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The Newton Project The Chymistry of Isaac Newton The Newton Project Canada by Robert Iliffe; William R. Newman; Stephen Snobelen

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Digitizing Isaac Newton

*By Niccolò Guicciardini**

Robert Iliffe (Director). The Newton Project. <http://www.newtonproject.sussex.ac.uk>.

William R. Newman (Director). The Chymistry of Isaac Newton. <http://webapp1.dlib.indiana.edu/newton/>.

Stephen Snobelen (Director). The Newton Project Canada. <http://www.isaacnewton.ca/>.

Isaac Newton owes his fame to the books on which he is shown reclining nonchalantly in the baroque representation that adorns his funerary monument in Westminster Abbey. Yet, just as in the case of his contemporaries Christiaan Huygens and Gottfried Wilhelm Leibniz, his intellectual life is best revealed by his manuscripts. Like many scholars of his age, Newton kept a well-ordered archive of letters and manuscripts, some of which—especially those from his youth—are bound into notebooks organized as commonplace books, a way of organizing knowledge under headings that dates back to the Middle Ages. Knowing how to keep and update one’s archive of letters (including letters received and sometimes copies of those sent¹), original manuscript notes, and excerpts from books and manuscripts was a craft learned by example: in the case of Newton, the example was his stepfather, Barnabas Smith, whose huge and very valuable in-folio “Waste Book” (Cambridge University Library, MS Add. 4004)—which also contains the reverend’s theological annotations—the young subsizar inherited when he entered Trinity College in 1661. Manuscripts were not only a storage resource and a means of organizing knowledge under headings and subheadings: they were also a means of communication, since they were circulated and copied. They were often shown to visitors—Edmond Halley’s 1684 visit to Newton being iconic in this regard. The transmission of knowledge via manuscript circulation flourished in Restoration England, and Newton followed a policy of disclosure and concealment of his private writings that was dictated by his philosophical agendas, as well as—in the case of the theological manuscripts—well-justified worries concerning the consequences he would have suffered as a staunch anti-Trinitarian by their publication.

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I thank Rosanna Cretney for providing useful information on digital humanities.

¹ Newton seldom kept drafts of letters he sent.

Newton was a master in making use of his manuscript archive. He could locate and reuse notes he had jotted down decades before, as Leibniz learned—much to his chagrin—when the President of the Royal Society was able to amass evidence of his own priority in the invention of the calculus by retracing letters and papers he had written back in the 1660s with the help of the mathematics tutor and manuscript collector William Jones. We learn very little of Newton's thought, state of mind, objectives, and anxieties if we confine ourselves to his printed works. Yet the fate of Newton's estate after his death made most of his manuscripts and letters—especially those concerning alchemy and religion—unavailable to scholars. David Brewster, the major nineteenth-century biographer of Newton, caught only a fleeting glimpse of the sheets kept by the Portsmouth family at Hurstbourne Park before closing his positivist eyes in horror at the sight of the tormented writings of a man so different from the religiously orthodox and honest man of science he had it in mind to eulogize.

The story has often been told of how the Portsmouth Collection became available to the public—first in 1872, via a generous donation of the fifth Earl of Portsmouth to the University Library in Cambridge, and then in 1936, via an auction at Sotheby's, with John Maynard Keynes and Abraham Yahuda as the main buyers. Much of the present-day knowledge of Newton is based on scholarship built on the manuscripts in the custody of various libraries in and outside England: the most notable being the University Library in Cambridge (which in 2000 also acquired Jones's manuscript treasure trove, the Macclesfield Collection), Trinity College and King's College (Cambridge), New College (Oxford), the National Archives (Kew), the Huntington Library (San Marino, California, USA), and the National Library of Israel (Jerusalem). It was only after World War II that a legendary group of towering Newtonian scholars took up the task of editing Newton's manuscripts. The correspondence was magnificently edited by Herbert Turnbull, John Scott, Rupert Hall, and Laura Tilling.² No words of praise are sufficient to describe what Tom Whiteside achieved with the edition of the mathematical papers and Alexandre Koyré and Bernard Cohen with the *editio variorum* of the *Principia*. Alan Shapiro has edited the Lucasian lectures on optics, Rupert Hall and Marie Boas Hall a few manuscripts from the Portsmouth Collection (including the one known under the title *De gravitatione*); James McGuire and Martin Tamny have shed light on Newton's youthful studies by editing the "Questiones quaedam philosophiae." No Newton scholar nowadays can ignore these pillars of the "Newtonian industry."³ Yet in the early 1980s, when all these results had just been achieved, we were still lacking a great deal. First of all, the theological manuscripts were left almost untouched, notwithstanding the pioneering work of Herbert

