Technology and the Future

GTI Forum

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How will technology shape—and be shaped by—the global transition now underway? Disruptive technologies will influence which future emerges, yet they are subject to social choices yet to be made. This Forum explores these vital questions. Panel 1 focuses on vanguard technologies, such as bioengineering and artificial intelligence, and whether they have a role to play in a Great Transition. Panel 2 explores conceptual frameworks for understanding the interplay between technology and society. Does technology drive history, the reverse, or something else entirely?

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The Question of Technology

Paul Raskin

This **GTI Forum on Technology and the Future** explores a critical question: how might emerging technologies shape—and be shaped by—the global transition now underway? Our panels approach this knotty question at concrete and conceptual levels. In the first, contributors weigh the implications of *specific technologies*, for better or worse, for a Great Transition; in the second, contributors examine *theoretical frameworks* for making sense of the interplay between technology and society.

Disruptive Technologies

An astonishing array of potentially disruptive creations looms on the horizon. In this pivotal moment, what influence, for better or worse, might vanguard technologies have on the global trajectory? Which applications are inherently discordant with a Great Transition and should be resisted outright? Which have a legitimate place, in some form, in a Great Transition world and the struggle to get there?

Under prevailing Conventional World conditions, social change movements can oppose the adoption of specific technologies, advocate policies to regulate them, or, by ignoring them, cede the field to business-as-usual forces. Not surprisingly, given the diversity of environmental and social advocacy, controversy rages about such technologies as bioengineering, artificial intelligence, and the Internet.

To structure the discussion of this sprawling topic, panelists were invited to focus on the prospects of key technologies in three arenas:

Bioengineering: Will there be GMOs in a Great Transition? Surely we need to move from industrial agriculture to an agro-ecological model, but can this meet the nutritional needs of a growing population? Some see a role for regulated GMOs, while others passionately disagree.

Artificial intelligence: Will AI induce painful unemployment in the near term? By reducing socially necessary labor time, might it be the precondition for a post-scarcity society? What would a politically progressive AI strategy look like that balances such concerns?

Digital economy: Do blockchains and cryptocurrency merely foreshadow new financial and environmental burdens, or hold the promise, as some claim, of hastening a post-capitalist economy? Can social movements begin to coopt elements of platform capitalism to grow the infrastructure of platform cooperativism?

Interlocutors were asked to reflect on how different institutional contexts might shape the form each technology assumes and the function it plays, a consideration which segues into the discussion of theoretical frameworks, the theme of our second panel.

The Big Picture

How should we think about the interplay between technological and social evolution? Does technology drive history? Or the reverse? Or perhaps the logic of discovery defines a channel of possibilities for social evolution that delimits the scope for human agency?

Ask a professional futurologist (or a wonderstruck layman) what our grandchildren's world will look like, and odds are you'll hear a story about how disruptive technology inexorably will revolutionize economies and everyday life. For many, *technological determinism*—the idea that technology drives history—is a seductive lure that offers a through-line for explaining social change. We can resist, surrender, or adapt to the robots (and much else), but they are coming!

But in downplaying the other side of the equation—the ways history drives technology—technological determinism is reductive and simplistic. The robots and their ilk will not be dropped from the sky by technology gods; they will carry characteristics and functions congruent with the societies that spawn them. By insisting that the internal logic of innovation drives social evolution, technological determinism reverses that paternity. If technology marches to the beat of its own

drum, we can love it (*technophilia*) or hate it (*technophobia*) but not alter its essence. Both the techno-optimist gushing about cool gadgets and the techno-pessimist indicting the machine let the reigning political economy off the hook.

By contrast, the *social construction of technology* school rejects the idea of technology as an autonomous force, instead understanding it as embedded in society and subject to individual and collective choices. Social constructionism yields academic and policy insight into the regulation and management of R&D, but its granular focus cannot guide us in the big-picture challenge of shaping the social-technological culture of the future. Moreover, social constructionism's bias—history drives technology—obscures the objective constraints imposed by the state of technology and the laws of nature.

What are the contours of a systemic understanding of the technology-society dialectic? An adequate framework recognizes that technological and social conditions co-evolve at different spatial scales influenced by strengthening global forces. In stable times, the technological variants that prevail and become entrenched are those compatible with dominant interests and institutions. However, at pivotal moments of historical change like the present, techno-social systems can branch in myriad directions as disruptive innovations contribute to the stress on existing structures, helping to trigger and shape what comes next.

In our time of transformation, emergent technologies powerfully affect all future trajectories, whether of Conventional Worlds, Barbarization, or Great Transition varieties. The forms they assume and the roles they play are subject to choices yet to be made and struggles yet to be waged. If it is true that the robots will look like us, the prior question remains: what will we look like? Technology scenarios are subplots of the larger story depicted in the alternative narratives of the future.

With these general remarks offered as background for your critique and elaboration, our panelists examine tangible and theoretical dimensions of **Technology and the Future**.

About the Author

Paul Raskin is the founding president of Tellus Institute. His work has focused on visions and pathways to a decent future from local to global scales. He has developed widely used integrated assessment models for energy (LEAP), water (WEAP), and sustainability (PoleStar). In 1995, Dr. Raskin convened the international Global Scenario Group, whose valedictory essay—*Great Transition: The Promise and Lure of the Times Ahead*—became the point of departure for the Great Transition Initiative that he continues to direct. His most recent book is *Journey to Earthland: The Great Transition to Planetary Civilization*. He holds a PhD in theoretical physics from Columbia University.

Panel 1:
Disruptive Technologies

The Blockchain Revolution

Michel Bauwens

Whether we believe that technology itself has its own determinism or that it is shaped by material interests, there is always a residue of human agency to transform technological tools for the common good. A most unlikely candidate, the Bitcoin-generated blockchain can have transformative potential in this regard. The blockchain can be used as an essential tool to construct the next cyber-physical infrastructure that will allow humanity to produce for its own needs, while respecting planetary boundaries and our interdependency with the web of life.

Bitcoin is the recipient of many legitimate critiques by progressives. It was designed with Austrian economics and anarcho-capitalist values in mind, it is very energy-intensive in its production, and it is very unequal in its distribution of income and property, a distribution that is not accidental in view of the "oligarchic protocols" that it has chosen as incentives for its stakeholders.[1] But
it is important to distinguish the existence of a global distributed ledger, i.e., an open and interoperable accounting and logistical system that can be used to coordinate production on a global scale, from its first iteration as the ledger of Bitcoin. We now have different post-blockchain distributed ledgers that attest to this, and a number of these ledger projects are operated not according to libertarian values and rules, but by integrating the insights of Elinor Ostrom.[2]

A ledger is first and foremost an accounting tool, recording transactions. This is obviously not trivial: the first accounting systems in Sumer, with temple administrations recording the flow of grain and debts, stand for the origins of the state apparatuses; the double-entry accounting system for private competitive units created by a Franciscan monk Luca Pacioli in the Italian

city-states stood for the emergence of private forms of capitalism which would eventually become dominant.

Blockchain ledgers have currently inaugurated various forms of post-capitalist accounting, which seem to be just as non-trivial:

- Contributory accounting, which can record, value, and recompense non-commodified forms of contributions to ecosystems and networks, signifies the recognition of value outside the commodity form; it is a crucial tool signifying a transition to contributory regimes of value[3]

- Flow accounting, such as the Resource-Events-Agents software, allows every transaction to be recorded as an event in a network, and has abandoned double entry; it is an accounting for externality-aware ecosystems, not externality-ignoring closed entities.

- Thermodynamic accounting directly records the flow of matter and energy into an accounting system, such as the systems pioneered by R30.org and the Global Commons Alliance, who use a "global thresholds and allocations" approach to determine the maximum allowed flow in particular contexts.

These ledgers are linked to tokens and intelligent current-sees which can allow for expanded and complex value regimes.[4] We now have access to local currencies, which can protect and regulate local economies and domain-specific intelligent monies such as SolarCoin, generated by renewable energy, or FishCoin, which regulates the maximum volumes for the fishing industry.

Local-geographic currencies, domain-specific virtual currencies, and transformed nation-state currencies can coexist in a regime of socially and environmentally sustainable monetary biodiversity and a global regulatory currency that ensures the economy stays within agreed upon ecological limits.

With these tools at hand, integrated in a cosmo-global cooperative ledger, it becomes possible to transcend the violent competition between economic coordination systems that plagued the twentieth century.

Here is what we can then envision:

- The primary layer of human cooperation becomes "stigmergy," the gift of the commons economy that has been operating successfully within the open-source economy for two dozen years by now: open and transparent systems allow participating producers to freely coordinate their work in view of the needs and possibilities of the ecosystem as a whole, without needing central command. Collective agreements then result from negotiated coordination. The agents of this are the contributive communities, and the for-benefit associations that maintain their infrastructure of cooperation.

- The secondary layer consists of the generative market exchange mechanisms, post-capitalist market forms that regulate genuine exchange within planetary limits; this is necessary for the flow of all the resources that need investment and need to be renewed. The agents for this are generative and cooperative market entities that add value to the commons economy. Commons Stack, focusing on commons regulations, and RadicalXchange, focusing on the creation of generative market systems, are among the initiatives dedicated to this.

- The third layer is the planning layer. This is where thermodynamic accounting systems come in, by rendering visible the flows of matter and energy in a economic system, and where the ruleset of "global thresholds and allocations," allows for context-specific "maximums."

To a skeptic, the description so far will sound utopian. What could be the agent of sufficient change that would lead to the adoption of such a global infrastructure?

Our answer is that the commoners are the agents of such a change, following cosmo-local models, which we see as the "third possible future" for humankind.[5]

The first future is the continuation of multicultural neoliberalism, as espoused by the World Economic Forum.[6] It is a world run by public-private partnerships and natural asset investment vehicles, with weak national governments, strong transnational capital, and instrumentalized global NGOs. Its political preference is for alliances of the urban cognitive elites, organized under group allocation rules, which can be used to manage the unruly popular classes.

The second model is protectionist retreat, which aims for re-strengthening sovereign nation-states and attempts to control global flows of capital and labor to benefit a competitive nation. The danger of the second model is armed confrontation between states aiming for control of scarce resources.

The third model is the cosmo-local model: in this model, we aim for an intelligent relocalization, based on distributed manufacturing models, producing on demand using the maximum amount of biodegradable material. In such a model, local production units are linked to global open design communities, and a partner state, or "community state," enables and empowers individual and collective autonomy at the local scale and guarantees the equality of contributory capacity. Local alliances of public authorities, the commercial sector, the formal civil society, and research organizations support commons-centric public initiatives; they are mirrored, in a fractal way, by similar transnational institutions that support a domain-specific commons institutions, which we call the "magisteria of the commons."

We see these networked workers, organized in common third spaces, i.e., revamped makerspaces, as both local agents, rooted in their communities, and as agents that are linked to the global open design communities which are the vehicle of their social and technical knowledge. Barring or awaiting the emergence of political forces which can represent this cosmo-local order, the priority is to network the productive nodes and to construct the necessary transnational layer which can represent the counterforce to transnational capital. Partner state organizations are a vital link to facilitate the connection of local producers to the global streams of shared knowledge.[7]

Endnotes

1. To see how this differs from a commons-centric design, see the comparison table: "Contrasting the Propertarian Blockchain with Commons-Based Ledger Systems," https://docs.google.com/document/d/1RQXhk83jrRTuWXKzPC6R5pxcbm-hqA-WiRgsfjU9NIs/edit#heading=h.cfglx2edur25.

2. The Commons Stack project, part of the Crypto Commons Alliance, is exemplary in this regard. See https://commonsstack.org/.

3. The P2P Value project found that 75% of the 300 studied peer production projects were using, experimenting, or researching such accounting conventions and tools. See https://wiki.p2pfoundation.net/P2P_Value.

4. The concept is from Arthur Brock, founder of the Holochain post-blockchain ledger, a open and p2p-based interoperable ledger system that doesn't require a world computer but is based on the free interconnection of autonomous ledgers. See, for example, "the Metacurrency Myth," *The World of Deep Wealth*, March 10, 2016, https://medium.com/metacurrency-project/the-metacurrency-myth-8db61ed14fb8.

5. Cosmo-local production models are described in a new book by the P2P Foundation, which contains 40 case studies of initiatives combining local material production with globally shared open designs: José Ramos, Sharon Ede, Michel Bauwens, and Gien Wong, *The Cosmolocal Reader* (Geneva: P2P Foundation, 2021), https://clreader.net/.

6. See Wesley Yang, "Welcome to Year Zero," *Year Zero*, July 14, 2021, https://wesleyyang.substack.com/p/welcome-to-year-zero.

7. Michel Bauwens and Alex Pazaitis, *P2P Accounting for Planetary Survival: Towards a P2P Infrastructure for a Socially Just Circular Society* (Geneva: P2P Foundation, 2019), https://commonstransition.org/p2p-accounting-for-planetary-survival/.

About the Author

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Six Disruptive Technologies

Al Hammond

By all accounts, the next decade promises to be one of major advances and innovation, comparable to the decade that saw the birth of the Internet and the rise of global tech companies. These changes will likely have significant social impacts, good and bad. As a lifelong science and technology reporter, investor, and junkie, I would like to share some thoughts about what may lie ahead.

