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27 September 2019

Version of attached file:

Accepted Version

Peer-review status of attached file:

Peer-reviewed

Citation for published item:

Martin, Joseph D. (2015) 'Evaluating hidden costs of technological change : scaffolding, agency, and entrenchment.', *Techné : research in philosophy and technology.*, 19 (1). pp. 1-25.

Further information on publisher's website:

<https://doi.org/10.5840/techne201522325>

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**Evaluating Hidden Costs of Technological Change:
Scaffolding, Agency, and Entrenchment**

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Abstract: This paper explores the process by which new technologies supplant or constrain cultural scaffolding processes and the consequences thereof. As elaborated by Wimsatt and Griesemer, cultural scaffolds support the acquisition of new capabilities by individuals or organizations. When technologies displace scaffolds, those who previously acquired capabilities from them come to rely upon the new technologies to complete tasks they could once accomplish on their own. Therefore, the would-be beneficiaries of those scaffolds are deprived of the agency to exercise the capabilities the scaffolds supported. Evaluating how technologies displace cultural scaffolds can ground philosophical assessments of the cultural value of technologies.

Keywords: Scaffolding, Agency, Entrenchment, Technological Change, Technology Policy

1 Introduction

In popular discourse, technological development is often equated with progress. The prevalence of progressive narratives combined with a torrid pace of technological change bespeaks a need for tools to assess the drawbacks of new technologies alongside their benefits. This paper develops a framework for evaluating some cultural consequences of new technology and grounding public policy action that meets the challenges of technological change. Technologies often replicate capabilities that individuals previously enjoyed autonomously. Societies cultivate those capabilities by what Wimsatt and Griesemer, borrowing from developmental psychology, call *scaffolding*—structures that promote the acquisition of competencies by individuals or organizations (Wimsatt and Griesemer 2007).¹ With reference to this use of scaffolding to describe cultural phenomena, I define *cultural scaffolding* as the socially maintained processes, institutions, and traditions—and their relations—organized to imbue individuals with new capabilities, which they can subsequently exercise autonomously. When technologies render cultural scaffolding processes unnecessary to accomplish some tasks, thereby denying individuals the benefits of scaffolding that would help them acquire the autonomous ability to execute those tasks, they deprive individuals of autonomous agency, sequestering that agency in technological structures. Identifying when and how such penalties occur permits critical evaluation of the hidden costs new technologies exact.

A literary illustration can clarify the proposed framework. Agatha Christie's *Death Comes as the End* depicts the ascendant scribe class in ancient Egypt. In an early passage, Renisenb, daughter of the priest Imhotep and the book's protagonist, discusses the utility of written language with

¹ This paper focuses on scaffolding of individual rather than organizational capabilities, although the argument is scalable.

Hori, one of her father's scribes. Hori muses that Egypt would one day be filled with the literate, but when Renisenb suggests that this would benefit society, the scribe expresses his doubts:

[I]t is so easy and it costs so little labour to write down ten bushels of barley, or a hundred head of cattle, or ten fields of spelt—and the thing that is written will come to seem like the real thing, and so the writer and the scribe will come to despise the man who ploughs the fields and reaps the barley and raises the cattle—but all the same the fields and the cattle are *real*—they are not just marks of ink on papyrus. And when all the records and all the papyrus rolls are destroyed and the scribes are scattered, the men who toil and reap will go on, and Egypt will still live.

Renisenb sees the wisdom in Hori's reservations, realizing: "Only the things that you can *see* and *touch* and *eat* are real [...] One could write down lies" (Christie 1944, p. 13). Hori worries that although writing simplifies record keeping, eases financial transactions, and supplements memory, it can easily become a surrogate for that which it represents and cause both the writer and the reader to cease exercising the skills necessary to evaluate the things behind the text.

This example is helpful because the benefits of writing are so evident, making its less desirable consequences difficult to recognize. Writing facilitates precise communication and permits sustained logical evaluation of abstract concepts and so has been identified as an essential prerequisite for the development of civilization (Goody 1977). Asking which scaffolds writing displaces can expose its subtler effects. As Hori observes, reliance upon writing can hinder an individual's ability to understand and manipulate the things to which writing refers. The literate scribe enjoys the new capabilities that writing makes possible, but need not rely on memory to the same extent as an illiterate laborer, does not develop the know-how required to raise the livestock and reap the grain that keep the civilization intact, and is beholden to the written word, as a surrogate for the senses, as a source of knowledge.

Hori can draft a contract for the sale of cattle, but lacks the expertise to determine whether those cattle are of the health and quality the contract claims. Literacy gives him new abilities, but he has suffered what I define as an *agency cost*. By adopting a new technology, he has sacrificed the opportunity to develop capabilities he once would have needed to execute the tasks he can now complete only with the aid of the written word. A cattle owner, by growing up among livestock and participating in cultural processes that provide knowledge about the animals, knows instinctively what each one is worth. Living and working with animals scaffolds fair financial transactions in an agricultural context. If literate scribes who have not taken part in these scaffolding processes govern these transactions, then cattle are reduced to markings on paper for the purposes of trade, and the details of their exchange are removed from the real characteristics of the animals themselves. The scribe is able to conduct transactions more quickly, in higher volume, and with enduring records, but has paid an agency cost by sacrificing the ability to evaluate the livestock.

The trade-off Hori describes is a common feature of technological development. In some instances of technological change, new technologies replicate abilities that were once instilled via cultural scaffolding processes. In cases when these technologies become widespread, and pre-existing scaffolds either suffer or vanish, agency that was once conferred through scaffolding processes becomes solely or predominantly confined within the new technology. Tasks that could once be accomplished easily by suitably prepared individuals become difficult, and sometimes impossible, in the absence of the technological structures confining that agency. Individuals come to rely upon technology to exercise the desired capability and the technology becomes entrenched.

