

ISSUE 8



SUMMER 2014

WWW.THEPOINTMAG.COM

THE SOVIET SCIENCE SYSTEM

by Michael D. Gordin

Gather a crowd of historians and philosophers of science into a room and ask them to define "science." On second thought, don't try this at home, because you'd likely meet with stony-faced refusal on the part of the first and raucous disagreement from the second. Yet isn't the task rather straightforward? Isn't this just another classic instance of academics creating mountains out of molehills? Actually, no. The problem is fiendishly frustrating (and likely intractable) simply because of the kind of activity science actually turns out to be in practice.

Consider, for example, what it clearly isn't. Science cannot be simply a collection of true propositions about nature. Most of what has counted uncontroversially as "science" during the past few centuries—geocentric astronomy, phlogiston chemistry, ether physics, the inheritance of acquired characteristics—is now considered to be false. Even worse, much of what we *now* consider to be science is doubtless going to be proven false, since nature was unkind enough to deny us the answer key. Science is also not merely the proper execution of method, both because various disciplines display a whole hodgepodge of different methods, and also because one can apply all the accepted methodology and come up with doctrines (parapsychology, eugenics, phrenology) that we would with alacrity exclude. The problem gets worse when you go farther back in time or across cultures. Mayan astronomy, Classical Chi-

nese alchemy, Hippocratic medicine—all these are rather distinct from what we now consider to be "science," and yet it strikes most scholars as rather churlish to dismiss them. No one has been able to come up with a broadly consensual definition of science, and I am certainly not about to do so here.

Nonetheless, science seems as easy to identify as pornography was in the immortal characterization of Justice Potter Stewart: you know it when you see it. Why are we so confident that we recognize science? A major reason is that the elite natural sciences—by which I mean physics, chemistry, biology, geology and so on—resemble each other very strongly in their external features, however much they differ from each other in terms of theories, practices, fashions and organization of research (some in the lab, some in the field, some at the blackboard and most at a computer at some point during the day). The homogeneity is striking. Knowledge in these domains is communicated largely by articles and conference papers, not books. The journals *Science* and *Nature* sit at the apex of a byzantine hierarchy of periodicals that parse the disciplines and subdisciplines, and articles in almost every field display a standardized template (Introduction, Methods, Results and Discussion, a.k.a. IMRAD), entombed in the passive voice and simplified clause structure. The language of these communications is English; Russian, German, French and Japanese shrank to statistical insignificance decades ago. Postdocs cycle from Calcutta to Capetown to Cardiff to Columbus, and the laboratories they enter at each site, the journals they download to their laptops, the language they speak when they enter their new workplaces—all exhibit the familiarity of the only science they have ever known.

SYMPOSIUM

But this predictable uniformity has nothing to do with "truth" or "nature" or "scientific method." These are the hallmarks not of science itself, but rather of what we might call a "science system." In today's world there is only one of these. It resembles largely (but not wholly) that developed in the United States after World War II, and it is simply how science "is done" today, no matter where you happen to be. That's how we believe we know it when we see it: it is hard to conceive of science otherwise, because we are not regularly confronted with instances from a different system. But not too long ago, there was not one science system in the world, but two. A sojourn around the landscape of the second system—what I will dub the Soviet Science System—reveals an organization of expertise of the natural world that strikes us as undeniably science, but not as we know it.

Expertise is not organized neutrally; in fact, it is hard to imagine what a "neutral" organization of expertise would look like. Experts are organized *for* something, which means a decision—usually political—about appropriate goals, and experts must be organized to fit ideologically and institutionally within the broader culture and polity. The annoying thing about experts is, well, their *expertise*. Not everyone has it, or the opportunity to acquire it: it's expensive to train people, and nature does not distribute competence equally. For a Communist country like the former Union of Soviet Socialist Republics, the problem of experts was perpetually aggravating, and periodically burst into flame. (The same is true, by the by, for the Ameri-

can system: pointy-headed elites fare poorly at moments of populist politicking—witness the periodic Climategates—and centralized federal money after World War II aggravated partisans of states' rights decentralization.) The Soviet Science System presented one enormously influential solution to the perpetual problem of expertise—and then it vanished. Mostly.

Yet there was no single Soviet Science System. The structures that began to coalesce under the ramshackle regime controlled by Vladimir Lenin from a nineteenth-century European-style precursor was rather distinct from the one that Joseph Stalin consolidated beginning in 1928. Nikita Khrushchev in the 1950s de-Stalinized some aspects of the science system and left others intact. The most stable era of the Soviet Science System lasted from 1965 to 1991, spanning the slowly disintegrating Soviet Union from Leonid Brezhnev to Mikhail Gorbachev. (Some aspects of it continue—or are even being resurrected—under Vladimir Putin.) As with time, so also for space: the System manifested differently in Siberia as compared to the Baltics, acquired specific aspects in Moscow as opposed to Leningrad.

