The Forman Thesis: 40 Years After

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Forty years ago, in 1971, Paul Forman published *Weimar Culture, Causality, and Quantum Theory, 1918–1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment*. His landmark study (too long, too thorough and too fundamental to be called simply an article) became immediately famous, and famously controversial. It has remained at the heart of debates about the historical relationship between science and culture ever since. The controversy surrounding the Forman Thesis was practically unavoidable, for Forman's work put forward and placed at the centre of a broader discussion the argument that the cultural values prevalent in a given place and time could influence the results of discipline-bound research, i.e. the very content of scientific knowledge. This idea, if still controversial, has since become commonly used in cultural studies of science, but at the time of its introduction it created uproar as it explicitly contradicted generally accepted and cherished beliefs about science. Yet tectonic shifts were already underway, if not always visible, that would eventually put those very beliefs into question. The Forman study both reflected and forwarded these shifts in our general perspectives on the nature and practice of science. Despite some heated objections to its findings, Forman's work has fundamentally changed directions of research in the history, sociology and philosophy of science and established itself as a classic in this group of fields, sometimes collectively called science studies. In subsequent decades it has been read and discussed in practically every graduate program that trains students in those fields, circulating in numerous copies and translated into many languages, while the original publication in the journal *Historical Studies in the Physical Sciences* has long become a bibliographic rarity.

Forman's seminal paper is reprinted in full in the first part of this volume, along with his related articles of the same period, so that the reader may gain a comprehensive introduction to the Forman Thesis. Here, a short summary of its main argument suffices to present the issues at stake. Forman described the

cultural climate in economically depressed and socially volatile Germany after the nation's defeat in World War I and the collapse of the German Empire. A sense of spiralling social crisis affected all aspects of life, including science. It particularly inspired widespread discussion about the 'crisis in science', which encouraged some scientists to question the conceptual foundations of their respective disciplines. Fashionable philosophical and ideological treatises, including Oswald Spengler's *Decline of the West*, mobilised the educated public against ideas of rationality, progress, modernity and materialism popular prior to the war. In this new romantic intellectual atmosphere that elevated intuition and celebrated irrationalism, many academics wavered in their attachment to the rationalist values heretofore central to the practice of the exact sciences. Mechanical determinism, or the causality principle, came under special criticism as being too rationalistic and, indeed, mechanical. Responding to such hostile critiques, a number of prominent physicists and mathematicians expressed a readiness to accommodate their discipline to the *Zeitgeist* by abandoning or restricting the validity of causality in physics. Forman showed that proposals such as this predated 1925, the year of the invention of quantum mechanics. Once that revolutionary theory appeared, acausality was quickly ascribed to it and proclaimed the fundamental scientific principle of the new quantum mechanics of atoms and electrons.

As a methodological model, Forman's study has arguably been the most influential article ever published in the historical studies of science, with the possible exception of Boris Hessen's equally famous and controversial 1931 analysis of classical mechanics in *The Social and Economic Roots of Newton's Principia*. The two works have sometimes been confused as representing, in the eyes of some critics, the same 'externalist' approach to science. It is true that both upended, each in its own way, the essentially Platonic ideology of science as a pure intellectual activity, a noble search for abstract truth supposedly in control of its intrinsic scientific method and of the criteria of true knowledge. Instead, both approached science as an essentially human, and thus also earthly, social and cultural activity, and accepted the necessary epistemological consequences of such an assumption. Yet the differences between these two classic works, separated by another 40 years, are no less important than the similarities. Hessen developed a demonstrably Marxist argument that focused primarily on economic and technological influences on science. In Forman's analysis, culture plays a key role, mediating and channelling the impact of economic and social conditions. Hessen, writing in the midst of the revolutionary industrialisation of the Soviet Union, promoted an unabatedly optimistic view on science, counting it without reservation among the major forces of social and political progress. In Forman's day, in the era of DDT, napalm and Agent Orange, the question of science and scientists' political

associations became less straightforward. His study found some leading proponents of the quantum revolution entering a pact with anti-rationalist conservative ideological currents whereas those physicists who upheld the values of causality and reason, often rhetorically dismissed at the time as scientifically 'conservative', were frequently aligned with the progressive forces supporting the Weimar Republic. Last, but not least, Hessen's essay was largely declarative and programmatic. It inspired and required further empirical justifications, including Robert K. Merton's *Science, Technology and Society in Seventeenth Century England* (1938). The Forman Thesis relied on a extensive foundation of primary sources, many heretofore unused, and came out of a broader empirical — archival and historical — study then underway.

