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- Richard Yeo

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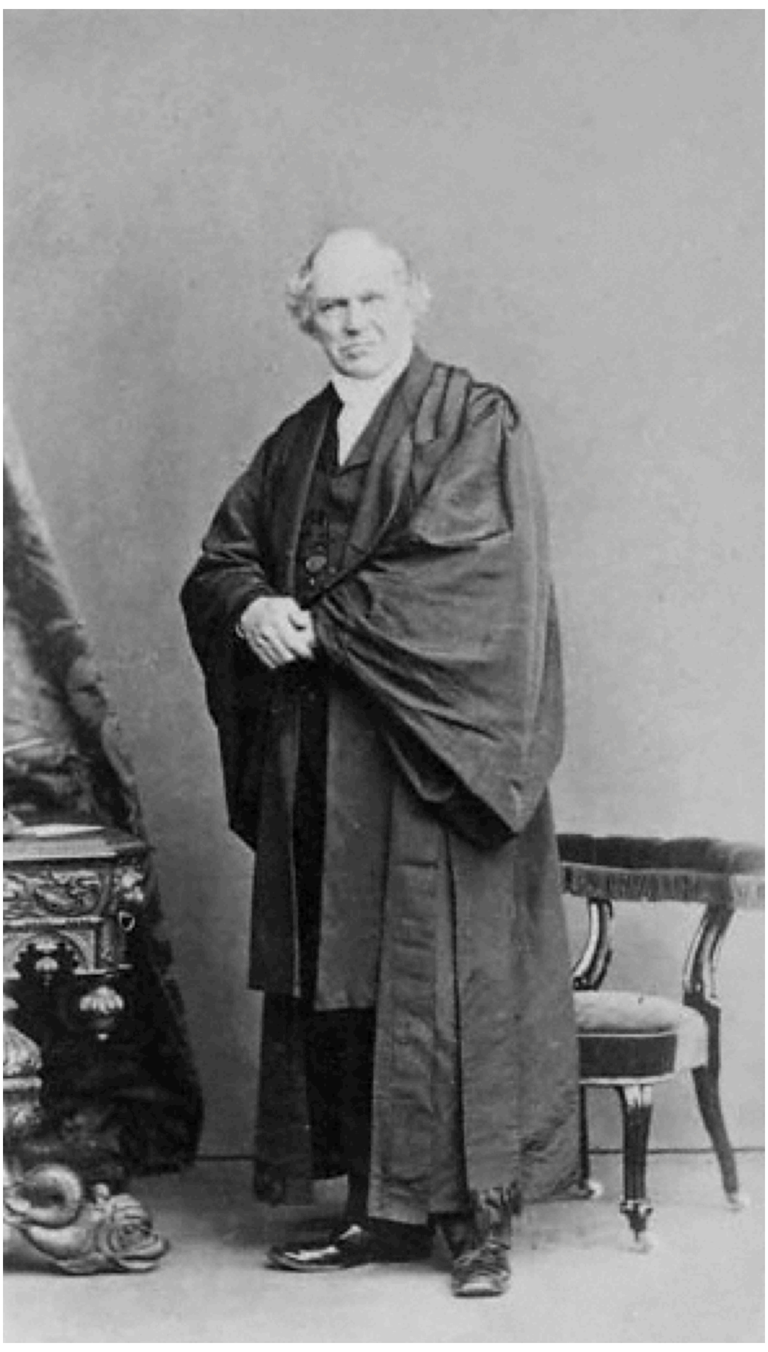

William Whewell (1794–1866)

by J. Rylands

Whewell, William (1794–1866), college head and writer on the history and philosophy of science, was born on 24 May 1794 at Brock Street, Lancaster, the eldest of seven children of John Whewell, master carpenter, and his wife, Elizabeth Bennison.

Education

Whewell at first attended the Blue School in Lancaster. Subsequently, at the suggestion of the Revd Joseph Rowley, the master of Lancaster grammar school, his father agreed to send him there, rather than making him an apprentice carpenter. In 1810 he transferred to Heversham grammar school in order to compete for a scholarship, worth £50 a year, to Trinity College. Before going to Cambridge he was also tutored for some months by John Gough, the blind mathematician of Kendal. Whewell was formally entered at Cambridge in 1811 and began his first term in October 1812 as a sub-sizar.

During his undergraduate years most of Whewell's family died: his mother in 1807, three younger brothers by 1812, and his father in July 1816. Only two sisters—Martha and Ann—remained after the eldest, Elizabeth, died in 1821. In his early years Whewell's own health is said to have been poor, and he was described as a delicate boy, but in November 1812 he told his father that 'I have enjoyed very good health since I left Lancaster' (Douglas, 9). From then on, Whewell's tall and powerful physical form was remarked on by his contemporaries, and was seen to match the vigorous style of his intellectual and personal exchanges.

