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'To mend the scheme of Providence': Benjamin Franklin's electrical heterodoxy

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Abstract. I suggest in this article that Benjamin Franklin's electrical experiments were naturalistic and reactive towards providential theories of natural harmony and electricity provided by the English experimentalists Stephen Hales, William Watson and Benjamin Wilson. Conceptualizing nature as a divine balance, Franklin rejected English arguments for God's conservation of nature's harmony, suggesting instead that nature had within itself the ability to re-equilibrate when rendered unbalanced. Whilst Franklin's work reveals an experimentally defined fissure between providential and naturalistic views of matter and motion in the mid-eighteenth century, his subsequent reflections on the use of natural philosophy sheds light on the divergent trajectory of utility implicit in these differing views. Hales and Watson in particular believed that insight into nature's providential manifestations gave the natural philosopher a medically restorative role, aligning the power of nature with God's benevolent purpose to heal the infirm. For Franklin, humanity behaved like nature, moving only when necessary. Natural philosophy existed to help these needs, making new worlds that had no dependence on God.

On 12 April 1753 Benjamin Franklin – Philadelphian printer, politician, wit and increasingly famous natural philosopher – wrote a fiery letter to his friend and New York governor Cadwallader Colden complaining of European disdain. 'I see it is not without Reluctance that Europeans will allow that they can possibly receive any instruction from us Americans.' Franklin was referring to the latest French trials of his lightning rod and how the Abbé Nollet, one of the foremost commentators, doubted its protection. Franklin surmised that Nollet had just given in to popular fear:

> He seems to apply to the superstitious Prejudices of the Populace, which I think unworthy of a Philosopher. He speaks as if he thought it Presumption in Man, to propose guarding himself against the *Thunders of Heaven*! Surely the Thunder of Heaven is no more supernatural than the Rain, Hail, or Sunshine of Heaven, against the Inconveniences of which we guard by Roofs and Shades without Scruple![1]

Contrasting Nollet's populism to his own philosophical sobriety, Franklin claimed that despite his notable finding that sometimes it is 'Lightning from Earth that Strikes the Cloud', his lightning rods would continue to work: the 'Methods propos'd for *Practice*, to guard against the Mischiefs of Lightning, they remain the same'.

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1 Franklin to C. Colden, 12 April 1753, in L.W. Labaree (ed.), *The Papers of Benjamin Franklin*, New Haven: Yale University Press, 40 vols., 1959–2011, vol. 4, 1961, pp. 463–464.

Franklin was not finished. After further complaining 'it is expected that I should answer Mons. Nollet', Franklin turned his attention to Colden's recent work on gravity, *An Explication of the First Causes of Action in Matter*, and penned 'the Objections I have to your book'. Principally, Franklin could not understand Colden's support for *vis inertiae*, Newton's principle within matter that resisted mechanical change:

> I cannot, after long considering the Point, persuade my self [*sic*] that there is in Matter any such Principle as is imagined under the Term *Vis Inertia* [*sic*]. I even conceit that the contrary may be demonstrated, ie. That Matter gives no Resistance to Motion.

Franklin's complaint against Nollet's superstition was one of the many quips lauded later by French *philosophes*, where the Enlightened Franklin battled courageously against popular ignorance. Franklin's rejection of *vis inertiae*, on the other hand, went unnoticed. This is unsurprising as lightning rods dispelling superstition had greater practical value to later propagandists than Franklin's theoretical musings on the activity of matter. It is notable, however, that the issue of *vis inertiae* and the activity of matter not only took up much of Franklin's private correspondence with Colden, but informed Franklin's earlier, theoretical works on God and nature's motion. It is also noteworthy that Franklin had confided in a recent letter to Colden that 'it is well we are not, as poor Galileo was, subject to the Inquisition for *Philosophical Heresy*. My whispers against the orthodox doctrine, in private letters, would be dangerous'.[2]

If Franklin's lightning work was already known and critiqued by the likes of Nollet as dangerously defying orthodox beliefs in God's judgment, what was this philosophical heresy that he whispered? This article argues that Franklin's heresy was not just his dismissal of prodigal readings of nature, but his conscious subversion of the providential modes of explanation embedded in contemporary natural philosophy. In his pre-lightning electrical experiments, Franklin opposed the English insistence that electricity was the physical manifestation of God's continued creative act, suggesting instead that the world worked according to rules of balance that required no divine conservation. Building on recent work done by Jerry Weinberger, who in his *Benjamin Franklin Unmasked* (2005) claims that 'his philosophy culminated in the critique of morality and religion', I explore the view that Franklin's partitioning of natural philosophy and providence, a direct response to a new alignment between the forces of nature and God offered by English experimentalists like Benjamin Wilson and William Watson, generated a secularist Franklinian 'relief of man's estate'.[3] Indeed, Franklin's understanding of natural philosophy's purpose as secularizing and directed toward mundane human needs will be shown to be divergent from Watson's own view that natural philosophy restored man's relationship with God. This in turn suggests the need for analytical care when aligning natural-philosophical endeavour and terms such as

2 Franklin to Colden, 23 April 1752, in Benjamin Franklin, *Experiments and Observations on Electricity*, 5th edn, London: Printed for F. Newbery, 1774, pp. 274, 275.

3 Jerry Weinberger, *Benjamin Franklin Unmasked: On the Unity of His Moral, Religious, and Political Thought*, Lawrence: University Press of Kansas, 2005, pp. 254, 255, 288.

'improvement' when it is precisely the relevant mode of 'improvement' which was at issue with respect to natural philosophy.

My placement of Franklin in a transatlantic context complements recent work by Joyce Chaplin, James Delbourgo and Nick Wrightson, all of whom have emphasized the interrelationship between Franklin's science and the English community.[4] At the same time, I illuminate how his youthful disdain for natural theology dovetailed with his electrical work to place Franklin as reactionary to the providentialism of English natural philosophy. Delbourgo's very readable *A Most Amazing Scene of Wonders* (2005) has helped focus this argument, placing Franklin at the centre of a reactive, Romantic American Enlightenment. Delbourgo suggests that Franklinian electricity represented a 'tension between experimental claims to rational knowledge and the persistence of wonder at the surprising powers of the electric fire'. Franklin was keen to catch the eye of the Europeans and yet doubted their trust in the claims of experimental philosophy, and Delbourgo suggests that he conceptualized electricity as a mysterious entity, transcendent of the explanations given by experiment, 'not simply matter in motion but an active power characterized, in almost Aristotelian fashion, by innate tendencies'. In this way, he argues that 'Franklin's electrical cosmos [was] one that dynamically pitted the ambitions of experimental mastery and the rational design of the Creator against a naturalized volatility'.[5]

Whilst one may agree with this view that Franklin's work represents a reactive, possibly naturalistic, position that opposed European views of nature, Delbourgo's diminution of the importance of experiment is confusing given the fairly substantial and convincing work by I. Bernard Cohen and John Heilbron that charted the influences that experimental philosophers like Jean Theophilus Desaguliers, Stephen Hales, Herman Boerhaave and Albrecht von Haller had on Franklin's ideas and experiments.[6] Indeed, part of the burden of this article is to show how Franklin looked to 'the ambitions of experimental mastery' to counter the providentialism of the above European experimenters. John Heilbron has hinted at potential fruit through such an approach, commenting on the similarities between Franklin's deterministic work in 1725, which argued that pain was an imbalance that forced people to seek a return to a former easy state, and his 1747 theory of charge, where an imbalance of electrical charge

