Personal Reflections on Dirk Jan Struik

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Years Ago *features essays by historians and mathematicians that take us back in time. Whether addressing special topics or general trends, individual mathematicians or "schools" (as in schools of fish), the idea is always the same, to shed new light on the mathematics of the past. Submissions are welcome.*

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Editor's Note: Dirk Struik and the History of Mathematics

Dirk Jan Struik, who taught for many years at the Massachusetts Institute of Technology and died on 21 October 2000 at the age of 106, was a distinguished mathematician and influential teacher. His early work on vector and tensor analysis, undertaken with Jan Arnoldus Schouten, helped impart new mathematical techniques needed to master Einstein's general theory of relativity. This collaboration lasted more than twenty years, but by the end of the 1930s Struik came to realize that the heyday of the Ricci calculus had passed. After the Second World War, having now entered his fifties, he gave up mathematical research in order to focus his attention on the history of mathematics and science. It was through his work as an historian that he left a truly lasting mark, not only as a writer but as a mentor to those who had the pleasure of knowing him personally. This column may help convey an impression of how he touched the lives of so many people.

As an historian, Dirk Struik saw culture, science, and society as tightly intertwined. Mathematics, his first love, was deeply embedded in the cauldron of cultures, not as something freely imported from without, but rather built from within as a product of human intellectual and social activity. Taking this approach, he tried to ferret out the links between scientific "high culture" and the work of artisans, technicians, and the myriad other practitioners who represent the "applied science sector" within a society's workforce. In *Yankee Science in the Making* (1948) Struik analyzed the local social, geographical, and economic forces that shaped the lives of those inventors and amateurs who contributed to the emergence of a new scientific culture in Colonial New England. A similar focus on local conditions animates his book on early modern Dutch science, *The Land of Stevin and Huygens* (Engl. Trans. 1981, *Het land van Stevin en Huygens*, 1958). Struik's sensitivity to the inner workings of scientific and technological cultures was a hallmark of his scholarship that helps to account for its enduring value for historians (Stapleton 1997).

Struik was a leading Marxist scholar and social activist, but his Marxism did not dictate his historical analyses, the best of which were guided by an intuitive grasp of the salient features that led to the formation of distinctive scientific cultures. Like his friend Jan Romein, he sought global patterns of development; both avoided reifying Marxist ideas or taking a reductionist approach to historical materialism. Inspired by the work of figures such as J. D. Bernal, J. B. S. Haldane, Lancelot Hogben, and others in the British tradition of the Social Relations in Science Movement, he became increasingly interested in the social underpinnings of scientific knowledge. Multiculturalism would only become a buzzword decades later, but Struik's scholarship already

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reflected a deep awareness of how ideas are molded and transported in a complex mix of cultural contexts. The best-known example is his *Concise History of Mathematics*, first published in 1948, which went through four English editions and has been translated into at least eighteen languages. It would be fair to say that no historical survey has done more to promote interest in the rich diversity of mathematical ideas and cultures.

Many readers of *The Mathematical Intelligencer* will have their own stories of Dirk Struik. Marjorie Senechal, perusing this article in draft form, fondly remembered reading Struik's work as a young college student. She recalled how her grandparents, themselves good communists, gave her an early edition of *Yankee Science*, which first came out under a different title with a left-wing publisher (*The Origins of American Science (New England),* New York: Cameron, 1957). Years later she got to know the author personally when she came across a paper he had written, in Dutch, about Aristotle's mistaken claim that regular tetrahedra fill space. Aristotle's authority was such that his assertion caused mathematicians from antiquity through the Renaissance to twist themselves into knots trying to prove he was right—a fascinating story. Having just returned from a sabbatical in Holland, she had pretty good Dutch, so she wrote and asked him for permission to translate the paper for publication. He, of course, agreed and so they worked on it together. The *Mathematics Magazine* agreed to publish it, and she brought the problem up to date; "Which Tetrahedra Fill Space?" (Senechal 1981) was the result. Struik inscribed her copy of *Yankee Science*.

