Modernism, Fiction and Mathematics

Reviewed by Johann A. Makowsky

Modernism, Fiction and Mathematics
Edinburgh Critical Studies in Modernist Culture
Nina Engelhardt

1. The Book Under Review

Nina Engelhardt's book is a study of four novels by three authors: Hermann Broch's trilogy *The Sleepwalkers* [1], Robert Musil's *The Man without Qualities* [8], and Thomas Pynchon's *Gravity's Rainbow* and *Against the Day* [12, 13].[1]

Her choice of authors and their novels is motivated by the impact the mathematics of the interwar period had on their writing fiction. It is customary in the humanities to describe the cultural ambiance of the interwar period between World War I and World War II as *modernism*. Hence the title of Engelhardt's book: *Modernism, Fiction and Mathematics*. Broch and Musil are indeed modernist authors par excellence. Pynchon is a contemporary American author, usually classified by the literary experts as postmodern.

Engelhardt's book is interesting for the literary minded mathematician for two reasons. First of all it draws attention to three authors who spent a lot of time and thought in studying the mathematics of the interwar period and used this experience in the shaping of their respective novels. Broch (1886–1951) and Musil (1880–1942) were Austro-Hungarians and wrote in German. They were translated into English[2] immediately after World War II and are recognized by connoisseurs and experts as the German language counterpart of Joyce and Proust. However, even in the German language world they are not widely read, both because of the length of their novels and the demanding complex narrative. Pynchon is also known for his lengthy novels and vast erudition and is read mostly by his literary enthusiasts. All three authors deserve the attention of a wider audience among mathematicians and scientists, as I will expound below.

The true merit of Engelhardt's book lies in its perspective. Without falling into the trap of over-interpretation, she discusses the interplay between modern mathematics and its foundational crisis and the development of the fictional characters described in the novels. She uses the modernist perspective cautiously to put the novels into the wider cultural context of the prewar and interwar period in central Europe, and she successfully avoids making wrong statements about the mathematics of this period.

To understand Engelhardt's goal I will have to explain how the notion of *modernism* can be understood so that it applies to both mathematics and literature. I then will explain why Engelhardt's choice of these four novels is justified by examining the mathematical background of the three authors Broch, Musil, and Pynchon. I will also indicate that, in a further study along the same lines, a close examination of Hesse's *Glass Bead Game* should be a valuable addition.

Engelhardt's view of the "modernist transformation" of mathematics is close to what Quinn describes in the *Notices* [14], although slightly less precise. In Engelhardt's words the impact of this "modernist transformation" on

Johann A. Makowsky is a professor emeritus at the computer science department of the Technion - Israel Institute of Technology. His email address is janos@cs.technion.ac.il.

[1] *An expanded version of this review can be found at* https://arxiv.org/pdf/1907.05787.pdf.

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[2] *The first translation of* The Man Without Qualities *in English was published by Ernst Kaiser and Eithne Wilkins in 1953, 1954, and 1960.*

H. Broch in 1909

R. Musil in 1900

T. Pynchon ca. 1957.

fiction consists in the development of autonomy and independence from the natural world, almost a kind of escapism into possible worlds. Musil's *man without qualities* is a *man of all possibilities*.

Engelhardt's monograph offers the readers a new framework of textual and cultural analysis in which one can understand the modernist and postmodern interplay of literature and mathematics. In her own words:

> *"In the revaluation of mathematics during its foundational crisis, the certainty and rationality of this most certain science is challenged, and the novels accordingly employ mathematics as an example for the dramatic transformation of the modern West, the wider loss of absolute truth, and the increasing skepticism towards Enlightenment values. Crisis, however, also implied some freedoms and opportunities for literature and criticism. When the developing modern notion of mathematics is defined by autonomy and independence from the natural world, it bears traits more commonly associated with literary fiction, and the novels examine the possible convergence of mathematics and literature in the freedom of imaginary existence. The novels thus highlight the unique position of the structural science mathematics in the relation of the (natural) sciences and the humanities and suggest it to escape or straddle the perceived divide between the disciplines."*

Engelhardt's goal in this study is to put the interplay between fiction and mathematical conceptualizations of the world into its historical context. She sees her work as a beginning for further studies on the role of mathematics, not only modern, in fiction in the wider field of literature and science.

