

Shift Happens

If you've seen that bumper sticker, you've seen what our culture has made of one of the central ideas in Thomas Kuhn's *The Structure of Scientific Revolutions*, published 50 years and 1.4 million copies ago. For the marketers and boosters of personal transformation who casually talk about paradigm shifts, the phrase designates not just a gestalt switch that casts things in a new light, but a world so insubstantial that it can be thoroughly transformed by a single idea. Tomorrow there may be another paradigm shift, and another after that. There is thus no real progress, just a new bubble as good as the old bubble.

This is of course not what Kuhn intended us to learn. Kuhn wanted to free us from the illusion that knowledge is independent of history and of the sociality that marks us as humans, but he did not think that all beliefs that our history and sociality put before us are equally worthy. Indeed, he quickly moved away from the "shift happens" conception of paradigms as bundles of beliefs, emphasizing instead that they're examples of good scientific practice that researchers apply in their daily work.

But Kuhn is not blameless for how we appropriated his thought. *SSR* shook up our culture in part because he wrote it in such bold strokes. More important, he struggled to find a way—not always consistently—to shove *SSR* from a shoal we still have not found a way around: Our old paradigm of truth is no longer up to the task, but we don't yet have a new one to replace it.

Kuhn's idea was slow to gestate. It began in 1947, when, as a graduate student in physics at Harvard, he was recruited by James B. Conant, the university's president, to teach a history-of-science course to humanities majors. In preparation, Kuhn was trying to understand how Aristotle could be such a brilliant natural scientist except when it came to understanding motion. Aristotle's idea that stones fall and fire rises because they're trying to get to their natural places seems like a simpleton's animism.

Then it became clear to Kuhn all at once. Ever since Newton, we in the West have thought movement changes an object's position in neutral space but does not change the object itself. For Aristotle, a change in position was a change in a quality of the object, and qualitative change tended toward an asymmetric actualization of potential: an acorn becomes an oak, but an oak never becomes an acorn. Motion likewise expressed a tendency for things to actualize their essence by moving to their proper place. With that, "another initially strange part of Aristotelian doctrine begins to fall into place," Kuhn wrote in *The Road Since Structure*.

From this, Kuhn learned several important lessons that surfaced in *SSR* 15 years later. First, scientific ideas occur within a context that enables them to make sense. Second, context is accepted for different sorts of reasons than are the hypotheses that emerge

within it. Third, the idea of a new scientific context occurs roughly the way his own illumination of Aristotle's ideas did: all at once, an entire whole snapping into view the way a duck-rabbit illustration switches instantly from one view to another.

During that 15-year gestation period, Kuhn got his doctorate in physics but increasingly turned to history and philosophy. In 1950 he met Sir Karl Popper, the pre-eminent philosopher of science, who steered him toward others who were challenging logical positivism, the dominant philosophy of science of the time. The positivists were strict parents. If a proposition could not be verified, it not only wasn't science, it was devoid of meaning. Popper had pulled much of the ground out from under the positivists by arguing that falsifiability was the real test: If a hypothesis doesn't come with ways to show it could be false, then it isn't a scientific hypothesis. Thus our best knowledge of the world isn't that which has been verified, but instead is characterized precisely by the fact that it can be decisively cast aside.

Kuhn undid Popper even more fundamentally than Popper had undone the positivists. The individual propositions within a science might be characterized by falsifiability, but how about the sort of gestalt that crystallized for Kuhn when at last and in an instant he understood Aristotle's idea of motion? That gestalt—which Kuhn of course called a paradigm—was of a different category than the propositions it enabled. Its acceptance may be rational in important ways, but Kuhn throughout his career could not bring himself to call paradigms "true."

