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> "For what were England…..without its tools, its machinery, its steam engine, its steam-ships, its locomotives. Are not the men who have made the motive power of the country, and immensely increased its productive strength, the men above all others who have tended to make the country what it is ?"
>
> S. Smiles, *Lives of the Engineers*, 1861

1. Introduction

In retrospect, it is clear that a major stimulus to the systematic analysis of innovation and technical change by social scientists was the interwar attack on the "heroic" concept of invention that had flourished in the nineteenth century. As is well known, this assault was led primarily by S. C. Gilfillan, but many others responded to his call.[1] The motivation of these scholars is also easily understood: they believed that technical change would remain incomprehensible without the abolition of "non-scientific" notions, such as "flashes of genius" or "serendipity", which featured prominently in the heroic accounts of inventions.

Interestingly enough, broadly similar arguments had been put forward by proponents of the abolition of the patent system during the "patent controversy" of the mid nineteenth century. Victorian abolitionists, such as Robert MacFie, contended that technical change developed through an inherent dynamism, the product of many incremental improvements; cases of simultaneous invention proved that no particular individual was indispensable and consequently the case for private intellectual property in invention was unfounded.[2]

Over the last twenty years or so, the "innovation studies" literature has largely moved beyond the controversy between "individualist" and "determinist" views of technical change, adopting a perspective that considers communities of inventors (sharing specific cognitive frames) collectively engaged in the generation and exploitation of technological opportunities. This perspective, inspired by T.S. Kuhn's philosophy of science, clearly emphasizes the social basis of inventive activities, but it is also able to account for ruptures

[1] S. C. Gilfillan, The Sociology of Invention (Chicago, 1935), and "Invention as a Factor in Economic History", Journal of Economic History, 5 (1945), pp. 66-85. Another noteworthy contribution is W.F. Ogburn and D. Thomas, "Are Inventions inevitable? A Note on Social Evolution", Political Science Quarterly, 37 (1922), pp. 83-98. Ogburn and Thomas based their argument on the high number of cases of simultaneous inventions that seems to punctuate the modern history of technology. See also R. C. Epstein, 'Industrial Invention: Heroic or Systematic ?', Quarterly Journal of Economics, 40 (1926), pp. 232-272.

[2] See C. MacLeod, "Concepts of Invention and the Patent Controversy in Victorian Britain" in R. Fox (ed.), Technological Change (Amsterdam, 1996). One early critique of the "heroic" view of invention can also be found in Marx: "A critical history of technology would show how little any of the inventions of the eighteenth century are the work of a single individual. As yet such book does not exist" (K. Marx, Capital, Vol. I, Harmondsworth, 1990), p. 493. A particularly insightful discussion of the historiography dealing with the role of science and technology in the early phases of industrialization is provided by A.E. Musson, 'Introduction' in A.E. Musson (ed.), Science, Technology and Economic Growth in the Eighteenth Century (London, 1972).

and discontinuities, with individual inventors or, more often, small "non-conformist" groups of initiators playing a critical role in the emergence and consolidation of novel "technological paradigms". [3]

On reflection, it is apparent that the influence of the social-determinist view of technical change on the historiography of the British industrial revolution has been rather limited and circumscribed, so that the figure of the heroic inventor has for long time dominated the technological narratives of this period. [4] In this respect, it is worth noting that accounts of technical change based on "heroic" inventors actually predated the lasting influence of Samuel Smiles and his works, in which the character of the "great inventor" epitomizes the utilitarian ideology of self-help. In fact, by the mid nineteenth century a seemingly compelling tale that linked heroic inventors, technological innovations and British ascendancy to economic power had been already forcefully put forward in many works on British history and on the origins of contemporary society.[5]

FIGURE 1 AROUND HERE

A powerful visual demonstration of this heroic narrative is the engraving of *Distinguished Men of Science of Great Britain, Living in the Years 1807-8*, by William Walker, with its accompanying *Memoirs* (reproduced here as figure 1). [6] As published in 1862, it depicted 51 "men of science", 27 of whom may be categorized as inventors (including 4 men better known as "scientists" such as Wollaston and Ronalds), 6 as civil engineers, and 18 as "purely scientists" (chemists, astronomers, botanists, geologists, etc) who are not normally credited with an invention, although some (for example, William Herschel) made improvements to their instruments. They are arranged in three groups, in an imaginary scene, set in the upper library of the Royal Institution, London. The central group, of innovative civil and mechanical engineers, is arranged around James Watt, who is using a diagram to demonstrate his separate condenser and governor. Across the table from him is John Dalton, expounding his atomic theory to a knot of chemists and inventors of chemical processes. The group on the right comprises mainly inventors, listening to Charles Earl Stanhope describe his process of stereotype printing; that on the left, mainly scientists, surrounding the astronomers William Herschel and Nevil Maskelyne, with Edward Jenner seated in front of

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[3] E.W. Constant, The Origins of the Turbojet Revolution (Baltimore, 1980), ch. 1, G. Dosi, "Technological paradigms and technological trajectories", Research Policy 11 (1982), 147-162 and C. Freeman, "The economics of technical change", Cambridge Journal of Economics, 18 (1994), 463-514.

[4] More than 40 years ago, A. P. Usher warned against the ultimately misleading influence of "extreme forms of romanticism in the history of invention" in the historiography of the British industrial revolution: A. P. Usher, "The industrialization of modern Britain", Technology and Culture, 2 (1961), pp. 109-127, p. 125.

[5] See, amongst others, Baines' account of the role of technological innovation in the rise of the British cotton industry: E. Baines, History of the Cotton Manufacture in Great Britain (New York, 1966; 1st ed., 1835). On Samuel Smiles and his influence, see T.P. Hughes "Introduction" in S. Smiles, Selection from Lives of the Engineers (Cambridge, 1966), and S. Dentith, 'Samuel Smiles and the nineteenth century novel' in D. Smith (ed.), Perceptions of Great Engineers: Fact and Fantasy (London, 1994). On the role of the "heroic inventors" in nineteenth century accounts of the industrial revolution, see C. MacLeod, "James Watt, heroic invention and the idea of the industrial revolution", in M. Berg and K. Bruland (eds.), Technological Revolutions in Europe (Cheltenham, 1998).

[6] The original is ascribed to Sir John Gilbert (grouping), Frederick J. Skill (figures), William and Elizabeth Walker (design and finish): Mary Pettman (ed.), K. K. Yung (comp.), National Portrait Gallery, Complete Illustrated Catalogue, 1856-1979 (London, 1981), pp. 648-9.

them. Two points merit particular emphasis. First, is the status that the picture bestows on inventors and engineers, by not merely portraying them on equal terms with the elite of British science--as represented by successive presidents and numerous fellows of the Royal Societies of London and Edinburgh--but by putting them in the foreground of the composition. Secondly, the choice of date (1807-8) situates the scene firmly in the era of the "industrial revolution", depicting men who were collectively at their most active between 1770 and 1830. This is reinforced by the positioning of Watt and his steam inventions at the centre of the group. During the second quarter of the nineteenth century Watt had come to personify "the era of manufactories" and Britain's resultant rise to international predominance. Indeed, Walker's prospectus was explicit in locating the work of these "eminent men of science" in this context: "The Steam Engine, the discoveries in Chemistry and inventions of Machinery, now so skillfully applied to the vast number of our Manufactories, are the grand Main-Springs of our National Wealth and Enterprise."[7] It was an interpretation echoed in the press coverage of the print's release. According to the *Mechanics' Magazine*, these were the "men whose doings have laid the foundations of our commercial prosperity"; for *Once a Week*, they were "the race of path-finders who are ever setting copies for the English nation to work by".[8]

Why, since its establishment as an autonomous academic discipline, about a century ago, economic and social history has failed to problematize the individualistic narrative of invention, which is at the heart of most accounts of the British industrial revolution, represents an intriguing historiographical puzzle.[9] Seemingly, economic and social historians have been mostly pre-occupied with the economic and social *effects* of technical change (i.e., the impact of new technologies on the dynamics of productivity and prices, on the division of labour and the working conditions in specific industries, on the standards of living, etc.), rather than with its *sources*. In this way, they have left the detailed study of inventive activities to historians of technology. In Britain, for a number of reasons, this field of study has remained, by and large, characterized by a strict adherence to an "internalist" approach and to a focus on individual inventors' biographies and personalities.[10] Many influential twentieth-century studies of technology during the British industrial revolution, such as those of Dickinson, Jenkins and Rolt, can readily be cited as examples of historical works written within this approach.[11] In this light, it is no surprise that the "great inventor"

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[7] Proof sheets, in Boulton District Archives, Crompton MSS, ZCR 73/3, 75/17.

[8] William Walker (ed.), Memoirs of the Distinguished Men of Science of Great Britain, Living in the Years 1807-8 (2nd edn, London: 1864), 165-6.

[9] On the emergence of economic history as an autonomous academic discipline in Britain, see D. C. Coleman, History and the Economic Past. An Account of the Rise and Decline of Economic History in Britain (Oxford, 1987) and N. Harte, 'The Economic History Society, 1926-2001' in P.Hudson (ed.), Living Economic and Social History (Glasgow, 2001).