4 On the international basis of Franklin's science see Joyce Chaplin, *The First Scientific American: Benjamin Franklin and the Pursuit of Genius*, New York: Basic Books, 2006; James Delbourgo, *A Most Amazing Scene of Wonders*, Cambridge, MA: Harvard University Press, 2005; and Nick Wrightson, '"[Those with] great abilities have not always the best information": how Franklin's trans-Atlantic book-trade and scientific networks interacted, ca. 1730–1757', *Early American Studies* (2010) 8, pp. 94–119. On Franklin's rejection of Christian revelation see A.O. Aldridge, *Benjamin Franklin and Nature's God*, Durham: Duke University Press, 1967; and Kerry Walters, 'Franklin and the question of religion', in Carla Mulford (ed.), *The Cambridge Companion to Benjamin Franklin*, Cambridge: Cambridge University Press, 2008, pp. 91–103.

5 Delbourgo, op. cit. (4), pp. 16, 42, 45–46.

6 See I. Bernard Cohen, *Franklin and Newton: An Inquiry into Speculative Newtonian Experimental Science and Franklin's Work in Electricity as an Example Thereof*, Philadelphia: The American Philosophical Society, 1956; John Heilbron, 'Franklin, Haller, and Franklinist history', *Isis* (1977) 68, pp. 539–549; *idem*, *Electricity in the Seventeenth and Eighteenth Centuries: A Study of Early Modern Physics*, Berkeley: University of California Press, 1979; and I. Bernard Cohen, *Benjamin Franklin's Science*, Cambridge, MA: Harvard University Press, 1990.

in objects caused an electrical snap.[7] However, Heilbron has insisted that these were products of Franklin's internal logic, a point made to confirm Heilbron's questionable claim that electrical experimentation in general 'was theologically and cosmologically neutral'.[8]

Indeed, my alignment between Franklin's experiments and his naturalism builds on the historiography that has challenged Heilbron's view. Historians like Simon Schaffer and Paola Bertucci have emphasized that natural philosophy and particularly English electrical experimentation in the 1740s were embedded deeply in providential discourse; electricity as a manifestation of God's activity was a contested commodity fought over by Whigs, Tories, Christian evangelists and mystical pietists.[9] Whilst, as Simon Schaffer has argued, these contests were over social status and prestige, representing how 'measurement and calculation defend and propagate a value system at the expense of others', electrical discourse represented also what Mordechai Feingold has called 'the Newtonian Moment', the self-conscious fashioning of one's natural philosophy as an extension of Newton's own work.[10] Personal prestige, theology and the Newtonian legacy were not unconnected. As Schaffer argued almost thirty years ago, Newton so clearly aligned his *Opticks* queries of nature's 'active power' with God's continued providence that 'any critique of such a conception of natural philosophy would engage it at the point of generation of apparently divine powers, and any *exposition* of such practices would affirm the importance of these powers and their status'.[11] To declare a position on a Newtonian topic like electricity, one engaged a zero-sum game, either assenting to providential matter theory or offering evidence as to how matter might be self-acting.

Perhaps one of the major reasons why historians have eschewed connecting Franklin's religious heterodoxy with his science was that Franklin did not openly dissent from an ingrained perception of Newton's authority in his electrical letters. Joyce Chaplin has suggested that Franklin always retained the public-appeal ethos of his printing background: 'knowing that his success as a printer depended on appealing to all[,] his

7 See John Heilbron, *Elements of Early Modern Physics*, Berkeley: University of California Press, 1982, pp. 190, 193, 240.

8 Heilbron, *Electricity in the Seventeenth and Eighteenth Centuries*, op. cit. (6), p. 2. See *idem*, 'Plus and minus: Franklin's zero-sum way of thinking', *Proceedings of the American Philosophical Society* (2006) 150, pp. 607–617.

9 See Paola Bertucci, 'The electrical body of knowledge: medical electricity and experimental knowledge in the mid-eighteenth century', in Paola Bertucci and Guiliano Pancali (eds.), *Electric Bodies: Episodes in the History of Medical Electricity*, Bologna: Università di Bolgna, 2001, pp. 43–68; *idem*, 'Revealing sparks: John Wesley and the religious utility of electrical healing', *BJHS* (2006) 39, pp. 341–362; Patricia Fara, *An Entertainment for Angels: Electricity in the Enlightenment*, Cambridge: Icon Books, 2002; and Bernadette Bensaude-Vincent and Christine Blondel, *Science and Spectacle in the European Enlightenment*, Aldershot: Ashgate, 2008.

10 Simon Schaffer, 'A social history of plausibility: country, city and calculation in Augustan Britain', in Adrian Wilson (ed.), *Rethinking Social History: English Society 1570–1920*, Manchester: Manchester University Press, 1993, p. 141; Mordechai Feingold, *The Newtonian Moment: Isaac Newton and the Making of Modern Culture*, Oxford: Oxford University Press, 2004.

11 Simon Schaffer, 'Natural philosophy and public spectacle in the eighteenth century', *History of Science* (1983) 21, pp. 1–43, 4.

ruthless self-discipline . . . would eventually affect the way in which he framed his claims in natural philosophy'.[12] Indeed, the collection of Franklin's electrical papers printed in 1751 was ultimately entitled *Experiments and Observations*, a quotation from the *Opticks* and yet another indication that Franklin was engaging the Newtonian moment. In fact, Franklin's title was the same used by the foremost English electrician, William Watson, who had published his own *Experiments and Observations* in 1745.[13]

As we analyse Watson's openly providential *Experiments and Observations*, however, not only does the technicality of providential readings of nature in England become clearer, but in these technicalities we find a measurement by which Franklin's own work can be judged. Simon Schaffer has argued that Watson was foremost amongst a new generation of Newtonian natural philosophers who married electricity, God's special providence and social status, combining 'natural theology and practical showmanship'.[14] Both Schaffer and Paola Bertucci have illustrated how Watson 'spent much energy on discriminating reliable natural philosophy from deception', not just through grand public demonstrations in front of royalty but by using his position as Royal Society reviewer actively to censor works of dubious quality such as the 1744 Italian claims that electricity had vital healing qualities, claims that nonetheless Watson himself would make over twenty years later.[15] Bertucci concludes that such inconsistency suggested Watson was seeking to be an 'authoritative arbiter in the assessment of controversial claims', working carefully over the years to integrate natural philosophy and medicine.

Assessing Watson's earliest electrical work of 1745 to 1746 we find him arbitrating not just disciplinary but natural-philosophical boundaries over matter's relationship to motion, a discussion that involved not just his competitor Benjamin Wilson but the ageing Stephen Hales. By arguing that electricity was an elemental fire, Watson purposefully opposed Wilson's and Hales's chemicalist understanding of electricity as a manifestation of air or aether. Despite this allegiance to Boerhaave, however, Watson maintained the providential *sine qua non* essential for any affirmation of Newtonianism. By using experiments on conduction to show how electricity was always separate from ordinary matter, Watson created an ontological separation between matter and the organizational capacity supplied by electricity. As he asked rhetorically in 1746, 'have we not found and separated it from water, flame, even that intense one of oil of turpentine, smoke, red-hot iron, and from a mixture thirty degrees colder than the freezing point?'[16] In this respect, electricity was experimentally verifiable as a divine fire, a product of God's direction of creation.

