Thinking About Design

Critical Theory of Technology and the Design Process

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1 Introduction

In this chapter we offer a framework for thinking about the design of technology. Our approach draws on critical perspectives from both social theory and science and technology studies (STS). We understand design to be the process of consciously shaping an artifact to adapt it to specific goals and environments. Our framework conceptualizes design as a process whereby technical and social considerations converge to produce concrete devices that fit specific contexts. How this happens – and the possibility that it might happen differently – is a crucial point for philosophers and other students of technology to consider.

To date, design studies have been focused predominantly on the work of what we might call proximate designers, while work in the field of STS has focused on the role of non-designers such as clients, stakeholders, and other socially relevant groups.[1] However, little attention has been paid to ways in which historical choices and cultural assumptions about technology shape the design process. Our goal is to address this oversight. We begin by posing a seemingly simple question: is design intentional? A review of the literature draws our attention to at least three possible levels of analysis: that of proximate designers, the immediate design environment, and broader society. We then present a critical theory of technology that provides a non-deterministic, non-essentialist approach to the study of technology. We argue that critical theory, with its emphasis on examining taken-for-granted assumptions, offers a theoretical space for thinking differently about design. Finally, we discuss the possibilities opened up by critical theory and some of the obstacles that stand in the way of realizing a richer world of design.

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[1] Woodhouse and Patton (2004) define *proximate designers* as those professionals closest to the design process: engineers, architects, draftsmen, graphical artists, and so on.

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2 Design and Intentionality

Design is typically conceived of as a purposeful activity, and so intentionality seems to be built into the very definition of the term. But is design really intentional? Put another way: to what extent do designers' intentions shape the artifacts they produce? A review of the literature reveals three general perspectives: first, there are those who see designers as having a great deal of control over the design process; second, there are those who see designers as being highly constrained and therefore unable to translate their goals and intentions into products; finally, there are those who see design as a function of the broader culture. This last perspective throws into question the very notion of intentionality by problematizing the distinction between designers and society-at-large.

2.1 Strong Intentionality: Designers are Powerful

The idea of achieving something "by design" suggests that designers have a great deal of power. It suggests – contrary to technological determinism – that people *can* steer technological development. Furthermore, it rests on the assumption that intentionality plays a significant role in design: that by consciously deciding on a course of action one can design better. The work of Norman (1988) provides a good exemplar of this perspective.

Norman sees a strong link between better designers and better design. For example, he places much of the blame for "bad design" on the fact that design work is "not done by professional designers, it is done by engineers, programmers, and managers" (1988, 156). Similarly, he places much of the responsibility for "good design" on professional designers: "[i]f an error is possible, someone will make it. The designer must assume that all possible errors will occur and design so as to minimize the chance of the error in the first place, or its effects once it gets made" (1988, 36). In this view, designers are powerful – it is, after all, *their* knowledge and *their* values that determine the shape of our technologies.

Like others in the strong intentionality camp, Norman assumes that a sharp division of labor between designers and the public is essential to good design. While he acknowledges that manufacturers, store owners, consumers, and others may have competing demands, he believes that "[n]onetheless, the designer may be able to satisfy everyone" (1988, 28). He thus sidesteps issues of conflict and power, and, while Norman sometimes calls for participation from non-designers – "[d]esign teams really need vocal advocates for the people who will ultimately use the interface" (1988, 156) – he does so in a way that makes clear it is the designers who are in charge. Users, when they are mentioned at all, are assumed to be largely passive recipients of technology.

The result is that Norman and authors like him assume that designers' intentions are expressed through design. His prescription for improving design is to have better, more enlightened designers. While this viewpoint has merit in challenging the notion that technological development is pre-determined, it also has several shortcomings. These include a lack of attention to diversity and conflict among user groups, to the constraints designers face “on the ground,” and to the cultural conditions presupposed by the designers’ work. Moreover, this viewpoint presupposes a sharp distinction between intended and unintended consequences that is highly problematic.[2]

The strong intentionality approach views proximate designers as key actors in the design process. This approach shows a certain affinity for an instrumentalist philosophy of technology in which technology is viewed as neutral means to human ends. The role of the designer is to assess the various demands being made of technology – demands that are deemed external to the design process – and then, using her expertise, to optimize according to those demands. Consequently, design is viewed as being primarily technical in nature. This view has been challenged in recent years by approaches (most notably from STS) that emphasize the social contingency of design.

