

‘...to whom it will be extremely Useful.’ Dr William Cullen’s adoption of James Watt’s copying machine

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ABSTRACT Dr William Cullen (1710–1790) was a leading physician of the Enlightenment era. As professor in Edinburgh he became the most influential teacher of theoretical and practical medicine in 18th century Britain. A renowned private practitioner, Cullen systematically archived his postal ‘consultations’, now held by the Royal College of Physicians of Edinburgh. Initially Cullen preserved his replies as transcriptions, but from April 1781 he began using a mechanical copier, newly devised by the Scottish engineer James Watt. This paper describes the development, promotion and functioning of Watt’s copier and considers Cullen’s own adoption of the machine. It is suggested that with Cullen’s adoption of Watt’s copier, medical record keeping entered a new historical phase comparable with the recent digital revolution.

KEYWORDS early mechanical copiers, history of medical record keeping, James Watt, Joseph Black, William Cullen

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Dr William Cullen (1710–1790) was one of the most respected physicians of the Enlightenment era. As a professor at Glasgow University and subsequently at Edinburgh University, where he also gave innovative clinical lectures at the Infirmary and served as President of the Royal College of Physicians of Edinburgh, he became the most influential teacher of theoretical and practical medicine in 18th century Britain.¹ Cullen also maintained a substantial private practice, including consultations enacted through the exchange of letters. At a time when close physical examination was largely taboo and diagnosis relied upon weighing symptom patterns against notions of individual temperament, this was not an unusual practice for an eminent consultant but uniquely Cullen systematically archived his postal ‘consultations’; a record of nearly 6,000 communications now held by the Royal College of Physicians of Edinburgh.²

From the mid-1760s onwards, Cullen not only retained each incoming enquiry but also recorded his replies, initially as transcriptions entered into a series of ‘case-books’ made either in his own hand or those of various amanuenses.³ Cullen’s epistolary practice expanded through referrals from the diaspora of his graduates as they became established in private practice or as physicians or surgeons in the army, navy or colonial companies. By the late 1770s he was receiving daily enquiries from throughout Britain, Continental Europe, the American Atlantic seaboard and the West Indies. As this workload increased, it is noticeable that the case-book entries often resort to summary and impromptu contractions. But then a solution came to hand: on 1 April 1781 Cullen began using a mechanised copying system newly devised by Scottish engineer James Watt.

With Cullen’s adoption of this mechanical innovation, medical record keeping entered a new historical phase comparable with the recent digital revolution.⁴ Whenever the copies of Cullen’s consultation letters are exhibited they arouse immense curiosity; however, there has been no substantial investigation into the circumstances surrounding their production. The following account falls into two parts; the first, outlining the development, promotion and functioning of Watt’s copier, is essentially factual. The second considers Cullen’s adoption of the machine before briefly reflecting upon its significance for the history of medical record keeping.

DEVELOPING AND MARKETING THE COPIER

James Watt began developing his copier around 1778.⁵ The impetus came in part from personal frustrations over the burden of copying engineering plans and a voluminous business correspondence. He was also encouraged by the physician, poet and inventor Erasmus Darwin (Charles Darwin’s grandfather), who had designed what he termed a ‘bigrapher’ consisting of ‘a duplex pen, a pen with two quills, by...which one may write two copies of anything’ (p. 10–11).⁶ Such clumsy devices, more commonly termed pantographs or polygraphs, had first been developed in the mid-17th century, but Watt’s own copier, which he patented in early 1780 (No 1244), was to work on entirely different principles derived more directly from printing. An off-set, impression copy was to be generated by placing the original against a moist sheet of tissue-like, unsized copy paper before sandwiching them both between boards for passing back-and-forth between two adjustable sprung wooden rollers.

