Computers and Society in the Past Half Century

The Conquest of Will Revisited

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Introduction: Computers and Society in the Past Half Century

Computer technology and its applications have evolved beyond the expectations of researchers and futurists writing a half century ago. A catalog of advances in computer hardware and software would take up a multivolume report. It is enough to observe that the prodigious improvements and enhancements in the performance capabilities of computers and related systems have provided the foundation for a host of applications with far reaching social consequences.

Here are a few of the most prominent developments in the world of computing since the mid-1970s. The computer network that was to become the Internet was evolving from experiment and limited access to a multipurpose network open to commerce and the public. Packet switching, a digital communications innovation fundamental to the Internet, was conceived in 1965, and was successfully implemented in a U.S. government sponsored networking project (ARPANET) in the late 1960s. Email was a novelty in the early 1970s, used primarily by academics in a handful of university and government centers. The online service provider America Online did not get underway until the mid-1980s. The Internet was opened to commerce in 1992. Time sharing was offered as a commercial service in this period, but this was a mere shadow of contemporary cloud computing. Mobile computing did not get started until the early 1990s, and the now familiar integrated smart phone took an additional two decades to appear. Until recently, Artificial Intelligence (AI) was a relatively obscure academic sub-discipline of computer science. It made its way into some prominent commercial applications such as expert systems, but did not take the world by storm until the advent of Large Language Models and ChatGPT in particular. Other notable developments include social network platforms, blockchain technology, Internet of Things, search engines, and sophisticated computer conferencing systems.

Some of these developments were anticipated fifty years ago, albeit through a glass darkly. Cloud computing, for example, was dimly perceived as an element of computer utilities in distributed computer services. Observers at the time conceived of these services as being analogous to regulated electricity and natural gas monopolies. The present day cloud services offered by Amazon, Microsoft and Google share some of the features of classical utilities but dedicated governmental rate setting bodies have yet to emerge. Another example is computer conferencing systems. The potential value of systems like Zoom and Microsoft Teams, which played such an important role in education during the Covid 19 pandemic, was appreciated but development and deployment lacked adequate computer networks. The precursor of contemporary smart phones dates back to Motorola's 1973 cell phone, a clunky device that was not available for sale until a decade later. It is doubtful that anyone at that time had a clear vision of the potential for changing the ways people communicate that have been brought about by the smart phone.

The Conquest of Will was arguably the first critical-analytic study of computers and society, presenting a socio-historical perspective on computing in the modern world. Instead of being purely celebratory, it attempted to place the computer in historical context going back to the beginnings of the Industrial Revolution. A colleague who read the book when it first appeared remarked "your theology is showing." Pure objectivity is not achievable and claiming otherwise is disingenuous. Paying equal attention to everything and offering no opinions produces uninteresting results. Although there is no section of the book explicitly stating my biases, they are clear from interpretations of the social significance of computers.

Here are my biases for the record. First, I am neither pro- nor anti-capitalism. Transposing what Churchill's said of democracy, capitalism is the worst form of economy except for all those other forms that have been tried from time to time. I believe that unbridled capitalism too often rewards undesirable, selfish exploitation, and the market is a far from perfect regulator. Those with capital who can purchase knowledge and other resources are in the best position to exploit technological

innovations. Witness the dominance of computer technology by mega-firms. Possible uses of new technology regarded by many as socially desirable may be shunted aside or blocked because they do not advance the interests of those with extensive capital investments. Second, I am neither Luddite nor booster of technological innovation. Technology is a fundamental component of human existence. However, it does not function in a social vacuum. Vested interests influence the ways it is deployed and used. It is important to recognize that possible outcomes of innovation are not the same as likely ones, and not all outcomes are equally desirable. Contrary to the expectations of early observers, the Internet has resulted neither in greater enlightenment, nor in more democratic governance. Third, I believe that our treatment of intelligent artifacts will have a profound influence on the direction of human and social evolution. We face a critical challenge in regulating the development and application of AI.

Much of my book focused on power, control and authority. A consistent observation was that excessive centralization of power and control in either private enterprise or in government is dangerous. Computer technology lends itself to centralization of control however it is deployed. Distributed operations may appear to foster decentralization of decision making, but that may be deceptive. Control can be embedded in algorithms used in all the components of an organization, thus achieving the aims of top management, without requiring their direct participation in local decision making.