² The importance of having an online edition linked to scanned images of the originals of the correspondence is obvious, if only for the opportunity it would offer for studying the evolution of Newton's handwriting and for the use of watermarks (when these were made visible in an Internet edition). For the use of watermarks to date Newton's manuscripts see Alan E. Shapiro, "Beyond the Dating Game: Watermark Clusters and the Composition of Newton's *Opticks*," in *The Investigation of Difficult Things*, ed. P. M. Harman and Shapiro (Cambridge: Cambridge Univ. Press, 1992), pp. 181–227.

³ H. W. Turnbull *et al.*, eds., *The Correspondence of Isaac Newton*, 7 vols. (Cambridge: Cambridge Univ. Press, 1959–1977); A. R. Hall and M. B. Hall, eds., *Unpublished Scientific Papers of Isaac Newton* (Cambridge: Cambridge Univ. Press, 1962); J. E. McGuire and Martin Tamny, *Certain Philosophical Questions: Newton's Trinity Notebook* (Cambridge: Cambridge Univ. Press, 1983); Alan Shapiro, ed., *The Optical Papers of Isaac Newton*, Vol. 1: *The Optical Lectures (1670–72)* (Cambridge: Cambridge Univ. Press, 1984–) (three volumes are planned); D. T. Whiteside, ed., *The Mathematical Papers of Isaac Newton*, 8 vols. (Cambridge: Cambridge Univ. Press, 1967–1981); and Alexandre Koyré and I. B. Cohen, eds., *Philosophiae Naturalis Principia Mathematica: The Third Edition (1726) with Variant Readings*, with A. Whitman (Cambridge: Cambridge Univ. Press, 1972).

McLachlan and, most notably, Frank Manuel.⁴ Ground-breaking attention to the alchemical manuscripts began in the 1970s with Karin Figala's and Betty Dobbs's pioneering works: the results were often problematic, both from an interpretative point of view and in terms of philological accuracy. The Mint papers were largely consigned to oblivion.⁵

The advent of the Internet and the development of digital humanities have made it possible to envision huge progress, destined to change our knowledge of Newton and to increase enormously the number of people around the world who have access to his work (the divide here will be between those who have an easy, uncensored, and fast connection to the Internet and those who are denied this facility). The indisputable leader of this exciting new era of Newtonian scholarship is Robert Iliffe, Director of The Newton Project (now based at the University of Sussex), the man behind the complex task of managing a team of twenty contributors and dealing with quality control, copyright, fundraising, and the demanding issues concerning the design of such a rich web resource, which aims to display recondite technical material in a way that is more accurate and comprehensive than is possible with print editions. Launched in 1998 under the general editorship of Iliffe and Scott Mandelbrote, The Newton Project was soon joined by two sister projects, The Chymistry of Isaac Newton, based at Indiana University and directed by William R. Newman, and The Newton Project Canada, based at the University of King's College (Halifax, Nova Scotia) and directed by Stephen Snobelen.⁶ All these editorial projects are in the trustworthy hands of eminent scholars who have provided momentous contributions to our understanding of Newton's religion and alchemy.