In my own case, I had the great pleasure of knowing Dirk during the last fifteen years of his life. Initially our mutual interest in the history of mathematics brought us together. But like so many young people—Dirk thought anyone under 70 was young—I quickly became fascinated with his whole life. One of my favorite memories is of a talk he gave in Mainz in 1994. This was right after the wonderful centennial celebration in Amsterdam, which already had him in high spirits. We drove down to Mainz where I introduced him to a packed audience, easily 300 people. He liked it when I introduced him not as a member of the '68 generation but the generation of 1917. His topic that day was simply "Some Mathematicians I Have Known." The whole while this amazing centenarian stood at the podium, a few note cards in hand, and proceeded to tell a string of fascinating anecdotes. He began in English, but kept slipping into German. Then he would catch himself and start speaking in English again. It was a wonderful example of how naturally he connected with people in so many languages and cultures, always with an immense sense of good will. He took lots of questions after his talk; people were sitting in the aisles, and I didn't notice anybody leaving. That evening he kept a small group of my students spellbound with his stories. A few of the young ladies present got extra attention, and when they told him about their own ongoing work in the history of mathematics he got that twinkle in his eyes that made all of us feel special and glad to be around him.

As he grew older, Dirk was often asked, of course, about the secret to his longevity. Those who knew him realized it had nothing to do with abstention from life's little vices

Figure 1. Dirk Jan Struik (1894-2000) in the mid-1970s.

(a pipe of tobacco and a glass of sherry were part of his daily regimen). Characteristically, he attributed his good health and zest for life to the three pillars of his spiritual strength, "the 3 Ms": Mathematics, Marxism, and Marriage. He shared these passions with his wife of some seventy years, Ruth Struik, née Ramler, herself a mathematician and a native of Prague; she died in 1993 at the age of 99. Dirk and Ruth Struik were political activists, deeply moved by the struggle against fascism in Europe and filled with high hopes that the Soviet Union's socialist experiment would eventually triumph as a new model for human society.

In 1934, after eight years in the United States, the Struiks became naturalized American citizens and began taking a

Figure 2. Dirk Struik with David Rowe toasting the good life in the Göttingen Ratskeller, August 1989. The occasion marks his return to Göttingen 63 years after his stay there as a Rockefeller Fellow.

more active part in supporting various political causes. In the wake of the Nazi racial laws aimed at "purifying" the civil service, they both tried to help several European mathematicians find refuge in the United States. Dirk was also involved in the often bitter disputes among American leftists regarding the Spanish Civil War. During the Second World War years he worked for the Council of American-Soviet Friendship, and in 1944 he helped found the Samuel Adams School in Boston, a short-lived organization that nevertheless came under the eye of J. Edgar Hoover's F.B.I. Dirk Struik had a boundless faith in the capacity of human beings to build a just society. He saw science and mathematics as liberating forces within society, but he also realized that the modern scientist has a responsibility to consider the social consequences of scientific research. In this regard, he was strongly influenced by his MIT colleague and friend Norbert Wiener, who refused to place his fertile mind at the disposal of government technocrats.

Teaching always played an integral part in Struik's academic life. During the 1940s he began offering an informal seminar on historical materialism and Marxism, a topic then outside the official curricula of universities throughout the country. George Mosse, who came to Harvard as a graduate student in the early 1940s and was eager to learn some Marxist theory, quickly found his way to Struik's seminar (George L. Mosse, *Confronting History*, pp. 121, 136). He went on to become a distinguished historian at the University of Wisconsin and a leading expert on the intellectual origins of fascism in Germany. Back in the 1930s, George Sarton pioneered studies of the history of science in the United States at Harvard. He regularly invited Dirk Struik to teach a special session of his Harvard seminar on the topic of history of mathematics. I. B. Cohen, then a graduate student at Harvard, later recalled how Sarton and Struik used to argue over the role of social factors in the history of mathematics (Sarton's favorite counterexample was magic squares). Yet, their differences notwithstanding, both men shared a cultural approach to the history of science of universal scope.

