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Nicholas Saunderson: The Blind Lucasian Professor

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Nicholas Saunderson (1682–1739), the fourth Lucasian professor of mathematics at Cambridge, was fluent in Latin, French, and Greek, and an accomplished musician. He enjoyed a reputation as an outstanding teacher, noted for both his popular lectures on natural science and his expertise in tutoring mathematics. He wrote two successful mathematics texts, *The Elements of Algebra* and *Method of Fluxions*, and invented a palpable arithmetic which also served as a geoboard. These achievements are especially remarkable considering that he was blinded by smallpox at the age of one. It was said at Cambridge that he was a teacher who had not the use of his eyes but taught others to use theirs. © 1992 Academic Press, Inc.

Nicholas Saunderson (1682–1739) a été nommé le quatrième professeur Lucasian de mathématiques à l'Université de Cambridge. Il parlait le latin, français, et grec avec facilité et était un musicien accompli. Saunderson était un professeur exceptionnel, renommé pour ses conférences populaires sur la science naturelle et pour son habileté en enseignant les mathématiques. Il a écrit et a eu du succès avec deux livres de classe de mathématiques: *Les éléments d'algèbre* et *La méthode de fluxions*. Il a aussi inventé une arithmétique palpable qui a aussi servi comme un *geoboard* (une planchette de calculus). Ses accomplissements étaient remarquables considérant qu'il était aveugle depuis l'âge d'un an à cause de la petite vérole. On a dit à Cambridge qu'il était un professeur qui n'avait pas l'emploi de ses yeux mais qui enseignait des autres d'employer les leurs. © 1992 Academic Press, Inc.

Nicholas Saunderson (1682–1739) war der vierte Lucasianische Mathematikprofessor an der Universität von Cambridge. Er sprach fliessend Latein, Französisch und Griechisch und war ein ausgebildeter Musiker. Saunderson war ein ausgezeichneter Lehrer, der für seine populären Vorlesungen über Naturwissenschaft und für seine Sachkenntnis im Mathematikunterricht bekannt war. Er schrieb zwei erfolgreiche mathematische Lehrbücher, *Die Elemente der Algebra* und *Die Differentialrechnung*, und erfand eine ertastbare Arithmetik, welche auch als eine *Geotafel* diente. Seine Leistungen waren insofern bemerkenswert, als er im Alter von einem Jahr durch die Pocken erblindet war. Man sagte in Cambridge, dass er ein Professor war, der nicht seine eigenen Augen gebrauchen konnte, aber andere lehrte, ihre zu benutzen. © 1992 Academic Press, Inc.

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Ball [1889, 88] once characterized the mathematician Nicholas Saunderson as a staunch Newtonian who barely escaped mediocrity. It is a description which unfortunately has proven true. Saunderson's research did very little to advance mathematics as a science, and without some coaxing, he probably would not have published any of it at all. Nevertheless, he overcame a great handicap and went on to hold the most prestigious mathematical chair in England for over a quarter century. An extremely diligent teacher, Saunderson set high standards for himself and instilled a high regard for truth in his students while introducing them to

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Nicholas Saunderson

Newtonian science and mathematics. The purpose of this paper is not to analyze the contents of his mathematical works but rather to describe the man behind the mathematics while bringing to light many of his forgotten accomplishments.

The West Yorkshire Archives [MS D28/37], in Wakefield, record that Nicholas Saunderson, the only son of John and Ann Saunderson of Thurlson, was baptized on 20 January 1682, in the parish of Peniston [1]. Nicholas was blinded by smallpox at the age of 12 months. The virus damaged his cornea and a secondary staphylococcus infection completely destroyed his eyes. Some psychologists [Bower 1977, 158–162; Hebb 1949, 109–120] have drawn a distinction between early and late learning; since Saunderson's blindness was not congenital, the development of his spatial concepts may not have been severely affected.

As a youth, Nicholas taught himself to read by tracing out letters on gravestones with his fingers [Anonymous 1877]. He was taught the rudiments of arithmetic by his father, who was an exciseman for the Peniston district for over thirty years. Nicholas attended the free school in Peniston, where he learned to speak French fluently [Davies 1740] and, under the tutelage of M. Staniforth, began to lay a solid foundation in the classics. His favorite classical authors were Horace, Vergil, and Tully [2].