Philosophers of technology, combatting the view of machines as inert, valueless tools, have focused attention on the ways in which technologies inhabit regimes of social and political control.

Winner identifies “the claim that machines, structures, and systems of modern material culture can be accurately judged not only for their contributions to efficiency and productivity and their positive and negative environmental side effects, but also for the ways in which they can embody specific forms of power and authority” as one of the most provocative claims one can make about technology and seeks to erode resistance to discussing the politics of artifacts (Winner 1988).

Feenberg deploys the tools of critical theory in order to expose technology’s role in forming and perpetuating hegemonic structures (Feenberg 1991, 1992). This paper contributes to this tradition by elaborating one mechanism by which technologies can adopt a hegemonic stance. When technologies deprive individuals of autonomous agency it increases their dependence upon those technologies and, by extension, of the systems and institutions controlling them.

If we can identify how technology confines agency, we can identify the capabilities that will suffer when new technologies appear, assess the value of the agency to exercise those capabilities autonomously, and decide whether those technologies should be checked or the affected capabilities scaffolded in other ways. The relationship between scaffolding and agency thereby furnishes a framework for identifying the consequences of technological change and offers a basis for critical evaluation of new technologies. Few people today would accept Hori’s conclusion that literacy should be kept to a minimum; however, we can learn from Hori’s hesitancy to adopt the unvarnished optimism that sometimes greets new technologies, consider their broader impacts, and identify valuable scaffolding processes that might be worth preserving, even if displaced by technologies that we otherwise consider desirable.

Section 2 develops the central framework in detail. Section 3 elaborates it through two historical examples. The first invokes Mark Twain, who depicts the process by which highly skilled

riverboat pilots were displaced by a band of less apt upstarts armed with a clever communication network in the mid-nineteenth century. Unionized pilots used their network to glean current information about river conditions, but lost the visceral knowledge of the river that distinguished their predecessors. The second example considers the medicalization of childbirth, which moved from the home to the hospital in the early twentieth century America partly because of the prevalence of drugs designed to control labor pains. As male obstetricians asserted authority over childbirth, birthing mothers and the midwives who traditionally attended to them lost a measure of agency they had enjoyed by virtue of one of the most ancient forms of cultural scaffolding, namely the feminine knowledge networks and practices surrounding childbirth.

Section 4 explores how this framework might be applied to contemporary issues. Scaffolding provides a vocabulary with which to study the impact of information saturation on the capability for conceptualizing problems for which a simple factual answer is not available. The expansion of information access through the proliferation of internet-connected mobile devices raises questions about how technology should feature in educational contexts, and I conclude by suggesting that the effects discussed here in the abstract might be further substantiated through social science research and that this framework can thereby offer directives for technology policy.

2 General Framework

Cultural scaffolding provides one framework with which to assess the impacts of technological change. The basic structure of this framework is as follows:

- (1) Cultural scaffolding processes support the acquisition of capabilities and competencies on the part of individuals and organizations (Wimsatt and Griesemer 2007).

- (2) New or improved technologies often replicate capabilities that individuals possess autonomously after benefitting from scaffolding processes.
- (3) If a technology replicates a capability that is supported by a scaffolding process and the technology becomes prevalent then the cultural activities that compose the scaffolding structure, which confers autonomous agency, can be halted or altered. In such cases, the technology becomes the predominant way in which the capability is exercised.
- (4) If (1) – (3) obtain, capabilities that individuals once possessed autonomously become difficult or impossible to accomplish without the aid of the technology that displaced the capability-conferring scaffold. By this mechanism, technologies become entrenched.

Before considering each of these steps in detail, it is worth emphasizing that I do not claim that this is the only relationship new technologies can bear to cultural scaffolding. Technologies might themselves be elements of scaffolds and new technologies might simply change the way in which autonomous capabilities are scaffolded. Technologies might create entirely new capabilities that demand new scaffolding processes to maintain. The framework, as elaborated below, should be understood as describing one kind of relationship that can obtain between technology and cultural scaffolding, rather than an exhaustive description of that relationship.

2.1 Cultural Scaffolding

Wimsatt and Griesemer borrow the scaffolding metaphor from developmental psychology and define cultural scaffolding as the “[s]ocial and cultural structures and activities that play a role in generating learning trajectories” (Wimsatt and Griesemer 2007, p. 229). Wimsatt elaborates, calling scaffolding “structure-like dynamical interactions with performing individuals that are

means through which other structures or competencies are constructed or acquired by individuals or organizations” (Wimsatt 2014, p. 5). Cultural scaffolding consists of socially maintained processes. Cultural scaffolding processes, composed of traditions, institutional machinery, socialization mechanisms, and their interactions are the means by which communities, organizations, and societies confer useful capabilities to their members.

Scaffolding processes can be informal or codified. Take two examples of language acquisition. Linguists have shown how child-directed speech—colloquially known as baby talk—helps young children absorb language (e.g. Matychuk 2005). Parents and caregivers, without explicit instruction, simplify their speech and affect a childish voice to engage children. This activity scaffolds early language acquisition. More formal structures are deployed to teach reading and writing skills. Phonics is a systematic scaffold used in elementary education to support the acquisition of reading skills. Its precepts have been fleshed out in the pedagogical literature and its practice is guided by published curricula (Stahl et al. 1998). Both of these are scaffolding processes, and they support the acquisition of similar competencies. Nonetheless, they are structured quite differently, one through informal, unscripted interactions between children and their caregivers and the other within the formal institutional context of the school system, shaped by layers of organization from local curriculum boards to national investigative panels.

