spokesman claimed, the outlay could be recovered by selling the machine in units of 56 spindles and providing instruction in its use for 200 pesetas (some 1000 reales or 92 libras) and licencing its use over the ten year period for a similar sum<sup>17</sup>. It is in this connection it is clear that a fourth calculation of the cost savings of the new technique was made in terms of such units of 56 spindles, entitled «Calculo echo del Algodon hilado en la Maquina Inglesa especulado sobre seis hilos, y arreglado en otra maquina de 56, que suponen ser las regulares de Agua»<sup>18</sup>. The proposal was, however, no more attractive to the calico-printers than the first. Four days later 55 of them met and of these 51 came out in favour of the monopolistic company. A solitary voice only, that of Erasmo Gonima, (but a significant one, he was the most notable industrialist of his generation), spoke out for the principles of competition - he favoured the proposed company, he said, «menos lo de la privativa por diez años, puesen quanto â esto se conforma en la libertad que propone el Sr vocal fiscal»<sup>19</sup>. The conclusions of the meeting were reported to the Junta de Comercio - «resulta â pluralidad de votos que se mantenian en adobtar el Proyecto de la sociedad, y en manera alguna el que proponia el Sr. Vocal fiscal; declarando que admitirian en la refda sociedad a qualquier fabricante de esta clase del Princo que quisiese interesase; sin haver havido quien por si solo, ni con otros, quisiese entender en abrasarlo por si solo, ni con otros, abrasarlo por mas que se viese la ventaja que comprendra»<sup>20</sup>.

Nor was the second plan of Civil any more to the liking of his rivals on the Junta de Comercio. They by now were confirmed in their views that «en manera alguna, en comun, ni en particular» would his first proposal find backing and the speed of the diffusion of the new machinery consequent upon adopting the second would make it impossible, they argued, for the Junta to recuperate their investment. In view of this they advocated the opting for the printers' monopolistic company, justifying their choice in terms of the printers now being prepared to allow anyone to join it<sup>21</sup>.

It befell the Junta as a whole to make a recommendation for a final decision by its superior body, the Junta General de Comercio. This it did on March 1st. It opted for Civil's second project insofar that «es el que proporciona mas pronta transcendencia al Publico de las utilidades de las Maquina» but recommending the initial project of the monopolistic company if the Junta General should not approve its using its resources for industrial purposes, as would be necessary for the second option, justifying the fall back position in terms of it being better than dismissing the English technicians<sup>22</sup>.

The need to obtain a go-ahead from the superior body, however, had the result of bringing the affair to a complete halt for nearly a year and a half. A series of letters requesting action, both from the Junta and the Englishmen, fretting at the inaction, brought no response. Alternative strategies were suggested - including allowing the mechanics to contract with individual manufacturers. No response, however, and, again, bad humour characterized the negotiations in this connection with the Englishmen: rather than take up the idea with respect to a machine for wool production they stated that they planned to depart «otra vez a la Corte para poderla colocar en las fabricas de Segovia, y otras que la superioridad hallase por conveniente»<sup>23</sup>. Perversely the Junta General then requested an explanation for the lack of progress in May 1791. In their reply the Barcelona Junta blamed the failure on the English and their «excesivas demandas, y reservadas explicaciones». A month later Floridablanca

17. Proposal of 11 Feb., 1790, reprinted in Torrella Niubb, *El moderno resurgir*, p 163. Manuscript copy in BC, JC, leg 23, no. 19, ff 37-8.

18. BC, JC, leg. 23, no. 19, f. 18.

19. BC, JC, reg. 12, Acuerdos, 15 Jan. 1790.

20. BC, JC, leg. 23, no. 19, ff 43-5.

21. BC, JC, leg. 23, no 19, ff 47-50.

22. BC, JC, Acuerdos, reg 12, 1 March 1790, ff 209-11.

23. BC, JC, leg. 23, no. 19, ff. 59-60.

requested copies of all the paperwork connected with the case, having mislaid his. Having gone over the affair again, he wrote to the Barcelona Junta requesting them to send the English machine back to Madrid so that it could be transferred to Avila for comparison with the machinery, resolving thereby «las [the machine] que se han de preferir»: only then, he pointed out, would he be able to issue a «providencia sobre el expediente que esta pendiente». The request arrived just too late to be acted upon - on August 6th the Englishmen, having renewed their passports with the Capitania General on the 4th, and then waited two days in order to pick up their daily 15 reales allowance (paid in advance until August 17th) had left for Madrid. The Junta was furious: «le es muy sensible que dhos Ingleses con la cautela con que han desaparecidos hayan dexados infructuosos los muchos pasos, providencias, proyectos y gastos que acompañada con el celo, y concurrencia de V.S. ha empleado para le logro de este bien publico», it complained to the Intendant<sup>24</sup>.

