

Can technologies represent their publics?

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Abstract

This article locates the frequent call for public participation in the governance of technology within a theory of democratic representation. The article examines several modes of representation—symbolic, formal, delegate, trustee, and descriptive—in light of their potential contribution to a democratic theory of publicly representative technology. Publicly representative technology depends on each of the modes, giving some preference to the representative as trustee. Not every technical artifact or system should be expected to represent its constituents in the same way, but each mode of representation has an important role to play in facilitating democratic representation through technology.

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1. Introduction

In his seminal 1977 book *Autonomous Technology*, Langdon Winner offered a powerful indictment of “technological somnambulism,” the widespread assumption that technologies are morally neutral tools that evolve according to technical and economic imperatives, neither requiring nor allowing conscious political direction [1, p. 324]. The most important reason for opposing this assumption and subjecting technology to thoughtful legislation, Winner wrote, is that “technology in a true sense *is legislation*” (p. 323, original italics). As with conventional legislation, technologies embody and promote the values that shape their development. “Far from being merely neutral, our technologies provide a positive content to the area of life in which they are applied, enhancing certain ends, or denying or even destroying others” (p. 29). It follows that technologies ought to be shaped in part by lay citizens. “To as great an extent as possible,” Winner argued, “the processes of technical planning, construction, and control ought to be opened to those destined to experience the final products and full range of social consequences” (p. 326). At the time, Winner’s call for participatory technology was part of a larger societal interest in expanding opportunities for lay participation in political arenas dominated by technical experts. Although few hopes have been fulfilled, the notion of participatory technology has continued to attract the attention of a wide range of scholars and practitioners [2–7].

Few commentators, however, have fully considered the implications of the qualifying statements that usually accompany calls for lay participation in technological development, as in Winner’s above formulation: “to as great an extent as possible.” Such qualifiers suggest that possibilities for participatory technology need

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to be examined in combination with their limits. One way of doing this, which I pursue in this article, is to embed the notion of participatory technology within the broader ideal of making technologies represent their publics.

The first part of this article briefly makes the case that democracy today not only depends on but also benefits from political representation. I then examine several standard modes of representation—symbolic, formal, delegate, trustee, and descriptive—in light of their potential contribution to a democratic theory of publicly representative technology. I also offer some preliminary thoughts on the relationship between technology and law as mediators of political representation. I argue that publicly representative technology, like democratic representation more generally, depends on citizens having access to diverse modes of representation—not through every particular political institution or technical artifact but within any system of representation as a whole. Systems of political representation vary enormously, of course, and it would be impossible to identify a single best way of linking together different modes of representation applicable to all societies. Indeed, this article does not provide an ideal vision of representative democracy but rather articulates some of the conceptual issues often confronted by those seeking to democratize technology in particular contexts. The article suggests that citizens need not fear granting technical experts the discretion required for effective promotion of public interests, provided that expert performance is informed by lay participation, embedded within a culture of critical public scrutiny, and subject to formal procedures of authorization and accountability.

2. Democratic theory and technology studies

The concept of political representation has long been a point of contention among democratic theorists. In response to the perceived incompetence of lay citizens, so-called democratic realists have offered elitist theories of representation that restrict participation to periodic elections. Participatory and radical democrats, in contrast, have tended to see representative democracy as a second-best alternative to direct democracy, made necessary by the size and complexity of modern states. More recently, some democratic theorists have begun to develop new approaches to representation centered on the notion that representative democracy potentially enables a more vibrant form of politics than direct democracy [8–14]. By asking citizens to recognize that their representatives must consider diverse and conflicting perspectives and interests, political representation calls upon citizens to think in ways that go beyond their individual self-interest. And by drawing a permeable boundary between government and society, representation shelters citizens from the pressures of decision making, thus fostering a critical public sphere. Understood in this way, political representation depends on diverse forms of public participation that shape and mediate between public opinion formation in civil society and decision making in both state institutions and the various non-state institutions (e.g., advocacy groups, NGOs, transnational institutions) that increasingly play a role in societal governance. In addition, as recent work on the “co-production” of science and social order makes clear, political representation is mediated by scientific knowledge and technical artifacts [15,16]. In this respect, the question “Can technologies represent their publics?” might seem misplaced, as the public most certainly cannot be represented without technology (e.g., the transportation, communication, and voting technologies required for conducting political campaigns and holding elections).