Watt's efforts to keep his idea a secret during development were thwarted by the need to find patrons. Cullen had known Watt since the late 1750s when the latter's work as official instrument maker to Glasgow University had first brought him to the attention of Cullen's protégé, the chemist and physician Joseph Black (p. 36).⁵ Watt started confiding in Black over the development of the copier in the summer of 1779. Black – by this date was Cullen's colleague at Edinburgh University – was encouraging but declared that he had no use for copying himself (p. 61).⁵ Nonetheless, armed with samples of copied documents sent by Watt, Black set about securing Edinburgh subscribers although the first he approached, a Writer to the Signet, was initially 'much alarmed on account of the frauds which he thought it might give occasion to'. Others were to share such fears and, despite Watt reassuring his London agent, the stationer James Woodmason, that 'the alarm about forgery has subsided', Woodmason was to have his shop at 5 Leadenhall Street stormed by a band of outraged bankers incensed that the copier could be used for forging (16 September 1780, p. 38).⁷ More encouragingly, Black thought that if the royal exchequer had not been so depleted by war, Watt might have gained a 'reward for communicating it to the Secretarys of state' (p. 68).⁵

In order to manufacture the copier, Watt, burdened by ill-health, had entered into a business partnership with Matthew Boulton and James Kier to form the Birmingham based 'J. Watt & Co.' (p. 73).⁵ Once patented, Boulton made particular efforts to advertise the invention, demonstrating it before both Houses of Parliament and The Royal Society (p. 13).⁶ To avoid piracy, Watt's business partners launched an advance subscription to confer on holders a formal licence with guaranteed delivery of the machine. Watt later confided to Black that he regretted having to sell his 'philosophical discoveries but my circumstances render it necessary' and promised that as soon the patent was secured, all interested parties in Scotland would be sent 'the first presses which are made', though at this stage no price was to be mentioned (pp. 73–4).⁵

In the autumn of 1779, Black urged Watt to take Henry Scott, 3rd Duke of Buccleuch, into his confidence over 'your method of taking a counterproof from fresh writing' (p. 71).⁵ Buccleuch was one of Scotland's wealthiest landowners and Cullen acted as family physician. By Christmas 1779 Black had also secured the interest of Cullen's colleague, the historian Adam Ferguson, while the Edinburgh banker William Forbes was eager to purchase 'the liquor from you with which it is done or paying a premium for a participation of the Secret, and under the condition of Secresy' (p. 72).⁵ By the first week of January 1780, Black was reporting to Watt that he also gained the interest of the moral philosopher and economist Adam Smith and 'Doctor Cullen to whom it will be extremely Usefull...' (p. 75).⁵

Cullen and Smith – by this date, commissioner for customs for Edinburgh – had been friends since the physician had supported the latter's first professorial appointment at Glasgow in 1751 and in 1780 they were domestic neighbours in Edinburgh's old town.⁸

By March 1780 when Watt was about to publish a 'proposal for the Copying scheme', the first presses were in production. However, as Watt informed Black, 'we have been obliged to raise the price to six guineas on account of more expense than we expected and the necessity of giving all the little implements along with it...' (p. 79).⁵ That was a considerable outlay; using the retail price index it would be roughly equivalent to £650 in 2015, and if set in relation to average annual earnings in 1780 it was significantly more. But since Cullen could command a fee of two guineas for answering a consultation enquiry, six guineas for the copier must have seemed like a sound investment.

Cullen apparently left no record of when he first heard about the copying machine but certainly by mid-May 1780 Watt was sending Black in Edinburgh 30 copies of the 'printed proposals for the Copying-Machines' for distribution or to be displayed in 'some Capital Booksellers Shops', including that of leading Edinburgh bookseller William Creech. Watt could also report that the first machines were just about to be sent out free from London and Hull (p. 89).⁵ These were destined for a limited number of 'particular' friends and subscribers including Buccleuch, who as he is 'to be served among the first I would be glad to be informed what size he will want the press whether for Common post paper which requires 12 inch Rolls, or larger. Our present apparatus will make them as far as 16 inches long which will take a half Sheet of Imperial paper – The price is ½ a guinea an inch of the length of the Rolls' (p. 89, 93).⁵ From an extant bill from Watt's and Co, dated 24 August 1780, we know that Buccleuch was charged six guineas for his copier which implies that he had ordered a 12-inch roller.⁹ This machine was eventually delivered in October 1780. Around this date, copiers also reached Erasmus Darwin, Joseph Priestley, and Black (p. 39–40).⁷ The latter, after experimenting with his, called at Dalkeith House, Buccleuch's residence ten miles outside Edinburgh, hoping to give a demonstration (p. 111).⁵ The Duke was away, but Black showed the Duchess how the copier worked and subsequently reported back to Watt that the couple were pleased with the results. Cullen may have first seen the copier being used by Black, but as the physician was in frequent attendance at Dalkeith House it may have been there where he first witnessed it in action. Precisely when he received his own copier is unclear but his name appears on a second list of subscribers who were to be advised over imminent delivery that Watt sent to Woodmason on 16 September 1780. This list was restricted to recipients in the north and west of Britain and Watt noted that 'it would be