These examples offer a first order indication of the diversity of ways scaffolding acts and the factors that make it difficult to identify. Processes that can be obscure or arcane often leave little or no record of their operation. In addition, scaffolding, although it might possess extended existence as a cultural structure, is temporary with respect to the acquisition of a capability on the part of the individual (Wimsatt and Griesemer 2007, p. 229). After a keystone is placed in an arch,

the wooden scaffolding that held up the voussoirs can be kicked away, and the arch will stand on its own. Similarly, a child will be able to speak long after outgrowing baby talk, and read long after ceasing to sound out words. When scaffolds are kicked away, evidence of their contribution can go with them making them seem less critical to the capability they support than they might actually be. Because scaffolding can seem ephemeral, it is easy to ignore when focusing narrowly on the features of skills and capabilities rather than the processes through which they are acquired.

The discourse surrounding new technologies typically focuses on what they allow users to accomplish and the capabilities users need to manipulate them effectively. The question of how the capabilities they replicate were previously acquired receives less attention. The first generation of users, those charged with determining the value of a new technology, learned to accomplish tasks the technology replicates the old way. They benefit both from the scaffolding and the technology, and so are less apt to consider the effect absence of the scaffold might have on the generation that learns the task exclusively using the technology. Consequentially, assessments of new technologies rarely consider potential deleterious impacts on pre-existing capabilities. To consider such impacts, it will be instructive to discuss how technology relates to human capabilities.

2.2 Technologies and Capabilities

Broadly speaking, a new or improved technology bears two types of relation to human capabilities. It introduces new capabilities and replicates existing capabilities. Technologies allow people to do things they could not do before and to complete old tasks in new ways. Navigation technologies offer a rich vein of examples. The Harrison H-4 marine chronometer permitted the first accurate determinations of longitude while at sea, a capability that was previously so elusive,

and so valuable, that the British government established a prize for the first person to accomplish the feat (Dunn and Higgitt 2014). In this sense, the H-4 was a capability-extending technology—it permitted the execution of a capability that was previously unavailable even though it also replicated the capability to keep accurate time in non-seafaring contexts. A more recent invention, GPS navigation, helps drivers successfully navigate the roadways. This capability was previously available to them through a combination of maps, memory, directions provided by more knowledgeable drivers, etc. The GPS allows people to navigate in a different way—with less preliminary planning, for instance—and it has novel applications in surveying, aviation, and timekeeping; however, in its common use on well-mapped roadways it offers few genuinely new capabilities.

Any new technology can be understood as either extensive or replicative, depending upon the frame of reference. The transistor—though it offered some meaningful improvements on vacuum tube amplification by avoiding the long warm-up time and being less susceptible to breakage—replicated the capability of the triode vacuum tube to amplify and rectify electrical signals. It also exploited surface states of semiconductors in a novel manner. This understanding led to the integrated circuit, laying the foundation for modern computing, and so in a significant sense the exploitation of the electromagnetic properties of semiconductors can be understood as an entirely new capability. Judgments about whether technology is best understood as extending or replicating capability depend upon both the interpretive frame of reference and how the technology is actually used. We might say that the invention of the airplane introduced the new capability of heavier-than-air flight. We could also say that it replicated the existing capability of getting from point A to point B. Which is more important depends on our interpretive goals.

This framework principally concerns the replicative dimensions of technology. If a capability introduced by a technology is new, then no pre-existing cultural scaffolding is available to be displaced. But when a technology replicates a capability, it has the potential to change the way that capability is exercised, and can alter the way that capability is acquired. I refer to the process in which a new technology substantially impacts the acquisition and exertion of capabilities as *scaffolding displacement*.

2.3 Scaffolding Displacement

A technology that replicates an existing capability is more likely to succeed if it creates the impression that it executes that capability better. The technology might achieve a task more quickly, with less effort, more safely, or with less planning. If the perceived advantage offers a powerful incentive to use the technology in lieu of previous methods, the technology might become the principle means by which a task is accomplished. Many, most, or even all people who previously would have benefitted from a scaffolding process that supported the acquisition of the relevant capability will eschew that process in favor of the technological solution. Note that in these cases individuals have not lost access to a capability. They can still exercise it with technological assistance. But the capability has been externalized and is now vested in the technology rather than the individual. By becoming the primary means of exercising a previously autonomous capability, technologies can displace cultural scaffolds that once supported the acquisition of that capability. If most people use the technology, little incentive exists to invest time and effort in an onerous learning process, and so demanding, time-intensive scaffolding structures fall into disrepair.

Displacement is not, of course, the only effect technology can have on cultural scaffolds. New technologies might generate entirely new scaffolds, inspire the modification of old ones, or precipitate the integration of previously unrelated scaffolding processes. We might define “scaffolding replacement” as the case in which a new technology becomes part of a scaffolding process that continues to confer autonomous agency. I restrict myself to the discussion of displacement here because it produces some of the least appreciated and most socially relevant consequences of technological change. A technology that displaces a scaffold replicates a capability and so it does not eliminate the ability to exercise the capability the scaffold supported. It does not deprive the first generation of users, who already benefitted from the scaffold, of the agency that scaffold conferred. Displacement is therefore a slow and obscure process.

The process can be distilled into three criteria. If: (1) a technology replicates an existing capability; (2) the capability is supported by a cultural scaffold—that is, processes exist that allow individuals to acquire the capability for themselves; and (3) the technology, through widespread use, interferes with the operation of that scaffold, then scaffolding displacement occurs. This is a process, not an immediate impact. It will disproportionately influence the generation that grows up with the new technology and so lacks either the opportunity or the incentive to participate in the scaffolding process. To return to the stalwart example of the GPS, a person who learns to drive in a car equipped with a navigation system will not undergo the same scaffolding processes as a person who learns to navigate with a combination of local maps, road atlases, consultations with locals, and memory. In cases of scaffolding displacement, the rise of a technology as the principle means by which a task is accomplished leads to abandonment of the scaffolding process that previously would have promoted the abilities necessary to complete that task.