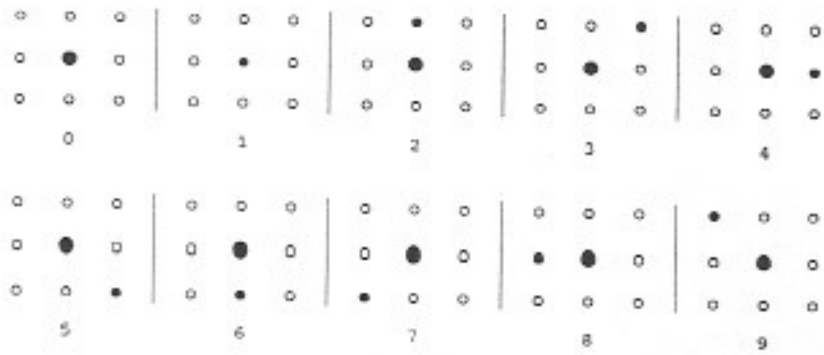

FIGURE 1

After grammar school, Nicholas helped his father with his excise figures. He was soon able to make long calculations using an ingenious counting board that he had devised, and which John Colson [1740] appropriately called a palpable arithmetic. Saunderson's device appeared nearly a century after the Italian mathematician–physican, Girolamo Cardano, famed for his contributions to the solution of the cubic equation, had proposed the idea that blind people should be taught to read and write using their sense of touch.

The board was approximately 1 square foot in area and was divided, using thin strips of wood, into 100 little squares. Each little square had a hole in the center as well as eight holes on its perimeter. Saunderson kept boxes of small-headed and large-headed pins handy when making his calculations, and by placing them in appropriate holes he could represent any one of the 10 digits. Saunderson represented the digit 0 by a large-headed pin in the central position, the digit 1 by a small-headed pin in the central position, the digit 2 by a large-headed pin in the center and a small-headed pin directly above it, and so forth. Saunderson's complete pin code is shown in Fig. 1.

Saunderson was extremely adept at using this abacus-like invention to perform arithmetic calculations, and he constructed a second board with a similar pattern which he used for depicting geometric figures using silken threads wound around the pins [Cave 1754]. This second board was undoubtedly a precursor to our present-day geoboard [Glenn 1978]. Heller [1979] called Saunderson's invention the first step toward progress in the education of the blind, but he criticized Saunderson for not publicizing his ingenious device in order to help other blind people learn to perform arithmetical calculations and geometric constructions in a similar manner [3].

At age 18 Saunderson was tutored in algebra and geometry by Mr. Richard West of Underbank and Dr. Nettleton of Halifax. Quick to learn, he enjoyed being read Euclid, Archimedes, and Diophantus in the original Greek, and he amazed his tutors with his mathematical dexterity when he performed intricate calculations in his head, such as finding square and cube roots. During these formative years, Saunderson's tutors must have spent countless hours reading to him, for his publications and lecture notes at Cambridge reveal that he was very well read, indeed. In 1702, Nicholas was sent to Attercliffe Academy, one of the more famous English dissenting schools, near Sheffield, to be tutored primarily in logic and metaphysics, but the mode of teaching mathematics here did not suit his genius, and he seems for the most part to have tutored himself while at the school [Hunter 1828/1974 II, 362]. He was known to have a good ear for music and could play the flute with some skill [Davies 1740].

At age 25, with the encouragement of his friends and teachers, Saunderson decided to go to Cambridge University where he hoped to share his knowledge with others. It is interesting to note that he wanted to go there not as a student but as a teacher of mathematics, feeling that Cambridge offered him the best opportunity "to give instruction and improve in his favorite studies" [Davies 1740]. If things failed to work out at Cambridge, a group of friends had generously agreed to set him up with his own school in London. Up to this time his education had been financed by his father.

