

## Seventeenth-Century ‘Double Writing’ Schemes, and a 1676 Letter in the Phonetic Script and Real Character of John Wilkins

Summary: Royal Society Classified Papers XVI contains a letter written in not one but two seemingly mysterious scripts. As a result, this letter has remained until now effectively illegible, and has been miscatalogued. These scripts are rare examples of the written forms devised by John Wilkins to accompany his proposals for an artificial language, published under the auspices of the Royal Society in 1668. This article therefore first correctly identifies and decodes this letter, which is shown to be from the Somersetshire clergyman Andrew Paschall to Robert Hooke in London in 1676, and then surveys other surviving texts written in Wilkins’s scripts or language. A second section addresses the contents of the letter, namely its author’s attempt to build a workable double writing device, in effect an early ‘pantograph’. Designs for such instruments had been much touted in the 1650s, and the complex history of such proposals is unravelled properly for the first time.

Keywords: Andrew Paschall, Robert Hooke, Artificial Languages, Phonetics, Double Writing.

### INTRODUCTION

Royal Society Classified Papers XVI is a collection of documents and letters relating chiefly to linguistic subjects. The first item is conjectured by its custodians to be a letter addressed by the Ipswich clergyman and language theorist Cave Beck (1623–1706) to the FRS and experimental philosopher Robert Hooke (1635–1703) in London. It is in fact a letter to Hooke from a clergyman of similar interests to Beck, but based in Chedzoy, Somersetshire, namely Andrew Paschall (1631?–1696), dated 17 January 1676. The misattribution is venial, however, as the entire letter is written in a mixture of the phonetic and real characters devised by the founding fellow John Wilkins (1614–1672) as the written form of his artificial language, published in 1668 under the imprimatur of the Royal Society as *An Essay Towards a Real Character, and a Philosophical Language*.

Paschall was one of the most active members of the informal group of English scholars coordinated by the FRS and antiquary John Aubrey (1616–1697), who worked, without lasting success, to perfect Wilkins’s scheme after its inventor’s death. The story of this revision group and its fortunes has been told several times.<sup>1</sup> But this letter, an early intervention in the debate by Paschall, has never been recognized for what it is, and has remained until now misattributed, unpublished, and in effect illegible. Moreover, it is a letter with effectively two subjects. Its form perforce renders it a contribution to the efforts to translate Wilkins’s language from theory into practice. Its content, however, largely concerns what Paschall calls (to transliterate his phonetic script into modern English for now) ‘a way of writing the same thing in two copies by the same hand at the same time’. This is a reference to ‘double writing’, or the search for a workable tool for producing exact copies of documents, usually by pens co-ordinated in a frame, or by some chemical alternative. This article therefore forms two sections, the former dealing with the practitioners of Wilkins’s language and scripts, concluding with Paschall’s letter itself; and the latter with the various schemes to perfect and market the ‘double writing’.

### PRACTITIONERS OF WILKINS’S ARTIFICIAL LANGUAGE

Enthusiasts for John Wilkins's artificial language were numerous in the later seventeenth century, but practitioners less so. The first was of course Wilkins himself, whose *Essay* contained a worked chrestomathy consisting of the Lord's Prayer and Creed.<sup>2</sup> Upon publication Wilkins sent his Oxford friend, the mathematician John Wallis (1616–1703), a letter in the real character, and Wallis responded with a romanized text in the language, thereby showing that he grasped both the system behind the language and Wilkins's proposed manner of rendering it effable. Wallis placed Wilkins's letter and his response, which he drafted fully three times, inside his own copy of the *Essay*, where they remain.<sup>3</sup>

The most prominent surviving attempt to write in the harder real character, however, is Hooke's translation, written on the last weekend of August in 1675, of his secret for the use of springs in his pocket-watch design. This text, which Hooke published as an engraved plate in his *Helioscopes* (dated 1676, but available late the previous year), was not just a means of protecting his research priority in one area (horology) but of stimulating activity, somewhat playfully, in another (linguistics).<sup>4</sup> The challenge was taken up by the Lancashire astronomer Richard Towneley (1629–1707), who worked on a translation of Hooke's watch secret in late 1675. Hooke himself, who was shown Towneley's effort in a coffee-shop in December of that year by fellow astronomer Sir Jonas Moore, declared it 'Decipherd right'.<sup>5</sup> Towneley's surviving papers show that he also attempted his own abortive translation of Aesop's fable on the Cock and the Jewel into the real character.<sup>6</sup> This in turn suggests that Towneley had been reading the other Restoration attempt at an artificial language, George Dalgarno's *Ars signorum* (London, 1661), as it had concluded with worked examples from Aesop.<sup>7</sup> Meanwhile, the young Oxford don and FRS Thomas Pigot (1657–1686) of Wadham College, who consistently championed 'the advantage of a praxis' in the language, had also risen to Hooke's challenge, sending to John Aubrey in October of 1676 his transcript of Hooke's spring watch text with his interlinear translation.<sup>8</sup> That Christmas Pigot even devised, as 'a Christmas sport', a set of twelve dice for learning the characters.<sup>9</sup>

Along with the London merchant and linguist Francis Lodwick (1619–1694), Pigot and Paschall were the most zealous practitioners of Wilkins's language. Paschall and Aubrey had been corresponding since probably April 1672, and would swap dozens of letters over the next two decades and more.<sup>10</sup> In early 1677 Paschall wrote an entire letter to John Aubrey in the real character, accompanied by an English gloss.<sup>11</sup> Paschall's letter was circulated by Aubrey, and Pigot supplied some corrections.<sup>12</sup> In 1678 Paschall developed large botanical tables displaying the Wilkins classifications of plants with the appropriate characters, which he hoped could be hung in greenhouses. These too he sent to Aubrey.<sup>13</sup> In the same manuscript in which they are found today are also some tables derived directly from Wilkins's *Essay*; but whereas the tables in the original essay were printed, these ones are engraved, and ought perhaps to be associated with Aubrey and the revision group.<sup>14</sup> It seems that Paschall and Lodwick corresponded directly in the real character, although no examples have been recovered. Lodwick, who according to Aubrey, could read the script 'standing on one foot', also translated at this time Sir William Petty's *The Discourse . . . concerning the Use of Duplicate Proportion* (1674) into the real character, a work now lost; and Lodwick listed in his library catalogue several other papers of his in various artificial scripts, including some 'Discourses on severall subjects in religion, in one of my new Carracters'.<sup>15</sup> Paschall worked with Lodwick on revising Wilkins's phonetic script, and two letters from Paschall to Lodwick including examples of this revised script have survived—although, interestingly, Paschall there employed the phonetic character as an encryption method when discussing alchemical preparations.<sup>16</sup>