The purpose of this essay review is to inform the readers of *ISIS* about these editorial projects: what has been achieved and what is planned. Writing this review has not been an easy task, for a number of reasons. The projects in question are works in progress: new material and features are being added as I write. Digital projects have an iterative nature, and their development is more open ended than is the case with print editions. Another difficulty is that it is often hard to attribute authorial responsibilities and merits: in this essay I will mention only the names of the general editors, but standing behind them there are teams of scholars (mentioned in the pertinent web pages) equipped with considerable skills.⁷ Finally, the criteria to be adopted in evaluating a digital edition are different from those accepted for print editions.⁸ The clear conclusion I have reached in this respect is that the digital editions under review comply with the highest standards required in the field of digital humanities. All the material uploaded is rigorously peer reviewed and

⁴ Isaac Newton, *Theological Manuscripts*, ed. Herbert McLachlan (Liverpool: Liverpool Univ. Press, 1950), provides a transcription of excerpts of manuscripts from King's College Library. See also Frank Manuel, *Isaac Newton, Historian* (Cambridge, Mass.: Harvard Univ. Press, Belknap, 1963); and Manuel, *The Religion of Isaac Newton* (Oxford: Clarendon, 1974).

⁵ Betty Jo Teeter Dobbs, *The Foundations of Newton's Alchemy; or, "The Hunting of the Greene Lyon"* (Cambridge: Cambridge Univ. Press, 1975); Dobbs, *The Janus Faces of Genius: The Role of Alchemy in Newton's Thought* (Cambridge: Cambridge Univ. Press, 1991); Karin Figala, "Die exakte Alchemie von Isaac Newton," *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 1984, 94:157–228; and J. Craig, *Newton at the Mint* (Cambridge: Cambridge Univ. Press, 1946).

⁶ See Rob Iliffe, "Digitizing Isaac: The Newton Project and the Electronic Edition of Newton's Papers," in *Newton and Newtonianism: New Studies*, ed. James E. Force and Sarah Hutton (Dordrecht: Kluwer, 2004), pp. 23–38.

⁷ Among the scholars working at The Newton Project, one might mention John Young (chief transcriber), Michael Hawkins (technical expert), and Daniele Cassisa (mathematical transcriptions).

⁸ See, e.g., University of Nebraska–Lincoln, Center for Digital Research in the Humanities, "Recommendations for Digital Humanities Projects," http://cdrh.unl.edu/articles/best_practices.php (accessed 5 Oct. 2013); and Todd Presner, "How to Evaluate Digital Scholarship," <http://idhmc.tamu.edu/commentpress/digital-scholarship/> (accessed 5 Oct. 2013).

offered with open access; the transcriptions and the scanned images (when available) are downloadable free of charge; the sites are designed both for scholars and for more general readers (for teaching purposes, for instance); and access worked well with all major browsers and different platforms I tried.

The Newton Project is a nonprofit organization dedicated to providing a complete online edition of all of Newton's writings—both published and unpublished. The edition presents a full list and brief descriptions of the works and existing manuscripts by Newton. This feature is already an immensely valuable tool for the Newton scholar. For a sizable portion of these texts it provides a full (diplomatic) rendition of all the amendments Newton made to his own texts, but it also offers more readable (normalized) versions (the former recording all the deletions, additions, errors, and alterations made in the original document, the latter edited to yield something more like a "finished" text). Here the advantages of an online edition over a print edition are apparent, since cancellations, overwritten words, interlineations, and the like can be rendered in a very legible way. To give a general idea of the magnitude of what has been achieved so far: as of the writing of this essay, in October 2013, 5.6 million words are online; another nine hundred thousand words will be added at the beginning of 2014: we will then have a complete transcription of all the religious (chronological, doctrinal, and prophetic) materials. The manuscripts and printed works have been transcribed with painstaking accuracy: it is amazing to see how careful the team has been in rendering millions of words that are often overwritten, crossed out, or barely legible because of damage to the paper. The policy has also been to offer manuscripts in their entirety, without omitting words or signs added by other hands. The Newton Project further provides a great deal of information that will be of interest to many professional historians as well as to the curious reader. By the end of November 2013, The Newton Project will have been enriched by the addition of forty to fifty thousand words of contextual essays on themes such as Newton's life and work, his personality, the controversies in which he was involved, his library, and the history of his papers.

