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Kranzberg's Third and Sixth Laws

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Kranzberg's Third Law

By Laura Ann Twagira

"Technology comes in packages, big and small"

In 1986 Melvin Kranzberg wrote: "If we look into the history of any mechanical device, we find that the basic invention required other innovative changes to make it fully effective and that the completed mechanism in turn necessitated changes in auxiliary and supporting technological systems, which, taken all together, brought many changes in economic and sociocultural patterns."[1] It was a statement of Kranzberg's Third Law: "Technology comes in packages, big and small." In a brief elaboration of the law, Kranzberg offers the example of radar and how as a technology it relies on multiple components (both big and small).[2] In the additional example of the assembly line Kranzberg referenced the idea of a technological system, especially as analyzed by Thomas Hughes.[3] Similarly, the tractor in figure 1 (see above) is comprised of multiple components and, as configured in this image, served to power other machines at a colonial agricultural project in French West Africa (the other unseen machine is a rice thresher). Here, elements both big and small worked together to produce threshed rice, seen in the large sacks piled behind the tractor. Importantly, in this example (and in the

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[1] Melvin Kranzberg, "Technology and History: 'Kranzberg's Laws,'" *Technology and Culture* 27, no. 3 (1986): 544–60, here 549.
[2] Ibid., 549.
[3] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983).

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case of the assembly line) the centrality of human labor and expertise is made visible. What might this driver have made of Kranzberg's Third Law in relation to his work and the tractor?

A few more thoughts on "systems" and "packages" offer some context for this question. Kranzberg suggested that technological systems were akin to his packages in that they were comprised of diverse components and processes, which together formed a kind of technological package. The system is a common metaphor in the history of technology, but Kranzberg's package merits greater critical reflection. In particular, the notion of a technological "package" takes on distinct meaning in the colonial context and pushes us to reflect on the implications of, in Kranzberg's words, "changes in economic and sociocultural patterns." Quite simply, technological packages like technological transformations are not neutral. Indeed, colonial technological packages were more than an assemblage of small and intricate components, devices, processes, and mechanisms. By the time Kranzberg articulated his laws, Daniel Headrick had demonstrated how Europeans in the nineteenth century relied on new technologies, such as steamships and quinine, to solidify their empires in Asia and Africa.[4] These new technologies were imbued with the trappings of imperialism. Similarly, European agents working for colonial agricultural projects, mining corporations, railroad companies, or health clinics in the twentieth century participated in the "transfer" of Western technology and know-how as a means of civilizing or developing their new colonies.[5] It was a technological practice rooted in the projection of political power. Implied in such transfers was an accompanying re-ordering of the economic and social realms. At the same time, colonial subjects often re-worked and re-imagined the meanings of colonial technologies.[6]

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[4] Daniel R. Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981).

[5] For a critical overview of the idea of "technological transfer," see Clapperton Chakanetsa Mavhunga, "Introduction" in *What Do Science, Technology, and Innovation Mean from Africa?* (Cambridge: MIT Press, 2017), 1–27, here 2–9.

[6] See for example Luise White, *Speaking with Vampires: Rumor and History in Colonial Africa* (Berkeley: University of California Press, 2000); Clapperton Chakanetsa Mavhunga, *Transient Workspaces: Technologies of Everyday Innovation in Zimbabwe* (Cambridge: MIT Press, 2014); Jennifer Hart, *Ghana on the Go: African Mobility in the Age of Motor Transportation* (Bloomington: Indiana University Press, 2016).

Figure 1. Unidentified tractor operator at the Office du Niger (French Soudan) n.d. (Source: reprinted with permission from the Archives Nationales de France d'Outre Mer [Aix-en-Provence].)

