Design Culture and Acceptable Risk

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Abstract Technological design is usually considered as a process of stipulating target functions. Technological artifacts are, however, not determined entirely by the intent of the engineers who designed them: they unavoidably contain unpredictable and uncertain characters that transcend engineers' intent, and they cannot be understood purely from a functionalist perspective. In aviation, for example, the smooth implementation of a flight is ensured by a system that includes pilots interacting with each other and with a suite of technological devices. Emphasizing the human aspect of technological designs, this article presents a theoretical framework that takes socio-cultural aspects of technology as the primary for a philosophical, ethical analysis. An analysis of the acceptability of risks shows that the reliability of a technology is determined by the reliability of the technological decisions, eventually the existence of a reliable technological culture. So the task of the ethics of risks is to provide ways to reform our technology culture.

1 Introduction

Presently, the problem of how to deal with the risks posed by technology is growing in importance.

Engineering is often considered as a cultural activity, i.e., an activity that people undertake within a social context. Thus, the ethics of engineering and those concerning risks are to be found within this cultural process. However, risk is also considered as quantifiable and objective, particularly in scientific risk analysis. Moreover, since the situations with which risk analysis is concerned are complicated in nature and involve uncertainty to some extent, a complete optimization of technology cannot be expected and the rationality of risk analysis must correspond to "bounded rationality." This might remind us of the well-known conflict between cultural relativism and naïve positivism. However, in this chapter, I adopt a different path by avoiding referring to this conflict, i.e., avoiding referring to the under- or overestimation of risk analysis. Therefore, I focus on the problem of the acceptability of risks.

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As an introduction to the following discussion, let us focus on the statement made by E. S. Ferguson. In “Engineering and the Mind’s Eye” (1992), while discussing computer-assisted design (CAD), he states that “numerical calculations always embody human judgment”:

> The precise outcome of the [design] process cannot be deduced from its initial goal. […] Computerized illusions of certainty do not reduce the quantity or the quality of human judgment required in successful design. To accomplish a design of any considerable complexity […] requires a continuous stream of calculations, judgments, and compromises that should only be made by engineers experienced in the kind of system being designed. (Ferguson, 1992, 37)

Man tends to distinguish traditional techniques supported by human expertise and skills from modern technology supported by science. Such expertise and skills, which are usually not visually or verbally articulated, are replaced by or translated into scientific knowledge. However, in reality, they are not entirely removed from modern technology (hereafter, referred to as “technology” unless otherwise indicated). As in the case of CAD, they remain as constitutive elements, even though they are partly objectified and thoroughly modified in modern technological procedures. Ferguson calls this kind of knowledge the “mind’s eye” or “intuitive sense.” Initially, this “mind’s eye” seems to be purely personal in nature. However, when analyzed from a reflective viewpoint, one can identify some cultural “style” that is strongly connected to it; this is because a calculation or judgment is made on the basis of the accumulation of tacit information and tacit understanding. Therefore, it is possible to state that in technology, certain cultural elements are incorporated. If technology, which is considered to exist within a social and cultural context, is characterized as “technology in culture,” these cultural elements incorporated in technology can be characterized as “culture in technology.” We will also refer to these cultural aspects of technology as “technical culture” in a wide and narrow sense, respectively (this distinction will be indicated clearly only if it is necessary).

From this perspective, we can discuss the problem of acceptability of risks within a cultural context, without denying the need for scientific analysis. The following are some of the issues that need to be addressed: how a particular risk is recognized as risk; how some risks are considered to be acceptable in a society; in which cases do people regard such acceptance risks as reasonable; and so on. Studying the acceptability of risk from this perspective, I seek in this chapter to consider the problem of risk within the “ethos of technology” and consequently find answers to practical and ethical debates regarding technology. In this manner, the technical culture of a society, or of an organization, will be discussed critically, thereby paving the way for an inquiry about the public nature of technology.

In section 2, I will review the Challenger space shuttle accident in order to discuss the notion of acceptability more concretely and show that it is deeply rooted in technical culture (in the narrow sense). In sections 3 and 4, I generalize this notion to technology as a whole and indicate that the reliability of technology depends on that of technical culture. In section 5, I focus on technology in culture i.e., technical culture in the wide sense. Based on the examination of the Ford Pinto case, I create a discussion where the definition and reliability of design is not only concerned with engineers but also with society at large. Finally, in section 6, I further explore the notion of public determination of technology. Highlighting the limitations of technological design and the engineer's responsibility, I suggest a possibility of a narrative ethics that can be devoted to the improvement of design culture, or technical culture in general.

