Who Invented Science?

Review of *The Invention of Science: A New History of the Scientific Revolution,* by David Wootton

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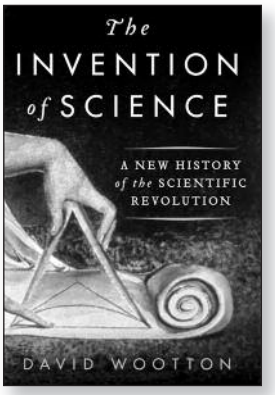

Harper, 2015.
784 pp. $35.00
ISBN 13-978-0061759529

The title of David Wootton's latest book, *The Invention of Science: A New History of the Scientific Revolution,* is doubly provocative. To begin with, it defends the concept that there was in fact a series of events worthy of the title "revolution" that led to the widespread adoption of the scientific method. The title also hints at the elegant argument that comes scribed on its pages: that the history of science needs to be rethought through the prism of the humanities, and rewritten in the context of global exploration and discovery during which it occurred. The humanities and the sciences split somewhere between the 1620 publication of Francis Bacon's *Novum Organum* (New Organ, or New Method) and the 1717 publication of Giambattista Vico's *New Science*. They have been inching closer together since Einstein made the observer part of the scientific process. The humanities and the sciences, partitioned by Bacon's new method and Vico's new science, have been narratively reunited by Wootton's new history.

For Wootton, the Scientific Revolution did not arrive in the West when medieval monks opened the dusty Arabic translations of Aristotle, but when Columbus sailed into the Americas. A fresh term, still sprinkled with ocean spray, animated the European language. It was "discovery." Wootton traces the introduction of the word to a letter by Amerigo Vespucci written shortly after Columbus's Caribbean landfall. "The invention of discovery, acting in combination with the printing press, transformed the balance between evidence and theory, tilting it away from the reinterpretation of old arguments and towards the acquisition and interpretation of new evidence" (136).

Open *The Invention of Science* and flip a couple of pages and you will see the cover of Bacon's *Novum Organum*, published in 1620. It has a ship sailing out into the ocean between the pillars of Hercules. Scientific discovery was built upon the analogy of exploratory discovery. Boats and bees (insects that leave the hive, find important things, and bring them back to make use of what they have found) were the stuff of Bacon's imagination, so is it any wonder that his novella *The New Atlantis* places the perfect scientific society on an island?

Wootton is more than clever for seeing this connection between exploration and science. Nobel laureate Steven Weinberg wrote of Bacon: "It is not clear to me that anyone's scientific work was actually changed for the better by Bacon's writing. Galileo did not need Bacon to tell him to do experiments, and neither I think did Boyle or Newton. A century before Galileo, another Florentine, Leonardo da Vinci, was doing experiments…" (202). This is a bit like saying that it is impossible to trace the influence of the greenhouse keeper on the flowers. Bacon's goal was to implant the concept of discovery into education. Do not just study old knowledge, implored Bacon, create new knowledge by experimentation. He wanted to systematize the process of experimentation that was already in place. While Weinberg attempted to judge Bacon by the standards of modern physics, where discoveries are built upon discoveries, Wootton realizes that Bacon's scientific importance was in the creation and explanation of new concepts. "While Bacon was writing about discovery, others were making discoveries. Slowly and awkwardly, in the course of the sixteenth century, there had come into existence a grammar of scientific discovery…" (85). When judged by a scholar of the humanities, Bacon is a linguistic genius; when judged by a physicist, he is a nonentity.

From this notion of discovery came the idea that evidence could be used to prove or disprove a preconceived theory. After all, we can imagine two men standing on the west coast of Portugal and theorizing about what was across the Atlantic. If one says "nothing, you'll just hit Japan or India" and the other says "no, there is a new landmass there," then actually sailing across the ocean would prove one of them right and the other wrong. What is the theoretical word for the evidence collected? Facts. Wootton writes:

> When and where was the language of the fact invented? Only quite recently historians thought there was a straightforward answer to this question. Francis Bacon invented the fact; from Bacon the fact entered the English language and was adopted by the Royal Society...on this account, it seemed that England had created and invented the culture of the fact. Unfortunately, this story just won't do. Crucially, the fact isn't English" (285).