As for Paschall and Hooke, a few items of their later correspondence are known; but the letter presented here marks the hitherto undetermined inception of their

acquaintance. But if Hooke replied, that letter has not survived.<sup>17</sup> Hooke himself was a vociferous advocate for Wilkins's language, hailing it in his *Helioscopes* as 'so perfectly and thoroughly Methodical ... [the] highest Idea of any Character or Language imaginable ... perfectly free from all manner of ambiguity, and yet the most copious, expressive and significative of any thing or Notion imaginable', and so forth.<sup>18</sup> He later claimed to have developed his own 'Universall Language', and his belief in the plausibility of such a scheme remained unshaken as late as 1686, the year in which he published a paper on Chinese writing, which contains several remarks on the feasibility of a language designed by philosophers.<sup>19</sup>

#### PASCHALL'S LETTER TO HOOKE

Wilkins's phonetic script, which had been developed by Wilkins in dialogue with Francis Lodwick and the clergyman, FRS, and musical theorist William Holder (1616–1698), was universal in its aspirations.<sup>20</sup> It operated by plotting sounds on a grid, the horizontal axis defining vowel, and the vertical axis consonant, values. Any given place, therefore, represented a vowel-consonant combination, and was given a distinct graph. In theory all available sounds could therefore be represented, not just the relatively small number employed by any given natural language. The script was designed in a manner that allowed one to distinguish between vowel-consonant or consonant-vowel ordering; and graphs were also provided for uncombined vowels and consonants. The nature and quality of Wilkins's phonetics is not to the present purpose, but in order to understand the transcription presented below, we should be aware that Wilkins distinguished six classes of vowels, which he notated  $\alpha$ , a, e, o, u,  $\ddot{y}$ . He then sorted consonants into unvoiced and voiced groups, prefacing these with separate marks for h, w, y (fig. 1 below).<sup>21</sup> A 'plaintext', as it were, can be generated by locating the desired character in the table below, and reading off its 'coordinates': if the character is found in the left-hand side of the table, the vowel is taken before the consonant; if in the right-hand side, the consonant is taken before the vowel. (Thus the character at 4, 11 in the grid below represents the sound 'at', whereas its counterpart at 11, 11 is 'ta'.) Paschall in his postscript in turn suggested certain modifications to the script, which he himself employed.

fig. 1: Wilkins's phonetic script, from John Wilkins, *An Essay towards a Real Character, and a Philosophical Language* (London, 1668), p. 376, from Royal Society, R65129.

As for the real characters, being the two lines of text numbered one and two in the middle of Paschall's letter, Wilkins explained the nature and use of these in the fourth and final part of his *Essay*.<sup>22</sup> The 'integral' characters displayed, in an Aristotelian manner, genus, difference, and species, by variations respectively to the centre, left, and right of a horizontal bar. Added loops at the left and right extremities distinguished synonyms and antonyms. (Thus, to take the final character of the first line, this graph expresses the genus space, in the second difference, and the second species. The left-hand loop signifies 'opposition'. Looking this up in Wilkins's tables, we obtain the concept 'distance'.) The 'particles' gathered around and separating the characters supplied the necessary grammatical information, expressing parts of speech, conjunctions, and so forth. This is why the characters are 'real': they represent things and notions directly, not the sounds arbitrarily assigned to those things or notions by given languages.

Paschall's letter is a striking but superficial performance. Wilkins had developed his phonetic script for philosophical purposes, a method of notating sounds

systematically, free of the arbitrary constraints of most writing systems. A phonetic script was necessary for his philosophical language, moreover, because, based solely on classes of object or thought as the real character was, it could not notate proper names, and had to defer to a phonetic script in such cases (as ‘awbrey’ and ‘andrew pascal’ below). But otherwise Paschall is merely using the script as a way of writing English in code, and is not really undertaking phonetic analysis. If we apply the principles of Wilkins’s *Essay* as explained above to this letter, the ‘plaintext’ is thus revealed:

S[r]

yt yz mÿy fȃrtun tÿ bey on of dhem tÿ hwom yu hav ecspressed a pȃrtycu | lar  
cÿyndnes yn dhat hywtsh yu latly mad pÿblyc yn dhe reāl character, dhat | mÿy  
gratytud may nȃt wayt ÿpȃn yu empty-handed, ÿy hyr prezent yu wyth a | thyng  
ȃf no valu, yf cÿmpared wyth dhoz thyngz hwyts ar wÿnt tÿ ymplȃy | yur gret  
mÿynd, bÿt ÿy prȃmÿz tÿ mÿy salf dhat yt wyl nȃt mys ȃf yur | acseptans, partly  
becawz yt may by ymprwved bÿy yu tÿ sÿmthyng ȃf pÿblyc yus, | pȃrtly becawz  
tyz wryten yn dhe reāl character, yt yz cȃnsernyng a way ȃf | wrÿhtyng dhe sam  
thyng yn tw<sup>23</sup> cȃpyz bÿy dhe sam hand at dhe sam tÿym.

1. join coupled pens, this one before that one, in delivered distance.
2. [put] the paper upon the writing ligament, so that the pair can vary together.<sup>24</sup>

S[r]

ÿy hav had sÿm thowts abÿwt fȃslyltatyng dhe learnyng ȃf dhys<sup>25</sup> character and |  
langwazh, and | abÿwt sÿm prȃbabl ways ȃf spreading yts cnowlaÿg and yus, bÿt  
ÿy | fȃrbear tÿ trÿbl yu wyth mÿh slender propȃzalz, becawz ÿy cȃnzhectur | bÿh  
sÿm lat letÿrz frȃm ÿwr wÿrdhy frÿend m[r] awbrey, dhat dhe wÿrc | yz yn ÿdher,  
and then ÿy am sur, yn beter handz, ÿy shȃl relyzhuws- | -ly ȃbsarv yur dezÿyr ȃf  
not ympartyng yur secret tÿ any hww | wyl nȃt learn dhe character.<sup>26</sup>

S[r] ÿy cannȃt meryt tÿ be admyted yntÿ dhe nÿmber ȃf yur | fryendz, bÿt ÿy  
mÿst ȃlwayz by [.]

