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**Laina Farhat-Holzman: *WORLDCHANGERS: Ten Inventions That Changed Everything*.  
The Civilizational Press, Kalamazoo, Michigan, 2012.**

Reviewed by George Von der Muhll

Laina Farhat-Holzman's *Worldchangers* is an ambitious book. In barely 90 pages she sets out to make a case for her selection of the ten technological inventions that most profoundly and extensively changed the course of human history. The range of her conspectus is broad indeed. It encompasses the globe, and its chronological scale runs from the Stone Age forward. Expositing the nature and significance of each invention she highlights obliges her to display some familiarity with the science underlying it as well as the more general state of contemporary scientific knowledge in that epoch. Moreover, her titular commitment to showing that the innovations she is discussing changed "everything" presupposes familiarity with many key elements of the diverse social orders impacted by the innovations she chooses to examine. In all, her project entails identifying the broadest, deepest, and most powerful currents giving form to world history. To an impressive extent she succeeds in her quest.

In pursuing this goal she throws in sidelight observations and intriguing connections that materially add to the stimulus of her central argument. She moves confidently and comfortably from Phoenician explorations to the Viking slave trade, from ancient Harappan irrigation projects in the Indus Valley to the invention of multi-staged fireworks rockets in 16<sup>th</sup> century Germany and to an evolutionary explanation for a possible selective genetic advantage enjoyed by women in learning second languages. She displays a sharp eye for striking statistics. Her concise, unpretentious, readily accessible prose enables readers to undertake long journeys in short order. Whatever prior knowledge they may have of the subject, they are likely to be grateful to an author who instructively and provocatively draws together so many informative insights in so undemanding a format.

Farhat-Holzman's declared objective differs appreciably in its emphasis from many earlier histories of technology. Rather than dwelling on the intrinsic importance of the inventions she examines, why these inventions occurred at a particular time and place in world history, and the previous developments required to make them possible, she takes them as points of departure for tracing the shock waves they generated in moving toward ever more distant outposts of the societies within which they were brought to fruition. Her central thesis is that technological innovations have too seldom received their due as progenitors of many of the most fundamental transformations of the worldwide social order. Though she does not explicitly say so, she bypasses the challenges posed in such studies as Abbott Payson Usher's *A History of Mechanical Inventions* and (for the most part) S.C. Gilfillan's *The Sociology of Inventions* to align herself with the tradition founded by the young Marx and carried forward in Lewis

Mumford's classic *Technics and Civilization* and David S. Landes's *The Unbound Prometheus*.

Her starting points for developing this argument -- i.e., her list of ten "world-changing inventions" -- will not startle most readers. The criterion she uses to determine that status is the extent to which the invention functioned as a "game-changer" in the history of humanity. An invention had this impact, she writes, to the extent that it gave "rise to all sorts of smaller technologies that enlarged what human beings can do" (2). Thus the first such invention--the "domestication" of fire through devising wooden fire drills to start fires when needed (and only then!)--was obviously in itself an intrinsically significant development in human history insofar as it provided protection at night from predatory animals, warmed dwellings so as to make living in cold climates tolerable for "naked apes," and extended lifespans through enabling humans to cook raw meat before consuming it.

More crucially to her thesis, however, the invention of the fire drill led over time to improvements in weaponry (fire-hardened sticks for use in hunting), to boiling and stewing food (through hardening clay cooking vessels into non-porous pottery), and to parching wild grains so as to render them edible for humans. At some later point, Anatolians and their neighbors discovered the art of putting fire to use in smelting metals, thereby dramatically refining and extending the range of tools and weaponry that smelting could produce and the undertakings in which they could be put to use.

Similar analysis leads to placing the adapting of wild plants to the nutritional needs of human beings on her list; in conjunction with what she calls "water technologies", these adaptations made possible the "agrarian revolution" that provided the infrastructure for settled agrarian societies that in turn could support cities as stable sites for diffuse innovations. The printing press and the telescope make an expected appearance in her discussion of the origins and efflorescence of the European Renaissance. Inventions permitting communication at a distance, the systematic development of new forms of energy, their controlled application to transportation, and the invention of the computer bring her list to a concluding, broadly inclusive tenth category embracing the prospective societal impact of innovations in space rocketry, brain "geography," medicine, and molecular biology.

Claiming to have identified "the" ten innovations with the greatest qualitative impact on society predictably raises questions transcending whether her "tenth" category in fact expands her list to half again its declared length. Was the invention of the telescope, for example, more qualitatively significant, whether as mechanism or as metaphor, than the mobile mechanical clock (which curiously receives no mention in these pages)? To be sure, telescopes stimulated a lens-grinding industry in the Lowlands. They aided sea captains in their explorations and military commanders on the field of battle. They notoriously contributed to the anti-scientific drift of the Vatican Counter-Reformation.

But these in themselves were hardly world-historical transformations, and the telescope's role in them was neither as a necessary nor as a sufficient factor. It was certainly not as far-reaching and pervasive a "game-changer" in its societal impact as were the possibilities opened up by increasingly reliable clocks that made possible precise coordination of terrestrial with celestial movements among thousands of interdependent human beings out of view of one another, and the complementary meshing of decisions with initiatives in military strategies as well as in the "satanic mills" of the Industrial Revolution.