A generation later, a young man named Joseph Dauben came to Harvard to study history of science, *en route* to writing a doctoral dissertation on the mathematics and philosophy of Georg Cantor. Along the way, he too fell under the sway of Struik's influence, a story he vividly recalls here. It gives me special pleasure to see his recollections appear in *Years Ago*, as I well remember the delight I took in reading Joe's wonderful biography of Cantor when I was a graduate student in Oklahoma. Soon afterward, I wrote to him and I was even more delighted to receive a warm reply inviting me to study with him at the CUNY Graduate Center. So began my own journey into the field of inquiry that owes so much to the inspiration of Dirk Struik. **D.E.R.**

I first encountered Dirk Struik through his *Concise History of Mathematics*, which I read when I was a senior in high-school. At the time I was taking an advanced calculus class at Pasadena High School in Southern California, and through a quirk of fate, the teacher had an evening class at the local junior college and invited me to present a lecture on the derivative, which, it was suggested, I might want to motivate with some historical background. Thus rather than my introduction to the history of mathematics being one of E. T. Bell's questionable anecdotes, I was introduced at the outset to the subject through one of the adepts, someone with a true feeling for both historical and political sensibilities. Of course, I did not really appreciate what Struik was up to in his book at the time, but then I was only in high-school.

Nevertheless, this says something about the readership Struik's work enjoyed—reaching even to impressionable high-school students. I next read Struik's book for a second time, and more thoroughly, in college (Claremont McKenna College, one of the Claremont Colleges) where I was taking a course on history of science taught by Granville Henry of the mathematics department. I was also writing my senior thesis on nonstandard analysis, overseen by Janet Myhre, and I found Struik's book again helpful in explaining the early concerns for infinitesimals in the 17th century and the rise of *epsilon-delta* techniques to avoid them entirely in the 19th century. But again, I still had no real appreciation for what the *Concise History* had achieved for the history of mathematics generally, or what a revolutionary, some might have even said what a radical, book it was.

The Marxist approach Struik had adopted only became apparent and important to me just before I was about to meet Struik for the first time, when I was a graduate student in the newly founded Department for History of Science at Harvard. I was fortunate at Harvard to be part of a cohort of new graduate students, one of whom was Wilbur Knorr, and the two of us could not have been better prepared for our general examinations in history of ancient and medieval mathematics than by John Murdoch, and in modern mathematics than by Judith Grabiner, who had just finished her Ph.D.at Harvard with a thesis on the mathematics of Lagrange. In 1967-1968, as I was studying for these exams, I was again reading Struik, but with a much more sensitive eye to the political and social contexts that he made clear were sometimes as important for understanding the development of mathematics as were its purely internal developments.

Thus I knew Dirk Struik quite well on paper, from his writings, but I had not as yet met him, and I was in fact unprepared when we did meet for the first time at one of the departmental Christmas parties held every year at the Harvard Faculty Club. I recall seeing the tall, gangly Struik discussing something with I. Bernard Cohen, who introduced us and then went off, leaving Struik and me to talk about history of mathematics. Struik had a way of making whoever he was with seem like the center of attention, at least his center of attention, and at that moment he wanted to know how I came

to study the history of mathematics, and to be at Harvard. After a brief answer, I asked Struik about the *Concise History*; into how many languages had it been translated? I also confessed that his treatment of the 19th century in particular had given me a much broader panorama of interests to consider as I thought about the subject of my dissertation. At that point I had decided to write about Bernhard Bolzano, and, through John Murdoch, I had been in touch with Luboš Nový at the archives of the Academy of Sciences in Prague about my working with him there. I had actually decided to divide my time between Prague and Vienna to work on Bolzano's logic and his paradoxes of the infinite. But as I was enjoying a brief vacation in August 1968 in Southern California, to see my family there before setting off for Prague, news came of the Russian invasion of Czechoslovakia. That changed things considerably, and over the next year I rethought the subject of my dissertation. Back at Harvard, I realized that in all of my reading I had never found a detailed biography of Georg Cantor, founder of transfinite set theory. I had always been interested in set theory, and it was a subject that would at least force me to learn German, a language I could read but by no means use—with any fluency.

