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John Banks: an independent and itinerant lecturer of natural and experimental philosophy at the threshold of the English industrial revolution

Luiz Carlos Soares[·]

Abstract

In eighteenth-century England, courses of natural and experimental philosophy delivered by independent and/or itinerant lecturers, whose textbooks and syllabi were based on Newtonian physics, became the main instruments for spreading and popularizing the idea of applied science. This effectively represented the application of the results of scientific knowledge to the population's needs and to the production of the material components of life. Thus, the activities of independent and/or itinerant lecturers, with their courses and publications, helped to spread knowledge on the principles of mechanical and experimental science among the men who became protagonists of their country's transformation into the first industrial power in the world. One among those lecturers was John Banks (1740–1805), who offered courses and specialized knowledge on mechanical physics and machinery to many manufacturers, engineers and mechanics, who stood at the forefront of England's industrial transformation and was himself one of the main intellectual exponents of this process.

Keywords

John Banks; Independent and itinerant lecturers; Natural and experimental philosophy, Industrial Revolution, England

John Banks: um professor independente e itinerante de filosofia natural e experimental no limiar da Revolução Industrial Inglesa

Resumo

Na Inglaterra do século XVIII, vários cursos ministrados por professores independentes e/ou itinerantes de filosofia natural e experimental, com seus manuais e programas de aulas, baseados, sobretudo, em teorias físicas newtonianas, constituíram-se nos principais instrumentos na disseminação e popularização de um ideal de ciência aplicada, que preconizava a aplicação efetiva dos resultados do conhecimento científico às necessidades da população e da produção da vida material. Assim, os cursos e publicações dos professores independentes e/ou itinerantes contribuíram a tornar acessíveis os princípios da ciência mecânica e experimental para aqueles que foram os protagonistas da transformação da Inglaterra na primeira potência industrial do planeta. Entre estes professores estava John Banks (1740–1805), que oferecia seus cursos e conhecimentos especializados em física mecânica e máquinas a muitos industriais, engenheiros e mecânicos que estiveram à frente no processo de transformação da produção industrial da Inglaterra, constituindo-se ele mesmo num dos principais expoentes intelectuais deste processo.

Palavras-chave

John Banks; Professores independentes e itinerantes; Filosofia natural e experimental; Revolução Industrial; Inglaterra

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[·] Fluminense Federal University, Rio de Janeiro, Brazil. ✉ luizcsoares@globo.com. The present is a modified version of an article published in Portuguese in *Revista Brasileira de História da Ciência* 5, no. 1 (2012): 171-82.

Introduction

In eighteenth-century England, various courses taught by independent and/or itinerant professors of natural and experimental philosophy, with their textbooks and syllabi mostly based on Newtonian theories of physics, were the main instruments for the dissemination and popularization of the idea of applied science, which effectively preached the application of the results of scientific knowledge to the population's needs and the production of the material components of life.[1] The courses and publications by independent and/or itinerant lecturers thus contributed to making the principles of Newtonian experimental science and mechanics accessible to those who would become the protagonists of the transformation of England into the first industrial power in the world.[2]

Many independent and/or itinerant lecturers carried out their activities in various English cities, as well as in Scotland, Wales and Ireland. Some of these became famous and had a very comfortable standard of living, such as John Theophilus Desaguliers (1683-1744), Benjamin Martin (1704-1782), James Ferguson (1710-1776), Benjamin Donn (1729-1798), Adam Walker (1731-1821) and John Warltire (1725/6–1810).[3] However, none of them was as specialized

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[1] For a more general analysis of the activities of independent and/or itinerant lecturers, see Luiz Carlos Soares, "O Mecanicismo Newtoniano e a Ideia de Ciência Aplicada na Inglaterra do Século XVIII", In *A Albion Revisitada: Ciência, Religião,Ilustração e Comercialização do Lazer na Inglaterra do Século XVIII* (Rio de Janeiro: FAPERJ; 7 Letras, 2007), 38-68.