Already at this preliminary stage, The Newton Project has much to offer scholars. For example, one can read the three editions of the *Principia* (books 1 and 2 so far: a transcription of book 3 is announced as "imminent") and search for words. The reader might be surprised to discover (in a matter of seconds) how many occurrences of the term "hypothesis" can be spotted in the 1713 second edition, which was to end with the famous "Hypotheses non fingo"! Another little experiment would be to search for the term "gravitatio" in the important notebook (MS Add. 4003) whose *incipit* is "De Gravitatione et aequipondio fluidorum et solidorum" and is therefore known as "De Gravitatione." It occurs only once, in the *incipit* just quoted: in the rest of the manuscript Newton employs the term "gravitas."

As it stands, the project is already a dream come true. Still, this work has certain limitations, though the editors should not be blamed for them; this is, after all, work in progress. Basically, the problem is this: The Newton Project has not yet produced annotations to many of the texts so far transcribed, even though for each item detailed information is provided on date of composition, number of folios (or pages) and words, languages, location, shelf mark, hands, and custodial history; in some cases the content of the text is described and an English translation is provided.

It should be noted that there are two good reasons behind the choice to put transcriptions online without an accompanying apparatus, which in a traditional print edition would take the form of, for example, an *apparatus fontium*, explanatory annotations, and an

index nominum et locorum. First, it is already a great service to the community of historians of science to make these reliable renditions so easily available. For the manuscripts belonging to the Portsmouth Collection and to the Yahuda Collection digitized images from originals are being made available: thus the reader can access information unthinkable in a print edition.⁹ Second, the institutions funding these projects often require that the texts go online as soon as they have been transcribed and reviewed.

The editors of The Newton Project envisage a future stage in which they will offer not only images of manuscripts linked to the texts but an explanatory apparatus and commentary as well.¹⁰ Indeed, one reads that a final stage will entail “applying a new level of markup to the encoded text to capture not just formatting information (what the text looks like) but content information (what it means). Names, places, dates, concepts, obsolete or technical terms and so forth will all be individually tagged so that they can be linked to explanatory apparatus. This also makes it possible for documents to be searched by theme and concept as well as explicit textual content.”¹¹ And that would be great. But when will we see it? How long will it take? Editing and commenting on 5 million words (and more are being transcribed all the time) is a gargantuan project requiring time, energy, and extraordinary technical competence. Digitization cannot make this work less demanding and time consuming than it was in Johan Ludvig Heiberg’s time. The Akademie edition of Leibniz’s works began in 1901 and is still an ongoing project that employs many research teams specializing in all the various sectors of Leibniz’s intellectual pursuits. One cannot think that Newton will require less time and expertise. It would already be a great achievement if the phase devoted to providing an explanatory apparatus could begin with a selection of manuscripts—for example, some of those pertaining to religion that are held in Jerusalem.¹² Other issues that will require attention are those relating to the study of Newton’s hand (its evolution over time and the consequent establishment of those texts that can with confidence be accepted as his holographs) and the ordering and dating of the manuscripts, which are often assembled in incoherent bundles constituted by folios containing texts that might be dated to different time periods. Historians of Newton’s

⁹ The images, of course, should be read *cum grano salis*, since file compression and the rendition of colors on a computer screen can to some extent hide details of interest to the researcher.

¹⁰ Digitized images of the Yahuda Collection are available via the webpage of the National Library of Israel, <http://web.nli.org.il/sites/NLI/English/collections/Humanities/Pages/newton.aspx> (accessed 6 Sept. 2013); while the Cambridge Digital Library has completed the digitization of the Newton manuscripts from the Portsmouth Collection held in the University Library at Cambridge, <http://cudl.lib.cam.ac.uk/collections/newton> (with the exception of Add. 3981 [a letter from Halley moved to King’s Library]; 3992, 3994, 3999, and 4001 [now in the Rare Books Collection]; and the mathematical treatises 3997 and 3998 in St. John Hare’s hand) (accessed 6 Sept. 2013). Both these resources are in the process of being linked to the transcriptions provided by the online editions under review.