The irrigated agricultural scheme called the Office du Niger (Office) in French West Africa is an instructive example. It is a large irrigation project located along the Niger River. Created in the 1930s under French colonial rule, the Office was meant to modernize rural French West Africa. The French administration imported large-scale digging machines to carve out a vast irrigation network. It also conscripted workers to build a large dam across the Niger River in order to send water to new irrigated cotton and rice cash-crop fields. In the subsequent decades the project increasingly mechanized, reinforcing its association with technology and modernization. Some early French observers even referred to the project as a machine. Yet, building the Office and farming its lands required a great amount of manual labor. Like many other colonial modernization projects it was marked by disastrous failures (both in its simple failure to produce crops to sell, or the technological failures of the irrigation system). Colonial era criticisms of the scheme even voiced concerns about its potential for

dehumanization. One memorable critique along these lines referred to farmers at the project as having become like robots. They had simply become part of the machine.[7]

In short, this project easily could be framed as a large technological system. As a system the Office was also connected to larger systems of colonial exchange and political governance. In this framing, however, the role of African technological agents is quite conscripted. What then do we make of the tractor operator in this system (see figure 1)? The driver likely had a sophisticated understanding of the big and small components of the tractor in relation to other technology at the project, as well as his particular role in the new colonial economy, and the Office's role in colonial politics. In short he had a role through his technological work in shaping the Office and rural West Africa in the twentieth century. It also mattered that his work had strong masculine associations. Indeed, gender, work, and technology mattered a great deal at the Office.

Women who lived at the Office (and were often out of view of the planners) were essential to making the project a livable space. Specifically, women produced food for local consumption, and it was critical work at a project plagued by food shortages. To accomplish this task, women planted food crops along the edges of irrigated cash-crop fields and created market networks with neighboring women to exchange project cotton and rice for necessary foodstuffs. They even interacted with the big technologies of the project: women winnowed rice alongside threshing machines and drew water from the project canals for domestic use (circumventing their designation to only water cash-crop fields). Women also drew on small or modest household technologies such as pots, buckets, and calabashes (see figure 2). This interplay between big and small technologies was not readily apparent to the planners of the Office, but the women's technological work across these "systems" enabled them to turn the agricultural machine into a project that produced food for daily consumption (and not just crops for export).

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[7] Laura Ann Twagira, "'Robot Farmers' and Cosmopolitan Workers: Technological Masculinity and Agricultural Development in the French Soudan (Mali), 1945-1968," *Gender and History* 26, no. 3 (2014): 459–77, here 459–60. On the Office du Niger, see also Amidu Magasa, *Papa-Commandant a jeté un grand filet devant nous: les exploités des rives du Niger, 1902-1962* (Paris : François Maspero, 1978); Jean Filipovich, "Destined to Fail: Forced Settlement at the Office du Niger, 1926-1945," *Journal of African History* 42, no. 2 (2001): 239–60; Monica van Beusekom, *Negotiating Development: African Farmers and Colonial Experts at the Office du Niger, 1920-1960* (Portsmouth: Heinemann, 2002).

Figure. 2. Hawa Diarra and granddaughter in Nara with a metal pot dating to the colonial era of the Office. (Source: photo by author.)

In short, the Office as a technological system would not have worked without women and their specifically gendered work of preparing food.[8] The colonial Office as a machine was comprised of multiple technological components and gendered processes working together in a very particular historic context. And these systems (the women's food production system and the canals and machines of the colonial cash-crop project) overlapped and also interacted with political, social, and economic systems more widely. While the system metaphor sheds light on some of these processes and connections across technological, social, economic, and political realms, most analyses of the Office rarely integrate women's technological experiences.

[8] Laura Ann Twagira, "Women and Gender at the Office du Niger (Mali): Technology, Environment, and Food ca. 1900-1985," Ph.D. diss., Rutgers University, 2013.

