TRANSFORMATIONS OF INFORMATION SOCIETY

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Summary

This essay first outlines an approach to understanding the specificity of the contemporary information society, as distinct from earlier societies which have necessarily involved much human information-processing, and in more recent terms have involved much use of technologies for storing, reproducing, and transmitting information. The emphasis is placed upon new information technologies, especially those based on the powerful and rapidly developing techniques of microelectronics. The development and use of these technologies has led to a widespread reevaluation of the costs and practicability of processing and using information across the economies and societies of the economically most advanced countries. The result is that we now have information societies in which historically unprecedented ways of deploying information are widely used in commerce, production, government, and leisure. The essay goes on to consider how information societies have themselves evolved, arguing that it is helpful to distinguish between three main stages of development, with a fourth stage arguably visible on the horizon. The stages are so distinctive that it is difficult to generalize from one to another about the implications of information society for employment, skills, and social organization. The essay also notes the diversity of outcomes that is apparent in different national societies, social groups, and economic sectors, stressing that these outcomes are a matter of social choice rather than technological determinism. Finally, the field of e-commerce is briefly examined to demonstrate the extremely different views of how new networking capabilities may be used, and the competing strategies that are based on such views.

1. Introduction

The terms "information economy" and "information society" have become very popular ways of describing the more economically developed parts of the world. Many people automatically associate these terms with the use of new information technologies, and this essay will to a large extent agree with this perspective. But before adopting such an approach unquestioningly, it is useful to consider the content of these terms. After all, do not all economies, all social life depend upon information? How could human beings achieve even the most basic forms of hunter-gatherer society, let alone agriculture and industry, without each individual processing information about their environment and social context, exchanging this information with others by means of speech, and drawing upon the knowledge established by previous generations? In a very fundamental sense, then, all societies are information societies, all economies are knowledge-based economies (see chapter *Global Management of Knowledge Systems*).

However, the ways in which we create and use information have certainly changed over the course of human history. Information has been marshaled into bodies of knowledge, and some of these concern information itself (library sciences, for example) and some concern information technologies. We have applied the latter bodies of knowledge with remarkable effect. A powerful case can be made for using the term information society (IS) in connection with the development and use of new information technologies (IT). (This essay shall henceforth employ the acronyms IS and IT as shorthand for the distinctively modern forms of information society and technology.)

But again, we first should ask just what is new about new IT? Surely we have had information technologies for millennia—writing and implements for creating and storing texts, means of long-distance communication such as smoke signals and drums, complicated systems of arithmetic, astronomy, cartography, and so on. Practically every human society employs some such information technologies.

The case here is that there is indeed something distinctive about new IT that is associated with the socioeconomic transformations apparent in the advanced economies in the last few decades of the twentieth century. The use of the notion of IS points to this: new tools are available for creating and using information, and new things are accordingly being done with these. By examining the nature of this novelty in a little more detail, we are able to better understand the dynamics of IS, and identify different phases or stages of IS. The next section of this essay will examine the specificities of new IT, before moving on to examine the evolution of IS through different phases.

2. Making Sense of Information Technology and Information Society

Early information technologies stored and displayed information (e.g. written records), and/or allowed it to be communicated over distances (written records can be carried around, but at the speed of their carrier; techniques such as smoke signals and talking drums allow for rapid transmission, but do not store the information for future reference). These information technologies encode speech as specialized signs embodied in materials or delivered through auditory or visual media. The technology involves both artifacts, tools for people to produce and display the signs, and skills to encode and decode the signs from and into everyday speech.

The more specialized language and associated conceptual tools of arithmetic were also early human achievements, motivated by applications in navigation, astronomy, and such social affairs as administration of tributes. Various information technologies were developed to support these activities, measuring instruments, maps and charts, and devices to facilitate computation such as the abacus (whereby encoding of the arithmetic information into the positioning of counters means that manual operations can support mental calculations).

For a very long time, the effective information technologies required high levels of skill, and these skills were often restricted to a small elite. Ancient libraries contained original texts and manuscripts that had been laboriously copied out by hand, and could be used only by a literate fraction of a largely illiterate population; the destruction of a library could well mean the loss forever of the material it contained. These factors account for the pivotal role in history played by the invention of the printing press, allowing for the large-scale reproduction and thus the mass distribution of texts. Coming at the dawn of the modern era, with the transport of ideas and people across continents becoming ever more practical, books and pamphlets enabled the diffusion of information about philosophy, science, technology, politics, and religion. It became harder for political and religious authorities to restrict the flow of information, even though mass literacy took centuries to achieve. Newspapers and even more ephemeral forms of printed text became established.