2.2 Weak Intentionality: Designers are Constrained

While some authors see designers as powerful, others suggest the opposite, i.e., designers are constrained by a variety of factors: economic, political, institutional, social, and cultural. Within such constraints, designers are thought to have varying degrees of autonomy. Consider the following three examples.

Noble (1977) provides an example of a neo-Marxist analysis of labor relations and corporate growth. Arguing that the rise of corporate capitalism in America went hand-in-hand with the wedding of science and engineering to industry, Noble shows that workers increasingly lost their autonomy as management became increasingly of a “science.”[3] New fields of study such as industrial relations were meant to be “the means by which farsighted industrial leaders strove to adjust – or to give the appearance of adjusting – industrial reality to the needs of workers, to

[2] Winner (1986) questions the whole notion of “unintended consequences,” contending that in many cases it is not helpful to fixate on whether someone “intended” to do another person harm: “[r]ather one must say that the technological deck has been stacked in advance to favor certain social interests and that some people were bound to receive a better hand than others” (26). For this reason, we prefer Sclove’s (1995) term of “non-focal effects,” as it draws attention to the fact that the “effects” of technology depend, first of all, on what one chooses to focus on or ignore in one’s analysis.

[3] Compare this with Chandler’s (1977) explanation of why managerial capitalism arose in America during the 19th century. While Noble explains the rise of management as an intentional move by corporations to gain greater control over labor, Chandler presents it as a necessary and inevitable step in the evolution of American businesses, a step precipitated by the arrival of new “revolutionary” technologies. Thus, while Noble seeks to point out the *power relations* underlying changes within corporate America, Chandler seeks to *obscure* them by appealing to the necessity of technological progress.

defuse hostile criticism and isolate irreconcilable radicals by making the workers' side of capitalism more livable" (1977, 290). While not specifically about design, Noble's book suggests that workers of all sorts, including designers, have little ability to follow their own intentions where these conflict with corporate interests. Of course, there is still room for some choice in design (e.g., what color to paint the car), but truly radical design alternatives are excluded by corporate control.

Others are less totalizing in their analysis. In his analysis of a high tech firm, for example, Kunda (1993) argues there is room for maneuvering and resistance, even as corporate control over workers becomes more subtle and insidious. He shows that constraints imposed on workers need not be explicit. Indeed, while "self-management" may be the catch phrase in today's knowledge economy, the demands of management hang heavy in the air of modern companies, even if they are never directly articulated by managers. Quoting from a company career development booklet, Kunda points out how responsibility for managing performance is shifted from management to workers:

> In our complex and ever changing HT [hi-tech] environment there is often the temptation to abdicate responsibility and place the blame for your lack of job clarity or results on 'the organization' or on 'management.' But if you really value your energies and talents, you will make it your responsibility 'to self' that you utilize them well. (1993, 57)

In such an environment, designers who start out thinking they have complete autonomy may find themselves constrained by the intricate web of norms and expectations of the corporate culture.[4]

Finally, Bucciarelli (1994) provides an optimistic view of constrained design. In his account constraints mainly stem from negotiating with co-workers. His analysis, while not exactly ignoring questions of political-economy or organizational control, generally skirts these concerns, focusing instead on how design teams come to agree on a "good design." Bucciarelli continually talks about negotiation between designers, suggesting that interests and intentions are central to his conception of design; if there are constraints on the designers in his story, these arise from having to work with other members of a design team to get a job done – a lesser constraint than, for example, external market pressures. In general, Bucciarelli assumes that despite numerous and often conflicting constraints, designers do have a significant degree of autonomy.

The weak intentionality approach views design as a complicated set of negotiations between proximate designers and those in the immediate design environment, i.e., clients, corporate executives, and other stakeholders. Institutional rules and organizational culture often play a role in this line of analysis. This approach is congruent

[4] Downey's (1998) ethnography of engineering students nicely illustrates this tension. He notes how students in a CAD/CAM class were presented with conflicting stories: on the one hand, they were told "[m]achines are slaves – they're dumb, they're stupid" (135). Yet, just a few days later – after considerable frustration with a lab project – students were told "[y]ou are also a slave to the computer" (137). Caught between these contradictory statements, these students began to question how much control they really had over the machine.

with certain approaches in STS such as social constructivism and actor-network theory, where designers are viewed as influential actors engaged in conflict and negotiation with other interested actors.

