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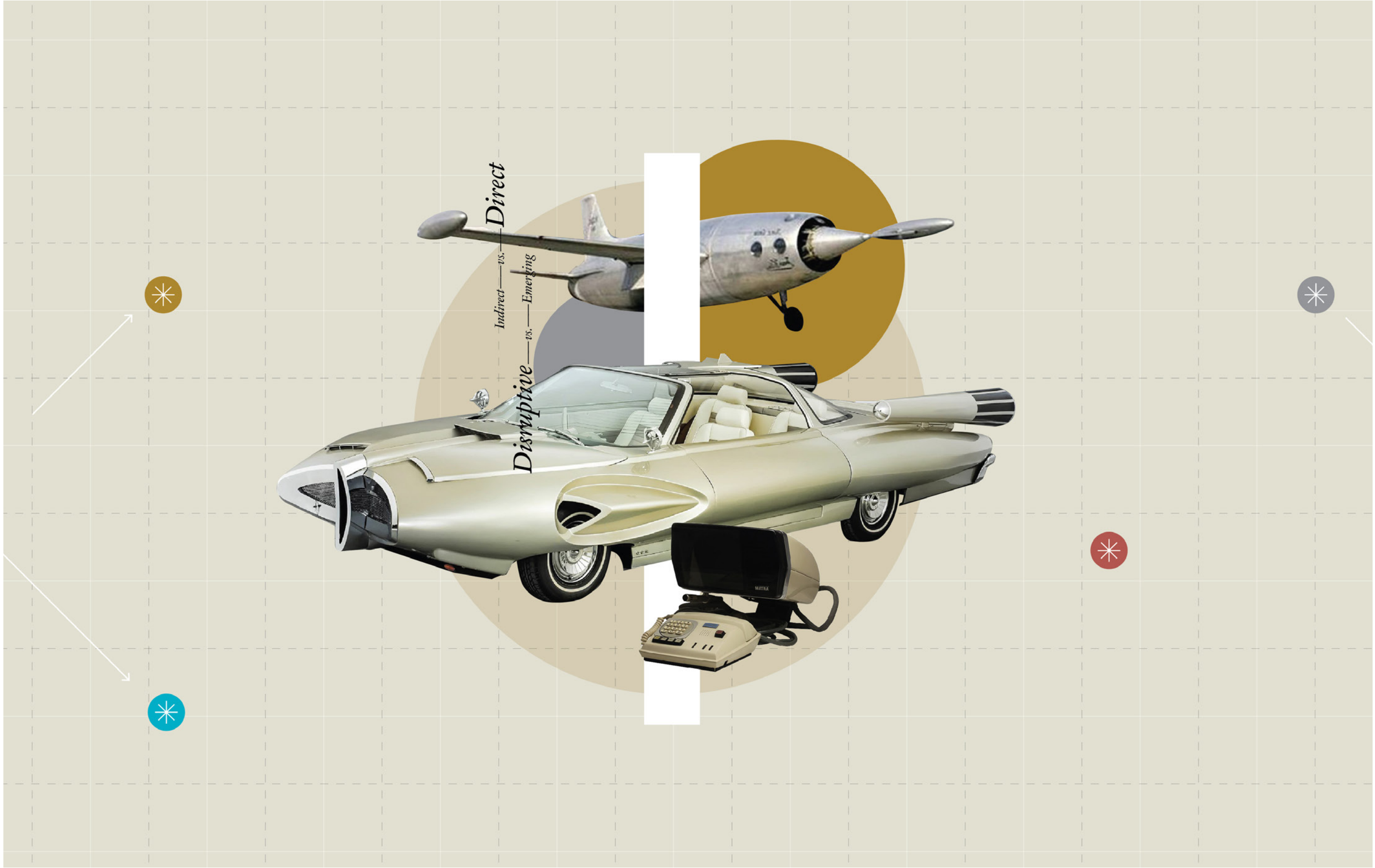