2 The Case of the Challenger Accident

First, let us examine the case of the explosion of the space shuttle Challenger in 1986; this is an important case for textbooks on the ethics of technology. The Challenger exploded immediately after lifting off from the Kennedy Space Center, killing all the seven crew members aboard the shuttle. In the ensuing investigation, the O-rings that seal the joints in the shuttle's solid rocket boosters were identified as the direct cause of the accident. Descriptions in textbooks identify two issues: 1) Roger Boisjoly, an engineer with Morton Thiokol, the engineering firm that was involved in the manufacturing of the boosters, had previously identified this problem and reported the risk to his supervisors; in fact, on the night prior to launch, he had suggested that the mission be delayed. 2) He was ultimately overruled by a management decision that was eventually responsible for the accident. In other words, the responsible behavior of Boisjoly, who doggedly continued to raise the problem, and the actions and attitudes of Morton Thiokol and the NASA management, who prioritized the schedule and proceeded with the launch though they were aware of the risk involved, can be depicted as the "professional ethics of engineers" versus the "logic of management." The above analysis presents the ethical issues regarding the responsibility of experts, honest and unbiased inquiries, reliability, and the conflict between engineers and their organizations (e.g., Harris et al., 1995, 4 ff.).

However, ethnographical research by the sociologist Diane Vaughan (1996), who carefully reviewed the extensive testimony of individuals involved in the accident, and the debates by Harry Collins and Trevor Pinch (1998) based on that research raised different issues.

To avoid any misunderstanding, it should be noted that Morton Thiokol and the NASA engineers were not unaware of the risk surrounding the joints. Rather, they were well aware of the problem and had dealt with it for a number of years. However, as Vaughan et al. pointed out, a) what they sought was not absolute certainty but an "acceptable" solution. That is, complete sealing requires unlimited time and expense, and even assuming that this is achieved, if its integration with the other parts is lacking, the stability and safety of the entire system would still not necessarily be ensured. In general, technology invariably involves some incompleteness as it depends on various factors and deviations arising in situations. However, determining which of these factors or deviations is definitive at that moment is only possible through a system of experience and knowledge. In the abovementioned case, the engineers of NASA and Morton Thiokol, who partly shared common views based on a common intellectual "horizon," decided to "go ahead" with the launch because the effects of the O-ring damage were within workable limits owing to redundancy. In addition, b) by definition, conflicts between the technical opinions of engineers is normal, and generally, whichever of these conflicting views is considered valid from the perspective of this intellectual horizon is deemed the “winner.” Boisjoly and the others were unable to present persuasive data regarding the reduction in the elasticity of the O-rings at low temperatures; moreover, their data analysis was rife with inconsistencies. Thus, the engineers of Morton Thiokol and NASA concluded that the opinions of Boisjoly and the others were not supported by adequate data. In other words, their opinions lacked the validity required to reverse a decision under the conditions that a technological discussion at NASA must fulfill.

Based on the above facts, the descriptions provided in the textbooks are extremely simplified depictions, and it seems to be mere hindsight that judges the processes from the perspective of the result, i.e., the failure. First, the engineers of Morton Thiokol and NASA believed that, despite the uncertainties, the joint was an acceptable risk. Their managerial decision-making was rule-based, i.e., no rule was violated. The launch decision was, so to speak, the outcome of a strict technical discussion (see Vaughan, 1996, 336). Second, there were no absolute criteria regarding the validity of technical knowledge, i.e., the validity of technological knowledge is dependent on the situation. In other words, technological knowledge is situated in nature. Third, typically, though a “technical culture” that is shared by engineers determines the nature of the technical discussions regarding the validity of technical knowledge, irrespective of the existence of biases, this technical culture, or culture in technology, is often taken for granted. As a cognitive basal stratum, certain systems of experienced implicit (and explicit) knowledge are a part of this culture, and based on this technical culture, the engineers arrived at a consensus with regard to determining acceptability. After the path was adopted, Vaughan stated that “the launch decision resulted not from managerial wrongdoing, but from structural factors that impinged on the decision making, resulting in a tragic mistake” (Vaughan, 1996, 335). However, it is clear that these “structural factors” do not refer to the factors concerning the physical structure of the space shuttle; rather, they refer to the factors concerning NASA’s organizational culture. As can be observed from the above discussion, although the Challenger’s case initially appears to be a moral issue of engineers, at its core, it is an issue regarding the sanity of technical culture.[1]