2.3 Questioning Intentionality: Designers and Society-at-large

Finally, some authors relate design to broader socio-cultural trends, thus questioning the whole notion of intentionality. A good example of this approach is Edwards' (1996) history of computer development during the Cold War. In his book *The Closed World*, Edwards argues that "American weapons and American culture cannot be understood in isolation from each other" (1996, 7). He shows how academic, military, industrial, and popular cultures intermeshed in the "closed world" of Cold War ideology.

Edwards defines a *closed world* as "a radically bounded scene of conflict, an inescapably self-referential space where every thought, word, and action is ultimately directed back toward a central struggle" (1996, 12). In such a world, it is questionable whether anyone truly has agency. How, for instance, could a designer escape from the values and assumptions of Cold War ideology and propose an alternative design? The closed-world discourse of the Cold War framed everything in terms of containment: the aim was to contain communism by protecting and enlarging the boundaries of the so-called free world. Within this discursive space, notions about what kinds of technologies would be necessary or desirable took on specific characteristics: increasing military precision required "a theory of human psychology commensurable with the theory of machines" (1996, 20); automation, "getting the man out of the loop", and integration, "making those who remained more efficient", were the answers provided by psychologists and other academics. Edwards concludes that the material and symbolic significance of computers is intimately connected to Cold War politics; indeed, Cold War politics is embedded in the machines computer scientists built during the past half-century.

A similar blurring of lines between designers and society-at-large can be seen in Abbate's (1999) study of the anarchic beginnings of the Internet. She argues that the "invention" of this technology was not an isolated, one-time event: "the meaning of the Internet had to be invented – and constantly reinvented – at the same time as the technology itself" (1999, 6). Her view of Internet history suggests there was no "master plan": the sources of its design are not to be found in any one place but are distributed among individuals and groups that, though loosely linked by a common culture, may not even be aware of each other.

This third approach is under-represented in contemporary studies of design. It conforms neither to the instrumentalist assumptions of the strong intentionality thesis nor to the weak intentionality thesis that is compatible with the methods of STS. Instead, a sociology of culture is presupposed which must then be combined with a philosophy of technology open to cultural considerations. Design is not only a strategic contest between interested actors and social groups, it is also a function of the way in which things appear to be "natural" to the designer. This insight shifts our attention away from proximate designers to the background assumptions that are at work in broader culture. We will explain this approach in the second half of this chapter.

2.4 Designers: Strong or Weak?

With these perspectives in mind, let us reconsider the role of designers in shaping technology. If designers are strong, then we would expect their views to be the key factor in determining the form of technologies. On the other hand, if designers are weak, then their role would be merely to implement out the views of others; devices would simply reflect the values of influential actors rather than those of the design team. Clearly, there are circumstances that can be accurately described by each of these positions. Designers do have a substantial influence on the design process and sometimes control the outcome. Nevertheless, to focus too much on those closest to the design process is to miss the larger political-economic and cultural structure within which their activities take place.

The intervention of non-technical influences on design takes the form of external pressures but it is also internal to the technical sphere itself. What appears technically rational to the designer is a function of many things, including her training and the codified outcomes of technological choices made in the past under various social influences. In other words, even when engaging in "purely technical" activities, designers are guided by rules that are culturally specific and value-laden.[5] Design thus invariably exhibits social bias. This bias is part and parcel of designing since optimizing for a given situation requires taking social concerns such as cost, compatibility, and so on into account. These social concerns, in turn, presuppose certain "facts" about the social world; they naturalize prior value judgments that are anything but natural, and how these past judgments were made is forgotten. It is this taken-for-grantedness to which critical theory draws attention.