2.4 Consequences: Agency Cost and Entrenchment

Scaffolding displacement has two consequences that are relevant for evaluating technological change. The first is *agency cost*. Scaffolds supplement their beneficiaries' autonomous agency by helping individuals develop capabilities that they can subsequently exercise without continuing scaffolding action, technological assistance, or other external aid. Should a technology displace a scaffold, as opposed to replacing or supplementing it, one clear consequence is that individuals will be unable to exercise a capability—or at least unable to exercise it as well—in the absence of the technology. They will suffer from reduced autonomous agency.

Someone who has studied a map in order to determine the best driving route between point A and point B will likely be able to repeat the journey without external navigation aids and will be more likely to follow alternate routes successfully in the event of traffic or road closures. Someone who follows the same route with the aid of a GPS should have more difficulty repeating the journey without similar assistance, being less likely to have committed the route to memory or become familiar with the surrounding area. This consequence has been illustrated with unfortunate results in recent cases of drivers in the southwestern United States who have gotten lost, occasionally with fatal consequences, in Death Valley while following faulty GPS directions (Clark 2011). By deferring the judgment required for successful navigation to a GPS, drivers sacrifice the agency to navigate successfully, and sometimes safely, on their own.

A related consequence of scaffolding displacement is *entrenchment*. Philosophers of biology have introduced the concept of “generative entrenchment” to measure the degree to which a feature of an organism is connected to downstream consequences. If a gene, for example, is

associated with many and various developmental features of an organism it will be more resistant to evolutionary change than a gene with fewer developmental implications (Wimsatt 1986; Schank and Wimsatt 1988). Generalized, entrenchment means that the more features of a complex system depend on one element of that system the more that element will resist perturbation.² Through this principle the analogy follows from evolutionary to technological change. If an agency cost makes a capability reliant on technological assistance, the technology in question becomes a stable feature of the landscape. Eliminating or substantially altering the technology would require ensuring that other ways existed to exercise the capability, demanding either further technological development or reinstatement of scaffolding processes. By displacing scaffolding structures that allow capabilities to be exercised independently, technologies can make themselves indispensable to particular tasks, and thereby weave themselves more tightly into the fabric of daily life.

Before delving into the applications of this framework, it will be useful to summarize the relationships between its central elements. Cultural scaffolding, because it is composed of diffuse, large-scale, decentralized processes, does not exist in a one-to-one relationship to a given capability or any particular technology. An individual's autonomous agency to exercise a particular capability might come as a result of several scaffolding processes working in concert, and a number of different technologies might influence the functioning of a scaffold or set of scaffolds at any given time. We should not think of scaffolding displacement as an instance in which a single new technology damages a unique scaffold that supports one particular capability. Instead, scaffolding displacement itself is an integrative process in which new technologies, by disrupting the operation

² Economists have made similar observations about “lock-in” in markets. The QUERTY keyboard, for example, was designed to regulate typing speed and prevent mechanical typewriters from jamming. When electric typewriters and computers became popular, enough people had learned to type using QUERTY that the barriers to adopting alternative and technically superior standards like DVORAK failed because QUERTY was “locked in” (David 1985; Arthur 1989).

of cultural scaffolding processes, generate downstream consequences for the autonomous agency of individuals. Considering discrete features of this process, however, does allow us to make assessments about the influence of new technologies on particular capabilities.

3 Historical Applications

This section applies the framework outlined above to two historical episodes in order to illustrate two ways in which scaffolding displacement can operate. The first considers how scaffolding displacement relates to deskilling. The second shows it acting as a mechanism of social control. Each example demonstrates how scaffolding displacement can be useful for historians and establishes a basis for understanding how scaffolding displacement works in the real world that can in turn be useful for evaluating contemporary technological change.

3.1 *Life on the Mississippi: Scaffolding Displacement and the Skilled Workforce*

Mark Twain's *Life on the Mississippi*, although anecdotal, provides a rich, first-hand account of the process through which a riverboat pilot learned his craft in the mid-nineteenth century. Twain describes his apprenticeship under the veteran pilot Mr. Bixby. Twain's training consisted of a grueling process of learning the idiosyncrasies of each twist and turn of the river in both directions. Bixby tells Twain: "you only learn *the* shape of the river; and you learn it with such absolute certainty that you can always steer by the shape that's *in your head*, and never mind the one that's before your eyes" (Twain [1883] 1901, p. 59). Both the process of rote memorization and the development of tacit knowledge—such as that required to distinguish an actual underwater obstacle from the illusion of one created by the wind—feature centrally in Twain's account of the process by which he became a competent pilot.

Twain was the beneficiary of a scaffolding process. His apprenticeship unfolds as a series of lessons, each of which cemented in his mind another subtlety of navigating the capricious Mississippi. At the end of this process, Twain was a sure-handed navigator who could confidently guide his boat upstream or downstream in almost any conditions. The wealth of knowledge and depth of skill such training provided came with considerable social status, especially aboard the boat. Twain describes how a pilot's skill defined the on-board power structure to the point where the captain was beholden to the pilot, in stark contrast to the normal hierarchy prevailing on nineteenth-century watercraft. A pilot could withhold the full benefit of his skill from an excessively frugal captain (p. 110–112), and had the latitude to visit torrents of colorful invective upon a skipper who questioned his judgment (p. 113). The rigorous scaffolding process a skilled pilot had to complete imbued him with social agency in addition to mechanical agency.