Considering that paradigms are central to *SSR*, it's surprising how ambiguous that work leaves the concept. At a conference in 1965, the late British philosopher Margaret Masterman listed 21 senses in which Kuhn used the term in that book. She clustered them into three groups: (1) a set of beliefs, (2) a "universally recognized scientific achievement" that serves as a defining example of how that science is done, and (3) the textbooks, instruments, and other physical artifacts by which scientists learn and practice their fields. In a postscript published in 1969, Kuhn emphasized the second view of paradigms, as exemplars that guide practice—"See? *That's* how you do astronomy!"—rather than as big ideas that provide the context for smaller ideas. He also talked in the postscript about paradigms' applying to communities of scientists that might be only a hundred strong. That is not the grand picture that has stuck in the public mind.

Paradigms were not the only influential idea in *SSR*. Kuhn focused on what he termed "normal science," the daily work of career scientists. He said they are not in the business of plotting revolutionary overthrows of existing paradigms, but are instead solving puzzles. Which puzzles are interesting, how to address them, and what counts as solutions all are determined by the paradigm—or, depending on which sense of paradigm one uses, those are the paradigm. Astronomers train telescopes into the sky looking for particular radio signatures because they work under a paradigm in which

that activity is important. They have learned to do this from textbooks that codify the paradigm, and they are trained by other scientists in their community. Kuhn spent much of the rest of his career trying to direct the focus of historians and philosophers of science on normal science rather than on revolutionary paradigms, perhaps because his concept of a paradigm was so powerful that it not only overshadowed the quotidian work of science but also threatened to take on an all too solid life of its own. No, Kuhn insisted, take away the practices, instruments, and textbooks of a scientific community, and there is no paradigm left over. Except those times when he left the opposite impression.

Kuhn's insightful focus on normal science may seem obvious to us now, but at the time it was controversial. The history of science had been viewed like the Great Man theory of history, or perhaps more accurately, like the history of literature: You write about the great ones because why would you waste your time on those who did nothing substantial to advance their field? As Karl Popper said, "In my view the 'normal' scientist, as Kuhn describes him, is a person one ought to be sorry for."

Kuhn did not see it that way. It's true that he did not talk about normal scientists as heroes ripping truth from the jaws of duplicitous Nature, but he saw scientific puzzle solving as a creative activity, not as the mere formulaic following of rules. Despite the scorn of heavyweights such as Popper and Kuhn's Berkeley colleague Paul Feyerabend, Kuhn's focus on normal science has found favor with many historians and sociologists, in part because it allows them to focus on the background, where institutional and social power is exerted implicitly, rather than on exalting the exceptional people in the foreground, which can give us a misleading idea of freedom and empowerment.

Scientific revolutions, according to SSR, don't occur when an apple happens to find the head of a genius, or when enough facts have slowly painted a new picture. Rather, in yet another of Kuhn's inversions, new paradigms emerge to explain the accumulation of anomalies: findings that do not make sense within the current paradigm. For example, if your paradigm tells you that fire consists of the release of phlogiston embedded in flammable materials, then the fact that some metals gain weight when burned is an anomaly. When a new paradigm is conceived that makes sense of the anomalies, science is in for a revolutionary shift.

In short, SSR did a gestalt flip on just about every assumption about the who, how, and what of scientific progress.

SSR immediately kicked up a stir. In a review that appeared in 1964 in *Philosophical Review*, Dudley Shapere recognized that it "is bound to exert a very wide influence among philosophers and historians of science alike," although he thought the concept of paradigms was overly broadly described, and he homed in on one of the issues that

was to dog Kuhn: Is progress possible? Mary Hesse began her 1963 review in the journal *Isis* with "This is an important book," and continued by saying that it transforms "our whole image of science" and will be "shocking to the orthodox philosophy of science." Charles Gillispie's 1962 review in *Science* began, "This is a very bold venture, this essay ... " and concluded with generous praise for the work as an initial provocation, for Kuhn positioned *SSR* as a sketch to be followed by a weightier tome, which he never delivered.

In the five decades that have followed, the importance of *SSR* has rarely been disputed. We seem to have accepted that Kuhn's work wreaked severe damage on the foundations of traditional philosophy of science. But there has been nothing like similar unanimity about the positive ideas the book attempted to establish.

