out the problems of refraction, visibility, and variability in moonrise and moonset positions due to declination and perturbation which would affect the use of the site in this way. The same criticisms can be applied to Thom's work where it involves lunar observations. Again, the misuse of archaeology undermines attempts to prove alignments: Krupp's use of Figsbury Ring, at least 1,000 years later in date than Stonehenge, as a foresight for the southern major standstill moonrise, is inexcusable.

Eddy's chapter on North America is the only one in the book where a sensible caution appears. His balanced view of others' work is exemplified by his regard for the archaeology as equally important as the astronomy in the analysis of the Chaco Canyon structures. His own work on the Indian medicine wheels is a model of careful and logical procedure. The same cannot be said of Aveni's chapter on Mesoamerica, where sites a millennium and several hundred miles apart are grouped on the basis of their similar orientation. The use in this chapter of words like "nearly", "close to" and "approximate" when describing alignments destroys their credibility. The claimed alignment of Teotihuacán on the setting of the Pleiades turns out to be "within 1 degree" of this event, a difference representing a sizeable slice of the horizon. Misunderstanding of archaeological data in this chapter results in Aveni using Flannery and Marcus' application of central place theory to Mayan settlements as evidence of geometrical and possibly astronomical location of these sites.

Krupp's chapter on Egyptian astronomy, mainly descriptive of previous work, is followed by his attempt to debunk von Däniken and the rest. His handling of the leyline controversy and the Glastonbury Zodiac lacks conviction, since he frequently ignores the most obvious line of attack; for example, he reproduces without comment the notorious leyline that runs from Stonehenge (third millenium BC) through Old Sarum (sixth century BC) to Salisbury Cathedral (AD twelfth century).

With the exception of Eddy's chapter, the book fails on its own terms, for it presents to the reader a picture based, in many cases, on misunderstood archaeological evidence and selective or imprecise numerical and astronomical data. The non-expert may unfortunately be persuaded by the jaunty air and punning subheadings (e.g. "A Serious Mystery" for a section on Sirius) into believing it all. □

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FRS extraordinary

J. Z. Fullmer

Benjamin Thompson, Count Rumford. By Sanborn C. Brown. Pp.576. (MIT Press: Cambridge, Massachusetts, and London, UK, 1979.) $19.95, £12.40.

BENJAMIN Thompson, born in March 1753 in Woburn, Massachusetts, died Benjamin Thompson, Count Rumford, in August 1814, in Auteuil, France. By almost any criteria his biography should make a rattling good yarn, for his adventurous life had episodes of intrigue, of mystery and of passion. He promoted large scale social experimentation and technological innovation; he interpreted his scientific experiments in ways that propelled him into controversy with the conservative members of the scientific community. When young and a volunteer member of the American army he functioned as a Royalist spy. In the spring of 1776, he fled to England, where he promptly ingratiated himself with influential British government officials. In 1783 he went to the Continent, becoming an agent for the British in Munich (or, perhaps, a double agent — the record is cloudy). Subsequently he shuttled back and forth between England, Ireland and Europe with no apparent regularity or design, his movements dictated by opportunity. He acknowledged two illegitimate children, one in Munich, the other in Paris, and sired one legitimate child, Sarah, born in Massachusetts. Assured that his abandoned American wife was truly dead, he married Jeanette Lavoisier (*née* Paulze), Antoine Lavoisier's widow, from whom he was soon divorced after a series of spectacular and public brawls. Moreover, during long periods in England and on the Continent he associated closely with well-placed reputed homosexuals, furthering his own career through these connections.

He managed to be close to centres of power in the government circles to which he propelled himself, and in the international scientific community. In 1780 he was elected Fellow of the Royal Society — he was 27 — after having attracted favourable notice for his very long paper on the nature of heat. For nearly a decade he earned the attention of Karl Theodore, the Elector of Bavaria, to whom Rumford owed his honorary title. The scientifically conservative Napoleon showered attention on him, and in England Sir Joseph Banks, PRS, abetted some of his plans. Rumford published a large number of papers: on the nature of heat and of light; on the best designs for stoves; on ways to feed the poor; on the efficient use of fuels in kitchens and fireplaces; on the boring of cannon; and on a pot for brewing coffee. He laid out the English Gardens in Munich; he devised plans to reduce beggary in Bavaria while feeding and clothing the army; he promoted the erection of a technological museum that offered visitors 'hands-on' experiences; he attempted to educate artisans in the factory ways of the industrial revolution; together with Banks he founded the justly famed Royal Institution of Great Britain.

Yet even this extensive listing of his promotional efforts does not exhaust them. While still alive Rumford proferred sums of money to England and America, endowing the prizes known as the Rumford Medals of the Royal Society and of the

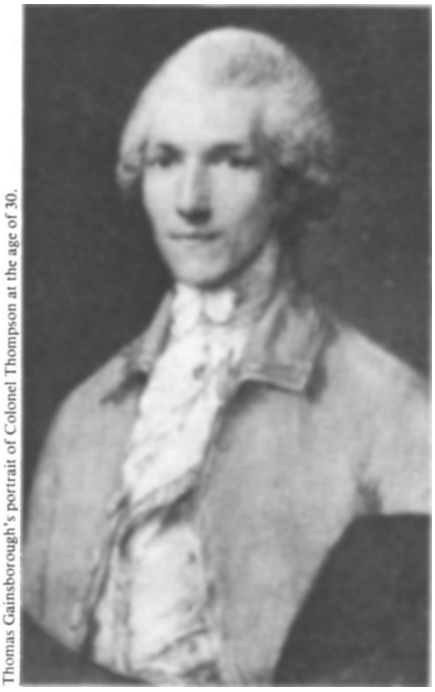
Demonstration lecture by Thomas Young and Humphry Davy, with Count Rumford watching.