[10] On the distinction between "internalist" and "contextualist" approaches in history of technology see J. S. Staudenmaier, Technology' s Storytellers. Reweaving the Human Fabric (Cambridge,1985). For a particularly terse appraisal of the peculiar evolution of history of technology in Britain, see D. Cannadine, "Engineering history, or the history of engineering ?", Transactions of the Newcomen Society 74 (2004), 163-180.

[11] H. W. Dickinson and R. Jenkins, James Watt and the Steam Engine (Oxford, 1927); H.W. Dickinson, A Short History of the Steam Engine (Cambridge, 1938); H. W. Dickinson, James Watt, Craftsman and Engineer (Cambridge, 1935); R. Jenkins, Links in the History of Engineering and Technology from the Tudor times (Freeport, 1971), L.T.C. Rolt, George and Robert Stephenson: the Railway Revolution (London, 1960); L.T.C. Rolt, Isambard Kingdom Brunel: a Biography (London, 1957), L.T.C. Rolt, Thomas Newcomen: the Pre-History of the Steam Engine (Newton Abbot, 1963); L.T.C. Rolt, Victorian Engineering (London, 1970).

narrative has continued, explicitly or implicitly, to inform our understanding of the early phases of industrialization in Britain.

Of course, it should be noted that economic historians such as Landes, Mathias and Rosenberg have added an important qualification to traditional accounts, by pointing out the economic significance of incremental inventions, alongside major technological breakthroughs.[12] Landes has termed this type of technical change "anonymous technical progress" to distinguish it explicitly from the most dramatic (and visible) technological breakthroughs. Similarly, Joel Mokyr has distinguished between micro-inventions (small incremental inventions typically originating from the processes of learning by doing and learning by using) and macro-inventions. Interestingly enough, Mokyr suggests that macro-inventions ought to be considered largely as "exogenous", thus leaving (proper ?) space for accounts of technical change based on heroic inventors.[13]

> Macro-inventions . . . do not seem to obey obvious laws, do not necessarily respond to incentives, and defy most attempts to relate them to exogenous economic variables. Many of them resulted from strokes of genius, luck or serendipity. Technological history, therefore, retains an unexplained component that defies explanation in purely economic terms. In other words, luck and inspiration mattered, and *thus individuals made a difference* (italics added).

Most recently, the heroic inventor approach (and the biographical method) has been championed by Patrick O' Brien in his study of Edmund Cartwright.

> [The] historian's task is to validate the nature of [Cartwright's] achievement and to expose all the forces, including the personal qualities that made these two significant mechanical "breakthroughs" possible. He and other inventors cannot (as modern theory suggests) be written out of history as dispensable men. The close attention to their biographies will show that they are more than "mere" agents of economic, social and cultural processes…[14]

We would contend that O' Brien's article *explicitly* sets out a perspective on technology which is *implicitly* underpinning many studies of the British industrial revolution. The return to biography has been even more marked in the history of science, where some authors justify it as a necessary corrective to the reification of science and to ahistorical narratives of the objective discovery of 'truth'.[15]

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[12] D.S. Landes, The Unbound Prometheus (Cambridge, 1969), P. Mathias, The First Industrial Nation (London, 1983; 1st ed, 1969) and N. Rosenberg, Perspectives on Technology (Cambridge, 1977).
[13] J.Mokyr, The Lever of Riches (Oxford, 1990), p. 13; see also ibid., p. 295. Mokyr's overall approach has clearly much in common with the contributions cited in footnote 12.
[14] P. O' Brien, "The micro-foundations of macro-invention: the case of the Reverend Edmund Cartwright", Textile History, 28 (1997), 201-233, 208. The most articulated contribution arguing for the indispensable historical contribution of individual inventors is J. Jewkes, D. Sawyers and R. Stillerman, The Sources of Invention (London, 1969, 1st ed. 1958). Another authoritative work which emphasizes the role of individual inventors is D. Cardwell, The Fontana History of Technology (London, 1994), see in particular the section on pp. 496-501, significantly entitled "In defence of Heroes".
[15] D. Outram, 'Scientific biography and the case of Georges Cuvier: with a critical bibliography', History of Science, 14 (1976), pp. 101-37; T. L. Hankins, 'In defence of biography: the use of biography in the history of science', History of Science, 17 (1979), pp. 1-16; S. Sheets-Pyenson, 'New directions for scientific biography: the case of Sir William Dawson', History of Science, 28 (1990), pp. 399-410.

In a further development of such biographical methodologies, a number of current studies of invention during the early phases of industrialization have adopted a "prosopographical approach". [16] Perhaps surprisingly, these stem from both an individualist and a social-determinist view of technological change. From the former perspective, prosopography seems to offer a straightforward route from individual biography to the study of the common characteristics in the backgrounds of the key group of "vital" actors responsible for technological breakthroughs. Simultaneously, it permits an important expansion of that group to include many more, less famous individuals. Such an expansion, however, has its costs: information about more obscure figures is much harder to find. Thus, an ambitious prosopographic exercise undertaken by O' Brien, Griffiths and Hunt analyses the group of men responsible for nearly 2,500 inventions (both patented and unpatented) in the textile industries during the period 1688-1851. Their goal is to verify whether this collectivity of inventors shared any noteworthy peculiarities (in terms of "education, birth, scientific orientation, or entrepreneurial acumen").[17]

Clearly, the determinist approach does not share the same "elitist" concern: rather, it is interested in detecting the specific impact of various "contextual factors" on inventive activities. In this case, prosopography represents a method for constructing a coherent sample of individuals engaged in inventive activities. It is exemplified by the studies of inventive activities during US industrialization undertaken by Khan and Sokoloff.[18] Their point of departure is indeed far from any heroic view of technological change. It is influenced by Jacob Schmookler and regards inventive activities as responsive to economic stimuli.[19] Khan and Sokoloff consider the inventive activities of a sample of American "great inventors" during the nineteenth century. Their sample was drawn from a number of American biographical dictionaries, extracting all the individuals to whom at least one major invention was ascribed. The primary goal of Khan and Sokoloff's first study was to test the heroic view of invention that, by regarding major technological breakthroughs as the products of strokes of genius and flashes of insight, or, in some cases, of serendipity or accident, would predict that they are essentially unconnected with everyday economic activities. In particular, they wished to explore Mokyr's distinction between such

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[16] For a thorough discussion of the merits and limitations of "prosopography" as a method of historical investigation, see L. Stone, "Prosopography", Daedalus, 100 (1971), 46-79. In the economic history of the British industrial revolution, there have been a number of prosopographical investigations of the social origins and cultural and religious backgrounds of the industrialists active in this period, see, amongst others, E. E. Hagen, On the Theory of Social Change (London, 1962), ch. 13, and F. Crouzet, The First Industrialists (Cambridge, 1985).

[17] Some preliminary findings of this exercise are reported in P.O' Brien, T. Griffiths and P. Hunt, "Technological change during the first industrial revolution: the paradigm case of textiles, 1688-1851" in R. Fox, ed., Technological Change (Amsterdam, 1996), and in P. O'Brien, T. Griffiths and P. Hunt, "Theories of technological progress and the British textile industry from Kay to Cartwright", Revista de Historia Economica 14 (1996), 40-67. For a survey of similar projects in the history of science, see L. Pyenson, "'Who the guys were': prosopography in the history of science", History of Science, 15 (1977), pp. 155-88. For reflections on the prosopographic method in the history of science and information about the biographical materials available in published sources, see S. Shapin and A. Thackray, "Prosopography as a research tool in the history of science: the British scientific community, 1700-1900", History of Science, 12 (1974), pp. 1-28.

[18] B. Z. Khan and K. L. Sokoloff, "'Schemes of practical utility': Entrepreneurship and innovation among the 'great inventors' in the United States, 1790-1865", Journal of Economic History, 53 (1993), 289-307, and B. Z. Khan and K. L. Sokoloff, "Institutions and democratic invention in 19th century America: evidence from 'great inventors', 1790-1930", American Economic Review, 94 (2004), 395-401.

[19] J. Schmookler, Invention and Economic Growth (Oxford, 1966).

"exogenous" macro-inventions and the micro-inventions that occur in response to perceived market signals. Through their systematic comparison of the inventive activity of their sample of "great inventors" with that of US patentees in general, Khan and Sokoloff demonstrated that there was no fundamental distinction between the behaviour of the "great inventors" and that of the much larger population of US patentees: the inventive activities of both groups were very similar in terms of their sensitivity to market signals. Indeed, what distinguished the "great inventors" was their "entrepreneurial abilities": they were more, not less, finely attuned than the average patentee to economic incentives. Somewhat ironically, then, while Khan and Sokoloff's contributions seem to resurrect the "great inventor" (carefully imprisoned in inverted commas), their results would imply his (definitive ?) re-interment.

Khan and Sokoloff treat the selection of their "great inventors" as unproblematic. They state: "The sample comprises virtually all the best-known antebellum inventors who were first active in the field of innovation between 1790 and 1846". Their "main source ….was volumes 1 to 10 of the Dictionary of American Biography. This was supplemented by Who was who in America, Historical Volume, 1607-1896 and The National Cyclopaedia of American Biography; additional details were obtained from a number of biographical sources."[20] In this article it is not our intention to question Khan and Sokoloff's conclusions concerning the nature of inventive activities in the United States during the nineteenth century. Rather, we contend that valuable and sophisticated exercises such as theirs should go hand-in-hand with a continuous reflection on the various conceptualizations of invention and the principles of selection that are being used – not least on those used by the compilers of the collective biographies that provided the source materials generally used for this type of prosopographical exercise.

