addition to the current formal literature, the outputs of conferences, symposia, lectures, research proposals, preliminary drafts of papers, and so on? Could this be done without destroying the very nature of the informal communications?

4) Will the blurring of the distinction between formal and informal scientific communication (for example, by worldwide distribution of preprints and other reports prior to refereeing or other evaluation) help solve the problem of excessive publication?

5) What is the relative importance of speed of communication as against quality control of the retrievable formal literature, such as is provided by the evaluation of manuscripts by referees and editors? The proposals being made range all the way from bypassing the control procedures entirely to an order-of-magnitude increase in the strictness of refereeing.

6) Should research results be deposited in the archival literature, not in the form of fragmentary articles as at present, but in predigested form by rapporteurs or "critical review" writers working from unpublished documents?

7) Should major changes in the system be arrived at through open debate in the scientific community, or through action by small groups on elements of the structure with which they are particularly involved?

Questions of similar generality and significance are being raised concerning the education and training of scientists, the character of scientific organizations, and the relation of science to society and to public policy. Ziman's book does not furnish definitive answers to such questions. But by its development of the thesis that science involves intrinsically the social structure of the scientific community with a built-in orderliness and logic, and in its cautious, even-tempered analysis of the elements of that structure and of their relevance to the whole enterprise, it provides a firm base from which to consider the many controversies that agitate science today.

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Hannah Smith's Son

A Portrait of Isaac Newton. FRANK E. MANUEL. Belknap Press of Harvard University Press, Cambridge, Mass., 1968. xviii + 478 pp., illus. $11.95.

The title of Manuel's book is somewhat misleading. A portrait of Isaac Newton it certainly is, but it is not merely another portrait. Working in a tradition that is well established though not, because of its extraordinary demands, widely followed, Manuel has exploited the vast body of Newtonian manuscripts to produce a historical psychoanalysis. "Should the unconscious perchance not exist," he remarks, with about the same degree of uncertainty that Newton felt when he asserted conclusions under the guise of queries, "one of the underpinnings of the book collapses." To which we might add that another underpinning begins at least to shake if the Freudian analysis of the unconscious turns out to be incorrect. It is one of the potential weaknesses of the work that it is thoroughly Freudian in approach at a time when Freud's authority is ever more challenged. Nevertheless, it is impossible to contend that Manuel's insights into Newton's character have validity only within a Freudian context. He has produced a stimulating and provocative book, which uses the devices of psychoanalysis to place the study of Newton the man on a new foundation.

The title of chapter 1 presents the central interpretative theme that Manuel develops—"Hannah and the fathers." "Hannah," of course, refers to Newton's mother, whom he possessed exclusively for a few years, whom he lost to her second husband at the age of three, whom he sought to rediscover and repossess for the rest of his life. "Fathers" is deliberately put in the plural, referring to the real father Newton never knew, to God the Father who merged with the real father in Newton's psychic life, and to the hated stepfather who at once violated the chastity of the real father's wife and deprived Newton of her presence.

> One is almost [sic] tempted to recognize in his genius a union of two experiences, his relations with the father whom he never saw and with the mother whom he possessed with such intense emotion, whom he saw with his own eyes and always longed to see again as he had in the early years of infancy—a fantasy he pursued in vain throughout his life. . . .

Manuel sees the major traits of Newton's character as products of the two basic experiences. From the "loss" of his mother derived his terrible insecurity and his sense of deprivation. Because of the latter, any attempt to seize and carry off a child of his brain aroused in Newton, as Hooke and Leibniz discovered, a frantic and enraged defence of what was his own. Manuel insists on the energizing role of the mother in Newton's career. The *annus mirabilis* of 1666 had its locus in Woolsthorpe, to which Newton returned because of the plague; and again in 1679, the discovery of the crucial theorem of the ellipse was connected with Woolsthorpe and the death of his mother. With Fatio de Duillier, whose enormous role in Newton's life Manuel is the first to insist on, he enacted again the scenes of affection and abandonment from his youth, and in his niece Catherine Barton, born in the year his mother died, he found her reincarnation.