3 Critical Theory of Technology

We have explained how the traditional design studies literature tends to focus on the work of proximate designers, conceptualizing design as an instrumental activity. Recent work in the field of STS brings in elements of the social by focusing on the

[5] An example of this is when designers make use of scientific and technical standards in their work. To the designer, these standards appear neutral and unproblematic: they represent established guidelines and best practices within their design community. However, as numerous STS studies have shown, the making of such standards are as much political as they are technical in nature: technical standards are never "purely technical" (Bowker and Star, 2000).

actions and strategies of social groups close to the design process. What is missing in both these accounts is an acknowledgement of how past technologies and practices – our technical heritage, if you will – shapes current design. As a result, the impact of historical and cultural developments on the design of technology has been under-theorized. Critical theory attempts to address this oversight.

3.1 Critical Theory Compared to Existing Approaches

A number of STS scholars have looked at the issue of design. From the many approaches employed, two have emerged to prominence: social construction of technology (SCOT) and actor-network theory (ANT). Briefly, SCOT theorists argue that technologies are contested and contingent, the outcome of battles between various social groups, each with its own vested interests. To understand a design one should trace the history of a specific technology's development and look for the influence of relevant social groups. Similarly, ANT theorists argue that technologies are contingent, the result of strategies and tactics employed by key actors in bringing together a stable network of people and devices in which a new technology will succeed.

Critical theory shifts attention away from the micro-level analysis of constructivist technology studies to the macro-level. We take the fact that technologies are socially constructed to be self-evident. However, whereas SCOT is focused on uncovering *which social groups* were most influential in shaping the design of a particular technology, and ANT is focused on the *strategies employed by various actors* in the design of a particular technology, we are interested in the *broader cultural values and practices* that surround a particular technology. Put another way, our focus is less on specific social groups or the strategies they employ and more on what *cultural resources* were brought into play in the design process (see table 1).

Table 1 Three theoretical perspectives on design

Theoretical perspective	Focus	How is design conceptualized?	Where is power located?
Traditional design studies	Proximate designers	Design as a technical task	Micro-level *(negotiations between key actors)*
Constructivist studies of technology	Designers and related actors / interest groups	Design as a political task	Micro- and meso-levels *(structured interactions between actors within an existing power hierarchy)*
Critical theory of technology	Culture, broader society	Design embedded in history and culture	Macro-level *(influence of tradition and culture on design practices)*

Feenberg (1999; 2002) has developed this approach as "instrumentalization theory." This is a critical version of constructivism that understands technology as designed to conform not just to the interests or plans of actors, but also to the cultural background of the society. That background provides some of the decision rules under which technically underdetermined design choices are made. This background takes two forms: beliefs and practices of the everyday lifeworld, and culturally biased knowledge sedimented in technical disciplines shaped by a history of technical choices. The cultural study of technology must therefore operate at two levels, the level of the basic technical operations and the level of the current power relations or socio-cultural conditions that specify definite designs.

To give an example, consider a simple technology: the bicycle. Anyone who has spent time in Holland knows that the bicycle is an important mode of transportation in Dutch cities – far more so than in most North American cities. Bike lanes are prominent features in Dutch cities and bicyclists co-exist peacefully with motorists. This contrasts with North American cities, where cyclists must fight with motorists for use of the road. Furthermore, the everyday use of bicycles is a technological practice that is supported by another technology, the "Dutch road," which extensively incorporates bike lanes and, just as importantly, social expectations about the proper use of bicycles.[6]

What is of interest to us here is the dominant meaning attached to a particular device, in this case a roadway: in Holland, it is accepted that bicycles and bicyclists are "legitimate" users of the road (indeed, cyclists commonly have the right-of-way); in North America, these same devices and people are oddities, either grudgingly accepted or met with hostility by the road's primary users, motorists. No one doubts that cars dominate the roadways of North American cities. In North America, the word "road" brings to mind cars; in Holland, the same word brings to mind both cars and bicycles.

Our claim is that the "naturalness" of the interpretation of a particular device within a given social context is singularly important. The fact that a person living in Amsterdam is inclined to think of cyclists as natural users of roadways – while a person living in Atlanta does not – matters. It matters because this taken-for-granted understanding – what in essence is "culture" – becomes a background condition to the design of technology. Neither SCOT nor ANT pay much attention to these background conditions, choosing to focus instead on the actions of specific actors or groups of actors.[7] Yet, to understand the ways in which technological design may be biased one needs to look at this broader context.

