

The Great Explanandum[†]

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Alfred W. Crosby's *The Measure of Reality: Quantification and Western Society, 1250–1600* is a broad survey of measurement animated by captivating examples drawn from four centuries of mathematics, astronomy, music, painting, and bookkeeping. The thesis he develops from this survey is that the unique success of European imperialism can be explained by a shift in Western *mentalité* in the late thirteenth century from a qualitative to a quantitative perception of reality. The larger significance of this book is that it is one of the more careful attempts to provide rigorous argument and historical documentation for a set of themes common in the historical literature of the twentieth century—radical breaks in Western thought and the uniqueness of the West. And as such, the shortcomings of Crosby's book suggest some of the larger problems in an entire genre of world history.

The more focused historical problem that Crosby addresses—setting aside for a moment larger claims about the West and its uniqueness—is an exceedingly complex one: the explication of a series of historical contingencies that led to the superiority of specific European empires (and not others) as of the nineteenth century in weaponry, navigation, and bureaucratic administration. Tracing any facet of these developments in Europe is a monumental task. Weaponry alone, for example, requires analyses of the developments in chemistry, metallurgy, and technology, to name a few, that transformed cannons from ineffective to deadly weapons.¹ Another aspect of the explanation would be the enormous manpower invested in the study of cannons by Italian mathematicians,² and the fortuitous fact that the problems of ballistics turned out to have mathematical solutions. But a complete explanation would also require comparative analysis, examining why other nations invested less in developing these particular technologies. The most obvious approach to explaining superiority in weapons, then, might be a comparative history of weapons.

However, victors of military conquest often prefer loftier explanations for their superiority; and Europeans are hardly unique in their attempts to attribute their success to more noble cultural traits claimed to be uniquely their own. Crosby rightly rejects at the outset as “hilariously unlikely” the modern variants of these apologetics—ones we are now likely to view as perniciously racist—that Westerners were “the most recent, highest, and, in all likelihood, final twigs on the exfoliating tree of evolution” or that they “were the brightest, most energetic, most sensible, most aesthetically advanced, and most ethical humans.”³ Crosby fails to note, however, that what such claims share with his own approach is a confidence in Western uniqueness: unique civilizations deserve unique explanations, and the usual kinds of explanations we grant for the military successes of Alexander the Great or the Mongols simply will not do.

One of Crosby's previous works, *Ecological Imperialism: The Biological Expansion of Europe*,

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900–1900 (1986), offered an important alternative to the usual genres of explanation criticized above. That is, against conventional historical explanations for European victories as the inevitable result of superior technology, and against apologetics that explained European success as resulting from their superior culture (including claims that link culture to science and weapons),⁴ Crosby uncovered unexpected factors that played a crucial role in European conquests—“the biological advantages that the white imperialists enjoyed” including diseases, animals, and plants. *Measure of Reality* is, Crosby notes, his third book in his “lifelong search” to explain “the amazing success of European imperialism.” Crosby here rejects his previous thesis as “biological determinis[m]”; he seeks to explain why “Europeans were incomparably successful at sending ships across oceans to predetermined destinations and at arriving at those destinations with superior weaponry—with, for instance, cannons superior to those of the Ottomans and the Chinese.”⁵

His answer is quantification.⁶ “Westerners’ advantage, I believe, lay at first not in their science and technology, but in their utilization of habits of thought that would *in time* enable them to advance swiftly in science and technology and, in the meantime, gave them decisively important administrative, commercial, navigational, industrial, and military skills. The initial European advantage lay in what French historians have called *mentalité*.” He argues there was a shift from a qualitative *mentalité* he terms the “Venerable Model” to a “New Model” of reality—a “devotion to breaking down things and energies and practices and perceptions into uniform parts and counting them,” which he terms “quantification.”⁷ Crosby pinpoints this crucial shift between 1275 and 1325, when “someone built Europe’s first mechanical clock and cannon, devices that obliged Europeans to think in terms of quantified time and space,” along with “*Portolano* marine charts, perspective painting, and double-entry bookkeeping” from approximately the same period. Crosby has thus located, he contends, the revolution that fundamentally transformed Europe: “There was nothing quite like this half century [1275 to 1325] again until the turn of the twentieth century, when radio, radioactivity, Einstein, Picasso, and Schönberg swept Europe into a similar revolution.” The result: in comparison with other cultures, Europeans “were thinking of reality in quantitative terms with greater consistency than any other members of their species.”⁸

What historical evidence does Crosby offer for this thesis? The first problem is his claim about quantification in the West: he never really offers rigorous criteria for determining what is to count as quantification. His examples include a very broad sampling from commercialization, calendars, clocks, and maps to perspectival painting and even musical notation.⁹ However plausible his claim of the increasing applications of measurement might at first seem, Crosby’s examples add little to a historical analysis of the specific time and location of these applications, their extent, and their rate of change over time. The examples he presents, then, provide very little basis to justify his claim of the marked “shift” that occurred in the late thirteenth century (rather than in, for example, the eighteenth century), and even less of a basis for any comparison with other civilizations.¹⁰ Quantification—its extent, location, dates, and purported shifts—remains unquantified.

