THOMAS KUHN'S REVOLUTIONS

A HISTORICAL AND AN EVOLUTIONARY PHILOSOPHY OF SCIENCE?

JAMES A. MARCUM

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PREFACE

Thomas Kuhn (1922–96), although trained a physicist at Harvard University, became a historical philosopher of science through the influence and support of Harvard's president—James Conant. In 1962, Kuhn's renowned work, *The Structure of Scientific Revolutions* (*Structure*—which is Kuhn's preferred abbreviation for the monograph), was published in Otto Neurath's *International Encyclopedia of Unified Science*. Kuhn's monograph helped to inaugurate and promote a revolution—the historiographic revolution—in the latter half of the twentieth century, by providing a new image of science in which periods of stasis (normal science) are punctuated with paradigm shifts (scientific revolutions). Kuhn's revolution not only had an impact on the discipline of history and philosophy of science (HPS) but on other disciplines as well, including sociology, education, economics, political science, and even science policy.

My first encounter with Kuhn was as a research associate at Massachusetts Institute of Technology (MIT) in early 1982. A friend, Phil Kenas, had recently lent me a copy of *Structure*, but upon first reading it, I was unable to appreciate the image of science presented in it because of my experience as a scientist-in-training. I then learned that Kuhn was at MIT and would be teaching a course on the nature of scientific knowledge, during the spring semester. I approached Kuhn about taking the course, and he graciously permitted me access to it. While taking Kuhn's course, I began to appreciate his image of science—one that was dynamic as opposed to the static image I had learned through my scientific training. From my experience in that course and from a continued relationship with Kuhn, I gradually switched from a career in the biomedical sciences to one in philosophy of science. My personal recollection of Kuhn is a man who cared deeply not only for the subject matter of his adopted discipline but also for his students and colleagues.

Since Kuhn's death in 1996, the secondary literature on his philosophy of science has continued to escalate. General surveys and analysis of his philosophy—as well as *Structure*—have appeared during the first decade of the twenty-first century (Andersen 2001a; Andersen et al. 2006; Bernardoni 2009; Bird 2000; D'Agostino 2010; Davidson 2006; Fuller 2000a; Gattei 2008; Hung 2006; Kuukkanen 2008; Marcum 2005; Maricle 2008; Nickles 2003a; Onkware 2010; Preston 2008; Sharrock and Read 2002; Torres 2010). In addition, studies focusing on specific themes arising from Kuhn's work have also been published since

his death, for example, paradigm (Kindi 2012; von Dietze 2001; Wray 2011a), incommensurability (Bird 2008; Demir 2008; Favretti et al. 1999; Hoyningen-Huene and Sankey 2001), and postmodernism and post-normal science (Funtowicz and Ravetz 2003; Koertge 2000; Kuntz 2012; Sardar 2000). Finally, *Structure* celebrated its fiftieth anniversary in 2012 with a fourth edition, including a preface by Ian Hacking (Bird 2012; Collins 2012; Dear 2012; Kaiser 2012; Rees 2012).[1] In addition, numerous symposia and conferences were held—along with published editorials and commentaries—to commemorate *Structure*'s golden anniversary (Gordon 2012; Grube 2013; Kindi and Arabatzis 2012; Wray 2012).[2]

One of the more recent developments in Kuhnian studies pertains to Kuhn's shift toward the end of his career from a historical philosophy of science to an evolutionary one (Kuukkanen 2012; Marcum 2012; Wray 2011b). The primary aim of the present book is to situate that shift—or "evolutionary turn"—*vis-à-vis* Kuhn's maturation of his philosophy of science from the 1951 Lowell lectures to an unfinished manuscript, *Words and Worlds: An Evolutionary View of Scientific Development* (*Words and Worlds*).[3] Besides the present book's primary aim, a secondary aim is to provide a comprehensive introduction of the development of Kuhn's philosophy of science. To that end, I focus initially on Kuhn's historiographic revolution—the "historical turn"—and on questions surrounding it, and then on the "evolutionary turn" and its associated revolution. What are Kuhn's historiographic and evolutionary revolutions? How did they come about? What impact did they have on science's image, and why? What, if any, are their future in both academia and society? At the heart of the answers to these questions is the person of Kuhn himself, i.e. his personality, his pedagogical style, and his institutional and cultural commitments, and the intellectual and social contexts in which he practiced his trade. I take a developmental approach to Kuhn's ideas, in which I map in detail the unfolding of his ideas, from the historical work on physical theory and the Copernican revolution in the 1950s to reflections on an evolutionary philosophy of science (EPS) in the late 1980s and early 1990s. Rather than present Kuhn's ideas as finished products, I attempt to capture them in their formative process—cut off only by his death. By following the development of Kuhn's ideas, a more accurate representation of them is possible. Kuhn resisted writing an autobiography, as his secretary Ms. Carolyn Farrow once told me. I hope this book reflects how he might have structured an autobiography.