Kranzberg's idea of a technological "package" is potentially helpful in analyzing the colonial and gendered contexts of technological processes (even if it was not Kranzberg's original intent). For example, the idea of a modernized industrial irrigation project is not just a "system" of production. It was created because French planners assumed that modernization and development under French rule involved a whole bundle of technologies, practices, and ideas rooted in French notions of civilization and progress. This is one package. It is illustrated by examining the history of one machine at the Office. In 1951 European staff at the Office nicknamed a rice threshing machine *La Bourguignonne*. The name associated the machine and more broadly technology at the scheme with France. Specifically, the name evoked the Burgundy region famous for its agricultural production (and not necessarily associated with modernity). The name also suggested a romanticized notion of French rural life and peasants transformed through modern French technology. This machine was meant to materialize this imagined identity or personality specifically associated with France. The playful nickname further suggested that French technological interventions at the scheme worked to transfer the hardiness and productivity of the Burgundy region to rural West Africa. Finally, *La Bourguignonne* symbolized the move beginning in the late 1940s to increase mechanization in the face of manual labor shortages.[9]

La Bourguignonne was an ill-fitting name in part because it failed to process the harvest. The machine did not mechanically reproduce the ideal bounty of France. Rather, male workers (all African) still processed much of the project's rice by hand. It was their labor by and large that produced the project's cotton and rice harvests. Yet, in the early 1950s *La Bourguignonne* made sense to the European staff as a name and as a symbol of French technological solutions for agriculture at the Office. Quite simply, the machine represented more than an effort to efficiently process rice paddy and modernize the harvest in West Africa. It symbolized a larger bundle of ideologies and ideas wrapped up in the transfer of colonial technology to the region.

Male workers at the project shaped other bundles of meaning at this scheme. They also identified particular machines (not to give them names) but as part of gaining

[9] Twagira, "'Robot Farmers' and Cosmopolitan Workers," 467.

masculine technological expertise. They knew the specific manufacturer names for tractors and diggers from England, France, Germany, the United States, and in later years from the Eastern Bloc. That knowledge was drawn together with a region-wide cultural understanding of work with metal as dangerous but also powerful and directly related to a respected male occupation and identity (the blacksmith).[10] The association of masculinity, modernity, and work was one African male workers shared with the male European staff. For African workers the scheme was about technology and making it work, but it was rooted in ideas about technological work that were not associated specifically with France. In fact, the African workers at the Office saw themselves as experts at evaluating its machines (not the European staff), and understood that through their work handling machines they knew where the best ones came from.[11] This is another package for understanding how technological and non-technological components of the Office functioned together.

Women also saw technologies working together and with distinct gendered meanings. For example, women's technologies, or the tools for women's housework were often drawn together as a bundle of women's things. In fact they even called these tools –such as pots, buckets, calabashes, the mortar and pestle, etc.—collectively "women's things." It was a gendered technological package, and its components were understood to work together for specifically gendered work.[12] The package metaphor in both latter cases lends itself to an analysis of specific gendered technological cultures and histories.

In looking back at this law, Kranzberg's thinking about packages offers a way to think creatively about the history of technology and in different ways that we have not done through the trope of a system. As a metaphor the system evokes movement, dynamism and sometimes breakdown. A package suggests other frameworks to think through the technological history of a colonial irrigation scheme. In its design the Office

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[10] On the cultural importance of blacksmiths in this region of West Africa, see Patrick R. McNaughton, *The Mande Blacksmiths: Knowledge, Power, and Art in West Africa* (Bloomington: Indiana University Press, 1988).
[11] Twagira, "'Robot Farmers' and Cosmopolitan Workers," 468–73.
[12] Laura Ann Twagira, "Machines that Cook, or Women that Cook? Lessons from Mali on Technology, Labor, and Women's Things," *Technology and Culture* (forthcoming).

was meant to be a technology transfer. Yet, the transfer of that colonial "package" of things could be unpacked and re-ordered in myriad ways. Indeed, looking at how the tractor driver at the Office might have conceived of his work as part of a new masculine mechanical world allows the historian to push back on the narrow framework of the Office as machine (or system). By also looking at women, who make sense of the Office from their own shifting technological world, the very nature of the Office is shifted. It is no longer a machine meant only to produce for export but one with components that are combined with women's things and re-designed for local consumption.