The pilots' monopoly, as Twain calls it, began to erode as the population of pilots grew (p. 113). Overtraining led to a pilot glut. New pilots would undercut the wages of more established professionals to secure work, depressing pay across the board. In response, veteran pilots formed a professional association to protect their interests. An unintended consequence of the generous benefits these veterans built into their organizational structure was that the association attracted rafts of upstarts: low-skill pilots who wanted to take advantage of the unemployment and burial insurance the society offered. The association, saturated with technically inept, out-of-work pilots became a laughing stock.

Two innovations brought the faltering pilots' association back from the brink. The first was enforcing the rule that association pilots could not share a boat with non-association pilots, which slowly squeezed out the non-association pilots as the organization grew. The second was an

infrastructural innovation. An association member would be equipped with a set of cards on which he would record the conditions of his most recent passage. He would deposit the completed cards in lockboxes at wharfs where the boat stopped. Each association pilot was issued a key to these boxes so that he could avail himself of the most recent information about river conditions in the stretch of water he was about to travel. A pilot prepped with recent reports about river conditions, in Twain’s characteristically nimble prose, “could not possibly get his boat into trouble without bringing the most ingenious carelessness to his aid” (p. 119).

The robust information-sharing network obviated the need for intensive training that would allow individual pilots to respond expertly to data they themselves gleaned from “reading” the river. As Twain reports: “The pilot who had formerly been obliged to put up with seeing a shoal place once or possibly twice a month, had a hundred sharp eyes to watch it for him, and bushels of intelligent brains to tell him how to run it” (p. 120). The association pilots, therefore, performed statistically better despite being less skilled on average. They grounded fewer boats, made better time, and prompted boats’ underwriters to pressure their captains to hire association men. The association thereby effected a monopoly over the riverboat industry and compelled the traditionally trained outsiders to either join the union or leave the business altogether.

It is likely, of course, that informal data networks existed among pilots before the association era. Pilots gathering at port would undoubtedly have shared the details of their most recent trips. The formal system of the association was nonetheless a substantive innovation. Access to informal data-sharing networks would have depended on the social standing of the pilots, which in turn would have been linked to their skill and reputation. The difference in scale made the formalized data network qualitatively different; the formal system gave association pilots access

reports from every other pilot coming in the opposite direction, rather than merely those who happened to be in port at the same time and with whom they enjoyed friendly relations.

The association and its lockbox network effectively displaced the scaffolding structure Twain describes. Fledgling pilots would still have to learn how to operate a steamboat, but they would not need to subject themselves to the rigorous process of learning the river by rote. Rather than mastering the river as Twain had, they could more easily learn to use the information system the association implemented. Some of the agency pilots previously enjoyed—both mechanical ability and social authority—dispersed into the association’s report-sharing system, and individuals trained with that system, having avoided a more rigorous apprenticeship, would not be able to get by without it. Similar processes go by the name “deskilling” in the historical literature. The advent of technological solutions to old problems lowers the level of skill required to complete the task and thereby deprives a class of professionals of privileged access to the expert knowledge or skills that once provided their livelihood and social status (Braverman 1974).³

Scaffolding displacement, though, offers a broader perspective than deskilling alone. Whereas deskilling highlights the craft knowledge possessed by individual pilots, scaffolding displacement emphasizes the social structure of the professional community. Changes in the social and mechanical agency of riverboat pilots were the consequence not only of the implementation of new technology, but also of the displacement of the scaffolding structures that gave riverboat pilots their authority. Pilots still possessed professional authority after the rise of the association, but they gained access to that authority through the professional organization rather than by virtue of

³ Braverman himself did not use the word “deskilling,” but the concept that now goes by that name is distilled from his landmark 1974 work.

individual ability and reputation. Unlike deskilling, scaffolding displacement tells us more than the fact that a skill has been lost; it points to where the benefits of that skill have gone.

In this example, we can see that a scaffolding process was displaced, and also that the character of riverboat navigation was altered in the process. A traditionally trained riverboat pilot enjoyed what might be called a flexible capability to navigate the river. His intimate understanding of the river and its dynamics allowed him to respond to rapid changes in conditions. In contrast, an association pilot's navigational acumen was only as good as his most recent information. His ability was rigidly constrained by the limits of the technological system upon which he relied. At the limits of that system, or in the event of its failure, his aptitude dropped off sharply.

Cultural scaffolds tend to instill flexible capabilities. Their goal is to allow their beneficiaries to proceed without them and adapt successfully to new contexts in which the relevant skill might be employed. The technologies that replace them, however, introduce new constraints on the system. So while the technology might allow a capability to be exercised more consistently within a circumscribed domain, the boundaries of that domain are sharper than they were with a scaffolded capability. Whereas a traditionally trained pilot would have no difficulty reacting to rapid changes in river conditions, an association pilot would be constrained by the speed at which new information diffused through the system.

Some of Twain's disdain for the association and its system no doubt derives from the damage he felt the association did to the romance of riverboat piloting (McCammack 2006, p. 14). A contemporary observer might well have concluded that, although the skill of a traditionally trained pilot was impressive, the stability offered by the new system nonetheless offered indispensable advantages. Irrespective of the judgment we render on the merits of the association's

system, however, the scaffolding displacement framework allows us to better understand how it took root and helps us place contemporary objections to it in their proper context.

3.2 Twilight Sleep: Scaffolding Displacement and Social Control

Between the mid-nineteenth and the early twentieth centuries, the use of anesthetics during childbirth became common in the United States. The goal was to relieve women—chiefly upper-class women who could afford the administrations of private physicians—of the pain of childbirth. The technique colloquially known as “twilight sleep” took pain relief to extremes. Injecting women who were commencing labor with a scopolamine/morphine mixture would induce an amnesic state, from which women would emerge only after labor was complete. Pain was not the only thing of which birthing mothers were relieved by this practice. They also lost the ability to remember the birth. This had a number of consequences, not least of which was the displacement of one of the most ancient cultural scaffolding processes: the ability of mothers to communicate the experience of childbirth to other women, including their own daughters. By denying mothers this agency, twilight sleep, intentionally or not, furthered the medicalization of childbirth and granted the medical discipline authority over parturient women. Scopolamine helped to displace scaffolds, in the form of feminine knowledge networks, which for thousands of years had prepared women for childbirth and in doing so transferred responsibility over childbearing to the professionalizing medical establishment.

