This is a preprint version of the following article:
Brey, P. (2005). 'Artifacts as Social Agents' in *Inside the Politics of Technology. Agency and Normativity in the Co-Production of Technology and Society* (ed. H. Harbers), Amsterdam University Press, 61-84.

Artifacts as Social Agents

1. Introduction: the agency of artifacts

Do artifacts act? Should agency be assigned to them in accounts of social change? Or are the only social agents human beings and social structures like groups and organizations? This is a pivotal question for technology studies, but one that has not so far received an equivocal answer. On the one hand, the literature in technology studies is filled with examples and cases that suggests that technological artifacts and systems do act: they have been claimed to prescribe behaviors, constrain political arrangements, induce cultural beliefs and practices and shape aspects of their social context. On the other hand, the social constructivist orientation of a large part of technology studies seems to be incompatible with an attribution of agency to artifacts, because it maintains that alleged properties of artifacts reduce to actions and interpretations of social groups.

There is a general agreement in technology studies that the introduction and use of a new technology is often accompanied by significant changes in its social context. Such changes may include changes in individual and collective behaviors, attitudes and beliefs, in social statuses and roles, and in social structures and institutions. This generally accepted idea goes against the notion that technologies are neutral, in the sense that they are mere means to ends that function to perform certain tasks more quickly, efficiently or powerfully, and that a proper analysis of them focuses on their function as an means to chosen ends. It is a central finding of technology studies that technologies must be understood in addition, and perhaps centrally, as building blocks of society and as instigators of social change, in ways that are often unrelated to their intended functions.

But here the agreement stops. One may agree that the widespread use of birth control pill has been *accompanied* by, and can be *correlated with*, sexual liberation and greater freedoms for women, and that *without* the pill, these changes would not have occurred. But then one may go on to seriously disagree on the agentive role of the pill in this whole process. On the one hand, one may present a narrative in which the pill is a powerful actor, a hero (or villain) that singlehandedly gave sexual freedom to a generation and liberated women. In this story, the pill may be depicted as a liberator, with sexual freedom written all over its chemical code. It only needed a chance to act. Yet, one may also tell a story in which sexual liberation is not created by a little pill, but by people who were already in the process of a revolution when a little chemical entered the scene, and who *made* it play an important role, by attributing meanings to it, and by implicating it in practices. In this story, there is no such thing as a pill with inherent liberative powers. The pill, as a catalyst for social change, is a social construction. Pills do not act; in themselves they are inherently powerless and amorphous. But people can make them look like they have powers and agency, by assigning interpretations to them and implicating them in practices.

These two perspectives characterize two of the three dominant perspectives in technology studies concerning the nature and status of technological artifacts and systems. They are the *realist perspective*, according to which artifacts have inherent properties and agency can be attributed to them in a straightforward way, and the *social*

constructivist perspective, according to which artifacts do not have inherent properties but only imputed or attributed properties, and any imputed agency of them ultimately derives from the interpretations and behaviors of individuals and social groups.

Next to these two perspectives, there is a third, which I shall call the *hybrid perspective*, which has been taken up most forcefully in *actor-network theory* (Callon, 1987; Latour, 1987; Callon and Latour, 1992). In this perspective, the neat distinction between the social and the technical or material, accepted by both realists and social constructivists, should be abolished, and artifacts and their properties should be neither analyzed as objective givens nor as mere social constructions, but as *both* real and constructed. Artifacts and their properties emerge as the result of their being embedded in a network of human and nonhuman entities. It is in this context that they gain an identity and that properties can be attributed them. Hence they are constructed. But since this network is not a purely social network (it includes nonhuman entities as well) they are not *socially* constructed. And since they are participants in the network as well, on can attribute agency to them, even though this agency derives from their place in the whole network.

In this essay, I will critically evaluate these three dominant perspectives on the agency of artifacts. My conclusion will be that none of these perspectives provides a satisfactory account of the agency of artifacts, and I will end up sketching an alternative perspective, which I will call *differentiated constructivism*.

2. Realism

Realists hold that social change accompanying the use of a technology can often be causally correlated with the design strucure of these technologies themselves, and that therefore these technologies can be properly analyzed as possessing *powers* for effecting change, and that when these powers are exhibited, the technologies are properly analyzed as *acting*. The agency of artifacts is moreover held to be irreducible to the agency of human agents involved in their production, regulation or use: it is a feature of artifacts themselves, just like your action to buy a sandwich is (although in many ways shaped by the society you live in) not reducible to actions of others.

There are many examples in the literature that seem to support this realist position by showing how the design of a technology constrains or enables practices, beliefs, or social configurations. In all these cases, one is tempted to say that it is the technology that brings it about that these practices, beliefs or configurations take place, and hence that the cited artifacts or systems have agency. Latour (1992), for one, discusses how mundane artifacts, like seat belts and hotel keys, may induce their users towards certain behaviors. A hotel key, for example, has heavy weights attached them in an attempt to compel hotel guests to bring their key to the reception desk upon leaving their room. Sclove (1995) points out that modern sofas with two or three separate seat cushions define distinct personal spaces, and thus work to both respect and perpetuate modern Western culture's emphasis on individuality and privacy, this in contrast to e.g. Japanese futon sofa-beds. Winner (1980) discusses nuclear power plants, which, he claims, require centralized, hierarchical managerial control for their proper operation. They cannot be safely run in an egalitarian manner, unlike, for example, solar energy technology. In this way, nuclear plants require that a particular form of social organization has to be adopted for their operation.

On a naïve form of realism, which may be termed *technological essentialism*, technologies may have inherent powers that manifest themselves in any context of use. Technologies may be *inherently* authoritarian, democratic, unjust, deskilling, repressive, egalitarian, individualistic, masculine, Western, etc. Langdon Winner

(1980) has claimed that a technological essentialist position is correct for at least some technologies. He has argued that some technologies are 'inherently political,' in that they have specific political consequences that will manifest themselves in any setting. The atom bomb, for example, is inherently political because '[a]s long as it exists at all, its lethal properties demand that it be controlled by a centralized, rigidly hierarchical chain of command closed to all influences that might make its workings unpredictable. The internal social system of the bomb must be authoritarian; there is no other way.' (34). Other cases of technological essentialism in the literature include Ivan Illich's (1973) distinction between convivial and anticonvivial or manipulatory tools, Lewis Mumford's (1964) distinction between democratic and authoritarian technology, and feminist analyses of technology as inherently masculine, or inherently patriarchal (e.g., Corea et al., 1985; Mies, 1987; Merchant, 1980).