FEATURE

The real landscape of technology-enabled opportunity

New technology can change the world, but so can old technology. Wise investment decisions draw on a more complete view of how technology disrupts markets

Peter Evans-Greenwood

Lost in the technological forest

We live in a technological age, and a great deal of our competitive advantage comes from how adept we are at using technology. But in a society obsessed by the new, it's easy to forget that most of the technology we're working with, that we rely on, is quite old. The assumption is that new technology is the major force shaping marketplace disruption—a form of technological determinism.[1]

It's true that new technology has disrupted some firms—Blockbuster and the shift from DVDs to streaming, and Kodak and the shift from chemical to digital photography, are two famous examples. But that's not the whole story. We often fail to realize that the astute use of old technology can often be a larger source of competitive advantage than new technology.[2] Our fixation on the new means that we're missing many opportunities, possibly significant opportunities, to change the marketplace by new and different uses of the old.

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What we need is a map, a tool, to help us think about where we might find these hidden opportunities. We can draw such a map by considering two dimensions to the problem: how *novel* a technology is, and the *impact* that a solution based on that technology will have.

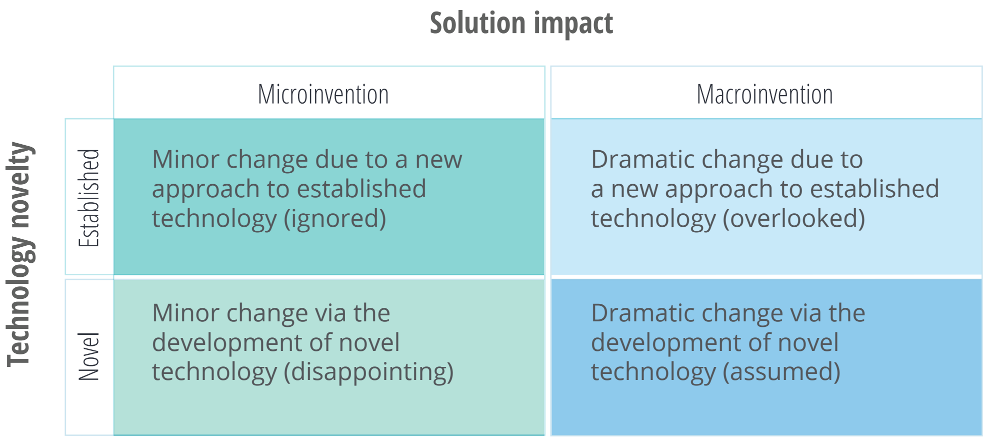
Let's handle novelty first. Some technologies, such as electric power distribution and nuclear fission, have few direct precursors. They don't emerge out of nowhere, but they do represent dramatic changes in technique. Other technologies, such as James Watt's celebrated steam engine, are the result of small tweaks to previous designs; they have obvious precursors upon which the latest version is built. We'll use the terms *novel* and *established* to distinguish between these two categories.[3]

Technologies, whether novel or established, are the building blocks for *solutions*: ways of using technology to yield a particular outcome. (For instance, nuclear fission is a technology, while nuclear power stations and nuclear-powered trains and [atomic] aircraft, are solutions.)[4] Different solutions have different impacts on society. Some, such as electric telegraph networks,[5] the networked home,[6] and the internal combustion engine (ICE) powered motor car, change the world in fundamental ways. We can refer to these high-impact solutions as *macroinventions*.[7] Other solutions, such as Francis Whishaw's 1838 invention of the hydraulic telegraph,[8] have smaller impacts. We can call these low-impact solutions *microinventions*.[9]

Combining the novelty and impact dimensions yields the four possibilities depicted in figure 1.

FIGURE 1

The (real) landscape of technology-enabled opportunity



		Solution impact	
		Microinvention	Macroinvention
Technology novelty	Established	Minor change due to a new approach to established technology (ignored)	Dramatic change due to a new approach to established technology (overlooked)
	Novel	Minor change via the development of novel technology (disappointing)	Dramatic change via the development of novel technology (assumed)

Source: Deloitte analysis.