The use of anesthesia in childbirth did not begin as an exertion of professional control. Leavitt, in her authoritative history of American childbearing *Brought to Bed*, argues that early deployment of pain relief drugs during childbirth indicated “the powers that women held in

America's birthing rooms, the easy assertion of their decision-making authority, and physicians' acceptance of the necessity to alter their own plans in the face of women's expectations" (Leavitt 1986, p. 118). Demand from women, especially upper-class women, drove the use of ether and chloroform in the mid-1800s, often in the face of resistance from medical professionals. Some doctors objected to losing valuable signals of the progress of childbirth labor pains provided, while others perceived that a difficult delivery could be navigated more easily if the mother was awake, alert, and could respond to instructions (Leavitt 1986).

Although the adoption of pain medication reflected birthing mothers' demands, and was therefore an exertion of feminine agency, it ultimately "enhanced the place and role of physicians in birthing rooms" (Leavitt 1986, p. 122). Doctors evolved dosing and administration procedures, which were originally subject to large local variation. Calls for standardization fueled medical debates over best practice, from which birthing women and midwives, who had previously maintained authority over home births, were excluded. Anesthetized women could not exert control over their deliveries, placing more responsibility in physicians' hands. Anesthetics thus became integral to the professionalization and institutionalization of childbirth practices.

Obstetrics was a new specialty around the turn of the twentieth century, scrambling for purchase within the American Medical Association. As part of professionalization efforts, male obstetricians claimed authority over technical practices from which female midwives and birthing mothers were excluded. Anesthesia furthered obstetricians' professional aspirations in part because it placed an arena of feminine expertise under masculine control (Dawley 2000; McGregor 1998).

Professional obstetrics liberalized physician's attitudes towards chemical management of childbirth, and, in the early twentieth century, paved the way for widespread use of scopolamine.

The drug, when administered in a morphine cocktail, did not merely relieve pain; it induced an amnesiac state from which mothers would emerge with no recollection of labor or the attendant discomfort. Like ether and chloroform decades earlier, scopolamine gained traction in American medical practice following a grassroots effort by women, mostly wealthy and mostly white, who demanded greater control over the birthing process. Advocates were often vocal feminists and suffragettes. At the same time, scopolamine could only be administered in hospitals with dedicated obstetric facilities. The twilight sleep movement might have demonstrated the power of American women to influence the medical profession, but it also furthered the transfer of childbirth into a masculine professional context—the growing specialty of obstetrics—and out of the home and company of other women in which it had traditionally been experienced (Leavitt 1986, p. 131-135).

Leavitt concludes: “Put to sleep with a variety of drugs, parturient women from the 1920s to the 1960s did not experience one of their bodies’ most powerful actions and thus lost touch with their own physical potential” (Leavitt 1986, p. 140). This is the crux of second-wave feminist critiques of anesthetized deliveries (Rich 1976). Anesthetized women were prevented from making key decisions during delivery and did not have the benefit of experience they might have communicated to their sisters, daughters, or women in their communities. Simultaneously, women in labor were more frequently attended by male obstetricians who had not experienced and could not experience childbirth, as opposed to midwives who could often draw on personal as well as professional experience to guide their interactions with their birthing women.

Gradually, American childbirth was medicalized. Hospital deliveries became the norm, and the perception arose that childbirth was dangerous to undertake outside of a robust technological infrastructure. Leavitt observes that increasing scopolamine use was inextricable from the rise of

obstetrics as a professional specialty: “Because of the need for expertise and extra care in the administration of scopolamine, the twilight-sleep movement easily fed into widespread efforts in the second decade of the twentieth century to upgrade obstetrical practice, eliminate midwives, and move childbirth to the hospital. Both the women who demanded the technique and the doctors who adopted it applauded the new specialty of obstetrics” (Leavitt 1986, p. 134).

My goal is not to judge home versus hospital births, midwives versus obstetricians, but to show scaffolding displacement at work. Slightly recast, feminist critiques of the twilight sleep movement claim that anesthesia displaced a scaffolding process. Rich writes: “‘freedom from pain,’ like ‘sexual liberation,’ places a woman physically at men’s disposal, though still estranged from the potentialities of her own body. While in no way altering her subjection, it can be advertised as a progressive development” (Rich 1976, p. 171). Anesthetics and the professional structures that mediated their use deprived women of control over childbirth in the guise of progress and affected individual women by placing the process of deliveries into the hands of physicians. It also operated on a collective scale by disrupting what is perhaps one of the oldest cultural scaffolds: the communal understanding, transmitted both horizontally between women and from midwife to patient, and vertically from mother to daughter, of how to manage childbirth and how the capacity for childbirth constructs feminine identity. The erosion of that scaffold was an unintended consequence of women’s campaigns for access to anesthesia and a critical contributor to the efforts of obstetricians to gain professional authority over childbirth. The result was the decreased social agency in childbearing contexts women in the mid-twentieth century reported (Rich 1976).

This example illustrates how scaffolding displacement can be a form of social control and a tool to establish professional authority. When a community uses a scaffold to promote valuable

agency, another group might exert authority over them by controlling a technology that displaces the scaffold. In this case American women, who set out to exert their existing authority over childbearing, became subject to greater control by the medical community when the technologies of the hospital, prominent among them anesthesia, became prevalent in routine deliveries. As Feenberg has observed, the common view of medical authority ensures that patients' rights "do not extend to interference with medicine's technical side" and this assumption makes it easy for social norms to be ossified within medicine technique (Feenberg 1995, p. 96-97). Here we see scaffolding displacement etching social norms and power structures into the technical practice of medicine.