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This also seemed like a good choice since Erwin Hiebert had just come to Harvard from the University of Wisconsin. Hiebert was a specialist in the history of modern German physics, and that would be a good match with what I wanted to do in mathematics. Hiebert also suggested that since Struik was emeritus at MIT but still affiliated with the Department at Harvard for just such purposes as directing the odd thesis that might turn up, I should ask him about working with me on Cantor, so I approached him about serving as one of my thesis advisors. I am forever grateful that when I first brought up this possibility, he was enthusiastic and agreed to help however he could.

Struik began by suggesting that I get in touch with Christoph Scriba, who was then Director of the History of Science group at the Technische Universität in Berlin, and that I should also arrange to meet the Director of the Alexander von Humboldt Forschungsstelle at the German Akademie der Wissenschaften in East Berlin, Kurt-R. Biermann. I did, and subsequently spent a very productive year during 1970-1971, living what I considered the life of a double-agent, stationed in West Berlin while doing most of my archival work in East Berlin. From time to time I would write to Struik to inform him of my progress, and he would usually write back with a reference or two that he thought I should read as background or as a foil to how I might otherwise have been thinking about a particular aspect of Cantor's life and work.

When I got back to Harvard, Struik invited me to his home in Belmont to provide a "full report" of the year in Berlin. As I arrived on his doorstep he asked me with a wink, "Is it still '*eine Reise wert*'?" This was one of the slogans often used to refer to Berlin, and I assured him that it was definitely "worth a visit." Actually, I considered the year I had spent in Berlin as my "Berthold Brecht Zeit," given that I was living in a cold-water flat with an octogenarian former singer from the German Opera above what can best be described as a bar that was a local conduit to the nearest brothel. Struik was delighted to hear of all this, and we spent that afternoon, a lazy day in late September, swapping stories about European capitals, his stories better than mine and full of names well known to every mathematician. But he was genuinely interested in Berlin and how it was faring with the wall up and the city divided.

I then spent regularly at least one afternoon each month visiting Struik delivering, chapter-by-chapter, my thesis as it began to unfold. I remember in particular one afternoon in the early spring—I had started delivering chapters to Struik in October, and by March I had gotten to Chapter VI. My writing was accelerating, and I had reached the point of Cantor's major mid-career work, the *Grundlagen*, which was his first large-scale introduction to set theory and transfinite numbers, although at that point only the transfinite ordinal numbers had been worked out and the transfinite *alephs* were another decade in coming. Struik was surprised by that—and wanted to know why Cantor had chosen alephs when he did come to introduce the transfinite cardinal numbers in the 1890s. The answer to that question was one that amused Struik to no end, because the answer was social, political, and in a sense economic as well, a nice Marxian trio as he put it to me at the time, and I had come to see it that way as well. As Struik also said, he had always thought Cantor had

chosen the *alephs* for his transfinite numbers because he was *Jewish*. That turned out to be another fable. In fact, Cantor's mother was Roman Catholic (his father's side of the family most likely had its roots in the Jewish community of Copenhagen). Cantor, who was raised as a Lutheran and seems to have been very comfortable in his correspondence with Catholic theologians (a part of my thesis in which Struik was also particularly interested), seems not to have been a practicing Lutheran or a follower of any particular faith. E. T. Bell's famous characterization of Cantor and Kronecker as the epitome of two antagonistic Jewish professors who were enemies to the death was even further from the mark. Their views on foundations were certainly at odds with each other, but they did their best to get on with one another, and at the end of both their careers, as Cantor was actively working to establish the German Union of Mathematicians, he invited Kronecker to be Union's first keynote speaker in 1891.

In any case, the true story about the alephs, which Struik particularly enjoyed, was basically pragmatic; Cantor knew that his transfinite numbers were special, and he wanted a special notation for the transfinite cardinals. As he told Giulio Vivanti (13 December 1893), all of the usual alphabets were taken, and letters from the Roman and Greek alphabets were too common in mathematics, whereas it would have been costly to design an entirely new symbol that most printers would not have on hand. But in Germany, virtually all printers had the Hebrew alphabet at their disposal. It occurred to Cantor that since the Hebrew aleph also represented the number one, it was the perfect choice for the first of his transfinite cardinal numbers.