Crosby’s link between quantification in general and the specific technical developments in weapons and navigation is equally weak. In the chapter on mathematics, after briefly mentioning Leonardo Fibonacci, the thirteenth-century Italian mathematician, the majority of the chapter describes the change from Roman numerals to Arabic (along with the asserted decline of number mysticism); he offers little analysis of important developments in mathematics during the period. The same is true of his discussion of music and astronomy. Without technical analyses, it remains impossible to understand the emergence of the techniques in navigation and weaponry that Crosby seeks to explain.¹¹

An even more serious problem is that, although his overall thesis purports to be fundamentally comparative, Crosby presents hardly any analysis of non-Western civilizations. For example, his few scattered remarks on China range from hackneyed stereotypes (the “Chinese had forgotten the giant clocks of the Song Dynasty, and their calendar was defective and stayed that way until the Jesuits helped them fix it”) to statements that are unintelligible (“the theoretical and practical eventually diverged”) or simply false (“unlike the societies of the East the West was hungry to learn by staring at standardized marks on paper”).¹² Crosby offers very little analysis of Chinese astronomy, mathematics, printing, or music, to name a few. Yet secondary scholarship—in English—on these topics is both easily accessible and well known. For example, many of these subjects constitute an entire volume in Joseph Needham’s *Science and Civilisation in China*. Crosby does not mention even the two volumes on military technology.¹³ A considerable body of more recent research is also easily available.¹⁴ Instead, in his passing references to China, Crosby chooses to cite purportedly comparative studies that present grand claims about the development of science without ever bothering to examine science.¹⁵ Other civilizations fare even worse than China, meriting only passing mention. Crosby’s failure to incorporate easily available secondary sources on non-Western civilizations makes it impossible to take any of his comparative claims seriously.

The problem here for Crosby’s thesis is that from these secondary sources one could easily write a similar history of quantification, measurement, and standardization in China, drawing examples from commercialization, census, taxation, land measurement, medicine, mathematics, astronomy, and even music. To offer but one example, in the search to refine court music, one scholar in the late sixteenth century discovered the equal tempered scale and calculated the twelfth roots of two to twenty-five decimal places. The Chinese were quantifying, but doing less technical work on cannons or navigation. Quantification, then, did not itself lead to advances in weapons. The apparent lack of quantification in other civilizations—the centerpiece of Crosby’s argument against which the accomplishments of the Europeans chronicled in his book appear so impressive—is just the result of his own failure to cite readily available examples from secondary historical studies.

The lack of historical evidence for Crosby’s claims is covered over by his shift from the empirical to a series of claims about thought, science, and their relationship to civilizations; these claims constitute the weakest part of this book. Again, the first problem is the lack of any critical analysis of many of the key terms within which Crosby frames his central thesis—terms such as “reality,” “Old Model,” “New Model,” “science,” and *mentalité*. He parenthetically defines reality as “everything material within time and space, plus those two dimensions per se.” The Old Model “perceived reality as an uneven, heterogeneous sort of thing.” The New Model “was simply this: reduce what you are trying to think about to the minimum required by its definition; visualize it ... divide it ... into equal quanta. Then you can measure it, that is, count the quanta.” “Science (and a great deal else characteristic of modern societies) can be defined as the product of the application of mathematics, with its Platonic precision, to Aristotle’s crude realities.”¹⁶ He offers for these simplistic caricatures neither references nor further explanations, neither historical evidence from the period nor any analysis from modern scholarship.¹⁷ To tie these together, Crosby turns to the notion of *mentalité*; his remark, “assuming eras do have zeitgeists,” alerts the reader that there will be no critical discussion of the reasons that this concept has proven so unsatisfactory.¹⁸ This then provides the framework for rhapsodic pronouncements about shifts in the Western perception of reality. To this mix, Crosby adds “visualization.” Ultimately, in place of historical explanation, Crosby can do no better than offer the analogy “striking the match” (his title for Part 2 of his book) to explain its relationship to quantification.