In pursuit of the father he had never known, the earthly father who was also the Heavenly Father, Newton saw himself as the one chosen of God. Manuel wishes even to maintain that Newton's unitarianism derived from his conviction that he himself was the only begotten son—born, after all, on Christmas Day, and spared by divine grace from the early death his weakness led everyone to expect. But the chosen of God also stood under the judgment of God, bound to obey the law and all too aware of his lapses from it. Newton bore a terrible freight of guilt to the very grave, and much of his life was devoted to the search for other culprits on whom to project his guilt that he might punish them to demonstrate his obedience. The condemned of God was at once

the chosen of God to inflict the punishment for his own guilt. "To believe that one had penetrated the ultimate secrets of God's world and to doubt it, to be the Messiah and to wonder about one's anointedness, is the fate of prophets."

Manuel is especially impressive in tracing the thread of rage through Newton's life—from the Reverend Barnabas Smith, who abducted his mother, to Hooke, to Leibniz, to the counterfeiters who, in their relation to the vengeful Warden of the Mint, embodied all that Newton hated in the world. It was his good fortune to occupy an official position through which he could vent his rage in a socially acceptable manner by punishing counterfeiters. If it was his good fortune, it was hardly theirs; he pursued them remorselessly to the very scaffold. His historical and theological research devoted to uncovering historical frauds filled the same psychic necessity. "One could, after all, have criticized Manetho's dynastic list," Manuel remarks, "without hurling epithets at an Egyptian who had been dead some thousands of years." Scientific controversy also offered an acceptable outlet, and Newton took care never to be without an acknowledged opponent.

> The lad Newton could not harm his half brother Benjamin or his stepfather Barnabas with impunity; but the great scientist Newton could destroy his rivals and his enemies living and dead. So deep is the hurt and so boundless the anger, however, that he cannot be appeased as long as he lives. His victories do not assuage; his anger is replenished by what it feeds upon.

Certainly the picture Manuel presents is provocative. Certainly it is compelling. But is it true? Here of course is the rub, as he himself knows very well. Who can say with assurance? More than once he tells the reader that he is feigning hypotheses, that he takes his own portraiture with a grain of salt; but a page later he has forgotten his reservations and soars off anew on the wings of fancy. No one reader, I suspect, will be prepared to accept everything he proposes. No two readers will agree on what to reject. Time after time, I found myself charging him with contradictions—painting a Newton at once devoured by insecurity and convinced of his special election, burdened with guilt and appointed by God to destroy evil. The contradictions emerge in the end as the very strength of the portrait. Manuel is convinced he is dealing with a titan, and he refuses to scale him down to ordinary size. If there are contradictions in the picture, the contradictions belong to Newton. And, he implies throughout, why should we expect otherwise from one of the supreme geniuses of the human race? If we have learned anything since Brewster wrote over a century ago, surely it is that Newton's surpassing genius is incompatible with the bourgeois respectability the Victorians expected in their heroes. The features of the portrait Manuel presents derive from documental sources. They add up to a Newton who could have written the *Principia.* Beyond this level of assurance interpretations such as Manuel's cannot proceed.

There are a few caveats I feel compelled to enter, however. The first concerns Manuel's treatment of Puritanism in its effect on Newton's life. From an examination of his conscience during his undergraduate career, Manuel takes various shortcomings to which Newton privately confessed, mostly though not entirely venial offenses such as violations of the Sabbath, and insists that Newton regarded them as mortal sins. They become then an objective record of the guilt so necessary to the analysis. I myself am not prepared to take them that seriously. Too much is known about English society in 1662 for us to believe that a young man in Cambridge could fashion a lifetime of guilt from pricking a fellow student with a pin on Sunday. Too much also is known about Puritanism for us to accept Manuel's hebraized version of it. As central to Puritanism as the law and guilt were the atonement and forgiveness. Newton rejected the divinity of Christ, it is true, but he had a concept of the atonement, and he could not have grown up in the Christian society of 17th-century England without one. The Christian God was a vengeful God to be sure, but He was also a merciful God. To seek out the evidence of guilt while forgetting the prospect of mercy is to mistake Restoration England for ancient Israel. There is more than one suggestion in the book that Manuel has consistently done so.