If we zoom in on the details, we'll be lost before we begin. Let's focus on the tapestry as a whole instead of the exquisite needlework. The primary notion to keep in mind is that any science system is primarily for organizing expertise, and that is a tale of ends (what is science for?) and means (how do we get there?). Translated into the Soviet Science System, this suggests we look at ideology and scale.

“Ideology” is a squishy term. In what follows, I will take it as given that everyone has an ideology, in the capacious sense of a set of principles (conscious or not) by which one makes sense of one’s surroundings. Scientists have ideology too, and the Western science system is shot through with it: flexible, mobile labor; double-blind peer review; competitive funding—these are not ideology-free (regardless of whether they are desirable). The difference with the Soviet system is that there the ideology, Marxism-Leninism, was explicit, although its precise interpretation went through rather dramatic transformations over its 74-year lifespan.

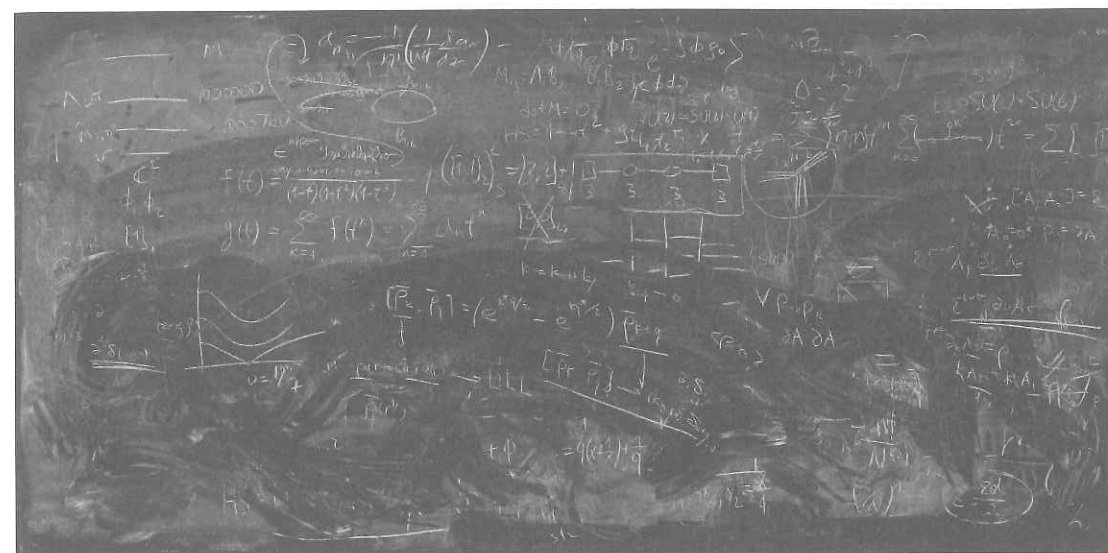
Marxism-Leninism applied to science was called “dialectical materialism,” and despite now having a somewhat malodorous reputation, it is actually a fairly presentable philosophy of science. As a materialism, it rules out vital forces, spiritual essences, souls—the vestiges of nineteenth-century *Naturphilosophie*. The dialectics part means that nature (or the perceptual apparatus by which we apprehend nature) behaves in a certain manner, such as through a transition from changes in quantity to changes in quality (think periodic table: add an identical proton and get a wholly different chemical element).

Dialectical materialism was official, so in principle every scientist in the Soviet Union either propounded it explicitly or at the very least didn’t spout off about logical positivism or other bourgeois nonsense. Marxism was *scientific socialism*, and science had a uniquely significant status in the Communist cosmology. Courses in dialectical materialism were required of all university students, and superficial adherence to its tenets was enforced. As Americans penned their IMRAD articles (themselves structured around an ideological

frame of neo-positivism), the Soviets publicly displayed conformity in technical papers on quantum electrodynamics or geomorphology through ritual invocations of the epistemological insights of Lenin or Engels (or, before the de-Stalinization of the mid-1950s, Stalin himself).