In 1707, Saunderson went to Christ's College, Cambridge, as a friend of Joshua Dunn, a fellow-commoner from Attercliffe, who resided at Christ's irregularly. At this time, Cambridge was a quiet little town of about 6000 residents who found the newly enacted window tax the raging issue of the day. Dunn probably brought Saunderson to Cambridge as his private tutor, for the latter was never officially listed as a member of Christ's [Peile 1900, 219]. Nevertheless, the Master and Fellows of the College offered Saunderson lodgings and library privileges during his stay in Cambridge [4].

At Cambridge, Saunderson was regarded as a person who learned mathematics with great ease and who could communicate his ideas rapidly to others. Through Dunn's intercession and with the approval and encouragement of William Whiston of Clare Hall, the Lucasian Professor of Mathematics, Saunderson was allowed to give lectures and tutor mathematics. A devout Newtonian, Saunderson became part of the so-called Newtonian School of Mathematics and Physics at Cambridge. Together with Roger Cotes, Robert Smith, and Whiston, he introduced students at Cambridge to Newton's works. Saunderson's lectures on Newton's *Principia*, *Optics*, and *Universal Arithmetic* attracted Newton's attention and a brief correspondence between the two ensued [Brewster 1855/1965 I, 336]. In a letter to Sir William Jones, Vice President of the Royal Society, Cotes wrote that he did not know Saunderson very well, but from what he could gather from their brief encounters, he found him to be extraordinarily bright [Rigaud 1841 I, 261–262].

In 1663, Henry Lucas, long-time secretary to the Chancellor of the University of Cambridge, made a bequest to the University which was subsequently granted by Charles II. The Lucasian Professorship, one of the oldest endowed chairs at the University, strictly bound the recipient to residence in Cambridge while the University was in session and carried with it a stipend of £100 per annum together with the proceeds from farmlands in Bedfordshire. The Lucasian Professor was also required to present to the Vice-Chancellor at the commencement of Michaelmas term a written copy of not less than 10 lectures that he had delivered in the previous year. Isaac Barrow, the first Lucasian Professor, held the chair for 5 years and was succeeded by Isaac Newton who, like Barrow, was a Fellow of Trinity College. In 1701, Newton resigned his Lucasian Professorship and was replaced by William Whiston who, by 1709, had come under severe criticism from members of the Established Church for his unitarian views. Under the terms of the Lucasian charter, Mr. Christopher Hussey of Trinity College was named deputy Lucasian Professor until the situation could be resolved [Whiston 1753 II, 312]. On 30 October 1710, the Masters of the Colleges at Cambridge found Whiston guilty of holding Arian beliefs and summarily dismissed him from his post [Foster 1890, 123–124].

Saunderson was regarded by many as Whiston's obvious successor. However, he was not a Fellow of a Cambridge College and Newton, by now President of the Royal Society and Warden of the Mint, supported Hussey for the Lucasian chair as did Roger Cotes, Plumian Professor of Astronomy at Cambridge, and Richard Bentley, Master of Trinity [Gjertsen 1986, 339–340]. Cotes and Bentley had asked Newton to support Hussey for the Lucasian position out of loyalty to Trinity College and because Hussey was an able mathematician [5].

The heads of the Colleges and the Honorable Francis Robartes, whose son John was one of Saunderson's first pupils and benefactors, applied to the Chancellor, the Duke of Somerset, for a mandate-degree for Saunderson, which was a necessary requirement for the Lucasian Chair. Subsequently, Queen Anne recommended an M.A. for Saunderson, but did not command it as was often the case. Nevertheless, on 19 November 1711, at age 29, Saunderson was awarded the M.A. degree and the very next day he was elected Lucasian professor, receiving six votes to Hussey's four [6]. Edmund Halley, who held the Savilian Chair of Geometry at Oxford, commented wryly that "Whiston was dismissed for having too much religion, and Saunderson preferred for having none" [Dyer 1824/1978, 142–143].

On 21 January 1712, Saunderson gave his inaugural address, in truly Ciceronian Latin [Baker 1897], concluding with a long encomium on how a knowledge of mathematics can lead students to reason correctly [Cave 1754]. Brook Taylor, who had attended St. John's College, Cambridge, said of Saunderson's on his appointment that "he is an extraordinary Algebraist and I expect great Improvements in that Art from his hand" [Feigenbaum 1986]. It is interesting to note that the Lucasian position held by Saunderson was one of the very few mathematical chairs open during Newton's lifetime in which the man Newton supported did not get the job.