better for us to send them from hence [Soho works, Birmingham], as it will save carriage' (p. 39–40).⁷ Cullen's name appears here alongside those of Smith, Ferguson and Forbes. This second delivery of copiers to Scotland must have arrived sometime over the winter for Cullen was putting his own copier to daily use from at least 1 April 1781 onwards and continued to employ it on an almost daily basis until five weeks before his death in February 1790.

Watt's copier proved popular, though he did not achieve anything like the thousand advance sales he had hoped for; 150 machines were sold by the end of 1780 rising to 630 after 12 months of sales (p. 73–4).⁵ Watt's initial problem was one of 'cash-flow' for, as he instructed Woodmason (16 August, 1780), the only reason to give a particular customer preference was 'immediate payment for the expense we have been at far exceeds our expectation & we much want some cash to go on with the others' (p. 20).⁷ Watt frequently complained about non-payment; 'some persons there are in the world who are more ready to subscribe than to pay' (p. 38).⁵ Watt's representative vigorously defended company policy when a customer took offence over being asked for payment 'up front':

We beg leave to observe that, since we began the business making and selling copying machines, we have laboured under many inconveniences from noblemen and people of station giving orders for machines and after having been furnished with them, have suffered themselves to be called to the country, or afterwards returned the machine, pretending that it did not answer the purpose for which they intended it. These circumstances repeated determined us to dispose of all our machines sold retail for ready money only (John Buchanan to William Fox, 15 December 1783, p. 227).⁵

An MP and a bishop were among those who had to be pursued for non-payment. With so many orders to meet by August 1781 Watt was informing Woodmason that 'we do not wish to advertise any more in England', but only give proposals out to 'persons going abroad...to countries where the fame of the copying machine has not yet reached' (21 August, 1780, p. 354).⁵ A certain 'Mr de Roveray...having a large foreign connection' was to be sent his machine gratis (7 September, 1780, p. 20).⁵

A few copiers were customised; one destined for the Empress of Russia was to be 'a little better jappaned' (p. 42).⁵ Other notable early recipients included King George III, Sir Joseph Banks, Edmund Burke, Benjamin Franklin and Thomas Jefferson. The latter went on to devote much inventive energy on further developments in mechanical copying. Watt's 1780 design had set a precedent for the development of 'pressure copying' into the 19th century, including many rival imitations such that Watt's son sought to retain his hold on the

market by releasing a portable version in 1795. Most of the surviving examples seen in museum collections are usually of this later portable type (p. 21).¹⁰ An example of the original table model employed by Cullen is owned by the Science Museum in London (Object Number: 1876-1508), and its use can be ascertained from the Directions issued to accompany sales.¹¹

THE TABLE-MOUNTED COPIER: DESIGN AND USE

Watt's original copier consisted of a roller press mounted by clamps onto a 28 inch high hardwood 'stand' (mahogany cost extra) (Fig. 1). The stand was 20 inches wide, with a fold-down leaf which, when extended, created a work-surface. It had a drawer for holding spare copying paper and beneath this were two open shelves 'for the drying and wetting books, and spare pasteboards etc', designed to militate against the mouldering, which might accrue if moist paper was stored in a sealed drawer. Watt soon refined the design to accommodate the addition of a 'wire-lattice front with a lock' to the upper shelf, so that 'the copies of the drying book may be kept secret, if chosen.' Such security measures no doubt appealed to Cullen whose letters inevitably contained sensitive patient information. For bulk users, Watt's company also supplied specially designed 'boxes lined with block-tin...in which the paper may be kept in the proper degree of moisture for many days' (p. 8).¹¹ Normally supplied in quarto or folio, Buccleuch's order included two of these 'packing Boxes', at the combined cost of five shillings.

