BOOK REVIEW

Alma Steingart, *Axiomatics: Mathematical Thought and High Modernism* (Chicago: The University of Chicago Press, 2023), pp. 300, $105 (hardcover). ISBN: 9780226824185.
doi: 10.1017/S1053837224000294

Axiomatics is written from the perspective of mid-century American mathematicians, with the purpose of drawing a general picture of mathematical thought and high modernism, to then account for how mid-century abstract axiomatic language spread out in various American academic fields. This means that instead of focusing on localized interactions between mathematicians and economists, social scientists, and humanistic scholars, or instead of attempting to show how economics was mathematized, as done, for example, by Roy Weintraub (2002), Alma Steingart seeks to show how mathematicians' abstract axiomatic modernist mode of thinking came to dominate a large spectrum of mid-century American intellectual thought. Because of this approach, contributions in the history of various fields like economics and mathematics are somehow folded to maintain the narrative coherence of the book, which offers, however, a very important historiographical contribution.

By exploring the intersection of mathematical modernism with developments in the humanities and social sciences, the author sheds new light on the intertwined histories of axiomatics, abstraction, and modernism to address the historiographical conundrum of mid-century American axiomatics. Mathematicians adhered to a Neoplatonic perspective of their field, highlighting the dual nature of axiomatics, accounting for both the purity and the utility of mathematics, and emphasizing the connection between axiomatics and the autonomy of esthetics. This Neoplatonic adherence situates axiomatics within the scope of the history of the humanities but creates tensions with the histories and philosophies of science, of which mathematics is also part, but which have traditionally rejected Neoplatonic mysticism since the 1960s. Steingart brings together the history of mathematics, the history of natural and social sciences, and intellectual history, recognizing the challenges in bridging analytical philosophy with conceptual history and the history of science with the history of ideas.

In addition to an introduction and epilogue on visualization, the book comprises six chapters exploring different dimensions of abstraction. Chapters 1, 2, and 5 delve into pure mathematics, applied mathematics, and the unreasonable usefulness of mathematics, respectively. Chapters 3 and 4 connect mathematical abstraction with the social sciences and humanities. The sixth chapter, "Historical Abstraction," provides the rationale that ties the book's themes under the umbrella of modernism, drawing on structural ideas about language. All started when, around 1900, Gottlob Frege and Bertrand Russell questioned David Hilbert's axiomatic abstractionist concept formation. Frege's and Russell's analytical philosophy and symbolic logic, expanded by Viennese logical positivists and Ludwig Wittgenstein in the 1920s and 1930s, aimed to establish a structural metaphysics-free symbolic language useful to fix the meaning of concepts.

ISSN 1053-8372 print; ISSN 1469-9656 online/24/000001-4

In this analytical conception of knowledge, the meaning of concepts was inseparable from their use in language. By reflecting on these trends, Steingart uses Thomas Kuhn's idea of science as an activity evolving through paradigms identifiable through scientists' language and Quentin Skinner's emphasis on the rhetorical use of concepts. She then shifts historian of mathematics Leo Corry's distinction between the body and the image of mathematics into a qua-linguistic category, differentiating between mathematicians' synchronic analysis in their axiomatic work and their diachronic approach to history and meaning. This leads Steingart to treat mathematicians' statements about mathematics and its history as evidence of their axiomatic language, rhetorical use of which she takes as proper axiomatic practice. Through reports from mathematicians of different generations from the 1930s to the 1970s, she reconstructs discussions and controversies within national mathematical associations, exploring mathematicians' epistemology and evolving contingencies.

Mid-century American mathematicians adopted Hilbert's axiomatics as their primary theory of knowledge and methodology, shaping the community until the 1970s. Steingart argues that axiomatics fostered a synchronic analytical perspective aligning with modernist ideals of analytic formal systems (in art and linguistics) and prioritizing pure abstraction. She traces the long history of abstraction in intellectual thought, noting an etymological reversal when mathematicians began defining mathematics based on arbitrary rather than phenomenological propositions. By viewing axiomatics and abstraction as interconnected structural qua-linguistic theories of knowledge, Steingart connects the history of axiomatics with high modernism in America, drawing parallels with the modernist crisis of meaning affecting mathematics and other fields. Despite axiomatic analysis sidelining contingency, mid-century mathematicians also engaged in diachronic explorations, seeking deeper meanings and continuity in the historical changes framing their field.

In chapter 6 Steingart argues that mathematicians' use of history and rhetoric is better understood from the perspective of recent reinterpretations of humanistic authors like Arthur Lovejoy, who suggested that ideas had their own logic, shaping conclusions beyond their users' awareness. In their quest for meaning in the historical records, she argues, mathematicians sought an epistemological-practice-based understanding of continuity rather than an ontological meaning of concepts. Steingart positions then mid-century American mathematical thought as a middle ground between analytically fixing concepts through axiomatics and humanistically recognizing that conceptual meaning was not confined to any fixed axiomatic system because uses of concepts continuously evolved. This epistemological middle ground, she holds, characterized the modernist conception of mathematics, portraying it as a field permanently in the making.