12 Joyce Chaplin, 'Benjamin Franklin's natural philosophy', in Mulford, op. cit. (4), pp. 63–76, 65.

13 See Isaac Newton, *Opticks*, 2nd edn, London: W. and J. Innys, 1718, p. 380.

14 Simon Schaffer, 'The consuming flame: electrical showmen and Tory mystics in the world of goods', in John Brewer and Roy Porter (eds.), *Consumption and the World of Goods*, London: Routledge, 1993, pp. 489–526, 497. For Watson's life see R. Pulteney, *Historical and Biographical Sketches*, vol. 2, London: T. Cadell, 1790, pp. 295–340.

15 See Schaffer, op. cit. (11), p. 13; and Bertucci, 'The electrical body of knowledge', op. cit. (9), p. 67.

16 William Watson, *A Sequel to the Experiments and Observations*, London: C. Davis, 1746, pp. 71–72.

Franklin's famous letters of 1747 may be instructively read as responsive to Watson's elemental fire: they show how experiment actually excised providence from electrical discussion. Franklin's findings suggested less a moving entity apart from matter than a shifting relationship between particles of matter. Far from being the sustaining force that represented God's conserving fiat, electrical snaps were part of nature's own rebalancing. As Franklin sent later letters, he became bolder and suggested that matter, and particularly glass, was not inert but contained active principles that were manifested when the balance of nature was shifted. Experiment revealed nature's latent force, illuminating 'the power to reside in glass as glass, and that the non-electrics in contact served only, like the armature of a loadstone [*sic*] to unite the force of the several parts, and bring them at once to any point desired'.[17] Watson's denunciation of Franklin's glass experiments between 1749 and 1751 and his contrary emphasis on a freely moving electrical entity through all bodies indicates a debate taking place between a providentialist and a sceptic, arbitrated by experimental apparatus.

The final sections suggest that by placing the work of Watson and Franklin within an analysis focused upon the role of providence, we can distinguish their views on the purpose of natural philosophy. Watson believed, like Hales, in the restorative value of science, where God's providence was elevated from one of natural conservation to one of healing, which 'recalled the radical distance of the divine' that Franklinist theory advocated.[18] For Franklin, there was no distance from the divine to recall: natural philosophy served to make new worlds to meet the intrinsic human desire for ease and betterment. Natural philosophy could 'mend the scheme of Providence' both in disproving the accepted interface between God and nature and in shifting nature for our own purposes, with no obligation to God.[19]

Providence and experiment, 1727–1746

In order fully to frame Franklin's experimental dissolution of the relationship between natural philosophy and providence, the particular English arguments he engaged must be reassessed in terms of their conceptualization of electricity and matter. Simon Schaffer has illustrated the complex socio-theological framework sustaining English electrical discussion, where 'electrical shows displayed the effects of some divinely generated active power'.[20] An outstanding issue remains as to how exactly God's power was manifested in experiment and how this informed divergent conceptions of providence. I suggest that two general scenarios were advocated by the leading experimenters Benjamin Wilson and William Watson. On one hand, Wilson adhered to a chemicalist theory of electricity as part of an atmospheric chaos. This required a concurrent providence that sustained

17 Franklin to Peter Collinson, 29 April 1749 (hereafter Letter IV), in Bernard Cohen, *Benjamin Franklin's Experiments*, Cambridge, MA: Harvard University Press, 1941, p. 192.

18 Charly Coleman, 'Resacralizing the world: the fate of secularization in Enlightenment historiography', *Journal of Modern History* (2010) 82, pp. 368–395, 395.

19 Franklin to Peter Collinson, 9 May 1753, in Labaree, op. cit. (1), vol. 4, p. 480.

20 See Schaffer, op. cit. (14), p. 496.

matter's motion through space and time. On the other hand, Watson advocated a Boerhaavian elemental fire whose activity suggested a conserving providence, where the initial creative fiat extended through time only.

Wilson's explanation that 'the aether and electric matter are the same' in *Essay towards the Explication of the Phaenomena of Electricity* (1746) resembled an older, chemicalist understanding of electricity where electricity was a localized product of particle friction. In the early 1730s Stephen Hales had suggested that electricity was a product of his chemically ambiguous 'protean air' composed of both repulsive and 'sulphureous' particles. Hales had argued that 'our atmosphere is a *Chaos*, consisting not only of elastic, but also of un-elastic air particles, which great plenty float in it, as well as the sulphureous, saline, watery and earthy particles'.[21] It was the friction of 'a watery fluid' that produced what Hales termed 'Vertue or Electricity' and informed his query on the electrical nature of muscular motion in *Haemastatics* (1733), where rubbing blood particles generated electricity that stimulated muscle movement.[22]

Whilst Wilson shifted electricity conceptually from a product of friction to a product of a universal aether, and thus somewhat distinct from ordinary matter, he still maintained Hales's conviction that electricity was connected to aerial principles; electricity was 'composed of aether, light, and other particles of matter that are of a sulphureous nature' which moved from particle to particle according to different densities.[23] This continuation of an aerial schematic to nature reflected both Hales's and Wilson's conviction that nature's abundance was explicable only through a functional chaos, aerial or electrical, whose infinite movements had to be governed by a concurrent providence, else it descend into destructive chaos. Whilst Hales had argued for God's particular direction, 'whereas were such powers under no guidance, they must necessarily produce a Chaos, instead of that regular and beautiful system of nature which we see', Wilson opted for God's preservation of motion, that 'as matter is in itself inert, the aether must of necessity receive its activity from an infinitely wise, and powerful spirit. This aether … may probably be the great instrument, by which the Almighty directs, governs, and supports the universe.'[24]

William Watson believed that electricity was a Boerhaavian fire that replaced any chemical or aerial schematic of nature. In two chapters of the unauthorized edition of Leiden natural philosopher Herman Boerhaave's lectures *A New Method of Chemistry* (1727), the author had framed nature's dynamic in a similar manner to Hales, through a functional chaos of particles. The crucial difference between them was that Boerhaave's chaos was directed by an elemental fire, for 'if there was no fire, all the bodies in nature

21 Stephen Hales, *Vegetable Staticks*, London: Scientific Book Guild, 1961, p. 179. On Newton's sympathies with this conception of electricity see R.W. Home, 'Newton on electricity and the aether', in Zev Bechler (ed.), *Contemporary Newtonian Research*, Dordrecht: Reidel, 1982, pp. 191–213.

22 Stephen Hales, *Statical Essays, Containing Haemastatics*, vol. 2, London: W. Innys and R. Manby, 1733, pp. 60, 96.

23 Benjamin Wilson, *An Essay towards the Explication of the Phaenomena of Electricity*, London: C. Davis, 1746, pp. vii–viii, 5, 25.