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[6] Dutch bicycles are typically designed for everyday transportation without many of the bells and whistles of North American bicycles, which often seem more designed for hobbyist use. This illustrates once again the way in which devices are expected and constructed to fit into dominant understandings of what a technology is and how it is supposed to work. In addition, as Pinch and Bijker (1987) show in their study of bicycle development, the variety of styles one sees today reflects differences in opinion among designers and users as to what values are most important in a bicycle (e.g., fashion vs. comfort or speed vs. safety).

[7] In their original formulation of SCOT, Pinch and Bijker (1987) posited an examination of the "wider context" as the third and final step in their analysis. However, few SCOT theorists have followed through with this promise. We would also suggest that it makes a difference whether one begins one's analysis with the "wider context" or ends with it as an afterthought.

3.2 *Instrumentalization Theory*

We now turn to a more detailed exposition of the instrumentalization theory. The starting point is the notion of *technical element*. By this we mean the most elementary technical ideas and corresponding simple implementations that go into building devices and performing technical operations. Anthropologists conjecture that the ability to think of objects as means, the upright stance and opposable thumb together form a constellation that predisposes human beings to engage technically with the environment. In this humans achieve an exorbitant development of potentials exhibited in small ways by other higher mammals. The starting point of this basic technical orientation is imaginative and perceptual: humans can see and formulate technical possibilities where other animals cannot. These most basic technical insights consist in the identification of "technical elements," affordances or useful properties of things.

What is involved in perceiving a technical element? Two things are necessary: first, the world must be understood in terms of the possibilities it offers to goal oriented action; second, the subject of that action must conceive itself as such, that is, as a detached manipulator of things. The technical disposition of such a subject and the manner in which it conceives its objects constitutes the "primary instrumentalization." *Primary instrumentalization* proceeds by decontextualizing objects and simplifying them to highlight those qualities by which they are assigned a function.[8] There appears to be very little of a social character about such technical insight and elements can be employed in a very wide variety of social contexts. In this sense they are relatively neutral with respect to different social values. Nevertheless, a detailed study would reveal in each case some sort of minimal social contingency controlling selection and implementation even in the simplest form. Where technical elements emerge in the context of complex technical traditions, they presuppose the results of past social and cultural shaping of technical practice and so may carry with them quite a bit of social content.

Technical elements are at first notional but achieve realization in transformations of objects. In the process, social constraints of a more complex nature than simple goals shape the elements. This is the "secondary instrumentalization" in which the elements are given socially acceptable form and combined to make a technical device. *Secondary instrumentalization* proceeds by reorienting and integrating the simplified objects into a given natural and social environment. Design is the process in which relatively neutral technical elements are arranged to form a strongly biased concrete device, one that fits a specific social context. The relationship between technical elements and devices is depicted in figure 1.

An example will help to make the distinction clear. Consider the design of an everyday object such as the refrigerator. To make a refrigerator, engineers work with basic components such as electric circuits and motors, insulation, gases of a special

[8] For a more detailed account of instrumentalization theory see Feenberg (1999), especially pp. 202–208.

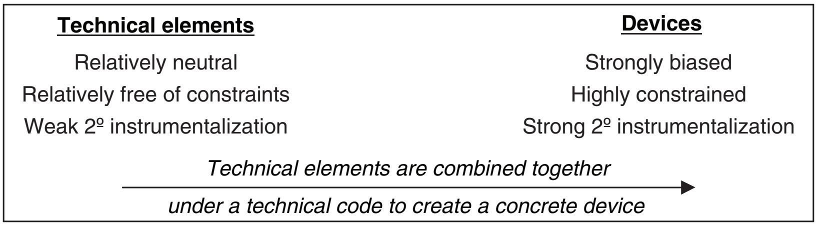

Fig. 1 Relationship between technical elements and concrete devices

type, and so on, combining them in complex ways for generating and storing cold. Each of these technologies can be broken down into even simpler decontextualized and simplified elements drawn from nature. This the level at which the primary instrumentalization is preponderant, taking the form of sheer technical insight.