Zhan 17. 1675/76

yur affecshonat hȃnwrrer and servan[t]  
andrew pascal.

ÿy yuz yn wr[.]tyng dhys lyterāl character | dhez cȃntracshȃnz, fȃr

<insert image>

thys iz<sup>27</sup> an instans ȃf dhe dÿbl wrÿytyng.

thys iz an instans ȃf dhe dÿbl wrÿytyng.<sup>28</sup>

fig. 2: Royal Society, Classified Papers XVI, item 1: Paschall’s letter to Hooke

fig. 3: Paschall’s sample of double writing (from Royal Society, Classified Papers XVI, item 1)

## ‘DOUBLE WRITING’

Most of Paschall’s letter is padded out with vague statements about the ‘character and langwazh’ it seeks to advertise. But at its core is Paschall’s presentation to Hooke, exactly in the manner of Hooke’s own watch text (the ‘secret’ to which Paschall refers), of a mechanical contrivance expressed in Wilkins’s real character, here functioning, not for the first time, as a combination of encryption, challenge, and advertisement. This contrivance is a double-writing machine, and Paschall’s interest in ‘wryhtyng dhe sam thyng yn tw cōpyz bÿy dhe sam hand at dhe sam tÿym’, was a technological preoccupation reminiscent of English schemes more of the 1650s than the 1670s. For Paschall’s ‘double writing’ evokes interregnum proposals associated chiefly with the inventor-dons William Petty and Christopher Wren, both soon to be celebrated for other and greater achievements. The latter half of this article thus turns to these proposals and their fortunes.

There is a larger problem of priority here. The first ‘pantographs’, as they were only later termed in English, appear to have been those designed earlier in the seventeenth century by the prominent Jesuit scholar Christoph Scheiner (1575–1650), who published an illustrated treatise on his invention, the *Pantographice*, at Rome in 1631. This treatise explains the construction and mathematical theory of a device based on flexible parallelogram frames, capable of holding two, three, or more pens, and useful as a device for scaling up and down as well as copying.<sup>29</sup>

fig. 4: Scheiner’s pantograph, from *Pantographice* (Rome, 1631), p. 29, from Royal Society, R62236.

It is notable that none of the English projectors mentions Scheiner’s priority, although it is hard to believe that Petty in particular, who had been educated by the Jesuits in Caen in the late 1630s, did not know of this work. The question itself was in fact put to Petty’s advertiser, the London-based intelligencer Samuel Hartlib (1660–1662), by one of his correspondents, the Silesian reformer Cyprian Kinner, who in April 1648 pressed Hartlib on the relation between Petty’s ‘Instrumentum Scriptorium’ and the Jesuit’s published contrivance.<sup>30</sup> And indeed it seems that Petty’s inspiration was divined at once by another of Hartlib’s correspondents, the English landowner and technological reformer Sir Cheney Culpeper, who as early as January of 1648 wrote to Hartlib to discuss a prototype he had built himself, but one ‘I firste learned out of a booke which you lent me & had afterwards made by your nayghbor, I meane the parrallellogramme instrumente’.<sup>31</sup> This is doubly revealing, because the final phrase confirms that the book under discussion was, specifically, Scheiner’s treatise, and because it also shows that Hartlib owned and lent the very book. So Hartlib knew all along.

Culpeper’s letter is in fact the most open account we have of contemporary English work on such a device—the rest being guarded funding pitches—and he discussed his trials for the ‘inlarginge or lesseninge of any mappe’, the possibility of making six or more copies of texts, of copying pictures, and of etching plates for printing, which in turn required reconfiguring the machine to copy backwards, which Culpeper illustrated by a diagram:

fig. 5: Culpeper’s frame for reversed etching: if *a* is fixed by a rivet, a directed pen inserted at *c* will cause a pen inserted at *b* to trace out the same graphs in reverse (The Hartlib Papers, 8/31/1B, courtesy of HRI Digital, University of Sheffield, <http://www.hrionline.ac.uk/hartlib>).

Culpeper explicitly stopped short of equating Scheiner and Petty's schemes, but for him Petty's contribution was reduced to an innovation concerning the regulation of the ink supply.

Petty first proposed his own instrument in 1647, writing out a biblical text in duplication before a group of witnesses—including Francis Lodwick—who signed a testimonial, retained by Hartlib. Petty then provided some self-publicity in his Hartlibian tract *The Advice of W. P.* (1647), and next printed *A Declaration concerning the Newly Invented Art of Double Writing* (1648), which included the text of a parliamentary ordinance granting him a fourteen-year monopoly.<sup>32</sup> But, to the increasing frustration of his supporters, Petty, who was fishing for major investment, failed to divulge his secret. As Hartlib complained to Boyle—to whom Petty had hopefully dedicated his discovery—'since the non-performance or non-divulging of the invention of his double writing, his credit is mightily impaired in *England*, and in other nations, which have heard of it'.<sup>33</sup> Foreign correspondents indeed continued to quiz Hartlib about the fate of 'instrumente illud of double writing', as one said, even adopting the English phrase for the promised contrivance.<sup>34</sup>

Other figures then stepped in with comparable claims, notably the Oxford dons Christopher Wren and Francis Potter. John Aubrey received news of the former's 'engin' in 1651, and Hartlib had learnt of both men's schemes by 1653.<sup>35</sup> Wren later denied that he had any knowledge of a prior inventor; Petty and Wren evidently worked apart, and Wren observed that double discoveries were not impossible. As he wryly remarked, 'I should have readily imagin'd because of the Obviousness of the Experiment that it might as easily have had a double Father as have produc'd a twin Copy'.<sup>36</sup>