[2] To understand the impact of Newtonianism on eighteenth-century English culture and on the development of the idea of applied science, which became a powerful intellectual lever in the process of social change that resulted in the Industrial Revolution, see: Robert E. Schofield, *The Lunar Society of Birmingham: A Social History of Provincial Science and Industry in Eighteenth-century England* (Oxford: Clarendon Press, 1963); Albert E. Musson, & Eric Robinson, *Science and Technology in the Industrial Revolution* (Manchester: Manchester University Press, 1969); Albert E. Musson, & Eric Robinson, *James Watt and the Steam Revolution* (London: Adam & Darta, 1969); Margaret C. Jacob, *Scientific Culture and the Making of the Industrial West* (New York: Oxford University Press, 1997); Margaret C. Jacob, & Betty J.T. Dobbs, *Newton, Culture of Newtonianism* (Amherst: Humanity Books, 1995); Margaret E. Jacob, & Larry Stewart, *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687-1851* (Cambridge: Harvard University Press, 2004); Thomas L. Hankins, *Science and the Enlightenment* (Cambridge: Cambridge University Press, 1985); Roy Porter, *Enlightment: Britain and the Creation of the Modern World* (London: Allen Lane, 1985); Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002); Joel Mokyr, *The Enlightened Economy: An Economic History of Britain, 1700-1850* (New Haven: Yale University Press, 2009).

[3] Soares, "Mecanicismo Newtoniano". For the trajectories of John. Desaguliers and Benjamin Martin, see Luiz Carlos Soares, "John Theophilus Desaguliers: Um Newtoniano entre a Patronagem e o Mercado," *Revista Brasileira de História da Ciência* 2 (2008): 82-95; John Theophilus Desaguliers: A Newtonian between Patronage and Market Relations," *Circumscribere* 18 (2016): 12-31; "Benjamin Martin: Professor Itinerante, Fabricante de Instrumentos Científicos e Divulgador da cCência Newtoniana na Inglaterra do Século XVIII," in *Anais Eletrônicos do XXV Simpósio Nacional de História: História e Ética* (Fortaleza: Associação Nacional de História – Universidade Federal do Ceará, 2009). An excellent biographical study about Martin is provided in John R. Millburn, *Benjamin Martin: Author, Instrument-maker and 'Country Showman'*

in mechanics and in the knowledge of machines as John Banks, from the town of Kendal, who from the 1770s to the beginning of the nineteenth century enjoyed great success as independent and itinerant lecturer.

From 1775 to 1800 Banks published four editions of his book, *An Epitome of a Course of Lectures on Natural and Experimental Philosophy,* in which he presented the entire content of the courses he delivered to the public.[4] In 1795 he also published an important treatise on machines and factories entitled *A Treatise on Mills, in four parts*, at a crucial moment for the English industrial development, in which steam engines and the systems of machines based on them began to spread across the cotton textile industry, which was a pioneer in the use of modern machinery and in the creation of the large mechanized capitalist factory. Therefore, this treatise was not written for amateurs, apprentices or the many people who attended Banks' courses, but it rather targeted specialists and individuals with knowledge of the problems of mechanics, machines and engines (both hydraulic and steam), presenting situations with a solid mathematical approach.[5] Banks presented his treatise to many industrialists, engineers and mechanics who were leading the process of transforming the English industrial production, thereby establishing himself as one of the leading intellectual exponents of this process.

A textbook of natural and experimental philosophy for the general public

Between the early 1770s and the first decade of the nineteenth century, John Banks, from Kendal, Cumbria, worked as an independent and itinerant lecturer on Newtonian natural and experimental philosophy. Carrying scientific instruments and a complex apparatus to perform experiments, Banks traveled to various English towns, especially in the north of the country, which was then preparing for the striking socio-productive transformations that would result from the establishment of a large mechanized industry.

Banks prepared for his students and others who attended his classes a textbook entitled *An Epitome of a Course of Lectures on Natural and Experimental philosophy*, published for the first time in 1775 in Kendal. In the preface of this book, Banks emphasized that it was the result of the "request of a great number of [his] subscribers at different places," and it was principally meant "for the use of those who have attended [his] course of experiments." However, the author also indicated his textbook for those who had not yet had "the opportunity" to discover

(Michigan: Noordhoff International Publishing, 1976). For the trajectory of James Ferguson, see John Millburn, *Wheelswright of the Heavens* (London: Vade-Mecum Press, 1988).

[4] John Banks, *An Epitome of a Course of Lectures on Natural and Experimental Philosophy* (Kendal: W. Pennington, 1775), second edition (Kendal: W. Pennington, 1789), third edition (Kendal: W. Pennington, [s.d.], certainly from the 1790s); and fourth edition (Kendal: W. Pennington, 1800). Actually, there is not a much difference among the four editions of the book. The second, third and fourth editions were rather reprints with few corrections and different printing format.

[5] John Banks, *A Treatise on Mills, in four parts* (London & Kendal: W. Richardson & W. Pennington, 1795).

