## *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.

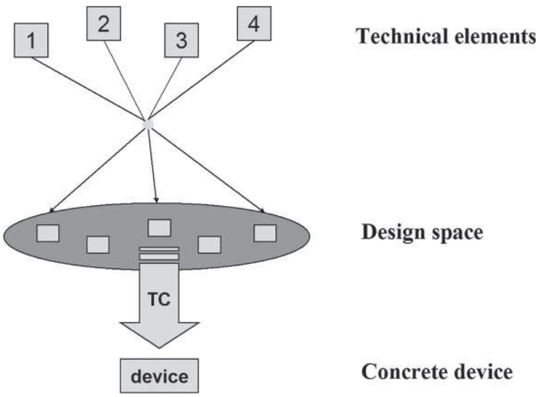


**Fig. 2** Schematic diagram showing relationship between technical elements, design space, and a concrete device or technology. *In Critical Theory of Technology*, a technical code (TC) is what enables the selection of a "best" design from a multitude of design possibilities. Exactly how this code is 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.