Mehrtens, modernism, and modernity: An introduction

Lukas M. Verburgt

Independent scholar
Email: lukasverburgt@live.nl

This special issue takes a second look at the work of the German historian of mathematics and science—or, as at some point he preferred to call himself, "cultural scientist" ("*Kulturwissenschaftler*")—Herbert Mehrtens, who passed away on May 27, 2021 at the age of 75. More specifically, the contributors revisit key aspects of Mehrtens' oeuvre to reflect on its influence on the course of the historiography of mathematics and science from the mid-1970s onwards, and to consider its connection to the present priorities of these disciplines. In doing so, the essays do not just look back, tracing what new avenues of research Mehrtens opened up and what new themes, topics and approaches he engaged with—including contextualized national and social histories of mathematics, particularly under National Socialism, as well as the role of mathematical and technocratic modernism in shaping modernity. Rather, they also look forward, critically reflecting on Mehrtens' contributions in light of current scholarship and exploring how some of Mehrtens' historical-theoretical reflections are still inspiring fresh research today, and will likely continue to do so in the near future.

This brief introduction comes in three parts, which together form the background to, and set the scene for, the essays in this special issue of *Science in Context*: after a sketch of Mehrtens' intellectual biography, focused on the 1970s-90s and his work on scientific modernity (section 1), it introduces the theme of (counter-)modernism in mathematics (section 2), and concludes with a selected bibliography of Mehrtens' work (section 3).

1. A sketch of Mehrtens' intellectual biography

Herbert Mehrtens was born in Bremen, Germany in 1946.[1] In the summer of 1968, aged 22, he entered the University of Hamburg to study mathematics, history of science, and philosophy, driven by his political interests. He received his doctorate there in 1977 with a dissertation on the history of lattice theory, arguing that its emergence as a branch of pure mathematics was partly a technical and partly a social process.[2] As the American pioneer of lattice theory, Garrett Birkhoff (1911–1996), wrote: "By its faithfulness to truth, recognition of the importance of personality, and imaginative use of original sources, Dr. Mehrtens' thorough yet humane book sets a style which could be followed to great advantage . . . by other historians of mathematics" (Birkhoff 1980, 456). Despite this praise, Mehrtens later shifted his focus more and more from the history of mathematical ideas to the social history of mathematics. From 1977 to 1992, he went through a

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Dedicated to the memory of Herbert Mehrtens (1846–2021), whom I never met but whose work has been a constant source of inspiration for me and undoubtedly for countless others.

[1]The following biographical sketch is based largely on Reinhard Siegmund-Schultze's obituary of Herbert Mehrtens, to which the reader is referred for more detail and discussion: Siegmund-Schultze (2022). I would here like to express my sincere gratitude to Reinhard Siegmund-Schultze for his help and support in writing the biographical part of this Introduction.

[2]This dissertation was published as a book in 1979. See Mehrtens 1979.

period of what he himself called "scientifically productive unemployment," holding various temporary positions in (West) Berlin, including distinguished fellowships such as one at the Wissenschaftskolleg zu Berlin (1986-87).

Around the late 1970s, Mehrtens' research on the history of mathematics followed two closely related paths: empirical work on early nineteenth-century German mathematics and theoretical work on the methodology of the social history of mathematics. One important connection, in this regard, is the work of Thomas S. Kuhn, whose notion of "scientific community" Mehrtens adopted, and whose *The Structure of Scientific Revolutions* (1962)—particularly the concepts of "revolution" and "crisis"—he considered carefully in terms of their applicability to the history of mathematics. Following Michael Crowe,[3] Mehrtens' take on Kuhn was critical, and his thinking at the time was shaped more strongly by Marxist work, from the "classical" (Boris Hessen, Dirk Jan Struik, Joseph Needham) to the "Eastern" (Hans Wussing) and "Western" (Luke Hodgkin). But the fact that Mehrtens engaged with Kuhn's "new historiography of science" from the perspective of the search for a new historiography of mathematics is indicative not only of his forward-looking spirit, but also of his deliberate eclecticism. Together with Henk Bos, Ivo Schneider and several others, Mehrtens edited a highly influential collection on the interaction of mathematics and society, pioneering the study of social factors in histories of mathematics that still flourishes today.[4] Similarly, issues relating to the disciplinary and historiographical connections between the history of science and the history of mathematics are on the current scholarly agenda—though not as much they as could, or perhaps should, be.[5]