24 Hales, op. cit. (21), pp. 196–197; Benjamin Wilson, *A Treatise on Electricity*, London: Printed by C. Davis, 1750, p. 201.

would fix into one rigid constituent mass. Whence it easily follows, that all operations are perform'd by means of fire'.[25] Watson's support for this elemental fire in both *Experiments and Observations* (1745) and *A Sequel to the Experiments and Observations* (1746) was premised on evidence that electricity travelled through air and thus represented a more elementary particle: 'the electrical aether is much more subtile than common air, and passes to a certain depth through all known bodies'.[26] Electricity existed in fire itself: 'flame conducts the electricity, and does not perceptibly diminish its force'.[27] It passed through 'several glasses at the same time; through any one of which, though ever so thin, air cannot pass. It likewise passes, as I have mentioned before, through all known bodies'.[28] Watson went so far as to set ablaze with electricity a chemical substance like turpentine from which Hales, and most recently Hales's friend Jean Theophilus Desaguliers, had suggested electricity was derived. Watson demonstrated 'that the opinion of those is erroneous, who suppose the electrical effluvia to be of a sulphureous nature'.[29] Electricity operated through and despite any chemical reaction and represented an Ockham's razor that was unavailable to Hales's or Wilson's aerial or aetherial chaos, as one entity rather than infinite combinations could now explain nature's system.

Disagreeing with these chemicalist views of electricity, Watson still based its philosophical supremacy on a providential framework. In response to Desaguliers's suggestion of 1742 that 'electricity is a property of some Bodies', Watson carefully separated electricity from ordinary matter, showing how electricity could never be isolated within any body, especially the glass rods or globes that seemed to generate its effects. In *Experiments and Observations* Watson revealed condensation as the reason behind the 'Capriciousness' of interruptions in electrical experimentation about which Desaguliers complained.[30] Being a 'Conductor of Electricity', water settling on a glass rod used to collect the electric fire could immediately change the experimental dynamic: 'if you only blow through a dry glass Tube, the Moisture from your Breath will cause that Tube to be a Conductor of Electricity'.[31] Water naturally conducted accumulated fire away from the rod, preventing electrical experimentation, and suggested a conduit for electricity: 'what an Extraordinary Effect is this! That a drop of cold Water . . . should be the Medium of Fire and Flame'.[32] When Watson found strong evidence for the universal dispersal of electricity throughout nature in 1746, he expressed pleasure that Desaguliers's suspicions of a special electrical quality of glass were disproven: 'the glass tubes and globes had not the electrical power in themselves, but only served as the first

25 See Herman Boerhaave, *A New Method of Chemistry* (tr. Peter Shaw and Ephraim Chambers), London: printed for J. Osborn and T. Longman, 1727, p. vi. See pp. 277– 299, 301–302.

26 Watson, op. cit. (16), p. 50.

27 William Watson, *Experiments and Observations Tending to Illustrate the Nature and Properties of Electricity*, London: C. Davis, 1745, p. 9.

28 Watson, op. cit. (16), p. 51.

29 Watson, op. cit. (27), p. 9; see Hales, op. cit. (22), pp. 95–96; and Jean Theophilus Desaguliers, *A Dissertation Concerning Electricity*, London: W. Innys, 1742, p. 41.

30 Desaguliers, op. cit. (29), p. 31.

31 Watson, op. cit. (27), pp. 12, 13.

32 Watson, op. cit. (27), p. 37.

movers and determiners of that power'.[33] Even the recent discovery of the Leyden effect, where a charged vial of water both retained and gave a shock, was explained by Watson as a consequence of electricity's peculiar properties being directed through conductors. Like his French counterpart the Abbé Nollet, Watson invoked a 'double flow' of electricity, where it oscillated between prime conductor and the metal contacts on the vial.[34] Again, Watson argued that the crucial component in the phenomena was the water in the vial, suggesting that the glass merely contained the water, which held the charge; any water that built up on the external parts of the glass conducted the charge away.[35]

Watson concluded his *Sequel* by arguing that his electrical conception of Boerhaave's elemental fire was the providential mechanism by which nature moved. As he 'constantly had in view that excellent maxim of Sir *Isaac Newton* … [that] the investigation of difficult things by the method of analysis ought ever to precede the method of composition', Watson could appreciate the need to divorce Newton's theoretical queries of electricity from his advice to experiment and observe:

> Does not the power we are now masters of, of seeing the separation of fire from bodies by motion; and of seeing it restored to them again, even after that motion has ceased; cause us rather to incline to the opinions of *Homberge* [*sic*], *Lemery* the younger, *s'Gravesand* [*sic*], and *Boerhaave*, who held fire to be an original, a distinct, principle, formed by the creator himself; than to those of our illustrious countrymen, *Bacon*, *Boyle* and *Newton*, who conceived it to be mechanically producible from other bodies?[36]

Newtonians were wrong in suggesting that the frictional activity of matter or aether could produce this effect. Rather, the 'separation' and 'restoration' of electricity to bodies indicated that electricity had qualitative differences which prevented any dangerous entanglement between matter and motion.

'The power to reside in glass as glass': Franklin's challenge to Watson

On 28 March 1747, some months after the publication of Watson's *Sequel*, Benjamin Franklin wrote the first of his famous letters to the natural historian Peter Collinson promising new observations on electrical behaviour. As Nick Wrightson has argued, this was the moment where Franklin's burgeoning natural-philosophical interests overlapped with the correspondence networks that he had established as a printer. Franklin had hired recently the journeyman printer David Hall from William Strahan, notable London printer and friend of Collinson.[37] This gave Franklin added financial security as a businessman with fashionable British contacts, which in turn gave him enough

33 Watson, op. cit. (16), p. 31.

34 See Watson, op. cit. (16), pp. 32, 43. On Nollet's concept of electricity see R.W. Home, 'Nollet and Boerhaave: a note on eighteenth-century ideas about electricity and fire', *Annals of Science* (1979) 36, pp. 171–175.

35 Watson, op. cit. (16), pp. 12, 49–50.

36 Watson, op. cit. (16), pp. 72–75, 78. This declaration paraphrases a long footnote describing the philosophical division in the second edition of Peter Shaw's translation of *New Method*; see Boerhaave, *A New Method of Chemistry*, 2nd edn (tr. Peter Shaw), London: T. Longman, 1741, p. 206.

37 Wrightson, op. cit. (4), p. 115.

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credibility to approach Collinson in the autumn of 1746 for the latest equipment and books he needed to carry out his investigations. Collinson supplied him well, as by May 1747 Franklin mentioned notable English electrical works like 'Martin's Electricity & Watson's first Part and Sequel'.[38]

Collinson had provided Franklin with the material resources, but it is clear that Franklin's electrical concepts were constructed and verified upon experimental postulates that opposed the providentialism of Benjamin Wilson and especially William Watson. To do this, Franklin changed the philosophical stakes. Franklin suggested that nature, rather than needing a push from God, operated according to inherent, naturalistic laws of balance and moved only when this balance was disrupted. As John Heilbron suggested, this line of thinking was evident in *Dissertation on Liberty and Necessity* (1725), where Franklin had argued that humanity need not move until afflicted by pain, 'for till we are uneasy in Rest, we can have no Desire to move, and without Desire of moving there can be no voluntary Motion'.[39] This notion may also have been of Mandevillian provenance: Franklin spent much of his first trip to London in 1725 chatting with Mandeville, 'a most facetious entertaining Companion'.[40] Towards the end of *The Fable of the Bees* (1714), Mandeville had pointed out that the providential harmony argued by the Newtonians did not match human experience in the world, where all elements, flora and fauna conspired to kill the most virtuous Christian:

