Five-Dimensional Technology

Daniel Bell, 1973

Technology, like art, is a soaring exercise of the human imagination. Art is the aesthetic ordering of experience to express meanings in symbolic terms, and the reordering of nature—the qualities of space and time—in new perceptual and material form. Art is an end in itself; its values are intrinsic. Technology is the instrumental ordering of human experience within a logic of efficient means, and the direction of nature to use its powers for material gain. But art and technology are not separate realms walled off from each other. Art employs *techne*, but for its own ends. *Techne*, too, is a form of art that bridges culture and social structure, and in the process reshapes both.

This is to see technology in its essence. But one may understand it better, perhaps, by looking at the dimensions of its existence. For my present purposes, I will specify five dimensions in order to see how technology transforms both culture and social structure.

1. *Function.* Technology begins with an aesthetic idea: that the shape and structure of an object—a building, a vehicle, a machine—are dictated by its function. Nature is a guide only to the extent that it is efficient. Design and form are no longer ends in themselves. Tradition is no justification for the repetition of designs. Form is not the unfolding of an immanent aesthetic logic—like the musical forms of the eighteenth to early twentieth centuries. There is no dialogue with the past. It is no accident that adherents of a machine aesthetic in the early twentieth century, in Italy and Russia, flaunted the name Futurism.

2. *Energy.* Technology is the replacement of natural sources of power by created power beyond all past artistic imagination. Leonardo made designs for submarines and air conditioning machines, but he could not imagine any sources of power beyond what his eyes could behold: human muscles or animal strength, the power generated by wind and falling water. Visionaries of the seventeenth century talked grandiosely of mechanized agriculture, but their giant combines were to be driven by windmills and thus could not work. Energy drives objects—ships, cars, planes, lathes, machines—to speeds thousands of times faster than the winds, which were the limits of the "natural" imagination; creates light, heat and cold, extending the places where people can live and the time of the diurnal cycle; lifts weights to great heights, permitting the erection of scrapers of the skies and multiplying the densities of an area. The skyscraper lighted at night is as much the technological symbol of the modern city as the cathedral was the emblem of medieval religious life.

3. *Fabrication.* In its oldest terms, technology is the craft or scientific knowledge that specifies ways of doing things in a reproducible manner. The replication of items from templates or dies is an ancient art; its most common example is coinage. It is the essence of technology that its reproduction is much cheaper than its invention or development, owing to the standardization of skills and objects. Modern technological fabrication introduces two different factors: the replacement of manual labor and artisan skills by programmed machines; and the incredible rapidity of reproduction—printing a million newspaper copies a night—which is the difference in scale.

4. *Communication and Control.* Just as no one before the eighteenth century could imagine the new kinds of energy to come, so, well into the nineteenth century, no one could imagine—even with the coding of messages into dots and dashes, in telegraphy—the locking of binary digits with electricity, or the amplification of ethereal waves, which has produced modern communication and control systems. With telephone, radio, television and satellite communication, one person can talk to another in any part of the globe, or one person can be seen by hundreds of millions of persons at the same moment. With programmed instructions—through the maze of circuits at nanosecond speed—we have control mechanisms that switch trains, guide planes, run automated machinery, compute figures, process data, simulate the movement of the stars, and correct for error both human and machine. An odd phrase sums it up; these are all done in "real time."

5. *Algorithms.* Technology is clearly more than the physical manipulation of nature. There is an "intellectual technology" as well. An algorithm is a "decision rule," a judgment of one or another alternative course to be taken, under varying conditions, to solve a problem. In this sense we have technology whenever we can substitute algorithms for human judgment.

We have here a continuum with classical technology, but it has been transposed to a new qualitative level. Physical technology—the machine—replaced human power at the *manual* level of raw muscle power or finger dexterity or repetition of tasks; the new intellectual technology—embodied in a computer program, or a numerically controlled machine tool—substitutes algorithms for human *judgments*, where these can be formalized. To this extent, the new intellectual technology marks the last half of the twentieth century, as the machine was the symbol of the first half.

Life: the expression of the surface properties of the biopolymers.

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