The aim of this article is to perform a critical prosopographical investigation of the major British inventors in the period 1650-1850, as selected by the Victorian edition of the Dictionary of National Biography (henceforth the *DNB,* as is affectionately known in Britain), paying particular attention to the criteria adopted by the compilers for the inclusion of individual inventors.[21] Accordingly, our choice of the Victorian edition of the *DNB* as a source (rather than the new revised edition, published in September 2004) is not accidental. The first edition of the *DNB* constitutes "an enduring monument to the drive and dedication of the Victorians in the pursuit of information about the individual dead".[22] Therefore, it is immediately clear that this iconic work of collective biography is unlikely to provide a random or representative sample of inventors. On the other hand, by carefully examining the distortions affecting the selection criteria of the *DNB* we may actually hope to probe deeply into the late Victorians' conceptualization of invention and, perhaps, to unravel

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[20] Khan and Sokoloff "'Schemes of practical utility'", pp. 305-306.

[21] Leslie Stephen (ed.), Dictionary of National Biography (London: Smith & Elder, 1885-1900). The DNB was also used by R. K. Merton in his study of science and technology in Britain in the seventeenth century, see R. K. Merton, Science, Technology and Society in Seventeenth century England (New York, 1970; 1st ed., 1938); by N. Hans to study the educational backgrounds of 680 scientists born between 1600 and 1785, see N. Hans, New Trends in Education in the Eighteenth Century (London, 1951), pp. 31-6; and by R. Bendix to study the social origins of the most prominent British entrepreneurs in the period 1750-1850, see R. Bendix, Work and Authority in Industry (New York, 1956), p. 24. None of these studies dealt in depth with the possible biases of this source.

[22] Stone, "Prosopography", p. 49.

the extent of its influence on the successive layers of historical works on the British industrial revolution. This is an important exercise because the new Oxford Dictionary of National Biography (Oxford, 2004), while revising and updating the entries of the original edition, includes them all: there have been additions to the list, but no deletions. Consequently, the Victorians' notion of what gave an inventor sufficient significance for inclusion in this definitive national "pantheon" may, to some extent, continue to inform the twenty-first century's concept of "the inventor"—especially since its machine-readable format will make the *ODNB* an attractive source for prosopographers. It should be emphasized, therefore, that although the methods employed in our prosopographical exercise are very similar to those of Khan and Sokoloff, our concerns are rather different.

2. The Dictionary of National Biography

The *DNB* was a triumph of Victorian literary engineering and private enterprise. Its original 63 volumes were produced in "eighteen years of unremitting labour" between 1882 and 1900, at the formidable rate of one volume every three months (precisely).[23] The initiative belonged to a philanthropic publisher, George M. Smith (of Smith, Elder & Co.) who had made his money from the sale of Apollinaris Water ("the Queen of Tablewaters") and put up £150,000 to fund the construction of this national monument to "their ancestors' collective achievement".[24] It was intended to provide "full, accurate, and concise biographies of all noteworthy inhabitants of the British Islands and the Colonies (exclusive of living persons) from the earliest historical period to the present time".[25]

Smith chose the eminent literary critic and historian of ideas, Leslie Stephen, as his first editor.[26] Stephen's method of selecting the names for inclusion in the *Dictionary* was described by Sidney Lee, his assistant-editor and subsequently his successor as editor.[27] His primary list "comprised all names that had hitherto been treated in independent works of biography, in general dictionaries, in collections of lives of prominent members of various classes of the community, and in obituary notices in the leading journals and periodicals."[28] Recognizing, however, that this list omitted many equally important names, which, said Lee, "it was the special province of a new and complete Dictionary to supply", Stephen and his assistants explored "a wide field of historical and scientific literature" and surveyed "the most miscellaneous records and reports of human effort".[29] His next step was, twice a year, to print the proposed list of names for each volume in The Athenaeum, the leading cultural journal, inviting its readers to suggest additions, corrections and criticisms—an invitation

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23 [Sidney Lee], "The Dictionary of National Biography, A Statistical Account", in Dictionary of National Biography, vol. 63 (1900), p. v; David Cannadine, "British Worthies", London Review of Books, III, 13-16 Dec. 1981, pp. 3-6.

24 [Lee], "A Statistical Account", p. xxii.

25 Lee's memoir of George Smith, cited in Colin Matthew, "The New DNB", History Today, 10-13 Sept. 1993, p. 10.

26 'Smith, George Murray (1824-1901)', by Bill Bell, ODNB (http://www.oxforddnb.com/view/article/36138, accessed 25/2/05); for Stephen (1832-1904), see Noel Annan, Leslie Stephen, The Godless Victorian (London, 1984); Alan Bell, "Leslie Stephen and the Dictionary of National Biography", Times Literary Supplement, 16 Dec. 1977, p. 1478.

27 Lee (1859-1926) was appointed assistant editor in 1883, joint-editor with Stephen in 1890, and sole editor (when Stephen retired, exhausted by his labours) in 1891, responsible for the final 37 volumes: [Lee], "Statistical Account", pp. vii, ix.

28 Ibid., p. vii.

29 Ibid., p. vii.

which some accepted with gusto! The Athenaeum, founded in 1828, and published weekly at the astonishingly low price (1861-1914) of 3d, had a circulation of over 20,000; not only did it enjoy a reputation for "fair-minded authoritative criticism" in the fields of literature and the fine arts, but it prided itself on making the latest scientific theories and technological developments comprehensible to a lay audience—through the pens of some of "the greatest scientists of the day as regular correspondents and staff writers".[30] Thus, the selection of names for inclusion rested ultimately with the upper echelons of British society: mostly male and university-educated, probably members of the liberal professions, "gentlemanly capitalists", or recipients of a private income. While grounded primarily in the arts and humanities, they had been at least exposed through their leisure reading to science and technology.

The original 63 volumes contained 29,120 entries.[31] It was Lee's belief that they "include[d] all men and women of British or Irish race who have achieved any reasonable measure of distinction in any walk of life"; we may note that his list of 18 "walks of life" mentioned the inventor sixth, after "statesmen, lawyer, divine, painter, author".[32] The four centuries since 1500 accounted for 90% of all entries; the nineteenth century alone for 44%. Lee speculated that, despite "the inevitable propensity to exaggerate the importance of contemporary achievement, and, more especially . . . the multiplication of printed records", this bias towards the most recent past reflected a real increase in "the opportunities of distinction". He cited, in particular, "the multiplication of intellectual callings—take engineering and its offshoots, for example—and by the specialisation of science and art"; he also pointed to improvements in education.[33]

Lee's breezy claim to inclusiveness belied the controversies (and howls of anguish!) that had accompanied the editors' choice of subjects. Subsequent commentators have remarked on some of the more obvious systematic biases in this regard: against women (only 4% of the entries), non-metropolitans, members of the working class (in particular, trade-union leaders), and most surprisingly, given the *Dictionary's* paternity, businessmen and entrepreneurs.[34] Remedying them became a primary goal of the new *Oxford DNB* , which now contains more than 50,000 entries (both in hard copy and on-line): there are over 2,000 new nineteenth-century subjects and nearly 8,000 new twentieth-century ones.

A preliminary, less systematic attempt at filling the gaps was made in the 1980s, when an appeal (primarily to the university sector) for suggestions and contributions resulted in the volume of *Missing Persons;* this contains entries for 1,086 individuals, missed by the original

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[30] Leslie A. Marchand, The Athenaeum: A Mirror of Victorian Culture (Chapel Hill, 1941), pp. 12-13; also pp. 52-4, 81-2, 89-94.
[31] This rises to 30,378 entries in the Concise DNB, since it includes the two *Supplements*, published in 1903, which contained people who had died since the *DNB* began publication in 1882.
[32] Ibid., p. viii. He estimated this represented one in every 5,000 adults who had inhabited the British Isles since Roman times, or one in every 10,000 infants born there.
[33] Ibid., pp. xii-xiv.
[34] Matthew, "The New DNB", pp. 12-13. To a considerable degree these omissions were remedied by specialised works of collective biography published in the later twentieth century: Dictionary of Labour Biography (10 vols., 1972-); Biographical Dictionary of Modern British Radicals (3 vols., 1979-88); Dictionary of Business Biography (5 vols., 1984-6); Biographical Dictionary of British Feminists (2 vols., 1985-90). See Brian Harrison, "British Biography, Large and Small", Blackwell History Compass (http://www.history-compass.com/article.asp?ref=1816&section=5&type=full, accessed on 27/05/04).

DNB and its subsequent supplements, from 1885 to 1985.[35] We have identified 67 inventors (65 men and 2 women) born between 1650 and 1850 among these *Missing Persons*.

Despite its respectable, Victorian origins and recognized biases, it would be a mistake to imagine the *DNB* as simply a catalogue of "the great and the good". One of the original *Dictionary's* characteristics was its "remarkable eclecticism": it contained a "legion of minor figures".[36] Not only was it Leslie Stephen's contention that "it is the second-rate people that provide the really useful reading", but he was also concerned to give notoriety its due, to include the criminal as well as the saint.[37] The result was a biographical dictionary that, in the words of its most recent, modern editor, was "open, fair, liberal, accurate, and quirky. Begun in the high-noon of imperialism, it welcomed deviants, rebels and dissenters."[38] It was also begun, we may remark, in the high-noon of British pride in invention, and, as we shall see, it found space for over 370 men (they were all male) whose primary claim to fame (or notoriety) was their inventiveness.