The Cambridge University of the early 18th century was a far cry from the institution as we know it today. Mathematics was not considered a topic for research but rather as one of the Liberal Arts, and thus an aid to reasoning. Euclidean geometry, on the other hand, was considered the fundamental mechanism for inculcating the tools necessary to discover the divine truths of nature. Not until the early 20th century did Cambridge institute significant educational reforms regarding the role of mathematics in the curriculum [Richards 1988, 10]. In Saunderson's day, Cambridge professors often neglected their duties: they were sometimes even unacquainted with their subject matter and tried to avoid both teaching and tutoring. Saunderson, on the other hand, was very assiduous in carrying out his responsibilities, not that he always found it easy to do so. On several occasions, the gentleman commoners and noblemen at the University made his life miserable; Saunderson often became exasperated with them and others who did not pay attention to his lectures, and he once commented that if he was to "go to hell, his punishment would be to read lectures in mathematics to the gentleman commoners in that university" [Nichols 1815 IX, 372–374].

At Cambridge, Saunderson taught numerous classes of scholars in private lectures annually, and with great success [Wordsworth 1877/1969, 69]. Davies [1740] estimated that Saunderson lectured and tutored at least 7 or 8 hours a day and Dr. Heberton recalled that, around 1730, Newton and Euclid were only known to those who chose to attend Saunderson's lectures [Wordsworth 1877/1969, 66]. Perhaps because of his blindness, Saunderson preferred algebra and analysis to geometry. He never doubted the importance of Euclid's *Elements*, but questioned its use as a book of instruction for the average Cambridge student [Guicciardini 1989, 24]. His position with regard to the teaching of geometry was far in advance of its time and often led him into arguments with other Cambridge professors. Saunderson's lectures at Cambridge were usually full to capacity and he found it difficult to divide the day amongst all who applied for his instructions [Nichols 1815 IX, 372–374]. Sir Horace Walpole, the Prime Minister's son, once recalled that when he first went up to Cambridge he took mathematics with Saunderson and was mortified when the latter told him, "young man, it would be cheating you to take your money, for you can never learn what I am trying to teach you" [Lewis 1960; Fowler & Fowler 1984, 137–138; Chainey 1985, 77].

The young Walpole struggled with another tutor, Dr. Trevigar of Clare Hall, for almost a year at his own expense before finally accepting the truth of Saunderson's sage observation; he decided to pursue a course of study in Italian and drawing instead. John Jortin (Jordain), another admirer of Saunderson, took mathematics under him while supporting himself at Cambridge by translating Homer for Alexander Pope [Nichols 1815 II, 556]. Lord Chesterton, who was at Trinity Hall from 1712 to 1714, thought Saunderson an excellent lecturer and a professor "who did not have the use of his eyes, but taught others to use theirs" [Baker 1897].

In view of the conditions at Cambridge at the time, Saunderson must have been an imposing figure for diligent students to emulate. Guicciardini [1989, 27] noted that Saunderson and Robert Smith, who was Cotes' cousin and succeeded him as Plumian Professor, were instrumental in establishing a rigorous program in mathematics which during the second half of the 18th century produced such mathematicians and scientists as Edward Waring, William Cavendish, George Atwood, John Brinkley, and Nevil Maskelyne. Unquestionably, Saunderson was feisty, forthright, and a very intelligent individual, willing to spend endless hours guiding his students in their studies. Unfortunately, his mathematical research while at Cambridge was almost nonexistent [7]. His only publications consisted of textbooks designed to acquaint students with the fundamentals of algebra and the method of fluxions, and even though helpful as guidebooks, they did little to advance the mathematics of his day.

Saunderson was known to his colleagues as an excellent companion and a lively conversationalist, full of wit and vivacity [Hutton 1795]. As a teacher, he was revered at Cambridge for inculcating a reverential regard for the truth in his students [Davies 1759, 15]. He was often characterized as passionate and outspoken, but more apt to inspire admiration than to make or preserve friends. His frankness got him into trouble on numerous occasions at Cambridge and, in 1714, he was involved in a lawsuit which required him to go to London to settle [Rigaud 1841 I, 265].