Equally I am put off by Manuel's attempt to fit every facet of Newton's life into his scheme. His skeptical disclaimers serve more to delude him than to describe his procedure, for once he gets under way he throws caution to the winds. One of the themes of his work is Newton's need to assuage his insecurity by constructing a closed and absolute system in which everything finds its definitive place. Those who engage in the psychoanalysis of others expose something of themselves in the process, of course, and they must expect their analysis to be analyzed in turn. What childhood trauma goads Manuel to construct a closed and absolute system? Having explored the evidence with great insight and elaborated a theory of Newton's character that vastly expands our understanding of his conduct, why is he unable to confine himself within the boundaries that psychoanalysis may properly claim? Why does he attempt to explain everything, even those things which fall more justly within the province of logic and scientific inquiry?

In the preface, Manuel announces his intention to steer his course between the Scylla of historians of science and the Charybdis of psychoanalysts. I cannot speak for psychoanalysts, but I can assure him that he has given history of science a wide berth. I do not intend the statement as a gibe. While I might complain that a portrait of Isaac Newton that omits the central theme of his life, the development of his scientific thought, is a strangely foreshortened picture, nevertheless an author has the right to define his own problem for himself. Manuel is concerned with Newton's style of life, the springs of his conduct, and he explores the subject brilliantly. What I do object to—and in my opinion have every right, as a historian of science, to object to—is his tendency to think he can write the history of science from the vantage point of psychoanalysis. Details of Newton's optical experimentation are traced to his desire to enjoy again "the pleasures of intimate visual exchange" with his mother. This is a game that has no rules and no end. Anyone can play it. Any chance "insight" is apt to be as valid as another. Any conclusion can be derived from any premise because all are equally beyond proof. In this case, the suggestion is useless because it proves too much. Experimentation similar to Newton's had been the common fare of optics since the discovery of the

camera obscura in the Middle Ages. To be sure, all the students of optics may have been pursuing the pleasures of intimate visual exchange with their mothers, but it is not apparent to me that the contention, if true, notably enhances our knowledge of the science of optics.

Once launched on this current, Manuel presses on under full sail. Where did Newton discover the law of universal gravitation? At Woolsthorpe, near his mother, of course. And was his longing for his mother not an attraction akin to that of gravity? You may be sure that it was. Although Manuel describes the idea as the wildest hypothesis, he notably does not refrain from feigning it. Attention to the details of the history of science could have spared him such a blunder. While Newton derived certain quantitative relationships in 1666, he did it without the concept of attraction, as his technical manuscripts reveal.

In passing, Manuel presumes to settle many of the basic questions of Newtonian science on similar terms, often with condescending asides to the historians of science who appear to think there is a logic internal to scientific thought. While scholars have searched for the origins of Newton's philosophy of nature in Gassendi and Henry More, his view of matter really stemmed from his dread of physical contact. Princess Caroline, with an insight into the psyches of Newton and Leibniz that was remarkably similar to Manuel's, grasped the secret meaning of the controversy better than scholars intent on a simplistic, rational verdict between the two. Learned accounts of Newton's ether with their fine distinctions of meaning are summarily swept aside and the issue is settled by recourse to the analyst's couch. As a historian of science, I find these passages balderdash. When Manuel does his thing, he does it very well indeed, and I know of no historian of science who can approach him. When he does our thing, however, it's another ball game. If scientists have psyches, as I certainly believe they do, science has a logic of inquiry and demonstration that is subject to other rules.

Lest anyone be in doubt, some of those learned accounts that Manuel brushes aside with ill-disguised disdain carry my name. Having worked off my spleen, I find that I am breathless in admiration of the total work. It is a virtuoso performance. I do not know any more about psychoanalysis than the average educated man, and I am unable to predict how psychoanalysts will receive the work. I flatter myself that I know a considerable amount about Newton, however, and as a Newtonian scholar I find it impossible to doubt that the book will be received as a masterpiece in its genre. It is a portrait of Newton such as no one has been able to produce before, not merely superior to others but vastly superior. So who cares if he doesn't like my learned articles?