Technological essentialism tends to underestimate the interpretive flexibility of technology and is vulnerable to counterexamples, that show that such technologies, when used in a different cultural or social context, may often exhibit properties that are thought to be incompatible with their claimed essence. A more sophisticated variety of realism, which I shall call *contextual realism*, is more sensitive to the context-relativity of the workings of many technologies. Contextual realism holds that artifacts may impose constraints on their environment that derive from their physical design properties, but hold that such constraints will often be different in different environments, or settings. Take, for example, Winner's (1980) famous case of the Long Island bridges. Winner claimed that these bridges were built at a height of often no more than nine feet, a height that prevented buses to pass under them, hence effectively blocking access by public transportation to Long Island. Because most blacks depended on public transportation at the time these bridges were constructed, the bridges consequently worked to bar access for many blacks to Long Island. The relevant constraint imposed by these bridges is hence that blacks were largely excluded from accessing Long Island (especially its popular public parks).

On a contextual realist analysis of this case, it is a feature of the material design of these bridges, their construction at a height of nine feet, that was responsible for the constraint these bridges imposed on their environment, viz. making it impossible for buses from New York to access Long Island, and thereby barring easy access to Long Island for most blacks. Clearly, being discriminatory against blacks is not an intrinsic property of bridges in general, nor specifically of bridges built at a height of nine feet. In many conceivable settings, bridges with a height of nine feet would not be discriminatory against blacks. For example, they would not be in settings where blacks are not economically disadvantaged or have alternative modes of public transportation available to them, or where buses are less than nine feet high.

So although nine-feet-high bridges are not intrinsically discriminatory against blacks, they may become discriminatory in particular settings, particularly in situations in which they are placed in areas in which blacks (and not whites) use buses as their predominant mode of transportation, where these buses are more than nine feet high, and in which blacks cannot easily switch to alternative modes of transportation. The setting constituted by New York and Long Island in the 1960s constitutes such a type of setting, and hence the nine-feet-bridges in them are discriminatory. This discriminatory character derives from the relation or 'fit' between the physical design features of these bridges (i.e., their being built at a height of nine feet) and their setting, or context of use.[1]

Other cases discussed by Winner also fit a contextualist analysis. For example, Winner discusses pneumatic molding machines used at a 19th century reaper manufacturing plant in Chicago. In that particular setting, these

[1] Indeed, the setting has changed since the 1960s. One change since then is the emergence of the camper van. The bridges now also discriminate against owners of camper vans, who cannot pass under them.

machines had the effect, incidentally intended by the owner of the plant, of breaking the union who represented the skilled workers in the plant, because they undermined the power of skilled workers as they could also be used by unskilled workers. Clearly, helping to break a union (or even of undermining the power of skilled workers) is only something pneumatic molding machines can do in particular settings, that is, in plants in capitalist societies in which skilled workers are united in unions.

If the agency of technologies is hence context-relative, as contextual realism claims it is, would it not be more proper to say that agency does not reside in the artifact but rather in the whole setting, that is, *the artifact plus (relevant aspects of) the context in which it is used*? Contextual realists would, I believe, say that attribution of agency to the artifact alone is justified because the artifact functions as the *major independent variable*. That is, whereas the agency is dependent on other variables as well, that are found in the environment of the artifact, the artifact itself is most directly and specifically linked to the changes that occur. Thus, whereas the bridges over Long Island would not have discriminatory politics if blacks in New York were not economically disadvantaged, the immediate cause of their being barred is clearly not the economic politics of New York, but the construction of the bridges. Thus, it is the bridges that are discriminatory, even though they can only have the discriminatory politics they have because of various other contextual factors.

Realists emphasize the physical structure and operation of artifacts and correlate social change with this structure and these operations. By focusing on the physical design of artifacs, they downplay the role of social factors in effecting change. Although social factors may play a subsidiary role in contextual realism (e.g., social factors that are responsible for the poverty of many blacks in New York, in the case of the Long Island bridges), they are usually assigned a mere background role. One type of social factor that is particularly downplayed in realist analyses is that of *social representation*. The social representation of artifacts is the process of constructing shared (i.e., social) representations of them and their properties. Such social representations determine to a significant extent how an artifact is perceived by individuals, what features (including functions and relations to other entities) are recognized in it, how these features are evaluated, and ultimately how the artifact is used and what consequences result from this use.

Consider, for example, pink baby clothes for girls. Such clothes do not just have the intended function of clothing the child, they also impose a gender constraint by perpetuating a gender stereotype: they symbolize femininity, along with associated traits like sweetness, cuteness, passivity, etc. In this way, they promote a gender stereotype and promote treatment of the baby girl in accordance with this stereotype. A realist analysis of this gender constraint appears to be incorrect. Pink baby clothes do not somehow physically induce a gendered treatment of the baby girls who wear them. It is instead the fact that a still widely accepted social representation exists of pink as symbolizing femininity and stereotypical female qualities that this treatment will often result. The color pink does not wear this symbolical meaning on its sleeve. This gendered social representation of pink is instead a social construction that only exists in certain societies.

Another example, discussed in Pfaffenberger (1992), is that of the Victorian hallway bench, used in the hallway of Victorian houses to seat servants and tradesmen while they had to wait. The bench itself was plain and uncomfortable, without upholstery, whereas it often included an ornate mirror and delicately carved hat hooks. The bench served to mark social status: it reminded servants of their inferior status, while also underscoring the superior status of the master, through the mirror and hat hooks below which the servants were seated. Here, again, the hardness of the bench and the ornateness of the mirror and hat hooks do not somehow physically require the persons

who are seated on them to have inferior status, or the owner of them to have superior status. It is rather that social representations existed of higher and lower social statuses, including representations of attributes that were considered 'fitting' for this class. It was considered 'fitting' for the lower classes to make use of 'plain' artifacts, whereas the higher classes used 'luxurious' artifacts. Because the bench was socially represented as 'plain,' and this social representation was associated with 'lower class,' (and the 'luxurious' mirror and hat hooks with the higher class of its owner) the bench (and the mirror and hat hooks) could be used to mark social class.

Even when it may seem that social change is due to the physical design of a technology, social representation processes often play an important role. Take, for example, the case the atom bomb, which is claimed by Winner (1980) to impose a political constraint: it requires a strong, authoritarian security network because of its lethal properties, which pose a danger of theft or terrorist acts. But in a sense, it is not the objective lethal properties of the bomb that impose this constraint, but rather a social representation of the bomb as having lethal properties and of posing risks when not guarded well. It is these perceptions of lethality and risk, and not any objective features of the artifact itself, that are the immediate cause that certain actors organize an authoritarian security network about the bomb, and that take away resistance by third parties to this authoritarian network by legitimizing its existence.