The contributors to the *DNB* numbered 653, but three-quarters of the *Dictionary's* 29,000 pages were written by just one hundred people. Among the most voluminous contributors were the two editors and several members of their small editorial team: Lee wrote the equivalent of three volumes, Stephen the equivalent of two and a quarter. As far as possible, however, they used "experts . . . in their special fields of study".[39]

3. Inventors and the Dictionary of National Biography

We have compiled a list of all individuals born in the period 1650-1850 who are credited with at least one invention in their entry in the *DNB*. In this way, we have identified a set of 374 "great" British inventors.[40] Despite (as noted earlier) being mentioned sixth in Sidney Lee's "walks of life", inventors accounted for only slightly more than 1% of all original entries. Although this may seem a small proportion, it is worth comparing the judgment in a similar field of Angus Buchanan who, having identified 489 entries of engineers in the *DNB,* was initially disappointed—until he recognized the inclusiveness of the enterprise, and "the rich tapestry of British history" that the *Dictionary* represented. "The surprising thing, indeed, is not that so few engineers are mentioned," concludes Buchanan, "but rather that they receive such substantial representation in a selection so widely drawn."[41]

Certainly, if the *DNB* had been compiled a century earlier, the representation of inventors (as well as engineers and FRSs) would indeed have been negligible. The growing regard for

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[35] Christine S. Nicholls (ed.), The Dictionary of National Biography: Missing Persons (Oxford, 1993). That even Fellows of the Royal Society had been subject to omission is evidenced by J. H. Appleby, "A new lease of life for 71 missing Fellows", Notes & Records of the Royal Society of London, 48 (1994), 121-5.
[36] Mark Curthoys, "Modern Britain", in Oxford Dictionary of National Biography (publicity leaflet, [2004?]).
[37] Quoted in Cannadine, "British Worthies", p. 6.
[38] Matthew, "The New DNB", p. 11. Cf. W. N. Medlicott, "Contemporary History in Biography", Journal of Contemporary History, 7 (1972), 91-106, esp. p. 95.
[39] [Lee], "A Statistical Account", pp. xv, xviii.
[40] By way of comparison, Khan and Sokoloff 's sample of US inventors comprise 160 individuals for the period 1790-1865 and 409 individuals (408 men and one woman) for the period 1790-1930: see respectively Khan and Sokoloff, "'Schemes of practical utility'" and Khan and Sokoloff , "Institutions and democratic invention".
[41] R. A. Buchanan, The Engineers: A History of the Engineering Profession in Britain, 1750-1914 (London: Kingsley, 1989), pp. 21-2.

inventors and engineers since ca.1800 peaked in Britain during the second half of the nineteenth century. The men who selected the entries for the original *DNB* mostly grew up in a society that celebrated the achievements of the inventor and the engineer as never before or since, in literature, museums, and public art. The second half of the nineteenth century began with the Great Exhibition in the Crystal Palace and ended with the novel elevation to the peerage of inventors and engineers such as Lord Joseph Lister, Lord Masham (Samuel Cunliffe Lister), Lord William Armstrong and Lord Kelvin (William Thompson). It witnessed the erection of statues in city centers and major public buildings to such men and others, whose reputation was cherished by a public that was prepared to pay for its preservation in bronze and marble. It saw the opening in South Kensington of the Patent Office Museum (later, part of the Science Museum), which attracted 4.5 million visitors between 1855 and 1878;[42] a worrying number of whom were so impressed by the iconic exhibits that they picked off flakes of rust from Stephenson's *Rocket* as souvenirs! And it was awash with biographical studies, of which Samuel Smiles' represented only the tip of a publishing iceberg. However, it was not the case that all the *DNB*'s inventors were selected for their technical proficiency-- there was also space for eccentricity and quirkiness. Thus, we find an entry for Richard James Morrison (1795-1874), "inventor and astrologer, known chiefly by his pseudonym of 'Zadkiel'" who proposed various contrivances to the Admiralty, but was "chiefly remarkable...for his devotion...to the pseudo science of Astrology". Another entry immortalizes John Austin (fl. 1820), "a Scotch inventor", known mainly by his publication of shorthand systems, including "A System of Stenographic Music" for the easy transcription of music as it was played.

TABLE 1 AROUND HERE

The memoirs of our 374 inventors were written by a variety of contributors, the majority of whom each wrote fewer than five entries. This probably reflected the division of labour by topic that, at least to a degree, characterized the publication of the *DNB*. Table 1 reports the details of the distribution of entries among the various contributors. They included both specialists and generalists, for whom inventors represented only a small proportion of their tally. The most prolific contributor of entries for inventors (40) was R. B. Prosser (1838-1918), who was on the staff of the Patent Office and the author of a carefully researched book about Birmingham inventors.[43] It may be indicative of the contributors' lack of influence over the selection of subjects for the *DNB* that most of the Birmingham inventors whom Prosser most admired are not noticed in the *Dictionary*. H. T. Wood, author of 13 entries on inventors, was employed as a clerk at the Patent Office, served as secretary of the Royal Society of Arts, and published a book on industrial history[44]. By contrast with Prosser and Wood, the second most productive contributor, G. C. Boase, had no special expertise in the field of technology, but was a biographer and antiquarian: his 28 memoirs of inventors

[42] I. Inkster, "Patents as indicators of technological change and innovation – An historical analysis of the patent data, 1830-1914", Transactions of the Newcomen Society, 73 (2003), pp. 179-208.
[43] John Hewish, Rooms Near Chancery Lane: The Patent Office under the Commissioners, 1852-1883 (London, 2000), p. 59; R. B. Prosser, Birmingham Inventors and Inventions [Birmingham, privately published, 1881], with a new foreword by Asa Briggs (Wakefield, 1970).
[44] 'Wood, Sir Henry Trueman Wright (1845-1929)' by R. T. Smith, ODNB (http://www.oxforddnb.com/view/article/57833 accessed 12/12/04).

constituted but a small fraction of his total of 723.[45] In similar vein was Thomas Seccombe, another literary scholar, whose 500 entries included 13 for inventors.[46] Most of the entries for inventors of astronomical instruments, however, were written by Agnes Mary Clerke, the author of a very popular work on astronomy and of 150 memoirs (mostly of astronomers) for the *Dictionary*.[47] Likewise, all the memoirs of chemists in the second half of the volumes and of nearly all the naval inventors were produced by specialists—Hartog and Laughton respectively.[48] Distinguished contributors of a single article on a major figure included Sir Frederick Bramwell FRS (James Watt), Professor A. H. Church FRS (Josiah Wedgwood), and Professor Silvanus Thompson FRS (Sir Charles Wheatstone).[49]

The contributors were a remarkable and rather sophisticated group of Victorian intellectuals with, in many cases, a sound knowledge of specific technological developments. However, although their memoirs were less didactic and heroic than Smiles' tales of invention, it seems likely that these scholars also reflected the "intellectual climate" of the time: in particular, the idealized connection between heroic invention and the industrial revolution.

What then brought a particular inventor to the attention of the compilers of the *DNB ?* Gender is quickly dealt with. As mentioned, our list of 374 inventors comprises only men. The *Missing Persons* volume contains two female inventors from this period: Eleanor Coade (1733-1821), inventor and manufacturer of 'Coade stone', a weather-resistant ceramic body sculpted to decorate buildings, and Henrietta Vansittart (1833-1883), whose patented screw-propeller was fitted to many warships and liners. It was not that women did not invent. Researchers have identified 62 patents registered in women's names between 1635 and 1852, and a further 178 between 1853 and 1884.[50] There is a growing literature on why women struggle to be recognized as inventors - even today. [51] As we shall see, the compilers' neglect of women's inventions, besides being indicative of a general bias against gender (that permeates the *DNB* as a whole), also stems from a bias against certain types of inventions produced in specific technological fields.