It is fair to say that in her book Nina Engelhardt does succeed in giving us an inspiring *tour d'horizon* of this interplay. If some readers of this review pick up only one of these novels and start reading it (possibly but not necessarily together with the relevant chapters of Engelhardt's book) they will be amply rewarded. Hopefully, these readers will then look for the necessary leisure time to go on reading more.

2. Modernism

What is modernism? Modernism as a phenomenon in European culture is traditionally associated with the emancipation of art and science from their exclusive role in representing the true view of the world based on the notion of immediate perception. Kantian epistemology was questioned throughout the 19th century, a cultural pessimism blossomed and the church's monopoly on the sovereignty of interpretation of the true world was shattered. Its breeding ground was the social changes in the period of intense industrialization before and after WWI.

I do not think that there is a causal connection between the various manifestations of modernism. It is more natural and convenient to see it as a confluence of various developments of social, technological, and even political character.

Certainly, some of these developments are interconnected, but not always in an obvious way. The discovery of non-Euclidean geometry definitely was not a result of social or political changes, neither was the emergence of relativity theory in physics, nor the discovery of the periodic table in chemistry, nor the discovery of the Mendelian laws in biology. On the other hand, discoveries in the natural sciences and technological progress are interrelated, and there is no doubt that social and political developments were partially accelerated by technological advances. Nina Engelhardt's book deals with the interplay of modernism in literature and modernism in mathematics. The former can indeed be seen as a general socio-cultural phenomenon. However, the latter is the result of exclusively internal developments within mathematics.

Modernism in art, music, and literature. In painting, the advent of photography, the rise of the industrial bourgeoisie, the changing socio-economic conditions for painters, the confrontation with and the influence of

non-European art brought about by colonialism, and the discovery of non-Euclidean geometry, all may have played a role in the development of abstract painting. Painting stopped being the "true picture" of the world.

In music, the advent of acoustic recording played the same role as photography in painting, and the new discoveries of Helmholtz and others in acoustics played a similar role to the discovery of non-Euclidean geometry. The encounter with non-European music together with the changing social standing of professional musicians opened the way for experimentation. Twelve-tone music was not only developed by Arnold Schoenberg and his followers in Vienna but also by Nikolai Roslavets in Russia.

In literature the modern and modernist trends are more varied, and it is difficult to bring them into a coherent picture. Trends in poetry, drama, and prose are diverse. Influences of philosophy are divergent. Schopenhauer, Nietzsche, Bergson, and Kierkegaard were among the influential cultural pessimists. Ernst Mach, Carl Stumpf, Edmund Husserl, Ernst Cassirer, the Neo-Kantians, and the philosophers of the Vienna Circle (re)examined the nature of perception and the scientific method, and altered our epistemological outlook.

For our discussion here, it is noteworthy that among the German language authors of novels Hermann Broch, Hermann Hesse, Thomas Mann, and Robert Musil (in alphabetical order) are considered paradigmatic for modernist prose in German. The same holds for James Joyce in English and Marcel Proust and Paul Valéry in French.

Modernism in mathematics. Modern mathematics is largely the result of two internal developments in mathematics: the discovery of non-Euclidean geometry and the emergence of set theory. In the years between 1874 and 1897 Georg Cantor created set theory single-handed, followed by Felix Hausdorff's *Grundzüge der Mengenlehre* from 1914 and in 1899 Hilbert published his *Foundations of Geometry* [6] and started emphasizing the use of axiomatic methods. To the readers of the *Notices*, "modernism in mathematics" may sound familiar from Yuri Manin's review [7] of Jeremy Gray's *Plato's Ghost: The Modernist Transformation of Mathematics* [4], and from Frank Quinn's *A revolution in mathematics? What really happened a century ago and why it matters today* [14]. In his review of [4] Solomon Feferman [3] describes "modern mathematics" as follows:

> *"Modern mathematics–in the sense the term is used by working mathematicians these days–took shape in the period from 1890 to 1930, mainly in Germany and France. Strikingly new concepts were introduced, new methods were employed, and whole new areas of specialization emerged, while other themes were relegated to the dusty shelves of history. At the same time, the nature of mathematical truth and even the consistency of mathematics were put into question, as mathematicians, logicians and philosophers grappled with the subject's very foundations. […] modernism is defined as an autonomous body of ideas, having little or no outward reference, placing considerable emphasis on formal aspects of the work and maintaining a complicated–indeed, anxious–rather than naive relationship with the day-to-day world."*

Books reflecting the spirit of modern mathematics are sometimes called "Modern Algebra" (van der Waerden), "Modern Analysis" (Dieudonné, Rudin), and the modern approach culminates in Bourbaki's unfinished multivolume enterprise.

In order to appreciate Nina Engelhardt's book we can summarize the modernist aspect of (modern) mathematics as follows: the intuitive notion of mathematical truth (facts) is replaced by the axiomatic description of relationships where the only concern is consistency. Mathematics passes from describing the true world to describing mere possibilities.

Formalists vs intuitionists. One of the first modern(ist) mathematicians who was also a successful philosopher, playwright, and essayist was Felix Hausdorff. He started his career as a successful writer under the name of Paul Mongré, and his writings could easily be classified as modernist. In 1903/04, in his lecture course *Time and Space* he remarked[3] about mathematics in general, reflecting on Hilbert's view on the axiomatic method:

> *"Mathematics stands completely apart not only from the actual meaning that one attributes to its concepts but also from the actual validity one ascribes to its propositions. Its undefinable concepts are arbitrarily chosen objects of thought, its axioms are also arbitrary, though chosen so as to be free from contradiction. Mathematics is the science of pure thought, just as formal logic."*

His literary works were mostly published between 1897 and 1904 and consisted of a volume of poems, a play, a book on epistemology, and a volume of aphorisms. He wrote no novels, and as a philosopher he was mostly influenced by the younger Friedrich Nietzsche. However, he was in correspondence with Moritz Schlick, the founder of the Vienna Circle, and seemingly influenced Schlick's early views on time and space.

The modern(ist) view of mathematics led to heated debates in continental Europe between Formalists and Intuitionists, with heavy political overtones. In philosophical circles such as the Vienna Circle around Hans Hahn and Moritz Schlick, and its Berlin version around Hans Reichenbach, this view led to a new and very strict definition of what constitutes the scientific method. The two philosophical circles were also influenced by Ludwig

[3] *Quoted from* [10].

Wittgenstein and the emergence of mathematical logic. Both Kurt Gödel and Karl Menger were students of Hans Hahn. Among the eminent mathematicians Karl Menger was an active member of the Vienna Circle and David Hilbert became a member of the Berlin Circle.

3. Modernist Writers and Mathematics

While I studied mathematics in the late 1960s I was preoccupied with the question of the nature of mathematical thought. I read a lot of material pertaining to this question: philosophy, psychology, neurology, and also literary works. Among the latter I came across five authors who struck me as significantly influenced by modern mathematical and/or musical thought: Paul Valéry, Robert Musil, Hermann Broch, Hermann Hesse, and to a lesser extent Thomas Mann. All of them are Europeans who wrote mostly before WWII. Broch and Musil are among the subjects of Engelhardt's book. Valéry, Mann, and Hesse are not. That Valéry and Mann are excluded may be justified. However, I will argue below that Hesse could (or even should) have been included. Thomas Pynchon is American and contemporary and writes in English. Engelhardt's book originated as a PhD thesis from 2012 in the department of English Literature at the University of Edinburgh, *Mathematics in literature: modernist interrelations in novels by Thomas Pynchon, Hermann Broch, and Robert Musil*. Pynchon's two novels both deal with mathematics and science, and are set partially in continental Europe of the period of Broch and Musil. I will also briefly discuss why Pynchon, besides fitting a thesis in the department of English Literature, is a major author discussed in Engelhardt's book.

