Welcome to the post-industrial society

The US is passing into a post-industrial phase in which theoretical knowledge is a strategic resource and science policy determines political action.

Daniel Bell

A number of countries in the West, the United States among them, are now passing from an industrial into a post-industrial phase of society. The change primarily affects the socio-technical dimensions of society and is generally independent of the nature of political change or political structure. The main difference between an industrial and a post-industrial society is that the sources of innovation in a post-industrial society are derived increasingly from the codification of theoretical knowledge, rather than from "random" inventions. Every society in human history has been dependent upon knowledge, but it is only in recent years that the accumulation and distribution of theoretical knowledge has come to the fore as a directive force of innovation and change.

Information society

A post-industrial society is basically an information society. Exchange of information in terms of various kinds of data processing, record keeping, market research and so forth is the foundation for most economic exchanges. The changes that this implies are shown in figure 1. Data-transmission systems are the transforming resource of the society, just as in an industrial society created energy—electricity, oil, nuclear power—is the transmuting element, and natural power—wind, water, brute force—is the transforming resource of the pre-industrial society. The strategic resource of the post-industrial society becomes theoretical knowledge, just as the strategic resource of an industrial society is money capital, and the strategic resource of a pre-industrial society is raw materials. Thus, just as capital and labor frame the problems of an industrial society, so information and knowledge frame the problems of a post-industrial society. Instead of a society based on a labor theory of value, the central idea of which comes from Adam Smith or Karl Marx, the post-industrial society rests on a knowledge theory of value—that is to say, value is fundamentally increased, not by labor, but by knowledge.

Talented tinkerers versus scientists

The industries that have come forth as representative of the last third of the twentieth century are science-based industries, which derive fundamentally from the application of the findings of theoretical knowledge. These twentieth-century industries differ radically from nineteenth-century industries, which are still the major industries in Western society—steel, automobiles, electricity, telephone and aviation. These can all be regarded as nineteenth-century industries, even though steel began in the eighteenth century with Abraham Darby and the coking process, and aviation was invented in the twentieth century with Wilbur and Orville Wright at Kitty Hawk, because they were founded or created by talented tinkerers, men who worked independently of the scientific establishment and were ignorant of many of the theories of basic science. Sir Henry Bessemer, who created the open-hearth process, knew little of the work of Henry Sorby on metallurgical properties. Thomas Edison, who was a great genius in creating the electric light, the motion picture and the gramophone, was literally mathematically illiterate. Alexander Graham Bell was an elocutionist who invented the telephone largely to amplify sound so that deaf people could hear, and he knew nothing of the work of James Maxwell on electromagnetism. In a similar way Guglielmo Marconi invented the radio with little theoretical knowledge of the fundamental physical principles he employed.

These nineteenth-century industries contrast strongly with twentieth-century industries, which derive directly from the investigations of scientists into the basic phenomena of nature and the application of this research to technological problems. The basic research of I. I. Rabi and Charles H. Townes into the possibility of sending a molecular beam through an optical field led to the creation of a maser and then a laser, and this in turn led to Dennis Gabor's development of the hologram. William B. Shockley's research on transistors is responsible for a huge transformation in modern electronics, and the work of Felix Bloch on solid-state physics is the basis of much of computer technology. Theoretical knowledge in the twentieth century is organized and used in a radically different way than in the nineteenth century. Advances in twentieth-century technology are dependent upon the progress of basic research and the codification of theoretical knowledge, as well as upon science's sense of direction and sense of search. For this

Daniel Bell is professor of sociology at Harvard University.

reason the first truly modern industry is the chemical industry, because a base of theoretical knowledge is necessary in order to manipulate macromolecular structures and develop new products and new techniques.

Just as twentieth-century industries have not replaced the basic nineteenth-century industries, however, the post-industrial society does not replace or displace an industrial society. Rather, the whole structure is a system of superimposed layers, like a palimpsest. An industrial society does not displace an agrarian society, except in numbers. Agriculture in the United States today is important in that it furnishes food for our society and a large part of the rest of the world, but only 4% of the US labor force is involved in food production. But just as an agricultural base still exists, an industrial base still exists.