Whewell's letters from Cambridge to his family convey a strong sense of being their chosen representative in a different social world. Announcing a first place in every subject in June 1814 Whewell told his father that '*We* have reason to be proud' (26 June 1814, Whewell MSS, Add. MS a. 301). His string of academic successes began with the Latin declamation prize in 1813. In 1814 he won the Chancellor's medal for an English poem on Boadicea (published in 1820), but assured his family that he was not neglecting mathematical studies. These triumphs were unexpectedly interrupted when Whewell graduated as second wrangler in January 1816, beaten by Edward Jacob of Caius College, who was also first Smith's prizeman, with Whewell taking the second prize.

However, Whewell's aim was not just academic glory but a fellowship that would justify the financial support of his father and give him an independent position. His father died in July 1816, before his graduation and election as fellow in October 1817. Of the latter event, Whewell explained to his sisters that it was 'the most substantial benefit at which you ever had to rejoice with me. It secures me a comfortable establishment for life at least so long as my life is a simple one' (1 Oct 1817, Whewell MSS, Add. MS a. 301). He was appointed mathematical lecturer and assistant tutor in 1818, tutor in 1823.

Social elevation and marriage

These academic achievements were accompanied by personal trials associated with the passage from Lancaster to Cambridge. For a time Whewell was not only very much alone, but also seen as unusual. His manners and speech were considered rude or rustic. There is a report of Whewell's comment upon a herd of pigs being driven past the college gate soon after his arrival: 'They're a hard thing to drive—very—when there's many of them—is a pig' (*The Athenaeum*, 333). Having visited London for the first time in 1815 Whewell admitted to his sisters that he had only seen the city from 'the outside' because, not knowing anyone there, he could not 'see anything of its society' (14 April 1815, Whewell MSS, Add. MS a. 301). Whewell regarded Trinity College as a second home, so much so that his letters to his family were punctuated with excuses for not making more visits to Lancaster. In April 1815 he explained to his sister that a trip to Lancaster was expensive and that, in spite of the plague in Cambridge, he had decided to stay 'because I can employ my time better here'.

Although known for his constant reading Whewell appears to have participated in a wide range of undergraduate social activities; indeed, Isaac Todhunter hinted that some of his early acquaintances were not salubrious, and that he ignored the proper boundaries between town and gown (Todhunter, 1.3). But the summer pursuits Whewell described to Richard Gwatkin in 1815 were harmless: 'shooting swallows, bathing by half dozens, sailing to Chesterton, dancing at country fairs, playing billiards, turning beakers into musical glasses, making rockets, riding out in bodies' (ibid., 2.8). In March 1817 he was president of the union—a society of undergraduates—when the vice-chancellor sent the proctors to disband a meeting. It is not clear why, but at a time when some European countries were monitoring student societies and the Sidmouth Acts in Britain banned large assemblies the prospect of critical political discussion no doubt frightened the leaders of the university. Whewell is reported to have stood his ground, achieving an audience with the vice-chancellor, even though the meeting did then disband.

Whewell was able to make and sustain friendships that gave him intellectual and personal support. Richard Sheepshanks, another student from the north of England with scientific interests, entered Cambridge in the same year as Whewell. From 1819 they made several trips to the continent, after surviving a shipwreck on their first attempt. Whewell also travelled in 1823 with Kenelm Digby to study the architecture of churches and abbeys in Normandy and Picardy. He met John Herschel (senior wrangler in 1813), Charles Babbage, George Peacock, Michael Slegg, and Edward Bromhead as members of the Analytical Society, founded by Babbage and Herschel in 1811 to advocate continental mathematical notation in the use of the calculus, and to introduce formal algebraic analysis into Cambridge teaching. Whewell was at first impressed by their plans, but when in a position to influence the curriculum, through his textbooks, he began to fear that continental analysis, especially Lagrange's treatment of the calculus, did not ensure a proper geometrical grasp of the problems addressed in mechanics and other branches of mixed mathematics. In addition to these mathematical friends the political economist Richard Jones, the astronomer George Biddell Airy, the professor of botany John Henslow, and the classical and theological scholars Julius Hare, Connop Thirlwall, and Hugh James Rose were all colleagues at Cambridge. The geologist Adam Sedgwick, who graduated in 1805, was an older and respected member of the college; with him Whewell took geological field trips to the Lake District, and first met William Wordsworth there in 1821.

By 1817 two of his closest friends, Herschel and Jones, had left Cambridge, and Whewell spoke of the loss he felt. However, he continued a lively correspondence with them, as he did with other early friends such as Hare and Rose, and later with younger men, some of whom he worked with on various projects: John Lubbock, Robert Willis, Augustus De Morgan, William Rowan Hamilton, and James Forbes. Whewell's extensive correspondence reveals him as a candid and sensitive friend, a penetrating critic, and an astute participant in a range of scientific and university debates and activities.