By March of 1972, despite his interest in what I had been writing, Struik was becoming worried that I wasn't going to finish in time for a June degree. I assured him that I was writing at full speed and was certain I could finish the last two chapters (as I then envisioned them) in April or mid-May at the latest; one chapter was on Cantor's "*Beiträge*," his last major statement of his set theory, including both the ordinal and cardinal transfinite numbers, and a concluding chapter was about his philosophy of mathematics, the paradoxes of set theory, and the slow but eventual acceptance of set theory and the new mathematics. Struik apparently wasn't convinced, because within the week I received a phone call from my mentor at Harvard, I. Bernard Cohen. I was also the head TA for Cohen's Scientific Revolution course at Harvard, for which he was justly famous. I thought Cohen was calling about the next meeting of the course when I heard him say: "Joe, I've heard something rather disturbing about your thesis." This did not sound like good news, and so I asked him what the problem seemed to be. "I understand," said Cohen, with a suitable pause for dramatic effect, "that it is getting rather long, and I've spoken with Hiebert and Struik and they both assure me that what you've written is plenty for your Ph.D.We think you should stop. Where are you?" "I'm at home," I said, without really thinking. "No—I mean where are you in the *thesis*?" "Oh," I replied, "More than halfway—I've only got two more chapters to go and I'll be done."

Nevertheless, I did indeed stop where I was, more or less, and my thesis, instead of being a history of Cantor's entire work, became instead "The *Early* Development of Cantorian Set Theory." And so, thanks possibly to Dirk's behind-the-scenes intervention, I received my degree in June and began teaching at Herbert H. Lehman College of the City University of New York in the fall of 1972. But before leaving Cambridge for New York, I had one last afternoon on the porch with Dirk at his home in Belmont. With a cold bottle of Riesling, we sat and watched the sunset and talked about his many travels. Among the most nostalgic, he mentioned Rome, knowing that I had spent a part of the past summer at the American Academy in Rome where I had visited the mathematician Lucio Lombardo-Radice. Struik knew Lombardo-Radice and had instructed me to visit in hopes of getting permission through Lombardo-Radice to see letters between Cantor and Vivanti that were still in the hands of Vivanti's family. Struik reminisced about the time he had spent there with his wife Ruth at the University of Rome in the 1920s. His memory was as accurate about the university and the friends he had made there as if he had only been away a few weeks, rather than decades, and he spoke of Rome as if it were an old friend. He could still see, smell, and feel its pulse as he talked about walks along the Tiber or coffee in the Piazza Navona.

As I remember, I next saw Dirk not in Belmont, but in Hamburg, Germany, in the summer of 1989. The occasion was the XVIII[th] International Congress of the History of Science in Hamburg, and Struik was to receive the first award of the Kenneth O. May medal for outstanding contributions to the history of mathematics—an award he was pleased to share with his old friend and colleague from the Soviet Union, the Russian historian of mathematics Adolf P. Yushkevich. As the Chairman of the International Commission on History of Mathematics, which had established the prize, it was my pleasure to make the actual presentation of the medals,

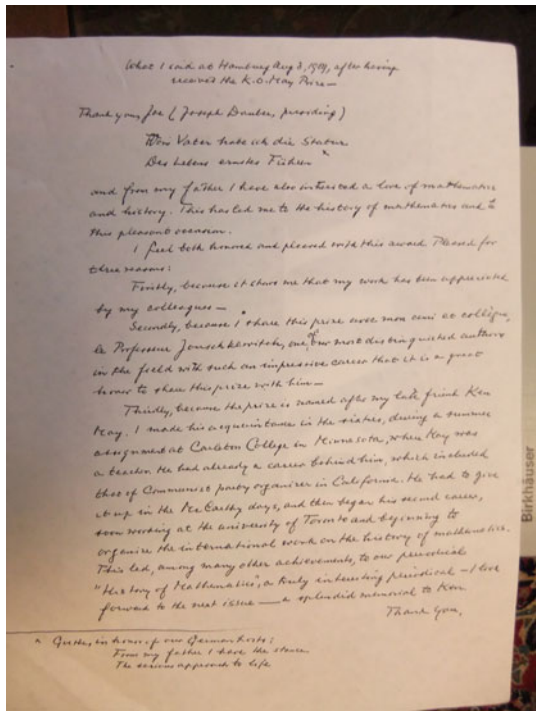

Figure 3. Struik's handwritten remarks, beginning with a passage from Goethe, on accepting the K. O. May Medal, Hamburg, 3 August, 1989.