Finally, Kranzberg's attention to components both "big and small" encourages scholars to see modest tools like a cooking pot and analyze them alongside large-industrial scale machines. The cooking pot is one of those singular components without which cooking would not work, but also without which the Office, a large irrigated agricultural scheme, would not work either. Moreover, it draws attention to quotidian labor at the center of a mundane but essential technological process. Indeed, both men's and women's gendered labor is central to this story of technology in colonial West Africa. While Kranzberg is careful to draw the social world into the history of technology, the value of human expertise, labor, and *techne* is absent in his elaboration of what actually makes these technological packages take shape in practice. Putting African tractor drivers and cooks into the analysis of technological processes allows us to more fully appreciate the work of packages big and small.

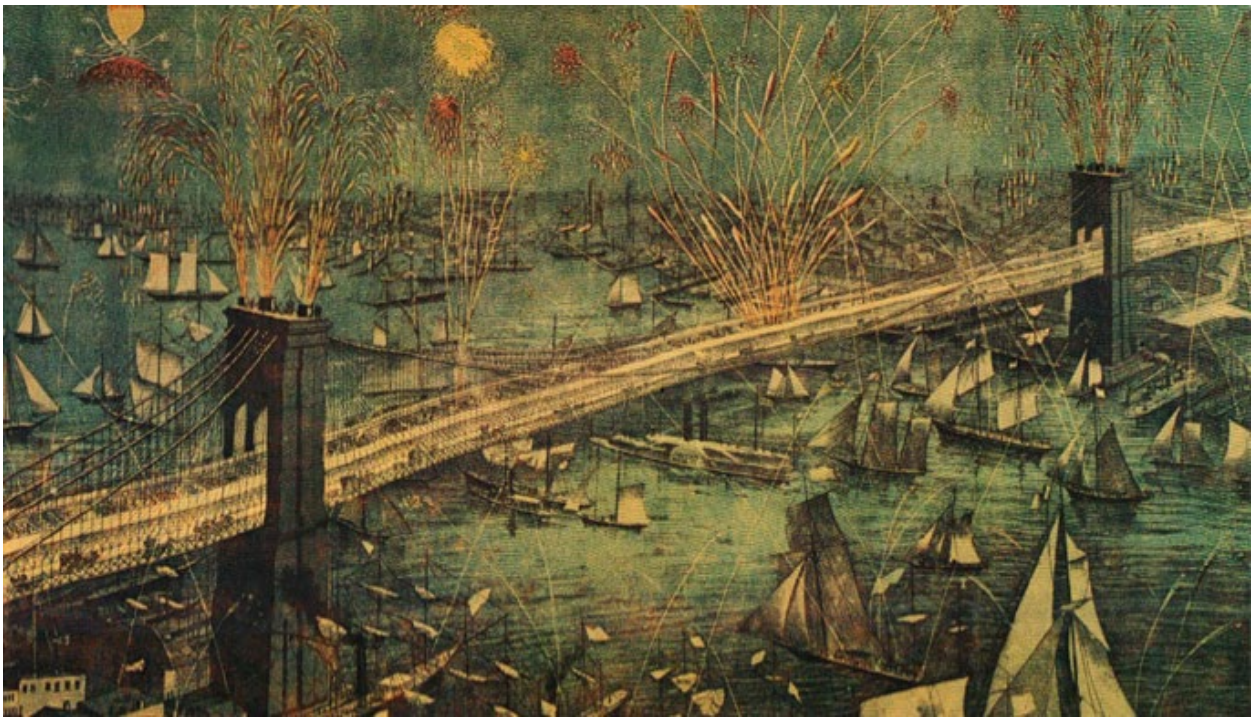
Kranzberg's Sixth Law

By Mara Mills

"Technology is a very human activity"