During the 1820s Whewell began to move more easily in the social circles outside the university. In 1823 he met Sir John Malcolm, who lived at Hyde Hall, near Cambridge, and he subsequently enjoyed the friendship of the Malcolm family. There is a definite sense in which this was a surrogate family for Whewell; his correspondence with Lady Malcolm continued after the family moved from the Cambridge area in 1827, and soon after his marriage in 1841 Whewell told her that he remembered this earlier period as 'one of the bright passages of my life' (Douglas, 239). Whewell also met aristocratic graduates of Cambridge such as the third Earl Fitzwilliam (1786–1857) and the second marquess of Northampton (1790–1851), both of whom were involved in the affairs of scientific societies.

From the 1830s Whewell's activities extended beyond Cambridge as he became more involved with the British and European scientific and intellectual communities. He was consulted by William Vernon Harcourt, the first secretary of the British Association for the Advancement of Science (founded in 1831) and suggested the commissioning of annual reports on the state of the various sciences. Whewell's own reports on mineralogy (1832) and electricity and magnetism (1835) were informed by the historical insights later used in his major works. Whewell did not attend the first meeting of the British Association in York, but subsequently served as vice-president in 1832 and 1837, local secretary in 1833 for the Cambridge meeting, and president in 1841.

Whewell's social rise was completed in June 1841 when he was engaged to Cordelia (*d.* 1855), the daughter of John Marshall, a flax spinner of liberal political sympathies; his eldest daughter, Mary, had married Lord Monteagle. Whewell had been introduced to the Marshalls by the Wordsworth family. On 12 October 1841 Cordelia married Whewell in Cumberland. On the same day Christopher Wordsworth, master of Trinity, wrote to Whewell saying that he intended to resign; by 17 October 1841 Sir Robert Peel, the Conservative prime minister, had written that the queen had accepted his recommendation of Whewell as the next master—a decision that passed over his senior colleague, Sedgwick, who might have been appointed under a whig government.

Early writings

Whewell's first book was *An Elementary Treatise on Mechanics* (1819), a textbook that he revised in five later editions; this was supplemented by *A Treatise on Dynamics* (1823). The second work, in particular, introduced calculus to Cambridge undergraduates and praised its use by the French mathematician and astronomer, Pierre Laplace, in his *Mécanique céleste*. But subsequent editions of both these books contained far less calculus and more emphasis on geometrical methods. Whewell's *Essay on Mineralogical Classification and Nomenclature* (1828) sought to offer a revision of Friedrich Moh's system. In 1830 he published, anonymously, *Architectural Notes on German Churches, with Remarks on the Origin of Gothic Architecture*; other editions appeared in 1835 and 1842, both now bearing his name. This discussed the mechanical principles underlying Gothic architecture, a topic pursued in more detail by Whewell's collaborator, Robert Willis. In 1833 his *Astronomy and General Physics*, a volume in the Bridgewater Treatises on natural theology, was a clear success, becoming the best-seller of the series and reaching a sixth edition in 1864. This offered a fairly conventional argument from design: Whewell suggested that the position of the earth in the solar system and its orientation to the sun were clearly and benevolently adapted to the needs of living things, including human beings. But he also included a discussion of inductive and deductive thinking, noting the tendency of the latter to dilute appreciation of design in nature. Two major works followed: *History of the Inductive Sciences* (3 vols.) in 1837 and *The Philosophy of the Inductive Sciences* (2 vols.) in 1840. During this period Whewell also wrote reviews for some of the major quarterly journals, scientific papers on mineralogy and chemistry (both on nomenclature), a pamphlet on mathematical education, a book *On the Principles of English University Education* (1837), *Sermons, Preached in the Chapel of Trinity College* (1847), reports for the British Association for the Advancement of Science, and (with others) a translation of Goethe's *Hermann und Dorothea* (1837).

Master of Trinity

By 1841 Whewell had made his scholarly mark and completed an extraordinary feat of social elevation. The conventional markers of this rise were his university posts and his writings. He was assistant mathematics tutor in 1818, head tutor at Trinity in 1823, ordained deacon in 1825 and priest in 1826, professor of mineralogy in 1828, Knightbridge professor of moral philosophy (formerly moral theology) in 1838, and master of Trinity from 1841. Whewell took formal possession of the master's lodge on 16 November 1841. This position allowed a continuation of his association with Trinity—the college, as he often reflected, of Bacon and Newton. As master he allowed a statue of another past resident—Lord Byron—to be rescued from a London vault and installed in the college library in 1843; he also commissioned a copy (by Henry Weekes) of the statue of Francis Bacon at St Albans for the ante-chapel. Whewell revised the college statutes in 1844, sought to limit the system of private tuition and placed more emphasis on professorial lectures. As master of the largest college in the university he was well positioned to influence academic policy, which he did in the role of vice-chancellor in 1842–3 and again in 1855. Whewell initiated the installation of Prince Albert as chancellor in 1847 and seems to have had his support for broadening the Cambridge curriculum—as achieved with Whewell's introduction of the moral sciences and natural sciences triposes in 1848. When the royal commission into Cambridge reported in August 1852 Whewell replied to its queries but resisted its intrusion, partly because he wanted reform to be internally directed rather than externally imposed, but also because he did not wish to weaken the autonomy of the colleges in favour of the central power of the university. He defended the practice of election as the mode of entry to fellowships, rejecting open competition on the ground that this might weaken the obligation of fellows to the colleges. Whewell was also reluctant to abandon the tradition by which the master and eight senior fellows governed the college.