The Industrial Revolution, taking off in the nineteenth century, saw the application of energy and motor technologies to a wide range of economic activities—steam engines, powered trains, and factories. These technologies were applied to the mass production of written texts—the nineteenth century saw a huge boom in books and newspapers, and social innovations such as mass schooling began to establish highly literate societies. The essential ideas required for creating computers, based on mechanical manipulations, were created by Babbage (and Lovelace developed associated notions of computer software) in the first half of the nineteenth century. But technical difficulties and, more importantly, the absence of any "demand-pull" for the automated computation from more than a few highly specialized mathematical applications, meant that the technology remained stillborn. Only a few of Babbage's earlier and less sophisticated devices were eventually assembled (the "Difference Engines," as opposed to the programmable "Analytical Engines," which were never realized). Their use was limited and brief, and they never went through the process of design improvement required to make pioneering technologies user-friendly, reliable, and inexpensive.

Some other information technologies which were developed later in the century are of particular interest. These include photographic and phonographic devices that allowed for the automatic encoding and display of, respectively, audio and visual data. The images and sounds could be captured, respectively, on cameras/photographic plates and films, and by microphones/recording devices, without human translation into signs (as in painting, drawing, musical notation, text). These new technologies operated in what we now call an analogue fashion, automatically translating data from one form (light or sound waves) into another (chemical or physical transformations of a photographic or recording medium); the structures imposed on the new medium reproduced key elements of the visual or auditory patterns.

The process of industrialization may have had at its heart new methods of social organization (such as the factory) and new technologies for replacing human and animal effort with motor power, but it would have taken a very different course had there not been the development of transport and information technologies that enabled the coordination of activities on increasing scales and over increasing distances. The telegraph was a significant invention in this context, allowing for language to be encoded (initially by a human operator) as a series of binary signals, transmitted over long distances as variations in the electric current over telegraph wires. (The heliograph had used a similar form of code to transmit information via pulses of light, and the later invention of radio was to use Morse code extensively for many decades.)

Analogue forms of many different kinds, however, were used to represent data in most early information technologies. In the first half of the twentieth century, new knowledge, based around electrophysics, was developed, resulting in the establishment of electronic engineering. Electronics was applied to a wide range of information technologies, allowing new means for capture recording, transmission, and display of information. (One major exception was photography, which remained a matter of optics and photochemistry, though television and associated technologies provided a different route to the capture and display of visual information.) But the application of electronics to information technologies largely retained the emphasis on analogue representation of data even though it is now electrical or magnetic charges in which the data are encoded. The encoded data followed the patterns of the original phenomenon, with the auditory signals converted into electrical pulses of differing amplitude, with the visual image converted into a matrix of dots following the spatial structure of the image, and so on.

The thermionic valve was an important invention underpinning the rapid growth of electronics. This provided a means of controlling electric currents automatically, rather than requiring human operators to turn switches or operate other controls. Valves could switch currents on or off, amplify them, even transform one pattern into another. But valves were fragile and unreliable: at their heart was an electrical component (the anode), which was being heated—in a vacuum or inert gas. Valves thus also required high levels of electrical current, and created excessive heat. Valve technology was steadily—but relatively slowly—made smaller, more reliable, more energy-efficient. The first half of the century saw a remarkable development of electronics-based information technologies, for businesses and consumers. Radios and then television became new mass media for the populations of the industrialized countries, phonographs were augmented with amplifiers (the radiogram combined radio, record player, amplifier and speaker(s)), telephones were widely adopted for person-to-person communication (especially between businesses).

During and immediately after the Second World War the first programmable computers (“stored program computers”) were produced, initially for military purposes and soon for business applications. Famously, it was estimated that the world as a whole would only require a handful of such devices. Computers introduce something distinctive to information technology: they actively process information in a "central processing unit" (CPU), in addition to capturing, storing, or transmitting it. Earlier calculating machines based on manipulation, mechanics, or simple electronics allowed for basic arithmetic to be performed rapidly. The new computer technology uses stored "programs" as instructions to govern the processing of data. Different programs allow for very different types of processing to be undertaken: while the early uses of computers centered on the decoding of secret documents and the manipulation of large volumes of numerical data, in principle any data that could be represented in a suitable electrical form could be transformed by an appropriate program. Computation, involving the active transformation of information according to programmable sets of instructions, is at the heart of new IT. But this could not be the case until an alternative to the bulky and inefficient valve was developed.