"the first principles of the sciences, provided they [would] be content with naked assertion, without either mathematical demonstrations or experiment proof."[6]

We might assume that although not all the students or individuals attending the classes were acquainted with natural and experimental philosophy, Banks designed his textbook to teach the basic concepts and principles underpinning this discipline, as well as seeking to provide experimental evidence for the understanding of various natural phenomena. As he stated:

> "This course is intended to explain, in the most easy, and familiar manner, the general properties and laws of matter; and to set before the inquisitive mind, the causes of the most material phaenomena which we observe amongst natural bodies; at least, so far as discovered (...)."[7]

Educated in the principles of a moderate eighteenth-century enlightened scientist, in accordance with the preferences of the English Newtonians, Banks showed in his writings to be an authentic theist, in other words, a very religious man, who believed in the existence of an "all powerful God", whose works in the creation of the universe and the establishment of the laws of nature would never be fully understood by man. Banks admitted that "the works of infinite wisdom [could] never be fully comprehended by the faculties of man," even, "when assisted with instruments," could achieve much, while those works "[would] seem almost equally indeterminable." However, in spite of this human limitation for the knowledge of nature, he also admitted that

> "(…) the philosophers of the present age, tho' still wholly ignorant of the true causes of many the most common phaenomena, have nevertheless, by diligent enquires and experiments, gained the knowledge of many equally unknown to our forefathers, and by them, perhaps deemed incomprehensible; and there is no doubt but in future ages, science will continue its progression".[8]

The end of the quoted paragraph is a clear indication that Banks agreed with the enlightened "epistemological gradualism" that advocated the existence of a "Science" which developed and was improved "progressively", as had been taught since the second half of the seventeenth century by the inductivist and empiricist tradition of English natural philosophy. Banks also sought to expand this idea, arguing that the "progressive" development of "Science" was fundamental for the constitution of society itself and that it ought to be "providentially appointed, as some way necessary for the carrying on, or well-being of society, that the sciences should be gradually improving."[9]

Nevertheless, in spite of placing himself within the field of enlightened rationalism, unlike many of his contemporaries Banks did not adopt a "deterministic" posture. For him, the

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[6] John Banks, *Epitome of a Course, 3rd* ed.

[7] Ibid., 5.

[8] Ibid., 6.

[9] Ibid.

"progress of Science" was not always the result of the human rational capacity, but could arise by chance or from accidental situations. Thus being, he stated:

> "Yet still it must be acknowledged, that many things are known, which reason could never have led us to the knowledge of. But whilst man has been diligently seeking after one thing, he has accidently, or rather providentially, hit upon, or discovered another, of greater importance, and of more extensive utility to mankind".[10]

Regarding the use of philosophy, and more specifically natural philosophy, Banks admitted that this was "almost unlimited, and [might] be recommended to people of all ranks." Within a perfect Neo-Platonic tradition, he insinuated that philosophy could help us get to know the essence or the real dimension of the phenomena, "many things [appeared] to be, what in reality they [were] not." He completed his reasoning as follows:

> "Thus to the eye, unassisted by philosophy, the sun appears to be a flat shining plate, the stars to be small lucid points like diamonds, and all at equal distances from us; and seem to revolve round the earth in twenty four hours, while the earth seems to be fixed, and to be by much the largest body in the universe".[11]

Speaking about what he considered to be "competent knowledge in philosophy," Banks reiterated his alignment with the English and British Neo-Platonic empirical tradition, established in the middle of the seventeenth century by Henry More (1614-1687), Isaac Newton (1643-1727) and other philosophers from Cambridge. Banks emphasized that:

> "(...) a competent knowledge in p[h]ilosphy will strip things of the disguise and false colours under which they appear; or rather instead, as is too commonly supposed, of contradicting the plain and positive proof of the senses, evince, to the most unanswerable demonstration, the impossibility of their appearing otherwise; and from those very appearances deduce the most convincing arguments to support its own assertions; thus will it furnish the mind with more just and sublime ideas, by removing the errors of prejudice, received by false education, custom, or the authority of men".[12]

Yet, reinforcing a more pragmatic dimension of the English Neo-Platonic empiricism (which emerged in the seventeenth century and was accentuated by the Newtonian experimentalist mechanism), Banks emphasized that philosophy "[was] of universal utility to mankind," above all because "it [was] concerned in the invention and adjustment of machines". According to him, to this more pragmatic philosophical dimension,

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[10]Ibid.

[11] Ibid., 6-7.

[12] Ibid., 7.