Uh oh. Wootton claims that the word "fact" was used in Latin, Italian, and French before entering into English. He thinks that Hobbes has a better claim on the use of the word than Bacon, and then states that it was Blaise Pascal, writing under a pseudonym, who solidified the word's meaning in his *Provincial Letters*. When an ecclesiastic named Henry Hammond translated this work into English a new word and new phrase entered the lexicon. Wootton writes: "In the

Provincial Letters the word 'fact', and particularly the phrase 'Matters of fact,' as opposed to matters of law and of faith, become an intellectual slogan and a powerful political weapon" (290).

The creation of the "fact" in the European mind was a crucial development for science. As Wootton writes in a later chapter, the word "evidence" that was then available contained too many meanings to be useful for the new natural philosophy. By the middle of the 16th century the ship, the tongue, and the pen had collaborated to invent the words "discovery" and "facts." What made these ideas stick in Western society?

Wootton identifies the traditional factor of the printing press as this final causal agent, and in doing so provides a solid argument while at the same time giving the impression that his book is not just about overturning the existing narrative of the Scientific Revolution. Wootton seems to argue that the printing press still does not get enough credit for altering history. He writes:

> Thus the printing press strengthened the hand of the innovators by making it possible for them to pool information and work together. It replaced the professional lecture, the voice of authority, by a text in whose margin you could scribble your dissent. It replaced the manuscript, read more or less in isolation from other texts, with a book which be consulted in a library, surrounded by competing authorities…It was the perfect tool for the Scientific Revolution (305).

This is the only place in Wootton's opus where a larger world historical point of view might have been useful. Science, of sorts, had developed in China, India, and the Islamic world but had never displaced the traditional authorities and belief structures nor formed the nucleus of society in the way that science in the West did. Could it be that these societies peaked too early before the invention of the press? Or could it be that the long-standing philosophical and political structures in the east became too reactionary and conservative to embrace new technologies and ideas? The Ottomans, after all, had banned the printing press in the late 15th century and in 1515 Sultan Selim I reiterated the ban by declaring that any violating printers be executed.

Wootton does not explore the world in search of causes or historically and geographically created societal petri dishes. He stays in the West and traces local causes and consequences. In a chapter titled *The Disenchantment of the World* Wooton details the slow process by which scientific experimentation disentangled alchemy and angels from experimentation and evidence. Coffeehouses, public demonstrations of experiments, and the authority of black ink on paper brought about an end to humanity's childhood. Fantasy gave way to facts, but not quite. Wootton ends the chapter with these words "The real historical puzzle, we might think, is not the eighteenth-century loss of belief in witches and demons, but the progressive re-enchantment of the world in the nineteenth century" (475).

Wootton then examines the effect that science had on industrialization, and presents and then counters the argument that scientific research was not directly connected to industrial improvements. He writes: "A series of studies, however, (those of Alfred Rupert Hall being particularly influential), have claimed to show that, whatever the intentions of the scientists may have been, in practice, the new science had virtually no influence on technological progress" (478). The key piece of evidence for this non-connection is the steam engine. Wootton encapsulates that argument well, but then counters it with a case of his own. In the 18th century, John Smeaton performed experiments on waterwheels and found "to his surprise, that overshot wheels (where the water enters the wheel at the top) were twice as efficient as undershot wheels (where the water flows along the bottom of the wheel)…(487).

Smeaton's work came only after a millennia of waterwheel evolution, and its rapid development was a result of Smeaton's time and intellectual climate. Smeaton "combined practical and theoretical knowledge, as Hooke had in watchmaking" (488). Then "It would thus seem clear that it would have been impossible to carry out Smeaton's experiments in the 1580s but perfectly possible in the 1650s, and straightforward once the arguments of Newton's *Principia* (1687) began to be widely understood…. The theory was not new in the 1750s, but the confidence was. The source of that confidence was a sustained programme of advertising the new science through public lectures and books…" (489). Experimentation and evidence collection did not lead directly to technological innovation, but the domestication of a process of understanding the world that had once been sporadic and random, did.