Steingart explains in chapter 1 that since the 1930s, trained American mathematicians treated axiomatic abstraction to continuously achieve greater generality, akin to modernity itself. This process involved constantly rewriting the relationships between binaries in mathematical research, such as signified and signifier, leading mathematicians to continually revise and restructure mathematical theories. Constructed from abstraction upon abstraction, axiomatic language provided unity to a field that was no longer primarily concerned with solving worldly problems. Believing in a qua-linguistic structural division between the analytical and phenomenological aspects of a theory (like Rudolf Carnap and other logical empiricists), the author holds in chapter 2, mathematicians abandoned scientists' traditional inductive and experimental methodologies

and adopted (unlike Carnap and other logical empiricists) a purely deductive approach. To accentuate the utility of mathematics, mathematicians emphasized individual professional value judgment and used the axiomatic method to reformulate worldly problems. Fields like operational research, communication theory, computing, and game theory showcased this shift, highlighting mathematicians' belief that decontextualized analysis was the best response to the fallibility of human rationality and Cold War political anxieties.

In chapter 4 Steingart defends the idea that modernism's constant reformulation led mathematicians to regard mathematics as a creative activity, analogical to art, and therefore as a humanistic endeavor. They saw their main task as bringing abstract objects to life, valuing the freedom and creativity of axiomatics as protection against the Cold War utilitarian conception of science. Not mere rhetoric, assessments like these made esthetic considerations central to mathematical thinking and favored transformations through which, like modern art, mid-century abstraction mathematics came to emphasize form over subject matter and to separate esthetics from social and political concerns. Steingart thus connects the histories of axiomatics and art formalism, highlighting an epistemological commitment to the autonomy of esthetics in both fields.

In chapter 5 Steingart explains that the discursive value-free and apolitical nature of axiomatics allowed mathematicians' modernist abstraction to flourish in Cold War American thought. Despite financial pressure to focus on practical applications due to governmental and military funding, mathematicians preserved their disciplinary autonomy in research and education by stressing the importance of abstract formalism. They argued that this approach underpinned the applicability of mathematics. In the 1960s both pure and applied mathematicians embraced Eugene Wigner's idea that the applicability of abstract mathematics was a mysterious but empirical law of mathematical epistemology. While this discursive strategy enabled them to present knowledge for its own sake and analytical realism as the two sides of the same coin, it also entailed transforming mathematicians' understanding of mathematization and the relation between theory and phenomena.

In chapter 3, "Human Abstraction," Steingart argues that the mathematization of mid-century social sciences in McCarthy's America involved a shift away from associating mathematics with quantities and measurement. Social scientists, especially in psychology and economics, began using mathematics for theoretical construction and conceptual clarity. By redefining meaning on axiomatic grounds, this shift transformed what counted as theory and promoted the belief that pure abstraction was useful and essential for discovering social regularities. Here lay the main influence of axiomatic thinking in social sciences: it created a clear qua-linguistic separation between analytic formalism and empirical phenomena by offering economy of thought, as the ability to reinterpret axiomatic systems over and over again, easing the determination of structural connections necessary to uncover inner relations, and settling the idea among social scientists that the essence of things was never evident but always hidden beneath the surface of the language of axiomatics. This separation meant that sound theory in social science relied on axiomatic thinking rather than mathematical technique, with the meaningfulness of theories tested by their conclusions, not their assumptions. Thus, Steingart argues, axiomatic thinking fostered the predominance of deductive approaches in mid-century American social sciences.

By the 1960s Thomas Kuhn's and Quentin Skinner's work had contributed to separate the history of science from intellectual history. Concomitantly, the focus on abstraction in mathematics caused a split between mathematicians and other scientists, as well as between older and younger mathematicians, with the latter being overspecialized and less familiar with theoretical physics than older generations. In the 1970s, Steingart notes in the epilogue, computerized visualization of otherwise abstract mathematical objects led mathematicians to challenge the abstractionist and universalist views of their predecessors. This visual technology blurred the lines between pure and applied mathematics, breaking down the previous hierarchy and rekindling connections between art and mathematics that had been neglected by mid-century American mathematicians.

In brief, Steingart convincingly reintroduces mathematics into the discussion of mid-century American intellectual thought by highlighting the significance and qualinguistic embeddedness of abstraction in the modernist movement that shaped axiomatics and art formalism. She suggestively urges historians of economics, social science, and the humanities to regard mathematics as a continuously evolving discipline primarily concerned with reformulating worldly problems based on deductive methods, and not with observation and quantification related to inductive approaches. Inductive methods, however, never vanished from economics and social science. Additionally, the book raises the historiographical puzzle of why (theories of) visualization became relevant to mathematicians only in the 1970s, despite their earlier emphasis on axiomatics as a creative activity akin to art, including visual art, in which esthetic concerns were epistemologically relevant. An open-ended contribution, as I interpreted this book, *Axiomatics: Mathematical Thought and High Modernism* is highly recommended for readers of this journal interested in the recent history of (mathematical) economics.

Juan Carvajalino
Université Paris 8 Vincennes Saint-Denis

COMPETING INTERESTS

The author declares no competing interests exist.

REFERENCES

Weintraub, Roy. 2002. *How Economics Became a Mathematical Science*. Durham: Duke University Press.