Compared to the valve, the transistor was small, robust, and less demanding of power. It operates by using the "solid state" properties of semiconductor materials (most commonly used at present is silicon, one of the more common elements in the earth's crust—in the future it may well be that we will use special plastics for the task instead). Transistors could be applied to tasks carried out by valves, and in many environments where valves were not viable—in small spaces, in (low-power) battery-operated devices, etc. They enabled considerable *miniaturization* of electronic components—soon evident in such applications as lightweight portable radios and other consumer electronic devices. But this was only the beginning. Further advances in semiconductor technology laid the foundation for new IT.

Just over a decade from the development of the transistor, the integrated circuit (IC) was introduced. Instead of connecting individual transistors by wires to make up "circuits" of connected components, an IC further miniaturizes the circuit on a single "chip" of semiconductor. Much smaller, and faster and more reliable and energy-efficient circuits could be manufactured; and the manufacturing process reduced the expensive and error-prone business of assembling the circuits from components. The IC is an assemblage of a large number of individual electronic components; over time this number has grown astronomically. Small-scale integration achieved the equivalent of 10 transistors per chip; medium-scale integration involved around 100 transistors per chip; with large -scale integration there were thousands, and with very large-scale integration (VLSI) tens of thousands of transistors per chip; by the end of the twentieth century hundreds of thousands or millions of transistors could be placed on each chip. A modern chip contains many more components than would have been found in a large electronic device of the mid twentieth century.

The new field of research and engineering practice that was created around the increasing levels of integration (especially VLSI and beyond) became known as microelectronics. A particularly important invention here was the *microprocessor*, developed in the early the 1970s (initially in order to make more effective electronic calculators). The microprocessor chip contains its own CPU—thus it has been described as a "computer on a chip." The first "microcomputers"—small desktop machines—followed in the later 1970s. Microprocessors also rapidly became applied in industrial control systems; in communication systems (leading some commentators to describe the telephone network as effectively comprising a large computer), in the form of "embedded computers" used for information processing, display and control functions of machine tools, automobiles, consumer electronic and electrical appliances; and of course in the evolution of microcomputers into "personal computers" (PCs), laptops, palmtops, and so on.

Finally we have reached the distinctive heart of the new IT: microelectronics (and semiconductor technology more broadly) is a "heartland technology," underpinning a new technological revolution. Cheap (because of the low costs of chips), flexible (because of their programmability), and powerful (because of the large amounts of data that can be stored and processed) information-processing capabilities have become available. These can be applied in practically all spheres of economic and social activity. Other new technologies complement the development of microelectronics, of course, and help to facilitate its application and diffusion. Among these are technologies such as optronics (the use of laser technology in particular, for data storage, as in the CD and DVD; in transmission, as in the use of optical fiber networks; and perhaps, in the future, the commercial use of optical information-processing systems, "optical chips") and software technologies, as well as numerous innovations in such areas as visual displays, magnetic memory storage, satellite communications, etc.

Another important feature of new IT is that it generally involves *digital* information processing. Data of all kinds are encoded in the form of a string of digits, which can be stored, transmitted, and manipulated in common ways. New IT thus promises the convergence of previously distinct ways of handling information—even photography is being transformed by electronic cameras and the digital storage and manipulation of photographs taken by conventional cameras. Telecommunication systems are increasingly handling computer data alongside voice telephony, and the Internet has grown to be a new mass medium. As information of all kinds is handled as digital data, it has become easier to transport information from one device to another, to create new multimedia products, and so on.

The term "information society" can helpfully be seen as signifying the transformations in social and economic affairs associated with the development and diffusion of new IT and the new knowledge that underpins this technology. This new knowledge, and the techniques associated with it, allows for changes to be made in an extremely wide range of products and processes. The new "heartland technologies" can be and are applied to operations common to a wide spectrum of economic activities. Equally, they are themselves the triggers for a multitude of innovations in the form not only of new devices and software, but also of new ways of doing things, new organizational structures, and so on.

