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The Dialectic of Tech and Society

Contribution to GTI Forum Technology and the Future

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Since the heyday of technological determinism in the 1960s, many authors have written eloquently about how developments in technology are more typically the outcome of particular social and economic arrangements. Some contributions that have significantly shaped my own thinking include the following:

• Lewis Mumford's observation that inventions like glass and steam engines were first developed for mainly ornamental and ceremonial purposes (opening heavy temple doors in the latter case), centuries before they were mobilized for more practical uses.[1]

• Murray Bookchin's account of how Iroquois and Inca societies, one increasingly egalitarian and the other rigidly hierarchical, relied upon very similar late Paleolithic "toolkits."[2]

• Langdon Winner's research on agricultural mechanization, especially Cyrus McCormick's famous reaper. Winner concluded that various innovations in the manufacture of McCormick's reapers at first made them more costly and less reliable, but they helped concentrate economic power more firmly in the hands of production plant managers.[3]

• David Noble's detailed examination of the origins of numerically controlled machine tools in the mid-twentieth century. His conclusion is similar to Winner's: to implement this initial step toward industrial automation, manufacturers had to overlook widespread inefficiencies and a loss of much of the knowledge and flexibility that was shared among manual machine operators. The perceived overarching benefit, however, was to disempower shop floor labor and concentrate knowledge and control in the hands of engineers and managers.[4]

• Andreas Malm's more recent exploration of the origins of "fossil capital," i.e., why British textile manufacturers in the mid-eighteenth century transitioned from riverside watermills to coal-fired steam engines. As Malm has examined in detail, watermills remained far more efficient and reliable for several decades into the coal era, and there was never a shortage of potential sites for new water-powered textile mills. However, rural workers who lived along England's riverbanks were far more independent-minded, and more likely to abandon the mills when working conditions became too onerous, than often-desperate urban workers. The latter proved far more willing to work long hours under harsh conditions in steam-powered mills, which could be located anywhere. Once the transition began, the ability of steam-powered mills to operate around the clock in all seasons enabled production increases and an expansion of global trade that would have been unimaginable a generation earlier.[5]

These examples reveal a profoundly dialectical relationship between technological developments and social evolution. Technologies emerge as a response to social needs—as perceived by those best able to invest in new innovations—and then serve to enhance and reinforce the social conditions that initially fostered them. Technologies emerge from what Bookchin called their "social matrix," and then ultimately reify the patterns and contradictions of the social realities that shaped their development.

This pattern is markedly reflected in two technological developments that I have spent considerable time and energy grappling with over several decades: nuclear power and genetic engineering. Nuclear power was mainly the product of a perceived military necessity during the first two decades of the Cold War: to maintain a steady supply of nuclear technology and engineering expertise through advancing the myth of the "peaceful atom." It was massively subsidized by the US government (and ultimately the Soviet Union, France, and others), and most of the nuclear plants in the US were built in the immediate aftermath of the 1970s "energy crisis."

Hundreds of nuclear power plants were initially planned in the US, but their development was cut short by rising public opposition, a scarcity of investment capital, and the unwillingness of people in most US states to allow utilities to pass on their massive capital costs to utility ratepayers. Attempted nuclear "revivals" during the George W. Bush and Barack Obama presidencies foundered in the face of continued public skepticism, uncontrollable cost overruns, and the lack of a viable solution to the proliferation of nuclear waste. Catastrophic accidents at Three Mile Island, Chernobyl, and Fukushima helped reinforce public opposition, and needed safety enhancements in the aftermath of those events raised the economic stakes even higher. While nuclear proponents continue to promote the myth that a new generation of reactors will lower costs and alleviate safety concerns, the fallacies behind the myth are just as transparent as they were when these claims were first advanced during the 1980s.

The development of genetically engineered varieties of staple agricultural crops similarly reflects the social matrix and distinct corporate agendas from which the technology emerged. Just a few years after scientists at Stanford University demonstrated the feasibility of splicing DNA from one living organism into the cells of another, Monsanto began to investigate whether this new technology could be mobilized to enable crops to tolerate high doses of chemical herbicides. What problem was Monsanto trying to solve? Patents on some of their top-selling products, glyphosate-based "Roundup" family weed-killers, were going to expire in 2000, and they needed to find a way to keep selling more Roundup, even as cheaper, generic formulations were likely to hit the market.

The first Roundup-tolerant soybean, corn, and cotton seeds were sold to farmers in 1996, along with a contract mandating that growers buy their herbicide from Monsanto, and their use quickly skyrocketed. Why? Because farmers facing overwhelming pressure to cut costs could now spray Roundup indiscriminately throughout the growing season, saving on cultivation costs and initially reducing their use of chemicals that had more demanding spraying schedules—though the latter advantage quickly faded once the problem of Roundup-tolerant weeds swept the US Midwest. Also, Monsanto went on a massive merger spree, buying up many of the largest seed companies in the US and other countries, eventually controlling more than a quarter of the world's commercial seed market. Today, as much as 85 percent of all the crop acreage planted with GMO seeds consists of crop varieties that have been genetically engineered to tolerate applications of Roundup, even as Monsanto—the technology's most aggressive developer and promoter by far—has been merged into Bayer's global agribusiness and pharmaceutical empire.

But what of all the claims about future, more beneficial uses of GMOs? Does genetically engineered agriculture have a place in the transition to a healthier and more ecologically benign agricultural system? The evidence clearly suggests otherwise, confirming just how much the technology is wedded to its initial raison-d'être. For twenty-five years, Monsanto and other companies have promised a host of agronomic and nutritional benefits tied to further GMO research, but none have come to pass. Genetic engineering offers no systematic advantage for crop yields, and when Monsanto made headlines during the 2010s with products like a low-trans-fat soybean and a drought-tolerant corn variety, it turned out that both traits were products of conventional plant breeding. These products' sole GMO trait was—no surprise—tolerance to Roundup-brand herbicides. While sophisticated biotech diagnostics often play a facilitative role in current plant breeding research, enabling scientists to scan offspring for particular genetic markers, the purported benefits from genetic manipulation of plant cells have time and again been shown to be entirely mythical.

A related approach that has made headlines in recent years is the gene editing method enabled by CRISPR technology, which has produced such innovations such as apples and potatoes that don't turn brown with age. But what do these products offer, beyond the ability for companies to sell fresh produce with a longer cosmetically acceptable shelf life? It is not yet clear what other aspects of declining freshness are masked by the lack of visible browning. And recent evidence suggests that the advertised "precision" of CRISPR-based gene editing is far less reliable than claimed, with the unintended consequences of edited genomes frequently mirroring those of conventional genetic engineering. Thus the development of GMOs and gene-edited crops reaffirms the many ways in which new technologies both reflect and help reinforce the commercial imperatives, and the larger social matrix, from which they emerged.

Endnotes

1. Lewis Mumford, *Technics and Human Development* (New York: Harcourt Brace Jovanovich, 1966).

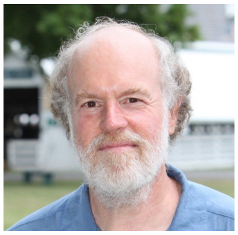
2. Murray Bookchin, *The Ecology of Freedom: The Emergence and Dissolution of Hierarchy* (Pao Alto, CA: Cheshire Books, 1982).

3. Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* 109, no. 1 (Winter 1980): 121–136.

4. David Noble, *Forces of Production: A Social History of Industrial Automation* (London: Routledge, 2011).

5. Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (New York: Verso, 2016).

About the Author



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