In the first part of the book, the intellectual and the personal background to Kuhn's life and work is reconstructed and discussed—particularly as it paved the road to *Structure*'s publication in 1962. To that end, I explore in the first chapter Kuhn's familial and pedagogical contexts, which shaped his personal character and professional career. Kuhn's early scholarship in the history of science—the "historical turn"—is scrutinized in the next chapter, especially the role of the 1951 Lowell lectures in *Structure*'s genesis. In the

next part of the book, I discuss Kuhn's influential monograph, *Structure*, and its critics. In the third chapter, I outline *Structure*'s major themes, including the paradigm concept and paradigm shift, normal and revolutionary science, and the incommensurability thesis (InT). In the fourth chapter, I review various criticisms leveled against Kuhn's monograph, especially during the important London colloquium held in 1965. I also examine Kuhn's response to these criticisms in "Postscript—1969," a work intended as an addendum to the revised edition of *Structure*. In the third part of the book, Kuhn's own scholarly paradigm shift—an "evolutionary turn"—is investigated and discussed. His scholarly work during the 1970s and 1980s—his most productive years—are explored in an initial chapter, culminating with a final chapter on the replacement of a historical philosophy of science with an evolutionary one. In the last part of the book, I examine Kuhn's impact on various academic disciplines. First, I explore in the seventh chapter the impact Kuhn had on HPS and the natural sciences, and then in the eighth chapter his impact on the behavioral, social, and political sciences. In an Epilogue, I discuss various issues arising from Kuhnian studies, along with their future.

The book's main thesis is that Kuhn was a major participant and contributor to the historiographic revolution of the mid-twentieth century, in contrast to Steve Fuller's thesis that Kuhn was a mere bystander—if not victim—of the times. Not only has Kuhn's historical philosophy of science influenced HPS, but it has also shaped the very understanding and image of science itself. But, to focus only on Kuhn's historical philosophy of science and its revolution is to envision a truncated view of Kuhn's overall philosophy of science and the direction it began to take in the late twentieth century—EPS and its revolution. Kuhn's impact then is not just one revolution but two revolutions. The influence of these revolutions transcend the boundaries of the HPS community to include other professional communities as well, such as sociologists, economists, political scientists, educators, and even policymakers and politicians. Although the book is primarily an introduction to the development of Kuhn's historical philosophy of science and its replacement with an evolutionary one, it is also a sustained argument that establishes the above thesis and strives to interpret and situate Kuhn and his philosophy within a larger academic framework than simply HPS.

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CONTENTS

PART ONE

The road to *Structure*

In the first part, I explore the road Kuhn took during his career—especially with respect to *Structure*'s publication. To that end, I explore in the first chapter the contextual background proximal to Kuhn's life and work. That background includes Kuhn's early personal and family life, as well as his matriculation to Harvard College. While at Harvard, Conant was influential in transforming Kuhn from being a physicist to being a historical philosopher of science. The chapter continues by charting his professional career at academic institutions, including the collegial scholars who influenced his intellectual development, until his death in 1996.

In the part's final chapter, I review and reconstruct Kuhn's early work in HPS prior to *Structure*'s publication in 1962. The approach is developmental and dynamic, since many of the ideas found in the 1962 monograph are present embryonically in Kuhn's early work. Rather than reconstructing *Structure* as a finished product, then, I approach it as "in process"—much like Kuhn analyzed texts in the history of science and how he envisioned science and its knowledge unfolding developmentally or revolutionarily—and later evolutionarily. To that end, I begin with an undergraduate essay on metaphysics and physics and then

turn to a letter Kuhn wrote to the Harvard general education committee, in which he discussed the main tenets for a new image of science. Next, I initially discuss Kuhn's 1951 Lowell lectures and the themes he introduced in them that eventually appeared in *Structure*. In addition, a Guggenheim fellowship is briefly examined to demonstrate the development of his thinking about the nature of scientific methodology. I then cover Kuhn's book on the Copernican revolution and its significance for the development of a historical philosophy of science. Finally, I examine three essays, especially one in which he articulated an "essential tension" between normal scientific practice and revolutionary upheavals, crucial for *Structure*'s emergence.