In his early years as master Whewell acquired a reputation for imperiousness and formality. Not all of this was new behaviour, because his dominating physical presence, fierce debating, and hard horse riding were well known. Airy remembered a section of Cornwall as the place 'where Whewell overturned me in a gig' (Airy, 84). Hare's advice to Whewell in December 1840 not to think of taking up a college living was informed by a judgement that he was better suited as a doctor, not a pastor, of the church. Hare mentioned the possibility of the mastership, but when it came to Whewell a year later this new office elicited a stiffness and formality that had not been so evident. Whewell's admonition of Sedgwick is often cited. Whewell wrote to his older colleague in 1845 saying that 'your frequent appearance in the College courts accompanied by a dog [his pet] is inconsistent with … Rules [of the College] and with the Statutes cap.xx' (Clark and Hughes, 2.97–8). But even Whewell's harshest critics agreed that he was the most prestigious master of Trinity since Richard Bentley.

Scientific interests and achievements

As second wrangler in 1816 Whewell had the credentials for major participation in science, and might have been expected to use the security of his fellowship as a basis for such activity. This was the path to a scientific vocation pursued by colleagues such as Sedgwick in geology and Airy in astronomy, although it differed from that followed by Herschel, Charles Lyell, and Charles Darwin, whose independent incomes allowed full-time devotion to scientific research.

Whewell's practical scientific work indicates his considerable presence in a number of fields. While his mechanics textbooks reflected pedagogic rather than research interests, he was involved in geological expeditions with Sedgwick from 1821 and sought the most advanced instruction in mineralogy and crystallography in Berlin, Freiburg, and Vienna in 1825. Commenting on a paper by Whewell about mathematical aspects of crystallography, Herschel affirmed that it was 'fit for the transactions of any Society in the world' (Herschel to Whewell, 15 Oct 1823, RS, Herschel MSS, vol. 18, no. 164). This paper appeared in the *Philosophical Transactions of the Royal Society of London* in 1824; he also contributed four papers on related topics to the *Cambridge Philosophical Transactions* between 1821 and 1827. In May 1826 Whewell set off to Cornwall with Airy to spend several weeks in a mine shaft experimenting on the mean density of the earth. They planned to compare the effect of gravity on invariable pendulums at the surface and at a depth of 1200 feet. Whewell wrote letters to Herschel and Lady Malcolm describing himself as a correspondent 'sitting in a small cavern deep in the recesses of the earth' (Todhunter, 2.65–7; Douglas, 103–4). The experiment was not successful and they made another attempt two years later, accompanied this time by Sheepshanks. A description of their efforts was published as *Account of Experiments Made at Dolcoath Mine, in Cornwall* (1828). In that year Whewell became professor of mineralogy, nominating for the position on the platform of applying mathematics to crystallography and improving classification in mineralogy. He had already published five papers in the area. In 1834 he began to develop a self-registering anemometer to measure the velocity of the wind; by 1837 he had devised such an instrument. These scientific activities supported Whewell's election to the Royal Society in 1820, admission to the Geological Society in 1827 and nomination for its presidency in 1837, a position he occupied until 1839.

Whewell's most significant scientific work was his study of tides—or 'tidology', as he called it—recorded in fourteen papers presented to the Royal Society of London from 1833 to 1850. With John Lubbock (his former student) he began a quest to chart the movements of the world's oceans, aiming to produce a map of co-tidal lines showing the points throughout the globe where high water occurs at the same time. This research was substantially funded by the British Association, and, although he was not fully satisfied with the results, Whewell was rewarded in 1837 with a royal prize medal from the Royal Society. In spite of these achievements Whewell did not consider himself a major scientific discoverer. His contributions in mineralogy and tidology were important, but neither met his own criteria for truly significant advances in science. By 1840 Whewell was devaluing his scientific achievements, saying that 'there is nothing of such a stamp, in what I have attempted, as entitles me to be considered an eminent man of science' (Todhunter, 2.286).

Whewell as omniscient

Leslie Stephen remarked that the sheer mass of Whewell's publications evinced his 'extraordinary powers of accumulating knowledge' (*DNB*). But Stephen also identified a puzzle: 'Whewell began as a man of science' but then 'scarcely became a philosopher'. From a late Victorian perspective this made Whewell's reputation an indeterminate one. Francis Galton offered a similar diagnosis in 1869. Noting that fame in science was heavily influenced by the association of an individual's name with some striking discovery, he cited Whewell as an example of one who, in spite of being among the most able of his generation, was destined to be forgotten.