Most theorists of technology, however, seem to have adopted the prevailing assumption among democratic theorists that political representation, while practically necessary, generally conflicts with participation. Andrew Feenberg, for example, writes that “representation is required wherever distances and large populations conspire against direct face-to-face deliberation” [17, p. 133,138; cf. 2, p. 95; 3, p. 37–9]. Feenberg [17, p. 106] reinforces this view by drawing a sharp distinction between efforts to democratize technology through regulations imposed from “above” and projects that focus on micro-politics from “below” seeing far more potential in the latter. At the same time, however, Feenberg criticizes those who overemphasize the role of local participation in democratizing technology [17, p. 132–40].¹ Indeed, Feenberg is one of the few scholars (along with Bruno Latour, discussed later) to explicitly link technology to questions of political

¹Similarly, Winner’s [2, p. 61–97] analysis of the 1970s appropriate technology movement criticizes its vague dreams of “decentralization” and its failure to come to terms with the realities of political institutions.

representation: “If technology is political and its design a kind of legislation, then surely it must represent interests much as do ordinary political decisions and laws” [17, p. 137]. Feenberg goes on to delineate some of the important differences between political and technical representation, which I discuss later, but in the end his primary concern is public participation rather than representation.

In this context, it makes sense to take a step back and consider the concept of representation in terms of the relations among its various meanings. Both critics and defenders of representation tend to focus on just one of its many elements, forgetting that representation is not an internally consistent concept with a single definite meaning. Rather, as Hanna Pitkin [18] showed in her classic study on the topic, the concept of representation includes multiple meanings, and most theories of representation privilege some meanings over others. This article examines five modes or ideal types of representation: symbolic representation, descriptive representation, formal representation, and the trustee and delegate modes of representation. It suggests that an adequate theory of publicly representative technology depends on each of these modes of representation. Throughout the article, I use the term “technology” in a very broad sense to include all the various forms of knowledge and activity involved in making material artifacts, as well as the artifacts themselves and the technological systems into which they often become incorporated [cf. 19, p. 149–51].

3. Symbolically representative technology

The notion of symbolic representation casts representation as a relatively static relationship between people or things, one of which “stands for” the other [18, Chapter 3]. Representation as “standing for” usually resides not in particular activities but in their results. Flags stand for peoples or nations; political leaders stand for their governments. In this static quality, symbolic representation is similar to what is sometimes called descriptive representation, according to which one thing mirrors or resembles something else. Maps, opinion polls, or portraits can all be said to represent in this sense. (I briefly discuss the relevance of descriptive representation for publicly representative technology below.) Some symbols, like those used on a map, provide factual information about what they represent. Many symbols, however, provide little or no such information. Rather, they evoke whatever thoughts and emotions have come to be associated with the symbol [18, p. 98].

It is widely acknowledged that technologies are symbolically representative in this second sense. From the steam engine to the atomic bomb, technologies and their makers have symbolized everything from social values of efficiency and progress to individual genius to national power and prestige [1, p. 44–5]. In a telling example, Yaron Ezrahi [20, p. 41–2] recounts how tour guides at the Kennedy Space Center once explained to admiring visitors that the Saturn 5 space craft was assembled from parts made by companies located all over the country. Once people heard that one part of the rocket was made in Texas, another in Nebraska, and another in California, they could all feel represented by the assembled artifact.² Just as modern democrats have long appealed to an idealized conception of science as a symbol of rational deliberation, they have often portrayed technological achievements as “standing for” the democratic ideal of collective problem solving.

Although symbolically representative technology can thus foster a commitment to certain democratic values, this mode of representation has serious limitations. Like other forms of symbolic politics, symbolically representative technology is grounded in affective association rather than formal procedures or substantive reasoning. A technology symbolically represents something for no other reason than that people see it as such. “It makes no sense to ask whether a symbol represents well, for there is no such thing as mis-symbolizing” [18, p. 110]. Democracy certainly depends on affective associations that shape and nurture political identities and practices, and in this respect symbolic representation plays a key role in democratic politics. But symbolic representation does not have a necessary relationship to democracy, and technologies have often served symbolic functions in non-democratic societies. Although public participation in technical design might engender a vague sense that the resulting technologies are symbolically representative of their respective publics, such affective associations must be linked with other modes of representation if they are to foster democracy.

