Introduction: 'Mind almost divine'

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Whosoever to the utmost of his finite capacity would see truth as it has actually existed in the mind of God from all eternity, he must study Mathematics more than Metaphysics.

Nicholas Saunderson, *The Elements of Algebra*[1]

As we enter the twenty-first century it might be possible to imagine the world without Cambridge University's Lucasian professors of mathematics. It is, however, impossible to imagine our world without their profound discoveries and inventions. Unquestionably, the work of the Lucasian professors has 'revolutionized' the way we think about and engage with the world: Newton has given us universal gravitation and the calculus, Charles Babbage is touted as the 'father of the computer', Paul Dirac is revered for knitting together quantum mechanics and special relativity and Stephen Hawking has provided us with startling new theories about the origin and fate of the universe. Indeed, Newton, Babbage, Dirac and Hawking have made the Lucasian professorship the most famous academic chair in the world.

While these Lucasian professors have been deified and placed in the pantheon of scientific immortals, eponymity testifies to the eminence of the chair's other occupants. Accompanying 'Newton's laws of motion', 'Babbage's principle' of political economy, the 'Dirac delta function' and 'Hawking radiation', we have, among other things,

From Newton to Hawking: A History of Cambridge University's Lucasian Professors of Mathematics, ed. Kevin C. Knox and Richard Noakes. Published by Cambridge University Press.

Figure 1 Newton deified. G. Bickham's 1732 illustration propels Newton's radiating cameo into the heavens, where cherubs hold a variety of philosophical and mathematical instruments that helped the professor construct a new vision of the universe.

'Barrow's proof' of the fundamental theorem of calculus, the 'Saunderson board' (a calculating instrument for the vision-impaired), 'Waring's theorem' of integers, 'Airy's criterion' of telescopic resolving power, 'Stokes's law' of fluid resistance, 'Larmor frequency' of atomic precession in a magnetic field and 'Lighthill's fourth law of engine noise'. Small wonder, then, that scientific and historical literature, as well as a huge array of statuary, tombs, stamps, money, relics and the like, bears tribute to these colossal giants of science. Many of these homages, like the inscription on Newton's tomb in Westminster Abbey, put us mere mortals in our place:

> Here is buried Isaac Newton, Knight, who by a strength of *mind almost divine*, and mathematical principles peculiarly his own, explored the course and figures of the planets, the paths of comets, the tides of the sea, the dissimilarities in rays of light, and, what no other scholar has previously imagined, the properties of the colours thus produced. Diligent, sagacious and faithful, in his expositions of nature, antiquity and the holy Scriptures, he vindicated by his philosophy the majesty of God mighty and good, and expressed the simplicity of the Gospel in his manners. Mortals rejoice that there has existed such and so great an ornament of the human race![2]

Countless other tributes to Newton and his successors are equally as humbling. Take these lines from the obituary notice of George Gabriel Stokes published in *The Times*:

> We may enumerate his scientific papers, we may expatiate upon his work in optics or hydrodynamics, we may dwell upon his masterly treatment of some of the most abstruse problems of pure mathematics, yet only a select body of experts can readily understand how great he was in these various directions, while possibly not all experts understand how much greater was the man than all his works . . . Sir George Stokes was as remarkable for simplicity and singleness of aim, for freedom from all personal

> ambitions and petty jealousies, as the breadth and depth of his intellectual equipment. He was a model of what every man should be who aspires to be a high priest in the temple of nature.[3]

Today, one can make a pilgrimage to a temple – the Cambridge-based Isaac Newton Institute for Mathematical Studies – to worship these high priests of nature. There, visitors are prompted by a series of artefacts to recapitulate the heroic story of the Lucasian professorship. Outside the building are three symbolic statues, representing intuition, genesis and creation, as well as an arboret descended from the Woolsthorpe apple tree that allegedly inspired Newton to invent his theory of gravitation. Upon entering, visitors are presented with a bust of Dirac and a portrait, bust and death-mask of Newton.