Thus IS really refers to the whole economy and society. It is not simply, as some commentators assume, about IT sectors or "information sectors." To talk of IS does not mean that we are assuming that such sectors are economically dominant, nor that IT products should take up the lion's share of investment or even consumption expenditure. IS simply refers to a society in which there has been widespread diffusion and use of new IT. We can argue about just how far this diffusion has to take place before we have "really" entered an IS (see below). But, the point is that all sectors are potentially IT-using sectors. This does not mean that they all become IT sectors, just that all sectors are parts of the IS, and thus that their role and functioning may be transformed through the application of new IT and associated developments. Likewise IT can be "embedded" into a vast range of other products—microelectronic chips are already found in birthday cards, toys, washing machines, and motor cars, as well as being used in products that are overtly concerned with handling information such as telephones, music systems, and of course computers.

IT thus enables major innovations in practically all economic processes (design, production, transactions, etc.), and in practically all economic sectors. This adoption of new tools and techniques has led to changes in products and processes and in working practices. These changes are not "impacts" of the technology. They result from human understanding of, and choices concerning, the application of the new knowledge. Entrepreneurial activity means that new firms and industrial sectors have arisen around the new knowledge and its applications; and mangers have made decisions based on their understanding of relative shifts in the costs and benefits associated with sending messages, processing data, and other activities. Centers of economic power, too, may emerge, grow, or decline as new opportunities are recognized and seized. As in earlier technological revolutions associated with steam and electrical energy, such developments are liable to unfold over a long period of diffusion and experiment. Many different social, institutional, and organizational innovations are liable to be experimented with; and the influence of popular management and political philosophies, of market fashions and social needs, of competitive rivalries among firms and nations, all have their role in shaping the patterns of application and further development of the new knowledge, and thus of IS itself.

The development and application of IT, and the shaping of IS, thus result from the strategies undertaken by numerous social actors such as employers, labor forces, and governments. Their strategies are informed by many sorts of knowledge. Their understanding of the potentials of new IT is important: awareness of the potential significance of the new knowledge for organizations of all sorts has grown, and is liable to continue to grow. We can thus expect to see even more diffusion and development of new IT. Strategies are forged in a social context in which actors also need to take account of each other's choices. Thus, views as to the changing competitive context implied by globalization and the strategies of competitors and partners; the economic and symbolic rewards which actors are striving for; these and similar factors also play important roles. Though it is possible to discern some broad trends in IS, there are many elements of the new society that remain contested. IS will be shaped by the interactions of these strategies.

3. Evolutionary Stages of Information Society

The question was raised above as to precisely when a society is supposed to have become an IS—or, to put it another way, what is the criterion for saying that a society is or is not an IS? The question is rather misleading, however. There is no good case for expecting a sharp break in social and economic affairs to happen when a particular threshold is attained; if anything, we should expect the contours of IS to emerge slowly as IT and its applications develop and diffuse. There may be some value, say for benchmarking regions or classifying countries for purposes of comparative statistical analyses, in adopting a strict demarcation point—say 50% of the workforce being involved in using IT at work, 50% of firms operating a website. But really IS refers more to a trajectory of socioeconomic development than to a clear demarcation. It may be easy enough to declaim categorically that a society with very low IT use is clearly not an IS, while one with most of the population networked clearly is one. But there will be a smaller or larger gray area, where the elements of IS are becoming progressively stronger but there remains scope for debate as to whether individual cases do meet the criteria for IS. And this leads to another point.

As IS has been evolving, so it is becoming apparent that there are and have been very different patterns of IT use. Simply to talk about the proportion of people or organizations using IT is problematic, when the capabilities of the technology and, even more importantly, the ways in which it is used and the ends to which it is applied, are evolving. Our criteria for thinking about IS have also been changing over time. In particular, the growth of mobile communications and the Internet over the 1990s suggest that the emerging IS is very different from one based on stand-alone, bulky systems in fixed locations. It is actually useful to identify distinctive stages in IS itself, though we should not seek to be too hard and fast about when each of these begins and ends. There are numerous discussions of "generations" in IT, but here four phases in the development of IS will be outlined, the first three of which can be very roughly identified with the decades from 1970 on.

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Biographical Sketch

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