Sydney Smith's quip—that science was Whewell's forte but omniscience his foible—has influenced most responses to the man and his work. It is not surprising that Whewell has commonly been approached as a polymath, an individual who, on his own early confession, aspired to 'universal knowledge' or omniscience (Whewell to George Morland, 15 Dec 1815, Todhunter, 2.10). By any measure, the range of his writings and accomplishments was remarkable: mathematics, mechanics, architecture, mineralogy, tidology, moral philosophy, political economy, educational theory, natural theology, translations of Greek philosophy and German poetry, and the history and philosophy of the physical sciences. This breadth and productivity were extraordinary, especially by the standards of a Cambridge don at a time when research was not a required duty of academic life. When Lyell told a friend that he had taken Whewell's last work to read while travelling on the continent he was asked to clarify to which of the three works—published within a year—he was referring (*Life, Letters, and Journals*, 2.38). Herschel doubted whether any other individual had gathered a 'more wonderful variety and amount of knowledge in almost every department of human inquiry … in the same interval of time' (Herschel, liii).

Thus Whewell was seen as a phenomenon—the equal of other polymaths of the period like Macaulay, Brougham, and Coleridge—but different in that science was his forte, even though he did not make a major discovery. On the other hand, members of the scientific community appreciated the synthetic overview his works provided. Critical reflection on the nature and value of science was not peculiar to Whewell—other men of science such as Herschel, Lyell, and David Brewster also made such pronouncements. But, in admitting that research and discovery were not his main concerns, Whewell was seen to be different. In 1836 Lyell said that he used to regret that Whewell had not concentrated on one or two sciences, but now he believed that by being a universalist rather than a specialist he was assisting the progress of science. Lyell told Whewell that this was his proper calling (Todhunter, 1.112). In the same year Whewell told Herschel that 'In a year of two I expect to be a philosopher and nothing else' (Todhunter, 2.235). How did Whewell pursue this vocation?

Critic and reviewer of science

Even before his two major works Whewell offered critical commentaries on the nature of science. He did this in his address to the British Association in 1833, in two reports to that body on the state of particular sciences and, for a wider audience, in reviews of scientific works in periodical journals. His review of Herschel's *Preliminary Discourse on the Study of Natural Philosophy* (1830) in the *Quarterly Review* for July 1831 was his first appearance in public (albeit under the convention of anonymity) as a philosophical writer. In the same year he reviewed two other major works: the first volume of Lyell's *Principles of Geology* (1830) and the *Essay on the Distribution of Wealth, and on the Sources of Taxation* (1831) by his friend, Richard Jones—both in the *British Critic*. These three works allowed him to discuss Baconian methodology and comment on the new sciences of geology and political economy in relation to the mature disciplines of astronomy, mechanics, and optics. Whewell explained that the mature sciences had reached the stage of being able to deduce consequences from general laws. On the other hand, some political economists were being prematurely deductive, without having the necessary empirical data, such as that contributed by Jones about different kinds of rent. Geologists, however, now had a good store of observations. In reviewing, at Lyell's request, the second volume of *Principles of Geology* for the *Quarterly Review* in March 1832, Whewell coined 'Uniformitarian' and 'Catastrophist'—terms that were adopted as labels for the opposing doctrines in the geological debates of the day. Later, Whewell described disciplines such as geology, archaeology, and philology as 'palaetiology'—studies of historical causation—and supplied Lyell with Eocene, Miocene, and Pliocene as names for geological periods.

Whewell also first introduced the term 'scientist' in a review article on Mary Somerville's *On the Connexion of the Physical Sciences* (1834) in the *Quarterly Review* (51, 1834, 59). He had made this suggestion—by way of analogy with 'artist'—at a meeting of the British Association in 1833. He used the context of this review to offer this word as a means of noting the common enterprise of those who studied the natural world, even if the various scientific disciplines were becoming more specialized and less unified than Somerville thought. Whewell confirmed this neologism in the *Philosophy*, saying that 'as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist [also his word], or Naturalist' (*The Philosophy of the Inductive Sciences*, 1847, 2.560). One of his other significant contributions to scientific terminology came in the course of discussions with Michael Faraday about appropriate terms to describe opposing directions of electric currents. In 1834, and again in subsequent letters, after rejecting some of Faraday's suggestions, Whewell recommended 'anode' and 'cathode' (Whewell MSS, O.15.147–8; Todhunter, 2.179–81).

Historian and philosopher of science

Whewell's two major works, *History of the Inductive Sciences* (3 vols., 1837) and *The Philosophy of the Inductive Sciences* (2 vols., 1840; 2nd edn 1847), were appreciated as considerable achievements when they appeared. Even his critics drew upon the *History*, but the *Philosophy* was seen by some as too close to Immanuel Kant's idealist epistemology. Herschel and Jones, for example, regarded this as inconsistent with the empirical character of scientific inquiry and a threat to its claim to offer true descriptions of the natural world. Today, however, Whewell's work is seen as posing some of the central issues of the philosophy of science—the relationship between theory and observation, the role of imagination and hypotheses, and the concept of theoretical revolutions, all supported by appeals to the historical record.

