Forming the Analytical Society at Cambridge University

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The Analytical Society, an organization begun by students at Cambridge, was founded in 1812. Even though it was entirely student-led, the society was responsible for significant changes in the Cambridge mathematics curriculum and in the way mathematics was perceived in Britain throughout the nineteenth century. Its success was likely due to the outstanding students who formed the group, some of whom went on to become leaders in British science and mathematics for the next fifty years. In this paper we will briefly look at several of those who played important roles in forming and leading the society and we will consider the circumstances leading to its formation.

In the fall of 1809, John Frederick William Herschel (1792 – 1871) matriculated at St. John's College, one of the two largest colleges at Cambridge University. A serious student of mathematics, Herschel came from a privileged, upper-class family. When it didn't work out for Herschel to be away at school, his family was able to hire a private tutor and allow Herschel to finish his education at home. Because his father, William Herschel, was a world-renowned astronomer--he discovered the planet Uranus--John Herschel likely grew up accustomed to scientific talk and held to high expectations. At Cambridge Herschel would distinguish himself as a superior student, finishing as the senior wrangler in 1813. After graduating from Cambridge Herschel was elected to the Royal Society and became a fellow of St. John's. Although he continued to do mathematics for several years, primarily as an avocation, Herschel eventually followed in his father's footsteps and became a distinguished astronomer.

Like Herschel, George Peacock (1791 – 1858) began his studies at Cambridge in the fall of 1809, entering Trinity College, the rival of St. John's in terms of size and influence at the university. Peacock's background, however, was much different from that of Herschel. Born in the Yorkshire village of Denton, Peacock's father was the parish rector and ran a small school, where Peacock received his early education. Before entering Cambridge, he also attended the Richmond School, where he seemed to blossom under the tutelage of The Reverend James Tate, a Cambridge graduate and a fellow of Sidney Sussex College. Apparently thinking a great deal of Tate, Peacock dedicated his most famous work, *A Treatise on Algebra*, to him and refers to Tate in glowing and affectionate terms.

Because of his relatively simple background, Peacock's prospects were somewhat limited. Distinguishing himself at Cambridge would be his best hope for an academic career and Peacock certainly succeeded. He was a talented student of mathematics and eventually rose to a position of leadership among an elite circle of talented students. Peacock finished second on the tripos exam of 1813, bested only by Herschel. After that impressive performance he became a fellow of Trinity and went on to have an important career at Cambridge. By all accounts he was a popular and influential tutor at Trinity, where two of England's most important mathematicians, Augustus DeMorgan and Arthur Cayley were among his students. While at Cambridge, Peacock made a number of contributions, including his work in reforming the Tripos exam, and by

extension, the entire mathematics curriculum. Most people are aware of Peacock as the author of *A Treatise on Algebra*, a book that is credited with transforming the way algebra was perceived, freeing it from simply being thought of as a generalized arithmetic. In 1839 Peacock followed the path of several other Cambridge faculty members and left his faculty post at Cambridge to become Dean of the Cathedral at the nearby town of Ely, where he served until his death in 1858. Throughout his life, even after moving to Ely, Peacock was actively involved in the affairs of the university, serving on various university commissions and committees, many charged with instituting significant reforms.

Coming to Cambridge a year after Herschel and Peacock, Charles Babbage enrolled at Trinity in 1810, later moving to Peterhouse College. Since his father was a wealthy banker, Babbage wasn't under the pressure of having to earn honors to make a place for himself in academia. Given that sense of freedom, Babbage chose to venture outside the established system and did not take the Tripos exam, passing up any opportunity for honors. However, by deciding to forego the exam, he also freed himself from the need to laboriously prepare for the exam and instead was able to focus on things he wanted to study. Primary among these was mathematics. His decision did not adversely affect his later life as he went on to become famous as the developer of the analytical engine and wrote extensively in a variety of areas, including philosophy and apologetics. Although he was not actively involved with the university, Babbage was given the honor of being appointed Lucasian professor in 1828. As Ball states, he "held the chair until 1839, but by an abuse which was then possible he neither resided nor taught"[1], but that's a story for another day.