Working prototypes must have existed. Petty's was, as we have seen, witnessed in operation. Wren's machine, which he elsewhere dubbed his 'Diplographical Instrument', appears in a list of devices displayed before the club of experimentalists headed by Wilkins in the 1650s in Wadham College, Oxford; and Wren forwarded a 'Copy [i.e. a diagram, not an actual instrument] of my Double-Writing, after a larger form' to an unidentified correspondent, claiming that the instrument had been shown to Oliver Cromwell just before he became Lord Protector, so before late 1654.<sup>37</sup> Petty also heard in early 1653 that '*the Double Writing hath beene offered My Lord Generall Cromwell*', and so Cromwell may indeed have assessed some kind of system, assumed by Petty—perhaps tactically, for he had his legal monopoly—to be his own.<sup>38</sup> In 1653, too, Hartlib heard from the London instrument maker Ralph Greateorex that Greateorex had made ten or twelve models to Wren's design, selling for 12s a piece ('*The more careles you write the better*'), and that some of the clerks working under the Secretary to the Council of State and spy-master John Thurloe were employing Wren devices.<sup>39</sup>

Nor were these the only men involved in proposing double writing machines. In early 1651, for instance, Hartlib heard about one John Raimond of Sherborne in Dorset, who claimed to have 'not only double but 7-foldwriting', although this may have been a calligraphic rather than a mechanical feat.<sup>40</sup> But a further entry in Hartlib's Ephemerides for late 1653 suggests that John Denham the poet was also 'about a common or double writing'.<sup>41</sup> Then in late 1654 Hartlib learnt from Robert Boyle about 'one a fellow of *Oxford* who hath found out another double-writing, that hath not so many inconveniencies in it as that of Dr Petty or Wren'.<sup>42</sup> Shortly afterwards a Cambridge don joined the throng, known to Hartlib at this stage only as 'Morlack'. This was the talented inventor Samuel Morland (1625–1695), who early the next year (1655) confirmed to Hartlib that he, too, had invented such a contraption, requiring 'a *Weeks* practise before one bee habituated'—'but countes it no better then a toy'.<sup>43</sup> Hartlib may have discussed this provocative claim with Wren, as the former soon afterwards recorded that the latter 'hath an other sort for Pens for double Writing then Moreland', and I propose that it was

Morland's claim, therefore, and not the far older claim of Petty, that moved Wren to his letter in defence of his own priority.<sup>44</sup> To this we must also add in the same year yet another Cambridge don, this time William Dillingham (c. 1617–1689) of Emmanuel College, who declared that he too had invented 'a peculiar kind of double writing'.<sup>45</sup>

None of these machines proved economically viable, for if they had, they would have been noticed. Hartlib, in the course of a complaint to Robert Boyle about the failure of Petty's machine to materialise, commented that even Wren's construction was, according to Greateorex, 'not worth a rush; for it can never be readily practised'. (This was, however, probably misinformation sown by Potter, who of course was not neutral in this matter.<sup>46</sup>) What is to be observed is that many different figures were working on similar projects at the same time.

Such contrivances must themselves be located within the larger category of the hopes Hartlib and his many informers had for all sorts of schemes for duplicating writing, including methods that are more akin to printing from engravings, or to developing chemically treated paper, than to any mechanically co-ordinated device. As early as 1634, for instance, Hartlib had heard about a process discovered in Lübeck whereby treated white and black sheets of paper were stacked alternately, 'and writing hard vpon the first the impression will bee seene legible vpon all the rest'.<sup>47</sup> Then there is a 1635 memo among Hartlib's papers on a 'new and profitable invention' by one 'I. P.' (perhaps John Pell?) for copying by means of engraving on tin plates, an idea Hooke himself would later revive.<sup>48</sup> Petty himself did not restrict himself to double writing, but even claimed in 1649 to have 'brought to perfection' a 'Printery-Invention', and that 'hee was about to print in it of China Arabick and the like Letters *which* are not to bee had at all. But *protested* solely hee would not have it spoken to any body nor would hee affirme it that hee had any such Invention etc'.<sup>49</sup> Again, John Evelyn recalled a visit to Hartlib in late 1655 where he was told of a special ink 'that would give a dozen copies when moist sheets were pressed on it'.<sup>50</sup> It is no coincidence that many of the names associated with such schemes also had wider interests in script and language reform, including the real character. Culpeper, for instance, drew up proposals in 1646 that were simultaneously technological (more cost-effective printing) and theoretical (how to reform the notation of language), citing the example of the character-based scripts of the 'Leuante', an allusion to Francis Bacon's influential remarks on oriental scripts in his *Of the Advancement and Proficiency of Learning* (1605).<sup>51</sup>

Discussions of the double writing instrument in this period have focussed, sometimes misleadingly, on the claims of Petty and Wren. But Wren evidently did not regard Petty as a competitor, still less a collaborator, and this implies either that Wren, improbably, was ignorant of Petty's work, or that Wren believed his own device to be sufficiently different from that proposed by Petty for it to be treated as a separate enterprise.

After the mid 1650s, however, discussion of double writing contraptions appears to die down. This may be related to issues of state secrecy. In the second half of the 1650s Morland was in the employ of Thurloe, tasked with opening and resealing letters, copying and on occasion forging contents, and cracking encoded material. It seems that Morland used an offset process for copying, whereby treated damp tissue was pressed against the inked page in order to make copies.<sup>52</sup> (Indeed, I conjecture Morland's was the very process reported to Evelyn by Hartlib above.) Morland may also have employed mechanical devices in his work, as in the Restoration, so he claimed, after having presented several texts of a letter so exactly copied that the original could not be isolated, he displayed in private before Lord Arlington and Charles II 'several modell[s] in little of several engins and utensils', to their great satisfaction. He thereafter established a chamber for opening and copying mail, but lost it in the Great Fire.<sup>53</sup> Even Morland's

wet copier, however, seems soon thereafter to have been forgotten by the public and the government alike. This may have been deliberate: upon his accession and yet more petitions for money from a desperate Morland, William III is said to have commented on Morland's arts that 'he thought the secret ought to die with him, as too dangerous to be encouraged'.<sup>54</sup>