> There is nothing Good in all the Universe to the best-designing Man, if either through Mistake or Ignorance he commits the least Failing in the Use of it; there is no Innocence or Integrity that can protect a Man from a thousand Mischiefs that surround him: On the contrary every thing is Evil, which Art and Experience have not taught us to turn into a Blessing.[41]

Human industry was not a reflection of its blessed position in the divine order, but was a response to humanity's needs and desires in a Creation which was less than fully disposed to meet those needs. Franklin's supplement to Mandeville came first of all in his *Dissertation*, where pain was not just an unfortunate circumstance that humanity had to overcome, but represented the premise for all animal movement:

> for how necessary a Thing in the Order and Design of the Universe this Pain or Uneasiness is, and how beautiful its Place! Let us suppose it just now banish'd the World entirely, and consider the Consequence of it: All the Animal Creation would immediately stand stock still, exactly in the Posture they were in the Moment Uneasiness departed; not a Limb, not a Finger would henceforth move; we should all be reduc'd to the Condition of Statues, dull and unactive.[42]

Franklin subverted the claim, found for instance in the 1705 Boyle Lectures of Samuel Clarke, that humans flourished less as they turned away from God's direction and

38 Franklin to Collinson, 25 May 1747, in Cohen, op. cit. (17), p. 178.

39 Benjamin Franklin, *Dissertation on Liberty and Necessity* (1725), in Labaree, op. cit. (1), vol. 1, p. 64. Hereafter *Dissertation*.

40 Benjamin Franklin, *The Autobiography*, in *The Autobiography and Other Writings* (ed. A. Houston), Cambridge: Cambridge University Press, 2004, pp. 1–142, 35.

41 Bernard Mandeville, *The Fable of the Bees* (ed. F.B. Kaye), Oxford: Clarendon Press, 1924, p. 345.

42 Franklin, *Dissertation*, in Labaree, op. cit. (1), vol. 1, p. 64.

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embraced their 'Self-Will', agreeing instead with Mandeville that humanity's release from Eden represented its true beginning as an artful species.[43] Furthermore, this artful vitality was defined by an internal motion, a desire to escape from this primary pain of existence; any uneasiness 'produces an equal strong *Desire*, the *End* of which is freedom from the *Uneasiness*'.[44] Pleasure derived from this action was not the recovery of divine harmony, but the neutralizing of pain.

Franklin's dismissal of divine harmony is evident in other philosophical musings made through the 1730s, but it was just prior to his electrical experiments performed some twenty years later, in the autumn of 1746, where Franklin extended these principles of natural balance and internal re-equilibrium to cover all types of matter. In this respect he attacked the notion of conserving providence advocated by Hales and Wilson.[45] In a letter reviewing Andrew Baxter's *Nature of the Human Soul* (1733), Franklin went to great pains to show how Newtonian physics itself was not built upon the *vis inertiae* or matter's inherent passivity used by Newtonians to show matter's dependence on God's continued direction and order.[46] In addition to a Spinozist shaft defending thinking matter, that if God had created everything, he must have 'done it out of his own Thinking immaterial Substance . . . if any part of Matter does not at present act and think, 'tis not an Incapacity in its Nature [but] a positive Restraint', Franklin suggested that a continuous divine push was not required for an ever-moving universe that moved according to principles of disequilibrium. Whilst Baxter had claimed that the movement of a mass was directly proportional to the 'Force impressed upon it', Franklin countered that movement was due not to the size of force, but to the duration of force:

> Here I suspect some Mistake creeps in occasioned by the Author's not distinguishing between a *great* Force apply'd *at once*, and a *small* one *continually* apply'd, to a Mass of Matter, in order to move it . . . no Mass of Matter how great soever, but may be moved by any Force how small soever (taking Friction out of the Question) and this small Force continued will in Time bring the Mass to move with any Velocity whatsoever.[47]

Nature did not require a large force for its motion, but could operate by temporally extended small forces. Franklin went on: as Baxter himself had calculated, the motion of nature could never be reduced to zero, so the forces of nature could never be reduced to zero. '[Where] then is the mighty *Vis Inertiae*, and what is its Strength when the greatest assignable Mass of Matter will give way to . . . the least assignable Force?' If nature could never be at rest, and if the smallest of those omnipresent forces could move the largest objects as a resting mosquito could move 'two Globes each equal to the Sun and to one another, exactly equipoised in Jove's Ballance [*sic*]', then it was difficult to see any need

43 Samuel Clarke, *A Discourse concerning the unchangeable Obligations of Natural Religion, and the truth and Certainty of the Christian Religion, in The Works of Samuel Clarke, DD*, vol. 2, London: John and Paul Knapton, 1738, p. 641.

44 Franklin, op. cit. (39), p. 65.

45 See Aldridge, op. cit. (4); and Weinberger, op. cit. (3).

46 See J.R. Wigelsworth, *Deism in Enlightenment England*, Manchester: Manchester University Press, 2009, pp. 154–159.

47 Andrew Baxter, *An Enquiry into the Nature of the Human Soul*, London: printed by James Bettenham, 1733, p. 2. Franklin to Francis Hopkinson, 16 October 1746, in Labaree, op. cit. (1), vol. 3, pp. 85, 88.

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for the additional providential animation required by Baxter, Hales and Wilson. Writing ten months later to Cadwallader Colden whilst in the midst of his electrical experiments, Franklin boasted that 'I boldly deny'd the Being of such a Property [*vis inertiae*] and endeavoured to demonstrate the contrary. If I succeeded, all his Edifice falls of course'.[48]

Franklin had hinted at the end of his Baxter letter, 'I know not yet what other Consequences may follow.' I think that the consequences of Baxter's fallen edifice are found not just in a subtle suggestion to Colden to rethink his own support for *vis inertiae*, but in Franklin's ability now to target Watson's electrical fire, which he does in his electrical experiments.[49] His second letter to Collinson of 25 May 1747 on electrical charge, that electrification is caused by a relative imbalance of electrical matter between objects, was premised on his idea that subtle imbalances in force could redirect nature's movement:

> *A*, who stands on wax and rubs the tube, collects the electrical fire from himself into the glass; and his communication with the common stock being cut off by the wax, his body is not again immediately supply'd. *B*, (who stands on wax likewise) passing his knuckle along near the tube, receives the fire which was collected by the glass from *A* . . . To *C*, standing on the floor, both appear to be electrised: for he having only middle quantity of electrical fire, receives a spark upon approaching *B*, who has an over quantity; but gives one to *A*, who has an under quantity. If *A* and *B* approach to touch each other, the spark is stronger, because the difference between them is greater.[50]

Generating an electrical snap involved not the absolute movement of electricity, as Watson had suggested, but shifting the electrical relationship between objects to create a relative imbalance. As a mosquito might tip a balance of planets, so the tube acted to tip the balance of electricity in human objects. The experimenter did not so much manipulate the quantity of electricity within objects as reveal various manifestations of this imbalance. 'Thus you may circulate it, as Mr Watson has shewn; you may also accumulate or subtract it, upon, or from any body'.[51]