Indicative of his manner is a letter of 1727 that Saunderson wrote to Sir William Jones, Vice President of the Royal Society. In it, Saunderson indicated that nothing had been published at the University since his last letter, except a work entitled *The Principles of the Philosophy of the Expansive and Contractive Forces* by Dr. Robert Greene, a Fellow at Clare Hall. Saunderson dismissed this work with the following words:

> If there had been anything in it instructive or diverting I should have sent it to you; but I can find nothing in it, but ill manners and elaborate nonsense from one end to the other. The gentleman has been reputed to be mad for these two years last past, but never gave the world ample testimony of it before. [Rigaud 1841 I, 263–264] [8].

A forthright biographical article, which mostly praised Saunderson, noted his sarcasm, vivacity, and honesty, but castigated him for "uttering his sentiments of men not only freely, but licentiously, with a kind of contempt and disregard for decency and commmon sense." The note went on to criticize Saunderson for his: "indulgence of women, wine, and profane swearing to such a shocking excess, that he did more to harm the reputation of mathematics than he did good by his eminent skill in the science" [Anonymous 1766, 157–158].

In 1714, as a consequence of holding the Lucasian Chair, George I appointed Saunderson a Commissioner of the Board of Longitude, where he served with Newton, Halley, Cotes, Flamsteed, and Keill. The Board was formed to oversee and award a prize for the most practical and accurate way devised to determine longitude at sea and met on a regular basis in London. On 21 May 1719, Saunderson was elected a Fellow of the Royal Society [Thomson 1812], where his closest associates included De Moivre, John Keill, the Savilian Professor of Astronomy at Oxford, and John Machin, an astronomer, all of whom were involved in some way with the Society's efforts to settle the Newton–Leibniz debate [9].

Saunderson resided at Christ's until 1723 when he took a house in Cambridge and soon thereafter married Abigail Dickons, the daughter of William Dickons, rector at Boxworth, a small village about 7 miles northwest of Cambridge. Saunderson's love for Abigail was "undoubtedly kindled by the touch of her eyelashes" [Anonymous 1766]. The couple soon thereafter moved to Boxworth, from whence Saunderson rode to lecture and tutor at Cambridge via the village of Lolworth.

Saunderson was an avid equestrian and was known to follow a pack of hounds "not only with ardor but with desperation" [Cave 1754]. Nicholas and Abigail had two children, a son John, baptized on 16 December 1724, and a daughter Anne, baptized on 7 March 1730. John was educated at St. Neots and Ely, entered Christ's College 19 May 1742, and received his B.A. degree from Cambridge in 1754. According to the Peterhouse admissions records, John held a Ramsey Fellowship at the College, before serving as a clerk in the Home Office until his death in 1759. Ann married Marshall Allen of Market Harborough in Leicestershire and had three children, Ann, Charles, and John [Allen 1881].

At Cambridge, as part of his Lucasian responsibilities, Saunderson offered a series of natural science lectures. The highly popular lectures were descriptive in nature and were intended for a general audience and as a consequence contained very little mathematics. The only calculations involved the determination of the epact and the solar cycle in the technical chronology section and an example of Kepler's third law in the astronomy section [10]. The lectures cover topics in hydrostatics, optics, sound, mechanics, astronomy, the tides, technical chronology, and heat and cold [11].

The natural science lectures make for fascinating reading and with a few emendations and additions they could easily form the core of a natural science course for today's nonscience students. Numerous references in his notes indicate not only that he was well read scientifically but that his knowledge was remarkably up to date. The notes, unfortunately, contain a few misconceptions on Saunderson's part. For example, he espoused belief in life on Mercury and Venus and thought that the gravitational attractive force turned repulsive at some great distance from the earth so as to keep the stars fixed in the heavens [Guicciardini 1985]. Nevertheless, Edmund Burke, the Irish statesman and writer, considered Saunderson's notes to be of excellent quality, especially the ones relating to light and color [Burke 1766]. John Harrison, who was eventually rewarded by the Board of Longitude for his invention of the chronometer, claimed that Saunderson's lecture notes were instrumental in sparking his interest in the sciences [Taylor 1967, 425]. From 1745 to 1760, James Bradley, Astronomer Royal, used Saunderson's lecture on hydrostatics as part of his lectures as Savilian Professor at Oxford. Furthermore, in *The Principles of Mathematics and Natural Philosophy* (1795–1799), James Wood and Samuel Vince based their discussion of hydrostatics on Saunderson's notes.