However, even though these technical issues have been so thoroughly simplified and extracted from all contexts, knowledge of the components is still insufficient to completely determine design. There remain important questions such as what size to build the refrigerator, which are settled not on technical terms but rather on the basis of social principles (e.g., in terms of the likely needs of a standard family). Even the consideration of family size is not fully determining: in countries where shopping is done daily, on foot, refrigerators tend to be smaller than in those where shopping is done weekly by automobile. Thus, on essential matters, the technical design of this artifact depends on the social design of society. The refrigerator seamlessly combines these two entirely different registers of phenomena.

The two aspects of technique have a complex relationship. No implementation of a technical element is possible without some minimum secondary instrumentalization contextualizing it. Very little is required at first, perhaps no more than a socially sanctioned goal of a very general sort. Once the technical actor begins to combine these elements, more and more constraints weigh on design decisions. Some of these constraints have to do with compatibility between the various components of the new device and between the new device and other features of the technical environment. Some have to do with natural hazards or requirements that will affect the device. Others have to do with ethical-legal or aesthetic dimensions of the surrounding social world. The role of the secondary instrumentalization grows constantly as we follow an invention from its earliest beginnings through the successive stages in which it is developed and concretized in a device that circulates socially. Indeed, even after the release of a new device to the public, it is still subject to further secondary instrumentalizations through user initiative and regulation.

The iterative character of secondary instrumentalizations explains why we have a tendency to view technology in abstraction from society. It is true that technical elements are not much affected by social constraints, but we must not interpret fully developed technologies in terms of the stripped down primary instrumentalization of the initial technical elements from which they are made.

3.3 Design Spaces and Technical Codes

In all cases certain aspects of a device's design will vary depending on various sorts of demands while others will remain invariant. Those aspects that do not change include many that are invisible to the user, e.g., the type of components used, and others that have been standardized. What remains is a set of design possibilities – ways in which technical elements can be combined to create a workable device. We shall call this set of technically feasible possibilities the *design space*. It is from this set of possibilities that a "best" design will ultimately be selected.

Note that what is "technically feasible" depends on both the technology in question and on past history. Every design community inherits from its predecessors certain practices, assumptions, and ways of viewing the world. This "technical heritage" is at least as influential on design as any vested interest or lobby group. While in theory there may be hundreds of technically feasible design options for a particular technology, in practice professional designers typically consider only a small subset. Many technically feasible options are non-starters for reasons so obvious that they need no social justification – they are simply dismissed out of hand. These forgotten options are precisely the ones researchers should look at, if they wish to reveal the taken-for-granted assumptions and values that are part of the "black box" of technological design. As we have argued, the choice of "best" design is never a purely technical matter: designs are always underdetermined, and it is only through the application of the secondary instrumentalization that the actual form of a device is resolved.

Note that the set of available design options becomes progressively smaller as one moves "down" the design process, i.e., as more and more social requirements are added. Sometimes, however, it is possible for the black box of technological design to be reopened; when this happens, the design space for a particular device is suddenly enlarged. Controversies are one way to re-open the black box. Consider again the example of the refrigerator: at one point in time, the idea of using CFCs was not even a design question; it was simply the way things were done. However, when environmentalists made the case that CFCs were a danger to the ozone layer, this taken-for-granted assumption was made visible, and the question of "how to cool this device?" was put back on the design table.

The secondary instrumentalization exhibits significant regularities over long periods in whole societies. Standard ways of understanding individual devices and classes of devices emerge. Many of these standards reflect specific social demands that have succeeded in shaping design. These social standards form what we call the *technical code* of the device in question. In the example of the refrigerator, the technical code determines size as a function of the social principles governing family size. In other cases the technical code has a clearly political function, as in the deskilling and mechanization of labor during the industrial revolution. Labor process theory shows that the technical code prevailing in these transformations of work responded to problems of capitalist control of the labor force (Noble, 1977).

Technical codes are sometimes explicitly formulated as design requirements or policies, but often they are implicit in culture and training and need to be extracted from their context through sociological analysis. In either case, the researcher must formulate the technical code in an ideal typical manner as a norm governing design. The formulation of the norm as such helps to identify the process of translation between the discourse and practice of technologists and social, cultural, or political facts articulated in other discourses. This continual process of translation between technical and social is fraught with difficulty but nevertheless largely effective. In the end, this line of analysis allows the researcher to follow the evolution of a specific technology from technical elements through various design options to, finally, a concrete device (see figure 2).