Whewell saw these two works as parts of a single inquiry into the philosophy of knowledge, focusing on the nature of 'the most certain and stable portions of knowledge which we already possess' (*The Philosophy of the Inductive Sciences*, 1847, 1.1). It was commonly accepted, he contended, that these were the sciences concerned with knowledge of the material world. In the *History*, Whewell abandoned the orthodox Baconian account of induction assumed in his earlier notebooks, and defended the speculative guesses of Johann Kepler as the more usual path to great discoveries. In using the term 'induction' he referred to the general process by which laws and theories were attained; but he stressed that this was more than a mere generalization from the facts because it involved the addition of a conception from the mind of the scientist. When a number of facts were brought together under some conception Whewell called this the 'Colligation of Facts' (ibid., 1.ix). He made this point directly in *The Mechanical Euclid*, published in 1837: 'Some notion is *superinduced* upon the observed facts. In each inductive process, there is some general idea introduced, which is given, not by the phenomena, but by the mind' (*Mechanical Euclid*, 1837, 178). Whewell suggested that once this had been accomplished previously detached observations assumed a unity that now required an imaginative effort to dissolve: 'The pearls once strung, they seem to form a chain by their nature' (*Philosophy*, 2.52).

In the *History*, Whewell began with this assumption:

> the present generation finds itself the heir of a vast patrimony of science; and it must needs concern us to know the steps by which these possessions were acquired, and the documents by which they are secured to us and our heirs for ever.
>
> *History of the Inductive Sciences*, 1.4

He outlined a three-stage pattern in the progress of particular sciences, especially in astronomy, his 'pattern science'. In this tripartite scheme, the crucial period of discovery—the 'inductive epoch'—was marked by a convergence of distinct facts and clear, appropriate ideas in the minds of great discoverers. This was preceded by a 'Prelude' in which these facts and ideas were gradually clarified. The inductive epoch was succeeded by a 'Sequel' in which the discovery was accepted and consolidated by the scientific community. Although progress was the motif of the drama that Whewell unfolded he was not dismissive of failures, arguing that they often revealed clues about the nature of scientific discovery. One implication was that present theories, especially in new scientific disciplines, may not be permanent ones.

Whewell's historical vision of the inductive sciences combined moments of dramatic, theoretical change—he used the term 'revolution'—with periods of gradual progress and consolidation. On this view, each science built on its past, incorporating aspects of older doctrines in most recent developments. This idea of a balance between progress and continuity was also a feature of Whewell's political outlook, one that resonated with Peel's Conservatism. In a letter to James Marshall (his brother-in-law) Whewell professed his belief in 'our National Constitution and in our National Religion', and argued that both needed to be invigorated by 'a formative spirit which makes *reform* unnecessary' (Douglas, 282).

In the *Philosophy* Whewell elaborated the epistemological doctrine underlying his view of the intimate connection between facts and ideas in the formation of scientific theories. He called this the 'Fundamental Antithesis' of philosophy. Whewell contended that all knowledge depended on the practical union of sensations and ideas, facts and theories; equally, philosophy required their analytical separation. Thus while not denying such distinctions, he argued that the distinction between 'Fact and Theory' was not a simple one. There was, he declared, 'a mask of theory over the whole face of nature', so that a fact from one perspective was a theory under another (*Philosophy*, 1.42).

Whewell believed that inadequate views about the nature of scientific and other knowledge could in part be attributed to John Locke's view of the mind as a passive receiver of knowledge from the world. For Whewell the mind was active: ideas were not simply transformed sensations; they were the active element that gave form to sensations. 'We cannot,' he explained, 'see one object without the idea of space; we cannot see two without the idea of resemblance or difference'. These and other 'Fundamental Ideas' (as he called them) such as time, number, cause, substance, likeness, and polarity supplied 'Ideal Conceptions' appropriate to the various sciences: for example, that of the ellipse in Kepler's astronomy, or force in dynamics. Whewell claimed that these, and other ideas, regulated the active operations of the mind and were the grounds of the necessary truths which certain branches of science had so far established (*Philosophy*, 1.66). Over time other fundamental ideas would be progressively revealed as the basis of necessary truths in other branches of science (*On the Philosophy of Discovery*, 1860, 354–75). Because different branches of science were grounded in distinctive fundamental ideas, there was, in Whewell's philosophy, a limit to synthetic notions of the unity of sciences.

In Whewell's account of science the mind was dynamic and creative; great discoverers were imaginative and speculative in their quest for knowledge of nature. There was no simple art or method of discovery, but Whewell sought a philosophical understanding of how knowledge advanced. This included some reference to what later became known as the logic of proof and verification. Thus Whewell's notion of the 'Consilience of Inductions' suggested a way of identifying powerful hypotheses: for example, 'cases in which inductions from classes of facts altogether different have thus *jumped together*, belong only to the best established theories which the history of science contains' (*Philosophy*, 2.65).