American Academy of Sciences. Instructions in his will established from the residue of his estate the "Rumford Professor of the Physical and Mathematical Sciences as applied to the useful Arts" at Harvard. These eponymous memorials furthered his imprint on the scientific community. Perhaps Rumford was not unique, for adventurers of all sorts abounded in revolutionary times. Moreover, the history of technology provides us with occasional examples of scoundrels — but Rumford must be unique in the degree of his rascality. He appears to have been a man devoid of real allegiances, clever enough to exploit the political turmoil and the scientific conceptual turbulence of his times for his own good.

Sanborn C. Brown, Emeritus Professor of Physics at MIT, presents the fruits of nearly 40 years of search for the original documents relating to Rumford's career. For these efforts every subsequent scholar will be grateful. In 1962 Brown wrote *Count Rumford Physicist Extraordinary,* one of the publications in the Science Study Series, which related in a chronological way what he had learned of Rumford's life. Brown's new biography expands upon that earlier book without deviating from its patiently explanatory tone and linear structure.

Brown, of course, has not been alone in paying attention to Rumford's life and accomplishments. Many historians of science, historians of technology and sociologists of science have examined portions of Rumford's activities, and it is to the neglect of this informing and analytical literature that Brown's biography owes its greatest weakness. Examples are not difficult to come by. Robert Fox in *The Caloric Theory of Gases* (Oxford University Press, 1971) has examined Rumford's work on the nature of heat, and placed Rumford's ideas within their contemporary milieu. Although Brown cited Fox's work, he did not use it to inform his own discussion. Morris Berman has analysed the early days of the Royal Institution in *Social Change and Scientific Organization: The Royal Institution, 1799–1844* (Cornell University Press, 1978). While Berman's general interpretation and analysis is the subject of considerable debate, much of what he has said is both useful and informative to the biography of Rumford. Brown appears to have been unaware of Berman's contributions.

Reading the biography of any practising scientist (even a part-time scientist, as Rumford assuredly was) raises the question: what is the most important aspect of such biography? To be sure, the biographer owes his subject as accurate a chronicle of the chief events in the life as can be achieved. Brown has provided that for Rumford. But the biographer of a scientist also owes his reader the benefits of his analysis of the subject's endeavours, of his achievements as seen by his contemporaries, of his failures as judged by his contemporaries, and an assessment of where the subject fits into the histories of science and of technology. While Brown discusses Rumford's work on the nature of heat chronologically, he has not truly shown what motivated Thompson's extensive experiments. What is missing is the deep analysis which a historical study requires. When Brown discusses Thompson's social reforms he chronicles the major efforts, but he fails to show whether Thompson regarded his projects as intellectual solutions to complicated puzzles, as palliatives to grievous human needs or as a means for currying personal favour for himself. Above all, Brown does not appear to have realized how much of an outsider Count Rumford was; the narrative suggests that Rumford functioned at his best only when he enjoyed a perverse, self-engendered alienation. Perhaps, in this instance, the abiding question should have been "What made Rumford run?".



Thomas Gainsborough's portrait of Colonel Thompson at the age of 30.

Physicists publishing research findings must do more than offer raw data. Generally, that data has to be placed within a larger conceptual framework. The historian and the biographer have the same obligation. To view a man as a two-dimensional cardboard cut-out (no matter how colourful), jerked into spasmodic action by unseen wires and strings against a flat backdrop, impoverishes our understanding of him. It is on this score that Brown's biography of Rumford is most disappointing. Brown's biography is not the definitive life of Rumford, but it does offer a brave factual beginning on which subsequent analysis must rely. □

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Of special concern

Austen Albu

Science and Technology: A Five-Year Outlook. By the National Academy of Sciences. Pp.544. (Freeman: San Francisco and Oxford, 1980.) Hardback £8.90; paperback £5.40.

In 1977 the United States Congress legislated for a periodical Five-Year Outlook on Science and Technology. The responsibility for this work was eventually transferred to the National Science Foundation. In 1978 the Foundation asked the National Academy of Sciences to prepare a report describing the current state of significant research areas and pointing out those areas which would be of special concern within the five year period. A review procedure by members of a number of other bodies was established. Those involved included 50 contributors, 20 editorial consultants, and 170 reviewers and additional contributors. Although the resulting report is by no means comprehensive and only intended as a preliminary study, it covers a number of fields in encyclopaedic fashion and one can only express admiring astonishment that it should have been produced by March 1979.

British Members of Parliament have long envied the resources available to their American colleagues and, for all their growing interest in science and technology during the past few years, they would never have succeeded in commissioning a report on this scale. Written in a straightforward style, not over-popularized, it offers descriptions of recent and likely future developments in such fields as geology, biology and biochemistry, physics, computers, energy, and US demography and health. Some of the subjects are politically sensitive and tend to be dealt with in a rather didactic manner; but on the whole the problems requiring research in the near future seem to have been set out fairly. Of course neither the average congressman nor this reviewer is capable of judging the scientific quality of these descriptions and proposals, and the problem of choice of priorities remains as difficult as ever. I am reminded of a remark of my son's when, in his twenties, he was facing a choice in his life on which he had consulted his liberal parents: "Just like my parents, tell me all the pros and cons and leave the decision to me".

Two criticisms can be made of this report: there are no price tags attached to any proposals for the future, without which serious consideration of alternatives by a legislative body is impossible. Perhaps equally serious is the lack of any reference to Defence R&D, the cost of which overshadows all the rest and which itself