Furthermore, starting in the 1970s, Mehrtens was always willing to consider and incorporate insights from other disciplines—be they philosophy (Michel Foucault), history of science (Kuhn), sociology (Niklas Luhmann, Pierre Bourdieu) or, somewhat later, cultural studies (Clifford Geertz)—as these related to, and if they could help improve, the history of mathematics. As he wrote in 1981, for instance:

> Thus the best advice to the historian might be to ruthlessly exploit the offerings of theoretical disciplines while scrupulously checking the applicability and explanatory range of the pieces used against his empirical material. . . . Although I believe philosophy of mathematics to be necessary for historiography to some extent, I should rather argue that any philosophical prescription for historiography sets undue limits upon it. The historian has to be pragmatic about his conceptions of mathematics. Otherwise he will restrict his possibilities [e.g.] of approaching mathematics in different cultures. (Mehrtens in Mehrtens, Bos and Schneider 1981, 271 and 267).

Much like the connections between the history of science and history of mathematics, the question of whether and, if so, how philosophy of mathematics bears upon history of mathematics is very

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[3]In spite of the popularity of Kuhn's *Structure of Scientific Revolutions*, the question of the applicability of Kuhn's ideas to mathematics only started to attract sustained attention in the mid-1970s, from scholars including Stephen G. Brush, Ivor Grattan-Guinness, Joseph Dauben and, especially, Michael J. Crowe. Crowe's seminal 1975 paper sought to use the new historiography of science to examine the historiography of mathematics, only to conclude that revolutions practically never occur in mathematics. The debate was continued in 1992, when Donald Gillies published *Revolutions in Mathematics*. See Crowe 1975 and Gillies 1992.

[4]Mehrtens, like others writing in the 1970s, put the emphasis on institutional as well as national histories of mathematics, based on the belief that mathematics, of all forms of knowledge, "seems to be the least affected by social influences" (Mehrtens, Bos and Schneider 1981, ix). Hence, the focus was on "outside" influences *on* mathematics and "outward" influences *of* mathematics. Today, however, mathematics is being more and more widely seen as a social practice in itself. See the preface in Mehrtens, Bos and Schneider 1981. See also, in this regard, Bos and Mehrtens 1977. For recent work on mathematics as a (social) practice see, for instance, Ferreirós 2016.

[5]See, for instance, the contributions to the 2011 *Isis* "Focus: The History of Science and the History of Mathematics," introduced in Alexander 2011.

much alive today.[6] Alma Steingart explores various aspects related to this topic in her contribution to this special issue, "A Dangerous Preposition: The Boundaries of Mathematics," where she places Mehrtens' work in the wider context of developments in the field of the history of mathematics since the 1970s.

Already in 1978–79, Mehrtens moved away from the social history *of* mathematics towards the place of mathematics *in* society, as one part of what he called the "social sub-system in which systematic knowledge about nature is produced, translated, and disseminated" (Mehrtens in Mehrtens and Richter 1980, 41). During the 1980s, he focused on archival and theoretical research on the history of mathematics and science in Nazi Germany, which was then still largely unexplored territory.[7] This resulted in numerous articles, in German and English, and the volume—co-edited with Steffen Richter—*Naturwissenschaft, Technik und NS-Ideologie: Beiträge zur Wissenschaftsgeschichte des Dritten Reiches* (1980). Mehrtens was among the first to challenge historians' exclusive focus on the negative aspects for science of adaptation to Nazi ideology, informed, as it was, by the sometimes rather self-serving and/or apologetic post-1945 notions of scientific freedom and autonomy. Instead, Mehrtens argued that a more balanced and comprehensive view was needed to understand science in Germany in the 1930s-40s, one that made it possible to account for the structural relations between, and the interdependence of, science, industry, war and the state in this period, also at the level of (higher) education.[8] To paraphrase Mehrtens, only in war does pure science show itself: it offers not just speed, precision and efficiency but also—as a model of instrumental rationality *par excellence*—a royal road to establishing an ideology.[9] Hence, rather than assuming science's independence *from* politics, historians were called upon to study the creation of scientific independence *through* politics. Among the key concepts that Mehrtens introduced, in this context, were that of "irresponsible purity," "self-mobilization" and "collaborative relations," which highlighted different aspects of mathematicians' and scientists' active involvement in the Nazi regime's political projects (see e.g. Mehrtens 1993b; 1994).