Design of the society

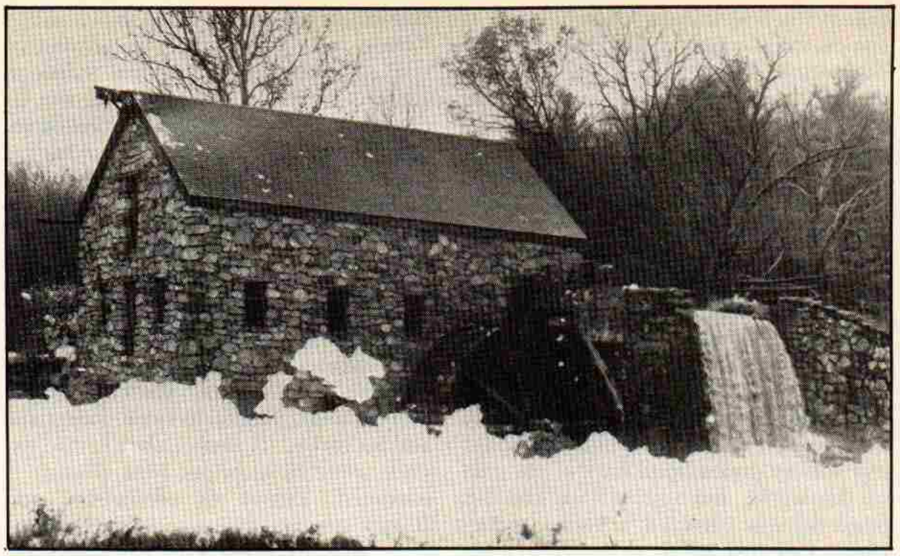
One other aspect is crucial to an understanding of the way in which the sense of one's world is colored by socio-technical changes. This is the so-called "design of the society." A pre-industrial society is a game against nature, a game in which one is subject to the vicissitudes of wind and water, the depletion of the soil and the never-ending turn of the seasons. The rhythms of life are played out against a conflict with the elements. An industrial society is a game against fabricated nature, in which Man has used energy to make large machines that add to his power to transform his world. But a post-industrial society is a game between persons, between teacher and student, doctor and patient, research team members, and so forth. It means that in the experience of most of our lives, Nature is excluded, except as recreation, and things are excluded, except as hobbies. The basic experience of each person's life is his relationship between himself and others. This state is rather unique in Man's existence. Most of the coding of Man's behavior has been predicted by his role as a member of a hunting society or an agrarian society, in which he was forced to use his ingenuity against Nature. The Man–machine relationship is a fairly recent phenomenon in terms of Man's history and Man's experience. But the Man–Man relationship has never been the central issue in terms of his history or his attempts at survival.

The problem with the exclusion of Nature and things, with interpersonal relationships as the focus of each man's thoughts and actions, is the fact that people do not know how to live easily with one another. We often need an external artifact, such as Nature or machines, in order to weld us together or to discharge our aggressions. This point is important because the one other element that is crucial to a sociological understanding of the modern world, particularly the post-industrial society, is the increasing multiplication of interactions between persons. If there is any single characteristic that is true of our time, it is not so much the increase in the pace of technology, but the increase in the number of personal transactions

The Post-Industrial Society: A Comparative Schema

MODES	PRE-INDUSTRIAL	INDUSTRIAL	POST-INDUSTRIAL
MODE OF PRODUCTION	Extractive	Fabrication	Processing; Recycling
ECONOMIC SECTOR	Primary *Agriculture* *Mining* *Fishing* *Timber* *Oil and Gas*	Secondary *Goods-Producing* *Manufacturing* *Durables* *Non-durables* *Heavy Construction*	Services Tertiary: *Transportation*, *Utilities* Quaternary: *Trade*, *Finance*, *Insurance*, *Real Estate* Quinary: *Health*, *Education*, *Research*, *Government*, *Recreation*
TRANSFORMING RESOURCE	Natural Power *Wind, Water, Draft animals, Human muscle*	Created Energy *Electricity—oil, gas, coal* *Nuclear power*	Information[1] *Computer and data-transmission systems*
STRATEGIC RESOURCE	Raw Materials	Financial Capital	Knowledge[2]
TECHNOLOGY	Craft	Machine Technology	Intellectual Technology
SKILL BASE	Artisan, Manual worker, Farmer	Engineer, Semi-skilled worker	Scientist, Technical and Professional occupations
METHODOLOGY	Common Sense, Trial and error, Experience	Empiricism, Experimentation	Abstract Theory: *models, simulations, decision theory, systems analysis*
TIME PERSPECTIVE	Orientation to the past	Ad hoc adaptiveness, experimentation	Future orientation: forecasting and planning
DESIGN	Game Against Nature	Game Against Fabricated Nature	Game Between Persons
AXIAL PRINCIPLE	Traditionalism	Economic Growth	Codification of Theoretical Knowledge

we experience. A person born in 1830 would have experienced a steam engine and a steamship, just as a person born in 1930 would have experienced television, space satellites and commercial jet transportation. The great difference does not seem to be the acceleration of change, but the enlargement of an individual's world that accompanies the advance of technology. There is a tremendous change of scale in the number of persons one knows or knows of. Developments in transportation and communication have extended each person's pool of potential interaction from a village to a city to a nation and beyond.