The press also came with a wooden press-board suitably bevelled to ease insertion between the adjustable, sprung rollers made from *lignum vitae*. To create a copy, the original was laid under a sheet of pre-moistened copying paper and together these were laid on a thin pasteboard, on top of the press-board. The copier was delivered with the board, the pasteboards, oiled papers and thin copy paper all laid in the required order in the drawer. The general advice on making good copies included avoiding having the copy-paper too damp and ensuring that the originals were fully dried out, but it is worth examining the process in detail.

The Directions urged that originals needed to be written on good quality 'well-sized' writing paper that would not absorb too much moisture from the copying paper. To ensure the originals were properly dried after copying they should be laid near a fire or passed through the rollers between sponge-papers. Copies could normally be made between 24 hours and 3–4 days after writing, but the ideal time to take a copy was effected by such variable factors as the weather. Success was particularly dependent upon getting the copying paper to just the right degree of wetness, which for individual sheets was best achieved using a brush. Novices were advised to err on the side of having the paper too dry

to avoid puckering, though this could be remedied by running the dampened copy paper through the press. 'Damping-Boxes' were used to store up to 24 quarto sheets of pre-wetted copying paper, which had been placed between sponge-paper in a 'Wetting-book' (a folder used to squeeze out excess moisture). The machines even came supplied with a measured phial to indicate the precise amount of water required to achieve the ideal level of moisture for a given quantity of paper. With the right conditions, the pre-moistened copy paper could be stored for up to a month.

The Directions warned that at first the copies might appear pale but within 24 hours 'they will become a good dark blackish colour, if well taken, and from good ink' (p. 9).¹¹ Dark patches indicated imperfect drying or over-wetting. Watt encountered particular problems over establishing the correct thickness for the copying paper and the formulation for the ink. He told Black about attempts at 'improving the colour by wetting the paper with an astringent' while 'depriving astringents of their colour' (p. 73–4).⁵ He urged his papermaker to be 'attentive as you can to the preservation of colour' and to 'evenliness'; and, writing to Woodmason, he complained that he had been undertaking 'numberless experiments towards curing the paper of the fault of diffusing and turning reddish with the ink' (p. 12).⁷ When he first tested the copier, Black was largely impressed but 'not satisfied upon the Subject of your Inks tho of this I have not uttered a syllable to any other person' (p. 97).⁵ Watt apologised for an inexplicably bad batch, before detailing the difficulties of creating a suitable ink: he needed a readily soluble powder fit for use within an hour or two, which was sufficiently fluid for writing and could be easily stored without going thick or mouldy, while being 'capable of giving an impression without diffusion, soon after it was wrote' and 'capable of yielding an impression at the end of 24 hours after it is wrote with' (or longer). It also needed to keep its colour and be fit to transport as far as the West Indies. Black, as a pioneering chemist who had conducted his own experiments with ink-making, advised basing the ink on 'white wine spirit' (p. 97).⁵ We do not know if any of Black's suggestions were adopted, but Watt's company continued to provide their own specially formulated ink powder 'prepared of the best ingredients', while warning against using poor-quality ink, or letting ink deteriorate by leaving it exposed in open vessels (p. 10).¹¹ To this end, Watt also endorsed the use of Wedgewood and Bentley's new narrow-necked, earthenware inkpots.

Though a 'drying book' was provided for individual copies, when many were being made you were advised to hang them up on drying lines stretched across the room and then flatten them out by running them back through the rollers. Once dry the copies were to be mounted in loosely bound letter-books made up of thick sheets larger than the largest size of paper being copied.