Crosby's claim to have found the underlying cause of an asserted great shift in Western thought is, of course, not new. In fact, claims about radical shifts in Western thought were a central theme of the history of science in the first half of the twentieth century; precisely what that shift was and when it occurred was a central topic of debate. For Pierre Duhem, it was debates over Aristotle and the Arab philosopher Averroës in Paris in the fourteenth century; for Alexandre Koyré, it was the shift from the closed world of the ancients to the infinite universe of the moderns; for Thomas Kuhn, it was the change from a geocentric to a heliocentric model in astronomy; for A. C. Crombie, it was the experimental work of the thirteenth-century English natural philosopher Robert Grosseteste; and this is to name only a few of the most important theses from the history of science.¹⁹ Crosby does not contextualize his own claim within this body of literature. More importantly, Crosby does not address the important conclusions of recent research in the history of science—the growing skepticism toward claims for great shifts, and in particular, the emerging consensus that there was no “scientific revolution.”²⁰

Lacking rigorous criteria for what quantification is, a way to measure it, a causal connection between quantification and technical innovations in weapons and navigation, and lacking any comparative analysis, Crosby's thesis about Western quantification clearly does not begin with empirical evidence and proceed toward historical explanation. Instead, it begins with the Great Explanandum: What differentiates the West from the rest? What makes the West unique? This thesis of the uniqueness of “the West” (setting aside momentarily the problem of what the West might be) requires some preliminary clarification. For it might seem at first to have a simple enough answer: only in the West does one find Plato, Shakespeare, and Galileo; only in the West does one find Euclidean geometry, Aristotelian logic, and Copernican astronomy. Yet in no civilization other than China can one find Confucius, Mozi, and Zhu Zaiyu; only in China can one find the iron and steel production of Kaifeng, celestial-origin algebras, and the voyages of Zheng He. The question, then, cannot be what makes the West unique but rather what makes the West *unique*—if all civilizations are to be in some sense unique, some are more unique than others.

The variant of European uniqueness that Crosby initially sets out to explain is “the amazing success of European imperialism. Europeans were not the cruelest and not the kindest imperialists, not the earliest and not the latest. They were unique in the degree of their success. They may retain that distinction forever.” This success is unique because “Cyrus the Great, Alexander the Great, Genghis Khan, and Huayna Capac were great conquerors, but they were all confined to no more than one continent and at best a wedge of a second. They were homebodies compared with Queen Victoria.”²¹ Here, then, is what makes the West *unique*: instead of a single empire dominating a single continent, several empires (all combined in this accounting under the rubric “the West”) dominated several continents. Elsewhere, Crosby offers other claims about what made the West unique: it chose “to perceive as much of reality as possible visually and all at once”; it was able “to bring mathematics and measurement together and to hold them to the task of making sense of a sensorially perceivable reality”; it was “uniquely prepared to survive and even to profit from such an avalanche of [social] change”; it was “unique in its enthusiasm for clocks”; it was “advancing faster than any other large society in its ability to harness and control its environment.”²² To this incongruous list, we must add, of course, quantification and the New Model of reality. Crosby's thesis thus only adds to an already extensive literature on Western uniqueness: a very short list includes language (alphabetic scripts, the copula), economics (capitalism, double-entry bookkeeping), religion (Puritan ethic, disenchantment), philosophy (natural law, causal thinking, perception of time and space, demonstrative logic), and politics (democracy). The search for the

key features distinguishing the West from the Rest continues to this day.²³ Apparently—contrary to these assertions—there is no unique answer to what makes the West *unique*; given that the West is unique, almost any explanation will do.²⁴

The Great Explanandum begins with a credulity toward “the West” as a fundamental category of historical explanation. Recent work in cultural criticism has questioned nations as “imagined communities”; yet this same literature has too often failed to analyze the ways in which the West is imagined. *The Measure of Reality* itself provides one striking example: the West (which for Crosby begins in the Neolithic period, includes Greece and ultimately Europe) becomes reified and anthropomorphized (it “stumbled down,” “invented,” “fizzed and bucketed”; elsewhere we find “the West was making up its mind”).²⁵ Ultimately, the West becomes the fictional subject of a praise-and-blame civilizational hagiography, which narrates its trials, tribulations, and eventual triumph.