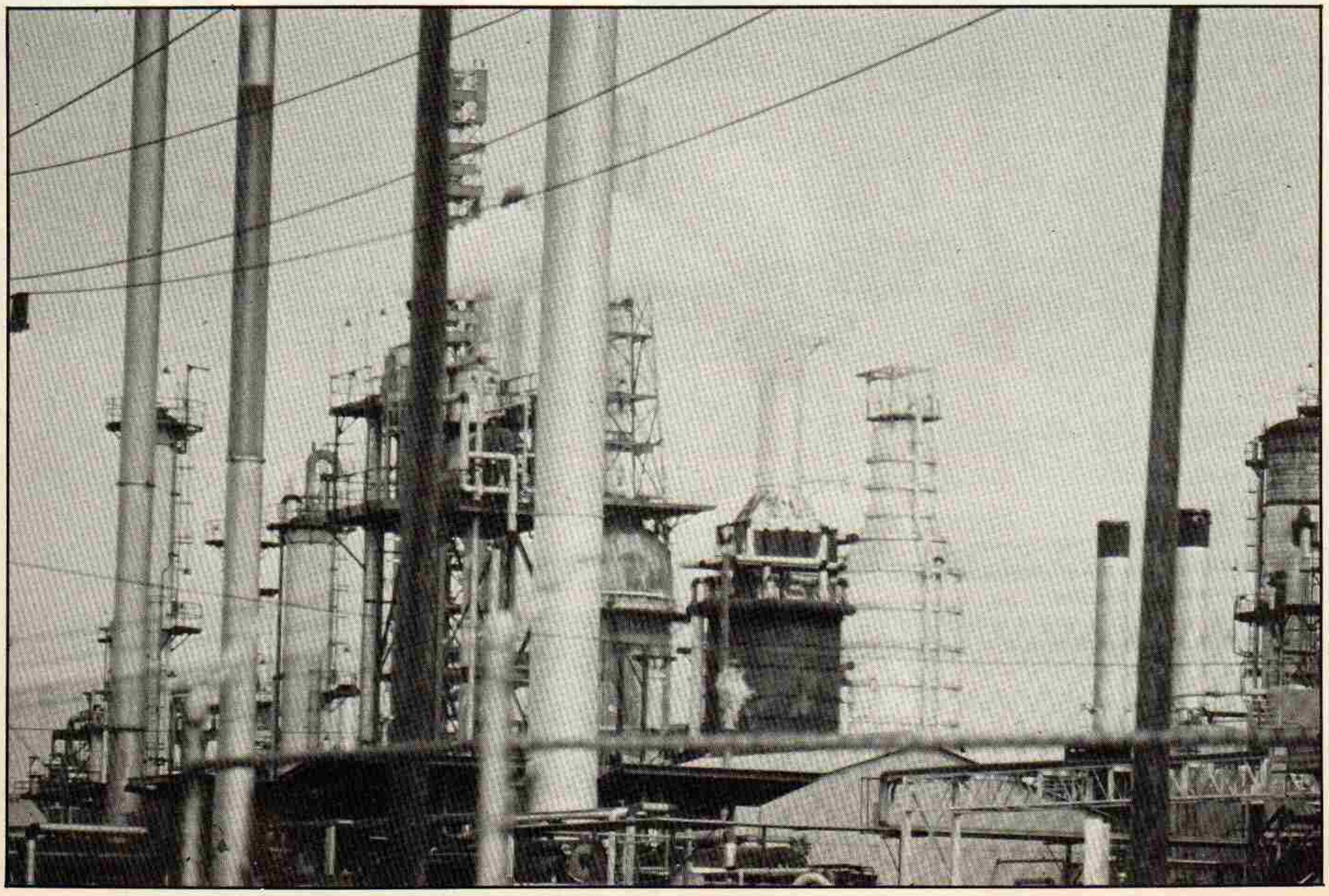


The limits of the scale

This change of scale is a central issue as we approach the twenty-first century. John von Neumann pointed out about twenty years ago that the rapid development of modern technology increased speed not so much by shortening the time requirement as by increasing the areas affected by its development. The reason is clear. Since most time scales are fixed by human reaction time, by physiological processes, the increase in speed of technological processes enlarged the size of political, economic and cultural units that are affected by technological operations. That is, instead of performing the same operations as before in less time, now large-scale operations can be performed in the same time. This important evolution has a natural limit—the earth's actual size. This limit will soon be approached.