On 26 April 1728, George II came over from Newmarket on his way back to London and conferred 27 doctoral degrees, the most significant being a degree of Doctor of Laws upon Saunderson [Nichols 1815 IX, 396; Monk 1833; Cooper 1852]. In 1733, Saunderson was struck with a life-threatening fever. At the urging of his students, friends, and several of the senior tutors at Cambridge, he decided to spare some time from his lectures and tutoring in order to publish his notes on algebra. He based his work on notes that he had written up for John Robartes, Earl of Radnor, to aid him in his mathematical studies [Peile 1913]. The project occupied the last 6 years of his life and through the efforts of his wife and son, together with the help of John Colson, Saunderson's successor in the Lucasian chair, the *Elements of Algebra* was published posthumously in 1740.

Saunderson's *Elements of Algebra* contains an account of Euclid's doctrine of proportion, the solution to numerous Diophantine problems, the construction of magic squares, solutions to quadratic equations and to simultaneous linear equations, solid geometry, rules of exponents and logarithms, some work on infinite series, and concludes with solutions to cubic and biquadratic equations. The book includes an innovative algorithm to express the greatest common divisor of two numbers as a linear combination of the numbers themselves (the algorithm can be found in [Stewart 1966, 39–43; Andrews 1971, 18–19]). John Saunderson wrote a preface for the book, and Dr. Richard Davies, Fellow of Queens', appended a biographical sketch of Saunderson much of which was extracted from a letter to Mrs. Saunderson from Mr. Gervase Holmes, Fellow of Emmanuel. *The Elements of Algebra* also contains Colson's account of Saunderson's palpable arithmetic and an appendix supplied by De Moivre who included his method for determining roots of complex numbers [12].

Saunderson's book was used as a text at the Royal Military Academy at Woolwich during the second half of the eighteenth century [Guicciardini 1989, 110]. Ball [1889, 86] claimed that the text gave a fair idea of how the subject was treated in the lecture rooms of Cambridge in the eighteenth century, although Schaaf [1981] found the book to be "a conventional treatise of the times," adding that "the two ponderous tomes contain nothing unusual save a sketch of his life and a brief description of his palpable arithmetic." This latter opinion was not well founded, however, for the presentations in the text are, in fact, very clear, and the book contains a multitude of good examples. A student using the book diligently could easily master the art of algebraic manipulation.

Saunderson's *Method of Fluxions* was published posthumously in 1751. It consists of three sections: the first, an introduction to the method of fluxions, the basic rules of differentiation, maxima–minima problems, and integration techniques for determining area under curves; the second, Cotes's integrals as well as some problems from Cotes's *Scholium generale;* and the third, Saunderson's *Commentarius in principia philosophiae Newtoniana*, which is one of the best general accounts of Newton's scientific discoveries [13].

Throughout his life, Saunderson was well known for his uncanny perception. It was said that upon entering a room he could immediately judge its size and his distance from its walls and, if lit, the location of its fireplace. He had a keen sense of touch and would amaze his friends by distinguishing in a set of Roman coins the genuine from the false although they had fooled an expert who had the sense of sight. If taken for a stroll in Cambridge, he could retrace his path backwards, and identify any part of it by tapping the sidewalk. He could also tell if an object were held in front of his face and sense the change when clouds blocked his sunlight, but he could not distinguish color strictly with his sense of touch. According to Drever [1955], the blind who acquire their knowledge of the world by touch and movement are much better at sensing pressure and are often superior in tactile–kinesthetic perception to sighted persons.

J. C. Milner, a local magistrate in Peniston, related the following story concerning Saunderson's amazing retentive powers. It appears that Saunderson returned to his Yorkshire homestead after many years in Cambridge and upon encountering the gate at the bottom of Stottercliffe Hill tried to open it from the hinged side. When he realized his mistake, he claimed to those present that 40 years ago the gate had opened from the other side. After checking with the local villagers it was determined that the hinges of the gate, in the past, were indeed on the other side [Paterson 1880].