²Ezrahi goes on to note that this sense of symbolic representation is made possible by the technical performance standards acknowledged by all involved. Popular suspicions that the privatization of innovation will corrupt public goals are allayed by the confidence that technical norms provide standards to which private businesses can be held accountable.

4. Formally representative technology

Whereas symbolic representation has no necessary political content, Abraham Lincoln's famous formulation of the democratic ideal in his *Gettysburg Address*—"government of the people, by the people, for the people"—nicely captures three modes of political representation with distinct political implications. The reference to "government of the people" suggests a formal mode of representation. The government is seen as publicly representative insofar as public officials fulfill certain formal criteria, such as being elected according to accepted procedures, obeying the laws while in office, and stepping down at the end of their terms if not re-elected. The formal mode of representation appears in the common notion that representatives must be authorized by, and held accountable to (and by), their constituents.

Scientists and engineers generally receive some sort of formal authorization through procedures of academic education and professional certification. Insofar as these procedures are open to public scrutiny, one might argue that professional authorization transforms engineers into public representatives. Similarly, efforts to make technology publicly accountable have employed mechanisms that either reward or sanction technicians and their sponsors for the public effects of their work. The US Bayh–Dole Act of 1980, for example, sought to foster the production of socially useful technologies by creating incentives for the commercialization of publicly funded research [21, Chapter 5]. Ethical review boards and public oversight committees might also be seen as formal controls on the activity of scientists and engineers. Such mechanisms give technicians an incentive to align their designs with public values, while leaving them relatively free from direct public involvement in their work. Formal mechanisms of authorization and accountability thus economize citizen participation, allowing citizens to trust experts most of the time while retaining the possibility of sanctioning experts when things go wrong [22, p. 56].

Despite these advantages, grounding the notion of publicly representative technology in mechanisms of authorization and accountability has important limitations. First, because authorization functions prospectively, and accountability primarily functions retroactively, neither applies to the activity of representation itself. Although accountability procedures might provide an incentive for technicians to consider public values in their design decisions, any sanctions or rewards come into effect only after technical artifacts have been created. Accountability requirements thus do little to counter the problem of path dependency, whereby initial design decisions create conditions that limit future options [1, p. 100–6]. Accountability requirements also create few opportunities for political participation in the shaping of technology. Indeed, scientists and engineers often suggest that their formally certified expertise enables them to represent the public better than elected officials [17, p. 137]. Finally, the notion of holding technicians accountable does not itself provide any criteria as to what they should be held accountable for. Indeed, according to the authorization and accountability views of representation, representatives might entirely ignore their constituents' interests, and as long as they have been duly authorized and allow themselves to be held accountable, they are still said to have represented the public [18, p. 113].

A theory of publicly representative technology ought to include a place for formal modes of representation, but they need to be complemented by more substantive modes that offer criteria for evaluating the activity of representing. The most familiar criteria appear in the delegate and trustee modes of representation. I first consider what it would mean to view technologies themselves as either delegates or trustees and then turn to the engineers and technicians who produce technology.

5. Technologies as delegates or trustees

The second aspect of Lincoln's democratic ideal, "government by the people," speaks to what is often called the delegate mode of political representation. This mode emphasizes the importance of participatory procedures through which citizens express their perspectives, opinions, and interests. The task of political representatives, according to this view, is to promote the subjective wishes expressed by their constituents with as little distortion as possible. Advocates of the delegate view thus often see delegates as substituting for their constituents, acting exactly as their constituents would have acted. At the extreme, they conceive interests as so fundamentally subjective that representatives cannot be trusted to distinguish between their own interests and those of their constituents [18, p. 206–8].

A provocative effort to conceive technologies as the delegates of their makers and users appears in the early work of Bruno Latour. Latour argues that technologies are best understood in terms of their capacity to perform tasks that people would otherwise fulfill themselves. As a general rule, he writes, “every time you want to know what a non-human does, simply imagine what other humans or other non-humans would have to do were this character not present. This imaginary substitution exactly sizes up the role, or function, of this little character” [23, p. 229]. Latour goes on to describe technologies as the delegates of the people whose work they perform. Hinges and doors are the delegates of those who would otherwise have to tear down and rebuild a wall every time a person wanted to go through it; an automatic door closer is the delegate of a porter; automatic seat belts are the delegates of those who want to reduce automobile fatalities; traffic lights and speed bumps are the delegates of police officers, and so on. Whenever people want a particular task to be performed but would prefer not to do it themselves, they can delegate it to a technology.³