In one sense the first limit was reached in the geopolitical sphere. As von Neumann pointed out, World War II was in many ways the last war of mass human civilization because it was the last war in which there was sufficient land area for a large army to retreat, as the Russian army could still retreat from the Germans. But there is no retreat from intercontinental ballistic missiles. We have reached an absolute limit in that respect.

In other senses, too, we are reaching the limits of our physical world. We are now in a situation of "real time" in almost every part of the world. The revolution in telecommunications, which is in many respects the last major revolution in the twentieth century, allows for immediate exchange of information, financial transfers throughout the world, the shipping of news and so forth, all almost immediately to every



part of the globe. There is a very real question of what happens when the whole world becomes part of a world-interactive network and the increase in interaction is brought to its outer limits.

It was once suggested that 5040 persons was the optimum size for the city-state, based on the fact that it took at least half a day per year for each person to have at least some intercourse with another individual. Athens, the largest of the Greek city-states, had at its peak 40 000 male citizens, with the quorum in the assembly fixed at 6000. The number of adult citizens in New Zealand is about 30 times that of Athens, in the Netherlands 100 times, in France 500 times, in the US 2500 times, and in India about 6000 times that of Athens. In the face of this, what does participation mean? What is the character of human contact? What are the limits of human comprehension?

Problems for institutions

The increase of scale creates two effects that pose problems for the institutions that govern the post-industrial society. One is that the increase of scale in communications and transportation extends the range of control from a center of power, particularly when there is a command-and-control system. (A wit once remarked that Stalin was Genghis Khan with a telephone in one hand.)

A second problem is that the linear extension does not simply make an initial institution large, but creates a threshold that transforms it. A university that has 50 000 students is not the same university as one with 5000 students, even though the name may be the same. The Harvard University of 1869 under Charles Eliot is not the Harvard of today. Its entire structure is vastly different.

This refers to something familiar to all physicists—the notion set down by Galileo called the "square–cube law." If something doubles in size, it will triple in volume, but its shape will also change. The biologist D'arcy Wentworth Thompson once pointed out that Galileo said that if someone tried to build ships, palaces or temples of enormous size, the beams and bolts would cease to hold together. Nor can Nature grow a tree or construct an animal beyond a certain size and still retain the proportions and materials that sufficed for the smaller structure. The monster will fall to pieces under its own weight unless either the relative proportions are changed or a harder and stronger material is used. So it appears clear that a change in scale becomes necessarily a change in institution. The problem appears to be that institutions that double in size do not always take the appropriate shape.

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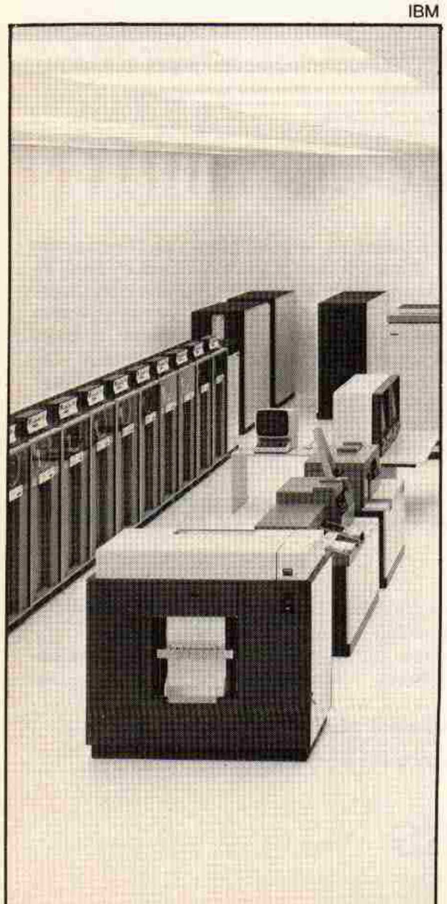

Political problems

The key political problems in a post-industrial society are essentially elements of science policy. Theoretical knowledge, the strategic resource of the post-industrial society, must be produced and distributed. This implies the care and nurturing of science and a research and development effort, and the identification of human capital becomes important in the development of the strategic resource. We know very little about identifying human capital, about spotting good people early and nurturing them, enriching their education, making them creative and innovating and developing opportunities for them. Even though we may have a surplus of educated labor at the moment, human capital is still a scarce resource in the society.

In the end a major political problem will be the post-industrial society's information policy. Whether a computer utility is established or a completely free market in computer systems is developed, various other dimensions of the politics of information handling will arise from the nature of information itself.

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This article is adapted from a talk delivered at the Annual Meeting of the AIP Corporate Associates, held at the National Academy of Sciences, Washington, D.C., October 1975. □