Wren's interest in double writing, too, was to resurface briefly at the Restoration, when he wrote a Latin epigram on the return of Charles II phrased as a conceit on his double writing instrument; this may therefore have been engraved on a resurrected prototype.<sup>55</sup> Intriguingly, when Hooke was informed about a continental scheme for 'printing without press' in 1680, he replied to his foreign correspondent that he had already seen such a contrivance demonstrated by Wren 'about 14 years since'.<sup>56</sup> No account of this has been recovered, but a decade after the supposed demonstration Hooke noted in his diary: 'to Blacklocks coffee house where I discoursd w<sup>th</sup> F Barnard [Francis Barnard, physician and bibliophile] about Printing wood cutts. double writings. S<sup>r</sup> Ch: Wr. way of printing by hobby plate. S<sup>r</sup> W Pettys way by casting in tobacco pipe clay'.<sup>57</sup> What 'hobby plate' is remains obscure, but some kind of engraving in softer metal seems likely. Furthermore, Hooke's revelation about Petty suggests that the latter's secret 'Printery-Invention', dating back to at least 1649, most likely depended on casting in clay, a method that had in fact been developed six centuries previously in Song dynasty China.

Hooke had a broad interest in possible new technologies for printing both images and text, noting in his memoranda many possibilities, from engraving on horn and printing from it using a rolling press, to employing bundled needles in a letter press to make images, and so forth.<sup>58</sup> But after Hooke we do not hear much of double writing instruments until, once again, they were 'invented' by Erasmus Darwin in the 1770s, with his 'bigrapher' and 'polygrapher' devices. A paired original and a perfect copy of a letter executed by Darwin using his own machine survive; but the polygrapher was quickly supplanted, largely through marketing, by James Watt's portable chemical copying press. Once again, mechanical and chemical methods of duplication were vying for either the technological or the economic edge, and we can now appreciate that both Darwin and Watt's inventions were really reinventions.<sup>59</sup>

It is not known for sure how Paschall came across these earlier schemes, but references to Petty's scheme were available in print. Hooke himself, as mentioned, was fleetingly interested in 'double writing', as we find it mentioned in his diary for 2 January 1674, and then again on 19 November 1676. But Hooke's references explicitly to 'double writing' lie in time just before, and then somewhat after, the letter recovered here. Perhaps then we should suppose that Paschall had picked up talk of such an instrument during his time at Cambridge, where he had been a student and a don between 1647 and 1663. As we have seen, there were many pretenders to the invention, in Oxford, Cambridge, and London. At any rate, the double writing machine does not, for once, appear to have been a topic of interest in the meetings of the early Royal Society. Nor do Paschall's lines in the real character get us very far, technologically speaking: he too proposed a system based on fixed pens in some kind of frame, as Scheiner had done two generations before him, but further detail is not forthcoming. Whether the sample Paschall actually provided is genuine is also open to debate, although we might give Paschall the benefit of the doubt.<sup>60</sup> What this indicates is that, once again, many people were and are capable of either producing or repeating similar inventions; the real challenge is often one not of concept, but of engineering.

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<sup>1</sup> The two essential accounts are Vivian Salmon, 'John Wilkins' *Essay* (1668): critics and continuators', *Historiographia Linguistica* 1, 147-63 (1974); Rhodri Lewis, 'The efforts of the Aubrey correspondence group to revise John Wilkins's *Essay* (1668) and their context', *Historiographia Linguistica* 28, 333-66 (2001), developed in his *Language, Mind and Nature: Artificial Languages in England from Bacon to Locke* (Cambridge University Press, Cambridge, 2007), pp. 200-21. For a summary see William Poole, *John Aubrey and the Advancement of Learning* (The Bodleian Library, Oxford, 2010), pp. 54-61.

<sup>2</sup> John Wilkins, *An Essay Towards a Real Character, and a Philosophical Language* (Samuel Gellibrand and John Martyn, London, 1668), pp. 395-413 (real character), 421-34 (phonetic script).

<sup>3</sup> It is now Bodleian Library, Oxford, Savile A 4, letters edited in *The Correspondence of John Wallis. Volume II (1660-September 1668)*, ed. Philip Beeley and Christoph J. Scriba (Oxford University Press, Oxford, 2005), letters 212, 215. Wallis's reading notes, also tipped into the front of this volume, and his corrections to the errata on sig. d2r, show how closely he checked, and corrected, both Wilkins's phonetic script and his characters.

<sup>4</sup> Robert Hooke, *A Description of Helioscopes and Some Other Instruments* (John Martyn, London, 1676), Tabula III. We can date the composition of this text from Hooke's earlier diary; the same source also tracks the printing and publishing of *Helioscopes*, which, despite the proleptic imprint, was ready to be distributed to friends including Francis Lodwick, Sir Christopher Wren, and Robert Boyle, by 12 October 1675. See H. W. Robinson and W. Adams, eds., *The Diary of Robert Hooke M.A., M.D., F.R.S. 1672-1680* (Taylor and Francis, London, 1935); a much improved edition of these 'memoranda' by Felicity Henderson is in preparation.

<sup>5</sup> *The Correspondence of John Flamsteed*, ed. Eric G. Forbes, Lesley Mordin, and Frances Willmoth, 3 vols. (Institute of Physics, Bristol, 1995-2002), vol. 1, pp. 380 (Flamsteed to Towneley, 15 November 1675), 383 (Towneley to Flamsteed, 24 November 1675); Hooke, memoranda for 9 December 1675.

<sup>6</sup> Bodleian Library, Oxford, MS Eng. d 3537, fol. 23r.

<sup>7</sup> George Dalgarno, *Ars signorum* (for the author, London, 1661), pp. 125-26 (see also the edition of David Cram and Jaap Maat, *George Dalgarno on Universal Language* (Oxford University Press, Oxford, 2001), pp. 285-89).

<sup>8</sup> Bodleian Library, Oxford, MS Aubrey 13, fol. 105r, letter of 15 October 1676. This is Pigot's first surviving letter to Aubrey, but he refers to one prior, now lost.

<sup>9</sup> MS Aubrey 13, fol. 106r, Pigot to Aubrey 28 December 1676.

<sup>10</sup> Their earliest and latest surviving letters are dated 18 April 1672 and 2 June 1693 respectively (MS Aubrey 13, fols. 49-51, 85).