Latour’s conception of technologies as delegates highlights at least two important aspects of the politics of technology. First, it allows us to see that the traditional ontological division between society and technology, between the moral purposes of human beings and the instrumental work of technology, fails to capture the various ways they shape each other. The porter who delegates her task to an automatic door closer was herself the delegate of those who wanted to keep the door closed. The porter’s routinized behavior, automatically opening and closing the door whenever someone approaches, is itself a form of technology. Latour’s examples suggest that we locate various human and non-human delegates at different places along an ontological continuum. Different kinds of humans and non-humans differ only relatively rather than absolutely in the degree to which they can be trusted to perform their delegated tasks. This does not mean, however, that there are no differences between them. Non-human delegates can generally be relied upon to perform their delegated tasks with only periodic maintenance. Moreover, they have a “built-in inertia” that makes it more difficult to change their instructions than those of a human delegate [23, p. 231]. Human delegates, in contrast, generally require ongoing supervision and discipline.

Second, Latour’s account shows how technologies embody the goals and values of those whose tasks they perform. An automatic door closer embodies the moral prescription to keep the door shut, as well as an unintended prescription against those in wheelchairs or carrying large packages who might have trouble getting through the door before it closes. Similarly, a factory assembly line conveys the prescription to work according to a certain speed set by management [17, p. 103]. Such embedded values may change over time, and recent accounts have shown how users often adapt technologies to purposes not intended by their designers [26].

Despite helping to clarify these aspects of the politics of technology, conceiving of technologies as delegates has important limitations. Most obviously, Latour’s account suggests that technical delegates do work that humans could otherwise do themselves, but this is clearly not always the case. A human could certainly do the work of a door closer or traffic light, but what about a steam engine or nuclear power plant? These technologies both magnify and transform human capabilities, and they cannot be sensibly understood as performing tasks that people could otherwise do themselves. Moreover, even if it makes sense to think of discrete technological artifacts as delegates, the concept cannot be easily applied to the vast technological systems that emerge gradually through diffuse social processes and today pervade daily life. As Winner [1, p. 104–5] argued, contemporary systems of transportation, communication, financial exchange, or energy production and distribution are not discrete products of intentional design, nor do they fulfill clearly defined tasks.⁴ One might still ask to what extent such technical systems represent public interests, but it makes little sense to think of them as delegates of particular people or groups.

Another limitation of Latour’s account becomes apparent in light of a careful look at the distinction between representation and substitution. Echoing the view of representation assumed by participatory critics of representative government, Latour suggests that because technologies substitute for people they can be

³The view of both technical and political representation as a matter of substituting for the represented also appears in Latour [24, p. 71–3]. In his more recent work, Latour [25, p. 55, 146–48] continues to discuss representation as a matter of “faithful translation,” which suggests a delegate view, but he also argues that representation always involves transformation of the represented.

⁴Winner [1, p. 11–2] distinguishes among four types of technology: apparatus (physical devices), techniques (rational purposive ways of doing things), organization (rational social arrangements), and networks (large-scale systems connecting people and apparatus).

viewed as those people's delegates. Delegation is properly understood as a form of representation, but the same cannot always be said for substitution. A substitute teacher, for example, does not represent the regular teacher and is not the regular teacher's representative. The substitute teacher may act according to more-or-less precise instructions from the regular teacher, but what the substitute does or says is not necessarily binding upon the regular teacher. Nor is the substitute required to promote the regular teacher's interests. The substitute's responsibilities are not primarily to the regular teacher but to the school, profession, or students. The same could be said of a substitute football player, pilot, or musician [18, p. 131–3].

At this point I want to consider whether some of these limitations of the delegate mode of representation could be avoided by taking up Lincoln's third aspect of democracy, "government *for* the people," which speaks to what is often called the trustee mode of representation. Often associated with Edmund Burke, this mode of representation casts representatives as guardians who promote a more-or-less objectively determined public good. The trustee mode emphasizes the importance of reasoned judgment, moral virtue, technical expertise, and substantively effective policy, often at the expense of citizen participation. At the extreme, representatives become technocratic experts who aim to serve the public good with no input from their constituents.