Table 2 displays the patenting behaviour of our sample of 374 great inventors. The table subdivides the sample into four birth cohorts (1650-1700,1701-1750,1751-1800, 1801-1850). A disproportionate number (166, corresponding to a share of 44%) of the inventors

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45 'Boase, George Clement (1829-1897)', by W. P. Courtney, rev. Nilanjana Banerji, ODNB (http://www.oxforddnb.com/view/article/2736 accessed 12/12/04).
46 'Seccombe, Thomas (1866-1923)', by E. I. Carlyle, rev. K. Mullin, ODNB (http://www.oxforddnb.com/view/article/36001 accessed 12/12/04).
47 'Clerke, Agnes Mary (1842-1907)', by H. P. Hollis, rev. M. T. Bruck, ODNB (http://www.oxforddnb.com/view/article/32444 accessed 12/12/04).
48 'Hartog, Sir Philip Joseph (1864-1947)', by Elizabeth J. Morse, ODNB (http://www.oxforddnb.com/view/article/33742 accessed 12/12/04); 'Laughton, Sir John Knox (1830-1915)' by G. A. R. Callender, rev. Andrew Lambert, ODNB (http://www.oxforddnb.com/view/article/344420 accessed 12/12/04).
49 [Lee], "A Statistical Account", pp. xvii, xx-xxi; Gillian Fenwick, The Contributors' Index to the Dictionary of National Biography (Winchester, 1989), pp. 321, 404.
50 Autumn Stanley, Mothers and Daughters of Invention. Notes for a Revised History of Technology (Metuchen NJ, 1993), pp.758-9; for Vansittart, see p. 495.
51 Judith McGaw, "Inventors and other great women: toward a feminist history of technological luminaries", Technology and Culture, 38 (1997), 214-231; S. McDaniel et al. "Mothers of invention ? Meshing the roles of inventor, mother and worker", Women's Studies International Forum 11 (1988), 3-12.

contained in the *DNB* belonged to the third cohort (1751-1800). The members of this cohort were mostly active in what historians have often considered as the "classic" period of the Industrial Revolution, i.e. 1760-1830 if we use T. S. Ashton's dating.[52] Accordingly, a large number of the inventors who have featured as principal characters in the grand technological narratives of the British Industrial Revolution belong to this cohort—for example, Samuel Crompton (1753-1827), William Murdock (1754-1839), Thomas Telford (1757-1834), George Stephenson (1781-1848), Henry Maudslay (1771-1831), Richard Roberts (1789-1864). In this respect, the compilers of the *DNB* could rely on a substantial extant body of literature that documented the achievements of these inventors and, more importantly, made an explicit connection between heroic tales of invention and Britain's ascendancy to industrial prowess. [53]

TABLE 2 AROUND HERE

In contrast, it is worth noticing that the fourth cohort (1801-1850) suffers from under-representation, both because its members had had less time in which to become famous before the publication of the *DNB* began, and because most of them were born too late to enjoy the hagiographical treatment accorded to their predecessors by the Victorians, especially when they could be inserted in the grand narrative of the Industrial Revolution.[54]

The most striking finding to emerge from Table 2 is the very high share of inventors with no patent (38.7% in the total *DNB* sample). It is important to notice that our sample also includes some inventors of unpatentable techniques, such as new surgical procedures (most famously, for example, Joseph Lister's introduction of anti-septic surgery) or new social inventions, such as Rowland Hill's Penny Post. However, a detailed examination of our list of inventors reveals that this affects our results only at the margins. Thus, it remains the case that in Britain one could easily become a "great inventor" without obtaining a patent for a technical invention. By contrast, only 10 of Khan and Sokoloff's 160 American "great inventors", active between 1790 and 1846 held no patent (that is, 6.25%).[55] This may reflect the relative cheapness and ease of use of the American patent system, which increased the general propensity to patent inventions in the USA: in 1870, a UK patent maintained in force for its full 14 years cost 30 times as much as an American one.[56] However, in Britain, this result may also reflect a Victorian tendency to esteem public-spirited inventors who foreswore intellectual property rights, thereby enhancing their reputation as disinterested benefactors (for example, Humphry Davy's invention of the celebrated miner's safety

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52 T. S. Ashton, The Industrial Revolution (Oxford, 1957).

53 See C. MacLeod, "James Watt, heroic invention and the idea of the Industrial Revolution", in M. Berg and K. Bruland (eds.), Technological Revolutions in Europe (Cheltenham, 1998).

54 Interestingly enough, while this shortfall was to some extent corrected in the Missing Persons volume (52% of whose 67 inventors came from the birth cohort, 1801-1850), it still managed to find another 20 inventors to add to the third cohort (thereby totaling 167 over the fourth's 148).

55 Khan and Sokoloff, "'Schemes of practical utility'", p. 290. Curiously, they do not mention how many inventors in their larger 1790-1930 sample held no patents, see Khan and Sokoloff, "Institutions and democratic invention".

56 I. Inkster, "Machinofacture and technical change: the patent evidence", in I. Inkster, C. Griffin, J. Hill, and J. Rowbotham (eds.),The Golden Age: Essays in British Social and Economic History, 1850-1870 (Aldershot, 2000), p. 135; B. Z. Khan and K. L. Sokoloff, "Patent institutions, industrial organization and early technological change: Britain and the United States, 1790-1850", in M. Berg and K. Bruland (eds.), Technological Change in Europe (Cheltenham, 1998), pp. 298-300.

lamp).[57] As we shall see, many inventors in the *DNB* achieved various forms of public recognition.

At the other extreme, however, a large clutch of patents provided a relatively sure route into the *DNB:* prolific patentees were much more likely to be noticed than those who held only a single patent. Our sample of *DNB* inventors, in particular the last two birth cohorts, contains a substantial share of prolific patentees (inventors with 6 to 10 patents and inventors with more than 10 patents). In Harry Dutton's terminology, these men formed the emergent group of "quasi-professional inventors", men who could earn a living by inventing – most often by selling and licensing their intellectual property rather than becoming manufacturers themselves.[58] A patentee's chance of being recognized by the *DNB* fell broadly in step with the number of patents he held: of the approximately 6,100 holders of a single patent, only 69 appear in the *DNB*; compare this with the 24 *DNB* entries among the 54 holders of eleven or more patents. This attention to prolific patentees may also be related to the presence among the contributors to the *DNB* of men, such as R. B. Prosser and H.T. Wood, who had a good degree of familiarity with the patent records.[59] Nonetheless, there were some surprising omissions of prolific and commercially successful patentees. It was left to the *Missing Persons* volume to rectify, for example, the absence of Augustus Applegath (1788-1871), who obtained 15 patents before 1852, mostly for his printing machinery, which revolutionized newspaper production. It also rescued William Gossage (1799-1877), whose 13 pre-1852 patents were but a prelude to many important ones after 1852, including the Gossage tower, that reduced the air pollution from alkali production.

TABLE 3 AROUND HERE

Table 3 considers the type of inventions made by the *DNB* inventors. Again we compare these results with those provided by Dutton for the population of British patentees in this period. Of course, due to the differences existing in the propensity to patent across various technological fields, the pattern of inventive activities emerging from the patent records cannot be considered as a faithful representation of the overall contours of technological change.[60] Notwithstanding this fundamental qualification, it is instructive to examine how the profile of inventive activities of the *DNB* inventors compares with that of a much wider population of contemporary inventors (i.e. the patentees). To facilitate a comparison between the two patterns, the relative percentage shares of inventions in the different technological classes for the two complete samples (ie, the first two columns of the table, all patentees 1751-1852 and all *DNB* inventors 1650-1850) are also given in figure 2.

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[57] D. Knight, Humphry Davy: Science and Power (Oxford, 1992).

[58] H. I. Dutton, The Patent System and Inventive Activity during the Industrial Revolution, 1750-1852 (Manchester, 1984).

[59] Of the 40 articles written by Prosser, 32 concerned patentees and, of these, 7 dealt with patentees who held more than 10 patents. Wood wrote 13 articles on inventors for the *DNB*, 11 of these were concerned with patentees, and, of these, 3 covered patentees who held more than 10 patents.

[60] C. MacLeod, Inventing the Industrial Revolution: the English Patent System, 1660-1800 (Cambridge, 1988), pp. 75-157.

FIGURE 2 AROUND HERE

Perhaps surprisingly, the leading category of inventions (13.37%) for the sample of *DNB* inventors is the field of "instruments" (including scientific and optical instruments, chronometers, clocks and watches, and photographic equipment). This outcome may be linked to a strong amateur interest in science among the readership of The Athenaeum, which often involved the collection and indeed use of scientific instruments, time-pieces and photographic equipment. Furthermore, since the late seventeenth century, leading instrument-makers had enjoyed a high degree of public recognition: they signed their products, their shops lined the best streets in London and Bath; many were elected Fellows of the Royal Society, and two of the most prominent eighteenth-century clock-makers (George Graham and Thomas Tompion) were buried in Westminster Abbey.[61] Finally, as we have seen, one of the most industrious contributors to the *DNB* was A. M. Clerke who may have suggested to the editors the inclusion of a number of astronomical instrument makers.

Another category with a remarkable share of *DNB* entries (especially when compared with the patent record) is the field of humanitarian inventions (for example, advances in medicine and surgery, new drugs, life-saving equipment). The discrepancy between the two patterns may owe something to the genuine humanitarian motivation and ethical concern of some inventors in this field, who were not interested in financial gain and therefore obtained no patent; on the other hand, this putative under-representation in the patent record could have been outweighed by the promoters of proprietary medicines, who keenly exploited the publicity value of patents, especially in the later eighteenth century.[62] On the other side of the equation, however, it seems likely that inventors of successful humanitarian devices and surgical advances—their achievements celebrated in the press and popular literature--would have enjoyed an increased propensity to attract the attention of the *DNB's* compilers.

Apart from these two categories, our sample of *DNB* inventors is skewed towards the "big science and engineering" achievements that characterise the traditional technological narratives of the British industrial revolution – steam engines, railways, textile machinery. Other categories with sizable shares in the *DNB* sample are technologies that could be recognized as belonging to Daniel Headrick's "tools of empire" (navigation, weaponry and the newly emerging communication technologies).[63] Each of these categories (with the exception of textile machinery) enjoys a share of *DNB* entries that is higher than its proportional representation of total patents in that category. This finding suggests that the attention of the editors and compilers of the *DNB* was attracted by particular types of invention—by the more glamorous and novel (not to say "macho") icons of mechanical and military hardware. This association with the technological icons of imperialism and the industrial revolution made such inventors much more "visible" than others.