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In introducing the New Model of reality that forms the central thesis of his book, Crosby offers the example of Niccolo Tartaglia’s experiments with cannon balls: “He fired from a culverin two balls of equal weight with equal charges of powder, one at 30 and the other at 45 degrees of elevation. The first went 11,232 Veronese feet, the second 11,832.” Crosby exclaims: “This is quantification. This is how we reach out for physical reality, push aside its darling curls, and take it by the nape of the neck.”²⁶ The question is this: to explain Tartaglia’s experiment, do we really require recourse to an abstraction termed “the West,” endowed with a *mentalité*, shifting its perception of reality from the qualitative to quantitative? Or might we instead adopt a *deflationary* viewpoint, that Tartaglia—along with the majority of Italian mathematicians of the period—was in fact genuinely interested in measuring the flight of cannon balls? To explain the superiority that several European empires developed in weaponry, do we really require theses extolling the uniqueness of Western thought? Or might we instead (providing the same kind of historical analysis we offer for other conquests) explore a comparative history of weapons, a history in which the experiments of Tartaglia are but one part?

In *Measure of Reality*, Crosby proposes a “big-picture” thesis: “The West in the sixteenth century was unique”—its “New Model offered a new way to examine reality ... providing humanity with unprecedented power.”²⁷ Without anything more than anecdotal evidence for changes in the extent of quantification, Crosby’s claim of a great shift from a qualitative Venerable Model to a quantitative New Model in the late thirteenth century is nothing more than yet another repackaging of discredited claims of a radical shift in Western thought. Without the technical analyses of the sciences of weapons and navigation, historical explanations for developments in these fields are impossible, and Crosby can only turn to claims of the efficacy of a special, newly discovered method of knowing reality. And without any examination of non-Western civilizations, comparisons are meaningless; the dramatic differences between the West and other civilizations that appear in Crosby’s book are simply the result of his failure to present information easily available from secondary sources about the non-Western civilizations. In sum: instead of deriving historical conclusions from empirical evidence, Crosby begins with an often-repeated mythology about the West, its radical shift from ancient to modern, its uniqueness among civilizations, and its ultimate triumph. To this, he adds a new set of explanations—the “Old Model” and “New Model”—for which he offers neither rigorous definitions, supporting evidence from primary historical documents, nor justification from secondary research in the history and philosophy of science.

The shortcomings of Crosby's *Measure of Reality* are representative of the problems of an entire genre of historiography written in the twentieth century. In this literature, the imagined communities of "the West," "China," and "Islam" were taken to be the central protagonists in praise-and-blame histories of civilizations; simplistic teleologies of science provided universal benchmarks to measure the progress of civilizations toward modernity; the purported radical break between the ancient and modern in the West was transposed onto a fictive Great Divide between the primitive non-West and the modern West; the ignorance of the science of other non-Western civilizations was mistaken for ignorance of other civilizations of science. And in this literature, with the Great Explanandum—the known uniqueness of the West—as the given starting point, practically any study of language, thought, society, institutions, or politics could be called into service as the explanation of what makes the West unique. One task for critical history, then, must be to analyze the rhetorics, ideologies, and academic disciplines that authorized this particular genre of world history.²⁸

Notes

- ¹ For one example, see Bert S. Hall, *Weapons and Warfare in Renaissance Europe: Gunpowder, Technology, and Tactics* (Baltimore, 1997).
- ² See Mario Biagioli, "The Social Status of Italian Mathematicians: 1450–1600," *History of Science* 17 (1989): 41–95.
- ³ Alfred W. Crosby, *The Measure of Reality: Quantification and Western Society, 1250–1600* (Cambridge, 1997), ix–x.
- ⁴ For a striking analysis of twentieth-century apologetics, see Norton Wise, "Pascual Jordan: Quantum Mechanics, Psychology, National Socialism," in Monika Renneberg and Mark Walker, eds., *Science, Technology, and National Socialism* (New York, 1994).
- ⁵ Crosby, *Measure of Reality*, x, ix.
- ⁶ Crosby does not clarify here whether disease, animals, and plants remain factors in his explanation of European conquests.
- ⁷ Crosby, *Measure of Reality*, xi, 11, italics in original.
- ⁸ Crosby, *Measure of Reality*, 19, see also 227; xi.
- ⁹ Interestingly, he argues that "the individuals chiefly responsible for the New Model were townspeople" (58), and "bookkeeping has done more to shape the perceptions of more bright minds than any single innovation in philosophy or science" (221).
- ¹⁰ For example, John Heilbron argues that a key shift in quantification occurred in 1760. "Introductory Essay," in Tore Frängsmyr, J. L. Heilbron, and Robin E. Rider, eds., *The Quantifying Spirit in the 18th Century* (Berkeley, Calif., 1990), 2–3. The problem of comparison with other civilizations is discussed below.
- ¹¹ Crosby's book is apparently intended for a broad audience, but this does not explain the absence of technical analysis. For a classic example of a book that summarizes technical arguments for a broader audience, see Thomas S. Kuhn, *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought* (Cambridge, Mass., 1957).
- ¹² Crosby, *Measure of Reality*, 17, 231.