One might see an analogy between technologies and political trustees in the limited sense that the relative independence of political trustees from the wishes of their constituents is similar to the above noted obduracy or "built-in inertia" of technology. Other scholars have conceptualized this phenomenon as "technological momentum," noting that political efforts to shape technological systems are more successful when a system is relatively young than when it has become socially established [27, p. 112–3]. Just as trustees do not attend to every fleeting change in public opinion, established technologies cannot be transformed with every change in the values or preferences of their users. One might even be tempted to view technologies that reliably perform tasks "for" their users as their users' trustees. Whereas the delegate conception of representation captures the ways that technologies embody the values prescribed by their designers, the trustee conception highlights the objective quality that such prescriptions acquire over time.

But here the analogy begins to fall apart. Although technologies embody human goals and values, they lack the capacities of reason, will, and emotion from which such goals and values arise. And although the meanings and uses of technologies often change, technologies generally cannot transform themselves in response to a designer's or user's changing needs or desires (of course, some argue that developments in artificial intelligence, robotics, and related fields suggest this may not always be the case). Whereas both political trustees and delegates have an obligation to remain both responsive and responsible to their constituents, technologies merely embody or reflect the values and decisions of their makers and users. Despite highlighting certain aspects of the politics of technology, thinking of technologies as either delegates or trustees does not realize everything one might expect from a democratic theory of publicly representative technology.

6. Engineers as trustees, descriptions, or delegates

In addition to considering the extent to which technologies themselves may be said to represent citizens, it will be helpful to think about how those who design and build technologies can be seen as public representatives. Do technicians and engineers, by promoting public interests or responding to the expressed wishes of citizens and consumers, represent their publics?

There is nothing new about the idea that engineers should serve the public interest. Professional engineering societies have long seen promoting the public welfare as part of their mission, and engineering schools increasingly require courses in professional ethics and social responsibility. The various social benefits of engineering suggest that engineers might be seen as public trustees. Engineers "act for" their constituents' generally shared interests in economic development, national defense, medical technology, and other generally shared human needs. "Once fundamental goals are taken as common to different people and such equality before reality is an accepted premise, professionalization can evolve as a form of authoritative instrumental 'representation'" [20, p. 47]. As suggested above in Section 4, experts often cast themselves as "the true representatives of a universal human interest in efficiency already embodied in their technical culture" [17, p. 137]. Insofar as public needs are widely shared and can be objectively assessed, engineers can serve as public trustees.

Once again, however, the notion of engineers as trustees does not capture everything that belongs to a democratic theory of representation. Given the institutional constraints and commercial incentives that compel most engineers to serve short-term market needs whether or not they benefit the public, calling on them to act as public trustees cannot be expected to have much impact on engineering practice [28, p. 73–4]. Like other experts, moreover, engineers who promote shared public needs in the absence of public involvement do not represent their constituents so much as substitute for them. Insofar as the representative-as-trustee pursues truly shared human needs, she is not pursuing needs specific to her constituents. Constituents thus easily become passive recipients of their trustee's services, just as most medical patients passively receive the services of their doctors [18, p. 135–40]. Promoting the public interest does not by itself make engineers democratic representatives.

A somewhat different rationale for a trustee conception of representation has long been found in descriptive similarities between representatives and constituents. A descriptive view of representation was prominent among the Anti-Federalist opponents of the US Constitution, for example, one of whom argued, "The very term representative, implies, that the person or body chosen for this purpose, should *resemble* those who appoint them—a representation of the people in America, if it be a true one, must be *like* the people" (quoted in Ref. [29], p. 110, original emphasis). Similarly, the eighteenth-century doctrine of "virtual representation," prominently defended by Burke, asserted that representatives who share economic, cultural, and emotional bonds with their constituents can "virtually" represent them without having been elected to "actually" represent them [18, Chapter 8]. More recently, the descriptive view of representation appears in the claims of advocacy groups to speak for all those who ostensibly share the group's interests, even if they are not members of the group or have expressed the group's interests. Descriptive representation also appears in the use of demographic criteria to select participants for consensus conferences, citizens' juries, and similar attempts to involve lay citizens in technology assessment [30]. Finally, descriptive representation appears in the notion, prominent among feminists in the 1980s, that a technology based on "women's values" would be more attuned to social relationships and basic human needs than the patriarchal, mechanistic, rationalistic modes of thought that were seen as dominating technological design [31]. Many such approaches to making technology publicly representative assume that descriptive representation translates into interest representation. Whereas the delegate mode of representation binds representatives to their constituents through elections and communication between elections, the descriptive view suggests that representatives who in some way resemble their constituents will spontaneously promote their constituents' interests. To the extent they do, one might promote publicly representative technology by encouraging social diversity among engineers.