Blockchains, the future of finance, and Internet 3.0. A financial system that is not centrally controlled (e.g., by governments, banks, and credit card companies) could in principle help level the playing field and make financial services of many kinds more widely and equitably available. That might be strongly compatible with a Transformed World, especially if blockchains also become the technological standard for elections, preventing manipulation of outcomes by rulers or political parties. More broadly, if information can be stored and shared on blockchains in ways that cannot be manipulated by private or political interests (think Facebook, Fox News, and Trump's Twitter feed), that could also be a potent tool for bottom-up social transformation. Blockchains run by governments, on the other hand, could decimate privacy and liberty: think China on steroids.

Artificial Intelligence. A dangerously powerful tool in the wrong hands (e.g., Facebook, authoritarian governments), but also what is likely to drive very rapid, transformational advances in agriculture, biomedicine, personalized healthcare, educational practices, and possibly politics. It is not at all clear whether this technology can or will be regulated by governments or social conventions.

Fusion power. Close to a breakthrough, thanks to superconducting magnets, fusion could

transform electricity generation with small, widely distributed plants that create no radioactive waste and generate cheap power. This is likely the best hope for mitigating global warming and avoiding the worst of the forced mass migration from equatorial regions (and ensuing social disruption) that will otherwise ensue.

Quantum computing and communications. Still in its infancy, but likely to undermine all current cybersecurity measures (although quantum communications could restore security), as well as enabling modeling and problem-solving and AI tools that are immensely powerful. Who will/should control such tools?

Electrical and autonomous vehicles. This major shift in transportation technology now seems certain, with major benefits to the climate and urban pollution and significant social benefits—fewer accidents, and in urban areas, many fewer vehicles altogether, freeing parking spaces for more productive uses. The costs are real, including job losses among taxi and truck drivers and auto mechanics, but it overall seems a net positive for a transformed world.

Industrial automation, robotics, and 3-D manufacturing. This trend—in package sorting, in manufacturing, in waste recycling—will likely accelerate, reducing many types of routine physical labor jobs but improving efficiency and safety. Together with on-site 3-D parts manufacture, this transformation will create new, higher-paid jobs.

I think that all of these technological transformations will happen, driven largely by market forces. But markets evolve, and are ultimately driven by consumers, so the uses to which these new tools are put depend enormously on what societies decide. Can a more educated populace learn to use these tools (or demand that they be used) for the common good? That question of who decides—governments, the private sector, or more bottom-up social consensus—seems very much up for grabs.

About the Author

Al Hammond is a serial entrepreneur, a widely published author, and a global leader in market-based solutions to poverty. He is co-founder and Executive VP for Strategy of Healthpoint Services, which delivers safe drinking water to rural and small town communities in India, and the former leader the Health for All program at Ashoka, a global network of social entrepreneurs. Earlier, he helped to launch the base-of-the-pyramid movement that transformed how large companies and the international development community address poverty. He has served as a consultant to the White House Office of Science and Technology Policy, to several US federal agencies, to the United Nations, to a number of major corporations, and to several private foundations. He holds degrees from Stanford and Harvard Universities in engineering and applied mathematics.

Toward a People's Social Media

Derek Hrynyshyn

The steady pace of technological development can be easily taken for granted when the social order appears stable, as new innovations help meet society's needs and demands in forms that are usually uncontroversial, even if they sometimes come at a surprising speed. But in pivotal moments of historical change, or times of crisis like the present, when the future looks uncertain, new technological developments become politically contentious in ways that can, if we observe them carefully, reveal much about the present and help us anticipate what kinds of futures are possible.

But this requires an adequate conceptual framework for making sense of the interplay between technology and society, not one based on the celebratory marketing rhetoric of the industry behind the innovations. The lure of technological determinism is understandable, but as multiple crises deepen and defensive responses to the problems that follow in wake of technological disruptions are articulated, it becomes clearer that such thinking serves as an apology for the anti-human trajectory of the development by currently dominant forces behind the technologies we are offered: "Resistance is futile" is the main lesson of such approaches.

An alternative framework of thought is needed to set our world on a transition towards sustainability. We need to imagine how technologies can serve different, more democratic goals. A social constructionist framework that sees each particular technology serving a particular interest at a particular time is such an alternative, but it is often unable to explain the unintended consequences that arise or the path dependence of innovations. What is needed is an approach that can interrogate the relationship between the broader structures of power and the overall trajectory of technological development. In other words, we need to understand technological developments as taking place within a context of complex social systems as a whole.

Such a conceptual framework can be illustrated through examination of the new systems of media and communication technology that have come to dominate the flow of information around the world in recent years. Social media platforms have occupied a central role in the struggles for power in many states in the last half decade, but they can also be subject to regulatory constraints at the hands of governments. Dominant platforms function as the means of diffusion of information, misinformation, and ideological content, shaping our cultural values and political behavior. How these systems are further developed will be crucial to determining our future, since the values embedded in the techno-social systems of the future, and the ways that they are designed, implemented, and regulated will depend on the ideas promoted by these platforms.

While such networks were originally hailed as liberating us from the gatekeepers of information, these systems have been developed in ways that are deeply imbricated with the existing structure of economic power, and consequently have furthered our progress along the Conventional World trajectory that is heading towards Barbarization. The basic business model of all the dominant platforms is the extraction of profit not from selling services to their users, but from selling the attention of their users to advertisers. Thus it is the demand of the advertisers that determines how the systems operate, not the needs of the public. This system is intended to maximize the value of the users' attention, which incentivizes the platforms to manipulate the algorithms that control the distribution of information across the dominant platforms in ways that provoke emotionally resonant responses from the users.

It is now clear, from both academic analysis and whistleblowers from within the corporations that operate the platforms, that this process amplifies extremist political tendencies and drives a polarization of political discourse. More broadly, the effect might be described as the shaping of the consciousness of the users in ways that suit the needs of existing economic interests of platform capital, and of the consumer capitalist economy more generally.

The resulting harms to the democratic functioning of political systems are visible in a number of countries. But the impact on electoral processes is not the only observable effect. Misinformation about many issues, such as public health crises and climate change, presents obstacles to efforts to solve these crises through collective rationality. In general, these algorithmic harms are inherent

to the commercial operation of the platforms and make it difficult to ensure technological innovation is oriented towards solving these problems (as in the case of sustainable energy sources) or used to solve them when made available (as in the case of COVID vaccines).

These problems are now well known, and efforts to deal with them through regulation have begun in a number of liberal democracies, including Europe, the UK, the US, and Canada. Perhaps this gives hope that the problems will be overcome and a more democratic way of distributing information can be regulated into existence. But what has been proposed so far does not address the basic problems at the level of the business model and its effect on the minds of the users. If the amplification of the tendencies that are pushing our societies towards barbarism is to be countered, we will need sustained political pressure in multiple societies to ensure that the flow of information is freed from the demands of private, unaccountable interests. Such pressure is not likely to be successful in the immediate future, but should be supported where it emerges.

This implies that the society-technology relationship needs to be understood as existing within the structure of material power of a neoliberal capitalist economy. Innovations in energy sources, bioengineering, artificial intelligence, and other fields of technology are also enmeshed in such as a structure and as such are driven by the interests of those with the resources to invest. As with communication technology, this means that technological systems are most often developed, extended, organized, and ultimately used in ways that serve the existing structure of power in our social system. This structure of power needs to be challenged so that newer, more humane technologies can be devised. Otherwise, new technological development will likely continue to lead us further down the road to a future of Barbarization.

We need to support struggles for more democratic technologies and for more democratic processes of technological development, but we also need to see these struggles as part of a struggle against the concentration of economic power more generally. To do that, we need to imagine more democratic technologies, and envision how they can be integrated into social orders that are built on the basis of value systems that afford us a more complete flourishing of human capacities.

About the Author

Derek Hrynyshyn is a political theorist who teaches courses on media and politics at York University. He is author of *Limits of the Digital Revolution: How Mass Media Culture Persists in a Social Media World* and is currently working on a book-length study of the political economy of the media in Canada. He holds a PhD in political science from York University.

Sustainable GMOs: An Oxymoron?

Sheldon Krimsky

Can technologies, in and of themselves, be sustainable or unsustainable? The introduction of genetically engineered crops into agriculture in the mid-1990s has been heralded as the second coming of the Green Revolution. Among the expectations were high yields, fewer inputs like pesticides, and new nutritionally enhanced foods. Around the same period, the concept of sustainability was introduced into the working lexicon of many disciplines, practitioners, and corporations. To what extent, then, does such genetic engineering meet the standards of
this new concept? A careful analysis of the principles of sustainability and their applications to agriculture shows that sustainability cannot be applied to a specific technology without considering the system in which it is embedded.

The introduction of genetically engineered seeds, beginning with insect-resistant and herbicide-tolerant crops, brought international opposition from environmental groups like Greenpeace as well as several nations. In response to the controversy over the introduction of genetically modified organisms (GMOs) into agriculture, the European Union established a regulatory system that included risk analysis, testing programs, and strict criteria for adoption of GMOs into agricultural production and presence in food shipments to European nations. In contrast, the United States did not require testing but began with the assumption of "substantial equivalence," considering GMOs as safe as traditionally bred crops unless proven otherwise.

The terms "sustainable" or "sustainability" are among the most widely used terms in the titles of scientific papers. From Web of Science, I found 122,744 titles containing one of those two words. In 2020 and 2021, the terms appeared in 20,760 and 14,896 titles in scientific papers, respectively, while 19,255 books had the root "sustainable" in their titles. Before we can ask "Is X sustainable?,"

where X is a product, system, or technology, we must be clear about what we mean when people use the term "sustainability."

The Brundtland Report, the culmination of the work of the World Commission on Environment and Development in 1987, referred to sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Specifically, with respect to sustainable agriculture, the report states that the rate of depletion of topsoil, fish stock, and forest resources should not exceed the rate of regeneration. The operative term is "regenerative agriculture," also referred to as "sustainable agriculture." When we ask whether the technology of genetically modified organisms (crops) supports agricultural sustainability, we shall refer to the protection of the agro-ecological system.

In Hawaii, papaya tree plantations were blighted by the papaya ringspot virus (PRV), which could not be controlled by pesticides or netting to stop its spread by the aphid vectors. A laboratory technique initially called "coat-protein gene-mediated transgenic resistance" was developed for papaya cells. Under the right conditions, plants can be sensitized with a coat protein of an invading pathogen, inducing an immune response against the invading pathogens. In some respects, it is akin to vaccination in mammals.

The GMO papaya has been widely heralded as a success, which can be adapted to any sized farm. Its use mitigates against the use of insecticides and other environmentally damaging methods to destroy the aphids carrying the virus.

The GMO papaya is already in use, but there are also potential applications of transgenic crops that show a favorable approach to sustainability, such as the genetic modification of bacteria and plants to extend nitrogen fixation to new plants. The massive application of inorganic nitrogen fertilizers in agriculture is a well-documented environmental contaminant. The fertilizers drift away from agricultural fields leaching into lakes, rivers, streams, and aquifers, creating eutrophication. The excessive nitrogen sources, providing a richness of nutrients in bodies of water, frequently causes a dense growth of plant life and results in the death of animal life from lack of oxygen.

One of the earliest projects for the new biotechnology industry during the last quarter of the twentieth century was the transformation of plants that cannot naturally fix nitrogen into nitrogen

fixers. This involved genetically modifying bacteria that are symbiotic to these plants with nitrogen fixation genes or genetically modifying the plants with such genes. While creating new plants with nitrogen-fixing properties would contribute to sustainable agriculture, doing so has faced many obstacles.

Other new positive social applications of GMOs enhance nutrition without causing any detriment to the environment; take, for example, Golden Rice. The rice genome was genetically modified to contain a precursor to vitamin A, which the body can turn into the vitamin. As blindness is common in vitamin A-scarce communities, this product could help reduce the worldwide prevalence of child blindness, and in 2019 it was approved for use as human food in the Philippines. The American Society of Human Nutrition reported that a cup of Golden Rice consumed daily could provide 50 percent of the Recommended Daily Allowance for vitamin A.

However, other GMO crops do not meet the criteria for sustainability. One of the earliest GMOs to enter commercial markets were herbicide-tolerant crops. The premise behind their development was that they would resist any damage from spraying herbicides, which could then be used to eliminate weedy competitors of the crops. Glyphosate-based herbicides (GBH) have proven to be highly controversial. In 2015 the International Agency for Research on Cancer (IARC), an independent research arm of the World Health Organization, issued a report that glyphosate is a probable human carcinogen. Other studies have found GBH deleterious to many species, including butterflies, quails, and frogs.

Given the extensive environmental impacts of GBH and its suspected effects on humans, this class of herbicides does not meet the standards of agricultural sustainability. Thus, the system in which GBH is embedded and with which it is co-dependent, namely, GMO transgenic crops, cannot be sustainable.