[1] M. Davis, for example, insists on a “wrongdoing” (self-deception) in the attitude of R. Lund, Vice President of Engineering at Morton Thiokol. Lund had initially supported Boisjoly’s position; however, during the pre-launch caucus, he changed his mind following the advice of J. Mason, Senior Vice President at Morton Thiokol, “It’s time to take off your engineering hat and put on your management hat” (Davis, 1989). However, in her detailed analysis, by citing the evidences presented in the caucus by Thiokol Vice President J. Kilminster et al., Vaughan describes Mason’s decision as being typical of cases where engineering disagreements could not be resolved by data that drew everyone to a consensus. “Someone has to collect that information from both sides and made a judgment.” (Vaughan, 1996, 315 ff.). If this was the case, although by all considerations, Lund found himself in an extremely difficult position, one should consider his decision as an act of neglecting his loyalty toward engineering and replacing it with management logics. Based on this, it would be possible to argue that this is not an issue of personal morals but rather one of structure.

3 Organizational Accidents

Such a determination of the acceptability of risk on the basis of technical culture is typical to technology in general. In other words, it is neither specific to technology accompanied by enormous risk and uncertainty, similar to the case of the space shuttle Challenger, nor to the design process of technology. In fact, a culturally, or experientially, dependent nature is a fundamental characteristic of technical knowledge. Extremely similar situations are also observed with regard to more established technologies and in instances of management and operation of technical systems. In these cases, cultural determination does not involve technical discussions and calculations, but involves practical human-artifact relationships. Above all, embodied tacit knowledge plays an important role in these cases.

For example, with regard to the cockpit of an aircraft, large control devices as seen in the past are considered to be outdated. However, during take-off and landing and in emergency events, the existence of several people in the vicinity can be extremely significant in handling the situation and sharing the burden of making appropriate decisions. For instance, with regard to a large control device, the pilot's action to lower the gear lever for the landing gear is subconsciously noticed by the copilot, who is informed by his counterpart that the pilot is controlling the aircraft. Such an "awareness of the situation" obviously serves to develop natural communication between the pilot and copilot. In this example, the mechanical control serves as the medium for a message; therefore, the synchrony of intersubjective communication and action through mechanical media, training, and teamwork permits the smooth operation of the overall system (Norman, 1993, 139 ff.).

This case reveals that the human aspect of a technological system, which is latent in usual situations, becomes evident in the case of emergency events. In current engineering practices, the involvement of humans in mechanical systems is generally believed to cause human error; therefore, it is preferred to maintain as little human involvement as possible. Conversely, humans are indispensable for rectifying problems and errors that occur constantly. Humans, in a sense, use artifacts and one another as extensions of their knowledge system, or rather their own body. In fact, one could suggest that a technological system is created through the interaction of humans and devices (cf. Hutchins, 1995; Norman, 1993). Thus, when increased workload or decline in proficiency negatively affects human reliability, automation through machinery does not increase the safety and reliability of a human-artifact system. Lisanne Bainbridge termed such situations as the "ironies of automation" (Bainbridge, 1987).

Humans design, produce, and manage complex systems. Thus, when a major accident occurs, the individuals who made the mistakes are often held responsible. The morals of engineers and an awareness of themselves as professionals is assumed to ensue, although these morals and the types of behavior that they comprise are the actions of human beings who are acting rationally in pursuit of optimality (cf. Renn et al., 2001). However, the problem now is that a vast majority of knowledge has become routine, and even if this knowledge was once accompanied by careful consideration, it is no longer perceived as such. Nonetheless, acts are committed in accordance with the knowledge “in hand” (Schutz, 1970); therefore, we are usually unable to identify “dis-situated” or disembodied subjects. Moreover, dealing with this knowledge is difficult; this is because if one does not adopt a retrospective viewpoint by asking the question “why,” it is not thematized in this manner (Schutz, 1970). Such knowledge allows the smooth and reliable operation of a system; however, it is also fraught with the possibility of a reduction in the reliability of the system with regard to certain aspects such as safety and product quality. The reliability of a system depends upon the reliability of the technical culture. In this context, James Reason noted the “latent conditions” in an organization that induce errors such as the unsuitableness of design, i.e., lacking consideration of human factors, and inadequate direction; accordingly, he proffered the concept of “organizational accidents” (Reason, 1997). Again, the issue here is regarding the improvement in culture and organization. Therefore, the nature of culture, i.e., embodied knowledge, and the nature of the corresponding designs, organizations, and systems, will be examined in the next section.