Clearly, we mortals have placed great value on the work of the Lucasian professors, and as a consequence much of their handiwork has entered the common coin of our (corruptible) world. We have put tremendous faith in the professors and their intellectual products. As trustworthy icons corporations even trade on their names. As well as being emblazoned on the old one-pound banknotes, Newton has been used to sell everything from apples to zenith telescopes. A chain of computer software stores is named after Charles Babbage; in the UK, Stephen Hawking, whether aware or not that his predecessor George Biddell Airy had invented a method for correcting astigmatism, has endorsed a spectacles retailer.

Even without spectacles – or Newton's telescope for that matter – the Lucasian professors are understood to see farther and with unparalleled perspicuity. The professors themselves have perceived this legacy. As a young, obstreperous reformer, Charles Babbage deemed Newton's *Principia* the 'mill stone around the necks' of gownsmen; but in later life he reflected how the professorship had been 'the only honour I ever received in my own country'. The fiscally mindful Babbage gushed that 'the names of Barrow and Newton have conferred on the Lucasian chair a value far beyond any which mere pecuniary advantage would bestow'. Almost every other incumbent

has shared Babbage's deep affinity with Newton. Upon graduating at the top of his class, Isaac Milner – later to be Cambridge's seventh Lucasian professor – was 'tempted to commit his first act of extravagance. In the pride of his heart, he ordered from a jeweller a rather splendid seal, bearing a finely-executed head of Sir Isaac Newton'. Other Lucasians have worked even harder to memorialize their predecessors. Stokes was asked to arrange and catalogue the unpublished optical papers of Newton bequeathed to Cambridge University Library by the Earl of Portsmouth, while Stokes himself was made part of that monument of late-Victorian hagiography – the *Dictionary of National Biography* – by his successor, Larmor.[4] Most of the professors have been humbled by the gargantuan legacy that their predecessors bequeathed: 'It is nice to feel that one holds the same position as Newton and Dirac', James Lighthill said, 'but the real challenge', he admitted, 'is to do work that is even a small fraction as significant.' Although Stephen Hawking has criticized Newton's 'vitriol and deviousness' he also feels close to the author of the *Principia*. As he has recently quipped, 'Newton occupied the Lucasian chair at Cambridge that I now hold, though it wasn't electrically operated at the time.'[5]

From Newton to Hawking recounts the ways these celebrated scientific thinkers have conceived their place within the history of the prestigious professorship. Of greater import, this book uses the context of the mathematical professorship to examine the extraordinary developments in the physical sciences since 1663. These changes relate not simply to the technical content of mathematical and scientific enterprises but the diverse array of uses to which such work has been put, from contemplating the origins of the universe to the design of quieter jet engines. In addition to this aspect of their work, their astonishing talent, tenacious industry and insatiable curiosity help to explain why the Lucasians have dipped their hands in so many things. *From Newton to Hawking* explores the professors as antiquarians, alchemists, orators (Barrow has been called 'one of the great orators produced by England'), theologians, economists, engineers, politicians and church-music composers, as well as pure researchers.[6]

Accordingly, each chapter of this book provides a social history of mathematics, natural philosophy and physics and in so doing shows how the professors shared an intense preoccupation with the *application* of the sciences, both as reliable accounts of the natural world and as bases for such 'nonscientific' subjects as faith, ethics, politics and aesthetics.

Indeed, what emerges from this book is the significant extent to which these nonscientific topics permeated the enterprises of Lucasian professors at least as much as the research, administrative and pedagogical duties associated with their position. For instance, Isaac Newton and his eighteenth-century successors were as determined to restore the basis of true Christian faith through a scientifically rigorous scriptural exegesis as they were determined to promote the true (i.e. Newtonian) account of the natural world. Conversely, for professors like Charles Babbage and Paul Dirac, their 'pure' mathematical research was a means for expunging the corrupted mathematical techniques which inevitably led to dangerous religious practices and troublesome secular ethics.