The prospects of genetically engineering plants with insecticidal proteins provided another approach to the management of insects. It has been estimated that 37 percent of what is planted is lost from insect herbivores. In the mid-1970s, scientists discovered a plasmid (circular piece of DNA) in the bacterium *Bacillus thuringiensis* (Bt), which encodes crystalline proteins that are toxic to specific insects.

Natural forms of Bt have been used by farmers since the 1920s and were approved in the form of granules or as a liquid under the organic standards as a natural microbial pest control agent. The terms "Bt-transgenic crops" refers to those that had the insecticidal properties of Bt built into the genome of the plant. The first approved Bt crops were introduced into commercial agriculture in 1995 and included potatoes, corn, and cotton, and Bt has since been expanded to many other crops.

The prospect that Bt transgenic crops would substitute for billions of pounds of chemical insecticides that are sprayed promiscuously on farmland leaching into waterways made these GMO crops a prospect for sustainable agriculture. However, several problems arose from the extensive use of Bt crops. First, insects became resistant to them. Once the insects became resistant to Bt crops, farmers had to either use chemical pesticides or accept crops that had more than one toxic protein. Thus, plants had to be genetically modified to contain a pyramid of toxic proteins, imposing additional risks on the crops and the environment. Many of the early gains of reduced insecticide use had diminished. Secondly, organic farmers, who used Bt sparingly at the times that insects were invading their crops could no longer use the pesticide because of the rise of Bt-resistant insects.

Sustainable agriculture is not premised on a particular crop of set of crops, but rather on an integrated ecological system. A GMO crop cannot be assessed for its sustainability by itself without considering the system in which it is embedded. While a single crop or procedure cannot turn a non-sustainable agricultural system into a sustainable one, it can turn a sustainable system into a non-sustainable one. The ethics behind sustainability is fundamentally in the selection of a system, where all the parts fit together to preserve the ecology for future generations.

About the Author

Sheldon Krimsky is Lenore Stern Professor of Humanities and Social Sciences in the Department of Urban & Environmental Policy & Planning in the School of Arts & Sciences and Adjunct Professor in Public Health and Community Medicine in the School of Medicine at Tufts University. His research focuses on the linkages between science, ethics, and public policy. His books include *Agricultural Biotechnology & the Environment*, *Biotechnics & Society*, *The GMO Deception*, and *Stem Cell Dialogues*. He served on the National Institutes of Health's Recombinant DNA Advisory Committee from 1978 to 1981. He was a consultant to the Presidential Commission for the Study of Ethical Problems in Medicine and the Congressional Office of Technology Assessment and is a board member of the Council for Responsible Genetics. He holds a PhD in philosophy from Boston University.

Navigating the CryptoCommons

Sarah Manski

For most technologists, there is a blindness between social systems and technological systems. Rather than dwell on such problems, I find it useful to pay attention to those attempting to solve them. Thus, I focus here on a movement of technologists already designing technologies to create new post-capitalist economic spaces. These hackers have moved from resistance to revolution. What can we learn from them?

There are multiple decentralizing and potentially democratizing technologies in the mix, but the core one is blockchain, a form of distributed ledger technology, created by Satoshi Nakamoto in response to the failure of large financial institutions and governments to protect the value of currency. At their most basic level, blockchains are encrypted ledgers of value transactions combined with "smart contracts," which enable the automation of contract execution and enforcement. A simple smart contract would be to purchase a certain amount of a product when it reaches the desired purchase price.

Permissionless blockchains (also known as trustless or public blockchains) are open networks available to everyone to participate in the consensus process that blockchains use to validate transactions and data. This architecture creates the possibility of global open-source civic networks and generative economic coalitions surpassing the capacities of both state hierarchies and capitalist market dynamics. Blockchain technologies could enable the construction of a technological commonwealth wherein advanced exchange, communication, and decision-making technologies are used to aggregate, distribute, and govern capital at multiple levels and on a cooperative basis.

My research focuses on the emerging ethical questions related to the impact of technology on humanity and how a commons-based economic model with a new approach to value,

ownership, production, equity, work processes, and social dynamics can be built. While still in the minority, there is a diverse and growing global community experimenting with distributed technologies to create alternative forms of production, relationships, and ownership, with radically new and different logics beyond capitalist extraction, exploitation, market competition, and private ownership. The CryptoCommons movement is building systems incentivizing sharing, decentralization, and cooperation based on a global commons of knowledge, data, and the environment for the collective good, creating the new commonist economy of the future. Much of the debate around emergent technology focuses on technology's tendency to strengthen existing inequalities. Yes, let's be critical, but let's not stand so far removed that we do not take advantage of the new opportunities available to us with these extremely powerful technological tools.

As with all technology, design choices made early in its implementation lay down path dependencies, opening some possibilities and foreclosing others. The Internet ushered in a new phase in the history of the commons in 1993 because it enabled organizing outside the modalities of the state. The Internet distributed information and communication; however, because of the centralized architecture of the platform on which people interact, self-governance was not a natural right. That same architecture also governs the interaction between separate user-generated institutions. Most of the current digital platforms we inhabit constrain users' ability to create their own institutions and govern the interaction between separate ones.

The question is how to design distributed systems that increase humanity's responsiveness through popular sovereignty and collective empowerment.

Cryptocurrencies can be designed to reproduce capitalist inequalities, but they can also be designed to enable cooperation at scale, empowering every individual to be their best self. The Spatial Web moves the Internet into the material world. By combining online data and communication with Artificial Intelligence agents, virtual reality devices, decentralized computing, and blockchain, the Spatial Web will pair real and virtual relations. This technology enables users to both build a twin of physical reality in a virtual realm and bring the digital world back to the physical. It will overlay everything, including conversations, roads, conference rooms, and classrooms, with AI-powered interaction and intuitive information. The Spatial Web requires new

code to bring it to life, but not merely software code. Critically, it requires ethical and social codes as well.

An ethical starting point for the CryptoCommons movement is to design technologies so every part can see the whole, where the needs are, and where to participate, thereby creating feedback loops incorporating the energy from the edges. Another principle is designing technologies as non-corruptible "unenclosable carriers" of information so that people can interact freely. Additionally, they argue, overarching systems design for the future must include stakeholder incentive alignment, open-source code, semantically compatible protocols, and robust engineering practices.

The CryptoCommons movement includes activists working on open source, the commons, permaculture, platform and open cooperatives, blockchain, feminist economics, and open-value accounting. Technologies can deliver more than one type of technological civilization, and we have not yet exhausted their democratic potential. Already functioning corporate sovereignties such as Google are expanding their power by incorporating these new technologies into their systems. The introduction of new technologies' powers of verifiability and permanence could have the immediate effect of strengthening current hierarchies, centralizing power, exacerbating inequality, and generally weakening democracy. Furthermore, as some of the most advantaged players in the world system, corporations enjoy a significant head start in the race to program their logics into mainstream applications, as well as the capacity to enact state policies that block new applications threatening future disintermediation.

Yet, popular sovereignty, envisioned by the CryptoCommoners, may have a future by building a coalition of technologies and broader publics. As the proximate constitutionalizers of the new blockchain world, the technologists designing all our digital systems are in a potentially determinative position, and their affinities matter. They hold an intense desire to rebuild the world based on nature's design of regenerative, resilient, living systems. Let's embrace and support this movement and grow the commons together.

About the Author

Sarah Manski is a scholar of technology and political economy at George Mason University and the founder of the International Society of Blockchain Scholars. She studies technology as a site of social struggle and a force for democratization. For twenty-five years, she worked as activist, journalist, and researcher on projects for empowering workers. She advises foundations, conducts research for the P2P Foundation and the George Mason University Center for Social Science Research, and serves as an Expert Reviewer for the National Science Foundation. She holds a PhD in global studies from the University of California, Santa Barbara.

Relocalizing Technology

Anitra Nelson

If a future great transition manages to address the two key challenges facing humanity today, then I expect convivial and environmentally appropriate technologies to play a role. Such technologies will be more commonly thought of as techniques of living, subject to co-governance, demystified, and user-friendly.

The two challenges of global concern are, on the one hand, diverse and complex socio-political and economic inequalities and, on the other hand, deep planetary ecological unsustainability. Both are generated and reproduced by money, relations of credit and debt, at the hub of capitalism's wheel.

In our current economic system, capitalist managers and owners direct technological innovation and steer it in the direction of enabling growth following the formulaic management of production for trade, which boils down to money making more money. Of course, there are quasi-political regulatory limits and influences related to market demand and preferences that must be taken into account. However, capitalist logic and power are in the driving seat. Even as technologies are released as consumer commodities, those offered are regularly intended to become functionally or otherwise obsolete or unrepairable, and come in the form of services rather than goods, with a demand for continuous fee payments.

Although capitalist technologies are neo-imperialist more by nurture than by nature, they are likely to be barriers to a real transition, one that achieves equity and sustainability. It stands to reason that transitionary processes require that means incorporate end visions as quickly, directly, and completely as possible. Unsurprisingly, many movements working for a transition —such as the degrowth movement, ecosocialism, ecofeminism, and ecoanarchism—in

various ways and to varying extents support slow and small "alternative technologies," using human energy and minimal materials, re-use of natural renewable materials rather than artificial ones, and repairable tools. Such technologies honor human ingenuity and crafts, and respect the multivarious qualities and limits of Earth.

In contrast, genetically modified organisms are intended to improve on and master both Earth and work/ers, with capitalist owners and managers patenting, owning, and controlling a seemingly continuously more artificial environment, more intensively and extensively divorcing humans from their life sources. Such alienation reaches its apogee in so-called "artificial intelligence," which often commodifies erstwhile human skills in machines with simplified forms of human intelligence, robbing people of developing and expressing their creative intelligence and multiple skills.

Even if drones can replace human monitors in forests more effectively at one or a small suite of skills, they fail to fulfill the plethora of functions of community-based foresters who simultaneously and directly fulfill various human needs as well as those of the forest. Few studies on drones' efficiency take account of the back-end embodied material and energy, including human, to create and maintain the drone. Such studies are framed monetarily, sidelining social and ecological values.

Arguments in the technology chapter of my upcoming book *Beyond Money: A Postcapitalist Strategy* parallel points made by social scientist Jathan Sadowski for a neo-Luddism that "treat[s] technology as a political and economic phenomenon that deserves to be critically scrutinised and democratically governed." Unsurprisingly, *Beyond Money* analyzes digital technologies and digital currencies. A transformational social formation, the *Cooperativa Integral Catalana* (Catalan Integral Cooperative, or CIC) demonstrates associated arguments.

CIC aspires to decentralized production and exchange; an autonomous communalism; and open, transparent, direct participatory decision-making processes. CIC and the P2P Foundation have developed a global digital cryptocurrency, FairCoin, with the significant advance of using a fraction of the energy Bitcoin requires to operate. This is just one of a suite of Fair open-source tools for financial and non-financial purposes and "copyleft" licenses.

However, to the extent that CIC replicates market-oriented and money-based relations, it fails to deconstruct the building blocks of our current dilemmas, which are deeply associated with monetary processes that originate and facilitate inequality and unsustainability. Monetary values and production for the market suffocate, contort, and even obliterate the advance of local community-based decision-making using the real social and ecological values necessary to respect the needs of Earth and people.

Digital techniques might be applied in convivial and appropriate ways, say in a postcapitalism in which digital techniques are servants not masters, used minimally and appropriately. But, most importantly, for authentic co-governance of production to simply fulfill people's basic needs within Earth's limits, we need to produce on demand via collective and localized sufficiency. Here neither money nor market exist, and humans are transparently part of nature, of Earth. As such, techniques and technologies of living are ecologically and socially functional, fit for purpose, durable, friendly, and accessible to all.

About the Author

Anitra Nelson is Honorary Principal Fellow at University of Melbourne, author of *Beyond Money: A Postcapitalist Strategy* and *Small is Necessary: Shared Living on a Shared Planet*, and co-author of *Exploring Degrowth*. She was the co-editor of *Housing for Degrowth: Principles, Models, Challenges and Opportunities* and *Food for Degrowth: Perspectives and Practices*. Her research focuses on affordability and sustainability in housing policy as well as the potential for non-monetary economies. She holds a PhD from LaTrobe University.

Global Capitalism's Digital Revolution

William I. Robinson

Not since the Industrial Revolution has the world experienced such rapid and profound changes as those ushered in by globalization. But now it appears that the system is at the brink of another round of restructuring and transformation based on a much more advanced digitalization of the entire global economy and society. This restructuring had already become evident in the wake of the 2008 Great Recession. But the changing social and economic conditions brought about by the coronavirus pandemic are accelerating the process.

Computer and information technology (CIT), first introduced in the 1980s, provided the original basis for globalization. It allowed the transnational capitalist class (TCC) to coordinate and synchronize global production and therefore to put into place a globally integrated production and financial system into which every country has become incorporated. Just as the original introduction of CIT and the Internet in the late twentieth century profoundly transformed world capitalism, the second generation of digital technologies—spanning machine learning, automation and robotics, nano- and bio-technology, the Internet of Things (IoT), quantum and cloud computing, 3D printing, virtual reality, new forms of energy storage, and autonomous vehicles—is now leading to a new round of worldwide restructuring that promises to have another transformative impact on the structures of the global economy, society, and polity.