> "(…) we owe the construction of ships, steam-engines, water-engines, pumps, mills, clocks, watches, dials, telescopes, cranes, jacks, the organ, harpsichord, and every other kind of instrument, machine, or engine how ever complicated, or for what ever purposes they are appointed".[13]

Banks also discussed his concerns about the "teaching of Philosophy as a Science" and revealed how many "natural philosophers", or the ones who disseminated the idea of "Natural Philosophy" (as was his case), still cultivated an idea of "Science" as broad logical and rational knowledge, which had originated in scholastic concepts in the thirteenth century, and included the various fields of philosophy, but which had not been totally superseded by the end of the eighteenth century. Obviously, the consolidation of the idea of modern science would definitely invert this relationship in the following century, giving sciences a more specific or objective nature and placing philosophy in a more general and abstract dimension. In the second half of the nineteenth century, some (more radically positivistic) conceptions even tried to 'expel' philosophy from the sciences for the sake of combating 'metaphysics,' which the former represented. However, as we have shown above, at the end of the eighteenth-century Banks was still engaged in other issues of epistemological nature.

In his explanation of "teaching philosophy as a science," Banks reinforced the need to adopt an inductivist and experimental methodology, which was the foundation of the entire tradition of English science, which he embraced:

> "In teaching philosophy as a science, it is necessary to begin with the most simple and known properties of bodies; and thence to proceed, by inferring one truth from another 'till we arrive at the most abstruse parts; always sing experiments where the nature of the thing will admit of it, except that which is asserted be sufficiently plain without. And although the experiments afford the highest degree of entertainment to the rational mind; yet so much the more instruction will they convey, as this regular process is more attended to and better imprinted on the memory".[14]

The outlines and organization of *An Epitome of a Course of Lectures on Natural and Experimental Philosophy* did not differ much from what had been presented in various textbooks written by independent and itinerant professors of natural and experimental philosophy during the eighteenth century. Banks' textbook was neither as deep nor as detailed as the textbooks written by some of these teachers, notably John Theophilus Desaguliers, Benjamin Martin, James Ferguson, Benjamin Donn, Adam Walker and John Warltire. However, the manual prepared by Banks provided the basic content for those who wanted to start learning natural and experimental philosophy, which continued to attract many interested persons at the end of the eighteenth century.

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[13] Ibid., 7-8.

[14] Ibid., 8.

Banks organized the chapters according to the tradition of this kind of textbooks, that is, according to the lectures delivered. In his case, it was organized as follows: Lecture I – "Of the general Properties of Matter"; Lecture II – "Of Pneumatics"; Lecture III – "Of Hydrostatics"; Lecture IV – "Of Hydraulics, &c."; Lecture V – "Of Electricity"; Lecture VI – "Of Optics"; Lecture VII – "Of Mechanics"; Lecture VIII – "Of Geography"; Lecture IX – "Of Astronomy". At the end of the book, a poem by Richard Blackmore (a relevant English poet from the turn of the seventeenth century) is reproduced, and there is also an explanatory appendix with the technical terms used by the author in his classes. It should be noted that in the fourth class on hydraulics there is a description of a steam engine by Richard Newsham (d. 1743) and other steam engines, but not specifically the one invented by James Watt (1736-1819). This engine was known at the time, but Watt (in partnership with Matthew Boulton (1728-1809) had just obtained patent rights for it from the Westminster parliament, which hindered the description of its details and specifications.[15]

A treatise on factories, machinery and engines for a specialized public

John Banks' second book, *A Treatise on Mills, in four parts*, was a very specialized book with a profoundly mechanical, mathematical and experimental approach, mainly targeting professionals with vast knowledge on this field, such as mechanics, engineers and industrialists. It contained a large number of problems and experiments about various aspects related to factories, machines and engines. The four parts in which *A Treatise on Mills* is organized, according to its frontispiece, were the following: Part First – "On Circular Motion"; Part Second – "On the Maximum of Moving Bodies, Machines, Engines, &c."; Part Third – "On the Velocity of Effluent Water"; Part Fourth – "Experiments on Circular Motion, Water-Wheels, &c". Inside the book, however, the four parts are entitled somewhat differently: Part I – "On the Laws of Circular Motion, the Ratios of Projectile and Centrifugal Forces, the Periodic Times, &c."; Part II – "To Investigate the Velocity of a Machine; the Ratio of the Power and Resistance being given"; Part III – "On the Velocity of the Flowing Water"; Part IV –"Experiments on Circular Motion". It should be noted that the second part includes a specific section on steam engines, describing various mathematical problems about their operation.[16]

In the preface, Banks states that all the experiments in the fourth part, and some of the ones in third part, were presented at the classes and courses he had taught over 20 years (certainly from 1775 onwards). However, "at the request of many of [his] hearers", he had sought to make these experiments public through his book and although he "has prefixed few problems on circular motion", Banks really believed that, "in order to know the powers of

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[15] Ibid. The explanatory appendix is entitled "An Explanation of Technical Words, Terms, &c., Used in the Foregoing Lectures" (pp. 122-7). For the description of steam engines, see pp. 65-7. In relation to the steam engine developed by James Watt in partnership with Matthew Boulton, see Robert E. Schofield, *Lunar Society of Birmingham*, Musson, & Robinson, *Science and Technology;* and Musson, & Robinson, *James Watt*.