Surprising finds and ingenious insights can be found throughout *The Invention of Science*, but enough evidence has been given here to state the central thesis of Wootton's book. An argument needs to be made for its place in the canon of the history and philosophy of science, and we have reached a point in this essay where the facts of Wootton's arguments and the facts of the reviewer's arguments line up in a rough chronology.

After the initial phase of the Scientific Revolution in the 16th and 17th centuries, 18th and 19th century scholars of the humanities proved to be both envious of and threatened by the new methods of natural philosophy. In 1717, Giambattista Vico published *New Science* and tried to bring out general principles from the mess of the history of human civilization. Humans could not really know anything but themselves, he argued. It's a funny book, this *New Science*—romantic and scientific at once—and Anthony Graftin wrote of it in his introduction to the Penguin Classic version that "Vico's own imaginative brilliance seems as impressive as that of the ancient bards he liked to evoke, singing their tales around the fire…[Vico] saw what dozens of more learned scholars had not: that Homer described, and lived in, a world very distant from the present. Vico, in other words, had the sort of prescient structural insight into difficult problems which is more often found in scientists than in humanists" (xxi-xxii).

In the same vein, but in the next century, the British aesthete and essayist

John Ruskin reacted against industrialization by romanticizing medieval architecture. In his essay T*he Nature of the Gothic* he writes: "it is one of the chief virtues of the Gothic builders, that they never suffered ideas of outside symmetries and consistencies to interfere with the real use and value of what they did. If they wanted a window, they opened one; a room, they added one, a buttress, they built one; utterly regardless of any established conventionalities…in the best times of Gothic, a useless window would rather have been opened in an unexpected place for the sake of surprise, than a useful one forbidden for the sake of symmetry" (98). This is a pleasing declaration packaged in a beautiful sentence. Science brought symmetry, power, and structure, but a surprising window is nice to come across sometimes too.

Vico sent his work to Newton, who replied with a devastating silence. Knowing oneself did not seem such an important part of the scientific enterprise. A stone wall went up between the humanities and the sciences, until Albert Einstein found a surprising window and pointed out the importance of the observer. In the last 20 years, John Gribbin, Edward O. Wilson, Stephen Hawking, Leonard Mlodinow, and Douglas Hofstadter have all made arguments on the topics of epistemology. Gribbin has recognized the importance of epistemology in physics. Wilson has called for a consilience of knowledge between the disciplines. Hawking and Mlodinow have proposed a Model Dependent Realism and stated that scientists cannot discount epistemology nor forget that their cognitive processes are subject to language, experience, and analogies. Hofstadter has argued that all thinking is analogical, and that the deepest thoughts in physics come structured not in numbers but in intricate analogies.

Now, Wootton has rewritten the history of the Scientific Revolution. By focusing on the evolution of ideas into words and words into frameworks, he has displaced Thomas Kuhn as the most important philosopher of science. Kuhn was wrong, writes Wootton, factually wrong in many cases and just plain wrong about how facts throw paradigms into crisis. Paradigms don't enter into crisis and collapse because of new facts as Kuhn argued. Instead the facts gradually evolve a new mindset that comes to displace the old. Ideas *then* words *then* revolutions.

Please pay attention to Wootton. We have a new history of science and with a new history comes a call for a new future. Modern scientists would do well to focus not just on research but on etymology. What word should we use to describe the universe "before" the Big Bang? Why is this not the primary subject of cosmology right now? We have no analogies for singularities. What if we cannot think about things until we have words for them? Science in the West was once invigorated by the injection of a new numerical system. Should this happen again? Will unexpected analogies, funny looking windows in the layered stones, be allowed to push the scientific enterprise forward or will the conceit of "hard science" prevent this from happening?

Please read Wootton's book, and when you are finished, flip back to the picture of Bacon's *Novum Organum* featured in the front. The ship is sailing through the pillars of Hercules, but those pillars look a lot like the Roman numeral II. Perhaps Bacon and the earliest natural philosophers left room for a new era of science that would synthesize cold mathematics and hard facts with the poetry of the humanities. We would have not a revision then, but an addition that leaves the original intact: a sequel.

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