Medicalized childbirth rigidified the birthing process, making it less flexible, insofar as birthing mothers became insulated from decisions about childbirth and were subject to largely masculine medical judgments routinized by a professional structure. The social agency cost was not limited to the birthing room. Paltrow and Flavin, drawing on case studies from between 1973 and 2005, discuss how pregnant women have been criminalized when perceived by medical authorities to constitute a threat to the fetuses they carry. They suggest that the enshrinement of authority over childbirth within the medical profession has resulted in a threat to the constitutional personhood of pregnant women (Paltrow and Flavin 2013).

Scaffolding processes often do much more than promote the successful execution of a task. They support the skills, privileges, and authority that accompany the ability to complete that task autonomously. Women's ability to manage childbirth using scaffolding processes that consisted of female-controlled knowledge networks gave them the agency to advocate for changes in medical practice as childbirth was just beginning to become a subject for professional medicine. Ironically, women's campaigns for more options in the birthing room undermined that agency by displacing

the scaffolds that made that advocacy effective.⁴ The result was not only that female social networks and professional communities lost control over childbearing; it also meant that pregnant and birthing women became subject to new layers of professional and legal authority, which further undercut their agency in childbearing contexts.

4 Contemporary Applications: Thinking through an Excess of Information

The preceding examples have benefitted from historical perspective. It remains to be seen how this framework can be applied to technological changes as they unfold. This section aims to generate insights into emerging technological trends and suggest how we can assess impacts on cultural scaffolds as they are in progress with an eye to suggesting further avenues for research and crafting measured technology policy. The growing ubiquity of Internet-connected mobile devices, predominantly in the form of smartphones, has produced information saturation. This is not entirely due to smartphones—the rising proportion of the Western world with access to the Internet over the past decade and the organization that services like Google and Wikipedia impose on the web’s store of information are also contributing factors—but mobile devices allow access to vast reservoirs of data in any quotidian context. It is reasonable to ask, in light of the framework expounded above, what impact this rapid change might have on existing cultural scaffolds, in particular scaffolds that support the ways we acquire, manage, and manipulate information.

Data ubiquity allows many factual disagreements to be swiftly resolved with reference to an online source. Not long ago, a small factual question would be subjected to several rounds of

⁴ I am grateful to an anonymous reviewer for pointing out that this irony is built into the process of scaffolding displacement. Facility with a capability is frequently necessary to identify the potential of a new technology that replicates or supplements that capability. The beneficiaries of scaffolding processes are usually the best situated to identify and promote the technologies that end up disrupting those very same processes.

vigorous interrogation before the encyclopedia was brought in to arbitrate or a friend who could speak with authority called. With the rise of the Internet and its increasing prevalence on mobile devices, the average time such questions remain unresolved has plummeted. As a consequence, people do not wonder about trivia as much as they used to. This constitutes the displacement of a scaffold. Previously, when people wondered about factual information, either in social contexts or on their own, they had time to digest the question, think about how to approach it, generate speculations, weigh potential evidence, and consider the range of sources they might consult and evaluate their reliability. It could be argued that preventing people from wondering about minutia frees their minds for more complex analytical tasks, but I would contend that the mundane, but functionally important task of pursuing the answer to a well-defined factual question constituted a prevalent small-scale scaffolding process that helped people approach questions to which easy answers are not forthcoming and manipulate evidence to address those questions.

If in a casual conversation ten years ago the question had come up, “who was the goalie for the Chicago Blackhawks in 1981?” and no one knew for sure, a discussion might have ensued. The group would list candidates, dismiss some on the basis of available evidence, and consider several parallel routes to an answer. “Glenn Hall? Ed Belfour?” “No, I’m sure Hall played in the ‘60s, and I remember watching Belfour in the early ‘90s when he was just starting out.” “I know Esposito won the Vezina trophy in 1970. Do you think he was still around?” “Players didn’t move around much back then, it’s certainly possible.” “Didn’t Barbara grow up in Chicago? Maybe she knows.” You can supply your own examples, as conversations such as these used to be common. Although they were trivial and did not always generate a reliable route to the correct answer, they did involve practicing some sophisticated cognitive tasks. If you can pull out a smartphone and figure out in

17 seconds that the answer is Tony Esposito, then you and your interlocutors do not benefit from the process of wondering and the scaffolding that goes with it.

If college-age youth who have completed primary and secondary education in a connected age have engaged with less of this type of scaffolding on average, we might expect that many of them will be less equipped to employ the type of independent research skills they are called upon to demonstrate in college courses. We can expect them to be at a loss when confronting a question for which a clear answer is not readily available from a digital resource. This would lend some traction to recent observations that many enter college unprepared for the type of reasoning and research skills college courses demand of them (e.g. Hansen 2013). Curmudgeonly griping about the inadequacies of the younger generation is common to all eras irrespective of the technological context, however research has indicated that digital culture has influenced students' research skills.

College Libraries and Student Culture, the published report of the Ethnographic Research in Illinois Academic Libraries (ERIAL) project, describe how students who are natively proficient with digital tools understand and use library resources (Duke and Asher 2012). ERIAL's findings suggest that the digital facility that today's students enjoy constitutes an impediment rather than an advantage when tackling the more complex task of assembling topical resources using the array of catalogues and databases universities maintain. Duke and Asher observe: "the seeming simplicity of tools like Google belies a complex and iterative process that requires the integration of numerous analytical and technical steps, as well as knowledge and experience on the part of the user" (Asher and Duke 2012, p. 71). In the language of scaffolding, simple online tools for accessing simple information displace the scaffolds that previously supported the capability to identify relevant questions and manipulate evidence, resulting in lost problem-solving agency.