Although Herschel, Peacock and Babbage were talented mathematicians, the fact that they studied mathematics is not surprising. In the early nineteenth century, everyone at Cambridge studied a lot of mathematics and there are several reasons why. A young man went to Cambridge to be liberally educated not to prepare for a profession. Perfecting an ability to think logically and reason well was seen as an important part of that process, and studying mathematics was considered to be the best way to acquire those skills. Because it was the central part of a truly liberal education, everyone studied a lot of mathematics, even though it was expected that most graduates would never use the particulars of the subject after graduation. In fact, most students went on to have careers in the church, but still they studied mathematics and very little theology. Since no effort was made to prepare students to become professional mathematicians, there was also no need to revise the curriculum to include the latest theories or to prepare students to do research.

Another reason why mathematics played such a central role at Cambridge was the Tripos, or Senate House Examination. used to rank students for honors. It was necessary to have an objective exam to obtain precise rankings and mathematics certainly qualifies as an objective subject, so the exam was a difficult and comprehensive mathematics test. And, since mathematics formed the basis of this important exam, mathematics was also primary in the curriculum.

Even though mathematics played such a central role in the curriculum, by the time Herschel, Babbage, and Peacock matriculated at the university, the Cambridge mathematical community had become fairly stagnant. On the continent mathematicians, using the analytical methods they

preferred, continued to develop new results. At Cambridge, these methods were seen as not helping accomplish the goal of training young men to think logically and be educated as gentlemen, so they continued to emphasize the synthetic methods that are typical of areas such as geometry. Over the years, mathematics in Britain got further and further behind what was being done in places like France and Germany. Despite the efforts of one professor, Robert Woodhouse, who, prior to 1810 was the lone voice on the Cambridge faculty advocating for the analytical methods, the gap between what was being done on the continent and what was being taught at Cambridge continued to widen. Consequently, students, like Herschel, Peacock, and Babbage were not exposed to these new methods.

A second factor separating Cambridge mathematics from that of the continent was the use of different notation. Cambridge professors continued to use the notation introduced by Newton, while the continent was largely using the calculus notation introduced by Leibnitz, making it difficult for students to access foreign works. For example, the calculus text by Lacroix, which was popular in the era around 1810, was not being read by Cambridge students.

Finally, there was the continuing and looming presence of the Tripos exam, which ruled the curriculum. For example, as long as Newton's notation was used on the exam, it would be the primary notation used in instruction. Faculty also discouraged students, even the best students, from considering any topics or problems which would not be covered on the exam. Some students found this quite discouraging. For instance, in a letter to his father, Herschel reports that he is frustrated by not being able to read books that would be beneficial to his advancement, because the topics they covered were not pertinent to the exam material.[2]

In a similar vein, Babbage gives the following disappointing introduction to his life at Cambridge:

> "Thus it happened that when I went to Cambridge I could work out such questions as the very moderate amount of mathematics which I then possessed admitted, with equal facility, in the dots of Newton, the d's of Leibnitz, or the dashes of Lagrange. I had, however, met with many difficulties, and looked forward with intense delight to the certainty of having them all removed on my arrival at Cambridge. I had in my imagination formed a plan for the institution amongst my friends of a chess club and also of another club for the discussion of mathematical subjects.
> In 1811, during the war, it was very difficult to procure foreign books. I had heard of the great work of Lacroix, on the "Differential and Integral Calculus," which I longed to possess, and being misinformed that its price was two guineas, I resolved to purchase it in London on passage to Cambridge. As soon as I arrived I went to the French bookseller, Dulau, and to my great surprise found that the price of the book was seven guineas. After much thought I made the costly purchase, went on immediately to Cambridge, saw my tutor Hudson, got lodgings, and then spent the greater part of the night in turning over the pages of my newly-acquired purchase. After a few days, I went to my public tutor Hudson, to ask the explanation of one of my mathematical difficulties. He listened to my question, said it would not be asked in the Senate House, and was of no sort of

consequence, and advised me to get up the earlier subjects of the university studies.

After some little while I went to ask the explanation of another difficulty from one of the lecturers. He treated the question in just the same way. I made a third effort to be enlightened about what was really a doubtful question, and felt satisfied that the person I addressed knew nothing of the matter, although he took some pains to disguise his ignorance.

I thus acquired a distaste for the routine of the studies of the place, and devoured the papers of Euler and other mathematicians, scattered through innumerable volumes of the academies of Pertersburgh, Berlin, and Paris, which the libraries I had recourse to contained.