In the language of technology studies, technical codes may be conceived as the rule under which "black boxing" occurs. At the end of the development process of a technology, when it finally assumes its standard configuration, we know "what" it is; it acquires an essence.[9] This essence is of course revisable but only with difficulty compared to the original very fluid situation of the first innovative attempts to make the device. The technical code prescribes some important aspects of the standard configuration, specifically, those which translate between social demands and technical requirements.

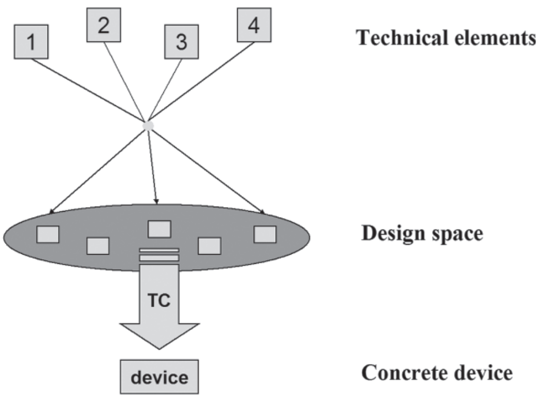

Fig. 2 Schematic diagram showing relationship between technical elements, design space, and a concrete device or technology. *In Critical Theory of Technology*, a technical code (TC) is what enables the selection of a "best" design from a multitude of design possibilities. Exactly how this code is selected and applied is an empirical question, which will vary depending on the case being studied. The researcher's task is to draw out the TC from a particular context through sociological analysis.

[9] Note that we do not mean "essence" in a Heideggerian sense, nor do we mean it in the ahistorical sense that essentialist philosophers of technology posit. The "essence" here is *specific* to a particular device within a particular social context. When the work of designing is done and all the technical elements have been combined together under a technical code to produce a concrete device, that device has an essence insofar as it reflects the particular values, demands, and social environment that figured in its design.

4 Conclusion: Towards the Realization of Design Possibilities

We began this chapter by asking questions about the role of intentionality within the design process. Specifically, we have suggested that the path from designers' intentions to the design of products is not a straightforward one. Though on the surface designers may seem like powerful actors, they are caught in the same web of constraints confronting other actors. Designers do not work in a vacuum. And all too often design demands, implicitly or explicitly, that new devices fit with established ways of being. In other words, designers must accommodate themselves to existing social worlds, which implies submitting to existing power relations and hierarchies. The stifling effect of such passive coercion is a significant obstacle to the realization of alternative designs.

We then outlined a critical theory of technology and explained how a greater focus on the historical and cultural conditions underlying the design process could help illuminate paths to different kinds of design. Technical elements, which in principle could be combined in any number of ways to form a device, are brought together under the constraints of a technical code to produce a concrete device that "fits" a specific social context. Moreover, designers are influenced by what has gone before: yesterday's tools inform today's designs, even when yesterday's tools may have been less than optimal.[10] This means that of the many technically feasible options available in the design space, only a small percentage are ever realized. We have argued that the process of resolving technically underdetermined choices should be the focal point of a philosophy of design. We have also argued that, rather than understanding this process solely in terms of the interests or strategies of specific actors (à la SCOT and ANT), we should look at the values and practices that are taken-for-granted in the broader culture.

If we understand technologies to be underdetermined, then the question facing society is not whether to accept or reject technology, but rather how alternative values can be brought into the design process so that the technical codes that determine design are humane and liberating rather than oppressive and controlling. An important first step in this process is to acknowledge that neither proximate designers nor the immediate design environment are decisive in determining the outcome of complex design processes. Instead, people's taken-for-granted assumptions about the forms and meanings of specific technologies – what we have called here our technical heritage – are crucial. Critical theory of technology draws attention to these background assumptions and asks that the researcher take these seriously. Our hope is that by *questioning* technology vigorously we can help open a space for *designing* technology differently.

[10] See, for instance, David's (1985) classic study on the QWERTY keyboard and how, despite being less than optimal in terms of layout and typing efficiency, it has remained the *de facto* standard for keyboards all over the world.

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