Had any form of diffusion of Arkwright's technology occurred in Barcelona during the nearly two years during which the English machine-makers had resided in the city? The appearances are that there had been none. There is no evidence of the Englishmen having done any actual machine-making during their stay. Some had been on the point of taking place in February 1792. This is revealed by a comment in the report of the Junta de Comercio's spokesman concerning the second of his two projects for diffusing the machinery - that which proposed the selling of machines in units of 56 spindles: the Junta is going to be able «Por de pronto...disponer la construcción de una Maquina de 56 Usos, y que operen con ella los Maestros Ingleses para que se verifiquen los buenos efectos que prometen», he noted. But the lack of response of Floridablanca to the Junta's requests for a decision would seem to have frustrated even this small, but crucial, step forward. Nor had the existence of the model of the machine provided a means of technical diffusion. The Englishmen had carried out their demonstrations, it was reported, «con cierto modo cauteloso para que se viesen los buenos efectos de su máquina y no pudiese comprender, ni su construcción, ni su manejo, y jamás quisieron permitir se sacase modelo de ella sobre que se instó muchas veces con esfuerzo, pues si se hubiese podido conseguir quedaba logrado todo lo que se descaba, respeto que mediante un modelo no havia faltado aquí a Artifice que la hubiese construido, y quien la hubiese manejado para sacar de ella las utilidades que promete; pero nunca pudo lograrse que se conformasen, antes bien lo resistian constantemente»<sup>25</sup>. The only bargaining power which the English artisans possessed consisted in restricting knowledge of their technical skill - it is clear that they had hung on to their secrets at all costs.

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This well documented example of a failed attempt to introduce the Arkwright technology in Barcelona between 1789 and 1791 serves to illustrate a number of facets of the new cotton technology, attitudes to it and mechanisms by which it was introduced.

As can be seen, the machinery was intended to be introduced in sets, sets whose size in fact accorded with that of the Arkwright patents and patent licensing practices in England<sup>26</sup>. The imprint of the English influence thus extended beyond the actual character of the machinery to impose itself potentially on the form of enterprise. It could be divided into smaller units and, as we have seen from this case, there was an awareness of this and an awareness, too, of the social implications of adopting one or the other type of unit for the diffusion of the new technology.

A rather theoretical approach is apparent in the planning stage for introducing the machinery - experiments are carried out, impressive calculations made, over-optimistic

24. BC, JC, acuerdos, reg. 12, acts of 22 July, 29 July, 18 Oct. 1790; 5 May, 12 May, 16 June, 11 Aug. 1791; BC, JC, leg. 23, no 19, ff 59-60, report from Roca Batlle; f 55, letter of Intendant, f 68, letter of Junta de Comercio to Intendant, 11 Aug. 1791.

25. BC, JC, leg 23, no 19, f 68; see also J Carrera Pujal, *Historia política y económica de Cataluña*, (4 vols., Barcelona, 1943-7), IV, pp 240-3; Carrera Pujal includes a description of these events. See also James Thomson, *Els orígens*, pp 298-302.

26. See SD Chapman, *The Cotton Industry in the Industrial Revolution*, (London, 1972), p 28.



estimates of the capacity of the new machinery to satisfy the local yarn market hazarded and, of course, the actual difficulty of the movement from project to implementation underestimated. The organizational difficulties involved in determining how to commercialize the machinery have been fully documented, the technical problems involved in introducing such a complex technology were not even begun to be experienced because of these organizational issues. In fact it is quite unlikely that Caldwell and Waddle would have been able to establish the manufactures which they promised. - Thomas Milne's example bears this out as does the gradual process by which the Arkwright technology is adapted in Catalonia later in the decade.

What does stand out in the history is the conservatism of the industry towards the introduction of the new technique and its preference for a corporative enterprise over individual initiatives for exploiting the machinery. Such characteristics of the Catalan industry at this stage have, however, already attracted comment<sup>27</sup>. Of interest, too, are the conflicts in attitudes towards technological diffusion revealed which are partly responsible for the failure of the initiative. Three approaches can be identified: that of the manufactures favouring monopoly, which has a weak, potential, theoretical justification in terms of the need to recompense the financing of innovation and thus, it could be argued, sustaining incentives to innovate, that of a part of the Junta de Comercio, which is representative of the cutting edge of the Spanish Enlightenment which had favoured the spread of industry to relieve poverty since Campomanes's *Discurso sobre el fomento de la industrial popular* of 1774, and that of Floridablanca and the Consejo de Castilla which can be seen to fluctuate between a theoretical support to diffusion - such a principle determined the dispatching of Waddle and Caldwell to Barcelona - but a practical need to protect its own enterprises which is apparent, we have argued, from the timing of the permission to allow the two Englishmen to set off for Barcelona and possibly also from the failure to expedite their initiatives once they arrived there.

A final insight provided by the material concerns the cultural gap between the English workers and the Catalan environment in which they found themselves. They arrived, we noted, expecting to be able to found and build and run their own concern for which they would be «supply'd with Proper Persons Money and all necessary Materials», they soon became reconciled to the fact that their role would be a secondary one only - building machines and training local labour to use it, finally they were confronted with a situation of such administrative breakdown that they were forced into a situation of total inactivity. Eventually it seems that they learned to play the game as circumstances dictated - we have seen their threat to leave for Segovia and John Waddle indeed ends up working for the Duke of Infantado in a cotton mill established at Santander<sup>28</sup>. They experienced, we have seen, a sharp conflict of interests too with the other parties interested in their venture, one to which the failure of the episode was frequently attributed. This, surely, is to make them into scapegoats. More fittingly, arguably, the vigilance which they showed in protecting their interests, maintaining secrecy about their methods and ensuring the regular payment of their allowances to the very end, in fact to beyond the very end, in what must have been a difficult environment for them, merits some admiration.

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27. See for example A Sánchez, «Los inicios del asociacionismo España: La Real Compañía de Hilados de Algodón de Barcelona, 1772-1780», *Hacienda Pública Española*, 108-9, (1987), pp 253-68.

28. J.C. La Force, *The Development of the Spanish Textile Industry*, (Berkeley, 1965), p 81.