It is hard to overestimate just how rapid and extensive the current digital restructuring of the global economy and society is. According to United Nations data, the "sharing economy" will surge from $14 billion in 2014 to $335 billion by 2025. Worldwide shipments of 3D printers more than doubled in 2016, to over 450,000, and were expected to reach 6.7 million by the end of 2020. The global value of e-commerce is estimated to have reached $29 trillion in 2017, which is equivalent to 36 percent of global GDP. Digitally deliverable service exports amounted

in 2019 to $2.9 trillion, or 50 percent of global services exports.[1]

The coronavirus pandemic has not only spotlighted how central digital services have become to the global economy; it has also accelerated this digital restructuring, which can be expected to result in a vast expansion of reduced-labor or laborless digital services, including all sorts of new telework arrangements, drone delivery, cash-free commerce, fintech (digitalized finance), tracking and other forms of surveillance, automated medical and legal services, and remote teaching involving pre-recorded instruction. The pandemic has boosted the efforts of the giant tech companies and their political agents to convert more and more areas of the economy into these new digital realms. The post-pandemic global economy will involve now a more rapid and expansive application of digitalization to every aspect of global society.

The giant tech companies, among them Microsoft, Apple, Amazon, Tencent, Alibaba, Facebook, and Google, and to which are now added Zoom and other companies boosted by the pandemic, have experienced astonishing growth over the past decade. Apple and Microsoft registered an astounding market capitalization of $1.4 trillion each in 2020, followed by Amazon with $1.04 trillion, Alphabet (Google's parent company) with $1.03 trillion, Samsung with $983 billion, Facebook with $604 billion, and Alibaba and Tencent with some $500 billion each. To give an idea of just how rapidly these tech behemoths have grown, Google's market capitalization went from under $200 billion in 2008 to over one $1 trillion in 2020, or a 500 percent increase.

As capitalists invest these billions, the global banking and investment houses become interwoven with tech capital, as do businesses across the globe that are moving to cloud computing and AI. By the second decade of the century, the global economy came to be characterized above all by the twin processes of digitalization and financialization.

The third leg in this triangulated bloc of capital is the military-industrial-security complex. As the tech industry emerged in the 1990s, it was conjoined at birth to the military-industrial-security complex and the global police state. Over the years, for instance, Google has supplied mapping technology used by the US Army in Iraq, hosted data for the Central Intelligence Agency, indexed the National Security Agency's vast intelligence databases, built military robots, co-launched a spy satellite with the Pentagon, and leased its cloud computing platform to help police departments

predict crime. Amazon, Facebook, Microsoft, and the other tech giants are thoroughly intertwined with the military-industrial and security complexes. The rise of the digital economy blurs the boundaries between military and civilian sectors of the economy, and brings together finance, military-industrial, and tech companies around a combined process of financial speculation and militarized accumulation.

The apologists of global capitalism claim that the digital economy will bring high-skilled, high-paid jobs and resolve problems of social polarization and stagnation. It is true that the first wave of digitalization in the late twentieth century generated high-paid, high-skilled jobs for some, giving rise to new armies of tech and finance workers, engineers, software programmers, and so on. However, digitalization produced a much more numerous mass of de-skilled, low-wage workers and an expansion of the ranks of surplus labor. But the new wave of digitalization threatens now to make redundant much so-called "knowledge work" and to de-skill and downgrade a significant portion of those knowledge-based jobs that remain. Increasingly, cognitive labor and gig workers face low wages, dull repetitive tasks, and precariousness. As "big data" captures data on knowledge-based occupations at the workplace and in the market, and then converts it into algorithms, this labor itself is threatened with replacement.

Even before the pandemic hit, automation was spreading from industry and finance to all branches of services, even to fast food and agriculture. It is expected to eventually replace much professional work such as lawyers, financial analysts, doctors, journalists, accountants, insurance underwriters and librarians. AI-driven technologies are at this time becoming more widely adopted worldwide as a result of the conditions brought about by the contagion. The pandemic allows the TCC to massively push forward capitalist restructuring that it could not previously accomplish because of resistance to the digital takeover. There appears to be a new bifurcation of work spurred on by the pandemic, between those who will shift to remote work and from their homes face new forms of control and surveillance, and those locked into high-risk "essential" in-person work, such as health care providers, cleaners, and transport and delivery workers.

Capitalist states face spiraling crises of legitimacy after decades of hardship and social decay wrought by neoliberalism, aggravated by these states' inability to manage the health emergency and the economic collapse. In the aftermath of the pandemic, there will be more inequality, conflict,

militarism, and authoritarianism as social upheaval and civil strife escalate. The ruling groups will turn to expanding the global police state to contain mass discontent from below. Well before the contagion, the agents of this emerging global police state had been developing new modalities of policing and repression made possible by applications of digitalization and fourth industrial revolution technologies, such as unmanned attack and transportation vehicles, robot soldiers, a new generation of superdrones and flybots, hypersonic weapons, microwave guns that immobilize, biometric identification, and more.

While the ruling groups deploy the new technologies to enhance their control and profit-making, this same technical infrastructure of the fourth industrial revolution is producing the resources in which a political and economic system very different from the global capitalism in which we live could be achieved. If we are to free ourselves through these new technologies, however, we would first need to overthrow the oppressive and archaic social relations of global capitalism.

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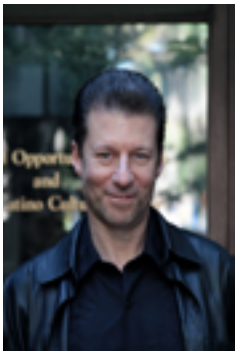

William I. Robinson is a Distinguished Professor of Sociology, Global and International Studies, and Latin American and Iberian Studies at the University of California at Santa Barbara. He is the author of such books as *The Global Police State*, *Global Capitalism and the Crisis of Humanity*, *Latin America and Global Capitalism*, and *Promoting Polyarchy: Globalization, US Intervention and Hegemony*. He worked for a decade prior to entering academia as an investigative journalist in Central America and has lectured widely at universities around the world on the topics of the global economy, international politics, and contemporary world affairs. He is active in several social justice movements, including immigrant rights in the United States and justice for Palestine. He holds a PhD in sociology from the University of New Mexico.

Fighting on All Fronts

Doug Schuler

Emerging—and existing—technologies are bringing us closer to the brink. And even if they turn out to be more benign, envisioning some technological advance as our salvation will waste precious time as the ecosystems upon which we rely move closer to collapse and the violent forces of authoritarianism gain power.

All technology, from hammers and hummers to routers and killer robots, is intended to increase power: to do something cheaper, easier, faster, with more entertainment value, with stronger impact, at greater distances, in more places, or with greater stealth. Technological power, like economic, political, cultural, institutional, or physical power, is distributed unevenly, and it tends to be accumulated by people and organizations who already have too much. Algorithmic power has accelerated those differences; the computer has helped create today's unprecedented economic divide. Many of the world's richest people gained their fortunes through such algorithms, and it is their ideologies as well as the computer systems themselves that are taking us in dangerous directions.

So many trends are headed in the wrong direction: climate change, extinctions and other assaults on nature, weaponization of new spheres and other preparations for war, mass migrations, famines, and pandemics, all of which are aided and abetted by widespread computer use. At the same time, our collective ability to address them may be declining.

The rise of authoritarianism worldwide further erodes our problem-solving capability. China has established the world's most extensive surveillance and control system. If you park your bike in the wrong place, you may find that your Internet speed has been throttled.[1] These systems—and China is not the only producer—are being purchased by authoritarian regimes who are eager to maintain tight control and keep track of their enemies[2] In cause for alarm, recent

surveys have shown that people in less autocratic countries are turning away from democracy and towards authoritarianism because of government dissatisfaction.

Meanwhile, the man who used algorithms to expose millions of unsuspecting users on his platform to racist propaganda is now welcoming us to a glittering three-dimensional zone where everyone will want to be since the weather, actual and metaphoric, outside the zone is so frightful. Twitter's Jack Dorsey and the venture capitalists argue about what form Web3 will take, but agree (without consulting us) that it will be based on blockchain technology and cryptocurrency.[3]

Even relatively benign technology presents challenges. It uses too much energy, and its usage is accelerating dramatically. According to a recent ACM TechBrief, "The energy demands and carbon output of computing and the entire ICT sector must be dramatically moderated if climate change is to be slowed in time to avoid catastrophic environmental damage."[4] Data centers use about 3% of the world's global electricity, twice as much as they did ten years ago. The use of AI takes a large bite: the required resources are doubling every few months; the usage increased an estimated 300,000 times between 2012 and 2018.

Will AI induce painful unemployment? The US has apparently already made that commitment. Companies are enthusiastically developing applications designed to perform tasks that humans do now. This could lead to mass demonstrations and social upheaval with unknown consequences. A progressive platform regarding AI would include more regulation and more transparency. (But not just for AI: less-smart software is also very capable of reinforcing racism and other unfortunate biases.) Bitcoin and other cryptocurrencies are a boon to speculators and criminals as well as those whose ideology alleviates them from tax burdens. Incidentally, the current dollar-based economy is far more egalitarian than the Bitcoin economy. And use of blockchain/cryptocurrency technology is growing so rapidly that its carbon footprint now exceeds that of entire nations.[5]

My version of moving forward is not popular because it relies on humans changing behavior and acting responsibly. Any "solution" that I would proffer would not rely entirely on government (or its absence); luck; technology; divine intervention; AI; demonization of people due to gender, sexual preferences, creed, race, etc.; neoliberalism (or its abolition); a favorable arc of history; or

any other singular leader, philosophy, religion, dogma, or manifesto to rescue us. We need middle-range theories, mutual adaptation and adjustment, and integrating thinking and acting.[6] If we are to survive with any of our humanity intact, it will be because enough of us tried hard enough and intelligently enough using the resources we could muster or develop as effectively as possible.

Social change, like waging war, requires pushing forward on all relevant fronts—and local conditions will vary. Social change movements will obviously use different approaches than the wagers of war, but they must employ the same logic: They cannot afford not to fight on all fronts. The idea that we must or can identify the "one thing" we need or the "first thing" we need to do is simply too risky. In other words, we can work for progressive uses of, say, blockchain technology, but certainly that should not mean opposing the cultivation of sustainable lifestyles or international networks.

While, as Paul Raskin suggests, we do need to resist some "specific technologies outright" (e.g., autonomous killer robots) and "advocate policies to regulate" other technologies (e.g., surveillance technology), we also need to actually be *building* technological alternatives, as to not "cede the field to business-as-usual forces." In the 1990s, there were over 200 digital community networks around the world that were free to use. The Seattle Community Network, which I helped launch, provided thousands of email accounts before the corporate tsunami swamped the innovative home-grown democratic institutions.

Work has continued in the civic tech arena, and some of the under-heralded technology initiatives are the most relevant for the great transition. Citizens, civil society, and governments worldwide are exploring avenues for building an informed participatory culture using technology that complements face-to-face venues. The focus is not about making democracy more convenient or delegating decisions to algorithms. In Barcelona, for example, activists worked with city government to develop an "ecosystem of public policies" using a variety of approaches including Decidem, which is now in use in New York City, Milan, and Mexico City.[7] Here in Washington State, the first climate assembly in the U.S. was recently convened. After extensive deliberation, a randomized group of citizens submitted nearly 100 recommendations to address climate change to the state legislature. This of course is only a minute sliver of the current work that includes citizen science, deliberation, decision-making, news reporting, and divides-bridging in diverse venues as well as

theorizing, empirical work, and institutional transformation. An important issue now is how to learn from and leverage these efforts worldwide.

This may seem like a tepid response in the face of the catastrophic scenarios unfolding around us. But we are a clever species, and we may just be clever enough not to annihilate ourselves. Success will depend on our civic intelligence, not on a technological deus ex machina. If the civic tech approach helps increase and improve our civic intelligence (including our ability to work together), then I can find some reason to be hopeful.

Left for another day is the question of what type of society might emerge from the ashes of the one that collapses. My feeling is that the smoldering ruins would not be the ideal breeding ground for a sustainable society. The grand experiment in which we learn whether humans can exist together may be coming to an end.

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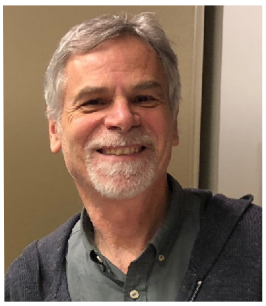

Doug Schuler is the president of the Public Sphere Project, an initiative devoted to the study and promotion of civic intelligence. He is Professor Emeritus at the Evergreen State College and the former chair of Computer Professionals for Social Responsibility. He is co-founder of the Seattle Community Network, a free public access system launched in 1993, and the co-author of *Liberating Voices*. For many years, he has worked on deliberative systems, including e-Liberate, an online system that allows people to conduct distributed meetings using Roberts Rules of Order. He holds an MS in computer science from the University of Washington.