Mehrtens' attempts at a more symmetrical perspective on science/mathematics-politics relations in the Third Reich culminated in an oft-reprinted article from 1987, but continued into the 1990s–2000s with several publications on "technocratic modernity" (Mehrtens 1987).[10] His work initiated a research program that is still being actively pursued and taken in novel directions, for instance through the study of the history of applied mathematics and the role of mathematics in WWI, WWII and geopolitics.[11] This is made vividly apparent in Mark Walker's and Mitchell G. Ash's essays in this special issue, entitled, respectively, "Collaborative Relations and Irresponsible Purity: Herbert Mehrtens' Transformation of the Historiography of Science, Medicine, Technology and National Socialism" and "Modernism, Modernity, and Politics in the General History of Science: Broader Implications of Herbert Mehrtens' Work." Walker describes in detail how Mehrtens almost singlehandedly created the now bourgeoning field of history of science, medicine and technology in Nazi Germany by breaking through a two-layered wall of

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[6]For interesting recent examples see, for instance, Epple 2011 and Barany 2020. See also the recent debate in the *Journal of Humanistic Mathematics*, e.g. Blåsjö 2014 and Fried 2014.

[7]The relevant archival sources, such as from the German Mathematicians' Association (DMV), were not easily accessible at the time. Mehrtens himself referred to the work of, among others, Alan Beyerchen, on the politics of physics, Karl-Heinz Ludwig, on engineers, and Paul Forman on German physics in the 1920s as pioneers of the serious study of history of science in National Socialist Germany. For an overview of work on mathematics in the Third Reich see Siegmund-Schultze (2009a).

[8]Mehrtens, in this context, also pioneered the study of mathematics education in Nazi Germany. See, for instance, Mehrtens 1993a.

[9]A fascinating collection, in this regard, is Erickson et al. 2013.

[10]As Ash shows in his contribution to this special issue, from the late 1990s onwards Mehrtens focused more and more on technological aspects of modernity, for instance in Mehrtens 2002.

[11]The literature, in this regard, is vast and ever-growing. For helpful starting points see Barrow-Green and Siegmund-Schultze 2015; Booss-Bavnbek and Høyrup 2003. Other works written in Mehrtens' wake include Ash and Söllner 1996; Siegmund-Schultze 2009b; Hoffmann and Walker 2012; and Mazliak and Tazzioli 2021.

"apologia" and "purity," standing in the way of serious historical scholarship. Reinhard Siegmund-Schultze, in his essay entitled "The Emergence and the Failure of an East-West-German Project (1988/89) on the 'History of Mathematics during the Nazi Period'," offers a first-person view of the historical situatedness, so to speak, of Mehrtens' bold and pioneering historical approach towards Nazi Germany. Ash, for his part, pulls together different threads from Mehrtens' oeuvre to bring out some of its broader implications for recent scholarship, for instance linking his work on mathematical modernism to histories of scientific and cultural modernisms and, via the notion of technocratic modernity, to the history of modernity itself.

During the 1980s Mehrtens also studied the Third Reich—more specifically its intellectual roots—from a less empirically-grounded, more theoretically-driven approach, as Siegmund-Schultze also points out. Mehrtens' research in this direction was initially oriented primarily around the figure of Felix Hausdorff, the well-known mathematician and Nazi victim (see Mehrtens 1980). It was in a 1984 German-language text that Mehrtens first discussed the broader topic of the connection between (pre-)fascist ideology, on the one hand, and scientific "modernity," on the other. The title of this paper was "Anschauungswelt versus Papierwelt: Zur historische Interpretation der Grundlagenkrise der Mathematik" ("World of Intuition versus World on Paper: Towards a Historical Interpretation of the Foundational Crisis in Mathematics"). Here, Mehrtens offered an account of the famous debate on the foundations of mathematics ('*Grundlagenstreit*') between L.E.J. Brouwer's intuitionism and David Hilbert's formalism.[12]