By far the most consistently attacked idea was what Kuhn referred to as *incommensurability*, a term taken from geometry, where it refers to the lack of a shared measurement. In *SSR* it means something like the inability to understand one paradigm from within another. In the book, Kuhn borders on putting incommensurability in its strongest imaginable form: A new paradigm causes scientists to "see the world of their researcher-engagement differently. In so far as their only recourse to that world is through what they see and do, we may want to say that after a revolution scientists are responding to a different world." Since that line does not advance his argument, Kuhn may just have been sticking his thumb further into the eye of the logical-empiricist book series that *SSR* was published as part of (at the behest of the best-known positivist, Rudolf Carnap, no less).

To overstate it: The scientists hated incommensurability because it seemed to imply that science makes no real progress, the philosophers hated it because it seemed to imply that there is no truth, and the positivists hated it because it seemed to imply that science is based on nonrational decisions.

And, apparently, Kuhn grew to hate being challenged about it, at least according to a story told by the documentarian Errol Morris, who as a graduate student at Princeton studied under Kuhn:

"I asked him, 'If paradigms are really incommensurable, how is history of science possible? ... Wouldn't the past be inaccessible to us? Wouldn't it be "incommensurable?"'

He started moaning. He put his head in his hands and was muttering, 'He's trying to kill me. He's trying to kill me.'

And then I added, ' ... except for someone who imagines himself to be God.'

It was at this point that Kuhn threw the ashtray at me."

Indeed, if science exists within paradigms, and if those paradigms can't understand one another, and if there is no Archimedean platform from which to view them, then how can we tell if we're making progress? It was easier before Kuhn, when science looked like it was the gradual accumulation of knowledge over time. Yet Kuhn was certain that science does indeed progress. He would not have traded Newton's physics for Aristotle's, or Einstein's for Newton's. He struggled to explain progress for the next 30 years.

SSR has a simple dodge of the question: Within any scientific paradigm it necessarily looks like progress is being made, since the normal work of science is to gnaw away at puzzles one by one. Likewise, new paradigms always look like steps forward because that's why they've been accepted. That explains the appearance of progress within a paradigm, but how about across paradigms? Do we have to "relinquish the notion," as he suggests in *SSR*?

To save progress, Kuhn proposed thinking of it as being like evolution. "Scientific development must be seen as a process driven from behind, not pulled from ahead," he said in a 1990 presidential address to the Philosophy of Science Association. That is, there isn't only one possible endpoint or a final paradigm, and there isn't an overall design. That's a useful hint about what progress isn't, but it doesn't tell us what progress is or how we can know we're achieving it.

Ultimately, Kuhn couldn't solve this puzzle, and for a reason that runs underneath so many of his difficult thoughts: Kuhn did not accept that truth consists of statements that represent reality. As he said in an interview published in 1990, "I take theories to be whole systems, and as such they don't need to be true or false. All we need to do is by some criteria or other decide which one we would rather have." Outside of the metaphysical paradigm that says a true statement corresponds to an objective reality, the concept of progress becomes problematic, or at least unfamiliar.

But that was not the end of the difficulties that incommensurability raised for Kuhn. That concept is also at the bottom of his view of the history of science as revolutionary. That idea was certainly in the air: Herbert Butterfield's 1948 lectures "got the English-speaking historians into the revolution-in-science" business, as Ian Hacking puts it, and Gaston Bachelard (among others) pointed to multiple conceptual discontinuities in the history of science.

But Kuhn saw these revolutions as so deep that there isn't even a shared language for talking across them. For this idea he was taken to task. For example, Stephen Toulmin wrote that the continuous small adjustments paradigms go through make them less discontinuous and more commensurable than Kuhn's use of religious language—"conversion," for example—often made them sound. The Nobel laureate Steven Weinberg, in a 1998 article, also wasn't buying the incommensurability of scientific

revolutions, pointing to the "hard"—that is, durable—parts of science that endure across paradigms, such as Maxwell's electrodynamics equations.