However enticing and instructive such disputations might prove in individual cases, this reviewer will not pursue them further here. It seems almost axiomatic that such debates will arise while reading a work as ambitiously comprehensive in geographical scope and chronological scale as this one. More instructive issues are raised by the instability of Farhat-Holzman's causal variables. Her chapter on "water technology" illustrates a specific form of a more general problem. The chapter begins with a discussion of irrigation (surprisingly making no mention of Karl Wittfogel's celebrated thesis that control of irrigation gave rise to "oriental despotism" and later to Soviet Communism).

It then shifts to the special advantages enjoyed by inhabitants of the European peninsulas at the western end of the Eurasian landmass in developing sea-going commerce; but advances in waterborne transport in this instance are presented more as productive adaptations to geomorphological configurations than as autonomous innovations with an independent impact on societies. After an intrinsically interesting discussion of the phenomenon of piracy that seems to have rather little to do with "water technology", the chapter concludes by inviting attention to coming "water wars" in the arid Middle East and the flooding of Bangladesh—topics that once again are *associated* with the importance of water as a commodity but not with innovations in water technology and their impact.

An inherent problem in designating any invention as a "game-changer" lies in showing that a particular invention thus singled out was more causally crucial in promoting the stream of innovations that followed than other inventions that chronologically preceded, succeeded, or were nearly contemporaneous with it. As a practical matter, patent offices must struggle with such questions all the time. Occasionally, a single invention stands out so dramatically—one thinks of the Wright Brothers' first mechanically-driven flight at Kitty Hawk, the first atomic bombs in July-August of 1945, and yes, Galileo's use of the telescope he devised—that most observers will not quarrel too long over what was special about the invention and what further improvements and ancillary technological developments to attribute to it.

But when, exactly, was the computer produced, and at what point did its potential impact as a "game changer" become clear? With the mechanical embodiment of binary number systems in calculators? With the creation and refinement of silicon

information-holding micro-chips for such machines? With Shannon and Weaver's development of information theory to the point at which "computers" ceased to be calculators limited to providing answers to problems formulated in a numerical language? With the production of affordable personal computers and the institutionalizing of the Internet?

Allied with an image of "an" invention as distinct from a set of interacting and mutually reinforcing technological developments is the temptation to simplify and over-dramatize the role of such inventions in societal change. Thus many historians became intrigued by the proposition that the invention of the stirrup produced medieval European feudalism because it enabled heavily armored knights to ride their steeds into battle. Farhat-Holzman is not free from this temptation. It is to be found in several chapters, but perhaps most conspicuously in presenting the telescope as the key progenitor of the 17<sup>th</sup> century scientific revolution in Europe (40-41).

This tendency leads to what might be described as an unbounded evolution and expansion of themes in her chapters. Thus the chapter that begins with the impact of the telescope on European society ends a few pages later with a section on death rates in childbirth and the consequences for women of the displacement of servants by the washing machine. The chapter on "water technologies" ends with a section on the role of "heavy water" in the production of the atomic bomb.

Attributing long chains of outcomes to a single specific invention also obscures what has often proved to be the single greatest impact of a technological innovation—its demonstration that a widely recognized problem *is* soluble through technical means. The historic importance of Edward Jenner's demonstration that inoculation--not incantations or consuming ground-up precious stones or burning witches--can be the key to checking the spread of infectious diseases lay in its role in stimulating widespread searches for analogical techniques for eradicating other diseases while generating feedback loops improving the original innovation itself.

Such models would seem to serve better than straightforward chains of cause and effect to explain the "lumpiness" evident in the history of technology. They account for the nearly simultaneous outburst in the Industrial Revolution of inventions centering around the steam engines. They help us to understand the rapid advance in the early 19<sup>th</sup> century in precision engineering--whether in producing clocks or Colt pistols--in Switzerland and Connecticut, and later the emergence of Wilhelminian Germany as the leading technological center of Europe through a multitude of interdependent inventions derived from systematic and sustained use of chemical analysis to produce new products with specified properties.

The societal "impact" of an invention therefore cannot be described in terms of Newtonian necessity as a straightforward function of its properties. As studies of the

Industrial Revolution have shown, that impact may well depend much less on the metaphorical “mass” and “force” of the invention itself than on the structure of the economy in which it is invented and the coexistence of other technological advances with which it is interdependent and for which it creates a demand. As the history of the last two centuries has shown, patent laws, military procurement practices, and the degree of institutionalization of technological research in universities and large corporations are likely to play critical roles in transmitting, accelerating, and diffusing (and thus determining) the impact of an invention.

It must also be acknowledged, however, that taking full account of many of the points raised in this review would require a book of at least twice the length of this intentionally slender volume. Taken for what it is and aspires to be, then, reading *WORLDCHANGERS* is an enriching experience not only in itself but for the questions that linger in the mind long after one has reached its last page.