<sup>11</sup> MS Aubrey 13, fol. 15r, letter of 13 February 1676[/7]. This letter opens by stating it is a response to a prior letter in the character, perhaps one by Pigot or Lodwick.

<sup>12</sup> MS Aubrey 13, fol. 107r, letter of Pigot to Aubrey, 24 March 1677.

<sup>13</sup> A. J. Turner, 'Andrew Paschall's tables of plants for the universal language, 1678', *Bodleian Library Record* 9, 346-50 (1978), describing the five tables in Bodleian Library, Oxford, MS Ashmole 1820B, fols. 54r-56v (the address to Aubrey is on fol. 54v, showing that these were all folded together and sent as a letter). For a further contemporary use of Wilkins's botanical classifications, compare Department of Plant Sciences, Oxford, MS Sherard 40, 'Bp Wilkins's division of Plants', compiled by Jacob Bobart the Younger (1641-1719), superintendent to the Oxford Physic Garden from 1680, equivalent to a complete tabular reduction of Wilkins, *Essay*, pp. 70-120. The published tables of plants, as of animals, were in fact drawn up for Wilkins by John Ray.

<sup>14</sup> The first printing of Wilkins's *Essay* was a victim of the Great Fire, although accounts conflict concerning what and how much was lost (Wilkins, *Essay*, sig. a1r; John Wallis, *A Defence of the Royal Society* (Thomas Moore, London, 1678), p. 12; Wilkins to John Ray, 20 October 1666, in William Derham, ed., *Philosophical Letters* (William and John Innys, London, 1718), p. 366, this last likely the most reliable testimony). The sheets in MS Ashmole 1820B, however, cannot derive from either the lost or surviving printing, as they consist of the tables from Wilkins's Part IV, which all accounts agree was not in type by the time the Fire, and present both the classifications and their accompanying real characters, all engraved; whereas the printed text presents only the classifications, set in type, and no characters. Paschall was certainly on the hunt for some materials still in the hands of Wilkins's printers, for as he wrote to Aubrey on 8 September 1676, 'I thanke you for the information you gave me of the sheets at Mr Gellibrands [one of the printers of the *Essay*], I never heard of it, & purpose to send for it by the next' (MS Aubrey 13, fol. 10r; see further Rhodri Lewis, 'The publication of John Wilkins's *Essay* (1668): some contextual considerations', *Notes and Records of the Royal Society of London* 56, 133-46 (2002), at p. 144, n. 22, for some other suggestions on these 'sheets'). It is just possible that the MS Ashmole 1820B engravings are those 'sheets', perhaps an early attempt to improve on the typeset tables; or, as I suspect, they represent a later initiative of the revision group. Their archival context strongly suggests a provenance through either of both Aubrey and Paschall.

<sup>15</sup> MS Aubrey 13, fol. 135r ('stans pede in uno'); MS Aubrey 13, fol. 100r, Petty to Aubrey, 29 May 1678; Francis Lodwick, *Writings on Language, Theology, and Utopia*, ed. Felicity Henderson and William Poole (Oxford University Press, Oxford, 2011), p. 59.

<sup>16</sup> Letters of 30 September 1681 and 9 August 1682, edited in Lodwick, *Writings on Language*, pp. 315-20, with the use of Paschall's phonetic table in MS Aubrey 13, fol. 57r. For Paschall's phonetics see Lewis, *Language, Mind and Nature*, pp. 218-20, where Paschall's table for his phonetic script is also reproduced. A remark at the bottom of another of Paschall's papers, MS Ashmole 1820B, fol. 16r, is also ciphered in this script.

<sup>17</sup> Their next surviving letter, from Hooke to Paschall, is only from 1 March 1679 (Royal Society, EL/H3/61); their last, from Paschall to Hooke, is dated 21 February 1680 (Royal Society, EL/P1/57). The gap between this and the 1679 letter is explained by the fact that Paschall corresponded very regularly with John Aubrey, who was lodging with Hooke, and their letters were shared. Paschall first appears in Hooke's memoranda on 15 April 1676, when he 'Met aubrey in feilds & saw cataloge of Fosters manuscripts from Mr. Paschall'. Then see Hooke's entries for 25 May 1678 (Paschall to Lodwick, and his response, read); 15 June 1678 (Paschall to Hoskins, read out by Lodwick); 2, 7, 8 April 1679 (Paschall visits London); 10 January 1681 (letter from Paschall); 24 June, 3 July 1689 (letters of Paschall to Lodwick).

<sup>18</sup> Hooke, *Helioscopes*, pp. 30-1.

<sup>19</sup> See especially Hooke's memoranda for 21 December 1677: 'I told my way of Regulating y<sup>e</sup> English to make it a vniuersall Language'. He got as far as discussing the printing of his 'naturall grammar' (also the title of the third part of Wilkins's *Essay*) with the Dutch printer Steven Swart in 1678: see British Library, London, MS Sloane 4062, fol. 191r, letter of Swart to Hooke, 28 June 1678: 'm<sup>r</sup> Wasberg [the publisher Joannes Janssonius van Waesberge] Has wel a mind to print your naturall grammer, but Hee begs of you to send Him over a ½ sheet of Wilkins Reall Karakter whaer in aer some Carakters for Hee seposes that som Carakters must bee Cut to such a book'. See also Lewis, *Language, Mind and Nature*, p. 211. Hooke's remarks on Chinese can be found in 'Some Observations, and Conjectures concerning the Chinese Characters', *Philosophical Transactions* 16, 63-78 (1686-1692), discussed in William Poole, 'Vossius, Hooke, and the early Royal Society's Use of Sinology', in *The Intellectual Consequences of Religious Heterodoxy 1600-1750*, ed. John Robertson and Sarah Mortimer (Brill, Leiden, 2012), pp. 135-53.

<sup>20</sup> Wilkins actually presented a second potentially universal phonetic script (*Essay*, pp. 378-80), but this did not attract Paschall's attention and may be passed over here.

<sup>21</sup> Wilkins, *Essay*, pp. 357-83. For Wilkins's phonetics, see E. J. Dobson, *English Pronunciation 1500-1700*, 2 vols. (Clarendon Press, Oxford, 1968), pp. 253-61.