The problem with realist perspectives is that they systematically underestimate the importance of the mediating role of social representations between the technology and its social context. Technologies rarely *force* behavior, in the sense of physically moving one's arm or stopping one's feet. Also, they do not *tell* people what new configurations or practices they enable. Instead, the direct basis of many social changes accompanying the use of a technology seems to lie in social representations about what a technology is and what it does. Importantly, these representations do not passively mirror the 'objective properties' of the technology. Instead, it has often been shown in technology studies that technologies have 'interpretive flexibility, (Pinch & Bijker, 1987) in that people can attribute very different functions, abilities and properties to them.

For this reason, also, realist analyses cannot give a satisfactory account of the politics of technology. Technological artifacts or systems rarely, if ever, have 'inherent' political consequences (*contra* Winner). They may contribute to shifts in power relations or in distributions of social goods, but a proper analysis of such political changes requires that an important role is also assigned to social factors, and particularly to the way users and others interpret and represent the technology. If such factors are neglected, then the false idea may take hold that political problems may be solved merely by designing technologies with desirable built-in political consequences, or by removing technologies that seem to have undesirable consequences. The politics of technology are usually a lot more complex than that.

3. Social constructivism

Whereas realists tend to downplay the role of social representations in the constitution of technological agency, social constructivists instead place all weight on them. Social representations are not just claimed to play a major role in the constitution of agency, they are claimed to fully determine it. Alleged technological agency is wholly the product of the way in which artifacts are socially represented (and hence used). The baby clothes, Victorian bench and atom bomb examples in the previous section demonstrate the plausibility of this position.

Social constructivists hold that artifacts have *interpretive flexibility*: different interpretations, or social representations, can be assigned to them, and these different interpretations assign different properties to them, not

just regarding their function, but also regarding their technical content. Sometimes, different social groups will represent an artifact quite differently. At other times, however, processes of social negotiation lead to *closure*: one dominant social representation is arrived at that henceforth will determine how the artifact is interpreted and consequently what human practices will evolve around it (Pinch & Bijker, 1987). This whole process is sometimes described by a textual metaphor: artifacts are *texts* that allow for different readings of them (Woolgar, 1991a). When closure is arrived at, however, one dominant reading of the text prevails and alternative readings of them may become difficult. On a social constructivist conception of affordances and constraint, then, these are not constituted by inherent design features of artifacts themselves, but rather by dominant social representations or 'readings' of them. Design features of artifacts that seem to be responsible for constraint are actually social constructions.

Perhaps the most fully developed social constructivist theory of the agency of artifacts has been developed by Bryan Pfaffenberger (1992). Pfaffenberger is specifically concerned with political agency. He argues that the political agency of artifacts derive from *affordances*: perceived properties of artifacts that suggest how they should be used, or, more broadly, how they should be responded to. For instance, it is a perceived affordance of a cup that it can be used to drink water, but in certain settings it may also be a perceived affordance of a cup that it can be used to emphasize one's taste in choosing decor, or to hold model airplane parts. Affordances are not objective design features of artifacts but rather social constructions, or social representations, as they depend on a selective and constructive process of 'reading' certain uses or meanings into artifacts.

For a particular way of 'reading' an artifact (i.e., a particular affordance) to become dominant, it must be *discursively regulated*. That is, the affordance must be legitimated by a sufficiently persuasive discourse. The most persuasive discourses are symbolical discourses of myth, ritual and classification, rather than the verbal discourses of proposition and argument. So, for example, the affordance of Victorian hallway benches to express class distinctions and humiliate the lower classes depended on a symbolical discourse that legitimated this affordance. This symbolical discourse derived from the Victorian myth of hygiene: the plain bench was presented as an artifact that had to be used by the servant class not because it would humiliate them, but because they had been on 'public conveyances' and would therefore soil upholstery with the filth of the streets.

Pfaffenberger adds that discursive regulation in itself is usually insufficient to endow artifacts with political affordances. Discursive regulation must be accompanied by *secular ritual*, standardized practices that follow relatively well-defined scenarios involving various acts and objects, that help regulate social behavior. It is through secular ritual that the political affordances of an artifact come to life. For example, the politics of the Victorian hallway bench were brought to life through ritualization of the hallway space. This space was the site of profound decorum standards, which called for members of the master's class to be admitted straight-away into the interior of the house, while members of the servant's class were seated on the bench, thereby signifying their inferiority. To sum up, according to Pfaffenberger affordances and constraints derive from perceived affordances of artifacts, which are social representations that are legitimated by symbolic discourses, and that are brought to life through secular ritual.

If affordances and constraints derive from social representations rather than from physical design features, can constraints still be legitimately attributed to artifacts, or would it be more proper to say that artifacts do not impose constraints, but that social representations external to the artifact do? This depends on how one defines 'artifact'. When 'artifact' is taken to mean a physical object on which particular social representations are projected, then it should be clear that artifacts do not impose constraints. Hence, Pfaffenberger's answer to the question 'Do

artifacts have politics?' is that in and of themselves they do not (1992: 294). However, the term 'artifact' is often reinterpreted within social constructivism as not denoting independently existing physical objects, but as denoting particular social representations of artifacts. For social constructivists often deny that there is any objective structure underlying social representations, and instead claim that reality is made up out of social representations; reality is a social construction. If artifacts are defined as social constructions, then it appears that artifacts are able to act.

Against social constructivism, it may be argued that it places *too much* weight on social processes and wrongly neglects the role of the physical design of artifacts. For there appear to be at least *some* affordances and constraints that derive at least partially from physical design properties. Indeed, artifacts sometimes seem to act in such a way that social representation does not appear to play an important role. Take, for example, the Long Island bridges that prevent buses from New York to drive below them to go to Long Island. This constraint (the exclusion of buses, not the exclusion of blacks) seems to derive from the physical design features of the artifact in question. Regardless of how these bridges are interpreted by bus drivers and others, they make it impossible for buses from New York to go to Long Island, as buses do not fit under them. Let us call constraints of this sort that seem to work by physical means alone *physical constraints*.

We may distinguish *strong* physical constraints, that physically require or prevent certain actions, events or situations, from weak physical constraints, that merely promote, discourage or hamper. Weak physical constraints are constraints that exert some amount of physical force, but can be countered, whereas strong physical constraints hold as a matter of physical law. For example, the prevention of buses going to Long Island by Long Island bridges seems to be a strong negative constraint, as a certain event is made physically impossible. The encouragement by hotel keys with heavy balls attached to them to guests to leave them at the front desk a weak positive constraint, as a certain event is made more likely to occur through physical force.