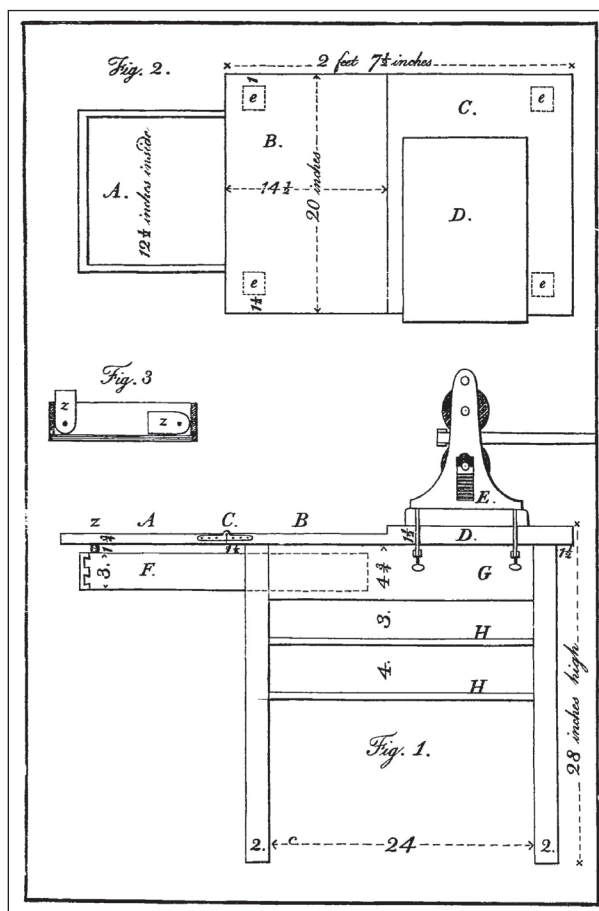


FIGURE 1 Plan of copier from *Directions for using the machine for copying letters and other writings*. Invented and made by James Watt and Company, of Birmingham (1780) (private collection)

The copies were to be mounted using paper wafers attached to each corner (i.e. small, gum impregnated circular-cut papers). The Directions warn that the flour paste commonly employed by bookbinders is adequate but the 'mucilage of gum tragacanth' from the *Astragalus* plant (recipe provided), was less likely to go mouldy (p. 7).¹¹

CULLEN'S USE OF WATT'S COPIER

Cullen's copies are mounted with wafers on thick paper exactly as directed. His consultation replies usually consisted of one sheet of paper which, when folded for posting, creates four quarto size pages of text, but many also included prescriptions written on 'a paper apart' for handing to the apothecary. These prescriptions are normally mounted adjacent to the copy of the letter with which they were associated. Cullen did not use Watt's copier exclusively for recording his consultation replies. Machine copies of some academic documents also survive and at least two, un-mounted machine copies of letters to personal friends are extant.¹² We must assume that he housed his copier in the office at his private residence in Mint Close, off the Canongate in