Franklin's solution to the Leyden phenomenon, reported on 28 July, pushed forward this observation of natural reorganization to suggest the reality of innate material powers: objects like glass that could reorganize the natural balance had a special quality within them. He suggested that the electrical power did not flow through glass, but was fixed within it:

> At the same time that the wire and top of the bottle, &c. is electrised positively or plus, the bottom of the bottle is electrised negatively or minus, in exact proportion; i.e. whatever quantity of electrical fire is thrown in at the top, an equal quantity goes out of the bottom. To understand this, suppose the common quantity of electricity in each part of the bottle, before the operation begins, is equal to 20; and at every stroke of the tube, suppose a quantity equal to 1 is thrown in; then, after the first stroke, the quantity contain'd in the wire and upper part of the bottle will be 21, in the bottom 19. After the second, the upper part will have 22, the lower

48 Franklin to Colden, 6 August 1747, in Labaree, op. cit. (1), vol. 3, p. 168. Brackets added.

49 Colden persisted in using *vis inertiae* in tandem with other sorts of material power to provide a naturalistic description of gravity, reprinting *Explication of the First Causes of Action in Matter* in the 1750s. He was criticized heavily by European mathematicians.

50 Franklin to Collinson, 25 May 1747 (hereafter Letter II), in Cohen, op. cit. (17), p. 175.

51 Franklin, Letter II, op. cit. (50), p. 176.

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> 18, and so on, till, after 20 strokes the upper part will have a quantity of electrical fire equal to 40, the lower part none: and then the operation ends: for no more can be thrown into the upper part, when no more can be driven out of the lower part. If you attempt to throw more in, it is spued back through the wire, or flies out in loud cracks through the sides of the bottle.[52]

Electrical charge was manifested not just between objects, but within an object like glass; 'So wonderfully are these two states of Electricity, the *plus* and *minus*, combined and balanced in this miraculous bottle!'[53] The Leyden effect was just the reorganization and magnification of the jar's internal makeup; as Franklin would clarify later, 'there is really no more electrical fire in the phial after what is called its *charging*' because 'the phial will not suffer what is called charging, unless as much fire can go out of it one way, as is thrown in by another'.[54] Franklin emphasized that the maintenance of the charge was not supplied by the conductors, but inherent in the glass; he suggested to 'Mr *Watson*' that this was evident by the fact that one can be shocked by the charged glass when standing on wax or other insulators.[55]

Despite the publication of Watson's *An Account of the Experiments Made by Some Gentleman of the Royal Society* (1748), which argued for the absolute movement of electricity through objects, Franklin insisted on the special nature of glass. In his letter of 29 April 1749 to Collinson, Franklin included a simple experiment that isolated the electricity within the glass:

> 17 . . . Purposing to analyse the electrified bottle, in order to find wherein its strength lay, we placed it on glass, and drew out the cork and wire which for that purpose had been loosely put in. Then taking the bottle in one hand, and bringing a finger of the other near its mouth, a strong spark came from the water, and the shock was as violent as if the wire had remained in it, which shewed that the force did not lie in the wire . . . we electrified the bottle again, and placing it on glass, drew out the wire and cork as before; then taking up the bottle, we decanted all its water into any empty bottle, which likewise stood on glass and taking up that other bottle, we expected if the force to reside in the water, to find a shock from it; but there was none. We judged then that it must either be lost in decanting, or remain in the first bottle. The latter we found to be true; for that bottle on trial gave the shock, though filled up as it stood with fresh unelectrified water from a tea pot. - - - To find, then, whether glass had this property merely as glass, or whether the form contributed anything to it; we took a pane of sash-glass, placed a plate of lead on its upper surface; then electrified that plate, and bringing a finger to it, there was a spark and shock.[56]

One by one, Franklin eliminated the potential domestications for the electrical fluid: the wire, the water, even the shape of the glass. The glass (bottle or plate) alone remained as the retainer of an electrical principle. 'Thus, the whole force of the bottle, and power of giving a shock, is in the GLASS ITSELF.'[57] The non-electric conductors merely magnified the latent power of glass. Franklin sent a parting shot to 'Mr Watson [who] still seems to think the fire *accumulated on the non-electric* that is in contact with the

52 Franklin to Peter Collinson, 28 July 1747 (hereafter Letter III), in Cohen, op. cit. (17), p. 180.
53 Franklin, Letter III, op. cit. (52), p. 181.
54 Franklin, Letter IV, op. cit. (17), pp. 189, 190.
55 Franklin, Letter III, op. cit. (52), p. 182.
56 Franklin, Letter IV, op. cit. (17), pp. 191–192.
57 Franklin, Letter IV, op. cit. (17), p. 191.

glass, p. 72 ... [whilst we] as far as we hitherto know, have carried it farther'.[58] Franklin's finding of an innate power in glass was far more insidious than merely disproving the primacy of conductors, as Watson's response indicated. By suggesting that some types of matter had internal powers that could redirect the behaviour of other matter, Franklin hinted that providential conservation was redundant as a methodological tool, casting doubt on the exercise of God's providence.

Watson, Hales and the restoration of natural philosophy

Predictably, Wilson and Watson disagreed with Franklin's isolation of electricity within glass. Wilson maintained *vis inertiae* and the requirement for an external aetherial principle that 'carries along with it sulphur and other gross matter' to cause electrification.[59] The Royal Society minutes of January 1749–1750 commented that 'Mr Watson is not quite Master of Part of this Gentleman's reasoning' and described how Watson replicated Franklin's glass experiment to show the accumulation of electricity in water-based and metallic conductors, not the glass.[60] In a 1751 article, Watson offered thoughts on the experiments of Wilson and the young Henry Cavendish with electricity *in vacuo*, maintaining electrical transference as a conducting phenomenon that declared a divine agency:

> by what denomination shall we call this extraordinary power? From its effects in these operations, shall we call it electricity? For its being a principle neither generated nor destroyed; from its being every-where and always present, and in readiness to shew itself in its effects though latent and unobserved ...?[61]

Unlike Wilson's later insistence that Franklin's lightning rods disturbed the providential direction of the world, Watson's argument for a divine fire did not extend to rejecting lightning rods.[62] Apart from recognizing in them the 'motives of humanity, and the hopes of public utility', Watson came to see in lightning rods the confirmation of his own theory of electrification.[63] As historians have pointed out, lightning could be interpreted many different ways, particularly as the minimal shift of electrical matter was not particularly reconcilable with observations of a stunning natural movement. Watson construed the rods as conduits of the divine electrical power, supplemented by other natural conductors, for 'every drop of rain brings down part of the electric matter of a thunder cloud, and dissipates it in the earth and water; and prevents thereby the

58 Franklin, Letter IV, op. cit. (17), p. 193.

59 Wilson, *A Treatise on Electricity*, 2nd edn, London: C. Davis, 1752, p. 110, see esp. pp. 138, 176–177.

60 Minutes of the Royal Society (11 January 1749–50), in Cohen, op. cit. (17), pp. 239–240.

61 Watson, 'An account of the phenomena of *electricity in vacuo*, with some observations thereupon', *Philosophical Transactions* (1751–1752) 47, pp. 371, 374, 375.

62 See T.A. Mitchell, 'The politics of experiment in the eighteenth century: the pursuit of audience and the manipulation of consensus in the debate over lightning rods', *Eighteenth-Century Studies* (1998) 31, pp. 307–331.