[16] John Banks, *Treatise on Mills*, 85-95.

different wheels, or which [were] best able to overcome an obstacle, it [was] necessary to know their central forces".[17]

The problems on the circular movement discussed had a practical purpose related to the obtainment of a better return from machines and improve their operation. Banks sought to clarify his intention better:

> "Where different powers are compared, as in Prob. XII, &c., they are supposed to act upon the wheel, while they descend through the same space. When a wheel or fly, of any given weight or magnitude, has received a given degree of velocity, no more power is required to continue that velocity, than what is sufficient to overcome the friction. Yet if it moves twice as fast, it will require four times the former power to continue that motion: hence, one would be apt to infer, that the friction increases with the square of the velocity. – In a water-wheel, the same power is not constant; for the same particles act upon the wheel during only a part of a revolution; their places are constantly supplied, or they are succeeded by others which act for their time, &c.: hence, a water-wheel soon acquires a uniform velocity".[18]

Banks admitted that in his country there were "many intelligent engineers, and excellent mechanics," as well as "others who [could] execute better than they can design." He regretted that "there would not have been so much money expended in attempting what men of science know to be impossible." Here, in real life, Banks sought to attribute value to the work he did as a "man of Science" through the projection of problems or in the conception of solutions likely to increase the effectiveness of machines or engines. These tasks could not always be carried out by "executors" (engineers and mechanics).[19]

Banks was trying to say that engineers and mechanics, overwhelmed by their daily tasks, were often unable to develop daring, creative and effective solutions for the problems they faced regarding machines and engines. In the present time, we know that the author's statement needs to be strongly relativized and that there were examples of engineers and mechanics who fully contradicted Banks' position, and who were responsible for significant technological innovations within the context of the English industrial revolution. However, for Banks, audacity, creativity and effectiveness could generally be found among the "men of Science" who did not accept the limits of knowledge and sought to alter or "invert the laws of nature." In this regard, he states:

> "When a man tells me he can construct a water–wheel in such a manner that, when once put in motion, it shall raise water to keep itself moving. Or that he has constructed a pump in such a manner, that one man may do the work of ten, &c. I pay the same attention to him, as if he told me he could create a system of

[17] Ibid., v.
[18] Ibid., vi.
[19] Ibid., viii.

worlds, and command them to move. Or, is he less to be credited who says he can communicate perpetual motion to dead matter? Both are indirectly saying, I can reverse the laws of nature".[20]

The concern with obtaining a better return from machinery and motors through experiments runs across Banks' book, such as, for example, in the explanation of problems related to the speed of machines in the second part, where he states that "Many of the problems in this part are intended not only to prove that a given power can only produce a given effect but at the same time to demonstrate what the greatest effect is, which a given power can produce (…)"[21].

Speaking about the experiments in the third part, "on effluent water", Banks also shows a concern with the effectiveness of mechanization, highlighted above, saying that these experiments "[differed] considerably from any theory; and, contrary to expectation, more water is discharged, in proportion, from small than large apertures". Banks also indicated that these experiments on the greater "quantity of water discharged", "through small holes", "in a given time", were carried out through "different processes" and "all of which [brought] out nearly the same conclusions", and that the "rules" derived from them "[would] be found sufficiently accurate in practice".[22]

It is interesting to note that Banks emphasized that although he had "much practice in making experiments," he "[had] not trusted entirely to [his] own observations." For this reason, in the experiments in the third part, he "[had] been assisted in the whole, by one or more gentlemen well acquainted with the subject," and does not forget to mention his oldest son and his wife. Afterward, he presents a list of collaborators, in a sort of acknowledgment:

"At Coventry, by the Rev. Mr. Banks, of Monks Kirkby, by Messrs. Baines, Watson, Decas, &c., of Liverpool, by Mr. Priestley, and Mr. Peckover, of Bradford, by my eldest son, and by my wife, who, *though a woman*, is perhaps as accurate in making experiments in philosophy, and some branches of ch[e]mistry, as most of men".[23]

Speaking about the experiments about circular movement in the fourth part of the book, Banks emphasizes that they "[were] sufficiently accurate to prove the truth of the theory, and the utility thereof, when applied to the construction of machines". They were considerations of a more epistemological nature, which sought to follow the empiricist and experimental tradition of the English natural philosophy, without leaving aside its utilitarianism or pragmatism. Thus, he complemented its reasoning:

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[20] Ibid.