Under these circumstances it was not surprising that I should perceive and be penetrated with the superior power of the notation of Leibnitz.[3]

There is yet another person who deserves mention in this story, someone who is neither a mathematician or even directly associated with the university. From 1783 until his death in 1836, the Rev. Charles Simeon was the rector of Holy Trinity Church in Cambridge. Simeon, a graduate of Kings College, was known for his inspirational preaching and had a vibrant and important ministry among Cambridge undergraduates. As D. A. Winstanley notes in his book *Early Victorian Cambridge*, "Many undergraduates were brought by Simeon's preaching to think seriously about religion for the first time in their lives; and sometimes these youthful disciples were a source of anxiety to the older members of their party."[4] The anxiety mentioned here is likely the result of an on-going discussion between the conservative members of the established church and the zealous evangelicals. These discussions were common with vocal supporters on both sides of the issue at Cambridge. For instance, Isaac Milner, who was president of Queens College from 1788 to 1820, was a strong evangelical.

As an evangelical, Simeon thought that Christians should find ways to use their inward piety to affect outward changes in society. Consequently, he was a strong advocate for various missionary ventures, inspiring the students who sat under his preaching to do the same. In 1804, Simeon was one of the founders of The British and Foreign Bible Society, organized with the goal of publishing and distributing Bibles without additional comment, allowing anyone to read and interpret the scriptures for themselves. While this sounds like a worthy goal today, at the time it was widely viewed as a threat to the Anglican Church, partly because it was supported by people from a variety of denominations. Endorsing the proper form of a popular version of the Bible became a symbol of the internal struggles between the established church and the evangelicals, including people like William Wilberforce, who continued to press for an outward expression of inward piety. Simeon's strong influence on undergraduates even extended to this new missionary venture, which the students approached with unusual enthusiasm. As Winstanley reports,

"With the generosity of youth they longed to give others the happiness and peace of mind which they themselves had obtained; and, not having yet learned the value of caution, they were perhaps too ready to think that their seniors were not

sufficiently active in spreading the good news of the Gospel. With such a vast vineyard crying for cultivation, it was almost impossible for the more enthusiastic of them to linger in the market-place, waiting to be hired; and under the influence of a few pious undergraduates in the autumn of 1811 conceived the idea of establishing an auxiliary branch of the British and Foreign Bible Society at Cambridge."[5]

This proposal, or any proposal initiated by students, was quite unusual. However, this would be the first of several such initiatives that were proposed in the next decade. This unusual proposal significantly combined the existing theological discussions within the church with the radical idea that students could even have a voice in forming a new group. Once the proposal was made, Winstanley describes a period of intense debate, with student advocates on one side and most of the senior leadership of the university on the other. Eventually the students gave way to Simeon's leadership who worked out an agreement with the leaders in the university to establish a Cambridge branch of the Bible Society in December of 1811. The fact that the impetus for this agreement came from students was itself a significant fact and an important prelude to the Analytical Society. In commenting about this Winstanley mentions that this episode, as well as a second incident which took place several years later, marked a turning point in the relationship between students and those in authority. He states ". . . but when peace returned to Europe and authority began to be seriously challenged, it was inevitable that undergraduates should attempt to cast off the shackles of the previous age."[6]

Once the students had succeeded in forming their branch of the Bible Society, a second debate immediately followed, about whether the Bible should be published alone or with the prayer book. This new discussion was just as intense as the first, involving many students and others in the Cambridge community. With this backdrop, it is interesting to read Babbage's account of the founding of the Analytical Society, taken from his manuscript *Passages from the Life of a Philosopher*.

> "At an early period, probably at the commencement of the second year of my residence at Cambridge, a friend of mine, Michael Slegg, of Trinity, was taking wine with me, discussing mathematical subjects, to which he also was enthusiastically attached. Hearing the chapel bell ring, he took leave of me, promising to return for a cup of coffee.
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> At this point Cambridge was agitated by a fierce controversy. Societies had been formed for printing and circulating the Bible. One party proposed to circulate it with notes, in order to make it intelligible; whilst the other scornfully rejected all explanations of the word of God as profane attempts to mend that which was perfect."[7]

Babbage goes on to report that after seeing one of their advertisements his first thought was that it might be a good idea to parody this group and organize a society for translating the small work of Lacroix on the calculus. He proposed "periodic meetings for the propagation of d's; and consigned to perdition all who supported the heresy of dots. It maintained that the work of Lacroix was so perfect that any comment was unnecessary."[8]