These insights complicate Prensky's dichotomy between digital natives and digital immigrants. Prensky, who introduced these terms in 2001, suggests that befuddled reactions instructors sometimes have to students raised in a digital culture betray misunderstanding of how digital natives learn, and that these differences should not be judged on the basis of digital immigrants' values. Rather, he suggests, established instructors should adapt their teaching techniques to suit the learning styles of students raised in a complex digital ecology (Prensky 2001). In one way of applying the scaffolding framework, we gain a language in which to re-express Prensky's insight that digitally sophisticated students exhibit learning patterns distinct from those of their instructors. By developing their cognitive skills through video games rather than Sesame Street, the digital generation benefitted from a different form of scaffolding that supported a different range of capabilities. They might be more adept at multitasking, for example, because that capability is more effectively scaffolded with fast-processing computers than with books or television, which demand sustained attention to a single task.

However, the findings the ERIAL project presents suggest that not all scaffolds are created equal. Digital-era scaffolding does not support the capability to think around complex problems that cannot be solved with instantly accessible information. Digital natives might enjoy agency that digital immigrants do not, but they have suffered a steep agency cost in the absence of scaffolding that supports deep learning. These observations track with those of other critics of the digital natives thesis. Livingstone suggests: "Watching children click links quickly or juggle multiple windows does not, necessarily, confirm that they are engaging with online resources wisely or, even, as they themselves may have hoped" (Livingston 2009b, p. 5). Facility with the mechanics of digital technologies does not imply facility with the information they convey. If we believe that the skills

necessary to approach complex problems are not disposable, and should not be outsourced to digital tools, then we have a responsibility to consider how displaced scaffolds can be rebuilt.

This is where the scaffolding framework demonstrates its potential use to education policy. By identifying critical features of the problem it can lay the groundwork for a possible solution. In this case, an informal scaffold has been displaced, but it might be replicated with a formal scaffold. If primary and secondary educators introduce activities to encourage thinking around problems in information-restricted environments and limits use of digital tools, students could develop the skills required to manipulate those tools more effectively. The suggestion that restricted access to information scaffolds valuable thinking skills raises skeptical questions about recent efforts to deploy more information technology in primary and secondary classrooms. It is beyond the scope of this paper to mine the example of technology in the classroom in detail, but understanding the differences in how digital natives learn as a question of cultural scaffolding can provide concrete directives for creating alternate means to develop the capabilities that digital natives might not develop through informal means.⁵

5 Conclusions

The scaffolding displacement framework described here provides a versatile tool with which to examine impacts of technological change that might otherwise be overlooked. By

⁵ Interested readers should refer to the example of the Maine Learning Technology Initiative, begun in 2001 to provide internet-connected devices to every student in Maine's public secondary and middle schools (State of Maine 2001). The initiative, which proceeded under the assumption that greater access to technology would allow students more opportunities to access information and develop valuable job skills, has been criticized for paying little attention to how curricular goals should be adjusted to accommodate an infusion of new technology (Kusiak 2011). Kusiak's assessment from the perspective of education mirrors Livingston's from the perspective of media studies. Livingstone's survey of research on the efficacy of information and communication technologies in the classroom concludes: "it is far from proven that internet use brings children greater pedagogic benefits than they would have gained without it," (Livingstone 2009a, p. 89).

displacing cultural scaffolds, new technologies change the way in which people exercise capabilities and can undercut their autonomous agency. Understanding how the process of scaffolding displacement has operated in history provides a basis for applying that understanding to the process of technological change as it happens, which offers the potential for addressing changes precipitated by new technologies with measured policy responses.

It is not my intention to imbue the bare framework with strong normative power. Cultural scaffolds are not intrinsically good and their displacement is not inherently bad. This framework nevertheless offers a descriptive tool to identify hidden consequences of technological change, and those consequences, as seen in the example of childbirth anesthesia, can have widespread implications for social, as well as mechanical agency. Understanding the relationship between technology and cultural scaffolding can therefore motivate evaluations of technology's social and cultural value and generate normative guidelines for responsible implementation and management of new technologies. When evaluating a technology's influence, the verdict with respect to cultural scaffolding might well be that it has no appreciable impact on cultural scaffolds, that the advantages the technology offers outweigh its agency cost, or that the agency lost to the technology is not culturally valuable. Furthermore, an assessment that a technology replaces a valuable scaffold does not necessarily imply a verdict that the technology should be abandoned, particularly if the autonomous agency can be maintained in other ways, for example by formalizing a previously informal scaffolding process. The conversation about how best to negotiate the displacement of a scaffold, however, can only begin once the process has been identified.

Identifying scaffolding displacement offers opportunities for social science research to test predictions the framework generates, such as those about smartphones and cognitive skills. If this

framework can be used to assemble robust data substantiating the consequences of scaffolding displacement and giving a quantitative assessment of the magnitude of the effect, then it will provide more sound foundation for policy action. The primary aim of this paper has been to supply a vocabulary for the consequences of technological change that are often difficult to identify and conceptualize. If that vocabulary can motivate further research and deeper insights into how technologies influence the capabilities we value as a culture, then it has the potential to become the basis for reasoned action to manage the impacts of technological change.

Acknowledgements

Discussions with Jennifer Alexander, Margaret Charleroy, Sahan Dissanayake, Betta LoSardo, Jessica Mozersky, Susan Rensing, Barb Wimsatt, and Bill Wimsatt guided this paper's construction. Thanks to lively audiences at the 2013 Society for Philosophy of Technology meeting in Lisbon, Portugal, the "Pressing Issues: The History of Technology Meets Public Policy" workshop at Colby College, and two anonymous reviewers for thoughtful and actionable feedback.

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