Hermann Broch and the Vienna Circle. Hermann Broch was born in 1886 in Vienna to a prosperous Jewish family and worked for some time in his family's factory. As the oldest son, he was expected to take over his father's textile factory, therefore, he attended a technical college for textile manufacture and a spinning and weaving college. Although he had from early on philosophical, mathematical, and literary interests, he pursued them only privately, mostly at night, while managing the textile factury during the day. In the years 1904–1905 he attended seminars and public lectures in mathematics and philosophy at Vienna University, especially those given by Ludwig Boltzmann.

After an unsuccessful marriage which led to divorce in 1923, he sold the textile factory in 1927 to devote himself full time to his intellectual interests. He studied mathematics, philosophy, physics, and also psychology and cultural history at the University of Vienna. Philosophically he was, like Hausdorff, first under the influence of Schopenhauer, Nietzsche, and Weininger, but later turned to neo-Kantian philosophy and logicism and got involved with the Vienna Circle, siding with Wittgenstein and Menger rather than being a strict positivist. From 1913 on he started to publish philosophical essays.

Broch studied at Vienna University until 1930 having among his teachers M. Schlick, R. Carnap, Hans Hahn, and Karl Menger.

Originally he was more interested in a scientific career and wanted to write a PhD, but he became discouraged, due to his lack of knowledge of Latin, which was at that time a compulsory subject for getting a PhD. The goal of writing a thesis in mathematics was delayed indefinitely and finally abandoned also because of his disenchantment with science due to its increased specialization. It is during this period that he wrote his trilogy *The Sleepwalkers* published in 1931 which marked the beginning of his career as a novelist, and which became known as a modernist novel par excellence. He also wrote a novel, *Die Unbekannte Grösse* [2] inspired by the events around Einstein's theory and its experimental verification during an eclipse visible only in the southern hemisphere. Among the writers whom Engelhardt discusses, H. Broch is definitely the most mathematically educated.

Robert Musil and the Berlin Circle. Robert Musil was born in 1880 in Klagenfurt (Austria) into a middle class family. His father was a professor of mechanical engineering at the German Technical University in Brünn (now Brno, Czech Republic), and, later, rose to hereditary nobility in the Austro-Hungarian Empire. Musil held two doctorates, one in mechanical engineering from his father's university (1901), and one, obtained in 1908, in psychology and philosophy from the University of Berlin under the renowned Professor Carl Stumpf. Carl Stumpf wrote his Habilitationsschrift in 1870 in Göttingen on the foundations of mathematics. Between 1900 and 1904 M. Schlick, one of the founders of the Vienna Circle, studied physics in Berlin. Musil studied under Stumpf from 1903–1908. It is very likely that Musil and Schlick met during or after some of the lectures or seminars given by Stumpf.

M. Schlick's early philosophy shows both appreciation and criticism of Stumpf's epistemology. Among Stumpf's students we also find Edmund Husserl, who established the school of phenomenology, and who had studied mathematics with Kronecker and Weierstrass. Musil's majors in Berlin were "logics and experimental psychology," and he was examined in 1908 in philosophy, natural science, and mathematics. A. Schwarz of the renowned "Schwarz' inequality" was among his doctoral examiners. The title of Musil's thesis was *Beiträge zur Beurteilung der Lehren Machs*, and dealt with the evaluation of the teachings of Ernst Mach. As a philosopher of science, Mach was a major influence on logical positivism and American pragmatism. Musil's thesis and other technical writings, covering the period 1904–1922, were republished in 1980 as [9]. In 1906 his first novel was published and at the same time