What the book is *not* is a reference work detailing the administrative details and tedious minutiae of the careers of the Lucasian professors. Nor is it a hagiographical account of disembodied scientific heroes. Alongside their magnificent triumphs are a number of spectacular failures, while the professors themselves have been the objects of scorn, jest and chastisement. They have had sordid controversies with others and have squabbled amongst themselves. The career of Charles Babbage is illustrative: his calculating engine never functioned during his lifetime while it was said that 'he never functioned as a professor'. With his predecessor, George Biddell Airy, he had vigorous disputes over Britain's railway standards and the financing of his computers. He could also be off-putting, to say the least – the great Victorian historian, Thomas Carlyle, once reflected how 'Babbage continues eminently unpleasant to me, with his frog mouth and viper eyes, with his hide-bound wooden irony, and the acridest egotism looking through it.'[7] These criticisms of Babbage also

illustrate how readers of *From Newton to Hawking* will learn how Cambridge's most distinguished professors fit into (or not!) their contemporary cultures. The point that the professors are necessarily products of their time cannot be overestimated. Nevertheless, it is a point that habitually has been overlooked, ignored and suppressed. Through careful management of the history of the professors, previous accounts of the Lucasian chair – by both historians and by the chair's occupants – have made it appear that the professorship transcends time and space. Generally, these accounts have taken it for granted that the current professors inhabit the same mental world as their predecessors and present their work as a unified, cumulative and coherent 'project'.

Like Newton's concept of 'flowing time', this idea of continuity is seductive and it is surprising that no publication hitherto has attempted to provide portraits of these men as part of a continuous history. Not only have the professors inhabited the same town and institution, but many have shared the same laboratories, technicians and research programmes. And each professor, in his own way, has envisaged himself as a cog in the scholarly corporation, a kind of temporary placeholder in the eternal succession of professors. As Hélène Mialet suggests later in the book, the professorial chair is akin to medieval kingship: although monarchs and Lucasian professors alike command great respect in the secular world, their temporal incumbency can seem relatively inconsequential compared to the everlasting corporate body they represent.

If the professors themselves often remark that they are mere markers in a continuum of mathematical splendour, one cannot neglect the elements of discontinuity that problematize this grand narrative. One might try to imagine Stephen Hawking and Isaac Newton engaged in an animated conversation (or as *Star Trek* envisaged, in a poker game), but it is likely that their lives, careers and values would have been utterly alien to each other. While the interests, methodologies, habits and research areas of the different professors have been extraordinarily diverse, the sciences and the university itself have

Figure 2 'MC Hawking'. The current Lucasian professor has become a multimedia rap-master. The 'phat' lyrics of '*E = mc Hawking*' assert ' "E" stands for energy, yo that's me, / I'm a brilliant scientist and a dope MC. / Before you step on me I'd think twice G, / I'm the Lord of Chaos, King of Entropy. / There ain't another motherf**ker hard like me, / I'm a universal constant, I'm a singularity.'

undergone radical transformations that make it difficult to compare professors from different eras. In 1663 the conception of the English university as a site of publicly funded experiment was still over two centuries away. Restoration Cambridge was not a research institution, nor would the varsity become one until the second half of the nineteenth century. Even Newton had trouble demonstrating to the republic of letters the value of mathematics, and the protracted transition of Cambridge from chiefly a religious seminary to a scientific Mecca is an integral part of the professors' history.

A BRIEF HISTORY OF CAMBRIDGE

Henry Lucas, who had studied at St John's College, believed that he recognized a breach in Cantabrigian scholarship. Wanting 'to testifie' to his 'affection' for Cambridge and for learning, he resolved to 'ordaine . . . a yearly stipend and sallerie for a professor . . . of mathematicall sciences in the said Vniversitie'. In his will Lucas said that his endowment would 'honor that greate body', as well as assisting 'that parte of learning which hitherto hath not bin provided for'.[8] Yet, although it is striking that the Lucasian professorship was not endowed until the university was over four centuries old, it is, of course, misguided to suppose that the varsity was somehow incomplete before a professor of mathematics began to grace its schools.