To us, having an “official philosophy of science” just sounds plain weird, and it has been the source of much mockery of Soviet science, by both Westerners and its former practitioners. But if you teach a whole nation a powerful philosophy of science, some of them might find it useful. Vladimir A. Fock (1898-1974) reported that his engagement with the ideology enabled him to devise a new set of harmonic coordinates for general relativity. Yakov I. Frenkel (1894-1952) developed his notion of “holes” and “collective excitations” in condensed-matter physics through extensive reflection on contemporary Soviet political thought. And it is impossible to read the theories of psychologist Lev Vygotsky (1896-1934) about the development of language in children—currently ascendant in cognitive psychology over Jean Piaget’s stage model—without observing how his notion of a social language explicates a distinctively Marxist position. These are all reasonable scientific theories whose origins are rooted in ideology.

Ideology mattered in other ways at the state level. When Khrushchev abandoned Stalin’s “socialism in one country” for the less confrontational but equally competitive “peaceful coexistence,” he also promoted a cosmonaut program designed not so much to bury the West as to demonstrate the superiority of Soviet methods for organizing knowledge. (The United States in turn promoted its own space program globally as the hallmark of Americanism.) In all these



Alejandro Guijarro, Stanford from *Momentum* series, 2010-2013

instances, ideology helped set the agenda for the organization of expertise, what expertise was supposed to be *for*.

It had a dark side, as these things often do. In the Soviet ideological frame, nature existed for the sake of exploitation by humans to build a better society, thus promoting catastrophic environmental degradation in the service of modernization—most graphically instantiated in the 1986 Chernobyl reactor meltdown. Content followed the same pattern as context. For example, in the late 1930s Vygotsky's theories were suppressed as ideological heresy, replaced by decades of behaviorism. Or consider the most notorious episode in the history of Soviet science: the "Lysenko Affair." In the late 1920s, a young Ukrainian-born agronomist named Trofim Lysenko began promoting a program he called *iarovizatsiia* ("vernalization" in the standard English translation), procedures like rubbing seeds with ice in order to enhance their viability during cold winters. Interestingly, this really works—in fact, it was not even a discovery, being already a much-discussed phenomenon among plant physiologists. Lysenko's innovation, assisted by several canny advisors, was to promote vernalization as part of a biological system he called "Michurinism," a Marxist-friendly theory of heredity. Soviet philosophers' problems with genetics were both ontological ("genes" were ideal, immaterial phantasms dreamed up by an Augustinian friar) and political (if heredity was unchangeable, there was little room for progress). According to Lysenko, the procedures of vernalization "shattered" the hereditary material of plants, transmuting a somatic shock into a transmissible trait—in short, the inheritance of acquired characteristics, vestiges of Jean-Baptiste Lamarck's

long-dismissed theory. Genes, Lysenko maintained, were pseudoscientific.

A vigorous debate between Michurinists and geneticists raged during the 1930s, quieted down in the early 1940s—but not before the leading Soviet geneticist, Nikolai Vavilov, was arrested and sent to a prison camp; he died of malnutrition in 1943—and then resurfaced with a vengeance in 1948. In August of that year, during the last session of a conference at the All-Union Lenin Institute of Agricultural Sciences that Lysenko had usurped from Vavilov in the internecine warfare characteristic of many science systems, Lysenko announced that Joseph Stalin had endorsed Michurinism. Genetics was proscribed. Stalin died five years later, but Lysenko held on at the pinnacle of Soviet biology until 1965, when the geneticists emerged from the sheltering protection of nuclear bomb-designers (in whose institutes their research had been coded as "radiation biology") and dethroned him. The era was an utter catastrophe for Soviet biology, which had to painfully resurrect the science of genetics.

Yet this most scandalous of displays within the Soviet Science System was also quite atypical. Periodically, would-be Lysenkos emerged from the woodwork, sporting dialectical-materialist slogans and seeking state backing, and almost always they failed. In the meantime, the Soviet Union produced some of the most brilliant physics, mathematics and geology of the twentieth century. The Soviet Science System had pathologies, but they were just that: pathologies. They were not the ordinary course of affairs, and most individuals functioned in the system undamaged by the Law of the Negation of the Negation or Friedrich Engels's views on energeticism. In the end, no matter what you

did, ideology framed the way you did it—how could it not?

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Once ideology has framed the ends, the science system must confront the problem of *means*. In the Soviet Science System, this was a matter of scale, which was then molded into institutions.

Had alien anthropologists voyaged to Earth fifty years ago to see how humans organized their knowledge of nature, scale alone would have drawn them Sovietward. The Soviet Union spanned one-sixth of the planet's land surface, and the Soviet Science System was even larger, spreading beyond its borders to the Communist bloc—Eastern Europe, China, North Korea, Cuba—and even to those regions of the globe that were once called the "Third World" (especially India, Egypt and parts of Latin America). On every level, the Soviet Science System liked things big.