[21] Ibid., ix.

[22] Ibid., x-xi.

[23] Ibid., x; original italics.

> "I have the preceding theory and experiments a necessary introduction to the principal subject, the experiments on wheels, &c.; in which I have endeavoured to investigate the truth, without a view to support any particular system, sentiments, or opinion. And in some of the experiments happen to recommend any construction of application different to the practice of some professional men, it might be well to enquire into the foundation of their practice, whether it is supported by experiments, or whether it rests upon the opinions of their predecessors. To rest satisfied with the opinions of others, however great their reputation, tends much to retard the progress of knowledge; for error is often found in high places".[24]

Continuing with his epistemological considerations, Banks points to the need to use "mathematical reasoning" or "theory," but emphasizing the essentiality of "experimental proof" for the knowledge on natural phenomena, saying that the latter could overcome the former or even reformulate it. Banks emphasizes:

> "However satisfactory mathematical reasoning may to be some, yet experimental proof is desirable, and, to many, much more so than the former; and without experiments, we often want *data* to reason from. But if we have certain principles, the conclusions drawn therefrom will often differ considerably from experiment, or rather the experiment from the theory. For the theory supposes the bodies to move in free space, without friction, or any kind of resistance; but as these impediments cannot be entirely removed, the experiments cannot perfectly coincide with the theory, though in some cases they come exceedingly near".[25]

After this epistemological consideration, Banks repeats with great clarity, the "chief end" of his treatise, which was to increase the effectiveness of machines and engines. Thus being, he states:

> "It will not be expected that I should attempt to instruct the mechanic how to form his cogs, divide the wheels, proportion their diameters, bevels, &c., as numbers of men maybe found who can both plan and execute these parts well. The chief end in view is, how to make the most of a given stream; and what the experiments recommend, has long since been put in practice, with acknowledged advantage. – If this treatise, in proportion to its sale, proves equally useful with the public lecture, I shall be satisfied".[26]

There cannot be any doubt on that *A Treatise on Mills* was a useful and important tool for engineers, mechanics and industrialists. The book's overall content and the problems presented in its four parts did not only deal with the nature of machines and motors, but also on how they

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[24] Ibid., xi-xii.
[25] Ibid., xi.
[26] Ibid., xii-xiii.

operated best or their effectiveness, a concern which would soon be understood by the nascent capitalist industry as likely to increase their productivity and lead to a greater possibility of profit.

The subscribers of *A Treatise on Mills*

In eighteenth-century England, it was very common for authors to request subscriptions from the interested public, especially due to the high cost of publishing a book. Although this practice was less common at the end of the century when compared to the first half, when the publishing industry was still establishing itself in the country, it nevertheless continued, as shown by the extensive list of subscribers to Banks' *A Treatise on Mills*, which is described shortly after the author's preface.

For his first book, *An Epitome of a Course of Lectures on Natural and Experimental Philosophy*, Banks had not request subscriptions, because in addition to having a smaller number of pages, the book was destined to his students and individuals attending his courses, a loyal clientele which allowed him to publish four editions of this work along 25 years. *A Treatise on Mills*, however, targeted a more restricted and specialized public, and for this reason Banks decided not to incur financial risk, but had resource to subscriptions, which gave each subscriber the right to obtain at least one copy of the book. However, it is also possible that Banks had taught classes in natural and experimental philosophy to individuals who were professionally linked to industrial activities and that they were attracted to the idea of a more specialized book, thus becoming subscribers.

The total number of subscribers of Banks' *A Treatise on Mills* was 247, who were given 270 copies of the book. Of these subscribers, 246 were individuals from many different locations and social origins and one was an institution, the Brighouse Library, which acquired one single copy of the book.

We might distribute the 246 individual subscribers according to their titles, i.e., what was written alongside their names. Of these, the vast majority, 208 individuals, were entitled 'Mr.'. In addition, there were 21 squires (landholders who were seen, and saw themselves, as minor rural nobility); 13 reverends, 2 'MD' (medical doctors), 1 'Dr.' (doctor, with a university earned doctorate) and 1 'A.B.' (art bachelor, graduate) from Queen's College, Cambridge (See Table 1).