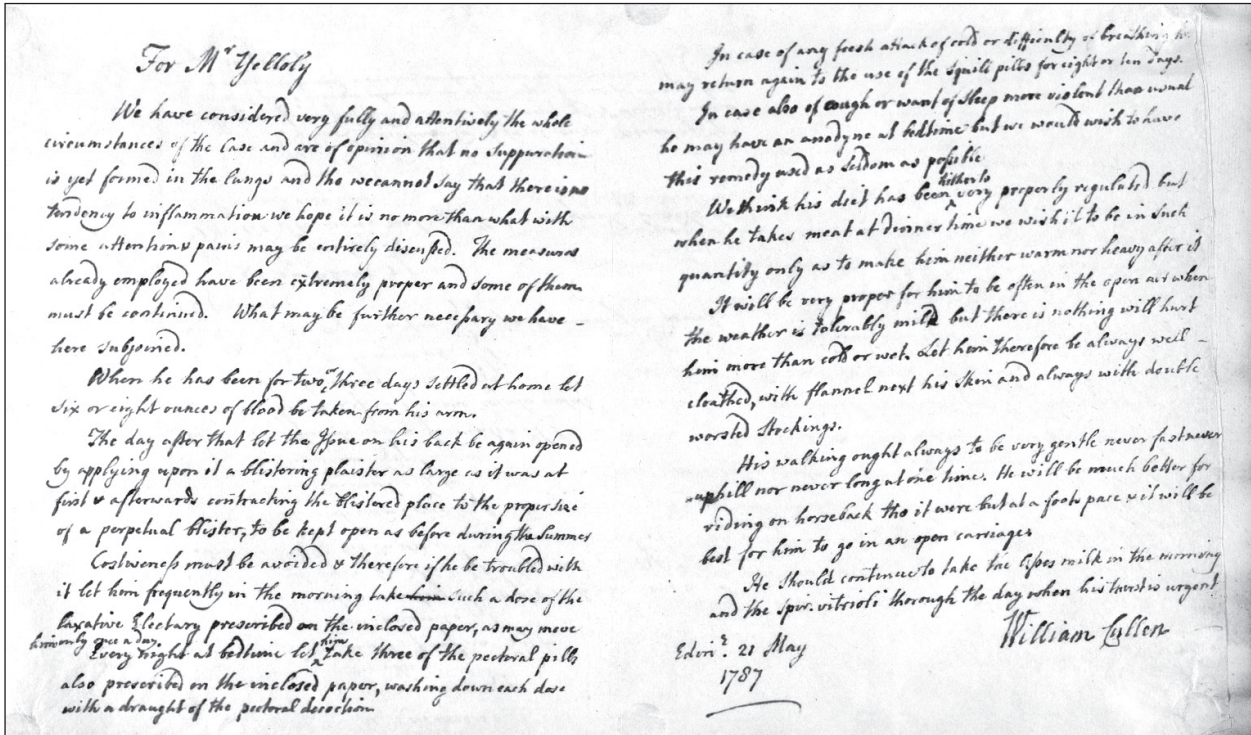


FIGURE 2A A typical crisp copy. Cullen for Mr Yelloly, 21 May 1787 (RCPE: CUL/1/1/2081)

old Edinburgh, from where he ran his practice. An assistant presumably operated it but no eyewitness account has surfaced, although Cullen's early biographer Dr John Thomson left a rather cryptic note of an interview with Cullen's last amanuensis, a Mr Paul, who recalled that 'When hurried', Cullen 'would begin three consultations at a time and finished them in that way with the machine' [italics added].¹³ It is unclear if this simply refers to those occasions when Cullen dictated to his amanuensis before adding his signature or implies that he habitually wrote three at a time before they were copied. Of course what we do have as material evidence is the numerous consultation copies which eventually came to fill nine folio volumes.

Many of the Cullen copies are crisp if slightly 'fuzzy' when compared with any extant originals (in a few instances, for unknown reasons, Cullen retained an original letter as well as a mechanical copy thus providing us with the opportunity to compare the two versions) (Fig. 2a). But a significant number display a range of faults, the most common being areas where the impression is very faint (Fig. 2b). As Watt's Directions warn, this stemmed from operational failures; the copy paper might have been insufficiently moistened, the original writing could have been left for too long after it was originally written or inadequate roller pressure was exerted. Less frequently, Cullen's copies are smudged, as if the paper were too wet. For ease of reference, Cullen's earlier handwritten case-book entries were headed with the name of the patient (and, when relevant, the person writing on their behalf), so for the machine copies the

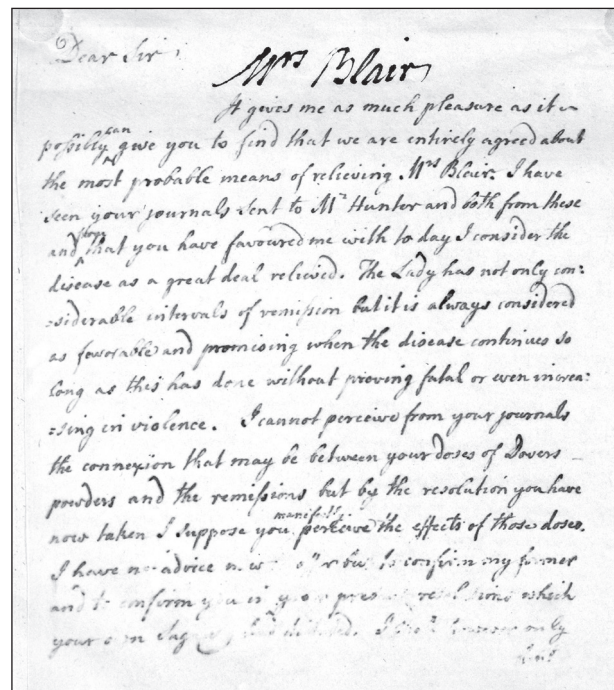


FIGURE 2B Some failure of impression in lower part. Patient's name added by hand when copy-paper was still moist. Cullen for Mrs Blair, 7 October 1782 (RCPE: CUL/1/1/131).

names had to be added by hand after the copy was made. Blurring implies that the copies were not entirely dry when these were penned (Fig. 2b). In a few instances, minor edits were added to the facsimile, implying that on rare occasions Cullen revised his wording after the copy had been made.