There are several types of constraints that seem to qualify as strong physical constraints:

(1) *Forcing functions*. Forcing functions (Norman, 1988: 132-38, 204-6) are physical constraints that require users to perform certain acts that not directly related to the purpose to which they want to use the artifact. An example is the forcing function imposed by the special interlock, required for a short period in history to be installed in each new car in the United States. Because of this interlock, the car would not start if the driver's and passengers' seatbelts were not fastened. So drivers had to fasten both seatbelts to be able to use the car.

Forcing functions are generally intentionally designed, and are usually, though not invariably, included in the interest of safety. Norman distinguishes three types of forcing functions that are used in safety engineering: Interlocks, lockins, and lockouts. *Interlocks* force operations to take place in proper sequence. For example, the pin on a fire extinguisher or the safety of a rifle require certain functional acts to be performed before these devices can be used. Automated teller machines nowadays require users to remove their ATM card before money is dispensed. This order is engineered in order to help users not to forget their card. When people open the door of a microwave oven, an interlock automatically disconnects the power the instant the door is opened.

Lockins keep an operation active by preventing someone from prematurely stopping it. This seems to apply mainly to mechanical and electrical devices. For example, most computers nowadays have a 'soft' on-off switch. When users turn off the computer, the power is not disconnected, but the computer first sends signals to programs to quit, checks that all files have been save, and only then turns off the power. A *lockout* prevents persons from entering a place that is dangerous or otherwise off-limits, or prevents an unwanted event from occurring, by making

sure that people only enter the place or use the device for the right reasons. For example, in public buildings, a bar is sometimes installed at the entrance of the stairs from the ground floor to the basement. This bar will help to prevent people from fleeing down the stairs into the basement, when there is a fire in the building and they flee down the stairs in panic.

(2) *User- and use-excluding physical constraints.* User-excluding physical constraints are physical constraints that exclude certain users from making proper use of an artifact. Use-excluding physical constraints are physical limitations on the use of an artifact. I will now discuss them in order. Artifacts impose a user-excluding physical constraints when they strongly require users to have certain physical attributes or be in possession of certain physical competencies, whether deriving from their own body or from artifacts used by them, like keys, cars, or hammers. For example, doorways will prevent people from entering whose waist size is greater than the size of the doorway. Fifty-pound bags of cement can only be lifted by construction workers who have the requisite physical strength. Computers can only be used by individuals who are not congenitally blind, or who have equipment that can transpose computer readouts to Braille or synthesized speech.

(3) Other strong physical constraints on actors. Next to forcing functions and user- and use-excluding physical constraints, there are all kinds of other physical constraints that may affect actors. Users of artifacts may experience all kinds of constraints that do not directly affect their ability to use the artifact in particular ways, but that nevertheless constrain their behavior. For example, the use of a car requires the user to sit down and use his or her arms and legs. While driving, it is physically impossible to stand up or turn around to face backwards. ATMs require the user to obey a time limit, or else the transaction is canceled. Making use of a room with no windows implies not being able to see what is going on outside. The use of electrical appliances that are not openable for repair or battery replacement implies that when the artifact breaks down, the user is physically prevented from making it work again. A car with two separate compartments physically prevents the driver to talk to, or touch, passengers in the back. Physical constraints may also be imposed on nonusers. For example, the use of noisy machinery in construction makes it impossible for bystanders to have a normal conversation. A building may physically prevent pedestrians from seeing what is behind it.

Social constructivists have argued against the existence of physical constraints by claiming that what appear to be instances of physical constraints are actually social constructions, particular 'readings' of artifacts that seem to refer to objective, physical conditions because they have become obdurate through closure. There are two varieties of this argument. On the first, physical constraints are first and foremost social constructions of the *users* of artifacts. Users are predisposed to 'read' an artifact in a way that constrains them. They could, however, learn to 'read' the artifact differently, after which the apparent physical constraint disappears. This argument is plausible for cases in which users seem to 'misread' artifacts, or 'read' them uncreatively. For example, an obese person may falsely believe that she cannot pass through a doorway whereas there are, in fact, ways of doing it. Against this social constructivist argument, it may be pointed out that there appear to be cases in which no change in 'reading' habits seems to be able to remove the constraint. For example, it seems that no matter how bus drivers represent the Long Island overpasses, they will still not be able to driver under them with their bus.

A second version of the argument is that apparent physical constraints are really social constructions of the *analyst*. Social constructivists may grant that there are physical constraints that, like Kant's things-in-themselves, impinge on the world, but may deny that these physical constraints are objectively verifiable by anyone, including the analyst. We only have reliable access to social representations, not to any reality behind them, and hence the

pretenses of an analyst to have reliable knowledge of physical properties and physical constraints are misguided. The analyst who tries to divides up reality into objective physical features and socially constructed features is trying to make distinctions that cannot reliably be made (cf. Woolgar, 1991a; Grint & Woolgar, 1992, 1995).

For example, an analyst may observe that twentieth-century kitchens only offered room for one worker and therefore did not support the sharing of kitchen duties (Wajcman, 1991: 114). However, the belief of the analyst that these kitchens only offered room for one worker may be based on an unimaginative 'reading' of these kitchens by her. Perhaps she sets very high criteria for what kinds of actions in kitchens count as acceptable use of it, and does not consider how users may come up with creative solutions to divide up the available space in a way that makes it possible for two persons to use it simultaneously. Similarly, an analyst of the Victorian hallway bench may wrongly identify certain relevant properties as objective whereas these are really dependent on his biased social representations. For example, the analyst may identify the bench as 'plain,' whereas its plainness is really a cultural construct. Or he may observe that members of the lower classes would often bring in filth that would stain benches with upholstery, not noticing that 'filth' and 'staining' do not denote objective phenomena, but imply particular value judgments.

It can be objected to this argument that even if users or analysts are never in possession of fully 'objective' representations of artifacts, there are enough instances of physical properties or physical constraints that are so uncontroversial that it seems silly not to make recourse to them in accounting for affordances and constraints. For example, it seems to be a plain fact that 10 ft. buses do not fit under 9 ft. bridges. And whereas two people may perhaps use a small kitchen simultaneously, the same is clearly impossible for twenty people. Hence, some constraints imposed by artifacts appear to be self-evident, and incontrovertible.