Table 1. Individual subscribers to *A Treatise on Mills*[27]

By title or form of address	Number
Reverend	13
Squire (small rural nobility, landowners)	21
MD (medical doctor)	2
Dr. (doctor)	1
A.B. from Queen's College, Cambridge (graduate)	1
Mr. (gentlemen)	208
Total	**246**

Among the 208 subscribers entitled 'Mr.', only 16 declared their occupation, while 192 did not. Of those who did, four were engineers, three owners of furnaces, three teachers of mathematics and other disciplines (which could include natural and experimental philosophy), two were elementary school teachers, one an architect, one a bookseller, one a watchmaker, and one a surveyor (See Table 2).

Table 2. Occupation of *A Treatise of Mills* subscribers qualified as "Mr."[28]

Stated occupation	Number
"Master of the Grammar School"	1
"Architect"	2
"Teacher of Mathematics, &c"	3
"Bookseller"	1
"Engineer"	4
"Watch-Maker"	1
"Surveyor"	1
"Furnace Owner"	3
Subtotal	**16**
Occupation not stated	**192**
Total	**208**

Although the information on the subscribers does not allow us to state with any degree of certainty how many individuals were involved with or interested in industrial activities, we might assume that among the ones with the title 'Mr.', there were many of this type, and not just the four engineers, three furnace owners and the watchmaker, identified above. This also applies to other categories of subscribers, such as squires and reverends. Among the squires there was John Rennie, a London engineer, who was also a Fellow of the Royal Society (F.R.S.), John Sturges who was the owner of a furnace in Bowling, Hampshire, as well as an important

[27] Banks, *Treatise on Mills*, xv-xxiv.

[28] Ibid.

politician, Robert Peel, who was a Member of Parliament (M.P.) for Bury (a town close to Manchester) and who became a rich textile manufacturer in Lancashire.[29]

Among the four engineers presenting themselves as Mr. were Edward Smalley and William Hirst, respectively from Wibfey-Low-Moor and Gomersal (towns in Yorkshire), and John Sammuels and William Sharrett, both from Manchester (Lancashire). These engineers were from two counties in the north of England which came to have a strong industrial presence at the end of the eighteenth century.

Among the ones entitled Mr., we might further highlight: Thomas Paley and John Raistrick, respectively owners of furnaces in Bowling (Hampshire) and Low-Moor (West Yorkshire); Robert Owen from Manchester (Lancashire), who became an industrialist in the city and a famous social thinker; William Kirk, a watchmaker from Manchester; Henry Leigh, Jr., owner of a metallurgy in Bowling (Hampshire); James Heyes, a surveyor from Haydock (Merseyside); David Broad, an architect from Manchester; Edward Greenwood, a bookseller from (West Yorkshire, who acquired four copies of the book); John Baynes, an elementary teacher in Liverpool (Merseyside); John Knowles, a teacher of mathematics and other subjects in Liverpool; John Dalton, a famous teacher of mathematics and natural philosophy in Manchester (and who had been a teacher at the Manchester Academy); John Taylor, from Moss-School in Rochdale (Lancashire); Thomas Harrison, a graduate from Queen's College, Cambridge; George Atkinson and James Atkinson, from Manchester and Kendal (Cumbria), respectively, who might be linked to the famous Atkinson family of industrialists.

Tables 3 and 4 describe the towns or localities and counties or regions of all 247 subscribers of *A Treatise on Mills*, the latter table being a summary of the information provided in the former. The names of the towns and localities were stated by the subscribers; we were able to identify the corresponding county or area for all of them, but for seven.

[29] Robert Peel had a son of the same name who became a prominent British politician in the first half of the nineteenth century. Robert Peel, the son, was the founder of the Conservative Party, was elected Member of Parliament for the first time in 1809, and held the office of Prime Minister on two occasions (1834-1835 and 1841-1846).

Table 3: Towns and localities of residence of the subscribers to *A Treatise on Mills*[30]