Saunderson became at length a chronic invalid, his body ravaged by scurvy. He complained for some time of a numbness in his limbs, which in the spring of 1739 resulted in a mortification of his foot. Gangrene set in, and on 19 April he died and was buried at the parish church, in Boxworth, which originally served as a small chapel to Huntingfields Manor. On the floor of the chancel a stone slab commemorates Saunderson's achievements. A painting of him holding an armillary sphere by I. Vanderbanck (reproduced at the beginning of this article), originally painted for Martin Folkes and bequeathed to the University Library in 1823 by the Reverend Thomas Kerrich, now hangs in the Old Schools Complex at Cambridge. The frontspiece of his *Elements of Algebra* contains a mezzotint lithograph of Vanderbanck's painting done by D. Vandergucht.

Saunderson's death bed scene plays a prominent role in Diderot's *Lettre sur les aveugles* [1749/1916], which is written in the form of a letter to Diderot's mistress, Madam de Puisieux, and relates his feelings about the blind. The essay includes Diderot's answer to a question, proposed in 1688 by William Molyneaux, first secretary of the Dublin Philosophical Society, to John Locke, concerning what the eyes of a blind person would see if they could be made to immediately perceive [Locke 1690/1975, 145–146]. Both Locke and Diderot argued that even if a blind person could distinguish between a sphere and a cube by touch they would be unable to do so visually upon immediately regaining their sight, a view that agrees with modern psychological opinion which suggests that visual aptitude can only be acquired through experience [Gregory 1973; Walk 1981; Goldstein 1979, 338–350].

Diderot's essay included a description of Saunderson's palpable arithmetic and praised Saunderson for his great accomplishments and the fine example he set for all blind people. But Diderot also used the case of Saunderson to argue that phenomena of nature could be perceived as due solely to natural forces, which are at times invisible. Diderot's deathbed scene depicts an atheistic Saunderson conversing with Reverend Gervase Holmes, and Saunderson stating that he could not believe in anything he could not touch. Diderot's essay brought severe criticism from Holmes who, in a rebuttal, recounted the deathbed scene and put an even longer, equally unlikely, deathbed confession in Saunderson's mouth [Holmes 1750]. Three-quarters of a century later Dyer [1824/1978, 142–143], writing about the incident, felt obliged to add that those present at his death remembered

Saunderson, "though no friend of Divine revelation," asked for communion just before he died.

Even though he was not Newton's choice for the Lucasian Chair, Saunderson was thoroughly Newtonian in style. He was clearly not the kind of innovator Cambridge required if it were to break the Newtonian bonds of fluxional thinking and enter into the mainstream of European mathematics. If his mathematical research was minimal, he was, nevertheless, an inspired and dedicated teacher and a devout critic of the substandard mathematics education of his day. Like the Russian topologist Lev Pontryagin, Saunderson lived most of his life in the dark, literally, but appears today as a bright light in the history of English mathematics in the post-Newtonian era at Cambridge. Unquestionably, his most impressive characteristic was his persistence in overcoming this handicap to become a successful and useful contributor to the Cambridge mathematical community.

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NOTES

1. Quite possibly Nicholas was named after an uncle who had died the previous autumn. He had three younger sisters, Fanny, Mary, and Ann [Hunter 1895], and preferred to spell his surname with a "u" as did Robert Saunderson, Bishop of Lincoln, author of the second preface to the English Common Prayer Book, and Nicholas Saunderson of Sandbeck, high sheriff of Lincolnshire, both of whom were distant relations [Paterson 1880].

2. One of the most frequently mentioned maladies in classical literature is blindness and one can envision Saunderson and his situation as akin to that of the andabata, the gladiators of ancient Rome who fought their battles blindfolded.

3. In the 1770's, Henry Moyes, a lecturer in chemistry at Manchester University, constructed a similar device that used three types of pegs and employed 576 squares. He, too, constructed it for his own personal use and not for the benefit of others who were blind [Moyes 1788].