The fundamental lesson this map teaches us is that *the novelty of a technology is unrelated to the impact of the solution*. Microinventions based on novel technology are possible, as are macroinventions based on established technology. The atomic (nuclear powered) aircraft was novel,[10] with few direct predecessors, but it is a mere footnote in history. On the other hand, Watt's incremental improvements to the steam engine turned it from a clever but an impractical idea[11] into one of the Industrial Revolution's most important drivers.

The fallacy that novelty implies impact—our tendency to focus near-exclusively on novel technologies as a driver of disruption—leads us to concentrate on the bottom-right quadrant of the map while ignoring the others.[12] This results in the common mistake of assuming that just because a technology is novel, it will result in a macroinvention when it is more likely to be a microinvention. One consequence is that we risk overinvesting in new technologies that have little chance of disrupting the marketplace, and so become disappointed when the solution doesn't meet our expectations.

This risk, of course, is well known. Advice abounds on how to distinguish "disruptive" new technologies from merely "emerging" ones.[13] The real shame—the potentially even more costly blind spot—is that our singular focus on the bottom-right quadrant causes us to miss opportunities outside it, when there may well be more opportunities outside it than inside.

How can these opportunities be brought to light?

Navigating our way to new opportunities

We can use our map of technology-enabled opportunity as a tool to improve our approach to innovation. Rather than looking only under the media streetlight of "disruptive innovation" (macroinvention via novel technologies), we can look elsewhere on the map to find innovations that would otherwise pass us by.

The flip side of our tendency to conflate novel technologies with high-impact solutions is the frequent assumption, when we see a high-impact solution, that it's based on novel technology. But just because a solution appears novel or high-impact doesn't mean that a novel technology was responsible. History is rife with examples of macroinventions based on established technologies. The development of modern public sanitation in the 1800s, for instance, relied on established technologies such as bridges, canals, and tunnels to execute an old idea (channeling waste away from populated areas), only on a much larger scale than in the past.[14]

In terms of our map, these types of opportunities are to be found in the upper-right quadrant. Organizations can do this in several ways.

Sometimes, a series of small developments can add up to a high-impact solution worth far more than the sum of its parts. One way to pursue macroinventions arising from established technologies is to *identify (and invest in) incremental advances that can complete a high-impact solution*. Mechanized weaving, for example, was the outgrowth of many separate advances, none of which were game-changing in themselves, that mechanized individual weaving tasks (the last was the flying shuttle, which simplified the task of passing thread across a loom through the weave). After all the tasks were mechanized, however, it became possible to automate the loom, replacing human power with mechanical power. This meant that weavers only needed to attend a loom when something went wrong or when it needed materials—providing an instant 2.5x productivity increase.[15]

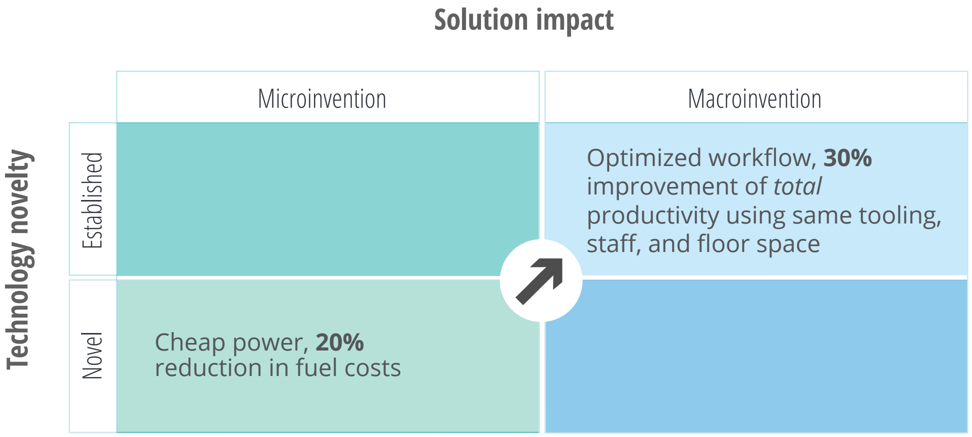
It's also important to *always be alert for opportunities to use established technologies in new ways*. An example is the emergence of "mass bespoke building" in the construction industry.[16] Mass bespoke building combines established building information management (BIM) technology, digital modeling and collaboration tools, virtual reality and drones, and the Design for Manufacture and Assembly (DfMA) modular construction process to the creation of bespoke, architect-designed buildings via digitally enhanced manufacturing techniques. Few, if any, of the technologies are new; what is new is the way they're being used.