Mehrtens' account used Kuhn's terminology to criticize earlier philosophical-historical interpretations of the foundational debate. What these interpretations failed to recognize, in his opinion, was twofold. First, that the debate was a "crisis" in the Kuhnian sense of the word: the focus of working mathematicians on fundamental questions concerning the existence and very meaning of their objects of study was a deviation from their "normal" practice. Second, Mehrtens argued that, in terms of the professional interests and political positions of mathematicians, the crisis began before the foundational debate had "officially" started (i.e. with the set-theoretic paradoxes) and came to an end (largely for extra-mathematical reasons) without the conflict itself having been "resolved." The 1984 paper laid the basis for Mehrtens' major study of mathematical modernism in his 600-page *Moderne—Sprache—Mathematik: Eine Geschichte des Streits um die Grundlagen der Disziplin und des Subjekts formaler Systeme* (*Modernism, Language, Mathematics: A History of the Struggle over the Foundations of the Discipline and the Subject of Formal Systems*), published in 1990 by the prestigious German publishing house Suhrkamp, to which we will shortly turn.

Mehrtens initially remained unemployed even after the book's publication, working partly as a translator and journalist. But in 1992 he was appointed Professor of Modern History at the Technical University of Braunschweig, where he remained until his retirement in 2011. In this twenty-year period Mehrtens did not publish a lot, instead devoting himself primarily to teaching students and working with colleagues.[13] Between 1992 and 2011, he did, however, publish a number of German-language articles which arguably deserve more attention. Here, Mehrtens took his earlier work on the history of mathematics and science in exciting, and perhaps even more ambitious, new directions, exploring the connections between modernism and modernity in the twentieth century and beyond.

2. Modernism and counter-modernism

To some colleagues and friends around him, Mehrtens' 1990 book (Mehrtens 1990), originally written in the late 1980s as his German habilitation thesis, must have come as somewhat of a

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[12]In this context, one is hard-pressed not to think of the possible connections—yet to be explored—with Bellone 1980.

[13]Some notable, and substantial, contributions from this period, indicative of Mehrtens' wide-ranging interests and pioneering spirit, are Mehrtens 2002 and Mehrtens 2004.

surprise. Its aim was to understand the radical transformation that mathematics went through over the course of the nineteenth and early twentieth century, not just on an institutional, biographical, ideological and political level, but also on the ontological ("what are mathematical objects?") and epistemological ("how are mathematical objects known?") levels. In doing so, a central question for Mehrtens was the relation between this transformation and the broader modernization of society, science and culture, covering topics from bureaucratization to professionalization. Indeed, though the idea itself was not new (Ernst Cassirer, for one, elaborated it as early as in 1910), Mehrtens was arguably the first historian of mathematics to address the theme of "mathematical modernism" in detail (see Cassirer 1910). But the bulk of the book was devoted to a philosophical—and at times rather speculative—analysis, introducing semiotics and psychoanalysis into the history of modern mathematics, which is arguably what made it "one of the most provocative and original contributions to the history of mathematics ... in recent decades" (Rowe 1997, 534).

At the core of Mehrtens' analysis stood the idea that the modernization of mathematics took place in terms of a dialectical process between two currents—"modernists" (*die Moderne*) and "countermodernists" (*die Gegenmoderne*).[14] This process, Mehrtens argued, could be traced back to the late-nineteenth century, but had reached a climax in the 1920s foundational debate and beyond, in Bourbaki's post-WWII work from the 1940s–60s. These currents were not to be understood in terms of a simple opposition, but as a genuine ambiguity inherent in the very idea of modernity. Both sides offered views that were contradictory and complementary, needing each other to fully express themselves in a way that, in Mehrtens' post-Marxist view, reflected the wider cultural and social changes of modernization itself.[15] Importantly, this explains, for instance, why Mehrtens labelled Felix Klein, Henri Poincaré, L.E.J. Brouwer, and several others as *counter*modernists and not *anti*modernists: they were part of, rather than standing outside, the process of modernization.