Thomas Winpenny, the historian of steel bridge construction whose 1988 article "Dare Anyone Add to Kranzberg?" indeed dared to more than double Kranzberg's list, elsewhere asked "what better example could anyone find of this great truth"—*Technology is a Very Human Activity*—than an "1800-foot cantilevered

bridge."[13] Kranzberg offered a similar illustration himself in the 1984 volume he co-edited to celebrate the centennial of the Brooklyn Bridge: a structure, he argued, that "represents and incorporates many of the sociocultural elements of the age that produced it." The building of the bridge entailed "more than machines, tools, processes, structures, and . . . material artifacts"; it "involve[d] institutions, value systems, and, especially, human beings."[14] Opened in 1883, it was the longest suspension bridge at the time and the first with steel wires. The Brooklyn Bridge did not just convey wheeled vehicles across the East River: it was heavily trafficked with handwritten messages, flying through a pneumatic mail tube, and electrified voices coursing through telephone cables; it became, straightaway, a meeting place of lovers and criminals, the muse of modernist painters and poets.



[13] Thomas Winpenny, "Dare Anyone Add to Kranzberg?" *STS Newsletter* (June 1988): 11–12; Thomas Winpenny, "Review: *The Bridge at Quebec* by William D. Middleton," *Technology and Culture* 43, no. 1 (2002): 173.
[14] Melvin Kranzberg, "Opening Remarks," in *Bridge to the Future: A Centennial Celebration of the Brooklyn Bridge*, edited by Margaret Latimer, Brooke Hindle, and Melvin Kranzberg (New York: New York Academy of Sciences, 1984), 1.

Figure 1. "Bird's-Eye View of the Great New York and Brooklyn Bridge and Grand Display of Fire Works on Opening Night," 1883. Brooklyn Museum Collection. (Source: public domain. www.brooklynmuseum.org/opencollection/objects/121732.)

More so than the other laws, six was Kranzberg's salvo against "technological determinism," the "intellectual cliché," as he put it, that "technology is the prime factor in shaping our life-styles, values, institutions, and other elements of our society." At worst, as he told a SHOT audience in Dearborn during his 1985 Presidential address, technological determinism implied that technology "has become autonomous and has outrun human control; in a startling reversal, the machines have become the masters of man."[15] The 1980s and 1990s witnessed extensive debate about the agency of technology and other elements in the physical world, with hardliners of social constructionism refusing to give technological determinists an inch, and compromises made in domains such as actor-network theory. Surveying the conceptual history of technological determinism in an article published last year in *Representations*, John Durham Peters enumerates what seem to have been the "sins" of this doctrine:

A sense of historical inevitability, pessimism or even fatalism; a denial of cultural contingency; the reification of technology into monolithic blocks; the overestimation of the power of engineers; an insistence on a single cause; the failure to appreciate the part played by people in the making of technical worlds.[16]

Peters notes that technological determinism is a pejorative phrase—it tends to be wielded as an accusation by one scholar of a "fallacy" (or unsound reasoning) on the part of another; yet he concludes with the provocative suggestion "that a fallacy might not necessarily be wrong."[17]

If fallacies can contain some truth, perhaps truisms, or "obvious truths"—another name Kranzberg gave his Laws—are not, in fact, always obvious. *Technology is a Very Human Activity* may still apply, though not universally or unquestionably. For one thing, non-human animals build bridges and use tools, too.

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[15] Melvin Kranzberg, "Presidential Address: Kranzberg's Laws," *Technology and Culture* 27, no. 3 (July 1986): 545.

[16] John Durham Peters, "'You Mean My Whole Fallacy is Wrong": On Technological Determinism," *Representations* 140, no. 1 (Fall 2017): 23.

[17] Ibid., 10.