This issue is too complex to discuss fully here, but it is worth mentioning a few reasons to treat such an approach with caution. As Young [12] and others have noted, although most people attach some meaning to conventional social groupings—e.g., women, the elderly, African-Americans—any attempt to define such groups with reference to a set of particular attributes or dispositions risks creating a stereotype. One can always find people who experience themselves as members of a group but who lack at least some of the allegedly group-defining attributes, and vice versa. Moreover, even people who define themselves as part of a particular social group may differ greatly in their political values and interests. Also, the very notion of group identity risks denying the multiple memberships in diverse social groups that most people experience. Thus while early feminist theories of technology rightly emphasized technology's value-laden quality, they often relied on an essentialist view of women that neglected both the diversity among women and the historical contingency of women's traditional association with so-called feminine values [32]. Beyond these problems with identifying the attributes of group members, the descriptive view of representation, like the symbolic view, has little determinate political content [18, p. 61]. Descriptive representatives can potentially provide information about the characteristics deemed typical of their constituents, but this by itself does not authorize them to act on their behalf. Nor can descriptive representatives be held accountable in the manner of delegates or trustees, since people can be held to account only for what they have done, not for what they are [18, p. 83–91].⁵

⁵Descriptive representatives can at most be held accountable for presenting the perspective they promised to present when they were selected [14, p. 522].

At the same time, however, completely rejecting the notion of descriptive representation fails to take account of ongoing patterns of privilege and exclusion, including the continuing under-representation of women and minorities in the engineering professions [33]. One way of ameliorating (but not eliminating) this dilemma lies in seeing group identity not primarily in terms of shared interests and opinions but rather in terms of shared experiences and perspectives [12, p. 136–41; 34,35]. Although African-Americans, for example, do not all have the same political views, many share similar experiences of racial discrimination and, as a result, similar political questions and concerns. Similarly, the problem with the relative lack of female engineers is not that men are incapable of representing women's interests, but that men generally lack the necessary experiences to consistently and competently raise issues that tend to concern women more than men. From this perspective, group representation is not a way of representing group interests but of increasing the inclusiveness, and thus the quality, of deliberation among representatives. Whereas sociologists of technology have tended to focus on relations among the "relevant social groups" actually involved in shaping new technologies [36], the notion of descriptive representation highlights the biases that might become embedded in new technologies by the absence of particular groups. Nonetheless, given the tenuous links between demographic categories and political interests, descriptive representation needs to be complemented by other forms. As Burke himself made clear, "virtual representation cannot have a long or sure existence if it has not a substratum in the actual" (quoted in Ref. [18], p. 177). For Burke, representatives could only represent some constituencies as trustees on a descriptive basis if they also represented similar constituents on the basis of election—and hence, in that sense, as delegates.

Engineers are not publicly elected, but one sense in which engineers act as public delegates is when they respond to the demands of interest groups and social movements. Environmental, anti-nuclear, women's health, and patient advocacy groups, for example, have significantly shaped a wide range of technologies [26, Chapters 5–8]. Engineers also act as public delegates when they design products in light of market research and consumer surveys. This is presumably the sense intended when the home furnishing giant IKEA proudly advertises the "democratic design" of its products. A major shortcoming of consumer-oriented approaches to representation is that they rarely consider the broad public consequences of technological design. Some consumers, of course, view their purchasing decisions as opportunities for self-expression, and when large numbers of consumers engage in coordinated boycotts or "green" consumerism, the sum total of their choices might compel engineers to promote public interests. But politically engaged consumerism is the exception that proves the rule that economic activity offers few opportunities for expressing one's views on political issues. Market research, moreover, is biased toward those who can afford the anticipated consumer technologies [3, p. 181]. Social movements and interest groups potentially offer more opportunities for deliberative consideration of public interests, but they often focus their efforts on the limited interests of particular social groups. Advocacy groups, moreover, rely more on the descriptive modes of representation described above than on the delegate mode—i.e., many of those for whom a group claims to speak may share the group's perspective or interest but did not explicitly delegate that group to represent them. Whereas the trustee mode assumes that engineers can represent objective social interests, the delegate mode reduces their task to representing subjective individual or group preferences. Neither the trustee nor delegate mode by itself can deliver a democratic theory of publicly representative technology.