What separated the modernists from the countermodernists was not at the level of the regular discourse *of* mathematics. Rather, it pertained to the discourse *on* mathematics, where the nature and meaning of mathematics is discussed at. Mehrtens went so far as to portray the *Grundlagenkrise* as a clash not over the *foundations* of mathematics but over *mathematics* as such. In other words, a conflict not over mathematics as a product but over the production of the mathematical, so to speak. Other ways of putting this are to say that modernists and countermodernists advocated different "self-understandings of mathematics," or that theirs was a struggle on the level of "reflexive mathematical knowledge," having to do primarily with the "image" rather than the "body" of their own discipline, with what counts as mathematical *per se* rather than with this or that subject matter.[16]

For modernists like Richard Dedekind, Georg Cantor, Bernhard Riemann, Hausdorff and Hilbert, mathematics was nothing other than the manipulation, according to certain rigorous rules, of symbols on paper. These symbols do not represent or refer to anything outside or beyond the written text, be it idealized or Platonic objects. This position views mathematics—in the sense of axiomatic systems—as entirely self-referential, the validity of its knowledge resting exclusively on formal criteria such as internal consistency.

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[14]Perhaps because Mehrtens' book has not been translated into English, in the available literature the terms "modernity/countermodernity" and "modernism/countermodernism" (and, similarly, "modernists/countermodernists" and "moderns/countermoderns") are sometimes used interchangeably. Since modernism and modernity refer to different phenomena, and tend to have different meanings in different disciplines, this can lead to confusion. Without wanting to push for a certain interpretation, I take Mehrtens to have been interested in several main topics at once: the place of mathematics in modernity, the modernization of mathematics, and modernism in mathematics. As such, the use of, for instance, "modernist" or "modern" to refer to a particular mathematician from the period should, strictly speaking, depend on the context. In this Introduction, I have opted for the pragmatic strategy of not "mixing and matching" the two terms.

[15]For (critical) accounts of Mehrtens' position see, for instance, Corry (2023); Epple 1996; and Gray 2008, 9–12.

[16]For this reading see Hesseling 2003, 340; and Corry 1993.

The countermodernists opposed this view and maintained, instead, that mathematics is rooted in some primordial ground, such as (*a priori*) intuition or (mental) synthesis, from which its objects are constructed step by step. This alternative was "modern" insofar as it also abandoned the idea of a transcendent reality. It was countermodern because it preserved a certain kind of reality for mathematics, making it contentful (i.e., about something) and finitary (i.e., constructed in human thought). On this basis, Brouwer, alongside Hermann Weyl and, somewhat later, Arend Heyting, famously abandoned large parts of classical ("infinitary") mathematics and created an entirely new ("intuitionistic") alternative.

Much has been written about this in terms of the titanic clash between Hilbert and Brouwer over the future of mathematics.[17] What mattered most about the modern/countermodern distinction for Mehrtens was its relevance to understanding mathematics in relation to its social and political reality—by which it was shaped and which it helped shape. This reality was that of Western modernity, which Mehrtens, much in the spirit of Adorno and Horkheimer, did not equate with progress, viewing the catastrophe of Nazism very much as its culminating crisis. Mehrtens' analysis draws attention, for instance, to the modernists' role in unleashing an "instrumental rationality" of rationalization, objectivity, and effectiveness as well as to Nazi theorists, such as Ludwig Bieberbach, who turned the countermodern notion of intuition into a racial category.

Nonetheless, when compared to his earlier work from the 1980s, *Moderne—Sprache—Mathematik* is primarily theoretical. This is arguably both its strength and its weakness. It is a strength because it offers imaginative and fruitful conceptual tools for the study of twentieth-century mathematics, as some of the contributors to this special issue, namely Michael Friedman, Jeremy Gray, and David E. Rowe, forcefully show. For this reason alone, Mehrtens' *Moderne—Sprache—Mathematik*, which has never been translated out of German and is now out of print,[18] deserves praise. But in their essays, Friedman, Gray and Rowe also draw attention to some of the limitations of Mehrtens' book, while presenting these primarily as having inspired new and ongoing work.