Hans Hahn

Moritz Schlick

Karl Menger

Carl Stumpf

he was developing an apparatus to research how people experience color. From then on he dedicated his time exclusively to his literary career, interrupted only by his military service during WWI. From 1918 till 1931 Musil lived in Vienna. We do not know whether Musil had direct contact with the Vienna Circle during these years in Vienna. In 1931–33 Musil lived in Berlin and was an active participant in the Berlin Circle around Hans Reichenbach and Richard von Mises. However, the first two volumes of *The Man Without Qualities* were already published in 1930. Musil's awareness of modern mathematics and the foundations of geometry must have been acquired while he studied for his doctorate in Berlin. Musil's background in engineering, psychology, and mathematics most definitely influenced his writing not only of *The Man without Qualities*. In his 1906 novel *The Confusions of Young Törless* the confusions are manifold, ranging from the sexual to the foundations of geometry.

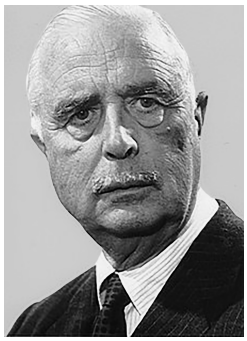
Thomas Pynchon. Thomas Pynchon is famously reclusive. About his mathematical and philosophical education we know rather little. As a writer he belongs more to postmodernism than to modernism.

I gather from the Wikipedia article about him the following. He was born in 1937 and holds a degree in English from Cornell. Starting in 1953 he studied engineering physics at Cornell University, but left at the end of his second year to serve in the U.S. Navy. Engineering physics is a unique branch of engineering which combines physics, mathematics, electrical engineering, and other advanced technology subjects. In 1957, he returned to Cornell to pursue a degree in English. From February 1960 to September 1962, he was employed as a technical writer at Boeing in Seattle. In 1964, his application to study mathematics as a graduate student at the University of California, Berkeley was turned down. The two novels discussed in Engelhardt's book are *Gravity's Rainbow*, published in 1963, and *Against the Day*, published in 2006. The former draws from his experience at Boeing, the latter contains a lot of mathematical material pertaining to Sofia Kovalevskaya and to Hilbert's school in Göttingen. Pynchon seemingly researched this material with the help of Michael Naumann, the German secretary of culture from 1998 until 2001. The only other good source of Pynchon's biographical material is his lengthy autobiographical introduction to the collection of short stories *Slow Learner* [11], published in 1984.

The novels by Pynchon are considered difficult to read. Nevertheless, he has his fans who created a Wikipedia-like website (`https://pynchonwiki.com/`), which should help potential readers to enter Pynchon's world. Literary critics celebrate him as one of the most important American novelists of the second half of the 20th century. *Gravity's Rainbow* and, even more so, *Against the Day* are novels fitting the topic of Engelhardt's study. Contrasting him to Broch and Musil, comparing modernist to postmodernist writing, makes Engelhardt's book a gem among the few studies linking mathematics and literature.

Hermann Hesse. There is one German modernist novel dealing with formal aspects of mathematics and music which should be mentioned: Hermann Hesse's *Magister Ludi* (aka The Glass Bead Game) [5]. One of the central themes of the novel is the Glass Bead Game and the way it is performed in public by its masters. The details of the game itself are only vaguely described in the novel as an amalgam of mathematics, music, and the Chinese I Ching. But it says that playing the game well requires years of hard study of music, mathematics, and cultural history. The game is essentially an abstract synthesis of all arts and sciences. It proceeds by players making deep, and sometimes unexpected, connections between seemingly unrelated topics. The novel is a dystopia in a post-historic setting. The mathematics is not specified in detail, but the sources used by Hesse concerning music, history, and Indian and Chinese cultures are well documented and identified.