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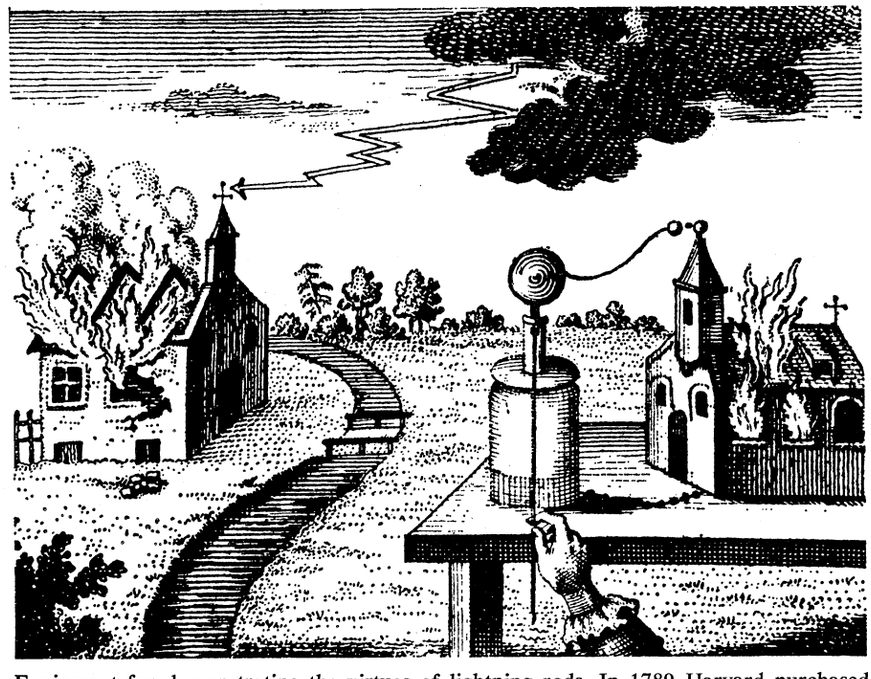
Antique Instruments

The Apparatus of Science at Harvard, 1765–1800. DAVID P. WHEATLAND, assisted by Barbara Carson. Harvard University Collection of Historical Scientific Instruments, Cambridge, Mass., 1968 (distributed by Harvard University Press). xii + 204 pp., illus. $20.

If the passage of time has separated the antique instruments of science from the living laboratory, its selective flow has helped to preserve some of the loveliest. And just such an occasion is at hand in this handsome, if casual (for few details of their operations are supplied), catalog of the collection of historical scientific instruments of Harvard University.

Ranging across the sciences, the collection contains telescopes and other astronomical instruments and models, surveying and drafting instruments, microscopes, clocks, vacuum pumps, chemical apparatus, and the equipment necessary to demonstrate and explain the common phenomena of physics—light, sound, electricity, magnetism, and the like. Excellent photographs of all the apparatus are given, with occasional plates in full color (of which perhaps the water pump in red mahogany and golden brass is the most attractive), and these are often accompanied by woodcuts drawn from related texts, though this association is sometimes forced, as in the juxtaposition of a cut from Chérubin's *La Dioptrique Oculaire* of 1671 with a Gilbert telescope of the late 18th century.

Although the book does not rival, in photography or text, such recent volumes as Henri Michel's *Les Instruments*



Equipment for demonstrating the virtues of lightning rods. In 1789 Harvard purchased from the Reverend John Prince a mahogany "thunder house" (similar to the model illustrated) 10 inches long and 8 high, with a lightning rod running up the gable. "Here was the lecturer's *tour de force!* When the circuit was complete, an electrical charge passed through the lightning rod without harm to the house. But a spark supplied to a broken circuit ignited a quantity of gun powder inside the house, blowing off the roof and flattening the four walls amid a cloud of black smoke, fire, and general approbation from the students." [Reproduced in *The Apparatus of Science at Harvard* from Beck's *Kurzer Entwurf der Lehre von der Elektrizität*, 1787]