In noting the anti-Lockean disposition of the *Philosophy*, Leslie Stephen judged that Whewell's work had not been very influential: even towards the end of Whewell's mastership John Stuart Mill was the authority in Cambridge. This assessment made the conflict between idealist and empiricist epistemology crucial for the estimation of Whewell's achievement—a consideration that has since affected his reputation, placing him on the losing side. Stephen said that his philosophy of scientific knowledge was 'scarcely coherent' (*DNB*) and did not gain acceptance. Nevertheless, Henry Sidgwick and Mark Pattison both admired Whewell's work for the way it kept the natural sciences in contact with philosophical thought. Sidgwick remarked that 'it is to Whewell more than to any other single man that the revival of Philosophy in Cambridge is to be attributed' (Sidgwick, 241–2). James Clerk Maxwell endorsed Whewell's search for the philosophical assumptions behind particular experimental inquiries, and soon regarded himself as more metaphysical than Whewell (Maxwell, 206–7). Another commentator, looking back on the *History* and *Philosophy* suggested that at the time Whewell was 'probably the only Englishman who was capable of conceiving the work, or of carrying out the conception' (Carlisle, 144).

Whewell answered philosophical criticism of his position, especially in a short book, *Of Induction* (1849), which replied to J. S. Mill's *System of Logic* (1843). Here Whewell marshalled his superior knowledge of the historical record. In a letter to Herschel, Whewell insisted that the role of fundamental ideas did not compromise the empirical content of science: 'Our real knowledge is knowledge because it involves ideas, real, because it involves facts' (*On the Philosophy of Discovery*, 1860, 488). But he was concerned about an unfavourable reception from practising men of science, and acknowledged that criticism of the section on physiology in the *History* indicated a more general issue:

Those who have well studied that subject, feel a persuasion, a very natural and just one, that nothing less than a life professionally devoted to the science, can entitle a person to decide the still controverted questions which it involves; and hence they look, with a reasonable jealousy, upon attempts to discuss such questions, made by a *lay* speculator.

Philosophy, 1840 edn, 1.xii

Educational writings

Whewell published three contributions to the debate on university education. The first of these—*Thoughts on the Study of Mathematics as a Part of a Liberal Education* (1835)—assumed that mathematics provided an invaluable mental training. Whewell did not think this needed a defence, although he was happy to argue the claims of mathematics against those of logic (philosophy)—as put by Sir William Hamilton in a review of this pamphlet in the *Edinburgh Review* in 1836. Whewell's main concern was with the appropriate kind of mathematics for undergraduates. On this question (as mentioned earlier), he was convinced that analysis, as practised on the continent, was not suitable, and he stressed the importance of solid geometrical reasoning in any elementary curriculum. He recommended the inclusion of Newtonian mechanics and hydrostatics in the undergraduate programme, and edited book 1 of Newton's *Principia* (1846). His two larger books—*On the Principles of English University Education* (1837) and *Of a liberal education in general; and with particular reference to the leading studies of the University of Cambridge* (1845–52)—considered the ideal of liberal education, again emphasizing the foundational character of geometry and classical languages. Both works proposed a distinction between 'permanent' and 'progressive' studies that allowed only the most advanced (and stable) physical sciences to be included among the permanent elements of the curriculum. Lyell complained to Whewell that this was a recipe for the exclusion of most of the modern sciences for perhaps a century, or until their degree of theoretical consensus matched that of Newtonian mechanics. Thus although Whewell was able to introduce a natural sciences tripos in 1848, his views on the priority of geometry and classics were seen as unhelpful to the campaign aimed at raising the status of science in Victorian society.

In his major writings Whewell did not comment in any detail on the triumphs of what is now seen as the industrial revolution. While acknowledging that the practical and mechanical arts (or technology) sometimes produced phenomena subsequently explained by science, he firmly distinguished technical applications from the theoretical understanding sought by science. However, in a lecture of 26 November 1851 on *The General Bearing of the Great Exhibition on the Progress of Art and Science* (published in 1852), Whewell praised the display of objects and machinery and accepted that modern technological developments—such as the electric telegraph and chemical industry—were more closely dependent on scientific discoveries.

Final years

Whewell's major writings on science and education were published by 1845. In the latter part of his career he produced new editions of the *History* (1847 and 1857) and *Philosophy* (1847); the latter was also rearranged (with some additions) under new titles: *Novum organon renovatum* (1858), *The History of Scientific Ideas* (2 vols., 1858), and *On the Philosophy of Discovery* (1860). His response to the anonymous *Vestiges of the Natural History of Creation* (by Robert Chambers) was a selection of chapters from his two major works, published as *Indications of the Creator* (1845). He also published two books on moral philosophy—*The Elements of Morality, Including Polity* (2 vols., 1845) and *Lectures on Systematic Morality* (1846), neither of which were well received, being seen as ponderous and conservative, especially by J. S. Mill and other utilitarian ethical thinkers. However, Whewell viewed them as important for his views on the analogies between the development of moral and physical knowledge. His *Lectures on the History of Moral Philosophy in England* (1852) derived from his teaching as professor of moral philosophy.