The book grew out of lecture notes prepared for an elective undergraduate course on computers and society in the early 1970s. A first draft of the book was completed almost exactly fifty years ago. Undergraduate degree programs in computer science began in the late 1960s and enterprising students were eager to learn about the social context of the new field they were entering. Enthusiasm declined gradually over the decade of the 1970s as the demands of the computer science curriculum increased, and computer science departments entered the mainstream of university education. For a brief period a required course on computers and society was part of the computer science curriculum in many universities. This requirement has generally been

replaced by the addition of a unit on ethics grafted onto a programming or project course.

Since publication of *The Conquest of Will* in 1976, the world has experienced monumental changes spawned by computer technology. Specific challenges posed by the technological innovations may not have been anticipated, but many general trends were. In some cases the social changes accompanying the advances in computer technology had been unfolding for decades. This holds for most areas of modern society including management of organizations, employment and work life, education, health care, and personal identity. The following offers justification for this assertion. All chapter numbers refer to *The Conquest of Will* reprinted in this volume.

Historical Context (See Chapters 1 and 2)

> "The effects of computer applications on people and institutions cannot be understood apart from the larger issue of the role of science and technology in our society. … Most, if not all, the problems surrounding computer technology derive from well-established trends in the modern world."

Until computer technology became a powerful force in the world's economy, the history of computing occupied a small corner of the history of mathematics. Since 1976 the history of computing has become an important study in its own right. Scholarly journals, such as *IEEE Annals of the History of Computing* and the *Journal of the Association for History and Computing*, dedicated to the subject, have emerged. Specialized museums too have appeared throughout the world. Some of the best known include The Computer History Museum, Heinz Nixdorf MuseumsForum, The National Museum of Computing, The Centre for Computing History UK Computer Museum, and American Computer & Robotics Museum.

The treatment of this history in the *Conquest of Will* was a brief introduction to a vast and important subject based on a limited corpus of material. It was designed to show the streams of intellectual and material development that contributed to the birth of the general purpose digital

computer. In the past fifty years the history of computing has become a ripe field of study. A number of general works as well as specialized ones are now available.

Computer Utilization (See Chapter 3)

> "[The] underlying motives for virtually all uses [of computers] may be resolved into three different categories. First, one observes a desire to achieve greater economy in an operation. ⋯ Second, an operation may not be feasible at all without the use of a computer. ⋯ Finally, the computer is often introduced for the purpose of achieving a deeper understanding of a complex process, or to rationalize an operation."

The information sector of the U.S. economy has grown from 3.5% of GDP in 1977 to 5.4% in 2022, an increase of 54%. Giant companies have emerged. Microsoft and Apple, for example, each has a market capitalization of about three trillion dollars. The cast of characters has changed greatly over this period, with many mergers, acquisitions, failures and successes. In the beginning the mainframe was king and IBM was the pre-eminent computer company. The mini-computer propelled Digital Equipment Corporation into second place for a time but the company did not survive into the personal computer (PC) era. Microsoft and Apple were pioneers in the PC arena. Now IBM, still a major company, has a market capitalization less than 6% of Microsoft's. In the 1970s, IBM was investigated by the U.S. Department of Justice for alleged monopolistic practices, and many articles were written for and against breaking up the company. Technological innovation has defused that hotly debated issue. However, the question of monopolistic practices has been revived in connection with the computer industry behemoths of today.

Before commercial word processing software like the early Word Perfect and the now ubiquitous Microsoft Word, many academic computer scientists thought that natural language processing (NLP) was not a serious thing for computers to do. A computer centre director once told me in the early 1970s that word processing was a waste of resources that

would be better used for numerical computation in finding approximate solutions of differential equations. This was told to me at the time I was using a local word processing system on a mainframe to draft my book. The many successful commercial applications based on NLP that have been developed in the past half century make such invidious comparisons between computer applications appear rather quaint.

The variety and scope of computer technology and applications continue to increase. To keep pace with this expansion software development has undergone major changes in the past fifty years. Methods and tools for managing complex software projects have been introduced and a new specialization – software engineering – has emerged to gain control of the development process. These changes have been dictated by the need to facilitate error checking, and to ensure correctness and reliability of computer programs. In addition, the methods currently in use are designed to manage the development process more effectively and efficiently.