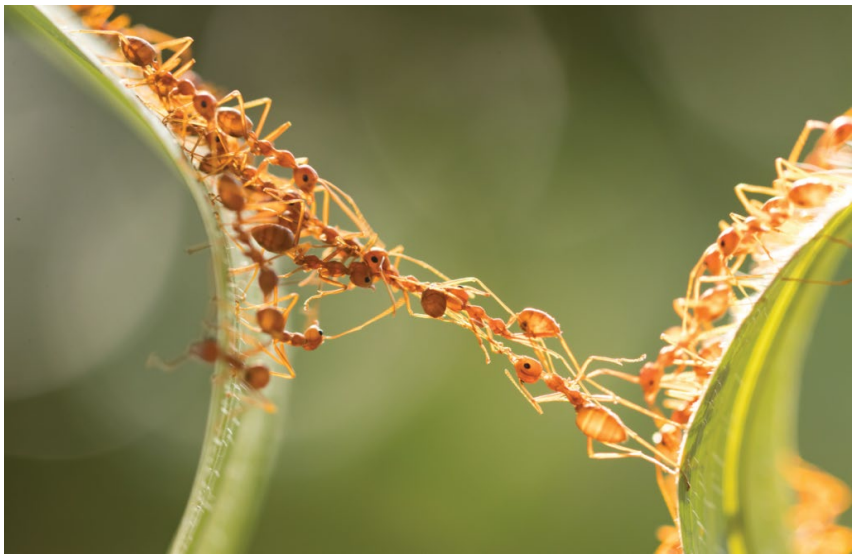

Figure 2. Army Ants Building a "Living Bridge." (Source: licensed from Adobe Stock.)

Moreover, the technoscape that informed truism six has changed, and the political force of its anti-technodeterminist stance is less self-evident in an era of AI and the Anthropocene, mobile phones and the digital humanities—to list a few keywords from the present—than it was in an anti-nuclear era marked by more certainty (arguably) about the effects and management of technology, greater technophobia in the arts and humanities, and an urgency regarding the democratization of high-tech. In his coda on the Brooklyn Bridge, for instance, Kranzberg at once rebuked "the anti-technological stance of . . . [many] humanists" and the state of living "in a world potentially on the brink of extinction through our technical capacities of mass destruction."[18] Kranzberg employed the phrases "social constructivism" and "social shaping" to describe his own approach, but it's worth noting that in his writing beyond the Sixth Law, he left open the possibility for the causal action of things themselves, especially in large-scale systems.[19]

In my brief reflection on this Law, I want to try thinking differently about the Brooklyn Bridge, running the history of technology and my own subfield of disability studies across it like parallel cables through which crosstalk might occur, to give two

[18] Melvin Kranzberg, "Confrontation or Complementarity? Perspectives on Technology and the Arts," in *Bridge to the Future: A Centennial Celebration of the Brooklyn Bridge*, edited by Margaret Latimer, Brooke Hindle, and Melvin Kranzberg (New York: New York Academy of Sciences, 1984), 343, 344.
[19] Kranzberg, "Presidential Address," 549.

other examples of the ways the terrain has shifted, such that topics of previous fervent debate are no longer central matters of concern.

First, across the humanities and social sciences, few authors use the phrase social constructionism, hard or soft, in their publications anymore, choosing instead to develop more specific models of technology use or political economic context—or to turn away from "the social" toward topics of materiality and embodiment. In disability studies, for instance, the long-dominant "social model of disability"—a constructivist thesis that takes disability to be the result not of medical factors but of societal ones such as workplace discrimination, stigma, and design exclusions—has been repeatedly challenged over the last ten years for its disregard or denial of bodily constraints. The building of the Brooklyn Bridge, to continue with this example, was famously beset with injury and death, as engineers and laborers were impaired by human-designed machines as well as the natural elements and sheer accident. John Roebling, who began designing the bridge in 1867, died of tetanus after his foot was crushed while scouting locations along the riverbank. His son Washington then developed decompression sickness, or "the bends" (with lifelong painful consequences) in 1870 while working underwater on one of the tower's foundations.