Against this objection, Woolgar (1991a: 32) has claimed that 'the whole point of interpretive flexibility is that apparent "self-evidence" and "incontrovertibility" are social accomplishments that are subject to change. Our recourse to self-evidence merely buys into one current definition. And it would be a pity to limit the scope of the theory to technologies whose impact currently happens to be controversial.' Woolgar's point is that buying into self-evident or uncontroversial 'truths' about technical artifacts biases the analysis because these 'truths' are in fact contingent social representations. Also, it may make analyses shallow by excluding the possibility of more profound critiques of affordances and constraints that question accepted truths. For example, an analyist in Victorian times, and even a present-day observer, might have missed the fact that some properties of Victorian hallway benches, such as their 'plainness' and their 'better resistance to filth' are in fact contestable social constructions that are part of the symbolical discourse that was used to humiliate the lower classes: it draws from a particular aesthetic and hygiene myth.

I believe that Woolgar is right that our perceptions of 'objective' physical features of artifacts always involve an amount of social construction, and that serious attention should be paid to uncover particular biases in these perceptions. However, I also believe that there are limits to such reflexive activity, and that it sometimes pays too little to keep questioning the 'objectivity' of certain putative physical properties or constraints. For example, it is unclear what will be the gain from deconstructions of the claim that 10 ft. buses do not fit under 9 ft. bridges. On the contrary, sometimes much can be gained if the analyst is allowed to make reference to this ‘fact’ in an analysis. Therefore, I believe that analysts should be allowed to appeal, with caution, to physical properties and constraints in their analyses. Social constructivism cannot do this and hence cannot give a complete account of technologically induced social change.

For the same reason, social constructivism cannot give a satisfactory account of the politics of technology. Shifts in power relations or in the distribution of social goods that result from the introduction of a technology necessarily have to be attributed to readings of the technology by various social groups. Bringing about changes in political arrangements then requires that these social groups start interpreting and using the technology differently. A social constructivist "politics of technology" hence implies showing "the malleability of technology, the possibility for choice, the basic insight that things could have been otherwise" (Bijker 1995: 280). Social constructivist studies are hence political by revealing the contingency or politics contained in technological choice. This information can subsequently be used by actors with a political agenda to influence technical change, including the "social impacts" of technologies. Yet, according to my critique, a social constructivist analysis of the politics of technology places too much faith in the malleability of technology, and has too little eye for physical constraints in technological artifacts that help give shape to political consequences and that often cannot be overruled by changes in social arrangements or interpretive schemes.

4. Hybrid constructivism

The term 'hybrid constructivism' can be taken to refer to any position that adopts the *principle of generalized symmetry*. This is a methodological principle according to which any relevant elements referred to in an analysis (whether 'social', 'natural', or 'technical') should be assigned a similar explanatory role and should be analyzed by the same (i.e., a symmetrical) type of vocabulary (Callon, 1987; Latour, 1987; Callon and Latour, 1992; Callon, Law and Rip, 1986). Hybrid constructivists (many of whom define their work as taking place within *actor-network theory*) analyze phenomena, such as the workings of a artifact, as the result of the activity of a heterogeneous networks of entities that work to co-construct the phenomenon. These entities are not treated differently in the analysis because they are labeled as 'social' (or 'human') or 'technical' or 'natural' ('nonhuman'). All are *actants* (things that act) that have similar (i.e., symmetrical) explanatory roles.[2]

Social constructivism is criticized by hybrid constructivists for assigning a special role in analysis for social elements, such as social groups and the social representations they employ, whereas 'natural' or 'technical' elements, such as natural forces and technical devices are prohibited from being explanatory factors in explanations. Hybrid constructivists also allows for technical devices and natural forces to be actants in networks through which particular phenomena are constituted. By an analysis of actant networks, any phenomenon can be shown to be a *post hoc* construction, the consequence of the stabilization of a whole network of human and nonhuman actors. This does not mean, however, that these phenomena are *socially* constructed, because the phenomenon is not only the result of social factors. It is the result of heterogeneous elements, all of which are accounted for by the same, symmetrical vocabulary, and none of which are explicitly identified as 'social', 'technical,' etc.

By thus rejecting the traditional distinction between nature and society (and hence between the naturally given and the socially constructed), hybrid constructivists reject a distinction maintained by both realists and social

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[2] Well-known work within a hybrid constructivist framework has been performed by Latour, Akrich, Callon, and Law (all adherents of actor-network theory). Bijker has also converted to this position (Bijker, 1992). Bijker, however, still calls his position "social constructivism", unlike Latour, who defines social constructivism according to my above definition, and holds the princple of generalized symmetry to be incompatible with social constructivism. Cf. Callon & Latour (1992).

constructivists. Realists hold that even though there are social entities, and even though some facts or objects may be socially constructed (e.g., money, marriages, and other social objects; cf. Searle, 1995) there are also purely physical and technical processes, facts, and objects that may sometimes, as with technical artifacts, have been constructed by humans and may have involved human choices in their design, but that have physical properties that are ontologically independent from social interpretation or negotiation. Social constructivists maintain the distinction as well, but go the other way than realists do: Instead of saying that socially constructed objects have a physical basis, they argue that the natural and the technical are constructed out of the social.

Its proponents hold hybrid constructivism to be plausible because they believe that realists and social constructivists, who maintain an asymmetrical vocabulary, fail to explain the various scientific and technical phenomena that they try to explain. Realists and social constructivists maintain distinctions that stand in the way of good methodology, which is methodology in which sound generalizations can be made that account for the complex interactions of people and things. Both cannot adequately account for moves "from action to behavior, from meaning to force, from culture to nature" (Callon & Latour, 1992: 361). The problem with realist analysis of technology, according to hybrid constructivists, is that it cannot shake an unwarranted technological determinism, according to which technology by itself affects change in the world. The problem with social constructivist analyses is that nonhuman objects are left powerless; only humans act, even though technical and natural objects appear to play the role of intermediaries in all kinds of processes. As Callon and Latour conclude, "The choice is simple: either we alternate between two absurdities, or we redistribute actantional roles.' (p. 356).

The symmetrical model for the analysis of technology has perhaps been developed most fully by Bruno Latour (1988a, b; 1992; 1995; Akrich & Latour, 1992). In Latour's vocabulary, no principled distinction is made between humans and nonhumans; all are actors, or *actants*, that are able to act, mediate, and influence. Actants are assigned *competencies*, that is, powers to act. The competencies of actants in a setting cannot be determined beforehand, but can only be attributed to them as the result of analysis of the whole setting in which they operate. The same is true of their *performances*: the concrete actions they perform in a particular setting. And, it may be added, the same is true of any generalizations, or *laws*, stated over the performances of actants. Notice that in this vocabulary, the whole distinction between physical objects and human actors, physical capacities and behavioral dispositions, physical processes and human actions, and physical laws and social norms or habits disappears: there is only an interplay of actants and their performances, that are all described in the same terms.