Innovations in programming languages since the mid-1970s have also played an important role in the growth of computer applications. C++, released to the public in 1985, extended the C language by adding object-oriented programming features. The widely used JAVA programming language was first released in 1995. Python's major revision released in 2008 has become a popular language and is widely used in machine learning applications. Specialized languages also contributed to the efficiency of software development. R, a language designed for statistical computing, became available in the early 1990s.

New computing paradigms have also emerged since the mid-1970s. Quantum computing was first proposed by Richard Feynman in 1981. Algorithms for quantum computations were developed in the next decade, followed by demonstrations of working quantum computers. Such computers may soon be able to solve problems in polynomial time that are known to be non-polynomial on classical, deterministic computers. Neuromorphic computing is another promising architecture. Modelled on the structure of the human brain it processes information in

a way that makes it well suited for detecting patterns in complex data, and requires less energy than quantum computing.

Examples of major computer applications that have emerged since the mid-1970s include crypto currency, mobile computing, social media, and Internet of Things (IoT).

A significant new computer application in finance illustrates the case of an operation that could not be performed without a computer. Crypto currency is a computation intensive application of blockchain technology. A blockchain can be viewed as a distributed ledger, a sequence of records linked to each other in a chain configuration. Any change in the contents of a record must be approved by all parties to the blockchain. This feature is realized by a clever encoding protocol requiring much computing power, which is the basis for generating a unit of crypto currency. The economic significance of crypto currencies is indicated by the fact that prices are now quoted regularly in financial media. Futures contracts have been traded for some time and quite recently the Securities Exchange Commission has approved exchange traded funds based on the spot prices of crypto currencies.

Mobile computing has revolutionized communication and commerce, but the literature of the 1970s did not anticipate this development. Mobile phones in the 1970s were used largely by business people and the so-called jet set. That ordinary people would be using smart phones constantly to keep in touch with friends and family, shop, transact banking or other business was an idea from science fiction. Email was just beginning to take hold, and the cost of long-distance phone calls before Voice Over Internet Protocol (VoIP) was expensive.

Social media platforms such as Facebook, WhatsApp, YouTube, Instagram, WeChat, TikTok, Telegram, Snapchat, X (formerly Twitter), and others have taken computer applications in directions only dimly anticipated fifty years ago. However, the notion of virtual community which is central to social media was present in various guises in the late1970s. A precursor of the online community was developed in 1976 by Murray Turoff at the New Jersey Institute of Technology. His Electronic

Information Exchange System (EISE) was described as a computer-mediated, multi-machine communications and conferencing system. This system supported message exchange and a shared memory platform, essential features of virtual community.

Also not anticipated fifty years ago are the consequences of social media experienced today. As I write, Congress is holding hearings on the harm done to children by excessive time spent on social media and victimization by online predators. Social media are largely exempt from liability for harm to users by the constitutional guarantee of freedom of speech. Since such freedom is not absolute, it is possible that legislation will be drafted to impose limits.

Harm to children is not the only negative externality of social media. Circulation of false or misleading information is easily disseminated to millions worldwide and has become a serious challenge to democratic governance. Jurisdictions governing internet service providers are spread over many different regions, localities and countries. This makes it difficult to prosecute behaviour in a jurisdiction where it is criminal, when the offending website is hosted in a place where the behaviour is accepted or protected. Moreover, internet users can remain more or less anonymous in the Dark Web, a portion of the World Wide Web that is not indexed by the major search engines. Virtual communities in the Dark Web can exert considerable political influence. Adding to the problem of misinformation is the use of deep fakes generated by AI software to impersonate influential figures. Such fakes can be so convincing that even those who know the real persons represented by the fake images and voices could be fooled sometimes.

A system with the basic functionality of the Internet of Things might have been imagined fifty years ago, but could not have been realized in the absence of a robust computer network. To reach global coverage, something like the Internet is essential. The documentary requirements of maritime transport such as bills of lading, customs forms, etc. stimulated development of Electronic Data Interchange (EDI) in the 1980s. This system of message exchange between computers could be viewed as a primitive forerunner of IoT but was very limited in scope. IoT

applications run the gamut of activities in modern life from managing home appliances to remote patient monitoring to industrial inventory control to product and package tracking.