Carl Jacob Burckhardt, the Swiss historian and diplomat, of the same family as the eminent historian and scholar of Renaissance culture Jacob Burckhardt, was a close friend of Hesse and can be recognized as one of the novel's protagonists. His career alternated between periods of academic historical research and diplomatic postings; the most prominent of the latter were League of Nations High Commissioner for the Free City of Danzig (1937–39) and President of the International Committee



H. Hesse (left), 1905 portrait by Ernst Würtenberger (1868–1934), C. J. Burckhardt (middle), former President of the International Committee of the Red Cross (ICRC) from 1944 to 1948 (copyright ICRC), H. Weyl (right), copyright ETH-Bibliothek Zürich, Bildarchiv.

of the Red Cross (1945–48). He was teaching contemporary history at the University of Zurich from 1927 until 1932.[4]

In the Hesse archive there is no written evidence of Hesse's inspiration concerning modern mathematics. However, in a talk given by Hermann Weyl [15] we learn that Hermann Weyl, Hermann Hesse, and Carl Jacob Burckhardt were close friends.

Commenting on his decision to leave Zurich to succeed Hilbert in Göttingen in 1930, Weyl writes:

> *"[…] it could have possibly been right to stay in Zurich, where my position was specially favorable to a vita contemplativa, paired with, relatively speaking, modest external impact. It was not easy for me to come to a clear decision. I have pondered the question in my mind together with two men, with Jacob Burckhardt and Hermann Hesse. The fate of the latter is particularly close to me. He went "South", not only geographically. His example is tempting, but also a warning. For he achieved only a deeper loneliness and a mild desperation, which strangely permeated the happiness of his senses, his eyes and his writing, which was at the same time exhilarating and loosening up. Burckhardt on the other hand rejected the offer to succeed Ranke in Berlin with self-evident determination."*

Hermann Weyl was known for his inspiring lectures, celebrating mathematics as a performing art. It is then likely that he was both the model for the magister ludi celebrating the Glass Bead Game, and the source of Hesse's awareness of modern mathematics as the art of the possible, rather than the science of true nature. The impact of Hermann Weyl on Hesse's *Magister Ludi* has not been explored in depth, but many mathematicians reading the novel conjecture modern formalist mathematics to be a major source of Hesse's concept of the Glass Bead Game. Few know that the source of Hesse's knowledge seems to be Hermann Weyl.

[4] *Paraphrased from the wikipedia* https://en.wikipedia.org/wiki/Carl_Jacob_Burckhardt

Hesse's Glass Bead Game can be viewed as the ultimate form of modernist and even postmodernist mathematics. The final disenchantment of the central character, Joseph Knecht, with the game possibly reflects Weyl's intuitionist sympathies and the reservation he had during the time of his friendship with Hesse towards Hilbert's strict formalist view of mathematics. It is only in later years that Weyl emphasized mathematics as "symbolic construction" and moved to a position closer not only to Hilbert but also to that of Ernst Cassirer. Seen like this, Hesse's novel would fit well into Engelhardt's program of studying the influence of modernist mathematics on modernist fiction.

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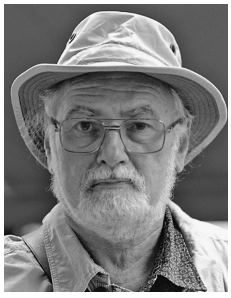

Johann A. Makowsky

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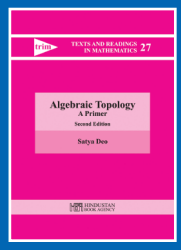

Algebraic Topology
A Primer (Second Edition)

Satya Deo, *Harish-Chandra Research Institute, Allahabad, India*

This is the second (revised and enlarged) edition of the book originally published in 2003. It introduces the first concepts of algebraic topology such as general simplicial complexes, simplicial homology theory, fundamental groups, covering spaces and singular homology theory in detail. The text has been designed for undergraduate and beginning graduate students of mathematics. It assumes a minimal background of linear algebra, group theory and topological spaces.

The author deals with the basic concepts and ideas in a very lucid manner, giving suitable motivations and illustrations. As an application of the tools developed in this book, some classical theorems such as Brouwer's fixed point theorem, the Lefschetz fixed point theorem, the Borsuk-Ulam theorem, Brouwer's separation theorem, and the theorem on invariance of domain are proved and illustrated. Most of the exercises are elementary, but some are more challenging and will help readers with their understanding of the subject.

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