4. Christ's held Saunderson in such high esteem that his bust is one of three that adorn the east end of the reflecting pool in their Fellow's garden. The other busts are of John Milton, the poet, and Ralph Cudworth, a former Master of the College [Rackham 1939, 289–290].

5. In 1709, Newton had recommended Hussey for the post of headmaster of the Rochester School, but this position went to John Colson, Saunderson's successor in the Lucasian Chair. Newton said that with respect to Hussey's mathematical abilities, he was well qualified for the Lucasian chair, but added that he had "made a resolution not to meddle with this election" except for writing a letter of recommendation for him. [Newton 1977 VII, 479].

6. Saunderson received the votes of Dr. Quadringe (Magdalene), who was the Vice-Chancellor, Dr. Roderick (King's), Dr. Covell (Christ's), Dr. Ashton (Jesus), Dr. Balderston (Emmanuel), and Dr. Fisher (Sydney), while Hussey received the votes to Dr. Bentley (Trinity), Dr. Jenkins (St. John's), Dr. James (Queens'), and Sir John Ellys (Caius), with the other heads of Colleges abstaining [Luard 1860, 7].

7. Saunderson received one of the first copies of De Moivre's *Doctrine of Chances*, and became well acquainted with its contents. Saunderson was a close friend of the physician–philosopher David

Hartley. Seigler [1983] noted that the first statement of Bayes' theorem in probability theory appeared in *Observations on Man* [Hartley 1749/1966], several years before it appeared in an posthumous essay by Bayes, and he speculated that Hartley learned this result from Saunderson. Dale [1988], however, has argued quite convincingly that Hartley's reference actually applies not to Bayes' theorem but to the inverse of Bernoulli's theorem in probability theory.

8. Roger Cotes wrote to Jones concerning another book that Greene had published in 1711, but was more diplomatic, writing that "his [Greene's] book is now in press and is almost finished. I am told that he will add an appendix in which he will undertake also to square the circle. I need not recommend his performance any further to you" [Edleston 1850, 211].

9. Saunderson may have traveled to London to attend meetings of the Spitalfields Mathematical Society, precursor of the Royal Astronomical Society, which was constituted chiefly of working men who met to discuss the scientific advances of the day. De Morgan [1872, 232–236] noted that a Saunderson was among its members in the late 1730s, but Cassels [1979] failed to fine any connection between Nicholas Saunderson and the Spitalfields organization, and concluded that De Morgan must have been referring to George Saunderson, a former President of the Society.

10. In the archives of Sidney Sussex College there is a Latin manuscript entitled *Saundersoniana*, which contains the first part of Saunderson's *Method of Fluxions* and a number of mathematical computations relating to, but not included in, Saunderson's natural science lectures. The manuscript is in the hand of Dr. Francis Sawyer Parris, Master of Sidney Sussex (1746–1760), who copied it from material lent to him by Mrs. Saunderson.

11. As was the custom, his notes were widely circulated, and hand-written copies can be found at the Cambridge University Library [Haswell 1723; Parnther 1723; Aynscough 1737], the Bodleian Library at Oxford [Bradley MSS 16413; Rigaud MSS 26203 & MSS 26204], the British Library [MS Add Eg. 834], the University College London [West 1731], the Wellcome Historical Medical Library in London [MSS 4373-74], the Stanford University Library, and the Norfolk Records Office in Norwich.

12. The method had appeared implicitly in [De Moivre 1722] and used a result from [De Moivre 1707].

13. The Cambridge University Library has a manuscript dated 1738 which contains the first two sections of *Method of Fluxions*. A copy of *Commentarius*, dated 1739, can be found in the Babson College archives [MS 454]. The Stanford University archives contain manuscripts of all three parts. Furthermore, the Gonville and Caius College archives contain a manuscript consisting of notes taken by a student who attended Saunderson's lectures on fluxions [Mickleburgh 1720]. When he was Master of Trinity College, Robert Smith recommended Saunderson's *Method of Fluxions* to students interested in learning about the subject [Watson 1817, 9]. Bewley [1756], in a review, noted that Saunderson had removed many of the difficulties in understanding the theory of fluxions but the sections on Cotes's work were not very clear.

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