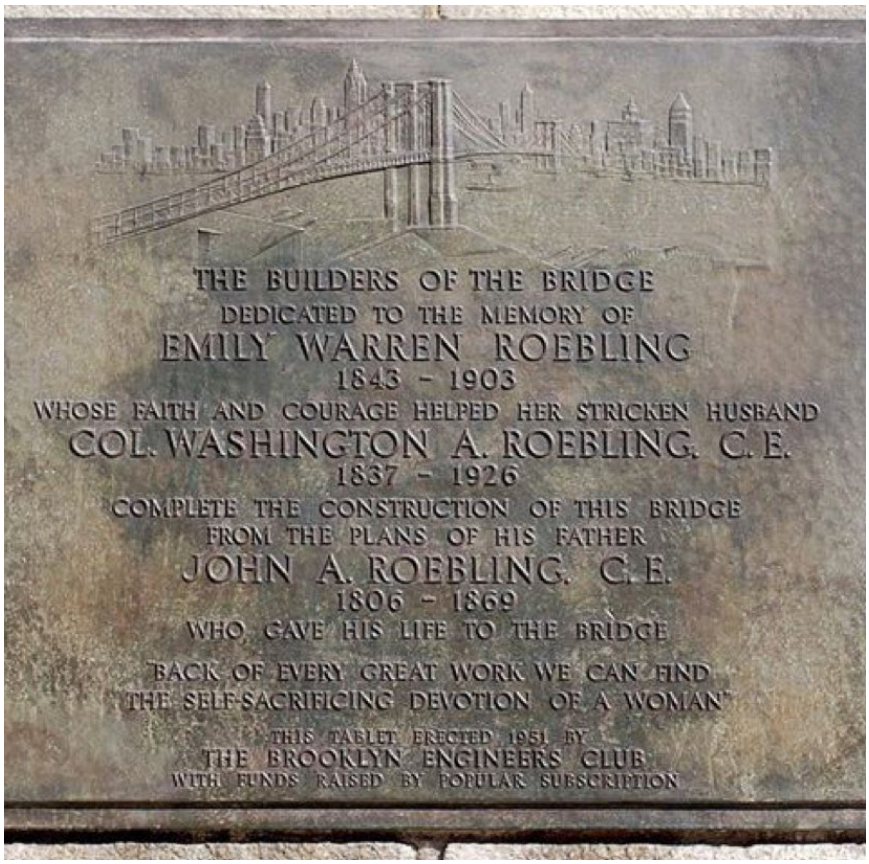

Figure 3. Plaque on the South Tower of the Brooklyn Bridge, dedicated to Emily Warren Roebling, who "helped her stricken husband, Col. Washington A. Roebling, complete the construction of this bridge from the plans of his father, John A. Roebling, who gave his life to the bridge." (Source: public domain.)

Recent work in disability studies has questioned the adequacy of "the social model" to account for every variety of infection, accident, illness, or impairment—not to mention their lived experiences. Alison Kafer summarizes this new position in her 2013 book *Feminist, Queer, Crip:*

> In its well-intentioned focus on the disabling effects of society, [the social model] overlooks the often-disabling effects of our bodies. People with chronic illness, pain, and fatigue have been among the most critical of this aspect of the social model, rightly noting that social and structural changes will do little to make one's joints stop aching or to alleviate back pain. . . . Focusing exclusively on disabling barriers, as a strict social model seems to do, renders pain and fatigue irrelevant to the project of disability politics.[20]

[20] Alison Kafer, *Feminist, Queer, Crip* (Bloomington, Indiana University Press, 2013), 7.

In response to criticisms such as these, scholars have proposed new vocabulary and new theories for the field of disability studies. Tobin Siebers, for instance, has suggested that social construction be replaced by a "new realism of the body" that foregrounds human variation.[21]

My second example is meant to suggest that the ban on theorizing technological agency has perhaps been lifted, even for those of us working outside the camps that go by such acronyms as ANT and OOO. I would argue, for instance, that aspects of the design of the Brooklyn Bridge point as readily to the causal agency of artifacts and their material elements as they do to human activity. In 1879, for instance—four years before the Bridge formally opened—several experimental telephone cables (each containing many wires) were laid across the structure within a handrail. Engineers soon discovered that voices leapt between the wires through inductive coupling. This phenomenon, known as crosstalk, would not be easily eradicated, and it came to be categorized as a transmission "impairment," an almost nonexistent word in 1800 that was increasingly applied to both human bodies and to telecommunications by the end of the century, set against the backdrop of statistics, life insurance, and a rising interest in workers' compensation and rehabilitation.[22]