The idea of connecting responsive devices in a network environment dates from discussions held in 1982 and the term IoT came into the lexicon in 1985. Development of IoT capabilities and applications accelerated at the beginning of the twenty-first century. By 2010 the number of things connected over the Internet was nearly twice the number of people connected according to Cisco Systems.

Radio Frequency Identification (RFID) and Quick Response codes (QR) are closely associated with IoT. Both technologies play an important role in identifying and tracking objects. RFID was long in coming based on theoretical work in the late 1940s. The first patent for an RFID passive tag, i.e., without a battery, was issued in 1996. QR was developed in Japan in 1994, and first used to track parts in automobile production.

These new technologies have changed the way we do things and have conferred benefits. They have also generated problems like the ones mentioned above in connection with social media. IoT, RFID and QR radically increase exchange, collection and storage of data thus creating new opportunities for compromising personal privacy. For example, scanning an innocent looking QR code could connect to a scammer who obtains personal information from the smart phone and uses it steal the user's identity.

Management and Decision Making (See Chapter 4)

> "[N]atural systems exhibiting hierarchical structure with central control are inappropriate models for social organizations. An individual in a corporation is not comparable to a liver cell. The latter is incapable of informing the brain of its views on the desirability of some action which does not have a direct effect on the liver. It is a mistake to suppose that specialization in social organizations extends to the point of requiring expert credentials for judging the desirability of organizational goals. Such judgments

> involve human values and call for wisdom in addition to expert testimony."

General purpose digital computers made their commercial debut in government offices in the late 1950s. From there they moved to large corporations. By the mid-1970s the mainframe computer had been joined by the mini-computer. Personal computers came on the scene a few years later. All these computers were deployed primarily as standalone devices. The most prominent business applications were programs that automated routine functions such as payroll, inventory control, tax compliance, and word processing. Other human resource functions like recruitment, employee monitoring and tracking, periodic assessment, etc. were also deployed. More sophisticated applications were developed to support management decision making, in an era of expanding globalization.

Computer networks evolved in tandem with globalization. Increased complexity of organization required ever more powerful Information systems with inputs from many diverse sources. Managers needed information on business choices associated with opportunities and risks. Not anticipated in the 1970s was a quantum jump in both availability and processing capability of what has come to be called "big data." Online marketing and shopping generate vast amounts of data from transactions, whose analysis offer the possibility of discovering important patterns in customer buying behaviour. These mountains of data are now processed by banks of computers working in parallel. Research was conducted on parallel computing and parallel algorithm design in the mid-1970s, but the occasion for collecting and processing masses of data awaited online commerce.

The computer's potential contribution to centralization of control in large organizations was a hot button issue in the 1970s. It is less talked about today because it is a *fait accompli*. One indication of this is the change in the ratio of average CEO compensation to that of workers. Top CEO compensation rose 1,209.2% from 1978 to 2022, while a typical worker's pay increased 15.3% in the same period, according to the Economic Policy Institute.

An idea that gained traction in the 1970s that has since become widely adopted is virtual organization. Made possible by advances in computer communications, allied with versatile transportation and financial systems, it has created new opportunities to exploit comparative economic advantage. It is a form of organizing and managing that separates the requirements of a task from methods of satisfying it. Pioneered by multinational corporations to exploit differentials in labour costs and tax rates across the globe, this management approach is now common to organizations of all sizes. Its advantages lie in the greater flexibility it confers. By treating requirements and satisfiers independently, management can switch from one supplier to another just as a user of a word processing system can cut and paste text. There are transaction costs in operating this way, but they can be balanced against the cost savings of cheaper goods and services from different suppliers.

Like all technologically based innovations, virtual organization incurs social costs or negative externalities. Labour requirements, for example, can be treated in the same way as the need for raw materials and other resources. People can be viewed as task satisfiers and moved in and out of the workplace, replaced by robots and computer-controlled machine systems, just as done with material satisfiers. The managerial flexibility conferred by virtual organization makes it feasible to convert full time to part time work, thus allowing companies to avoid the costs of worker benefits like health insurance and pension plans. Switching among suppliers also introduces economic instabilities, especially for small and medium sized enterprises that can no longer count on long term relationships.