The Truth about the Green Revolution

Tim Weiskel

We are surrounded on every side with evidence of a rapidly changing global ecosystem. The problem is that in our confusion and collective desperation to do the "right thing," we often cling to past misunderstandings and deep-seated cultural delusions of what led to "our" seeming "success" in Earth's unfolding evolutionary drama. In trying to re-enact or extend these misconceived scenarios of past "victories" over the constraints of nature, we fail to understand, in our system blindness and species arrogance, that we are all too often hastening our own demise.

Nowhere is this tragic tendency more apparent than in the rapidly developing realm of bioengineering. Deploying genetically modified organisms (GMOs) is no longer simply a theoretical possibility. GMOs have already been developed for a variety of purposes, from the production of animal feed for meat and poultry to boosting of production of bioethanol fuels. Moreover, the expanded adoption of GMOs to meet human food needs in the coming decades is being actively championed by some of the world's most powerful petro-chemical corporations (like Monsanto) and the world's richest people (Bill Gates, etc.). They often argue that it is only through the greater expansion of GMOs in the world's production of human staples that the food needs of a burgeoning world population can possibly be met in the coming decades and centuries.

The difficulty with this argument is that it is based upon a two-fold mistake stemming from (1) a fundamental misreading of the ecological evolution of recent human food history and (2) a tragic yet pervasive ignorance of the role that humans need to play in building top-soil to foster sustainable agricultural systems for human survival.

Humans will depend on soil—not oil—for a sustainable food future system. Many institutions and a vast majority of individuals will need to understand the importance of this fundamental fact very quickly.

In the very near future, principles of sustainable agriculture will need to govern food production systems all over the world. There is no such thing as a post-agricultural civilization. Nor will there ever be. Humans do not photosynthesize. We cannot. We depend as an entire species on the photosynthesis accomplished by other organisms whose characteristics and requirements now determine our future.

We cannot transcend this circumstance through the further application of engineering technology. Our lives depend upon the lives of countless other species in a complex and continuously evolving ecosystem fueled by solar energy. It is time we pay attention to how we can provide for these other species with a sustainable supply of their requirements if we wish to survive.

The reason why we have failed to see this as our task is that we have fundamentally misunderstood the dazzling accomplishments of the so called "Green Revolution," spurred by the insights and achievements since the 1940s of Dr. Norman Borlaug and his followers. Through selective breeding techniques and the massive application of nitrogen fertilizers and petro-intensive pesticides, herbicides, and fungicides as well as the significant expansion of irrigation systems and motorized tractor power, Norman Borlaug and his associates were able to achieve remarkable increases in the yields of maize, rice, wheat, and other human food staples in the post-war years of the 1950s and 1960s. Governments around the world were impressed by these accomplishments and sought to acquire and implement this new technology. In 1970, Norman Borlaug was honored with the Nobel Peace Prize for his work as a global "hunger fighter."

Borlaug lived to age 95, and toward the end of his career, he became, with the support of Monsanto, an advocate for developing GMOs and their expanded introduction in human food systems. In this regard, he saw GMOs, or the "Gene Revolution," as a natural extension of his earlier work in the "Green Revolution."

Yet the global community now must confront some very sobering and challenging questions about the direction and sustainability of this technology for the future of human survival. While

in economic and political terms, the "Green Revolution" and its successor "Gene Revolution" have very clearly led to impressive short-run "success stories," in ecological terms these technological interventions in the structure and function of agricultural systems worldwide are now being recognized as part of a longer-term ecological disaster for a sustainable future.

The so-called "Green Revolution" was, in effect, a "black revolution," representing a massive transformation from solar-sustainable food systems toward an increasingly petro-subsidized system on a global scale. The impressive expansion of the "miracle crops" in the Green Revolution depended entirely upon the increased use of non-renewable fossil fuels for the development of the fertilizer, the pesticides, the herbicides, the expanded use of tractor power, and the construction of water management systems and pumping for the irrigation of vast tracks of land. In addition, the rapidly evolving system increasingly involved the development of post-harvest crop storage, preservation, long-distance bulk transport, and preparation systems, all of which expended the further combustion of fossil fuels.

The result is that in a remarkably short period of human history, the world's agricultural systems have been transformed from being net energy capturing systems to becoming instead "energy sinks." That is, they have become systems wherein more energy was expended in the sum total of the steps involved in delivering food to humans than is currently "captured" by the photosynthesis itself. Briefly put, the energy expended in our current world food system is greater than the energy captured in the photosynthetic process itself. Indeed, out of every 10 Kilocalories represented in the food consumed by humans, 9 were supplied by fossil-fuel subsidies.[1]

The path for moving beyond the "energy sink" of our increasingly precarious global food system is already known. The lifelong work of Herman Daly on steady-state economics and his insights on "economics for a full world" has provided the fundamental insights for how we need now to proceed.[2]

In ecological terms, practical models for creating solar-sustainable agricultural and food systems are becoming more accessible. The predictable opposition to these much-needed transformations has been clearly signaled in the cumulative work of Frances Moore Lappé and Anna Lappé and other analyses of agribusiness corporations.[3] On an international level, the cumulative work of Dr. Vandana

Shiva on "Soil Not Oil" and the recent victory of the Indian Farmers' Movement deserve extended attention as the human community devises new strategies for survival.[4]

In principle, bioengineering technologies could be deployed to create GMOs that would restore and enrich natural soil fertility and promote water conservation, but the corporations that own the patents on GMOs are more likely to be motivated by the short-term profits to be made of expanding immediate human food supplies in the Borlaug tradition. This will not be a survivable direction in the long run.

Our main problem is *not* one of "running out" of fossil fuels. The problem instead is not being able to adjust human agricultural practices and institutions fast enough to anticipate changes in temperature, drought, and flood conditions while accommodating the devastation wrought by extreme and unpredictable weather events. All of this needs to be accomplished at the same time that we need to move agriculture beyond its global fossil-fuel addiction toward a solar-based sustainable food system. The reason is simply this: by definition, a global food system dependent upon non-renewable energy supplies will, over time, simply not be renewed.

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About the Author

Tim Weiskel is the founder of Cambridge Climate Research Associates and Transition Studies, an online video blog devoted to assisting organizations and individuals in understanding the transitions that must now be undertaken to enable the human community to move to a post-carbon world. Previously, he taught anthropology and history at Williams College, Yale University, and Harvard University. His principal field work was among the Baule peoples of the central Ivory Coast, focusing on the ecology of colonialism and post-colonial agriculture. A social anthropologist and historian by training, he holds a a Graduate Diploma in Social Anthropology and a DPhil in Modern History from Oxford University, where he was a Rhodes Scholar.

Panel 2:
The Big Picture

Beyond Modernity's Technology

Carlos Álvarez Pereira

What could be the role of technology in the unfolding of the Great Transition? The development of technology as it happens today is not contributing to such a shift toward equitable well-being within a healthy biosphere. Some aspects of technological innovation, however, could be repurposed to advance a Great Transition, and the attempts to do so deserve all our attention and support.

Nonetheless, the overall result of the current deployment of new inventions is simply to reinforce the political and economic framework under which technologies are being created. It is difficult to imagine how it could be otherwise, since research and innovation efforts (R&I) are mostly based on two premises: (1) that knowledge is divided into separate disciplines, and (2) that such knowledge is only helpful if it can be harnessed for greater levels of enclosure and control (of people, natural resources, intellectual property, future time, etc.), enabling financial returns on investments.

This leaves our current institutions of R&I unable to ask the questions that would be useful to address our big challenges. At the same time, public and private sectors expect R&I to deliver economic profits and keep alive the illusion of capital. Both premises are so far away from what is needed that it would require a miracle to make R&I contribute significantly to a shift in our trajectory.

Current technological development is not based on what science knows about Life, but on an outdated notion of society, originated at the dawn of Modernity. Its premises are rationalism, reductionism, individualism, objectivity, quantification, productivity, and colonization. This makes our reconciliation with the biosphere on which our own life depends more difficult.

In Modernity, we expect nature and humans to conform to our plans of exploitation and mechanization. We know this expectation is self-deceiving, but current framings of R&I activities do not allow for a greater harmony with Life.

The energy transition from fossil fuels to so-called renewable energies, for instance, is conceived as a techno-economic challenge. But if we assume a growing amount of energy per capita, humanity is doomed whatever the sources of energy since "renewables" also depend on non-renewable resources such as rare earth minerals. Attempts at addressing this issue through "decoupling" consumption from human well-being have failed, but we keep the same strategy in the hope that renewables will buy time until we implement some other source of energy without such limitations.

The obsession of Modernity with materialism and the maximization of production made us ignore that our health and sense of a purpose are not driven by consumerist prosperity, but rather by the quality of our relationships with others, humans and non-humans. This crucial point enables us
to imagine other ways of innovating and learning, in which relationships and interdependencies would play the dominant role.

Consider COVID-19. The response to the tragedy involved a mix of separation (isolating people from each other) and technical fixes at the individual level (vaccination). For public health, this was probably the most sensible thing to do. Nonetheless, by focusing on how to "build back better," we avoid questioning the underlying "development" paradigm itself, one in which the destruction of ecosystems has been a structural feature. Unsurprisingly, a tragedy of such a scale and impact has created a huge amount of private "wealth" in tech-driven sectors such as pharma and the digital industry.

Technology is the standard response of Modernity to any issue. Can it work against the limitations of its own framing? Based on a culture of separation, innovation is contributing to the destruction of the social fabric and creating more inequality, dehumanization, and a greater distance between the artificial creation of financial wealth and social and biophysical realities. Moreover, technology is spreading the idea that humans are defective. We are not creating robots like humans: we are expecting humans to behave like robots. The subtext in "Artificial Intelligence" is that people are

problematic, and our technical creations can be "better" than ourselves. AI tells us that we can and should get rid of humans. Ecological catastrophes could combine with radical robotization to achieve the destruction of ecosystems and humanity, at the same time.

Let me come back to the illusion of capital. The concept of "capital" was originally grounded in living processes: land can constantly produce resources useful to humans and hence feeds the idea that future returns can be expected. But this requires the sun, water, wind, and soil materials to contribute (no coincidence: these are the Four Elements of ancient traditions). Nowadays capital is given more and more abstract forms (e.g., AI algorithms), and legal practices ensure a number of privileges and keep alive the aura of future returns, without any biophysical grounding. This is hugely problematic as far as technology is concerned: if it is good for the creation of "capital," there are good chances that it will mean a greater disconnection from the biosphere we need to regenerate.

This process of abstraction of capital is actually a feature of Modernity and its R&I processes. Modernity reframes the crises it creates in a way leading to further levels of abstraction and disconnection from Life, and then to a formulation of "problems" for which R&I are called upon to design "solutions" avoiding a deeper learning. This is not the way to get out of the "suicidal war we are waging on nature" (and hence on ourselves) about which UN Secretary General António Guterres has spoken.

If Modernity is only able to learn whatever reinforces its own foundations, we face a daunting challenge. How do we create conditions for the kind of R&I and learning that addresses the blind spots of Modernity? We need to learn in an ecosystemic framework in order to reconnect with our fundamentally relational nature. Instead of abiding by the separatist framing of Modernity, we should start repairing artificially broken interdependencies, learn the re-emergence of relationships, and regenerate ecosystems, and in that way give renewed meaning to what we already know.

About the Author

Carlos Álvarez Pereira is a member of the Executive Committee of the Club of Rome and the Advisory Board of the International Bateson Institute, and holds the UNESCO Chair of Global Understanding for Sustainability. He has been a lecturer and researcher in applied mathematics at the Polytechnic University of Madrid (UPM), founder and manager of several digital consulting companies across Europe, and founder of a non-profit center devoted to research in complex systems and AI.

Whose Technology?

Alf Hornborg

There is no concept as urgently in need of rethinking as technology. It is a category that obscures the modes of social organization with which it is intertwined. If asked to define it, most of us would answer that it is human ingenuity applied to nature. If that were the whole story, there would indeed be an unbroken continuity between Paleolithic stone axes and space shuttles, as mainstream narratives of human history often suggest. However, the Industrial Revolution was a more profound discontinuity than historians of technology generally acknowledge. In the late eighteenth century, British capitalists developed technologies that depended not only on ingenuity applied to nature, but also on global market prices of embodied labor and other biophysical resources. From this point on, most technological innovations have been contingent on asymmetric flows of resources in the colonial and neo-colonial world-system—that is, ecologically unequal exchange. Such asymmetric physical flows are the result of global differences in the prices of labor, land, materials, energy, and other resources, but to this day remain invisible to mainstream economics. In not acknowledging the reliance of modern technologies on such flows, we tend to think that their only social implications are in terms of downstream consequences, while ignoring that the very existence of those technologies is a manifestation of an abysmally unequal world order.

