What Is Technology?

Stephen J. Kline

Bulletin of Science Technology & Society 1985 5: 215
DOI: 10.1177/027046768500500301

Bull. Sci. Tech. Soc., Vol. 1, pp. 215-218, 1985. Printed in the USA.
0270-4676/86

WHAT IS TECHNOLOGY?

Stephen J. Kline

In the late 20th century, there is only one thing most people agree about concerning technology -- it is important. It is discussed almost as much as the weather, and sometimes it seems, with as little effect.

But what is 'technology?' If we look with even a little care, we find this same word is being used to represent things, actions, processes, methods and systems. 'Technology' is also used symbolically as an epithet, for important working procedures, and to represent progress. This much conflict within the usage of one of our central terms won't do; it can lead only to chaos. Even more important, the current vague use of the word 'technology' hides from view two central concepts, and a central pattern of human behavior that we must have to make sense of our views of many critical questions in the current world including how we understand innovation, how we can communicate across Snow's culture gap, and how we understand the way in which we humans make our living on the planet.

We cannot get on with our work in STS studies even reasonably well until we 'unpack' the word 'technology' -- take apart the various usages and agree on names for each of the important concepts so that we can understand one another at least adequately. As Seneca told us two millenia ago, *"When the words are corrupt, the mind is also."*

Perhaps the commonest usage of 'technology' is to denote manufactured articles -- things made by humans that do not occur naturally on earth, for example: refrigerators, eyeglasses, atom bombs, paints, automobiles, pianos, paper, rubber, glass, aspirin, penicillin, airplanes, copying machines, furniture, roads, rifles, printing presses, boots, bicycles, and on and on. In the late 20th century, the list is very long. Engineers often call manufactured articles 'hardware;' anthropologists usually call them 'artifacts.' Since the phrase "manufactured articles" is awkward, we might use either the word 'hardware' or the word 'artifact.'

USAGE 1: **HARDWARE (OR ARTIFACTS):** Possible denotation: non-natural objects, of all kinds, manufactured by humans.

* * * * * *

The next most common usage of 'technology' is the process of manufacturing hardware. Usually this usage includes the manufacturing equipment, and sometimes it includes in addition the people who operate the equipment. In either case this is a truncated usage in a very important sense. What is usually being implied, in the important sense of this

usage, must be much more than just the machinery and the poeple. It is what I will call a sociotechnical system of manufacture. For example, a complete system for manufacturing airplanes, (or pianos, bicycles, eyeglasses, atom bombs, aspirin, blue jeans, etc.). This full usage is essential for many reasons that will be illustrated shortly.

USAGE 2: **SOCIOTECHNICAL SYSTEM OF MANUFACTURE**. Possible denotation: All the elements needed to manufacture a particular kind of hardware, the complete working system including its inputs: people; machinery; resources; processes; and legal, economic, political and physical environment.

* * * * * *

A third common usage of the word 'technology' is technique, methodology or 'know-how.' In a famous polemic Ellul uses the word 'technology' to denote any form of rationalized methodology. Others, such as Brooks, suggest 'technology' be used to denote the knowledge needed within a sociotechnical system of manufacture. These are even more truncated uses of the term 'technology.' and in some instances this truncation has caused significant confusions, as in some interpretations of Ellul's that occured in part owing to the translation of the term *"La Technique"* from the French. Others appear to use 'technology' to denote methodology for accomplishing any given task, as in, *"we have the technology to do the job."* In order to avoid these potential confusions, we might call these various functions: 'knowledge,' 'technique,' 'know-how,' 'methodology,' (or 'sociotechnical system') as appropriate.

USAGE 3: The information, skills, processes, and procedures for accomplishing tasks: Possible denotation: **KNOWLEDGE, TECHNIQUE, KNOW-HOW, OR METHODOLOGY** in the usual sense of these words.

* * * * * *

When we include the many variations and shadings of the three usages discussed above, they constitute together the common usages of the term 'technology.' However, there is a fourth related concept that has no common name, but which is essential to understanding the human implications of 'technology' in the ways intended by much public discussion. I will call this fourth concept 'sociotechnical systems of use.' Such systems form the basis of what we do with the hardware after we have manufactured it.