Cullen's recourse to Watt's copier exemplifies how a leading Enlightenment physician looked to harness the applied arts to ease a practical professional problem. It forms part of that drive for scientifically-led, technological 'improvement' that characterised the Scottish Enlightenment and informed Cullen's entire career as a chemist, agriculturalist and clinician.¹⁴ More specifically it suggests a point when the keeping of personal medical records makes a significant move forward into what Walter Benjamin, in his ground-breaking essay of 1936 concerning the cultural impact of new media, termed 'the age of mechanical reproduction'.¹⁵ It implies the start of a long technological trajectory whose current end-point would be a standard circular letter generated by a computerised address list requesting every registered patient aged over 50 to undertake bowel cancer screening. But Benjamin famously associated such mechanical reproduction with a deracinated modernity; a so-called loss of 'aura'. More broadly, medical humanists have been inclined to agree with the French army surgeon George Duhamel who, in reflecting back upon his experiences as the head of an ambulance unit in the First World War, observed that 'the climate of mechanisation is not the climate of sympathy' (p. 165).¹⁶

So it is rather ironic when we consider how, in effect, turning to mechanical copying helped Cullen sustain his own 'personal touch' when communicating with distant patients and colleagues. Contrary to a traditional portrait of Cullen swiftly dictating postal responses to an assistant over breakfast, the evidence implies that the physician endeavoured to reply to each postal enquiry in his own neat hand and in some cases even went to the trouble of carefully redrafting the wording of his more substantial individualised directions on regimen. The machine copies do show that Cullen, already 70 when he obtained the machine, did sometimes reply through an amanuensis but responded to patients in his own hand until shortly before his death.³ This personal approach was an inherent part of how Cullen wished to be perceived as a gentleman physician. Without wanting to imply that his professional success simply rested on having fine handwriting, elegant penmanship did help to instil trust (just as today's graphic designers of computer-generated circular letters will often choose a typeface that imitates neat handwriting).

Cullen's awareness of such appearances is evident from a letter full of paternal advice he addressed to his young son Jamie who was just about to board a ship for Antiqua to take up work. Cullen urges his son to write home frequently and keep a journal, but 'I tremble for your handwriting, and beg of you in the most earnest manner to take pains on that article. If you have any regard to my satisfaction you will, and, for your own sake, consider that nothing so much gives the appearance of mean and low bred as bad writing.' (11 November 1765, I, p. 133)¹ I do not know if anyone has established

when comments on the bad handwriting of doctors first emerged, but in 1917 one leading American medical professor was prompted to remark that the 'poor penmanship of some physicians only too clearly betrays their want of general education and is another of those small influences which, perhaps amount to little in themselves, yet exert such great influence in the aggregate in making or marring one's career' (p. 163).¹⁷

Cullen would have had to maintain his professional persona in the face of facetious popular charges that medical professionals deliberately indulge in obscurantism and obfuscation either out of a vested interest or in order to mask their own ignorance. As his colleague Dr John Gregory liked to remind students, 'we never meet a physician in a dramattick presentation, but he is treated as a solemn coxcomb and a fool' (p. 4).¹⁸ Cullen's attention to lucid handwriting meshed with his wider professional commitment to unprejudiced thinking, careful observation, precise reporting, and the honest communication of prognostic or diagnostic advice. The retention of facsimiles meant precise records; a concern essential to Cullen's commitment to knowing a patient's individual 'constitution' by having as much relevant information concerning their medical history to hand, including any subsequent reports on the effects of his recommendations. Now there is a certain symmetry at work here in as much as these 'mechanical copies' have themselves recently been subjected to an entirely new form of archival copying; digitisation. Cullen would surely have been intrigued to see how 21st century digital technology has allowed the preservation, collation and detailed textual mapping of his consultations in order to further our own understanding of this unique historical record of disease, illness and the attempt to cure. The online archive can be visited here – <http://www.cullenproject.ac.uk>

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