- ¹³ *Science and Civilisation in China* (Cambridge, 1954–) presently includes the following volumes: Vol. 1, *Introductory Orientations*; vol. 2, *History of Scientific Thought*; vol. 3, *Mathematics and the Sciences of the Heavens and the Earth*; vol. 4, *Physics and Physical Technology*—pt. 1, *Physics*, pt. 2, *Mechanical Engineering*, pt. 3, *Civil Engineering and Nautics*; vol. 5, *Chemistry and Chemical Technology*—pt. 1, *Paper and Printing*, pt. 2, *Spagyric Discovery and Invention: Magisteries of Gold and Immortality*, pt. 3, *Spagyric Discovery and Invention: Historical Survey, from Cinnabar Elixirs to Synthetic Insulin*, pt. 4, *Spagyric Discovery and Invention: Apparatus, Theories, and Gifts*, pt. 5, *Spagyric Discovery and Invention: Physiological Alchemy*, pt. 6, *Military Technology: Missiles and Sieges*, pt. 7, *Military Technology: The Gunpowder Epic*, pt. 9, *Textile Technology, Spinning and Reeling*; vol. 6, *Biology and Biological Technology*—pt. 1, *Botany*, pt. 2, *Agriculture*, pt. 3, *Agro-Industries and Forestry*; vol. 7, pt. 1, *Language and Logic*.
- ¹⁴ For a general bibliography of works on Chinese history, see John King Fairbank and Merle Goldman, *China: A New History*, enl. edn. (Cambridge, Mass., 1998), 459–514. For an overview of current research in Chinese science, see Nathan Sivin, “Science and Medicine in Imperial China—The State of the Field,” *Journal of Asian Studies* 47, no. 1 (1988): 41–90.
- ¹⁵ Derk Bodde, *Chinese Thought, Society, and Science: The Intellectual and Social Background of Science and Technology in Pre-Modern China* (Honolulu, 1991); Toby E. Huff, *The Rise of Early Modern Science: Islam, China and the West* (Cambridge, 1993).
- ¹⁶ Crosby, *Measure of Reality*, 23, 228, 16.
- ¹⁷ For a useful bibliography focused on the seventeenth and eighteenth centuries but also including work covering earlier periods, see Steven Shapin, *The Scientific Revolution* (Chicago, 1996). For a discussion of issues on science, see Peter Galison and David J. Stump, eds., *The Disunity of Science: Boundaries, Contexts, and Power* (Stanford, Calif., 1996).
- ¹⁸ Crosby, *Measure of Reality*, 11. See, for example, G. E. R. Lloyd, *Demystifying Mentalities* (Cambridge, 1990).
- ¹⁹ Pierre Duhem, *The Aim and Structure of Physical Theory* (Princeton, N.J., 1991), trans. of *La théorie physique: Son objet et sa structure* (Paris, 1906); Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore, 1957); Kuhn, *Copernican Revolution* (1957); A. C. Crombie, *Robert Grosseteste and the Origins of Experimental Science, 1100–1700* (Oxford, 1958).
- ²⁰ For an introduction to this literature, see Shapin, *Scientific Revolution*.
- ²¹ Crosby, *Measure of Reality*, ix.
- ²² Crosby, *Measure of Reality*, 11, 17, 53, 81, 238.
- ²³ Samuel P. Huntington, *The Clash of Civilizations and the Remaking of World Order* (New York, 1996).
- ²⁴ See Roger Hart, “On the Problem of Chinese Science,” in *The Science Studies Reader*, Mario Biagioli, ed. (New York, 1999).
- ²⁵ Crosby, *Measure of Reality*, 19, 60, 239, 10.
- ²⁶ Crosby, *Measure of Reality*, 11–12.
- ²⁷ Crosby, *Measure of Reality*, 238–39.

²⁸ For further discussion of these issues, see the web page for the conference “Rethinking Science and Civilization: The Ideologies, Disciplines, and Rhetorics of World History,” at <http://www.stanford.edu/dept/HPS/RethinkingSciCiv/>