Babbage shares this idea of a parody of the Bible Society controversy with Slegg who, in turn, mentioned it to one of his mathematical friends, Edward French Bromhead. Soon, what appeared to start out as joke was seen to be a good idea, and a meeting was proposed for the "purpose of forming a society for the promotion of analysis."[9] Herschel and Peacock are reported to have been present at that first meeting, along with several others, and it was decided to form a group called "The Analytical Society." Among the goals of the group was the translation of Lacroix's text, that regular meetings would be held and papers would be read, and to publish a volume of their transactions. Babbage reports that they were "much ridiculed by the Dons; and, not being put down, it was darkly hinted that we were young infidels, and that no good would come of us."[10]

Unlike the conscientious work and serious spirit that preceded the formation of the Cambridge branch of the Bible Society, the formation of the Analytical Society was almost accidental, conceived as a whim. There was apparently no group of students that were having serious discussions about the advantages of the analytical methods used by continental mathematicians or the deficiencies in the current Cambridge curriculum and how these could be rectified. It is interesting that Enros comments that those present at the first meeting were unacquainted with each other[11] although Babbage claims that they were all known to Bromhead.

What these young men could soon agree on was the need to incorporate more analytical methods and the continental notation in their mathematical study at Cambridge. This was not an entirely new idea at the university. As mentioned above, one member of the mathematics faculty, Robert Woodhouse had already been advocating for the use of analytical methods, but was not able to make any headway with his fellow faculty members. Because Woodhouse was a voice on the faculty for making these changes, some students, probably a few of the better students, were familiar with them, even though the new notation was not used on the all-important examinations.

In 1812, Herschel, Babbage, and Peacock were three of the best students in Cambridge. While it's difficult to believe that they did not at first know each other before the initial meeting in Bromhead's room, they soon became good friends. As Ball says, ". . . in 1812, three undergraduates—Peacock, Herschel, and Babbage—who were impressed by the force of Woodhouse's remarks and were in the habit of breakfasting together every Sunday morning, agreed to form an Analytical Society with the object of advocating the general use in the university of analytical methods and of the differential notation, and thus, as Herschel said, 'do their best to leave the world wiser than they found it.'"[12] Whether they had known each other prior to their first meeting or not, it is reasonable to conclude that the well-known debates about the distribution of the scriptures taking place in Cambridge throughout 1811 and into 1812, paved the way for other student-led initiatives and were a significant factor in planting the idea to form the Analytical Society.

With their initial enthusiasm, the leaders of the Analytical Society set out a number of goals, some of which were accomplished and some were not. For instance, their anticipated publication, which came to be known as the *Memoirs of the Analytical Society*, had contributions from only two authors, Babbage and Herschel, and soon ceased to exist. The translation of Lacroix,

however, was accomplished by Herschel and Peacock, with Peacock also publishing an extensive text of examples to illuminate the material in Lacroix. Perhaps the most enduring legacy was the reformation of the methods and notation used on the Tripos exam, an effort led by George Peacock. By the early 1820's the Tripos exam had been reformed to use the analytical notation and once that was accomplished, the nature and essence of the mathematics curriculum was changed for good. Even though Peacock, who was responsible for many subsequent changes, had a strong personality, the existence of this wider group of student associates had to have been a major influence on his work and on changing the nature of the mathematical culture in Britain for the rest of the century.

Footnotes
1. Ball, page 126.
2. Enros, page 110.
3. Babbage, pages 26, 27
4. Winstanley, page 18.
5. Winstanley, pages 18, 19.
6. Winstanley, page 25.
7. Babbage, pages 27, 28.
8. Babbage, page 28.
9. Babbage, page 29.
10. Babbage, page 29.
11. Enros, page 107.
12. Ball, page 120.

Bibliography:
Babbage, Charles, *Passages from the Life of a Philosopher.* London: Longman, Green, Longman, Roberts & Green, 1864.

Ball, Walter William Rouse, *A History of the Study of Mathematics at Cambridge*. Cambridge: University Press, 1889.

Dubbey, J., *The Mathematical Work of Charles Babbage*. Cambridge, University Press, 1978.

Enros, Philip C., "The Analytical Society: Mathematics at Cambridge University in the Early Nineteenth Century." Ph.D. Dissertation, University of Toronto, 1979.

Winstanley, Denys Arthur, *Early Victorian Cambridge*. Cambridge: University Press,1940.