<sup>22</sup> Wilkins, *Essay*, pp. 385-442.

<sup>23</sup> tw] MS: tw ~~or they~~

<sup>24</sup> The translations of both these sentence are problematic in detail, although the gist is clear. In particular, the imperative verb that commences the second sentence does not correspond to anything obviously congruous to the assumed meaning in Wilkins's tables.

<sup>25</sup> dhe learnyng af dhys] MS: \dhe learnyng af dhys/

<sup>26</sup> This passage responds to Hooke's injunction in *Helioscopes*, p. 31: 'And I have this further to desire of my Reader, who will be at pains to decipher and understand this description, that he would only make use of it for his own information, and not communicate the explication thereof to any that hath not had the same curiosity with himself'.

<sup>27</sup> iz] MS: is \z/ (and likewise immediately below)

<sup>28</sup> This paired phrase, evidently to persuade Hooke of the viability of Paschall's machine, is written perpendicular on the verso facing the letter text.

<sup>29</sup> Christoph Scheiner, *Pantographice, seu Ars delineandi res quaslibet per parallelogrammum lineare seu curvum, mechanicum, mobile* (Ludovicus Grignanus, Rome, 1631). On p. 3 Scheiner dates his invention to 1603, when he was at Dillingen. We might note that there were two copies of this publication in the Bodleian by the time of Thomas Hyde's 1674 catalogue of printed books; one is among the books of the scholar John Selden, and bears his motto. There is also a copy in the Royal Society's library.

<sup>30</sup> University of Sheffield, Hartlib Papers (available through <https://www.hrionline.ac.uk/hartlib/>), 1/33/23B (Kinner to Hartlib, 9 April 1648). Compare Hartlib's negative comment on Scheiner, made at probably this time, in his diary or 'Ephemerides' (31/22/1A).

<sup>31</sup> Hartlib Papers, 8/31/1A-3A (also edited in *The Letters of Sir Cheney Culpeper, 1641-1657*, ed. M. J. Braddick and Mark Greengrass, Camden Miscellany, 5<sup>th</sup> ser., vol. 7 (1996), pp. 320-21), letter of 25 January 1647/[8].

<sup>32</sup> Hartlib Papers, 71/7/3A-4B (testimonial, 27 December 1647); *The Advice of W. P.* (Samuel Hartlib, London, 1647), sig. A3r, and p. 5; *A Declaration Concerning the Newly Invented Art of Double Writing* (Samuel Hartlib, London, 1648), copy at Hartlib Papers, 71/7/1. Hartlib Papers 8/29/1A, a letter of Charles Cavendish in Paris to William Petty of 17 April 1648, shows that Cavendish acquainted the philosopher Thomas Hobbes with Petty's plans too. See further Charles Webster, *The Great Instauration: Science, Medicine*

and Reform, 1626–1660, 2<sup>nd</sup> ed. (Peter Lang, Oxford, 2002), pp. 164, 219, 377; Ted McCormick, *William Petty and the Ambitions of Political Arithmetic* (Oxford University Press, Oxford, 2009), pp. 58–60. An undated and anonymous proposal retained by Hartlib on ‘The nature & uses of *the* double writing Instrument’ (Hartlib Papers, 71/7/2A-B) may be, but is not certainly, associated with Petty’s scheme. Circumstantial evidence in favour of the connection is the presence of a copy in Boyle’s papers (Royal Society, Boyle Papers, vol. 37, fol. 108). Bundle 71 of the Hartlib Papers, it will be noticed, contains many of the schemes discussed here, as well as several papers on making ink.

<sup>33</sup> Hartlib to Boyle, 8 or 9 May 1654 (*The Correspondence of Robert Boyle*, ed. Michael Hunter, Antonio Clericuzio, and Lawrence Principe, 6 vols. (Pickering and Chatto, London, 2001), vol. 1, p. 178). Compare Hartlib Papers, 71/7/2A-B, an undated and unsigned attempt presumably by Petty and Hartlib to raise money for the machine by a direct taxation on paper. Petty’s letter dedicating his instrument to Boyle is dated 21 June 1648 (*Correspondence of Robert Boyle*, vol. 1, pp. 71–3).

<sup>34</sup> Hartlib Papers, 16/2/3A (G[eorg] H[orn] to Hartlib, 6 February 1652). Compare John Dury to Hartlib, 14 July 1648: ‘in the french letter to Monsieur de Geer [i.e. the Dutch merchant Louis De Geer (1587–1652)] ... I haue acquainted him with the double writing busines (4/1/21A).

<sup>35</sup> Bodleian, MS Aubrey 12, fol. 308r (John Lydall to Aubrey, 27 May 1651); Hartlib Papers, 28/2/49B (Potter), 28/2/78B (Wren). See J. A. Bennett, ‘A Study of *Parentalia*, with two unpublished letters of Sir Christopher Wren’, *Annals of Science* 30, 129–46 (1973), at p. 143, with letter at p. 144–45; J. A. Bennett, *The Mathematical Science of Christopher Wren* (Cambridge University Press, Cambridge, 1982), pp. 18, 114–15; Adrian Tinniswood, *His Invention so Fertile: A Life of Christopher Wren* (Cape, London, 2001), pp. 44–46; C. S. L. Davies, ‘The Youth and Education of Christopher Wren’, *English Historical Review* 123, 300–27 (2008), at p. 315. Lisa Jardine, *On a Grand Scale: The Outstanding Career of Sir Christopher Wren* (HarperCollins, London, 2003), pp. 90–96, is not reliable.

<sup>36</sup> See Stephen Wren, ed., *Parentalia* (T. Osborn and R. Dodsley, London, 1750), pp. 198, 214–16, quotation from p. 215, and Christopher Wren’s two letters to unknown correspondents on the matter, both in British Library, Add. MS 25071, fol. 40 (partially printed in *Parentalia*, 215–16), and fols. 42–3 (printed in Bennett, ‘Parentalia’, 144–5).

<sup>37</sup> Bennett, ‘Parentalia’, p. 144.