Most of the modern technologies mentioned in this discussion so far are available only to a privileged fraction of the world's population, yet they are referred to as something that "we" can choose to adopt or reject. This illustrates that the category of "technology" in the modern worldview refers to a phenomenon that is ambiguously located at the interface of natural and social science. Physicists and engineers are not asked to consider the extent to which an advanced technology is an inherently distributed phenomenon, while economists and social

scientists are not expected to understand the physical principles that it is designed to exploit. In other words, accounts of technology are perceived as having nothing to do with society, while understanding the economy requires no knowledge of nature. This binary divide between the material and the social reproduces the illusion that technology is merely a matter of revealing and harnessing the forces of nature, oblivious of the fact that the physical artifacts and infrastructures designed to do so are products of capital accumulation and unequal exchange. Technology thus seems to remain securely out of reach of critical social theory. Even Marxists are prone to conceptually sequester the "productive forces" from the "relations of production." Given what we now know about material flows and ecologically unequal exchange, the rising productivity of British workers that Marx celebrated in the nineteenth century was largely achieved at the expense of workers and ecosystems in the peripheries of the British Empire.

Attempts by constructionists to transcend the divide between the material and the social have demonstrated how technological design is a product of social context, but they have not acknowledged that even the physical substance of technologies is socially assembled. The posthumanist "neo-materialists," too, continue to ignore the materiality of world trade. At a time when the dilemmas of the Anthropocene are prompting us to revise our understanding of the interface between the natural and the social, it may be easier for us to grasp that even our technologies—foundational to our modern narrative of progress—are socio-natural hybrids. They are not just revelations of nature but social strategies for appropriating human labor time and natural space from other parts of the world-system.

Why is this rethinking of technology so crucial? Because technology is pervasively perceived as our savior. Technological solutions are understood as, in principle, available to everyone, once they can pay for them, and what is economically feasible—that is, purchasing power—is conceptually sequestered from what is technically feasible. This is the illusion that we must now transcend. If the ecomodernist dreams to which so many of us take refuge really were feasible for the eight billion people on the planet, we should expect them to start materializing. Yet they remain forever "around the corner," even in the wealthier countries of the world. To the extent that technology does suggest solutions to our problems, we must concede that the category "our" only denotes a minority of those eight billion, which means that such solutions are an

illusion from the start. The global social conditions for technological transitions are systematically obscured. Photovoltaic solar power, for instance, is an option in Europe as long as the panels are built by low-wage Asian labor using minerals mined where environmental legislation is less rigorous. Another example is the recurring rhetoric on a "circular economy." Given the wage differences, recycling will inevitably be more expensive for Europeans than importing fresh resources extracted in the periphery. There is a systematic socio-metabolic logic that displaces work and environmental loads to the Global South. Yet this is rarely a problem for either economists or engineers.

Technologies are ultimately generated by the way economic exchange is organized. Solutions to our global dilemmas must begin by reimagining how money is designed.[1] The central challenge for humankind is to master the artifacts that she herself has created, but that have become her masters. This certainly applies to technological artifacts, but even more fundamentally to the artifact of all-purpose money, which, in generating a globalized market, makes modern technologies possible. To achieve the Great Transition that we are hoping for, we need to consciously redesign the artifacts that in turn design us. The convivial technologies that we must aim for should make it possible for humans to sustainably draw on the resources provided by a globally average ecological footprint, rather than take abysmal global inequalities for granted. For most Europeans and North Americans, this clearly means degrowth.

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About the Author

Alf Hornborg is an anthropologist and Professor of Human Ecology at Lund University. His research focuses on theorizing the cultural and political dimensions of human-environmental relations in different societies in space and time. His books include *The Power of the Machine*; *Global Ecology and Unequal Exchange*; *Global Magic*; and *Nature, Society, and Justice in the Anthropocene*. He has also co-edited several collections at the intersection of anthropology, environmental history, political ecology, and ecological economics, including *Rethinking Environmental History*, *The World System and the Earth System*, and *Ecology and Power*. He holds a PhD in cultural anthropology from the University of Uppsala.

Our Robots or Theirs?

Deborah G. Johnson

Thinking about technology and the future is like thinking about an ocean liner moving in the sea and wanting to know its current destination or, more importantly, wanting to change its current course. The ship (the world we live in) is underway; no one can know with complete certainty where it will arrive, at least not in a long-term timeframe. That depends on so many and complicated factors, including the weather and conditions in the sea (nature, the earth), as well as decisions made by the captain, orders given to the captain by the ship owners based on their motivations and calculations, the mechanics of the ship, and the behavior of the crew, just to name a few. Although pretty good predictions can be made about the destinations the ship will reach in the short term, predictions farther into the future are fraught. Changing the direction of the ship is a daunting challenge requiring coordination and alignment of the many, many forces that keep the ship moving on its current course.

Many believe that technology is the major force directing us to the future. As many would have it, so-called "emerging" technologies will get us to a better place. For example, Bill Gates seems to believe, and invests in his belief, that new technologies will avert climate disaster.[1]

The problem is that technology is not an exogenous force: it does not follow its own course of development independent of other forces. Technology—technological artifacts and systems—is inextricably intertwined with the human social world in which it is embedded. The technologies we have now, and those that are on the horizon, did not come out of nowhere; they are products of social, economic, political, and historical forces, forces that continue to keep those technologies in place. Technology is not, at least not in any simple way, the steering wheel of the ship. Yes, new technologies have the potential to tweak the direction of the ship, but they also have the potential and the momentum to resist change and keep things the same. That is

because technology isn't just artifacts and material entities. The ship has material parts, but it is also people believing and behaving in a wide variety of ways. Think here of our energy systems and the institutions and cultural beliefs that keep us dependent on fossil fuels.

Technologies are sociotechnical; they are assemblages of artifacts together with human behavior, social institutions, social practices, and social meanings. Let's take one of the seemingly more fanciful predictions about technology and the future: intelligent humanoid robots. Technologists are hard at work developing robots that look and act like humans. R&D efforts seek to develop materials that are humanlike in appearance, sound, and touch; AI is being developed to make such robots highly socially interactive. The ship seems to be moving to a destination point in which it may be difficult for humans to tell when they are interacting with another human being and when a machine. Indeed, some predict that humanoid robots with general intelligence and autonomy will in the future become so human-like that we will have to grant them some form of moral status or legal rights.[2]

Is a world in which we can't, and perhaps don't even want to, distinguish robots from humans inevitable? Will it be a better place? The inevitability question is wholly misleading. To get from here to there—as with a ship—is not a matter of sitting back and just letting "nature takes its course." A good deal of social and technological effort is necessary to keep the ship going; R&D efforts

are what is bringing us humanoid social robots. Instead of thinking about the inevitability of such robots, we should be asking why the ship is headed in that direction. The answer is, of course, that there are a wide range of economic and market forces interested in this technology as well as an abundance of engineers and computer scientists who like this kind of challenge and hope to build their careers on achievements in this area. The point is that technology does not come out of nowhere. It is a human creation, a human product with meaning for humans. Even if humanoid robots continue to develop, what they will mean to us, how we will use them, whether we will recognize them as having moral status or not are all matters to be decided by humans. The big question is who is deciding and what are their interests.

To be sure, our relationship with computer technology is especially complicated because it is such a malleable technology. The malleability of computers and information technology has

led to its infiltration into nearly every domain of human life. Robots and AI are just one of the latest manifestations of human choices made about how to deploy the capabilities of computer technology. Some claim that current AI constitutes a special or even unique step in the expanding development of computer technology because AI constitutes systems that operate autonomously and learn as they go. The learning capacity means both that some AIs can make decisions that humans could not make (think here of AI systems detecting tumors that are not visible to the human eye) and that humans cannot always understand how an AI arrives at its decision (think here of an AI that detects fraud in millions of credit card transactions). While some argue that humans cannot be responsible for AI algorithmic decisions because humans don't and can't know how some AIs make decisions, the fact that humans cannot fully understand how AI algorithms operate means that mechanisms should be put in place to ensure that AI systems are not out of human control. Among other things, this means holding humans accountable for the behavior of AI systems.

Returning to the ship, the task of changing its course is daunting. Technology will play a role in where the ship goes, but if technology is developed in the same institutions that have produced it in the past, we have to be skeptical about the extent to which it can redirect the course of the ship. We have a chicken-egg problem here. We are not likely to change the course of the ship by the introduction of some disruptive technology unless the human institutions and motivations with which that technology is intertwined also change.

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Marx Was Right about Tech

Bonn Juego

Mainstream interpretations of the interplay between technology and society have revolved around three theoretical frameworks: technological determinism, social constructionism, and neoliberalism. Technological determinists center technology as the driving force of history. Social constructionists regard society as the shaper of technology's advance. Neoliberals prioritize multinational corporations and finance capital as the main drivers of technical innovation. All three agree on the progressive potentials of technology for social and economic development. However, each suffers from fundamental blind spots regarding the regressive logic of capitalist market competition, which constrains the possibility for technology-society synergy in service of human solidarity and a sustainable civilization.

An alternative perspective for a Great Transition should move beyond the stale debates on technology vs. society and state vs. market in innovation studies. Technology, society, state, and market are best understood as co-evolving and interrelated. In theory, the technologically feasible is greater than the socially necessary; in practice, society can direct the purpose and progression of technology. For example, the case for selective automation suggests that even if certain goods and services can be automated, there are techniques that should remain artisanal and traditional manual skills that are better conserved for meaningful reasons of the arts and cultural heritage. In critical political economy, the ideological opposition to market dominance over society is already exhaustive. In heterodox economics, the myth of market fundamentalism has been debunked with solid empirical research showing a positive-sum game of governments as proactive innovators and co-creators of innovative technologies with the private sector.[1]

What needs further critique, and should be altered, is the prevailing market-dependent, socially-disembedded, and anti-worker processes of technological innovation under capitalism.

Political Economy of Market Dependence

Global responses today to the twin crises of climate change and the COVID-19 pandemic, which threaten the survival of humanity and the natural life support system, signify how and why capitalist rationality for profits fail to maximize the liberating and democratizing potential of science and technology for universal benefit. This is despite the common sense that addressing these pressing development problems demands cooperation rather than competition. The science behind the technology (to produce green production systems and effective vaccines) may be considered neutral, but it is the overarching capitalistic economic structure that defines its potentialities and propensities. The supposed wonders of the current Information and Communications Technology (ICT) techno-economic paradigm, which began with the invention of the Intel microchip in the 1970s, have not been so wondrous at all especially if equitable distribution of the fruits of productivity explosion were the basis of developmental success. The Millennium and Sustainable Development Goals are clear articulations of persistent privation and intractable inequalities. The so-called digital divide is a manifestation of the combined yet uneven character of technology diffusion.

Importantly, technology policy also takes shape differently in particular political regimes and institutions. Recall that industrialization and mass production have taken different forms under Hitler's fascism, Soviet socialism, Chinese-type communism, US-style liberalism, and the Nordic model of social democracy. The politics of Big Data—their extraction, processing and management—is known by now to serve specific purposes for government agencies, social media companies, consulting firms, and other interest groups.

Under conditions of the capitalist system, there are tensions between forces and relations of production. The classic readings of both Marx and Schumpeter on the operations of capitalism argue that the causal force for social change is not technology per se, but the market imperatives of capitalist competition. Mature industrial capitalists do not lack knowledge of superior techniques or access to finance thanks to globalization and financialization. However, because technical change creates diversity in unit expenditure within economic sectors, capitalists calculate optimal trade-off

between operating costs and losses in capital value.[2] The business strategy of planned obsolescence manifests how the goal of profit maximization can delay the introduction of new, durable, and high-caliber technologies, to the detriment of our finite planet. The lack of profit opportunities in poorer countries is the major reason why they miss out on the investments in production technology needed for social progress and economic prosperity.[3]

Every techno-economic paradigm offers wide-ranging windows of opportunity for innovation to diversify productive capacity and unleash the benefits from the virtuous circles and multiplier effects of technology-based manufacturing activities.[4] However, the series and patterns of technological revolutions since the eighteenth century have not led to the reproduction of high-tech societies across the globe but of social antagonisms arising from class inequalities and insecurities. The real barrier to capitalist innovation is capital itself because the self-expansion of its own production is its primary limited purpose, extracting as much value as it can from the society of producers and the living world. This is recently exemplified by how rich countries and their pro-capital political forces have ignored legitimate moral appeals to waive or at least suspend patents of potent vaccines against the coronavirus disease to speed up the pandemic control. The Trade-Related Intellectual Property Rights (TRIPS) Agreement has proven once again to be a reflection of historical double standards and an instrument of the First World to maintain the unequal status quo.

The market dependence of innovation connotes that continuous development of technology depends on, and is mediated by, commercial relations and monetary exchange. Capitalism treats technology as the power of science commodified, whereas Marx postulates the general intellect about the social production process of technology as "products of human industry; natural material transformed into organs of the human will over nature…the power of knowledge, objectified."[5]

Workers

Theories on technological innovation usually account for the variables of technology, society, states, and market in their analyses but systematically neglect an indispensable set of actors: workers. Schumpeterian creative destruction, as well as some streams in orthodox and post-Keynesian economics, have theorized about how increased productivity resulting from the use of technology can lead to job losses and de-skilling. Oftentimes, discussions about novel technologies from artificial intelligence to digitalization and the platform economy assign the collective workers

as a mere reactive variable and factor of production in economic relations and the evolving development process. Indeed, understanding the evolution of technology in history and its role in past, present, and future society should never exclude the perspective, agency, and well-being of workers, without whom the socio-economic processes of production and innovation cannot be realized.