Even if you recall next to nothing about the Soviet Union's technical achievements, you likely know two things: the launching of the first artificial satellite, Sputnik, in October 1957; and the emergence of the Soviet Union as the second nuclear superpower after its first atomic test in August 1949. Both space and nukes dominated the foreign image of Soviet science and technology (massive arsenals, Yuri Gagarin as the first man in space, nuclear submarines and so on), but the bigness had a domestic face as well: enormous dam and canal projects, the construction of an expansive spur to the Trans-Siberian Railway through intractable

permafrost, electrification of the countryside and more.

The Soviet Science System did things on a gigantic scale because that is what it was set up for. It had the cadres for it. In 1991, the last year of the Soviet Union, state statistics counted more than 1.5 million scientific researchers. Official Soviet numbers should always be taken with a grain of salt, but external estimates consistently placed the quantity of Soviet scientists and engineers as ten to thirty percent greater than in the United States. With enormous labor at its disposal (some of it forced Gulag labor) and a lackadaisical relationship to punctilious bookkeeping, Soviet planners often disregarded human, financial and environmental costs in the interests of grand planning. The painful and murderous construction of the Belomor Canal between the Baltic and the White Seas is one infamous instance. (If you consider canal building "engineering" and not "science," see above about ideology.) Another never-implemented Stalinist project proposed reversing the flow of northward-bound Soviet rivers through multiple "peaceful nuclear explosions" across Siberia in order to address the falling water levels of the Aral Sea, itself a consequence of massive cotton plantations across Central Asia. Bigness begat more bigness, and the knowledge system operated the same way.

The institutions also had to be big. If the American Science System during the Cold War rivaled the Soviet in terms of scale per capita, at the administrative level the Soviet system exhibited features utterly foreign to bourgeois eyes. Dominating this knowledge bureaucracy was the Academy of Sciences of the Soviet Union. The Soviet Academy was no honorific learned society to which indi-

viduals were named when they reached the summit of their research careers at institutions of higher education. Teaching was done at Soviet universities, but teaching was the only thing universities did. The Academy was a purely research institution, the universities entirely pedagogical. This way the country's leading researchers wouldn't be bothered by pesky undergraduates and could fully devote themselves to science. The Academy distributed research funds to those within its hallowed domain, line items in a titanic budget that came as part of the job rather than as the result of a competitive peer-reviewed process—wasteful duplication of resources, from the Soviet point of view—and researchers spent their entire lives from graduate-education cradle to senescent grave within the bosom of specialized research. With constant research funds, permanent employment and no obligation to teach, Soviet scientists were free from the frictions of the Americanized research university framework.

The Academy had started rather differently. In 1724, Tsar Peter I (also known as "the Great," although the appropriateness of that moniker is one of the most debated questions of Russian history) capped a series of reforms of every aspect of Russian governance—civil service, military organization, taxation, the alphabet and even the location of the capital—by creating an Imperial Academy of Sciences. There were as yet no Russians trained to function at the elite level of European natural philosophy, so the ranks of academicians were staffed largely by Central Europeans recommended by Gottfried Leibniz's disciple Christian Wolff (among them Leonhard Euler, who would become the most illustrious mathematician of the century). The academicians published in Latin, a recent import to this decisively non-Catholic

land, and chattered away in German. Over the course of the eighteenth century, Latin faded but German persisted, and Russians recruited from a fledgling university system began to populate this scientific Olympus. (The rolls of the Academy were distinguished, although Russian savants familiar to us like Dmitrii Mendeleev and Nikolai Lobachevsky were denied access to its pastures.) Publications from the Academy continued to issue forth in international tongues like German and French, but Russian emerged by the end of the nineteenth century as preferred. The Imperial Academy was, in short, much like the Académie des sciences in Paris or the Prussian Akademie der Wissenschaften in Berlin: part honorific, part research, all prestige.

The Revolution of 1917 did not change this much. Academicians, like Russian intellectuals at large, ranged in conviction from blue-blooded monarchists to British-style liberals, and generally did not welcome Lenin's socialist republic. Yet they didn't lobby against it either, and the most influential of them, like Ivan Pavlov (think dogs, bells, drool), used his international prestige to better scholars' wretched living conditions during the painful years of civil war. The rupture came early in Stalin's reign, as young Bolsheviks railed against the privileges of this counter-revolutionary elite. Foreign specialists who had been consulting on industrial expansion in the mining and railroad industries were prosecuted as "wreckers," and "red specialists" came into ascendancy. In 1929 the Academy was "bolshevized": expanded to admit more scholars with pliant politics to dilute the possibility of this venerable institution becoming a venerable liability. With one hand Stalin took away, with another he gave: heaps of resources and mountains of status.