Whewell's most engaging and controversial work in the latter part of his life was the anonymous *Of the Plurality of Worlds: an Essay* (1853), followed by *A Dialogue on the Plurality of Worlds* (1854), a short supplement to the original essay. The book (well known to be by Whewell) reached a seventh edition by 1859—an indication of the reaction to his iconoclastic rejection of the commonly held belief in the probable existence of intelligent life on other planets. Whewell dismissed the analogies by which this belief was sustained, arguing for the uniqueness of rational life and human history on earth. In the course of his discussion Whewell also rejected a version of the principle of plenitude—as maintained by critics such as David Brewster—that God had filled all possible space with life. To this Whewell asked rhetorically 'whether Mount Blanc would be more sublime, if millions of frogs were known to live in the crevasses of its glaciers' (W. Whewell, *A Dialogue on the Plurality of Worlds*, 1854, 366). The prospect of Whewell (with his reputation for arrogance) choosing this topic stimulated Stephen to observe that the book was meant to prove that 'through all infinity, there was nothing so great as the master of Trinity' (*DNB*).

Whewell also edited other writings—explaining their significance in careful prefaces. James Mackintosh's *Dissertation on the Progress of Ethical Philosophy* (1836) and Butler's *Three Sermons on Human Nature* (1848) were relevant to his quest for a non-utilitarian ethics; the edition of *Literary remains, consisting of lectures and tracts on political economy, of the late Rev. Richard Jones* (1859) derived from Whewell's respect for Jones and his own interest in political economy. Whewell published three papers in the *Transactions of the Cambridge Philosophical Society* (1830, 1831, and 1850) on the political economy of, respectively, Thomas Perronet Thompson, David Ricardo, and J. S. Mill. In each case Whewell gave a mathematical exposition of the deductive reasoning of these writers, clarifying their premises, and then leaving open the suggestion that these were not grounded in empirical observation—of the kind Jones provided with respect to rents. In returning to this topic in 1850, at the time of his dispute with Mill over philosophy of science, Whewell indicated that Mill's inadequate grasp of induction in physical science was also revealed in his political economy. Between 1859 and 1861 Whewell produced *Platonic Dialogues for English Readers*; in 1857 he reviewed James Spedding's edition of the complete works of Francis Bacon for the *Edinburgh Review*; in 1860 he edited *The Mathematical Works of Isaac Barrow*; in 1862 he wrote two reviews of English translations of *The Iliad* for *Macmillan's Magazine*, and one of George Grote's edition of Plato, which was published posthumously in *Fraser's Magazine* in April 1866. His essay on 'Comte and positivism' for *Macmillan's Magazine* (1866) appeared in the month of his death.

The last ten years of Whewell's life were marked by personal losses. His wife, Cordelia, died after a long illness on 18 December 1855. He married Everina Frances, widow of Sir Gilbert Affleck, on 1 July 1858. She died on 1 April 1865. Whewell preached his last sermon in Trinity College chapel on 11 February 1866, returning to themes that had appeared both in earlier sermons and in his writings on science. Noting that geology and astronomy imagined 'vast cycles of change succeeding each other' he warned that this did not remove the religious conviction that there was a beginning, and that there will be an end, to the world. The manner of this event lay outside the common history of the world, but Whewell reminded his audience that the scriptures spoke of it as 'an event which is to be sudden, violent, and overwhelming' (Todhunter, 1.343–4). On 24 February he went riding outside Cambridge and fell from his horse; the injuries were severe and Whewell died at Trinity College on 6 March 1866. He was buried in the ante-chapel on 10 March 1866.

Reputation

At the time of his death Whewell was known as a great master of Trinity and a man of enormous intellectual power and learning. Within the scientific community throughout Europe he was recognized for his research on the tides, his contributions to conceptual debates and terminology, and for his unrivalled knowledge of the history of the sciences. Although some aspects of his philosophy of science were criticized, Whewell's work set an example for the critical study of the nature of science and, since the 1970s, the historical inquiry on which he claimed to base his philosophy of science has been more warmly appreciated. He combined this study of the physical sciences with publications on education, moral philosophy, and other subjects in a manner that astonished his contemporaries. He did this at a time when intellectual activity was becoming more specialized—a phenomenon that Whewell recognized in his own philosophy of knowledge. Today we are able to see that his achievement was one of the last of its kind.

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Likenesses

- J. Lonsdale, oils, 1825, Trinity Cam.
- E. U. Eddis, lithograph, pubd 1835 (after W. Drummond), BM, NPG
- G. F. Joseph, oils, 1836, Trinity Cam.
- M. Carpenter, miniature, 1842, Trinity Cam.
- S. Laurence, oils, 1845, Trinity Cam.
- E. H. Bailey, marble bust, 1851, Trinity Cam.; plaster cast, *NPG*
- T. Woolner, marble statue, 1872, Trinity Cam.
- E. Edwards, photograph, NPG; repro. in L. Reeve, ed., *Portraits of men of eminence* (1863)
- J. Rylands, carte-de-visite, NPG [see illus.]
- plaster death mask, Trinity Cam.

Wealth at Death

under £70,000: probate, 3 May 1866, *CGPLA Eng. & Wales*