4 Normalization of Deviance

Let us again return to the example of the Challenger accident. With regard to the launch decision, Collins and Pinch merely observed the familiar scenario in which “one opinion won and another lost”; engineers “looked at all the evidence they could, used their best technical standards, and came up with a recommendation” (Collins and Pinch 1998, 55). However, the conclusion that everything that was possible was done cannot be arrived at based on the above description of the situation, i.e., winning or losing the debate. Such a discussion is merely a kind of afterthought and relativism. With regard to deciding what is right or wrong, they posit that the discussion must further delve into the situation. Vaughan, as cited previously, noted the “normalization of deviance” with regard to the structural factors that cause an accident. In the Challenger accident, no explicit infractions were necessarily committed. Rather, an activity that could be considered to be natural in an organization was responsible for the accident. In this case, since the criteria for the conditions that a discussion by the engineers must fulfill were rigidly applied, there is little scope for recognizing any such deviance; however, this encouraged a definitive situation. Therefore, we can proceed to a discussion on normativity in technical culture.

The fact that introducing and following “rules” and regulations are not needed to improve society is already apparent from the paradoxical situation mentioned above. In order to apply rules and regulations appropriately, it is important to understand their interpretation in advance; this is because a rule itself does not determine whether it is applicable to a particular situation. Moreover, a severe restriction on the scope for action by rules and regulations in the pursuit of safety will result in people committing infractions on a regular basis. Therefore, contrary to the intent, this may lead to increased risk (Reason, 1997, 50).

Assuming that the above argument holds true, the next issue that we must consider is whether or not the individuals involved exercised "due care." However, questions on what due care implies are certain to arise immediately. In the case of the Challenger accident, we can identify a problem regarding the burden of proof. NASA engineers were conservative as a rule, what was usually done, and continued to demand a proof of safety with respect to Morton Thiokol; this emphasized the practicality of the design. In contrast, the tables were turned when Boisjoly and the others raised concerns immediately before the launch, and NASA demanded that they prove the existence of danger. Therefore, what kind of suspicion is reasonable with regard to such a "risk" that has yet to have an effect, what proof should be demanded in that case, and what decision should be taken in accordance with the given rules are the questions that fall under the concept of due care. Thus, this situation is accompanied by demands for normativity that transcend specific circumstances.

Here, we will avoid dwelling on individual measures to achieve improvement. However, when due care is generally required, besides the concerns regarding what comprises due care, determining who makes the decision is critical. For example, with regard to product reliability, the problem is whether it is appropriate that engineers with specialized knowledge determine a design with strict application methods such that they are not responsible for the outcome and the consumers bear those costs (Velasquez, 2005, 110). If done so, this is merely a kind of paternalism. Thus, keeping the design setting in mind, we will expand the scope of our discussion to "technology in culture" and examine the public nature of technology within it.

5 Historical Nature of Design

In general, design can be considered to be a process of stipulating target functions and proposing structures to implement those functions. This goal-orientatedness is considered to be a characteristic of technical knowledge. However, at the same time, it expresses the fact that technology is incorporated within a wider social context, for example, through markets or individual customers, etc. In this case, the relationship between society and design could still be perceived as that between social needs and optimal solutions. This view should not be understood from narrow perspectives. When examined from viewpoints such as due care with respect to safety and environment, the nature of social and cultural regulation extends to the design process as a whole, i.e., it is not merely restricted to direct functions but incorporates secondary functions, etc.

Here, let us consider the Ford Pinto case as an example. Despite the usual depiction in textbooks on engineering ethics, this case shows that the assessment of the uncertainty and incompleteness of technology includes a valuation beyond technology in the narrow sense. This case is usually explained as follows. In the late 1970s, the Pinto, a compact car designed by Ford, was developed in a short period of time to compete with competitors' compact models. Since style was prioritized, the car had a potential flaw in terms of design, in case of a collision, the gas tank could rupture if it were struck from behind. Regardless of the fact that Ford could have made improvements at the cost of just $11 per car, the company was attacked for continuing to manufacture the car based on its cost-benefit analysis until 1978, when new regulations became mandatory.