7. Publicly representative technology

A democratic theory of publicly representative technology needs to draw on all the above modes of representation. The traditional conflict between the delegate and trustee modes, and also between direct and representative democracy, revolves around whether public officials ought to act as passive mirrors or wise filters for pre-existing citizen preferences. The view of democratic representation alluded to in Section 2, in contrast, suggests that political representatives can neither reflect nor filter a pre-existing public will, because the practices and institutions of representation help constitute the same publics they represent. Different systems of political representation shape the roles and identities of citizens in different ways, and these political systems are themselves co-produced with technological systems. The locus of representation, therefore, is neither government nor technology but the entire sociotechnical system. From this perspective, the democratic shaping of technology is not a linear affair of citizen inputs leading to technology outputs.

Instead it requires reflexive, responsive, and incremental adjustment to ongoing changes in both technology and civil society [37]. Locating such adjustments within a theory of democratic representation raises questions that go beyond both technologies themselves and those who design them to include the relationships among citizen identities, technological networks, and social and political institutions. The last section of this article briefly outlines a few of these questions.

One key challenge for publicly representative technology lies in the power of modern technologies to shape the behavior and identity of citizens, potentially narrowing the critical distance upon which democratic representation depends. Advertising-driven political campaigns, poll-driven governance, and entertainment-driven television news all compress political space and time. They reduce or destroy the distance required for reflective communication among constituents, and between constituents and public officials, thus preventing genuinely democratic representation. Whereas direct democracy collapses the distance between citizens and their government, representative democracy depends on maintaining a tension between them [13, p. 761; 29, p. 174–5]. Similarly, popular deliberation and judgment concerning technology requires a certain critical distance from it. Much of Winner's analysis of modern technology suggests, however, that far from technology representing human needs and interests, human beings represent the actual or perceived imperatives of their technologies. "As they become woven into the texture of everyday existence, the devices, techniques, and systems we adopt shed their tool-like qualities to become part of our very humanity" [1, p. 190; 2, p. 12]. Indeed, emerging genetic technologies suggest new possibilities for radically reducing or even eliminating the gap between technology and identity. If technologies not only enable and constrain but also fundamentally constitute prevailing modes of thinking and acting, citizens may have difficulty engaging in the critical reflection upon which democratic representation depends.

Winner long ago proposed one way of responding to this dilemma that still seems promising: "epistemological luddism" [1, p. 330–3]. By disassembling existing technologies, either imaginatively or in fact, or by simply paying closer attention when technical systems break down, it may be possible to acquire some critical distance on the ways that technologies constitute social relations. For several months after the 1989 Loma Prieta earthquake in Northern California, for example, commuters had to switch from their daily automotive crawl across the Bay Bridge to the long-neglected ferry service. After their initial dismay, many drivers were quite pleased with this involuntary change in their transportation habits. Once the bridge was repaired, of course, everything went back to normal, but the event offered an opportunity for drivers to become more aware of the social dimensions of their transportation system. Similarly, by revealing the political values and decisions embedded within technologies, social studies of technology potentially foster critical distance between technologies and citizen identities.

Another key challenge for publicly representative technology lies in the character of the publics that technologies might represent. Modern technologies tend to fragment the local publics traditionally assumed by the delegate mode of representation. Consumer, transportation, and communication technologies often create obstacles for local community, even as they facilitate translocal "technically mediated subgroups" linked by the shared use of and subjection to technology [17, p. 135]. Given the fragmentation of local publics, Feenberg suggests that "the technical network itself" might serve as an alternative locus of representation [17, p. 139]. The constituency potentially represented by a technical network—e.g., a transportation system—consists of all those people affected by the network and potentially resistant to it. Such resistances need not have any connection to particular localities. The constituents of a particular technology might be as widely dispersed as the users of a consumer product or the employees of a multinational corporation. This spatial dislocation of technological constituencies means that if technologies are to facilitate democratic representation, the typical fixation on the territorial state as the locus of representation must be reconceived to include people and technologies in multiple countries [cf. 12, Chapter 7].