¹¹ <http://www.newtonproject.sussex.ac.uk/prism.php?id=51> (accessed 4 Sept. 2013).

¹² As I was writing this review, the Spanish scholar Pablo Toribio Pérez was publishing a critical edition—with annotations, a complete study of the sources, and a Spanish translation—of a Newtonian treatise on the early history of the Church. Toribio Pérez has reconstructed this work from MS Yahuda 1.5, fols. 78r–85r, and a complex reordering of folios now in MS Yahuda 12 and MS Yahuda 19. This is not the place for an evaluation of Toribio Pérez’s work: here it will suffice to say that his achievement reminds us that the existing corpus of Newton’s manuscripts requires the attentive work of the classical philologist, since, given the tormented life of the Newtonian Nachlass, the folios have often been scattered and reassembled in heterogeneous bundles. See Isaac Newton, *Historia ecclesiastica (de origine schismatico ecclesiae papisticae bicornis)*, ed. Pablo Toribio Pérez (Madrid: Consejo Superior de Investigaciones Científicas, 2013). This is part of a project, Edición Crítica de Textos Inéditos de Isaac Newton en Lengua Latina, directed by Ciriaca Morano Rodríguez, who has edited MS Babson 434, one of Newton’s works on the Temple of Salomon. See Newton, *El Templo de Salomón (Manuscrito Prolegomena ad Lexici Prophetici partem secundam)*, ed. Ciriaca Morano Rodríguez (Madrid: Consejo Superior de Investigaciones Científicas, 2009).

mathematics are aware that many of the mathematical manuscripts are difficult to date and that their present ordering does not easily reveal their original relationship. It seems that in some cases Newton reworked manuscripts he had jotted down years before, and in some instances one can surmise that he added dates in retrospect. This occurs, for example, in the “Waste Book” (Cambridge Univ. Library, Add. 4004), which contains texts in Newton’s hand written over a rather long period (from the mid 1660s up to the 1680s, or perhaps even later), with marginal dates that appear to be retrospective. I would add, as a further example, that the celebrated “October 1666 Tract on Fluxions” owes its name to a date squeezed at the top of a folio belonging to a youthful mathematical essay: however, the words “October 1666” are written in a shade of ink noticeably different from that used in the rest of the manuscript (Add. 3958.3, fol. 49r).

I do hope that the government authorities and the funding institutions that have supported these wonderful transcriptions of Newton’s manuscripts and printed works so far will have the vision to continue to do so when the new phase of the project begins—and at a pace that might set the deadline for completion at half a century or so in the future.

The Chymistry of Isaac Newton provides both a normalized and a diplomatic transcription of nearly all of Newton’s alchemical manuscripts (more than a million words).¹³ These manuscripts represent a real challenge for an editor: their dating is often very difficult, the sources of what are often Newton’s own transcriptions of obscure alchemical books or manuscripts are hard to locate, the terminology and symbols employed in describing experiments are arcane. Newman is one the few scholars who can competently edit these puzzling texts. The Chymistry of Isaac Newton team has created a fully functional suite of tools using techniques and concepts from computational linguistics and information retrieval that automatically locate parallel passages within the corpus of Newton’s alchemical writings. A combination of sophisticated computational tools and graphical forms of representation allow the user to construct a visual network showing both the probable chronological ordering of Newton’s alchemical manuscripts and their evolving textual dependencies on earlier sources.¹⁴ These electronic tools might in part replace—and in some respects even surpass—what can be gained by means of traditional editorial work. For each manuscript a careful description is provided of the title, content, physical appearance, foliation, measurements, watermarks, and state of conservation; of the hands and languages; and of the custodial history (obtained from The Newton Project). There is no physical detail (such as the occasional wormhole) that is not used to arrange the scattered sheets of Newton’s alchemical manuscripts in their most likely order. Many of the manuscripts are introduced by historical commentaries, and some annotations help the reader decipher the arcane alchemical terminology and symbols Newton employed. In some cases, translations from the Latin are also provided. The manuscripts are linked to scanned images (at the moment not from the original sheets, but from the Chadwyck-Healey microfilm collection) that can be downloaded in pdf format.¹⁵ The task of

¹³ James R. Voelkel’s contribution in transcribing and encoding the two notebooks Cambridge Univ. Library, Add. 3973 and 3975 should be mentioned here.