In most of the textbook descriptions, Ford is blamed for its "profits come first" approach that was grounded in its cost-benefit analysis. However, as some writers point out, despite the fact that Ford's analysis was malformulated, it is not evident whether this analysis was really the decisive ground of its (mis)conduct (Birsch, 1994).[2] Although this particular problem is beyond the scope of this chapter, I would like to use this case to highlight the issue concerning the definition of "safety." Obviously, an automobile cannot by nature guarantee complete safety; moreover, one cannot expect the same level of safety from a compact car as from a conventional large-sized car. In addition, the Ford Pinto is not said to have failed the safety regulations at the time (although there are some people who hold the view that this was a gray area). However, as Richard De George also noted, the reason Ford was attacked was not because of such facts but because, despite the existence of technological solutions, the company was negligent with respect to a risk that should have generally been avoided, i.e., explosion of the gas tank (De Georg,e 1994). Moreover, writers have also highlighted a background in which, amidst the consumer movements of the 1960s and the establishment of the National Highway Traffic Safety Administration (NHTSA) in response to these movements, people's awareness with respect to automobile accidents was shifting from the driver's responsibility for the accident to the manufacturer's responsibility for providing adequate safety (Saito, 2005). Given these views, a part of the reason for Ford's response was assumed to be that the company did not believe that people would be willing to pay for eliminating such a risk and that it could not have predicted that ignoring this willingness would invite a backlash in the future (Harris et al., 1995). I elaborate on this point in the discussion on the research of the history of technology.

If the above debate is an appropriate depiction of this case, determining what "safety" implies would not be primarily dictated by technology but by various other factors such as cost and human trust and desires. Such a social decision is embedded in design. Therefore, if we define the automobile as a form of mass transportation, the assessment of what is valued technologically or what items are risks is conducted on the basis of such a definition. In the words of De George, the decision to accept risk is "not only an engineering decision" but "also a managerial decision, and probably, even more appropriately, a social decision" (1994, 186).

[2]The validity and scope of risk assessment needs a deliberate analysis. This is an exhaustive task and will not be undertaken here.

A similar argument could be made with regard to other features and values of technology. Thus, a definite social context is an aspect of technical designs; however, in most instances, it is taken for granted and therefore often overlooked. Only amidst changes in circumstances or in the face of opposition, as in the case of the Ford Pinto, does this social or political nature become evident as a rule; thereafter, the design would be modified and re-embedded within a new context. It is important to note that such transformations of design are not made from a functionalistic perspective. Transformations of design occur within the public sphere and not within a narrow economic sphere, in which functions are considered to be efficiently adapted on the basis of the needs of the market or customers. Barrier-free design is another noteworthy example for this discussion. The former designs that chiefly took non-handicapped people into account come to be realized, for example, through the civil rights movement, as barriers that prevented the handicapped from social participation. From a reflective viewpoint, we can clearly observe the discriminative structure included implicitly in the former designs, and accordingly, the value of justice has been incorporated into the new designs. This transformation clearly reveals the political nature of technical designs. Design is also a historical entity that is developed by many people including engineers, managers, and laypersons.

6 Unintended Results and Public Nature

As mentioned in the previous section, design can be considered as a process of stipulating target functions. Considering the facts that technological design embodies social needs and relationships and that it creates a new social order (see the examples given above),[3] it would be possible to state that designing artifacts means simultaneously designing and defining the order of our world. In a sense, it is similar to a "legislative act" (Winner, 1986, 29). However, the power of this "legislation" is limited since one cannot presuppose the perfect predictability or analytical separability of means and ends. We must also note that the identification of objectives with "the intent of the designer" and of designing processes with the implementation of that design is problematic. As evident from the discussion above, this is because the dimension of what items will be established as objectives as well as what is emphasized in the process of design and what is viewed as secondary are dictated on the basis of culture, or routine knowledge that is often taken for granted. This is strongly associated with the assessment of the uncertainty and incompleteness of technology.

[3] The problem of technical mediation demands a separate study and is beyond the scope of this chapter. For an example from classical literature, see E. Cassirer (1985). "Tool carries out the same function in the sphere of object that can be found in the sphere of logics: it is as it were 'termimus medicus' which is grasped in the objective conception (gegenständliche Anschauung), not in mere thinking" (ibid., 61).

First, besides directly intended objectives, there could be latent secondary intentions that can cause unexpected results. For example, when a designer unintentionally designs an artifact that is primarily meant for non-handicapped people, it might be dangerous for the disabled and therefore result in them feeling discriminated against.

Second, the results of technology are not primary; instead, they accompany numerous effects and side effects. Technology exceeds the intent of the designer, resulting in unintended and unpredictable by-products. In the words of Tenner, technology "bites back" (1996). Results of technology cannot be controlled completely. In the context of risk analysis, with respect to the problem of side effects, a "risk trade-off" is often insisted, i.e., comparing the possibility and weight of a target risk with those of a potential risk that will take its place and determining whether an action should be performed. However, the effects of technology that should be valued can only be determined within the cultural and social context.