Actants may form *associations*, or links. This happens when two or more actants start interacting with each other on a structural basis. For example, an association is formed between a door and a door closer when the door closer systematically closes the door after it is left open. A similar association would arise when the door closer would be replaced by a human groom, who was disciplined to close the door at all times. Another association would be the link between a traffic policeman directing traffic and a road user obeying these directions. A similar link may exist between a road user and a traffic light. Again, it does not matter in the description whether the links are between human or nonhuman actants. When multiple actants form links with each other, *networks* of actants emerge. The *stabilization* of a network is the process by which associations in a network become stable, or solidify.

Now, Latour holds that any fact about the competencies and performances of a particular technical artifact (or, for that matter, a scientific phenomenon, or any other entity) is the product of a network of actants that jointly work to 'produce' this fact. Take, for example, the fact that a traffic light is able to direct traffic. This is not an intrinsic technical capacity of a traffic light, but is rather the result of a stabilized network of actants. These actants

include the traffic light itself, but also the road users, who are disciplined to respond to changes in the traffic light in particular ways, and it includes elements of the infrastructure that support the working of the traffic light (e.g., electricity cables) and elements of the road system used by the road user (e.g., the vehicle, the asphalt below the vehicle). It is the total stabilized network of actants that makes it that the traffic light has the competence to direct traffic.

Latour develops a whole vocabulary for the analysis of such actant networks. I will now discuss some of its key terms, beyond the ones already mentioned. *Delegation*, or *translation*, is a process by which certain actions performed by one or more actants are transferred to other actants that perform them more effectively or efficiently.[3] For example, in a hotel in which guests constantly leave the front door open, it can be decided that closing the door should be delegated from the guests (who do not form a stable door-closing link with the door) to a groom, or a door closer. When delegation indeed results in more durable associations, then it may be called an *inscription* (or *encoding*). Because machines are often create more durable associations than humans do, inscription often involves the delegation of human actions to a machine. However, the embodiment in cultural tradition of the owner manual of a car is also an inscription, as the instructions in the manual will be more reliable when part of everyday knowledge than when written down in a leaflet that must be consulted all the time.

Prescriptions (or *affordances*) are what a scene or setting, or a specific actant in a scene, forbids or permits particular actants to do. The term is most often used by Latour to describe presuppositions that technical artifacts (as embedded in, and defined by, a network of actants) have about the behaviors and attributes of their users. As Latour remarks, prescription "is very much like 'role expectation' in sociology, except that it may be inscribed or encoded in a machine." (1988b: 306)[4] Prescriptions need not be obeyed: the user may not be properly attuned to the prescriptions, and may refuse to follow up on them. E.g., a traffic light expects that its users will watch it from the street and not sideways. A hotel key with a heavy ball attached to it expects that guests will return it to the front desk, but guests need not obey this prescription. *Scripts* are the scenarios, or roles, played by human or nonhuman actors in a setting when they obey the various prescriptions inscribed in a scene, or inscribed in a particular actant in a scene. When defined relative to an artifact, a script is the framework of action together with the actors and the space in which they are supposed to act that is presupposed by the artifact and any other actants that help to define its prescriptions (e.g., notices, manuals).

Actants (and scenes, and networks of actors) may also be assigned *programs of actions,* that is, goals that they 'try' to reach and that are made the point of departure of an analysis. The associations of actants in a setting, and changes in these associations (and the competencies of actants, and hence their prescriptions) over the course of time can then be described in terms of their effect on this program of actions. For example, the scene, mentioned earlier, of the hotel door that should be kept closed may be analyzed from the program of actions 'keep the door shut'. This may be a goal of the hotel manager, and it may become a goal of properly disciplined guests, as well as grooms and other delegates such as notices and door closers. *Antiprograms* are programs of action of actants that are in conflict with the program of actions chosen as the point of departure of the analysis. For example, hotel guests may be too rushed to close the door behind them, and some may even leave the door open intentionally, for fresh air. A well-designed artifact (such as a good door closer) so carefully anticipates various anti-programs that is

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[3] Latour and Akrich sometimes appear to use the term 'translation' more broadly for any transfer of action from one group of actants to another, whether or not these latter actants perform the action more efficiently or effectively.

able to let its own program of actions preside over them. A program of actions is successful when the prescriptions of an artifact and its allied actants yield a script that conforms to this program of actions and is resistant to the antiprograms of other actants. To be successful in this way, artifacts must participate in a system of alliances with other actants that help issue a set of prescriptions.

So what is agency in this theoretical framework? Agency reduces to prescriptions issued by artifacts. Strong prescriptions are ones that the actant(s) to which the prescription is issued are somehow disposed to obey. Their competencies are such that they respond to the prescription by obeying it. It does not matter if the constraint is physical or symbolical (social, representational). For example, red traffic lights issue a strong constraint to stop to most drivers, because most drivers are strongly disposed to stop before a red light. Moreover, it does not matter whether the obedience to a prescription is willing or not; important is whether the prescription is sufficiently powerful. For example, a car that is wired to start only when the driver wears a seat belt may force its driver to obey the prescription "wear a seat belt (or you cannot drive the car)." Only a driver who has the competence to disable the wiring will be able to evade this prescription.

Strong prescriptions may *exclude* human actants (especially, users) when they are unable to play the roles required of them, even if they desire to, because they lack the required competencies. For example, an ATM may require its users to be literate, thus excluding illiterate prospective users. Alternatively, strong affordances and constraints may *frustrate* human actants because they are only able to play the required role by adapting (i.e., by developing the required competencies). For example, a door that is 6 ft. high requires someone who is 7 ft. high to stoop ('become a smaller person') when entering.

A *weak* prescription is one that may fail because actants to which it is issued may fail to have the required disposition. For example, a car which flashes a warning light when the driver wears no seat belt may not succeed in letting the driver wear a seat belt, because the driver can choose to ignore the warning light. Even physical force may only serve as a weak constraint when an actant subjected to it has the competence to resist it and carries an antiprogram against this force. For example, the Long Island bridges discussed earlier will not stop buses when the buses have the physical strength (competence) to ram through them, and if their drivers are disposed not to stop for the bridges.[5]

Notice that although Latour sometimes attributes prescriptions to particular artifacts, he does not hold that these prescriptions are the result of competencies intrinsic to the artifact and reveal themselves in appropriate settings. This would make his approach resemble a contextual realist one. Competencies, Latour holds, cannot be discovered by studying artifacts in isolation. They are inherently relational: they are realized as the product of the embedding of an artifact in a network of associated actants. When such a network stabilizes, competencies emerge as *black boxes*, that is, as apparently transparent properties of actants that obscure the fact that they depend on the network of alliances of which the actant is a part. Artifacts gain their identity only within such networks, and hence technological innovation is not just the isolated development of a new artifact, but the modification and development of a network of associations of which this artifact is to be a part.