CHAPTER ONE

Who was Thomas Kuhn?

Chapter Summary

Kuhn's personal biography and the events of his adolescence are surmised initially in this chapter. Then the crucial years as a student, as both an undergraduate and a graduate student, at Harvard University are examined, along with Conant's impact on Kuhn's early professional career. I also explore the impact of other thinkers on Kuhn's intellectual development, including Alexandre Koyré, Willard Quine, Ludwik Fleck, among others. Next, I discuss his appointments at Berkeley, along with his association with Paul Feyerabend, and then at Princeton, including his friendship with Carl Hempel. Finally, the chapter concludes with his appointment at MIT in which he underwent a "linguistic turn." In particular, I map the development of his professional career as Kuhn moved toward *Structure* and then away from it, especially from a historical to an evolutionary philosophy of science. Importantly, I embed Kuhn's personal context and intellectual development in the cultural milieu of the times.

I The early years

During the year that Moritz Schlick moved from Kiel to Vienna, Kuhn was born in Cincinnati, Ohio, on July 18, 1922.[1] He was the first of two children born—a brother Roger was born several years later—to Samuel (Sam) L. and Minette (née Stroock) Kuhn. His father was a native Cincinnatian and his mother a native New Yorker. The family, according to Kuhn, was "certified Jews. Non-practicing Jews. My mother's parents had been practitioners, not Orthodox practitioners. My father's parents had not" (2000, p. 266).

When Kuhn was six months old, the family moved to New York. But other members of the Kuhn family, including a favorite aunt, Emma (née Kuhn) Fisher, Sam's younger sister, remained in Cincinnati. Aunt Emma was a source of inspiration for Kuhn. During the Second World War, she opened her home to Guenther, a young German Jewish refugee. Kuhn inscribed his copy of *Structure* to her accordingly, "For Emmy—who as Aunty Emma—helped me find what I was and liked."

Kuhn's father, Sam, was a hydraulic engineer trained at Harvard and MIT prior to the First World War. He entered the war, and served in the Army Corps of Engineers. According to Kuhn (2000), these were the best years of his father's life. After the war, Sam left the armed services and returned to Cincinnati with his recent bride to help his mother, Setty (née Swartz) Kuhn, who was recently widowed. His father's career, after moving to New York, was a disappointment. But, Kuhn admired his father and considered him one of the brightest people he knew, next to Conant.

Kuhn's mother, Minette, was a liberally educated person, who on occasion did professional editing. She came from an affluent family and her stepfather was a lawyer. Minette's biological father died from tuberculosis shortly after her birth. Although Kuhn thought his mother more of an intellectual than his father, in that she was well read, he considered her not as bright as his father. Kuhn recalled that everyone claimed he took after his father and his brother after his mother. But he later recognized that the opposite was true, when reflecting on why he went on to study theoretical rather than experimental physics. Minette took an active interest in her son's career, and she read and discussed his books with him.

Kuhn's early education reflected the family's liberal progressiveness. In 1927, Kuhn began his education as a kindergartener at the progressive Lincoln school in Manhattan. "Progressive education," according to Kuhn, "was a movement which . . . emphasized subject matter less than it emphasized independence of mind, confidence in ability to use one's mind" (2000, p. 257). By Kuhn's own admission, he was taught to think independently, but little content accompanied that thinking. He remembered that by the second grade, for instance, he was unable to read proficiently to the consternation of his parents.

Beginning in the sixth grade, his family moved to Croton-on-Hudson, a small town about 50 miles from Manhattan; and, the adolescent Kuhn attended the progressive Hessian Hills School. According to Kuhn, left-oriented radical teachers, who taught the students to be pacifists, staffed the school. While at the school, Leon Sciaky—a mathematics teacher—was an inspiration for him. When Kuhn left the school after the ninth grade, he thought of himself as a bright and independent thinker. After spending an uninspired year at the preparatory school—Solebury—in Pennsylvania, Kuhn spent the remaining years of high school at Taft—a Yale-preparatory school in Watertown, Connecticut. Kuhn was even less enthusiastic about Taft, but he felt that "these schools gave me more formal training" (2000, p. 258).

He graduated third in a class of 105 students and was inducted into the National Honor Society. For his schoolwork in mathematics and science, he received the prestigious Rensselaer Alumni Association Medal.