One criticism levelled at Mehrtens has been that his account has an "oddly Hegelian ring" to it (Gray 2008, 11). In the end, the central figures in Mehrtens' narrative appear too much as small cogs in the dialectical machine. Whether or not this criticism is just, it sits well with other criticisms, pertaining for instance to Mehrtens' narrow geographical focus—a small number of protagonists (all Western European, most of them German, and all of them men), his narrow disciplinary focus—pure mathematics in isolation from applied mathematics and physics, his attempt to fit all relevant developments and figures into the categories of modern and countermodern, and his apparent failure to connect these to his own earlier work on the Nazi period. Each in their own way, Friedman, Gray and Rowe take up one or more of these criticisms, and contribute to attempts at nuancing and complicating Mehrtens' work as well as at expanding its scope in terms of geographies (e.g. Italy, Russia), disciplines (e.g. physics, logic) and gender (e.g. Emmy Noether, Iris Runge).[19]

Friedman, in his "Mathematics at the Oflag: On 'Self-Mobilization' in Captivity," focuses on the French mathematician Bernard d'Orgeval, who worked for several years in captivity in a war camp ("Oflag"). He links Mehrtens' work on mathematics in Nazi Germany to the modern/countermodern distinction, showing how their combination leads to a more complicated problem-situation. Gray, in "Poincaré and Counter-Modernism," makes a comparable move by zooming in on Henri Poincaré, arguing that he was modernist in some ways, counter-modernist in

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[17]A good starting point for further exploration is Mancosu 1998.

[18]I would like to seize upon this opportunity to call upon those with enough time and energy to take up the task of preparing an English translation of Mehrtens' 1990 book.

[19]For examples of recent research in these directions see Mazliak and Tazzioli 2009; Niederbudde 2006; Galison, Gordin and Kaiser 2001; Koreuber 2015; and Tobies 2012.

others. The case of Poincaré points to, and opens up, an entirely new avenue of research for "Mehrtensian" scholarship, also highlighted in Ash's contribution: that of historicizing modernism in the (exact) sciences as part of the larger process of modernization taken up in Mehrtens' *Moderne—Sprache—Mathematik*. Finally, Rowe, in his essay, "Brouwer and Hausdorff: On Reassessing the Foundations Crisis," pursues a different approach, in a sense using Mehrtens' earlier work on social history of mathematics to revisit the 1920s foundational crisis. Rowe, continuing and strengthening a reinterpretation initiated by Mehrtens in a 1984 paper, argues that the nature of the epoch-making crisis as well as of its "solution" had less to do with intellectual arguments than with personal and disciplinary tensions within the international mathematical community. Together, Friedman, Gray, and Rowe's essays provide a small *tour d'horizon* of the many possible ways in which Mehrtens' work on the history of modern mathematics inspires new research, both within and—as Walker and Ash point out—beyond this field. Steingart, in her essay, adds to this by writing about Mehrtens in the context of topics within recent and contemporary history of mathematics, such as computing and axiomatics.

Much more remains to be said about the legacy of Mehrtens' work as it will unfold in the years to come. For one thing, today it continues to influence not just the disciplines within which Mehrtens himself was active—history of science and history of mathematics—but also several other fields at the borders of his expertise. Within literary studies, for instance, the study of modernism and mathematics has seen a recent growth, with several monographs having appeared since the turn of the century.[20] Another example is the booming research on the history of science policy and science diplomacy and their role in shaping the post-WWII world.[21] Such influences, whether explicit or more tacit, can themselves be taken as signs of disciplinary cross-fertilization, for which some of Mehrtens' concepts (e.g. "irresponsible purity," "modern/countermodern") are continuing to prove highly fruitful. This is one reason why a second look at the work of Mehrtens means not just looking back but also looking forward to what lies ahead.

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[20]For a helpful overview of the literature, in this regard, see Engelhardt 2021.

[21]For recent examples see Kaldewey and Schauw 2018, and Wolfe 2018.

[22]This bibliography presents only a small selection of Mehrtens' publications, focusing almost exclusively on those which are available in English (translation). It has been compiled for the benefit of those not yet familiar with Mehrtens' work or eager to explore different aspects of his oeuvre. For a much more complete bibliography of Mehrtens' work see Siegmund-Schultze (2022).

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Lukas M. Verburgt is currently an independent scholar based in the Netherlands. A fellow of the Royal Historical Society, he has held visiting research positions at the Max Planck Institute for the History of Science, Trinity College, Cambridge, and Leiden University. His work concerns the changing relationship between science and philosophy, as well as the historical study of those fields, in the period from 1800 to the present.