Along with noise, echo, and a host of other transmission impairments, crosstalk impelled a great deal of engineering. It functioned somewhat like a "reverse salient," to paraphrase Thomas Hughes, "an area where the growth of technology is seen as lagging . . . a set of 'critical problems' that, when solved, will correct the situation."[23] Yet distinct from the reverse salient, transmission impairments are understood (even today) to be omnipresent in telecommunications. These not completely "solvable" problems range from endemic random noise to transient glitches to more serious distortion.[24]

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[21] Tobin Siebers, "Disability in Theory: From Social Constructionism to the New Realism of the Body," *American Literary History* 13, no. 4 (Winter 2001): 737–54.
[22] On the relationship between the term impairment and the rise of the life insurance industry in the United States, see Dan Bouk, *How Our Days Became Numbered: Risk and the Rise of the Statistical Individual* (Chicago: The University of Chicago Press, 2015).
[23] Donald MacKenzie and Judy Wajcman, "Introductory Essay: The Social Shaping of Technology," in *The Social Shaping of Technology*, 2nd ed., edited by MacKenzie and Wajcman (Buckingham: Open University Press, 1999), 11.
[24] For more on this theme, see my forthcoming book *On the Phone: Hearing Loss and Communication Engineering* (Durham: Duke University Press).

More importantly, transmission impairment and its management have seemed to require human factors engineering—in this case the bending or molding of human perception to the obduracy of the material world. Writing in 1998, former Bell Labs engineer A. Michael Noll commented on the necessity for human physiological solutions to impairments in media systems: "Transmission systems cannot be perfect in the sense of eliminating all forms of impairments," he wrote, "Instead, the design goal is to reduce their subjective effect on users to an acceptable level. Hence, the human factors of transmission impairments are an important consideration in the performance specifications for transmission systems."[25]

Technology is a very human activity, and if we grant technology more agency than the passive voice of this formulation allows, it does not presuppose determinism, nor the passivity of humans and societies. Tom Misa, the current president-elect of SHOT, observed in the 1990s that attempts "to demonstrate the socially constructed nature of technology [generally conducted through micro-studies] often omit comment on the intriguing question of whether technology has any influence on anything."[26] I've offered these reflections, strung along the Brooklyn Bridge, not to raise the determinism-constructionism debate from the dead, but to suggest that as a result of these debates, and a changing sociopolitical context, the Sixth Law has become a truism that is no longer obviously—or necessarily—true.

Editor's Note: These essays are drawn from the roundtable plenary "Kranzberg's Laws at Sixty," held at the Society for the History of Technology (SHOT) Annual Meeting, 11 October 2018 in St. Louis. Twenty-eighteen is the sixtieth anniversary of the founding of SHOT, and Melvin Kranzberg, a seminal figure in the emergence of both SHOT and the history of technology as a discipline. The article in which Kranzberg's Laws first

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[25] A. Michael Noll, *Introduction to Telephones and Telephone Systems* (Boston: Artech House, 1998), 89.
[26] Thomas Misa, "Retrieving Sociotechnical Change from Technological Determinism," in *Does Technology Drive History? The Dilemma of Technological Determinism*, edited by Merritt Roe Smith and Leo Marx (Cambridge, MA: The MIT Press, 1994), 141.

appeared is: Melvin Kranzberg, "Technology and History: "Kranzberg's Laws," Technology and Culture 27, no. 3 (1986): 544–60, available at http://www.jstor.org.

To learn more about Melvin Kranzberg, see Robert C. Post, "Chance and Contingency: Putting Mel Kranzberg in Context," Technology and Culture 50, no. 4 (2009): 839–72, available at https://muse.jhu.edu/.