Kuhn wrote a number of student essays while at Taft on various topics, ranging from student strikes to tariffs. One essay, entitled "Some things about E—," captured Kuhn's struggle to articulate the concept of quality or the nonquantifiable—a struggle that plagued him for the rest of his life. The essay is obviously about Aunt Emma. After describing certain ineffable features of his aunt, Kuhn ends the essay writing, "She has other qualities I would like to express, but I can't seem to catch and untangle them. I wish I could!" (Kuhn Papers, box 1, folder 2, p. 2). This essay must be contrasted with essays on technological devices. For example, in essays on the telegraph relay switch and on the icebox, Kuhn provides both accurate and modestly detailed descriptions and drawings, with little anxiety expressed over them. He also exhibited interest in literature. In an essay, "Character portrayal in *The Case of Sergeant Grisha*," Kuhn analyzed insightfully the development of a character (Kuhn Papers, box 1, folder 2). This revealed his early ability to place himself within a text and explore the development of its characters—an ability that would serve him well when he shifted from science to its history.

II The Harvard years

Undergraduate education

Kuhn later recalled that during grammar and high school he "had almost no friends. I was isolated. . . . I was quite unhappy about it. I wasn't a member of the group and I wanted terribly to be a member of the group" (2000, p. 261). All of that was to change for him when he matriculated to Harvard College in the fall of 1940, following his father's and uncles' footsteps. At Harvard, Kuhn was to acquire a sense of himself socially, by participating in various organizations. During the first year at Harvard, Kuhn took a yearlong course in philosophy. In the first semester, he studied Plato and Aristotle; while in the second semester, he studied Descartes, Spinoza, Hume, and Kant. Although he found these thinkers stimulating and challenging, Kant was a "revelation" for him, especially the Kantian categories and synthetic *a priori*. Later in his career, Kuhn called himself "a Kantian with movable categories" (Kuhn 2000, p. 264). He intended to take additional philosophy courses but could not find the time. He did, however, attend several of George Sarton's lectures on the history of science but found them "turgid and dull" (Kuhn 2000, p. 275).

Kuhn wrote several undergraduate essays that revealed an early interest in metaphysics. One such essay was "An analysis of causal complexity,"

which he wrote for a philosophy course taught by D. C. Williams, during the 1945 fall term. As Kuhn wrote,

> The essay represents an attempt to analyse (sic) the notion of cause so as to eliminate from it those elements which are irrelevant to a metaphysically reasonable formulation of scientific law and an effort to investigate the possible epistemological grounds of the remaining concept. (Kuhn Papers, box 1, folder 3, p. 1)

Kuhn drew upon the work of Russell and Hume to complete the task. Williams found the essay acceptable but in need of further development.

Kuhn wrote two other essays on metaphysical issues for an English course, taught by Mr. Davis. The first, "An Analysis of the Metaphysical Lyric, 'Death'," was on John Donne's metaphysical poem, in which Kuhn compared the poem's structure to Donne's development of the notion of death and concluded that the poem is not great because it does not inflame the passions as do other literary works (Kuhn Papers, box 1, folder 3). In comments on the essay, the instructor pointed out to Kuhn that great poems need not always excite the passions.

In the second essay, "The metaphysical possibilities of physics," Kuhn asked the question of whether physics is capable of discovering and formulating an exhaustive conception of the universe. To answer it, Kuhn proposed a two-step investigation. The first was to determine the nature of the data, and whether the data could yield a finite amount of information about the universe. Obviously, a finite amount of information would be conducive to comprehending it, rather than an infinite amount. The second step was to determine the relationship between concepts and data/information. That relationship is derivative. "They [concepts] are generalizations made," according to Kuhn, "to fit the data" (Kuhn Papers, box 1, folder 3, p. 10). This led Kuhn to the questions of "how are they derived and to what extent are they logically necessary?" (Kuhn Papers, box 1, folder 3, p. 10). But, he had no answers.

In the essay, Kuhn also addressed the question of how many concepts can be derived from data and information. In principle, Kuhn believed a limited number of concepts are possible. However, they may not provide the necessary knowledge about the world, only that the world is knowable. The problem was to pick out the right concept from the derived concepts to explain the data. But, Kuhn felt confident that even if there were an infinite number of concepts derived from the data, physicists would eventually arrive at one to explain the universe even though there would always be some question concerning its veracity. "But if this investigation, correctly performed, yielded the possibility of but one concept," concluded Kuhn, "we would believe that science could in time arrive at a picture of the universe, and that that picture would be an image of the reality" (Kuhn Papers, box 1, folder 3, p. 11).