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[61] On the growing public "visibility" of instrument-makers in the course of the eighteenth century, see R. Sorrenson, "George Graham, visible technician", British Journal for the History of Science, 32 (1999), 203-221.
[62] C. MacLeod, Inventing the Industrial Revolution: The English Patent System, 1660-1800 (Cambridge, 1988), pp. 84-8.
[63] D. R. Headrick, The Tools of Empire. Technology and European Imperialism in the Nineteenth Century, (Oxford, 1981). The impact of the developments in communication technologies on Victorian techno-scientific culture is discussed in I. R. Morus, "'The nervous system of Britain': space, time and the electric telegraph in the Victorian age", British Journal for the History of Science, 33(2000), 455-475.

By contrast, while the patent records exhibit a sizable share of inventions in consumer goods (consumer durables 8%, food and drink nearly 7%, and garments 4.3%), the *DNB* inventors sample is characterized by much smaller proportions (respectively 4.01%, 1.07%, and zero). The *DNB*'s disregard for this large field of "domestic" inventions helps to explain its omission of female inventors, for whom this was unavoidably a major sphere of activity. The patent records also re-orientate priorities within the realm of transport inventions. With slightly less emphasis than the *DNB* on the more prestigious rail and maritime sectors, the patents recognize the importance still attached to road transport: for example, while patents for improvements to carriages were legion, they did not generally provide a route to fame and into the *DNB* (except for Joseph Hansom and his cab). There is a similar effect in power generation: the patents reduce slightly the predominance of steam found in the *DNB*, but elevate markedly the significance of other forms of power production (water, wind, gas, and increasingly, electricity).[64] Finally, the *DNB* halves the importance accorded by the patent statistics to the invention of chemicals (a field that included many textile-related inventions, such as bleaching and dyeing).[65]

In summary, we may say that an inventor was more likely to become "great" (i.e. be included in the *DNB*) if he was inventing in certain, more prestigious technologies, than in other (older or more "feminine") spheres.

TABLE 4 AROUND HERE

Table 4 displays the occupations of the inventors in our *DNB* sample (we have considered what the *DNB* entry regarded as the main occupation). There appears to be a rather "imperfect mapping" between the types of invention reported in the second column of Table 3 and the occupation of the inventors noticed by the *DNB*. For example, while there are 25 "humanitarian" inventions in the total sample (corresponding to 6.68%), we have 40 entries for inventors (10.7%) active in the medical profession. By contrast, the number of agricultural inventions (14) exceeds the number of inventors engaged in agriculture (6). One could find other examples. This may suggest that a considerable number of the inventors contained in the *DNB* were actually "outsiders" to the industry in which they invented. This pattern is different from the one that Khan and Sokoloff identified in their sample of American "great" inventors. In the American case, they find that most inventions in the period 1790-1846 were actually made by "insiders" in the industries.[66] Again, as in the case of the patenting behaviour, this may indicate that in Britain the most "visible" inventors were characterized by a more limited entrepreneurial attitude than their American counterparts. Speculatively, one can also suggest that, whereas American "tales" had as a typical moral a story of entrepreneurial success, a number of British "tales" also portrayed the act of insight

[64] Contemporaries tended to conflate the early development of steam technology with its economic significance. These exaggerated judgments were frequently rehearsed in major historical works on the British industrial revolution, see, in particular, W. W. Rostow, The Stages of Economic Growth (Cambridge, 1960). For a detailed appraisal of the (limited) economic impact of the diffusion of the steam engine during the early phases of industrialization, see G. N. von Tunzelmann, Steam Power and British Industrialization to 1860 (Oxford, 1978). On the powerful influence of developments in steam power technology in nineteenth-century accounts of economic and social change, see D. Greenberg, "Energy, power, and perceptions of social change in the early nineteenth century", American Historical Review, 95 (1990), pp. 693-714.

[65] This was counteracted by the *Missing Persons* volume, which included 12 inventors of chemical processes and equipment.

[66] Khan and Sokoloff, "'Schemes of practical utility'", p. 206.

of an "uncommitted" mind which provided the solution to a technical bottleneck or a humanitarian risk.

TABLE 5 AROUND HERE

Table 5 reports the awards and honours obtained by the *DNB* inventors during their lifetime. The table is clearly skewed towards the last two cohorts. As we have noted, from the early nineteenth century inventive activities began to attract increasing public attention, but it was the second half of the nineteenth century before inventors began to be rewarded by the state with knighthoods and peerages.[67] Thus the surge in knighthoods (and, to a lesser extent, peerages) that were awarded to inventors in the last two cohorts raises the question of how far these honours were indicative of truly 'great' achievers; alternatively, was it their elevated social status which brought these particular inventors to the compilers' attention? Similarly, a fairly consistent share of *DNB* inventors, throughout the whole period, was admitted to the Royal Society, though again their representation was relatively highest in the final cohort, and raises the same question. The sizable number of FRSs is also indicative of rather porous boundaries between science and technology. In this sense, the broad notion of "distinguished men of science" (encompassing inventors and engineers) remained current throughout the nineteenth century .[68] Finally, there was a rise in (and between) the last two cohorts of inventors who belonged to the two major engineering societies of the time, the Institution of Civil Engineers (founded in 1818 in London) and the Institution of Mechanical Engineers (founded in 1847 in Birmingham).[69] It should be noted that membership of this two associations, based on cooption, was linked with some degree of professional distinction; of course, membership had not been available to the first cohort or any but the most long-lived of the second. In all our categories of awards and honours (except parliamentary rewards), it was members of the fourth cohort who received relatively the most.[70] In part, this finding provides evidence of the growing public respect for inventors in the second half of the nineteenth century; in part it may indicate a distinguishing feature that assisted the compilers of the *DNB* in deciding which among the host of contemporary inventors and patentees merited inclusion.

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[67] The state tended to reward those who had served it directly with inventions in the fields of weaponry, communications, and civil engineering: C. MacLeod, Heroes of Invention: Celebrating Industrial Culture in Nineteenth-Century Britain (forthcoming).

[68] For a discussion of the attitude of the members of the Royal Society towards the practical applications of scientific advances , see L. Stewart, The Rise of Public Science. Rhetoric, Technology and Natural Philosophy in Newtonian Britain 1660-1750 (Cambridge, 1992) and D. P. Miller, "The usefulness of natural philosophy: the Royal Society and the culture of practical utility in the later eighteenth century", British Journal for the History of Science, 32 (1999), 185-201.

[69] Most probably, behind the foundation of the Institution of Mechanical Engineers there was the feeling that developments in railway and marine engineering had not received the attention they deserved in the Institution of Civil Engineers. Tellingly, George Stephenson was elected first President of the Institution of Mechanical Engineers. For a condensed historical outline of the two institutions and their role in the expansion and consolidation of the engineering profession in Britain, see R. A. Buchanan, The Engineers. A History of the Engineering Profession in Britain (London, 1989), pp. 69-87.

[70] Until the early nineteenth century, Parliament was occasionally persuaded to make a pecuniary reward to an especially deserving inventor.

4. Heroic Invention and the British Industrial Revolution.

As Lawrence Stone predicted, progress in computing technologies, by permitting the construction and manipulation of large data-sets, has greatly enlarged the domain of prosopographical studies. It is no surprise then that, in the history of technology, recent research has paid growing attention to samplings of individual inventors and their background characteristics. By and large, researchers have adopted what Stone has termed a "shotgun scatter" approach, that is to say that they have reconstructed broad quantitative patterns of "aggregate" populations of inventors. These exercises have surely produced valuable insights, shedding light on some important features of the innovation process. However, in our view, insufficient attention has been devoted to the biases inherent in the historical sources that have been used. Sometimes, the findings of prosopographic exercises might actually reveal more about the lenses through which scholars or contemporaries have looked at particular phenomena, rather than about the properties of the phenomena themselves. In this specific case, the pantheon of British inventors selected by the compilers of the *DNB* provides us with a revealing picture of "the inventor" as perceived by the late Victorians.

Historians, who argue that the traditional narrative of the British industrial revolution is unduly concentrated on particular industries and technologies, will see the biases in the *DNB*'s selection of inventors as part of a major historiographical problem. In particular, the *Dictionary* exemplifies the neglect of consumer industries to which Maxine Berg has called our attention.[71] It was big science and prestige engineering projects that caught the attention of the compilers.. Similarly, personal anxieities about health or particular amateur interests may have drawn the compilers' notice to medical advances and to examples of the instrument- and clock-makers' ingenious arts. By contrast, home comforts, which were seen to belong to the feminine sphere, were largely taken for granted.

Correspondingly, the dictionary also downplays those major economic activities, no matter how innovative they were, that did not belong to the nineteenth-century narratives of industrialization and empire. Kristine Bruland has recently reminded us that the food and drink industries "were the largest single complex of economic activity; [and]....remained so during the nineteenth century". [72] She highlights five major areas of technological change in these industries. Significantly, none of the inventors she mentions received an entry in the *DNB* (except Admiral Sir Isaac Coffin (1759-1839), whose inventive achievement, the "perpetual oven" for baking bread on a large scale, is not mentioned in his entry). Similarly, the highly innovative glass industry is regularly ignored by the standard narratives and by the *DNB* (except for optical glass).[73]

To sum up, our discussion of the biases in the *DNB*'s treatment of inventors and inventive activities, resonates with some recent pleas to re-consider the multifarious technological

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[71] Maxine Berg, "Product innovation in core consumer industries in eighteenth century Britain", in M. Berg and K. Bruland, Technological revolutions.

