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History of Mathematics: A Global Cultural Approach

Organized by
Maarten Bullynck, Paris
Clemency Montelle, Christchurch
Volker Remmert, Wuppertal
David E. Rowe, Mainz

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Abstract.

The primary purpose of this workshop was to take account of progress on an ongoing six-volume cultural history of mathematics from antiquity to the present. This project is led by nine editors working with a large team of authors. Since the workshop had to be held remotely, it took the form of various group meetings held throughout the week. The final session involved assessments by editors of the six volumes with an eye toward completing the project by the end of 2021. The abstracts below summarize the contents of the individual chapters in the entire project, which will be published in Bloomsbury's cultural history series.

Mathematics Subject Classification (2010): 01A05.

Introduction by the Organizers

Culture, history, and mathematics are words that seldom appear together. Yet as the six volumes outlined below will demonstrate, mathematical activity has played a pervasive role in diverse cultures throughout human history. Indeed, these volumes represent merely an introduction to a vast and highly diverse range of developments that form an important component within and integral part of human civilization. Written by some fifty leading scholars, *A Cultural History of Mathematics* traces the many ways in which individuals and societies have interacted with mathematical phenomena from antiquity to the present. It also addresses the wide range of meanings and associations that have attached to the word mathematics. Originally, in the ancient Greek language, máthēma simply meant "that which one learns," though by the time of Plato and Aristotle the

discipline of mathematics was clearly associated with the study of numbers (arithmetic) and figures (geometry).

Since this project aims to provide an overall global history based on current scholarship, volume editors had to confront difficult choices about which topics and cultures to include. In doing so, they have tried to strike a balance between representative features of the period, on the one hand, and particular developments of long-term significance, on the other. All six volumes, the first two of which stretch over the ancient and medieval worlds, have placed special emphasis on the material culture of mathematical activities as well as on how mathematical knowledge changed over time alongside new forms of communication and circulation.

At the same time, each volume has its own distinctive character as described in the introductory essays written by their respective editors. Yet all six address seven general themes in as many chapters, which provide the overall structure for this project. Thus, each volume begins with three chapters – Everyday Numeracy, Practice and Profession, Inventing Mathematics – that deal with three different levels of mathematical expertise within the period under study. These chapters thus explore mathematics per se, as the notion evolved over time, whereas the three that follow – Mathematics and Worldviews, Describing and Understanding the World, and Mathematics and Technological Change – consider the larger impact of mathematics on other dimensions of human culture. Finally, the broader understanding of how mathematics manifests itself in other cultural spheres and what sorts of activities are deemed mathematical forms the subject of the final chapter on Representing Mathematics.

Workshop: History of Mathematics: A Global Cultural Approach

Table of Contents

Volume 5: Describing and Understanding the World in the Long Nineteenth Century

Scott A. Walter

The final quarter of the eighteenth century saw its share of revolutions. Among the changes brought about by the new French state was a closer alignment of science and technology with state interests, including the establishment of a variety of standards enforced by the power of the state. Among the most celebrated of the new French standards was the metric system of decimalized weights and measures. The meter, gram, and liter were prescribed, with the assistance of members of the Paris Academy of Sciences, for the measurement of length, mass, and liquid volume. The early years of the French Republic, soon to be overthrown by Napoleon, produced important institutional changes in the organization of science and technology with an impact that soon spread throughout Continetal Europe and beyond.

If the origins of this movement are to be found in France, the gathering of statistical data was also gaining momentum in Britain. Part of the motivation for this movement was provided by the Napoleonic Wars, as accurate census data were required in order to obtain satisfactory results from orders of conscription designed to expand the armed forces. In part, the British data-collection efforts were motivated by the social dislocation brought about by industrialization, and a concomitant fear of a French-style revolution on British soil. In Britain, as in France, the experts in calculation took an interest in the numbers produced by the new data-collection schemes. Led by Malthus, Charles Babbage, and others, a statistical section was formed in the British Association for the Advancement of Science in 1833.

Quantitative measurements concerned not only the natural but also the human realm, as the state apparatus collected "statistics", with which it meant to predict and control populations, from gathering data on birth, death, crime, education level, revenue, and the like. The acquisition of such statistics, combined with the use of mathematical modeling, gave rise, by the end of the century, to "economics". A new and important domain of application for probability arose in the aftermath of Darwin's theory of natural selection, which inspired his cousin Francis Galton to examine the statistics of human heredity. In a tangential way, statistical studies of the early 19th century further motivated the introduction of statistical reasoning in physics, a movement marked by the mid-century invention of kinetic gas theory by Maxwell and Boltzmann, and by Henri Poincarés new methods of celestial mechanics. At the end of the century, Max Planck put probabilistic arguments to use in order to express his law of blackbody radiation, setting the scene for the 20th-century revolution of quantum mechanics.

Alongside these developments, the 19th century, also saw the discovery of new forces and fields. By mid-century, Maxwell, building on Faraday's notion of "lines of force", proposed a unification of optics and electrodynamics, in a new theory of the "electromagnetic field". Although it took another twenty years to win over physicists, Maxwell's theory eventually opened up broad new horizons for physics

and technology. Most notably, the propagation of electromagnetic waves in air was demonstrated by Hertz, giving rise not only to wireless telegraphy, but to two revolutions of the 20th century: broadcast radio and radio astronomy. These two streams, electromagnetic field theory and probability, capture broad swaths of new mathematical thinking about the natural and social worlds in the 19th century. In some ways they were naturally antagonistic (particle vs. field), and yet they introduced a fruitful tension for a deeper understanding of the natural world.

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Volume 5: Mathematics and Technological Change in the Long Nineteenth Century

June Barrow-Green, Tony Royle

Mathematics underpinned much of the technological change witnessed throughout the nineteenth and early twentieth centuries. Advancements in transportation and innovative applications of electromagnetism provided a great deal of the impetus that would revolutionise many aspects of society. These were the two predominant threads within the fabric of technology that permeated and most influenced other areas of technological progress. Few would argue that the static steam engine was the salient device that powered the Industrial Revolution of the early 1800s, but it was its application to transport that sparked a fundamental change in methods of communication. The ability to move people and goods more efficiently over land and sea had a remarkable impact on life in general and radically influenced the way information was disseminated and exchanged. The ability to move information, goods, and people over ever-increasing distances in a timely fashion fostered efficient communication of ideas, bolstered economies, and enabled more frequent