For example, we embody automobiles in a system of roads, gas stations, laws for ownership and operation, rules of the road, etc., and use the combined system (the autos plus all the rest) to extend the human capacity for moving ourselves and our possessions about -- transport. We manufacture violins, pianos, drums, guitars, and other musical instruments. We then embody them in orchestras and bands to extend the ways in which we can make music. We build microscopes, telescopes, cat-scanners, thermometers, and other instruments and utilize them in systems to extend our ability to sense various aspects of the world around us. We make rifles, pistols, grenades, atom bombs, and other weapons and diffuse them into armies, navies and air forces which are systems for extending our capacity to kill, to oppress other peoples, and to protect ourselves from being oppressed by others. And, we do all this in order to perform tasks which individual humans cannot perform without such systems.

USAGE 4: **A SOCIOTECHNICAL SYSTEM OF USE** is a system using combinations of hardware, people (and usually other elements) to accomplish tasks that humans cannot perform unaided by such systems -- to extend human capacities.

* * * * * *

I am making a point of saying 'these systems' and not just 'hardware' because nearly always we need more than just the hardware to create these extensions of human capacities. Even if a single human is using a musical instrument, there is the need for knowledge of music and ingrained neuromuscular skills, from long practice, to make even adequate music. To create a band, a system of transport, an army, or a football team takes many more elements. The central point is that we have learned to vastly extend our muscular, sensing, and mental capacities through the use of sociotechnical systems of manufacture and use.

These extensions of human capacities by use of sociotechnical systems are both quantitative and qualitative. Using autos or trains we can move over the land much faster than we can unaided by such systems of transport. Using sociotechnical systems built to exploit airplanes, we can fly, a function hardly any of us can perform unaided. Using various weapons in armies, navies or air forces, we can vastly extend our ability to kill and oppress. Using telescopes and microscopes, X-rays and other hardware in appropriate systems, we can see far beyond the scope of the naked eye. Using engines and motors in appropriate systems, we can create manyfold extensions of our muscle power. In a relatively recent set of systems, we are extending our memory and data manipulating capacities by use of computer systems.

Without sociotechnical system of use, the manufacture of hardware would have no purpose. Taken together, sociotechnical systems of manufacture and sociotechnical systems of use, form the physical bases of all human societies past and present. The human consequences of this statement are so profound that they need a book for complete elaboration, but I will give a few illustrations here.

The pattern of creating hardware in special sociotechnical systems of manufacture and diffusing the hardware into other sociotechnical systems of use in order to extend our human capacities is not a product of the "high-tech age." On the contrary, the pattern was first adopted by our evolutionary ancestors two species before we became homo sapiens, roughly two million years ago according to the best current evidence from paleoanthropology. We humans have been making our living on earth by use of this pattern for so long a time, that it has materially affected our evolutionary path.

Other animals use sociotechnical systems (beavers, ants, bees and prairie dogs to mention only a few). However, we humans are the only species that purposefully makes innovations in our sociotechnical systems in order to (hopefully) improve their functioning. This characteristic of purposeful innovation in sociotechnical systems, distinguishes humans from other animals as least as clearly as any single characteristic.

The history of changes in sociotechnical systems is a history that accelerates with major eras each roughly a period of ten times shorter than the preceding period for the past million or two years. The changes

look much like a growth function. There is a sharp break in the rate of acceleration in the extension of human powers via sociotechnical systems about 1840 as both Lienhard (1979) and Kline (1977) have documented independently.

Without sociotechnical systems, we humans might not exist as a species, and if we did, we would be relatively powerless, few in number and of little import on the planet. Using the extensions that become possible with current sociotechnical systems, we have in a large measure become the lords of the planet. If we are to exercise the powers of lordship well, we will certainly need to be clear on the source of those powers and the processes through which they are exercized.

Few topics are more basic to STS studies than an understanding of the nature of sociotechnical systems and the pattern in which we humans use them to create the physical bases for our societies past and present.

Stephen Jay Kline is Professor of Mechanical Engineering, and Professor of Values, Technology and Society at Stanford University, Stanford, CA 94305.