At this juncture, the long-term agenda of the international institutions of economic governance is to complement the existing world market of exchange of commodities and money with a genuinely globalized capitalist relations of production through the creation of fully proletarianized laborers.[6] Their global development project envisions the growth and accumulation of capital to result in greater division of labor and the application of technology. The dynamic of capitalist competition not only entails incessant technological revolution but also necessitates permanent proletarianization—in which flexible, mobile, fluid, and disposable workers are completely subsumed to capital. Therefore, the crux of the matter at the turning point of the ICT paradigm, the maturation of old machineries, and the installation of new technologies is not simply the economic impact of specific technology, but the consequences of contemporary global capitalism for society, particularly for the workers.

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Trapped in the Technosphere

Alexander Lautensach

A sound prognosis on the role of technology in the Anthropocene must take into account current conditions and trends, as well as associated costs and benefits. Population growth and resource depletion (including food and water) are bound to cause per capita resource allocation to shrink. An additional source of insecurity for many people is the widening economic inequity. The diverse manifestations of climate change and the associated population displacement contribute to sociopolitical insecurity and strife. Pollutants pose new threats to public health. Those phenomena define the context of the Anthropocene "polycrisis," in which technological development will take place during this century.

Most of the costs and benefits of new technologies are neither foreseeable nor economic. The more costly a technological innovation, the more decisive will be the role played by power interests behind the scenes. The merits and dangers of innovations are addressed by two famous questions: (1) "Who benefits?" (credited to Jürgen Habermas), addressing power issues and motives, and (2) "And then what?" (credited to Garrett Hardin), focusing on downstream implications and consequences.[1] Both questions focus on real costs and benefits in terms of all the types of capital at stake—economic, social, cultural, environmental—along with potential long-term implications.

Ultimately, it is of course the living biosphere that bears the costs in terms of materials and ecosystem services, and those costs are too often neglected. The technosphere humanity has created has never been self-sustaining and therefore relies on environmental support structures. It consumes energy and materials in order to replace natural systems with artificial ones, dependent on high-energy inputs and complex maintenance regimes.[2] That technological assault on the biosphere and its material boon have weakened our capacity to

pay attention to what matters. Even in cases where a new technology promises a way to mitigate the polycrisis (e.g., genetically modified crops), costs and benefits to the biosphere are typically ignored in favor of human interests—in stark contrast to the biosphere's fundamental significance as the support base for all development and for all life.

The fundamental problem with technological innovation, then, lies with its origin: the technosphere. It functions according to its own imperative to grow at any cost and to build technological artifacts that efficiently dominate human affairs and the biosphere, driving global ecological overshoot.[3] The consumptive demands of the technosphere, along with population growth, are primarily responsible for humanity's overshoot—the fact that we now consume about 170% of the resources that the biosphere can deliver at a sustainable maximum.[4] Overshoot imposes its own conditions; viewed globally, it is that addiction to "living beyond our means," along with its unequal distribution across humanity, that continues to aggravate the Anthropocene polycrisis.[5] The costs and benefits of new technologies merely superimpose themselves on that background.

The eventual consequences of ecological overshoot will include crises that manifest regionally as economic, environmental, and social collapse events. Any remaining chances at a Great Transition depend on timely preparations in terms of developing resilience, relinquishing counterproductive ideals, restoring values and traditions that used to support sustainability, and reconciling cultures with the physical limits of our planetary home.[6] However, the technosphere and its supporting ideologies are making that difficult. Precedents such as the Internet, plastics, and fossil fuel energy suggest that technological development, as much as it is a result of deliberate planning, does not follow sound considerations of benefits and harms or prudent preparations. Instead, it is pushed by estimates of short-term commercial potential, short-term costs, and ad hoc solutions to urgent needs. It cannot, therefore, be regarded as a reliable instrument for bringing about a Great Transition. Its contributions remain spurious and inadvertent, and dependent on population size.

The size of the global human population crucially determines how much political latitude will be available to governments in the future and to what degree new technologies, such as bioengineering, artificial intelligence, and the digital economy may at all contribute to a Great

Transition. From a biological perspective, the present global population represents an extreme anomaly.[4] Before the advent of the technosphere, and specifically of fossil fuels, the global population never exceeded one billion. Regional populations were naturally regulated by resource availability and infectious disease, as is still the case in some "underdeveloped" regions. With development aid being cut and with the technosphere exerting ever-increasing costs, it cannot be taken for granted that the population will increase much further or even remain at its current level. It seems equally likely that it is substantially reduced as a result of natural adjustments.[7] Extending on that uncertainty, three possible trajectories emerge, setting different parameters for technological innovation and its effects.

(A) The global population increases beyond 8 billion, as projected in UN models.[8] The large size of the population, and weakened economies, would prohibit distributing the benefits of new technologies equitably. Instead, technological development will continue to be driven by the interests of affluent countries and dominant industries. Costs and harms are likely to be pushed on the least empowered regions and countries, and on future generations. This trajectory is the domain of Fortress World scenarios. The benefits of future innovations in high-tech diagnostics and therapies will be distributed as unequally as today's vaccine technology. In the context of mounting emergencies, climate disasters, and exploding populations, emerging technologies are unlikely to contribute enough equitable benefits towards a Great Transition.[9] At the same time, global overshoot and its harmful effects will worsen. Their technological remediation will be spotty at best. The potential for political conflicts and alliances between competing "fortresses" will further diminish the likelihood of international cooperation and global solutions. More likely is an eventual collapse of major proportions, leading towards trajectory B or C.

(B) The global population shrinks to 2 billion or fewer, a medium estimate of a sustainable population with equitable welfare and the standard of living of a moderately developed country.[11] This could pave the way for a Great Transition. The costs for equitably extending new technologies to all in that population will be relatively moderate and can be shared. The population decrease, by whatever means it came about, will have afforded opportunities for a great relinquishment of counterproductive ideals, beliefs, values, and attitudes that previously impeded the Transition. Instead, ideals of sufficiency, frugality, and adaptation inspire new sustainable lifestyles and the

equitable use of beneficial technologies.[12] Possible negative impacts and side effects remain below critical levels, and eventually even our overshoot can be deliberately reversed.

The smaller population will also allow for a more equitable sharing of specific technological benefits. Bioengineering at the ecosystem level has the potential to help us re-establish a sustainable balance between lands that are utilized to meet human needs and lands that are left as "wild" as possible. Artificial environments for controlled photosynthesis could enhance the spectrum of sustainable energy industries and revolutionize urban communities. Further developments in artificial intelligence could help with logistics, planning, and design. The digital economy might provide a stepping stone on the way towards a post-capitalist and post-growth economic order—a necessary condition for escaping overshoot.

(C) The global population fluctuates around present-day levels. This trajectory is the realm of Conventional Worlds, where business as usual remains the norm for a time. The gradual worsening of the polycrisis according to dominant trends will cause a gradual decline of human security in most regions. Population growth is more or less balanced by pandemics, famines, environmental toxicity, warfare, and reduced fertility; hectic regional fiddling with acute crises may involve new technologies in diverse local contexts, but without global coordination or internationally organized regimes. This kind of trajectory is unsustainable in the long run.

Endnotes

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Pathways to Sustainability

Melissa Leach

This important discussion has already and rightly buried the illusion that technology will solve the great challenges of unsustainability and inequality. Technological fixes, so beloved of policy, business, and scientific actors, and enmeshed in so much contemporary public discourse, are undermined by the myth not just of technological determinism, but of solutionism itself (that environmental and social ills are problems to solve, rather than manifestations of deeply rooted socio-natural and political-economic structures and processes). Technological innovation is not scalar—as in narratives of "more," "bigger," "better," or indeed linear progress—but, always and everywhere, directional.

The latter view underlies the conceptual framework that STEPS Centre colleagues and I first offered more than a decade ago.[1] Our "pathways approach" envisages complex, dynamic social-technological-ecological systems unfolding along trajectories of intervention and change, shaped by politics and power. Such systems (including but not only their technological elements) are subject to social construction, in the sense that different actors define, bound, and value systems and change in different ways. Thus, to take just one example, an agricultural seed system in highland Kenya might be understood and interpreted very differently from the perspectives of small-scale farmers and their livelihoods (and differently depending on whether women or men), Kenyan national food security planners, biotechnology firms, commercial crop exporters, or others. GMOs might (or might not) have a valued place in any of these constructed systems, but will carry very different meanings and implications depending on the system in which they are embedded.

Thus for any given issue, a simple heuristic would lead us to ask about four Ds:[2]

- What *Directions* are different pathways headed in? What goals, values, interests, and power relations are driving particular pathways, and how might they be re-oriented?

- Is there a sufficient *Diversity* of pathways? Are these diverse enough to resist powerful processes of lock-in, build resilience in the face of uncertainty, and respond to a variety of contexts and values?

- What are the implications for *Distribution*? Who stands to gain or lose from current or proposed pathways, or alternatives? How will choosing between different pathways affect inequities of wealth, power, resource use, and opportunity—whether across gender, ethnicity, class, or place?

- What are the implications for *Democracy*—broadly understood to encompass equity of opportunity for voice and inclusion, and processes that enable and enhance this, whether formal or informal?

Considering manifest or potential innovations and applications of digital, energy, carbon, or AI technologies in this way helps highlight opportunities and threats, ways in which technologies could be part of a great transition—but could also block, deflect, or destroy. Thus, digital phones and drones could, possibly, become part of pathways in which precision-farming complements agro-ecology for farmers in the Global North and South, supporting creative responses and future livelihoods amidst climate disruptions. But they are also embroiled in concentrations of power in capitalist agribusiness and—frighteningly—in surveillance and security applications that run shockingly against great transition values. Geoengineering technologies include, at one end of a spectrum, carbon capture through biochar applications that mimic, build on, and support Amazonian and African farmers' indigenous soil improvement techniques. But the spectrum is dominated by hubristic attempts to engineer planetary systems through techniques such as solar radiation management, whose dangers, ungovernability, and distraction from fossil fuel reduction give them no place in pathways to sustainability and social justice.

In understanding how different pathways (and the technological elements within them) come to emerge and interrelate, power becomes critical—in terms of both material political economy and

the politics of knowledge—concerning whose perspectives and interpretations come to count. Plurality emerges as a key principle, both in urging recognition that there are no singular roads to progress (and no single definition of the latter), and in operating as a countervailing force to locked-in powerful pathways that lead in problematic directions, or seek forms of control that, amidst the disruptions and uncertainties that pervade current and future worlds, are illusory and dangerous.

Put another way, and to extend the pathways metaphor more optimistically, system transformation can happen through myriad footpaths and bush paths, some coalescing into highways that might over time divert problematic motorways, while others pursue their own contextual, convivial routes that respect the diversity of humanities and socio-natural relations. Technologies—old and new, current and future—always have been and always will be part of such pathways, but in interaction with social and political processes that can spiral in multiple directions. Appreciating this may help in the task of building and enacting a politics of technology that is both more respectful of distributed agency and deliberation, and better connected with the politics of transformation more broadly.

Endnotes

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About the Author

Melissa Leach is Director of the Institute of Development Studies (IDS) at the University of Sussex. She co-founded and co-directed the STEPS (Social, Technological and Environmental Pathways to Sustainability) Centre from 2006 to 2014. A social anthropologist, she has served as vice-chair of the Science Committee of Future Earth from 2012 to 2017, lead author of the World Social Science Report 2016 on Challenging Inequalities, and a member of the International Panel of Experts on Sustainable Food Systems (IPES-Food). She is now working on COVID-19 as co-lead of the Social Science in Humanitarian Action Platform and the Wellcome Trust-funded Pandemic Preparedness Project. She is a Fellow of the British Academy and in 2017 was awarded a CBE for Services to Social Science. She holds a PhD in social anthropology from the School of Oriental and African Studies at the University of London.

Putting Technology in Its Place

Helena Norberg-Hodge

For more than forty years, I have been studying the impact of globalization on different cultures and societies around the world, and in 1992, I co-founded the International Forum on Globalization, a network of forty writers, journalists, academics, and social and environmental leaders from around the world. As we studied "free-trade" treaties, the principal drivers of globalization, a clear pattern emerged: as people are pushed into deepening dependence on large-scale technological systems, ecological and social crises escalate. In countries as disparate as Sweden and India, we saw how globalization intensifies competition for jobs and resources, leading to dramatic social breakdown—including not only ethnic and religious conflict, but also depression, alcoholism, and suicide.

The link between globalization and technological expansion began well before the computer era. Large-scale technological apparatuses can be understood as the arms and legs of centralized profit-making. And while 5G networks, satellites, mass data-harvesting, artificial intelligence, and virtual reality will allow the colonization of still more physical, economic, and mental space by multinational corporations, technologies like fossil fuels, global trading infrastructures, and television have already helped to impose a corporate-run consumer-based economy on almost every corner of the globe.