¹⁴ See the “latent semantic analysis” tool at <http://webapp1.dlib.indiana.edu/newton/Isa/index.php> (accessed 5 Sept. 2013).

¹⁵ This is changing rapidly, however. The recently uploaded texts (Yahuda MSS Var. 260 and Var. 1 MS 30, 38) are linked to high-resolution scans from manuscripts held in the National Library of Israel in Jerusalem. For the Chadwyck-Healey collection see P. Jones, ed., *Sir Isaac Newton: A Catalogue of Manuscripts and Papers Collected and Published on Microfilm by Chadwyck-Healey* (Cambridge: Chadwyck-Healey, 1991).

reproducing the alchemical symbols themselves has required years of font work that has led to the creation of a large set of alchemical symbols for the international Unicode Standard.¹⁶ Finishing touches are added to this rich website by a number of online tools (including a glossary of alchemical terminology) and an “educational opportunities” section that anyone who lectures in the history of science will find irresistible. Newman’s videos on metal transmutation and mineral vegetation provide a unique opportunity to witness some of Newton’s secret alchemical work.

One of the main tasks of The Newton Project Canada is to provide a center of operations for Canadian-based transcription work on Newton’s manuscripts and printed texts, mostly relating to Newton’s commentary on the Book of Revelation, his work on chronology, and the Leibniz–Clarke correspondence. Snobelen directs a team of transcribers whose work is sent to The Newton Project for a final check and then posted online. Snobelen’s group also maintains a website that is tiny compared to the two other websites. Yet the material provided is notable for the accuracy of its transcriptions and the scholarly commentary that accompanies it. It provides access to several downloadable pdf files consisting of transcriptions of Newton’s “Twelve Articles on God and Christ” (Keynes MS 8, King’s College Cambridge), with accompanying commentaries; transcriptions of several versions and documents pertaining to the General Scholium, which concludes the second (1713) edition of the *Principia*; and a transcription of Newton’s apocalyptic chart (Bodleian Library, Oxford, MS Locke c. 27, fol. 88r), with a brief commentary.

I cannot conclude without stressing the gratitude all historians of science feel for the arduous task that these fine scholars and their teams have set themselves. One of the biggest stumbling blocks to researching Newton in the recent past was the difficulty in accessing his manuscripts. That difficulty is no longer a hindrance. One of the strengths of the websites under review is that they bring together, in one virtual space, manuscripts that are literally scattered around the globe. This has led to a momentous leap forward in research into Newton’s thought. Indeed, we are now in a position to begin asking questions about the interconnectivity of Newton’s writings in a way that would heretofore have been impossible. These new possibilities have already enabled Newton scholars to overcome the somewhat sterile opposition that polarized the field a few decades ago: that between the defenders of Newton the scientist and those who gave a more prominent place to the “secret” adept of alchemy and heterodoxy. We all hope that generous sponsors will continue to be found in the future, in order to ensure the completion of this wonderful enterprise.¹⁷

¹⁶ In addition, The Chymistry of Isaac Newton project provides a free downloadable alchemical font. See <http://webapp1.dlib.indiana.edu/newton/reference/font.do;jsessionid=448ED4EBDB0CCCF04DDCE36499D828CA> (accessed 19 Oct. 2013).

¹⁷ Interesting information on the Newton Project and the relationship between print and online editions can be obtained at <http://www.newtonproject.sussex.ac.uk/prism.php?id=26> (accessed 2 April 2014).