Looking for indirect benefits is another powerful perspective that can reveal previously unseen opportunities. When we encounter a novel technology, we typically try to identify the type of problem it solves and then look for problems of that type—a focus on direct benefits. Given a hammer we go looking for nails. But we need to also consider how the new technology relates to our existing technologies, and how together they might enable us to approach old problems in new ways—indirect benefits. The question we should ask is not just what the technology can do, but also what it can enable *us* to do.

Indirect benefits can dwarf direct benefits. The electrification of factories is an excellent example. When electric power distribution was first developed, factory owners saw it as a cheaper and cleaner alternative to coal and steam. A factory that swapped its coal-powered steam engine for an electric engine, one connected to a local electricity utility, could realize a 20% saving in fuel costs.[17] This was a microinvention based on novel technology. Roughly 30 years later, however, manufacturing engineers realized that distributing electric power within a factory was much more flexible than distributing mechanical power.[18] Machines no longer needed to be organized according to how much power they consumed (how close to the central steam engine they needed to be). Floor space, workers, and machines were rearranged to optimize workflow rather than power distribution, yielding a 30% increase on *total productivity*. Though electric power distribution was hardly novel by that time, its use to pursue an indirect benefit created a new, high-impact solution—a macroinvention based on established technology.

FIGURE 2

Converting from steam and coal to electricity provided a direct benefit, while repurposing electricity distribution technology within the factory delivered a much larger indirect benefit



Source: Deloitte analysis.

Finally, when we encounter macroinventions based on established technologies, we should ask a crucial question: *What did change, if not the technology?* Understanding this can lead us to new opportunities by identifying what other solutions might benefit from these changes or, more proactively, investing in bringing about changes that could create the conditions needed for a macroinvention.

Many macroinventions using established technologies become so due to changes in the business and operational environment. Statistical machine translation is a case in point.[19] First conceived in 1949,[20] the technology behind machine translation was formalized in the 1980s and early 1990s by researchers at IBM's Thomas J. Watson Research Center before exploding into the public consciousness in 2006 with the release of Google Translate. The major development between the 1990s and 2006 was not in the core technology (though there had been ongoing technical improvements), but a significant increase in the number of digitized parallel texts available to use to train the translation algorithms and readily available cheap compute.[21] If we're to attribute the rapid rise of statistical translation to something, then it should be access to these parallel texts, coupled with an organization willing to sponsor its development, and not the development of new technology per se.

Toward a broader view of technology-enabled opportunity

New technologies *can* create new opportunities, but new technology is only one driver for marketplace and societal change. Our focus on novel technologies leads us to ignore the broader landscape of opportunity. Thinking in terms of micro- and macroinvention, and in terms of novel and established technologies, can help us explore more of this landscape.

Disruptive technologies—macroinventions driven by novel technologies—do exist. They are, however, the great white whale: valuable but rare. Other, less shiny opportunities should not be ignored in the hope that we're about to land the next whale.