The professional historiography of the quantum revolution, which was only emerging during the 1960s, stood at that time at the forefront of methodological innovation in the history of science. In preceding decades, with quantum mechanics still relatively recent science and its founders active and publishing, its history was dominated by participants' own accounts and physicists' popular writings. Entering the field as trained historians of science, Thomas Kuhn, John L. Heilbron, Paul Forman and Lini Allen embarked in 1961 upon the ambitious project of the Archive for the History of Quantum Physics (AHQP) — not an archive in the usual sense but a comprehensive effort to locate and catalogue an international body of manuscripts and correspondence of several hundred quantum scientists active between approximately 1900 and 1935. The resulting primary source database became the main foundation for practically every historian working in the field since, including AHQP team members' own research into the history of quantum ideas. Taking a proactive approach to sources, the AHQP project microfilmed many crucial collections, bringing them closer to researchers. It also pioneered the technique of oral history in the history of science by recording interviews with about 100 physicists, including Niels Bohr, Max Born and Werner Heisenberg.

As related in this volume by John L. Heilbron in his recollections of that *Sturm und Drang* era, contemporary events influenced historians' thinking about the past and encouraged them to ask questions beyond the traditional repertoire of the history of ideas. If the Vietnam War and the Cold War attracted their critical attention to scientists' social and political roles, the post-Sputnik transformation of science into a mass profession with an outsized infrastructure inspired inquiries about the scientific community as a whole, the institutions and funding that sustained it, and the social relations operating within it. A team effort by Forman, Heilbron and Spencer Weart produced by 1975 an international survey of physics as disciplinary practice circa 1900. Forman's own doctoral dissertation of 1967 analysed the German physics community from the angle of its placement within the economic,

political and social situation immediately after World War I. The dissertation remained unpublished (unjustifiably so), but established the empirical foundation for the development of the Forman Thesis three years later and has since been used by many historians in the new area of research that it opened up. Two of Forman's articles closely linked to its content are reprinted below: on the international relations of German science during the postwar boycott and its struggles for funding and political alliances. Together, they describe the postwar academic community and the general social environment within which the ideas of quantum acausality would brew. The other two papers that complete Part I of this volume extend the original Forman Thesis on its own terms. One takes the argument beyond the issue of causality by analysing other culturally sensitive notions (individuality and *Anschaulichkeit*) that were important for Weimar physicists' thinking, while the other examines the reception of quantum acausality outside the German cultural sphere, particularly in Great Britain.

The history of quantum physics has since come into its own as a mature subject, with detailed studies of its technical formalism, philosophical interpretation and institutional settings as well as biographies and editions of the collected papers and letters of its major contributors. Forman's work served as a touchstone for new generations of researchers; the methodology it adopted and the questions posed continue to generate further inquiries and controversies. Historians developing the genre of the cultural history of science applied and extended Forman's argument further, adapting its conceptual language and questions to other cases and situations, and checking its applicability in different cultural milieus. In March 2007, a conference in Vancouver, British Columbia, brought together scholars whose research addresses historical and philosophical problems related to the Forman Thesis. Many working in the field today — whether they agree with Forman, disagree over details or even disagree profoundly — feel indebted to his inspiring ideas. The papers in Part II of this volume represent, first of all, the lines of argument developed in contemporary research on the history of quantum physics. They explore different cultural environments of physics from the *fin de siècle* to the mid-twentieth century, compare the situation in Germany with those in other countries, analyse the cases of some major contributors and their detailed interactions in the process of inventing quantum mechanics and look at those quantum physicists who, in different political and social circumstances, strove for a causal understanding of the theory.

The latter case deserves special comment, since attitudes toward the philosophical interpretation of quantum theory have changed dramatically in recent decades. When the Forman Thesis was published in the early 1970s, the acausality of the quantum laws was generally seen as part of the core scientific formalism of the theory in accordance with the dominant Copenhagen Interpretation. Due largely

to the work of David Bohm and John Bell, physicists' views shifted, allowing more space for a philosophical pluralism within which different interpretations, including causal ones, are possible. Bell was aware of Forman's historical critique, which may have provided additional encouragement to his efforts in challenging the Copenhagen orthodoxy from the physics side. In recent years, more historians and philosophers of science have turned in their analyses to those physicists who disagreed with prevailing opinion and defended the causality principle in quantum mechanics, to whose previously neglected views Forman had called 'sympathetic attention'.