It's not just paradigms and revolutions that have come under withering criticism. Historians have disputed that the structure that Kuhn found in scientific revolutions is as uniform as he supposed, especially as he allowed that paradigms might be smaller than Newton's and Einstein's, eventually viewing them as a type of specialization of a discipline. Not all of these smaller revolutions go through the paces *SSR* describes.

So what's left of Kuhn's paradigm? The big ideas in *SSR* may not seem as grand and clear as they did in 1962. Nevertheless, the book still vibrates our culture's walls like a trumpet call.

History of science may not have become exactly what Kuhn thought it should, but *SSR* knocked it off its existing tracks. In a historical account of science, we now expect to hear about very human personalities, about the effect of social factors, and frequently about how the attempt to maintain and exert power was behind what looked like rational actors acting selflessly—although Kuhn vehemently rejected the reduction of history to a story about power. Likewise, we now expect some measure of incommensurability to deepen the narrative, as when Foucault shows that concepts, words, and institutions that seem continuous through history have actually had radically different meanings. This may not be what is taught to scientists in training, yet one analysis of Kuhn's impact found that by the mid-1980s, Kuhnian ideas were included in many articles about scientific education.

Still, as you watch Kuhn twisting under the withering gaze of intersecting disciplines, none of which quite counted him as a member of their club—the philosophy department at Berkeley insisted that he be granted a full professorship as a historian—you can't help feeling bad for him. He had a magnificent insight, which profoundly altered our view of science and more, but it was like a tent that keeps popping up its stakes as you madly circle it trying to get all of them pounded in securely. Except in this case, the problem is less in the design of the tent than in the ground itself.

Consider the popular take on *SSR*: Science consists of self-coherent bubbles that replace one another without necessarily progressing closer to the truth—a model of nonrationalism. This misunderstanding of Kuhn is understandable given his unwillingness to blurt out what so many of his readers wanted to hear: There are propositions that are true because they correspond to reality. "Does it really help to imagine that there is some one full, objective, true account of nature, and that the proper measure of scientific achievement is the extent to which it brings us closer to that ultimate goal?," he wrote in *SSR*. Well, yes, it would, if we're trying to show that our knowledge is progressively more in accord with that objective reality. But if that approach is closed to us—"We must learn to get along without anything at all like a

correspondence theory of truth," he wrote in 1986—we need another idea of what truth is and how we can ascertain if we're progressing closer to it.

Kuhn rejected our old metaphysics—consciousness consists of an inner representation of an outer reality—as incoherent, impossible, and fundamentally inhuman. That's why he begins *SSR* by invoking history not as a discipline that can be applied to science, but as a necessary part of scientific understanding. All understanding is historical, and no human project escapes the characteristics of history-based humanity: fallible, limited, impure of motive, social, and always situated in a culture, a language, and a time. Not even science with its method and its formulas. Our very words have meaning not because of a set of definitional rules, Kuhn thought, but because they are based on ostensive exemplars, paradigms. Our age, characterized by a Network that refuses to keep ideas, communication, and sociality apart, is making manifest the messy, inescapable humanness of all of our endeavors.

The problems that dominated Kuhn's life after his great moment of insight arose not because Kuhn wasn't brilliant enough. Rather, they arose and persist because while we increasingly understand that the old metaphysical paradigm has failed, for several generations now we have not found our new paradigm. Our culture has inappropriately latched on to Kuhn's message as an exaltation of the rootless disconnection of our ideas from the world because we were ready to hear that knowledge is not apart from our knowing of it. But he and we have not yet come to a new shared understanding about what it means to live truthfully as humans.

David Weinberger, a senior researcher at the Berkman Center for Internet and Society at Harvard Law School, is the author of *Everything Is Miscellaneous: The Power of the New Digital Disorder* (Times Books, 2007) and *Too Big to Know: Rethinking Knowledge Now That the Facts Aren't the Facts, Experts Are Everywhere, and the Smartest Person in the Room Is the Room* (Basic Books, 2012).