<sup>38</sup> Petty to Hartlib, 1 March 1653 (Osborn Collection, Beinecke Rare Book and Manuscript Library, Yale University, Document 24, available through the Hartlib Papers Online). For another example of Cromwell pursuing a technological secret, this time a system of telegraphy, see William Poole, ‘Nuncius Inanimatus: Telegraphy and Paradox in the Seventeenth Century: the Schemes of Francis Godwin and Henry Reynolds’, *The Seventeenth Century* 21, 45–71 (2006), at p. 63.

<sup>39</sup> Hartlib Papers 28/2/67A (Greatorrex); 29/4/28A (Thurloe).

<sup>40</sup> Hartlib Papers, 28/2/4B.

<sup>41</sup> Hartlib Papers, 28/2/81A.

<sup>42</sup> Hartlib Papers, 29/4/30B.

<sup>43</sup> Hartlib Papers, 29/5/13A.

<sup>44</sup> Hartlib Papers, 29/5/47A (Ephemerides, September 1655).

<sup>45</sup> Hartlib Papers, 29/5/21A, information from John Worthington, the master of Jesus College, Cambridge.

<sup>46</sup> Hartlib to Boyle, 8 or 9 May 1654 (Boyle, *Correspondence*, vol. 1, p. 178). All previous commentators have assumed Hartlib’s criticism was directed towards Petty. The grammar of this passage is ambiguous, however, on the matter of whether Hartlib means Petty or Wren’s contrivance, but compare the almost exact phrasing of Hartlib’s unambiguous note from Potter in the Ephemerides (Hartlib Papers, 29/4/10A): ‘Greattrick will not give a rush for Wrens [sic] double writing, it being not practicable or of daily vse. Mr Potter’.

<sup>47</sup> Hartlib Papers, 29/2/28A.

<sup>48</sup> Hartlib Papers, 71/8A-B. See Hooke’s memoranda for 13, 14, and 15 March 1679, e.g. ‘S<sup>r</sup> J. Hosk. told him my contrivance for tinplates for Rolling presse. & my method for printing books’.

<sup>49</sup> Hartlib Papers, 28/1/29A. From as far away as Antwerp and as late as 1658, Henry Oldenburg wrote to Hartlib that ‘I am told here’ about Petty’s portable copying instrument, asking for further information (Hartlib papers, 39/3/16A, letter of 18 July 1658).

<sup>50</sup> John Evelyn, *Diary*, ed. E. S. de Beer. 6 vols. (Clarendon Press, Oxford, 1955), under 27 November 1655. A later letter at Hartlib Papers 33/1/9A suggests that a rolling press might have been required too.

<sup>51</sup> Hartlib Papers, 8/31/4; copy at 71/1/1A–4B. Francis Bacon, *Of the Advancement and Proficiency of Learning*, tr. Gilbert Watts (Robert Young and Edward Forrest, London, 1640), pp. 258–60, and see Lodwick, *Writings on Language*, pp. 19–23, for the influence of this passage of Bacon on Hartlib and his contacts.

<sup>52</sup> H. W. Dickinson, *Sir Samuel Morland, Diplomat and Inventor* (The Newcomen Society, Cambridge, 1970), pp. 95–100. The contrivance of Morland that has attracted the most modern attention is his calculating machine, for which see most recently Matthew L. Jones, *Reckoning with Matter: Calculating Machines*,

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*Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago University Press, Chicago, 2016), pp. 16-31.

<sup>53</sup> Historical Manuscripts Commission [HMC], *Report ... Finch. Vol. II* (HMSO, London, 1922), p. 265, 'Sir Samuel Morland's proposals for secret service'; Dickinson, *Sir Samuel Morland*, p. 98. We can associate with these interests Morland's publication in 1666 of a *New Method in Cryptography*. This was actually quite a conventional wheel cipher, and yet Morland appears to have tried to have the whole impression of 500 copies made at public expense, as a bill was submitted to the government; vanishingly few copies of the book survive (The National Archives, State Papers 29/230, fol. 82r; ESTC only records two copies). Dickinson, *Morland*, p. 34, confidently assumes that Morland's bill was honoured.

<sup>54</sup> HMC, *Report ... Buccleuch ... Whitehall. Vol. II* (HMSO, London, 1903), p. 51.

<sup>55</sup> Wren, *Parentalia*, p. 214.

<sup>56</sup> Hooke to Henri Justel, 10 August 1680 (MS Sloane 1039, fol. 174r), a reply to Justel to Hooke, 13 June 1680 (Royal Society, Letter Book, vol. 8, pp. 119-21), where it is explained that the continental inventor was Christian Adolf Balduin of Dresden, more often associated with phosphorus.

<sup>57</sup> Hooke, memoranda for 19 September 1676.

<sup>58</sup> See, in addition to Hooke's idea on printing from tin plates discussed above, e.g. Hooke's memoranda for 4 December 1672, page following (engraving in horn), 3 January 1673 (where it is interestingly claimed that the illustrations to John Wilkins's *Mercury* (1641) were printed using engraved horn), 27 January 1673 (John Pell advises on a way of making printing by carving blocks from salley (i.e. willow) and enlarging them by soaking), 29 June 1674 (printing images in a letterpress by 'pinns'), 6 January 1675 (how to copy prints). Hooke and Wren even debated how best to publish an accurate facsimile of the famous biblical Codex Alexandrinus—by engraving, or by woodblock? (7 September 1678, 'the Alexandrian Bible of Tecla').

<sup>59</sup> Desmond King-Hele, *Erasmus Darwin: A Life of Unequalled Achievement* (de la Mare, London, 1999), pp. 151-55. See plate 9 opposite p. 246 for Darwin's copied letter, 'probably the earliest mechanical copy of a document'—with, now, Paschall's postscript as a possible precursor. For the mysterious device of Henry Mill, who was granted a patent in 1714 for 'an artificial machine or method for the impressing or transcribing of letters singly or progressively', see Michael H. Adler, *The Writing Machine* (George Allen & Unwin, London, 1973), pp. 47-8.

<sup>60</sup> We may note the seeming discrepancies between the two lines in, for instance, the spacing between the characters of the penultimate word, and the width of the final character. But the ink tone of the lower (presumably mechanically reproduced) line is consistent, and slight variations in graphs might result from looseness in the instrument itself.