63 William Watson, 'Suggestions concerning the preventing the mischiefs, which happen to ships and their masts by lightning', *London Magazine* (July 1763) 32, p. 372. See John Heilbron, 'Benjamin Franklin in Europe: electrician, Academician, politician', *Notes and Records of the Royal Society of London* (2007) 61, pp. 353–373.

mischiefs of its violent and sudden explosion'.[64] Watson's acceptance of Franklinian lightning regulation contrasts with Stephen Hales's insistence in 1758 that lightning was burning sulphureous air and could be controlled not by rods, but by kites and rockets that delivered flaming materials high into the atmosphere, which might 'inkindle the sulphureous Vapours some Hours before they would kindle if left to themselves.'[65]

Hales and Watson's view of natural-philosophical purpose was closer than this divergence over lightning suggests, however. Both expressed the conviction that natural philosophy acted in a soteriologically restorative manner by integrating experiment, medicine and theological enlightenment. In the same treatise where he advised 'inkindling' lightning, Hales argued that the introduction of fresh air into hospitals by his widely distributed bellows-driven ventilator superseded some arts of surgery:

> The Surgeons observe, that since St George's Hospital was ventilated, they are not subject, as before, to spreading Ulcers; these spreading Sores are peculiar to ill-aired Places; so that when they occur in Hospitals, they are often obliged to send such Patients into the Country, where they often get well, by their own Dressing, of such Ulcers as in the Hospitals used to defeat all the Art of the Surgeons. And doubtless, in most other Distempers the Sick will fare the better for having fresh, instead of foul putrid Air.[66]

The harm caused by poor air was alleviated by the ventilator, which shifted the chemical balance from one of disintegrating putrefaction to one of providential harmony. Having before established in *Haemastatics* how a protean air produced the electricity that activated the blood, Hales used that same air to cure sicknesses that evaded surgeons, amongst those who 'do not consider the Reasons of Things, and are used only to the practical Part'.[67]

In a similar manner, Watson's famous treatment of the seven-year-old foundling Catherine Field with tetanus through shock therapy in 1763 manifested his confidence in the experimenter's ability to reconcile God's divine vitality with the infirm. As Hales offered aerial reconfiguration as a more permanent healer than surgical mangling, so Watson suggested electricity as a powerful, permanent and providential healer, transcendent of other contemporary medicine:

> when a number of concurrent circumstances tend to establish a fact, we ought not in a certain degree to refuse our assent to it, though somewhat out of the common course. Thus in the case before us; when an unusual disease of several months continuance, and when the patient was supposed to be reduced to the last extremity; when medicines and applications of every kind, celebrated by the ablest writers and practitioners both ancient and modern, had been tried with little or no effect, at least with regard to the rigidity; when during a course of electrifying no medicines or applications of any kind were made use of; when likewise, during this course, the patient voided no worms, had no purgings, eruptions on the skin, or kindly impostumations, which might have been considered as critical discharges, and to have brought about the cure;

64 William Watson, 'Observations upon the effects of lightning', *Philosophical Transactions* (1764) 54, p. 220; see Heilbron, 'Franklin, Haller, and Franklinist history', op. cit. (6) (1977); and Peter Heering, Oliver Hochadel and David Rees (eds.), *Playing with Fire: Histories of the Lightning Rod*, Philadelphia: American Philosophical Society, 2009, on divergent readings of Franklin's lightning.

65 Stephen Hales, *A Treatise on Ventilators: Part Second*, London: R. Manby, 1758, p. 310.

66 Hales, op. cit. (65), p. 63.

67 Hales, op. cit. (65), p. 4.

> when, I say, none of these things happened, and the patient under electrifying only, and that at a very severe season of the year, has been restored to perfect health, I cannot refuse my assent in believing it effected by the power of electricity. That so active a principle, when properly directed to the diseased parts, should have important effects, no one can doubt who has been in the least conversant with it.[68]

As experiment had revealed electricity to be the conserving principle behind nature's direction seventeen years before, Watson now suggested natural philosophy had a potent redirecting capacity, turning sickness into health. Whereas Franklin had dismissed any lasting effects of medical electrification, and those that were temporary resulting only 'under the direction of a skilful physician', Watson held up his treatment as experimental revelation of the interface between providence in nature and providential healing.[69] Electricity's efficacious power suggested not just the innate power of matter, but an agent of God, endowed with life-giving qualities that gave the natural philosopher the roles of medic and priest.

Franklin and the revolution of need

Franklin's view of natural philosophy as transformative was illustrated in his reflections on local Indian nations in *Observations Concerning the Increase of Mankind* (1755) and a long 1753 letter to Peter Collinson. Franklin extended his experimental naturalism into a heterodox moral philosophy: as electrical snaps represented nature's response to a proportional imbalance in its constituent parts, so a naturally indolent humanity responded to its needs when pressed.

Just before travelling as part of a peace envoy to make a treaty with the Ohio Indians in the summer of 1753, Franklin wrote to Collinson commenting that the Indians, like all other people, sought the easiest state of life. 'It seems certain, that the hope of becoming at some time of Life free from the necessity of care and Labour, together with fear from penury, are the mainsprings of most peoples [*sic*] industry.' If there was no interruption to this state of ease, then no industry above basic subsistence was required:

> The proneness of human nature to a life of ease, of freedom from care and labour appears strongly in the little success that has hitherto attended every attempt to civilize our American Indians, in their present way of living. Almost all their Wants are supplied by the spontaneous Productions of Nature, with the addition of very little labour, if hunting and fishing may indeed be called labour when Game is so plenty, they visit us frequently, and see the advantages that Arts, Sciences, and compact Society procure us, they are not deficient in natural understanding and yet they have never shewn any Inclination to change their manner of life for ours, or to learn any of our Arts . . .[70]

Native indolence did not reflect the nature of their un-Christianized souls or intrinsic foolishness but the ability to live in accordance with nature's productions. They resisted change to this easy life by employing a cultural principle of parsimony, recognizing no

68 William Watson, 'An account of Dr Biancchini's *Recueil d'Experiences Faites a Venise sur le Medicine Electrique*', *Philosophical Transactions* (1751–1752) 47, pp. 19–20.

69 See Benjamin Franklin, 'An account of the effects of electricity in paralytic cases', *Philosophical Transactions* (1757–1758) 50, pp. 481–483.