In addition to the spatial fragmentation of technological publics, the above-noted obduracy of technology means that such publics are temporally extended. Technology depends on the gradual accumulation of skills, resources, and expertise, all of which requires time. Whereas the loss of popular control over political decisions arises in part from the physical expansion of the polity, the loss of popular control over technical decisions arises from the expansion over time of expert knowledge and skills. In this respect, technology always represents the past: it is "the bearer of a tradition that favors specific interests and specific ideas about the good life" [17, p. 139]. Whereas political representatives must consider the present needs and desires of their

constituents, technical specialists “represent the interests which presided over the underdetermined technical choices that lie in the past of their profession” (Ibid.). Representation in politics, of course, is also shaped and constrained by its history, most obviously by the existing constitutional and legal framework. But most policies and laws, and even most constitutions, can be more easily changed than established technical systems.

This greater obduracy of technology as compared to law has several implications for a theory of publicly representative technology. First, due to various technical imperatives, technicians are more constrained than public officials in the ways they can seek to represent their constituents. Technology is usually understood as faster and more adaptable than politics, but in some respects it offers far less flexibility. “Technical representation ... involves the embodiment of social and political demands in technical codes. These codes crystallize a certain balance of social power.... A specialist who failed to represent the interests embedded in the code would be a technical failure as well” [17, p. 142–3]. When trying to promote the interests of their constituents, engineers have less discretion and more immediate sanctions for poor performance than public officials.

Second, whereas both elected and appointed political representatives can be exchanged for others fairly easily, the social costs of technical failures are too high to simply discard technical personnel or artifacts that do not adequately represent their publics. Citizens cannot simply replace all at once the many technologies that either were designed without sufficient public input or cannot be adapted to public needs. This does not reduce the value of efforts to assimilate technological systems to public needs and values, but one need not be surprised when efforts to redesign technological systems require more patience and long-term planning than other types of political reform.

Third, one might draw an instructive parallel between Feenberg’s time/space modes of representation and the trustee/delegate modes presented in Section 5. Trustees require time to become wise guardians of the public good and to deliberate with other such guardians; delegates must reach across political space to solicit the expressed wishes of their constituents. This parallel suggests that although making technology publicly representative depends on public participation and input, it depends to an even greater degree on accumulated expertise, and to that extent it may require an emphasis on the trustee mode of representation. Trustees can be prevented from turning into technocrats by binding them closely to the other modes of representation. Feenberg [17, p. 142–7] thus highlights the need for electoral controls (i.e., formal authorization and accountability) on both private and public institutions that make and regulate technology. A division of labor between experts and laypeople may be both unavoidable and desirable, but it can be democratized by embedding it within a sociotechnical network that incorporates multiple forms of representation.

8. Conclusion

The multiple forms of representation discussed in this article require different types of institutions to facilitate them. Just as the legislative, executive, and judicial branches of government emphasize different modes of representation, so too do different kinds of civic organizations, interest groups, and transnational institutions. The degree to which citizens enjoy democratic representation, therefore, should be judged with respect to the ecology of institutions to which they have access, rather than with regard to any single institution. Deliberative forums such as consensus conferences and citizens’ juries, for example, are well positioned to increase the descriptive representation of diverse social perspectives in technology policy, and their descriptive representativeness may evoke a feeling of being symbolically represented within the population from which they are drawn. Such forums, however, are usually not directly authorized by their publics, nor are they held publicly accountable for their proposals [30]. The reverse is true for elected representatives, who are authorized and held accountable through elections, but who as a group are often not descriptively representative of their constituents. Interest groups, for their part, often succeed quite well at mobilizing citizens and facilitating a delegate mode of representation, but they often lack the trustee perspective fostered in both governmental and non-governmental deliberative forums.

Sociotechnical networks link citizens, technicians, and policymakers with technical and political institutions and with technologies and public policies. Although different contexts generate very different types of sociotechnical networks, to the extent they integrate each of the above modes of representation, the technologies they produce are more likely to foster democratic representation. Not all politicians, engineers,

technologies, or technical networks need to represent their constituents in the same way, but constituents should have access to each of the modes of representation. Generally speaking, the complexity and obduracy of technology requires granting the trustee mode a certain priority, embedded within a system of representation in which the symbolic, formal, delegate, and descriptive modes of representation also have a place.

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