[72] K. Bruland, "Industrialisation and technological change" in R. Floud and P. Johnson (eds.), The Cambridge Economic History of Modern Britain, vol I. (Cambridge, 2004), p. 129.

[73] Bruland, "Industrialisation", pp. 133-134.

dimensions of the British industrial revolution.[74] This should involve a careful re-assessment of the technological dynamism of sectors and locations that have so far been left at the margins of traditional narratives, which tend to concentrate on a handful of "glamorous" technologies. It is time to call from the back of the stage the "ingenious" and anonymous crowd, that has found no place in the heroic tales of invention told to us by the late Victorians. [75]

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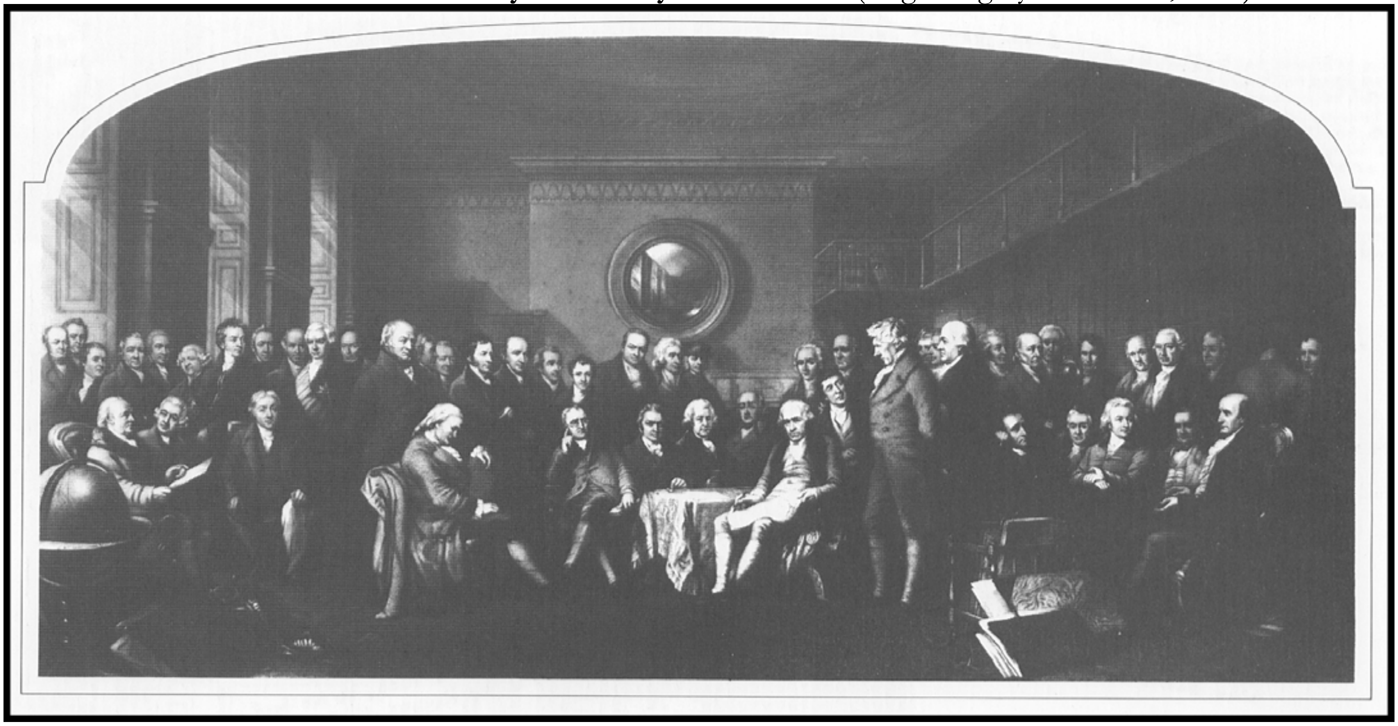
[74] M. Berg and P. Hudson, "Rehabilitating the industrial revolution", Economic History Review, 65 (1992), pp. 24-50; M. Berg, The Age of Manufactures, 1700-1820. Industry, Innovation and Work in Britain (London, 1994, 2nd ed.), especially pp. 28-30; K. Bruland, "Industrialisation and technological change", pp. 145-146.

[75] As a final note, we point to some recent contributions that are moving in this direction: A. P. Woolrich, "The London engineering industry at the time of Maudslay" in J. Cantrell and G. Cookson (eds.), Henry Maudslay and the Pioneers of the Machine Age (London, 2002); C. Behagg, "Mass production without the factory: craft producers, guns and small firm innovation, 1790-1815", Business History 40 (1998), pp. 1-15; G. Cookson, "Family firms and business networks: textile engineering in Yorkshire, 1780-1830", Business History 39 (1997), pp. 1-20; A. Nuvolari, "Collective invention during the British industrial revolution: the case of the Cornish pumping engine", Cambridge Journal of Economics, 28 (2004), pp. 347-363.

Figure 1: The Distinguished Men of Science of Great Britain living in the years 1807-1808 assembled in the Library of the Royal Institution (Engraving by W. Walker, 1862)



Source: National Portrait Gallery, London.

Table 1: Contributors of entries on inventors (1650-1850) in the *DNB*

Contributor	Number of entries in the DNB "Great inventors" 1650-1850 sample
R.B. Prosser	40
G.C. Boase	28
A.M. Clerke	15
E.I. Carlyle	15
Thomas Seccombe	13
H.T. Wood	13
Gordon Goodwin	13
James Burnley	12
Robert Hunt	9
P.J.Hartog	9
G.T. Bettany	9
Francis Espinasse	9
W.J. Harrison	8
Robert Harrison	8
C.W. Sutton	8
R.E. Anderson	7
H.M. Chichester	7
J.K. Laughton	6
A.F. Pollard	6
W.P. Courtney	5
T.H. Beare	5
anonymous	10
others with less than 5 articles	119
Total	**374**

Notes: the name of the contributors were retrieved from the online version of the DNB entries (http://www.oxforddnb.com/). The online version provides access to the entry of the Victorian edition of the DNB (so called "DNB archive" option)

Table 2: Patents held by all patentees and by the inventors in the *DNB*

Number of patents	All Patentees [1751-1852] (%)	DNB Total Sample [1650-1850] (%)	DNB Birth cohort [1650-1700] (%)	DNB Birth cohort [1701-1750] (%)	DNB Birth cohort [1751-1800] (%)	DNB Birth cohort [1801-1850] (%)
0	-	145	18	26	67	34
		(38.77)	(69.23)	(37.68)	(40.12)	(30.36)
Alleged patentees (DNB)	-	31	0	0	2	29
		(8.29)	(0)	(0)	(1.2)	(25.89)
1	Approx. 6,100	69	5	20	28	16
	(73.49)	(18.45)	(19.23)	(28.99)	(16.77)	(14.29)
2-5	1957	72	3	18	36	15
	(23.58)	(19.25)	(11.54)	(26.09)	(21.56)	(13.39)
6-10	190	33	0	2	20	11
	(2.29)	(8.82)	(0)	(2.9)	(11.98)	(9.82)
>10	54	24	0	3	14	7
	(0.65)	(6.42)	(0)	(4.35)	(8.38)	(6.25)
Total	Approx. 8,300	374	26	69	167	112
	(100)	(100)	(100)	(100)	(100)	(100)