Towns and localities, with corresponding county or area	Number of Subscribers	Towns and localities, with corresponding county or area	Number of Subscribers
Altringham (Cheshire)	1	Kirkless (West Yorkshire)	1
Ashburnham (East Sussex)	1	Knot-mills (Lancashire)	1
Askrigg (North Yorkshire)	1	Knowsley (Merseyside)	2
Baildon (West Riding of Yorks.)	1	Lancaster (Lancashire)	21
Backbarrow (Cumbria)	1	Leeds (West Yorkshire)	8
Birmingham (West Midlands)	1	Leicester (Leicestershire)	2
Blackburn (Lancashire)	9	Lime-hall (Cheshire)	1
Bolton-le-moors (Lancashire)	3	Little Bolton (Lancashire)	1
Bolton (Lancashire)	1	Liverpool (Merseyside)	14
Bowling (Hampshire)	3	London (Metropolitan Area)	2
Bradford (West Yorkshire)	6	Low-moor (West Yorkshire)	5
Brighouse (West Yorkshire)	6	Macclesfield (Cheshire)	3
Burnley (Lancashire)	2	Manchester (Lancashire)	26
Burton (East Staffordshire)	2	Millthrop (Cumbria)	1
Burton-in-Kendal (Cumbria)	1	Monks Kirkby (Merseyside)	1
Bury (Lancashire)	5	Newcastle-upon-Tyne (Northumberland)	1
Cambridge (East Anglia)	3	Newby-bridge (Cumbria)	1
Carle (Not Identified)	2	Northowram (West Riding of Yorkshire)	2
Castleford (West Yorkshire)	1	Okenrod (Lancashire)	1
Chipping (Lancashire)	2	Okenshaw (County Durham)	1
Colne (Lancashire)	1	Prescot (Merseyside)	2
Cottag (Not Identified)	1	Preston (Lancashire)	5
Crabtree-syke (Not Identified)	1	Pye-nest (West Yorkshire)	1
Dallam-tower Cumbria)	1	Rastrick (West Yorkshire)	1
Darwent (Cumbria)	1	Ratcliff (Metropolitan Area)	1
Dolphinholme (Lancashire)	2	Rochdale (Lancashire)	8
Eagley-bridge (Lancashire)	1	Royd's-hall (West Yorkshire)	1
East-wood (West Yorkshire)	1	Salford (Lancashire)	2
Edinburgh (Scotland)	1	Scorten (Lancashire)	1
Elland (West Yorkshire)	1	Settle (Lancashire)	1
Gomersal (West Yorkshire)	2	Sheffield (South Yorkshire)	2
Grange-moor (West Yorkshire)	1	Shrewsbury (West Midlands)	1
Halifax (West Yorkshire)	9	Skipton (North Yorkshire)	1
Hawkshead (North Yorkshire)	1	Smedley (Not Identified)	1
Haydock-hall (Merseyside)	1	Southhampton (Hampshire)	1
High-town (Merseyside)	1	Stamton (Not Identified)	1
Hipperholme (West Yorkshire)	1	Stern-mills (Not Identified)	1
Holbeck (Nottinghamshire)	1	Ulverston (Cumbria)	2

[30] Banks, *Treatise on Mills,* xv-xxiv; counties and areas were identified by us.

Holmfirth (West Yorkshire)	1	Wakefield (West Yorkshire)	7
Holt's-town (Lancashire)	1	Whitehaven (Cumbria)	2
Huddersfield (West Yorkshire)	1	Wibsey-low-moor (West Riding of Yorkshire)	1
Kendal (Cumbria)	21	Wirksworth (Derbyshire)	1
Keswick (Cumbria)	1	Woolley (West Yorkshire)	1
Kirkham (Lancashire)	1	Workington (Cumbria)	1
Total 1	**106**	**Total 2**	**141**
General Total of Subscribers		**247**	

Table 4: Subscribers to *A Treatise on Mills* by county or area[31]

County or Region	Number
Metropolitan Area (London and Its Environs)	3
Cheshire	5
County Durham	1
Cumbria	33
Derbyshire	1
East Anglia	3
East Staffordshire	2
East Sussex	1
Scotland	1
Hampshire	4
Lancashire	95
Leicestershire	2
Merseyside	21
Nottinghamshire	1
Northumberland	1
West Midlands	2
North Yorkshire	3
South Yorkshire	2
West Yorkshire	55
West Riding of Yorkshire	4
Not Identified	7
Total	**247**

Tables 3 and 4 clearly show that John Banks' strongest connections were established with subscribers who lived in the north of England, especially in industrial areas, or regions with strong commercial relations with the latter, such as Lancashire, all of Yorkshire, Merseyside and Cumbria. Obviously, this was due to the fact that since the 1770s, he had

[31] Ibid., xv-xxiv.

performed his professional activity as independent and itinerant lecturer on natural and experimental philosophy most intensely in these areas. Nevertheless, his connections also extended to other areas in the south (the metropolitan area of London, East Sussex and Hampshire) and the west of the country (West Midlands, which was also an industrial area), as well as Scotland.

The analysis of the social and geographical origin of the subscribers to *A Treatise on Mills* therefore provides us elements that allow us establishing not only John Banks' professional circuit and the concentration of his activities in the north of England, but also helps us understand the relevance of his work for the preparation of the intellectual and cultural foundations underpinning the transformation of the industrial activity and the development of the large mechanized capitalist factory.