Third, changes in the context incorporated in the design and the significance of that technology as a result of the transformations in lifestyle due to technology and other factors are also important. As Don Ihde states, all technologies are double-edged because they have "ambiguous, multistable possibilities" (1999, 44) that exceed the intent of the designer. He terms this phenomenon "designer fallacy" that is modeled on the phenomenon of intentional fallacy in literature. Such instances result in changes in the assessment criteria with regard to risk and the features of technology.

Therefore, the question that arises is: Who should be responsible for this decision? Since no one can manage the technological uncertainties, the question of what overall benefits does a particular technology produce should not be assessed paternalistically and decided solely by engineers. Rather, this question should be determined in public by analyzing it from a larger number of perspectives without being limited to a narrow technical perspective. In this case, the engineers cannot possess all the rights and responsibilities, and the perspectives of non-engineers must be incorporated. This is the reason (Shrader-Frechette, 1994, 94) for advocating the principle of "giving priority to third-party or public responsibilities in situations of uncertainty."

At the beginning of this chapter, I mentioned "culture in technology"; however, the existence of such a system of experiential knowledge implies that it will serve as a barrier that prevents the participation of people who do not share that system. Thus, it should be accepted that in our present society, experts have a monopoly on technological matters. There appears to be an asymmetrical relationship of dominance versus subordination between experts and laypersons. However, such a culture cannot be closed to both matters of fact and normative demands.

On the one hand, as claimed in risk theory, experts have noted the "risk-perception bias" of laypersons. In this case, experts often point to "literacy" in the sense of the capacity to understand science and technology. The thought is that acceptance without bias is only possible by redistributing knowledge, i.e., educating the public and enabling them to acquire the ability to understand modern science and technology "correctly". On the other hand, if one disregards this barrier, participation in discussions will remain at the most a formality to obtain consent. As evident from this discussion, the situation is instead one of "cultural friction." In other words, due to the differences between the systems of relevance of experts and non-experts, the matters that are considered problematic by non-experts are not viewed as problems by experts. Therefore, what is needed in the first place is "literacy" on the side of engineer's: literacy in the sense of a competency in understanding and responding to the questions raised by laypersons. This could be termed as the engineer's "responsiveness" to the public.

In order to further clarify this, I use the metaphor of a narrative or novel written by many authors, in this case, engineers, managers, laypersons, etc. In this sense, the current master narrative would be that of the engineers. What is required is a rewriting of the narrative of design through mutual recognition between experts and non-experts. This implies that both of them recognize each other in the dialogue as co-authors of the narrative, i.e., as agents with the rights and obligations to ask and answer (responsibility). Trust, identity (on both the sides), and solidarity are founded on the basis of such mutual recognition. Consequently, this shall act as a foundation for the improvement of technical culture in general, or what can be called design culture.

7 Conclusion

We can concretely elucidate "culture within technology" and discern technology as a social and cultural activity by focusing on "acceptability". In general, the history of technology is not only a history of creations or choices but a history of the acceptances of the former and the oblivescence of the latter. Various decisions, interpretations, and valuations are embedded in the history of technology; they are sedimented and taken for granted. In a sense, technology is a narrative given by many people including laypersons. Thus, technological activities are conducted on this historical basis. For example, the reliability of a technology is determined by the reliability of the technological decisions and eventually the existence of a reliable technological culture. Therefore, particularly in organizations, this depends on the cultural and social relations; the same can be said about risk.

We shall undertake a detailed discussion on this issue in the future; however, with regard to the ethics of risks, we can state that the moral of the individual engineer and the moral rules of the engineering profession are not the only central, although not incidental, problems. When designing some artifacts, engineers expect numerous effects, side effects, and possible influences. In this context, in order to recognize engineers as qualified personnel, it is imperative that they are competent in appropriately understanding and responding to the questions of laypersons. Responsibility, in this sense, is the basis for ethics. Based on this approach, we can move beyond the dichotomy of scientifically quantified risk, the bias of non-experts, and the cultural relativism of risks. Thus far, we have emphasized "culture in technology" and "technology in culture"; however, this does not imply that we should not continue to observe from a descriptive point of view. It is at every step. Design through mutual recognition between experts and non-experts engaged in dialogues is one such way. Technology and its risks are central to our discussion of human well-being.

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