Though it may *seem* so to us, the infiltration of mathematics into the Cambridge curriculum was not inevitable. In many senses Cambridge functioned eminently well without a mathematics professor. On the one hand, Cambridge produced plenty of able mathematicians without an endowed professorship, and there were plenty of tutors capable of guiding undergraduates through the rigours of the curriculum. On the other hand, the university's function had little to do with state-of-the-art mathematics. John Wallis – who studied at Emmanuel College in the 1630s before embarking on a career at Oxford as the Savilian professor of geometry – commented on the general low regard for mathematical studies in relation to the purpose of the English universities: 'Mathematics . . . were scarce looked upon as *Academical* studies, but rather *Mechanical*; as the business of *Traders*, *Merchants*, *Seamen*, *Carpenters*, *Surveyors of Lands*, or the like.' Wallis realized that this opinion concerning appropriate scholarly learning reflected certain interests which had been formed centuries earlier. For, before the Reformation, Cambridge's central mission revolved around its service to the mighty Roman Church, the university serving to train prospective priests. Following the Reformation, Cambridge became *the* site to seek ecclesiastical preferment within the Anglican Church. Accordingly, all undergraduates – whether preparing to return to their estate, to make their way in London at the Inns of Court or to enter holy orders – embarked on a strict regimen of religious tuition and prayer at their colleges, a tradition that was not short-lived. Charles Babbage reminisced how 'the sound of the morning chapel bell . . . call[ing] us to our religious duties' was the only thing that compelled him and his fellow undergraduates to end their night-long devotions at whist.[9]

Alongside his antipathy towards chapel, Babbage also 'acquired a distaste for the routine of studies'. In his opinion the curriculum of the early nineteenth century was antiquated, despite – or because of – its heavy emphasis on the Newtonian philosophy. For Babbage, the university had suffered from its Elizabethan legacy which from the sixteenth century had greatly influenced the trajectory of

learning and examinations. During the reign of Elizabeth and the next two Stuarts college tutors confronted undergraduates with subjects from the *trivium*, the *quadrivium* and the philosophies, their studies likely including logic, rhetoric, Aristotelianism, geometry, astronomy and some natural philosophy. By the middle of the seventeenth century tutors occasionally foisted the new natural philosophies upon their charges, and as an undergraduate it seems that, along with Aristotle and Virgil, Isaac Barrow received a dose of Cartesian philosophy. The mandate produced able scholars, but not professional mathematicians.

The Elizabethan statutes also determined how learning was to be *displayed*. In Barrow's time, oral examinations or 'disputations'– not particularly conducive to testing mathematical skills – dominated the evaluation of hopeful sophomores and seniors. Pomp, ritual and ceremony were the order of the day as students tried to convince examiners, and perhaps the occasional royal observer, that they commanded the emblems of good scholarship: 'To call these disputations merely debates between students', one historian has observed, 'is like describing a Spanish bullfight as the killing of a cow.' Even with the 'Newtonianization' of the curriculum, the rites and the spectacles associated with the Senate House Examination remained vital to the institution. Rather than radically overhauling the examination process, mathematical and scientific subjects came to dominate the exams through a glacial process of accretion. Only gradually did the Lucasian professors come to play a role in the process.[10]

The history of the professorship is also bound together with that of the colleges. Through the benefices of diverse wealthy patrons, the colleges had been founded one by one, sprinkled liberally throughout the commercial town, and each virtually independent from the others. Their wealth determined the extent to which each constructed its chapels, halls, common rooms, libraries, dorms and gardens. Regardless of its assets every college armed itself with a battery of bedmakers, cooks, porters and wine stewards to serve its master, tutors, fellows and students. As every Lucasian professor swiftly ascertained