For reasons that are increasingly evident, an acceleration of this process is the last thing we need in a time of serious social and environmental crises. What's more, the technologies themselves—from the sensors to the satellites—all rely heavily on scarce resources, not least rare earth minerals, the extraction of which in turn rests on massive exploitation of labor and environmental plunder. Some of the world's richest corporations are now racing each other to extract these minerals from the deepest seabed and from the surface of Mars. It has been

estimated that the Internet alone—with its largely invisible data warehouses—will use up a fifth of global electricity consumption by 2025.

And for what? So that we can all spend more time immersed in and addicted to virtual worlds, already exacerbating alienation, loneliness, and depression? So that we can automate agriculture to enable corporations to tighten their grip on the food system, and drive more communities off the land into swelling urban slums? So that drones can deliver our online purchases without an iota of face-to-face contact, shoveling even more of the world's wealth into the gaping maw of Big Retail, worsening inequality in turn?

When thinking about technology from within an already high-tech, urban context, we can easily forget that nearly half the global population still lives in villages, still connected to the land. This is not to say that their way of life is not under threat—far from it. I had my eyes opened to this when I was exposed to the ancient culture of Ladakh, or Little Tibet, which was unconnected to the outside world by even a road until the 1960s. But today you can find smartphones, cars, mountains of plastic waste, traffic jams, and more in the capital, Leh. Most Ladakhi children have been pulled out of their villages into Western-style schools where they learn none of the place-based skills that supported Ladakh's culture for centuries and are instead trained into the technological-modernist paradigm. As such, the traditional way of life is in danger of extinction.

While that process began less than a generation ago in Ladakh, in the West it has been going on far longer, with deeper impacts. But even here, more and more people are becoming aware that the technologization of their personal lives has led to increasing stress, isolation, and mental health struggles. During the pandemic, people have been forced to do more online than ever before—from classes to conversations with friends and family—and most have discovered how limited and empty online life can be. There is a clear cultural turning, visible now even in the mainstream, that goes beyond a desire to spend less time on screens. People are also rejecting the posturing of consumer culture and its work-and-spend treadmill, and wanting instead to slow down, to cultivate deeper relationships and to engage in more community-oriented and nature-based activities.

Small but ever-increasing numbers of young people all over the world are choosing to leave their

screen-based jobs to become farmers. (This return to the land is happening in Ladakh, as well.) Informal networks of mutual aid are arising. Friends are gardening, cooking, and baking bread together; families are choosing to live on the land and developing relationships with the animals and plants around them. We are seeing increasing respect for indigenous wisdom and for women and for the feminine, and a growing appreciation for wild nature and for all things vernacular, handmade, artisanal, and local. There is also an emergence of alternative, ecological practices in every discipline: from natural medicine to natural building, from eco-psychology to ecological agriculture. Although these disciplines have often been the target of corporate co-optation and greenwashing, they have invariably emerged from bottom-up efforts to restore a healthier relationship with the Earth.

All of these are positive, meaningful trends that have been largely ignored by the media, and given no support by policymakers. They are particularly inspiring when you realize that they are running uphill in a system that is favoring corporate-led technological development at every turn. They testify to enduring goodwill, to a deep human desire for connection.

When viewed from a big-picture perspective, the expansion of digital technologies—which are inherently centraliz*ed* and centraliz*ing*—runs contrary to the emergence of a more humane, sustainable, and genuinely *connected* future. Why should we accept an energy- and mineral-intensive technological infrastructure that is fundamentally about speeding life up, increasing our screen-time, automating our jobs, and tightening the grip of the 1%?

For a better future, we ultimately need to put technology back into its place, and favor democratically determined, diverse forms of development that are shaped by human and ecological priorities—not by the gimmicky fetishes of a handful of billionaires.

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Helena Norberg-Hodge is the founder and director of Local Futures and The International Alliance for Localisation, and a founding member of the International Commission on the Future of Food and Agriculture, the International Forum on Globalization, and the Global Ecovillage Network. She is a pioneer of the new economy movement and recipient of the Alternative Nobel prize, the Arthur Morgan Award, and the Goi Peace Prize for contributing to "the revitalization of cultural and biological diversity, and the strengthening of local communities and economies worldwide." She is author of *Ancient Futures* and *Local is Our Future*. She is co-author of *Bringing the Food Economy Home* and *From the Ground Up*, and producer of the award-winning documentary *The Economics of Happiness*.

Guidelines for Technology

David W. Orr

Our money says "In God we Trust," but our behavior says in a pinch we would bet it all on technology. Trusted or not, God is a mystery. So, too, is the science of quantum mechanics that underlies our smartphones, Internet, and supercomputers. "Not a human soul, alive or dead, actually gets it," said Chilean writer Benjamín Labatut, "the mind cannot come to grips with its paradoxes and contradictions."[1] We are "like apes, toying and playing with it, but with no true understanding." A pin stuck in the balloon of pretensions. In a universe which is 95% dark stuff about which we know virtually nothing except that our theories say it must be there—whatever it is. So, let's talk about technology.

Even though much of it is beyond our comprehension, our hope is in better gadgets not better systems design or improvement of the "still unlovely human mind." From the Titanic to Fukushima, however, hype exceeds the reality. Skeptics about technology, however, are frequently dismissed as "Luddites" by people ignorant of the history and issues of early industrial development in Britain. It is a knee-jerk reaction that we recognize in other circumstances as fundamentalism—the hermetically sealed assurance of infallibility no matter what the evidence. We need guidelines about technology.[2] Here is my first cut:

1. The use of prosthetic devices like tools, hoes, hatchets, shovels, and hammers to solve problems is not a solely human behavior. Some animals do so as well.

2. Every tool and technological device is embedded in a system of political economy, ecology, culture, and morality.

3. The benefits of technology come first, costs later—a pattern otherwise known as addiction.

4. The effects of any device, anticipated or not, ripple throughout the larger system with unpredictable consequences.

5. Sometimes these are counterintuitive, opposite to what we might logically expect, which is to say they "bite back."

6. Technology is, then, an arena of irony and paradox.

7. The invention of the process of invention in the nineteenth century made technological innovation a positive feedback system, and the rate of change is accelerating.

8. Technology-driven improvements often run counter to smarter systems design, which is generally cheaper, faster, and less destructive.

9. Technological development without prior public assessment is anti-democratic.

10. Is technology a blessing or a curse? In 1972, when asked what he thought of the French Revolution of the 1790s, Chinese Premier Zhou Enlai famously replied, "It's too early to say." Ah, so.

Endnotes

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About the Author

David W. Orr is Paul Sears Distinguished Professor of Environmental Studies and Politics Emeritus and former Counselor to the President at Oberlin College and presently a Professor of Practice at Arizona State University. He is a founding editor of the journal Solutions and founder of the State of American Democracy Project. Orr is the author of eight books, including *Dangerous Years: Climate Change, the Long Emergency and the Way Forward* and *Down to the Wire: Confronting Climate Collapse*, and co-editor of three others. He holds a PhD in international relations from the University of Pennsylvania.

Big Tech Meets Big Finance

Guy Standing

Technological change is continuous. What makes a period a "technological revolution" is when a major change or set of changes helps to transform the mode of production, the social relations of production, and the class structure outside as well as inside the industry in which it occurs. That is what is happening now.

Klaus Schwab, founder of the World Economic Forum and the Davos spectacle, has dubbed what the world is experiencing the "fourth industrial revolution." But this is at least the sixth. The first was in the thirteenth century, with the invention of the water mill, which cemented feudalism and fostered a village-based economy, with a feudal class structure and a localized time regime. The second was in the 1770s, with Richard Arkwright's water-powered factories, producing
mill towns and canals linking up towns and spreading time zones. The third was in the 1820s, ushering in the age of rail, steam, and coal.

The fourth was in the 1870s, known as the engineering age, based on Andrew Carnegie's use of the Bessemer process, leading to mass production of steel, revolutionizing transport and building. The fifth began in 1908, with Henry Ford's assembly lines, linked to Frederick Taylor's "scientific management," leading to mass proletarianization and the separation of the "conception" and "execution" of labor.

The sixth revolution began in the 1970s, dubbed the "Internet age" or "digitalization age." With military origins, it became transformational with Tim Berners-Lee's World Wide Web in 1990. It coincided with the rise of the newly hegemonic paradigm of "neo-liberalism" or "the Chicago school of law and economics," based on the Mont Pelerin Society and etched into the political landscape by Ronald Reagan and Margaret Thatcher.

The key was financial liberalization. As Karl Polanyi understood, financial capital takes hold in the early phase of a transformation, when the economy is out of control by society. It soon generates such inequalities and insecurities that there is a threat of the annihilation of civilization. But in this era, its tentacles coincided not just with technological breakthroughs but with expansion of US capital, led by Big Pharma, Big Tech, and Big Finance.

Full transition to rentier capitalism came in 1994, with the passage of TRIPS (Trade-Related Aspects of Intellectual Property) by what became the World Trade Organization (WTO). This globalized the US intellectual property rights (IP) system. Henceforth, in an unprecedented way, every technical change produced huge rental income, giving their owners monopoly income for twenty years or more and the power of hoovering patents and other forms of IP, fostering conglomeration, higher price mark-ups over production costs, plutocratic corporations, and a plutocracy manipulating politics, the media, our education, and our consciousness. By 2020, over 15 million patents were in force, and over 3 million are filed each year.

As with previous technological revolutions, a new class structure has emerged, with a new mass class, the precariat, facing patterns of exploitation and oppression unlike the old proletariat or earlier mass classes, the remnants of which persist. The insecurities, interests, and aspirations of the vanguard of this class differ profoundly from those of the proletariat when it was confronting Fordism and Taylorism.

Meanwhile, globalized finance is aiding global corporate capital, led by virulent forms of finance, notably private equity, the business model of which is maximization of short-term profits via asset stripping, resource depletion, and disregard for the commons. There is no hope of reversing global warming and the rush to extinction as long as finance is in charge.

For years, the world's governments and financial bodies have been dominated by Goldman Sachs alumni. Now, the most powerful is BlackRock, ex-executives of which occupy three of the top four economic posts in the Biden administration. Through its algorithm Aladdin, it manipulates the world's stock markets.

Financialization is destabilizing, as is globalized information technology. Connectivity is linked to defining features of our age—chronic uncertainty and pandemics. Nassim Taleb conceptualized

the idea of "black swans"—rare, unpredicted events with devastating consequences. But we have moved into an era of predictable unpredictability. COVID-19 is the seventh pandemic of this century, and the gap between them is shrinking. Financial crises abound as well. Technologies are more disruptive. As such, we are living with chronic uncertainty, eroding individual, societal, and global resilience. We must combat that by building a system of ex ante social protection.

The Tech-Pharma-Finance complex has made this technological revolution unique in terms of its global reach, speed, and monopolization. Although Pharma was the architect of the IP system, and has thrived in the pandemic, Big Tech provides most "innovations" that can be turned into intellectual property as rent-seeking devices. Neither could have gained their absurd opulence without Big Finance.

Aided by it, Big Tech does not compete in product markets; it simply buys hundreds of firms as commodities. Until the 1990s, the number and value of acquisitions were miniscule, but by 2021 they amounted to over $5 trillion, up 44% from 2020 and 21% from 2015. Big Tech corporations swallow hundreds of start-ups, many of which are Unicorns funded by Venture Capital. Similarly, private equity snaps up thousands of corporations, loads them with debt, strips them of assets, and then declares bankruptcy or sells them at a nominal loss. Big Tech, Big Pharma, and Big Finance are a rent-extracting alliance.

For example, Pfizer did no research into a COVID-19 vaccine; it took no risks, meant to be the justification for patents. It initially turned down the offer of collaboration from Biotech, the Turkish-German inventor of the vaccine, but then did so, mobilizing finance to become the world's primary "owner" of COVID-19 vaccines, blocking others from using the technology they "own." The answer is not to push for a vaccine waiver in the WTO, as President Biden and others have proposed, knowing there is minimal chance of success. The answer is to dismantle the intellectual property rights system, which is what makes this technological revolution uniquely regressive and ecologically destructive.

It is also producing neo-mercantilism that is generating a militarization linked to proxy wars and regional tensions. Although the USA set up TRIPS for the advantage of US capital, at a time when China was excluded, China joined the WTO in 2001, and has rapidly become the leading country in

registering intellectual property. Now, the US and Chinese governments are pouring subsidies into their national champions and expanding their zones of interest. Managing the tensions will be the decade's biggest geopolitical challenge.

China is the world's leading rentier economy, generating a massive precariat and gross inequalities and insecurities. As in "the West," those will generate internal discord, which by themselves technological changes will exacerbate.

Today's is the most unfree market economy in history; aided by AI, the panopticon and banopticon governance system marches on. The only hope lies in dismantling rentier capitalism. The plutocracy and their politicians will not do that unless we threaten them with the proverbial pitchforks. The vanguard of the precariat may lead the way.

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The Dialectic of Tech and Society

Brian Tokar

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

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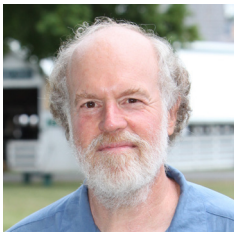
About the Author



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