Figure 4. Dirk Struik, Hamburg, August 1989. Photo courtesy of the International Commission on History of Mathematics.

which, thanks to Christoph J. Scriba, former Chair of the ICHM and one of the co-organizers of the Congress in Hamburg, were presented on boats in the "Binnen Alster," the inner harbor in Hamburg. At the appointed time, three boats carrying members and guests of the ICHM pulled alongside each other and were tethered together while the presentations and speeches were made.

After accepting his award, Struik came to the microphone and talked about the importance of the history of mathematics and how the field had grown from the time he started working, when he was something of a lone figure (Figure 3). Indeed, when he wrote his *Concise History*, nothing like it had really ever been written before, with its level of political and social consciousness that sat very comfortably with the technical mathematical history he also had to tell.

Over the years, whenever I was in Cambridge with time to spare, I would make a point of visiting Dirk Struik in Belmont. The last time I saw him was shortly after his 100th birthday. This was in the fall of 1995, just after publication of my biography of Abraham Robinson, and I wanted to give Struik a copy. I made the familiar trip out to Belmont and congratulated him personally for having passed his 100th birthday. I reminded him of the phrase with which he had ended his personal remarks for the *Festschrift* Robert Cohen published in his honor in 1974. After noting that he and his wife had just celebrated their 50th wedding anniversary and had 3 daughters and 10 grandchildren, he simply added: "Wish me luck." I remarked about this that it seemed to have worked, to which he replied in his usually laconic way: "much better than expected!"

Once again, as so many times before, we were sitting out on his porch, enjoying a late September afternoon in Belmont, and along with the book I had brought a bottle of Riesling. As Struik poured out two glasses, he asked me what I had been working on since Robinson, and I told him about a paper I was reworking about Charles Sanders Peirce and a Tiffany watch the Coast and Geodetic Survey had provided him. Once, on a trip to New York, it had been stolen, and Peirce, in accounting for how he managed to track it down, used this as an example of his theory of abductive reasoning, which he compared to the methods of Sherlock Holmes. The case of his finding the Tiffany watch by a process of elimination and intuition, as Peirce put it, made clear that "when all other possibilities have been excluded, what remains, however improbable, must be true."

Whereupon Struik immediately launched into a detailed account of Holmes and the connection between Holmes and Watson, recalling details of an article he had written that, he said, compared Watson to Zeno of Elea. Both are known only through the writings of others; in this case, what we know of Holmes, Struik said, came mainly from Watson. He said he thought he had copies of the article and would be happy to give me one. He suggested we go upstairs to his study to find it. As he made his way to the second floor, he observed wryly that at his age he no longer went up stairs as quickly as he used to, with the added footnote that "you know, I'm nearly a hundred-and-one." It took him a few minutes, but he indeed found the article in question—written in 1947!

Back on the front porch as he sipped his glass of Riesling, Struik told me about his active membership in the Boston Holmes Society, the Specked Band of Boston, and pointed out that in fact, he was in very good company: Holmesian devotees included Ellery Queen, Basil Rathbone, Isaac Asimov, Franklin Roosevelt, and T. S. Eliot, among many others. He didn't mention that his article, which later appeared in a collection of articles edited by Philip Shreffler, *Sherlock Holmes by Gas Lamp* (1989), not only suggested that Watson's Holmes was akin to Aristotle's Plato, but also covered a vast terrain of cultural information from Mortimer Snerd to the motets of Orlando de Lassus. But this was typical of Struik—he was interested in everything and everyone around him, and that is a large measure, I am sure, of his longevity. It is what kept him young. How remarkable, to have literally spanned a century, the entire 20th century and into the 21st. As historians of mathematics, we must be grateful that Dirk Struik made clear that our subject is not only of highly abstract, theoretical interest, but has very real, significant social roots. These—as he made apparent in one of the most widely read books on the subject—profoundly affect the societies in which mathematics today plays a pervasive role in virtually every aspect of the world in which we all live.

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