Historians have also extended Forman's argument to cases beyond physics and the exact sciences. The Weimar cultural atmosphere and the contemporary setting for the academic enterprise affected other fields of scholarship as well, if not in exactly the same way and without always framing causality as the main issue at stake. The papers in Part III of this volume explore similar ideological and political issues in cases involving the life sciences, the human sciences and philosophy, and in the ways that science was popularised and presented to the general public. Forman's ideas have also been tested for utility in a larger chronological frame of German history outside the Weimar period *per se*, in particular in inquiries into whether similar cultural influences continued during the Nazi period, or even to a certain degree into the post-World War II era. While many historians have built upon Forman's themes in the depiction of the cultural milieu, others have recorded variations and argued about non-uniformity of culture and its effects. An important and particularly contested problem for contemporary scholarship is the manner in which Weimar culture was heterogeneous, combining anti-modern with modernist trends.

Over time, perceptions of the Forman thesis have changed. Initially, most of the opposition came from technical challenges and, sometimes animating them, the modernist rejection of the possibility that scientific knowledge, supposedly universal, could be influenced by its local and idiosyncratic cultural setting. Yet as the paradigmatic example demonstrating such influence, the Forman Thesis was instrumental in the rise of new scholarly approaches to science during the 1970s and 1980s: namely, the sociology of scientific knowledge and cultural studies of science. With the growing number of examples involving various cultures and scientific disciplines, scholars who described them met with significantly less opposition than Forman initially did, until the understanding that science is produced locally in particular cultural and social settings has become widely accepted, almost to the point of hardly requiring a proof. Current assumptions about science, however, make it harder to explain how such locally produced knowledge manages to travel across cultures, establishing itself internationally; hence the importance of comparative studies related to the case described by Forman and similar ones. And

while the central methodological lesson of the Forman Thesis has been broadly accepted, other aspects continue to cause disagreement as well as discomfort to contemporary postmodernist feelings. Forman's account of physicists succumbing to ideological currents of the day, in particular, flies in the face of contemporary currents that insist that individuals are free agents, even when they shop as prescribed by the latest TV commercial. Here, we are dealing with one of the basic contradictions of contemporary postmodernist culture, which may only be sorted out once this culture, too, becomes a thing of the past.

Paul Forman's subsequent work on topics beyond science in Weimar Germany cannot be adequately represented or discussed in this volume. However, some of his major publications are listed in the bibliography that follows this introduction. In a series of groundbreaking papers in the 1980s and 1990s, Forman subjected to similar critical analysis the Cold War era in American science, in particular the then dominant ideology of scientists who claimed to be able to pursue 'pure science' while receiving funds from the military establishment and its granting agencies. In case studies centred on the development of quantum electronics, the invention of the maser and atomic clocks, Forman displayed how military and Cold War agendas underwrote the development and directions of basic research in physics in the 1940s and 1950s. His analysis, sometimes called the 'second' Forman thesis, has been as influential in the field of history of American science as his works on causality and quantum physics were in the history of science in Germany.

Postmodernism, too, has already experienced its own history. With Forman's finely-tuned radar for pressing questions and problems, he has come full circle to identify postmodernity as a provocation for historians of science and technology. In a recent article, again of monograph-like character, Forman discussed the controversial question of the aims and direction of knowledge production in postmodern societies. He argues that the 1980s experienced a deep caesura in the relation between scientific and technical knowledge. During the period of modernity, science held priority relative to technology. Then, in a sudden and unexpected reversal in the 1980s, technology gained priority over science. For Forman, the subsumption of science under technology serves as a demarcator of postmodernity from modernity, and he makes no bones about the fact that from a normative stance he is highly critical of this change. To the contrary: in his article, which meanwhile has become another landmark in the history and philosophy of science, Forman takes to task his fellow historians of technology. They have ignored the epochal elevation of the cultural standing of technology — and he attributes their deliberate ignorance of that fact to the ideological character of their discipline. Without claiming to be visionary, it is easy to predict that Forman has yet again come up with a seminal publication that will keep cohorts of students in science studies busy in the years to come.