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[4] Prescriptions are similar to what Pfaffenberger (1992) calls affordances. Notice that 'affordance' is also used as a synonym of 'prescription' by Latour.

[5] The strength of an artifact constraint, or prescription, is hence in Latour's theory relative to the competences and attunements of actants that it is aimed at. Artifact constraints may, however, also be called weak or strong in a more absolute sense, that is, relative to 'normal' or 'average' actants. The Long Island bridges may then be said to issue a strong constraint, in that average buses will not be able to resist them.

The apparent advantages of a hybrid constructivist approach over a realist or a social constructivist one are twofold. First, hybrid constructivism does not need to determine whether properties of artifacts that give rise to social changes are either objective physical features or social constructions. It does not need to say, for example, whether properties of Victorian hallway benches that help demarcate class (e.g., their hardness, or their plainness) is either an objective property or a social construction. Is its hardness objective or socially constructed? What about plainness? In a hybrid constructivist framework, it does not matter, because both physical properties (if any exist) and social representations, or any hybrid mixture of them, is treated the same: as a competence of an actant that may or may not help it to build associations with other actants.

Second, by transcending the distinction between the social and natural/technical (or between signs and things), hybrid constructivism is able to state generalizations about affordances and constraints that could not be stated when this distinction would be maintained, because then the required vocabulary would not be available to make such generalizations. In a hybrid framework, it is better possible, for example, to see how a physical artifact translates human behavior into a more durable form, or how a human groom and a mechanical door closer are instances of the same process of delegation. As a flipside to this, analyses are also less cluttered by distinctions (between signs and physical objects, social actions and physical behavior, etc.) that are irrelevant to the analysis.

I agree that these are both real advantages of hybrid constructivism. However, I believe that they are not decisive in favor of it. Although vocabulary of hybrid constructivism enables generalizations over affordances and constraints of artifacts that are not possible in a vocabulary that maintains the natural-social distinction, it does this at the price of detail. Because it cannot refer to things social or natural or technical, because it cannot use these traditional categories, it cannot discern any meaningful distinctions between physical and semiotic force, or between physical and social processes, and any relevant differences between the two cannot be made to play a role in the analysis. For example, the strategies by which human actors may try to resist symbolical force and physical force are surely different. Resistance against physical force may result in the disabling or modification of artifacts, whereas resistance against the force of symbols may result in the production of alternative symbols (cf. Pfaffenberger, 1992). Similarly, it seems to be relevant if prescriptions target human or nonhuman actants. Human actants have a richer behavioral repertoire by which they can respond to prescriptions, and humans may have various intentions, beliefs and motivations that may be relevant in the analysis. In a hybrid vocabulary, these differences between humans and nonhumans are obscured in the interest of symmetrical treatment.

For this reason, it is questionable if hybrid constructivism can give an adequate account of the politics of technology. In a hybrid vocabulary, there is no place for politics as it is commonly understood, because no distinction can be made between human and nonhuman actants. Political relations between actants the result of prescriptions issued by them and the degree to which such prescriptions are supported by the entire network of actants in which they generate their effects. So a hotel key may prescribes guests to return their key, but the same prescription may be issued by the human patron of the hotel, and likewise humans may issue presciptions to artifacts and artifacts to each other. So the meaning of politics becomes stretched to include any type of prescription relation that humans and artifacts may have to each other. And in a hybrid vocabulary, there is no way to single out humans as 'morally responsible' or 'oppressed' or 'victimized' without symetrically also applying the same vocabulary to nonhuman actants. This raises the question how a hybrid constructivist conception of politics relates to more mainstream conceptions of politics, and what their added value is. Although there have been attempts to develop a hybrid constructivist politics (e.g., Latour 1999; Mol & Mesman, 1996), this question has yet to be answered.

Since the mid-nineties, actor-network theorists have moved beyond some of the basic tenets of ANT as it has been developed until the early nineties (Law & Hassard, 1999; Lee & Brown, 1994). Specifically, many now do not want to claim that ANT contains a coherent set of principles, but emphasize the diversity of approaches in ANT, and the diversity of ways in which links between actants in networks can be created by the analyst, and the need to tell multiple possible inconsistent narratives about technologies rather than a single consistent narrative. Parallel to this, there has been a greater emphasis on multiplicity and difference, on the disorderedness of networks and the heterogeneous ways in which actants take on actantional roles and are multiply realized in different, partially overlapping networks. These recent approaches, however, still make use of a limited hybrid vocabularies that fail to recognize fine-grained differences that appear relevant in the much richer traditional vocabulary in which differences between the social, the natural and the technical are recognized.

5. Differentiated constructivism

The defense of hybrid constructivism rests in part on the supposition that it is the only alternative for realism and social constructivism. I now want to argue that a fourth position is possible, *differentiated constructivism*, that avoids some of the weaknesses of realism and social constructivism. Differentiated constructivism is the position that the agency of artifacts result in part from the material design structure of artifacts (*pace* realism) and in part from social processes (*pace* social constructivism). It is held that although it is often difficult to separate these two contributing factors (*pace* hybrid constructivism), such a separation usually can and should be included in the analysis. Just like hybrid constructivism, differentiated constructivism neither privileges the natural or technical nor the social or symbolical. Yet, it holds that *some* affordances and constraints correlated with artifacts are physical in nature, whereas *others* result from social representation. It also holds that affordances and constraints may be *in part* physical and *in part* social, and that it is possible in analyses to distinguish between these respective parts. Hence, *some* constraints are physical, *others* are socially constructed, and *yet others* are a combination of physical and social factors. Differentiated constructivism is hence a position on the agency of artifacts that maintains the distinction between the physical/technical and the social/symbolical (and hence rejects the generalized principle of symmetry), but also rejects exclusively realist and social constructivist accounts of affordances and constraints.

To illustrate this position, let us reconsider the (social constructivist) analysis of demarcation of social status by the Victorian hallway bench (section 2). On a differentiated constructivist analysis, it might be analyzed that the bench has certain objective properties. For example, it is hard, and does not have many carvings. These objective properties constrain certain perceptions (social representations) of the bench, for example, that it is plain. Plainness was a social construction that was associated with the lower classes in Victorian times. Because only people from the lower classes were told to use these benches, they therefore worked to mark social class. The difference between this analysis and the social constructivist analysis is that it goes outside social representations in the analysis of this constraint to appeal to 'objective' physical properties of the artifact. These play a role, together with social representations, in the constitution of affordances and constraints.