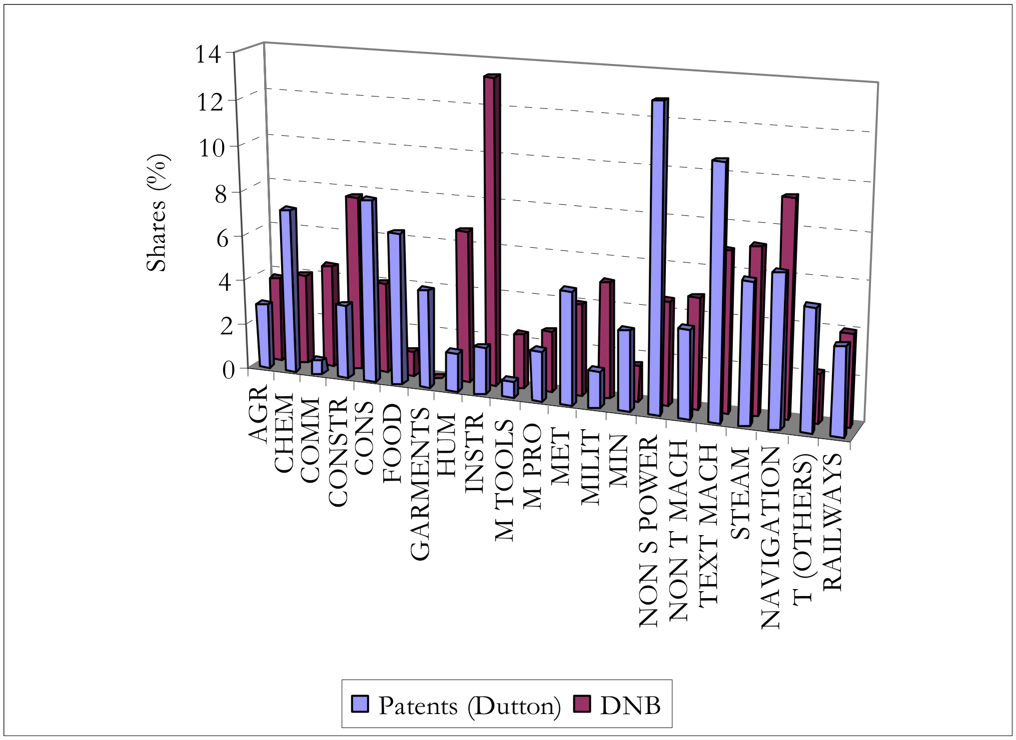
Notes: percentage shares are given in round brackets. Column 2 ("All patentees") is taken from H. I Dutton, *The Patent System and Inventive Activity during the Industrial Revolution* (Manchester, 1984), p. 115. The estimates of the total number of patentees and of the number of patentees with 1 patent are calculated assuming a value of 13,205 patents granted over the period 1751-1852 (as given in R. J. Sullivan, "England's 'Age of Invention': the acceleration of patents and patentable invention during the industrial revolution", *Explorations in Economic History,* 26 (1989), 424-452). The remaining columns were obtained by matching our sample of the *DNB* inventors with B. Woodcroft, *Alphabetical Index of Patents of Invention* (London, 1854). The second row ("alleged patentees (DNB)") reports the inventors who, according to their *DNB* entry, obtained at least one British patent, but who are not included in Woodcroft's *Alphabetical Index* (which covers the period 1617-1852), probably because their patents were granted after 1852. There are no consolidated indexes, similar to Woodcroft's, for the period after 1852.

Table 3: Types of invention by all patents and by inventors in the *DNB*

Type of invention	All Patents [1751-1852] (%)	DNB Total sample [1650-1850] (%)	DNB Birth cohort [1650-1700] (%)	DNB Birth cohort [1701-1750] (%)	DNB Birth cohort [1751-1800] (%)	DNB Birth cohort [1801-1850] (%)
Agriculture	501	14	1	3	7	3
	(2.92)	(3.74)	(3.85)	(4.35)	(4.19)	(2.68)
Chemicals	1245	15	0	2	4	9
	(7.25)	(4.01)	(0)	(2.90)	(2.4)	(8.04)
Communications (telegraphy, etc.)	106	17	0	3	5	9
	(0.62)	(4.55)	(0)	(4.35)	(2.99)	(8.04)
Construction methods	560	29	1	6	14	8
	(3.26)	(7.75)	(3.85)	(8.7)	(8.38)	(7.14)
Consumer durables	1377	15	0	3	11	1
	(8.02)	(4.01)	(0)	(4.35)	(6.59)	(0.89)
Food and drinks	1149	4	1	0	2	1
	(6.69)	(1.07)	(3.85)	(0)	(1.2)	(0.89)
Garments	738	0	0	0	0	0
(clothing, hats, boots, etc.)	(4.3)	(0)	(0)	(0)	(0)	(0)
Humanitarian (drugs, medical instruments,	289	25	2	5	10	8
etc.)	(1.68)	(6.68)	(7.69)	(7.25)	(5.99)	(7.14)
Instruments (scientific instruments, optical	355	50	5	15	17	13
instruments, photography, etc.)	(2.07)	(13.37)	(19.23)	(21.74)	(10.18)	(11.61)
Machine tools	124	9	0	1	4	4
	(0.72)	(2.41)	(0)	(1.45)	(2.4)	(3.57)
Manufacturing processes (pottery, glass,	380	10	3	3	2	2
etc.)	(2.21)	(2.67)	(11.54)	(4.35)	(1.2)	(1.79)
Metallurgy	848	15	2	3	4	6
	(4.94)	(4.01)	(7.69)	(4.35)	(2.4)	(5.36)
Military (weapons, etc.)	275	19	2	2	6	9
	(1.6)	(5.08)	(7.69)	(2.9)	(3.59)	(8.04)
Mining (ventilators, drainage, safety lamps,	603	6	0	0	5	1
etc.)	(3.51)	(1.6)	(0)	(0)	(2.99)	(0.89)
Non-steam power generation (water	2257	17	0	3	5	9
wheels, wind mills, electric motors, etc.)	(13.14)	(4.55)	(0)	(4.35)	(2.99)	(8.04)
Non-textiles production machinery	661	18	1	1	13	3
(printing, etc.)	(3.85)	(4.81)	(3.85)	(1.45)	(7.78)	(2.68)
Production machinery (textiles)	1872	26	2	11	8	5
	(10.9)	(6.95)	(7.69)	(15.94)	(4.79)	(4.46)
Steam engines	1053	27	4	3	17	3
	(6.13)	(7.22)	(15.38)	(4.35)	(10.18)	(2.68)
Transport (navigation)	1135	35	2	5	19	9
	(6.61)	(9.36)	(7.69)	(7.25)	(11.38)	(8.04)
Transport (railways)	659	15	0	0	10	5
	(3.84)	(4.01)	(0)	(0)	(5.99)	(4.46)
Transport (others)	914	8	0	0	4	4
	(5.32)	(2.14)	(0)	(0)	(2.4)	(3.57)
Total	17101	374	26	69	167	112
	(100)	(100)	(100)	(100)	(100)	(100)

Note: percentage shares are reported in round brackets. The source for the second column (All Patents, 1751-1852) is Dutton, *Patent System* , pp. 206-208. We have aggregated Dutton's data into broader categories. Dutton used the *Abridgements of Specifications*, which led to some double counting: this produced a total of 17,101, compared with the actual total of 13,205 patents, as calculated by Sullivan (see note to Table 2). For classifying the *DNB* inventors, we have used the most famous invention of the inventor in question (according to the entry in the *DNB*).

Figure 2: Types of Invention, All patents (1751-1852) and DNB inventors (1650-1850)



Sources: see Table 3

Table 4: Occupations of the inventors in the DNB, 1650-1850.

Occupation	**DNB Total Sample [1650-1850] (%)**	**DNB Birth cohort [1650-1700] (%)**	**DNB Birth cohort [1701-1750] (%)**	**DNB Birth cohort [1751-1800] (%)**	**DNB Birth cohort [1801-1850] (%)**
Agriculture	6 (1.6)	1 (3.85)	1 (1.45)	3 (1.8)	1 (0.89)
Artisan or tradesman (spinner, weaver, printer, bookseller, etc.)	30 (8.02)	2 (7.69)	7 (10.14)	17 (10.18)	4 (3.57)
Engineer (including millwright, mechanic and machine makers)	118 (31.55)	2 (7.69)	11 (15.94)	57 (34.13)	48 (42.86)
Industrialist	58 (15.51)	6 (23.08)	16 (23.19)	22 (13.17)	14 (12.50)
Instrument-maker	22 (5.88)	4 (15.38)	12 (17.39)	3 (1.8)	3 (2.68)
Medical (physician, surgeon, pharmacist, midwife)	40 (10.7)	7 (26.92)	6 (8.7)	14 (8.38)	13 (11.61)
Military and naval	18 (4.81)	0 (0)	4 (5.8)	9 (5.39)	5 (4.46)
Scientist/ University Professor	19 (5.08)	1 (3.85)	1 (1.45)	8 (4.79)	9 (8.04)
Other professional (lawyer, clergyman, architect, civil servant, etc.)	39 (10.43)	2 (7.69)	7 (10.14)	18 (10.78)	12 (10.71)
Other / not specified	24 (6.42)	1 (3.85)	4 (5.8)	16 (9.58)	3 (2.68)
Total	374 (100)	26 (100)	69 (100)	167 (100)	112 (100)

Note: percentage shares are reported in round brackets; source *DNB*.

Table 5: Awards and Honours of the DNB inventors, 1650-1850

Awards and Honours	DNB Total Sample [1650-1850] (%)	DNB Birth cohort [1650-1700] (%)	DNB Birth cohort [1701-1750] (%)	DNB Birth cohort [1751-1800] (%)	DNB Birth cohort [1801-1850] (%)
Peerage	5	0	0	1	4
	(1.34)	(0)	(0)	(0.6)	(3.57)
Knighthood	44	1	1	21	21
	(11.76)	(3.85)	(1.45)	(12.57)	(18.75)
Rewarded by Parliament	7	1	2	4	0
	(1.87)	(3.85)	(2.9)	(2.40)	(0)
Fellow of the Royal Society	75	5	15	25	30
	(20.05)	(19.23)	(21.74)	(14.97)	(26.79)
Member of the Institution of Civil Engineers	49	0	0	23	26
	(13.10)	(0)	(0)	(13.77)	(23.21)
Member of the Institution of Mechanical Engineers	16	0	0	5	11
	(4.28)	(0)	(0)	(2.99)	(9.82)
None	208	18	47	100	43
	(55.61)	(69.23)	(68.12)	(59.88)	(38.39)

Note: percentage shares are reported in round brackets. The ICE was founded in 1818; the IME was founded in 1847.Source**:** *DNB*.

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