Alejandro Guijarro, *Cambridge* from *Momentum* series, 2010-2013

From being a classic indicator of reactionary politics in the 1920s, by the 1950s “academician” was one of the most prestigious titles in the Soviet pantheon.

The Academy was gargantuan. The All-Union Academy had branches in Moscow, Leningrad and eventually Novosibirsk, as well as specialized institutions, ecological reservations and laboratories scattered everywhere. The fifteen constituent republics of the Soviet Union had their own Academies of Sciences, a mini-Olympus to mirror the structures of the Union. Ukraine got the first clone in 1918, then Belorussia in 1929 and then a deluge starting in 1941, as Stalin mobilized for the war and then re-mobilized for the postwar: loyal Georgia in 1941, but also newly annexed Lithuania, fruit of the Hitler-Stalin pact; all the way to Kyrgyzstan in 1954, the year after the *vozhd's* demise. (Did I say fifteen? I meant fourteen. There was one republic within the Soviet Union that never got its own academy: the Russian Soviet Federal Socialist Republic. This despite the fact that most institutions of the “All-Union” Academy were based on its territory. The oversight became a sticking point with Russian nationalists in the late 1980s and contributed to anti-Soviet mobilization.) Academies on the Soviet model were erected or restructured across the Communist world. Even the Prussian Academy of Sciences, located after World War II in the German Democratic Republic, was reshaped by the end of the 1960s into a massive research complex. Replication was a characteristic of the Soviet Science System, reproducing the same structures of funding, training, employment, intellectual property (or lack thereof) and publishing wherever it spread.

The Academy and its unfortunate step-brothers the universities were not the only institutions of science, of course, and I mention a few others only in passing because we know far less about them. The KGB had its own scientific institutions, reviewing the competence as well as the loyalty of scholars. During Stalin's time engineering shops (known as *sharashki*) were set up within the prison system, and prison labor was instrumental in the construction of the atomic and space megaliths. The largest parallel institution to the Academy, however, was the military, which controlled “closed cities” dotted across the map—or not quite, since they were erased from the maps to keep prying eyes out. Each of these was part of the structure to organize expertise, a structure molded closely to the shifting demands of politics and society.

So that was the Soviet Science System, in a nutshell. But was “Soviet science” truly a species of the genus *science*, or simply some horrific bastardization that had nothing to do with the pursuit of knowledge? Let us return to Potter Stewart's maxim: we know science when we see it. Did the Soviet Science System look like science? Most definitely. And it produced loads of knowledge too, much of it still considered foundational: the Moscow School of Mathematics, Lev Landau's extraordinary physics, the entire science of permafrost (itself a calque into English of the Russian *vechnaia merzlot*), semiconductor heterojunctions, hypergolic rocket fuels and so on.

But even broken clocks are right twice a day. Isn't our way of organizing science *best*, or at least better? After all, the Western system survived, even metastasized across the globe, and the Soviet system vanished with the empire that had spawned it. The question seems to me unanswerable. Metrics are defined within the context of a system. Americans won (many) more Nobel prizes than did Soviet citizens, but the Swedish Academy regularly snubbed the latter, and in any event usually could not read Russian to see what the fuss was about. There were fewer Soviet patents and inventions, but that's in no small part due to a radically different system of intellectual property, which preferred to compensate local geniuses with prizes and dachas. It doesn't seem to have been terribly *efficient*—an omnipresent critique of Soviet life in general—but I have seen few convincing measures of the efficiency of our own science system. (In any event, valorizing efficiency is an ideological criterion that characterizes our own science system—a forest of impact factors and performance metrics.)

To avert any misunderstanding: I am not *defending* the Soviet Science System; I am describing it. There was a great deal of shoddy work, rent-seeking and suffering within that system. But there was also extremely good

work, and the latter was a product of the system that engendered the former. That's the paradox that comes from looking at any science system: it wouldn't be a system at all if it didn't, in some sense, work. The American system has its own pathologies—creationist brush-fires and politicized funding panels—many of them born of the relative openness of media and the potential for expert judgment (and funding) to be subject to the whims of demagogues, cranks and zealots. Those features seem pretty normal to us, but they struck Soviet citizens as destructive of the essence of science.

There is no escaping the stubborn reality that our expectations of scientific normalcy, our epistemic sensibilities, are hardwired into our science systems. These systems have evolved in order to organize expertise in accordance with those expectations. At the same time, science systems acquire emergent properties of their own which subtly shift those sensibilities. However extraordinary the phenomenon of Soviet science appears today, we cannot forget that for a significant segment of the world's scientists it was simply how science was done, just as our system manifests to our minds not as a science system, but simply *science*, full stop.