Similarly, a hybrid constructivist analysis of political constraints imposed by the atom bomb would go along with the social constructivist supposition that the organization of an authoritarian security network around the bomb is motivated by social representations that attribute lethal properties to it. It would then go on to analyze these social

representations to be dependent on the presence of actual lethal properties in the bomb.[6] It may be granted by differentiated constructivists that for some affordances and constraints, physical properties of the artifact play a wholly arbitrary role. So the fact that pink baby clothes for girls promote gender stereotypes may be rightly analyzed as resting on a cultural convention or symbolism that arbitrarily connects perceptions of pink with stereotypical feminine traits. Still, then, it may be emphasized that the perceived pinkness of the clothes is not an arbitrary social construction, but is based on actual physical properties of the clothes.

The above examples illustrate a variety of differentiated constructivism that is closer to social constructivism than to realism in that it is still ultimately social representations that generate affordances and constraint, even if these social representations are themselves constrained by actual physical properties of artifacts. These physical properties hence only issue *indirect* constraints. A variety of differentiated constructivism that is closer to realism holds that physical properties of artifacts sometimes impose more *direct* constraints, that is, constraints unmediated by social representations. Often, these are constraints that result from the fact that the artifact exerts *physical force*: it makes certain states of affairs physically improbable or even impossible or makes them physically probable or even necessary. For example, a locked door imposes the constraint that those who open it have a fitting key (or have another means to take away the physical resistance of the door that prevents them from entering). This constraint is in place because the door will physically resist anyone from entering who does not have a fitting key. How the door is represented by that person appears to be irrelevant to this fact.

Or consider the modern western sofa, which has separate seat cushions that define distinct personal spaces and hence work to respect and perpetuate modern Western culture's emphasis on individuality and privacy. In part, this perpetuation of privacy derives from perceptions of the divisions between the cushions, and the learned convention that it is impolite to cross these when sitting next to someone with whom one is not intimate. However, these divisions do not just generate particular social representations, they also constitute a gap that makes it less comfortable to cross it, and hence in this way exerts some amount of physical force that stimulates people to remain within the confines of one seat cushion. Similarly, a heavy hotel key exerts a weak physical force on guests that stimulates them to return it to the front desk when leaving. Sometimes, this force may just serve a symbolical function, by reminding them to return the key. In other cases, the perceived discomfort may cause guests to return the key that they would otherwise have preferred to take along.[7]

Physical properties of artifacts do not always work to make things happen or prevent them from happening by exercising physical force. They may also make it possible for new things to happen by physically creating *new opportunities*. In an environment in which human actors actively seize this new opportunity, the technology may be interpreted as imposing a constraint. For example, the installation of running water and washing machines in houses in Ibieca, Spain made it possible for people to do their washing and laundering inside. Because many inhabitants

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[6] Notice that such analyses would then not only break with the generalized principle of symmetry of hybrid constructivism, that holds that humans and nonhumans must be treated in the same way, but also with the social constructivist principle of symmetry, according to which no assumptions are made in analyses about the truth of scientific claims or about the actual properties of technologies. It hence assigns to the analyst the competence to know the difference between reality and representation (or between 'good' and ''bad' representations). As will be argued later on, the analyst will not always be in a position to claim this competence, but may sometimes legitemately claim it.

[7] Notice that, as artifacts become part of everyday life, constraints issued by them that result from their capacity to exercise physical force may no longer be issued by their actual exercise of physical force, but by the perception of human agents that the artifact has this capacity. Human agents will then often act in accordance to the constraint so that they are not subjected to physical force. So most people will not try to walk through doors that they know to be locked and for which they do not have a key, and if they believe their key to be heavy, hotel guests may decide to return it to the front desk before lifting it.

preferred doing this to using the public fountain and washbasin, these fountains and washbasins were consequently abandoned. As a result, the social ties between Ibiecans were weakened. This social constraint is not physically necessitated by the new technology, but is afforded by it, and, in the right environment, such an affordance turns into a constraint.

What, finally, makes differentiated constructivism a constructivist position, rather than a variety of realism? This, I submit, depends on how these two positions are defined. Nothing important hinges on it. I earlier defined the realist position as holding that affordances and constraints have their basis in the material design structure of artifacts, and the constructivist position as holding that affordances and constraints are partially or wholly the product of processes external to the artifact. I also claimed that realists normally downplay the role of social representation in human-artifact interactions and that human agents normally respond to artifact on the basis of their objective physical features. Now, differentiated constructivism retains the realist premise that artifacts have real physical properties that can be analyzed by the analyst separately from third-person social representations of these properties. For some, this would suffice to call this position realism instead. However, I put more weight on the fact that differentiated constructivism, unlike mainstream realism, assigns a large role to social representation processes external to the artifact, and holds that human agents normally respond to such social representations in their interaction with artifacts, rather than (just) to their objective physical qualities.

Differentiated constructivism hence constitutes a healthy middle ground between realism and social constructivism. This also applies to its account of the politics of technology. On this account, the introduction of a technology may effect political change, as a result of an interplay of constraints, some more physical, others more social. The task of an analyst is to assess both the interplay and the respective contributions of such constraints. Different political arrangements can be realized both through changes in the interpretive framework of human agents, through changes in modes of social organization, by changes in the material infastructure in which the technology is used, or by reengineering the technology itself.

I want to claim, finally, that hybrid and differentiated constructivist accounts are not necessarily mutually exclusive. In fact, they may have a complementary role in analysis. With a hybrid vocabulary, it is possible to state broader generalizations in the analysis of affordances and constraints. The analysis may then be extended and deepened by employing the vocabulary of differentiated constructivism, that retains a number of distinctions that disappear within a hybrid vocabulary. This latter analysis may reveal more specific mechanisms of translation, delegation, and prescription that are difficult to uncover within the generic vocabulary of hybrid constructivism. Indeed, in his analyses, Latour makes frequent use of asymmetrical terms next to his hybrid terminology, by describing actants as 'human' or 'nonhuman,' by attributing intentions and desires to humans, and by calling things and events 'technical' or 'social'. These descriptions often seem to deepen, rather than undermine, his analyses.

6. Conclusion

Hybrid constructivists rightly point out that agency is produced by artifacts themselves, nor by social processes external to artifacts. It is the products of actor-networks in which the physical behavior of artifacts and the social behavior of humans blend together into a knot that is often difficult to untie. Both humans and nonhumans are agents (‘actants’) in that they have a causal or structural role within the network. Yet, I have argued, the vocabulary of hybrid constructivism is too general to untie the knot of actor-networks completely. A differentiated

constructivist approach can more specifically point to the relative contributions of artifacts, social representations, and other structures and processes.

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