Endnotes

1. The idea that “technology is the prime factor in shaping our lifestyles, values, institutions, and other elements of our society.” See Melvin Kranzberg, “Technology and history: ‘Kranzberg’s laws,” *Technology and Culture* 27, no. 3 (1986): pp. 544–60.
2. Such as how the horse and cart was more important in the Second World War than [newly developed] tanks. Tanks might have been a novel and potent weapon, but without supply chains which relied on horses they (and the entire effort at the front line) would have been for nought. See the chapter “War” on page 138 of David L. Edgerton, *The Shock of the Old: Technology and Global History since 1900* (London: Profile Books, 2007).
3. This is obviously an oversimplification. Novelty falls along a continuum from “few if any precursors” to “many precursors.” However, for purposes of mapping opportunities, dividing the continuum into a dichotomy provides a clearer view.
4. Enthusiasm for nuclear power in the 50s led to research into adapting nuclear power for land and air transport. See Sam Hewitt, “Remember the atomic locomotive idea?,” *Railway Magazine*, May 9, 2018; Karen A. Frenkel, “Resuscitating the atomic airplane: Flying on a wing and an isotope,” *Scientific American*, December 5, 2008.
5. The electric telegraph was first used for railroad traffic control then later, in 1848 with the foundation of the Associated Press in the United States and in 1849 in Paris with Reuters, for the transmission of news.
6. The introduction of water, sewer, and telephone as well as gas and electric networks into residential housing, and the development of public transport networks. Prior to the networked home 60% of the homemaker’s time was invested in carrying water and fuel into the home and waste out. See Robert J. Gordon, “The American home: From dark and isolated to bright and networked,” *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War* (Princeton: Princeton University Press, 2016).
7. Again, an oversimplification but again useful for our purposes.
8. Applying pressure to a transmitter connected to a water-filled pipe resulted in an indicator moving at a receiver located some distance away.
9. The terms “macroinvention” and “microinvention” were coined by Joel Mokyer. Initially they were used to refer to the “epistemic inventiveness” of an innovation, but they came to refer to inventions that “had a major impact on the economy.” We’re using the latter sense. See Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (New York: Oxford University Press, 1990). For a discussion on the evolution of micro- and macroinvention, see Anton Howes, “Macroinvention vs microinvention?,” *Medium*, February 21, 2017.
10. Using the heat from nuclear fission to directly heat air and so generate thrust, in contrast to jet- and propeller-driven aircraft. See Christian Ruhl, “Why there are no nuclear airplanes,” *Atlantic*, January 20, 2019.
11. Early steam engines, commonly known as atmospheric engines, were so inefficient that their only viable use was to pump water out of coal mines, at the point where the coal was being dug out of the ground.
12. One interpretation of Robert Gordon’s thesis in *The Rise and Fall of American Growth* is that the 100 years of exceptional productivity growth was due to a period of an unusually high proportion of macro- to microinvention. See Gordon, *The Rise and Fall of American Growth.*
13. Advice which is typically couched in terms of not investing too early, rather than recognizing that many of the technologies we consider “disruptive” are unlikely to ever result in macroinventions.
14. And likely had an equal, if not more, significant impact on public health than the invention of vaccines (a novel technology).

15. Weavers on the first power looms could produce 2.5 times as much coarse cloth per hour as a weaver on a handloom.
16. See Peter Evans-Greenwood, Robert Hillard, and Peter Williams, *Digitalizing the construction industry: A case study in complex disruption,* Deloitte Insights, July 2019.
17. See Warren D. Devine, "From shafts to wires: Historical perspective on electrification," *The Journal of Economic History* 43, no. 2 (2009): pp. 347–72.
18. Coupled with the fact that the electrical engines could deliver similar power and torque with a physically smaller engine than is the case with steam.
19. Taking it as read that machine translation is a macroinvention.
20. Warren Weaver, "Translation," *Machine Translation of Languages* (Cambridge: MIT Press, 1949).
21. Initially the Canadian Hansard (French and English), followed by the records of the European Union (in three procedural languages of French, English, and German and eventually all 24 working languages).

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