70 Franklin to Collinson, 9 May 1753, in Labaree, op. cit. (1), vol. 4, p. 481.

need to follow the European 'manner of life, and the care and the pains that are necessary to support it'.[71]

Competition from other nations inevitably forced a response. Franklin saw the necessary connection between human competition for resources and technological development. Indians had faced less competition historically than the Europeans and had less need for technology. With a twist, however, Franklin suggested that the new technology that had arisen out of European competition had become so engrained in European culture that it soon seemed natural:

> Though they have few but natural wants and those easily supplied[,] But with us are infinite Artificial want, no less craving than those of Nature, and much more difficult to satisfy; so that I am apt to imagine that close Societies subsisting by Labour and Arts, arose first not from choice, but from necessity: When numbers being driven by war from their hunting grounds and prevented by seas or by other nations were crowded together into some narrow Territories, which without labour would not afford them Food. However as matters [now] stand with us, care and industry seem absolutely necessary to our well being.[72]

The transition from Indian to industrious European did not involve providential blessing or historical development of classical virtue, but arose from necessity. In time this necessary transition seemed natural because of the habituated form of any particular society, its second nature – it was only in comparing English and Iroquois culture that one discovered that philosophical 'Learning' was valued only because English society simply could not exist in terms of skill and infrastructure if only 'acquainted with the true methods of killing deer, catching Beaver or surprising an enemy'.[73]

Franklin's later, dispassionate observation in his *Autobiography* that the termination of Indian societies made 'Room for the Cultivators of the Earth' indicates how he viewed the purpose of natural philosophy.[74] Whilst the English were not superior to the Indians through Christian blessing, their ascension on the hierarchy of needs had secured more stable modes of production in trade, property law and technology. Franklin made clear in *Observations* that statesmen, inventors and businessmen secured these hard-won benefits:

> Hence the Prince that acquires new Territory, if he finds it vacant, or removes the Natives to give his own People Room; the Legislator that makes effectual Laws for promoting of Trade, increasing Employment, improving Land by more or better Tillage; providing more Food by Fisheries; securing Property, &c. and the Man that invents new Trades, Arts or Manufacturers, or new Improvements in Husbandry, may be called *Fathers* of their Nation, as they are the Cause of Generation of Multitudes, by the Encouragement they afford to Marriage.[75]

As a society's needs were developed, specific leaders and innovators had greater influence over its direction, manipulating not just basic food provision but legislative and technological power for its continuance. Ultimately this society would vie for space with

71 Franklin to Collinson, 9 May 1753, in Labaree, op. cit. (1), vol. 4, p. 482.

72 Franklin to Collinson, 9 May 1753, in Labaree, op. cit. (1), vol. 4, p. 482.

73 Franklin to Collinson, 9 May 1753, in Labaree, op. cit. (1), vol. 4, p. 483.

74 Franklin, op. cit. (40), p. 101.

75 Benjamin Franklin, *Observations Concerning the Increase of Mankind*, in *idem, Experiments and Observations on Electricity*, op. cit. (2), p. 211.

another culture and seek to destroy that culture. If anyone or anything governed a nation's survival, prosperity and expansion, it was these shrewd 'Fathers'.

Amongst these Fathers were the natural philosophers, as Franklin had made clear in his 1743 proposal to create the American Philosophical Society: 'And all philosophical experiments that let Light into the Nature of Things, tend to increase the Power of Man over Matter, and multiply the Conveniences or Pleasures of Life.'[76] It was these men who devised and erected lightning rods 'and thereby secure us from that most sudden and terrible mischief'.[77] It was these men who garnered not only control of nature, but its manipulation so that even Franklin's family could now 'catch some of the lightning for me in electrical phials'.[78] It was these men who sought out further ways to manipulate this power of matter for human benefit, both to kill turkeys 'roasted by the electrical jack' and access even more potent properties; as Franklin commented to Collinson,

> there are no bounds . . . to the force man may rise and use in the electrical way: For bottle may be added to bottle *in infinitum*, all united and discharged together as one, the force and effect proportioned to their number and size.[79]

Ultimately, it was these men who could use electricity to secure a nation and assist in its expansion. As Franklin wrote in 1762 to his co-experimenter Ebenezer Kinnersley:

> when a single spark from a flint, applied to a magazine of gunpowder, is immediately attended with this consequence, that the whole is in flame, exploding with immense violence, could all this fire exist first in the spark? We cannot conceive it. And thus we seem led to this supposition, that there is fire enough in all bodies to singe, melt, or burn them, whenever it is, by any means, set at liberty, so that it may exert itself upon them, or be disengaged from them. This liberty seems to be afforded it by the passage of electricity through them, which we know can and does, of itself, separate the parts even of water . . .[80]

The natural philosopher could cook poultry or liquefy matter. In benefiting some humans with light or heat, electricity could allow those same men to destroy others, shedding a moral light on Franklin's claim 'to make us *safe* is not all its advantage, it is some to make us *easy*'. The divergent possible utilities of electricity were a matter of independent human moral disposition and judgement, not divine dispensation.

Concluding comments

In a 2006 speech at the Annual General Meeting of the American Philosophical Society, John Heilbron suggested that Franklin in his later years was less dismissive of natural philosophy's theological insights. In 1785, for example, Franklin hinted that the continuance of nature reminded humanity of God's conservation of the soul, and later, in 1788, echoed Descartes's view that the harsh climates experienced in the world

76 Benjamin Franklin, 'A proposal for promoting useful knowledge among the British plantations in America' (14 May 1743), in *The Autobiography and Other Writings*, op. cit. (40), p. 175.

77 Benjamin Franklin, *Opinions and Conjectures*, in Cohen, op. cit. (17), pp. 221–222.

78 Franklin to Collinson, September 1753, in Cohen, op. cit. (17), p. 269.

79 Franklin, Letter IV, op. cit. (17); Franklin to Collinson, undated (1751), in Cohen, op. cit. (17), pp. 200, 246.

80 Franklin to Kinnersley, 20 February 1762, in Cohen, op. cit. (17), pp. 371–372, 375.

reflected God's punishment after the Fall.[81] Certainly this was a softening of Franklin's sceptical rigour. Forty years prior he had not envisioned providential direction in his electrical cosmos. His demarcation between the power of God and matter as an opposing position to Watson's and Wilson's was clearly dismissive of God's sustenance in space and time.

At the same time, Franklin's alliance between a practical natural philosophy and anti-providentialism cannot be explained predominantly by what Larry Stewart called 'Legitimation – effectively a process of attaining public approval – [which] gave force to the meaning of experiment'.[82] Whilst it is very true that Franklin and indeed all the English experimentalists appealed to the public through a principle of practicality, this was only through a complex and continual evaluation and integration of theological reflection and experimental finding. Targeting directly Tory Anglican views of electricity as divine vitality in 1746, Watson warned his friends that by activating humans with electricity one might activate all of nature:

> must we not be very cautious, how we connect the elementary fire, which we see issue from a man, with the vital flame and *calidum innatum* of the ancients; when we find, that as much of this fire is producible from a dead animal as a living one, if both are equally replete with fluids?[83]

For Hales and Watson particularly, it was only after experimentally differentiating matter from its principles of motion that they suggested natural philosophy's mediating role in restoring human vitality, evidence of the functioning of God's providential direction and his benevolence. In opposing this providential utility with a philosophy of secular need, Franklin had to first throw doubt on the relationship between nature and providence, reconceptualizing the Newtonian universe from one of enduring motion to one of shifting balance. He could then offer experimental evidence that a primary force of nature provided proof of this balance and held within itself powers of motion. It is only after understanding these diverging trajectories over nature's behaviour that we can fully appreciate what 'practicality' meant to the various actors.

81 Heilbron, op. cit. (8), pp. 611, 613.

82 Stewart, *The Rise of Public Science*, Cambridge: Cambridge University Press, 1992, pp. 383–384. See the introduction to Margaret Jacob and Larry Stewart, *Practical Matter: Newton's Science in the Service of Industry and Empire, 1687–1851*, Cambridge, MA: Harvard University Press, 2004.

83 Watson, op. cit. (16), p. 75; See Schaffer, op. cit. (14).