The growth in wealth disparity in the United States since the 1970s has complex causes, but computer technology has played a role. Increasing management reliance on computers exemplifies what can be achieved by substituting machine systems for human performance. Costs can be reduced and flexibility maximized by reducing dependence on human borne knowledge and skill. The potential advantages of transferring human knowledge to artefacts spur adoption of commercial and industrial practices to secure them. One significant result is the formation of a knowledge market analogous to the labour market that emerged in

the Industrial Revolution. Just as the shift from craft to industrial production degraded the extended family, so will the substitution of artefacts for human labour degrade the nuclear family. The social consequences of this transformation may create disturbances even greater than those experienced during the Industrial Revolution.

Employment and Work Life (See Chapter 5)

> "Automation does in fact displace workers, and not all of them are able to find comparable jobs or acquire new skills. What is more, technology exerts a strong influence on the types of work society requires, which in turn affects educational and training needs."

Productivity has long been a rallying cry of business and industry. For management it means decreased unit costs of production, and the possibility of increased profits. For workers it means changes in working conditions, which often translate into behavioural monitoring, skill obsolescence, training opportunities, or redundancy. One obvious way to reduce unit costs is to lower the wage bill. There have been many predictions of increased productivity courtesy of computer applications in both factory and office. Complexity of measurement, especially for office tasks, has unfortunately muddied the waters; and the consequences of computerization in production have taken much longer to show up in the economy than most observers expected. However, productivity has increased as a result of computer utilization, much of it attributable to decreased labour requirements. Software systems in the office are less visible than robots on the factory floor, but just as effective in displacing human workers.

The latest direct threat to employment comes from advances in AI, namely generative AI and large language models. These innovations have become widely known through the deployment of ChatGPT developed by OpenAI. This system is free to use; it can answer questions, write essays, and engage in conversations. The sophistication of ChatGPT has significant implications for education and jobs. Teachers are grappling with the issue of students using ChatGPT to do their homework. There is also concern that systems based on large language models will soon

reduce the need for people with writing skills. Word processing virtually eliminated the need for dedicated typists in the office. Now the people required for writing reports, contracts, business letters, etc. may be next to become obsolete. Computer technology is slowly moving toward the creative end of the skill gradient.

The current frenzy to incorporate AI in every product and service, while no doubt overblown, is not likely a flash in the pan. Unlike earlier commercial applications of AI, the capabilities of current programs have staying power. They will eventually give rise to applications in manufacturing and services that replace people with hardware and software.

Predictions of dramatic increases in productivity are likely to be realized in the coming decades. Displacement of workers will follow, and it is far from clear how the displaced will be re-employed. Some displaced workers will be absorbed by new industries and commercial activities. As in the past, reduced demand for workers may be managed long term by increasing the time required for education and training. If people live longer, and community resources are available, normal adult life might begin later than it does today. It is also possible that the population will decline as is currently happening in several countries, creating other economic and social challenges. This would lower demand for goods and services and further reduce the demand for workers.

Education (See Chapter 6)

> "The development of automated instructional programs is somewhat analogous to that of management-information systems. Modest success with routine problems raised great expectations which later proved to be overly optimistic. In essence, it was discovered that technology cannot substitute for a genuine understanding of how people learn and what constitutes good teaching."

Every technological innovation in the classroom has at one time or another been hailed as the saviour of education. The computer is the latest in a long string of such innovations. Like its predecessors in the

classroom, the computer has not revolutionized education. Student performance has not been appreciably enhanced by the latest computer-based innovations. One might even argue that student performance has declined in the past fifty years. I taught a required undergraduate computer science course on discrete structures for several decades. The course content is basic mathematics for computer scientists and has changed very little over the years. Student test scores over this long period declined consistently and substantially. During this time, the percentage of students in a class turning in homework assignments declined from about 70% to 35%. The decline in performance suggests that students put in less effort to learn the material.

There are many possible explanations for these results, but one in particular stands out. This is the growing dependence of students on external computer-based sources of information, which has accompanied the development of the World Wide Web with its cornucopia of information. Rather than making an effort to commit facts to memory and to work out exercises, students, like everyone else, have gotten into the habit of looking things up online and then quickly forgetting. One of my history professors at the University of Chicago got it right, telling the class, "If you don't know the facts, the whole course is a sham."

The clamour for advanced technology in the classroom continues unabated. The disappointing experience of the 1970s also persists. This is evident from experiments involving distribution of cheap laptop computers to schools in low-income countries. The One Laptop per Child project launched in 2005 is a case in point. Failure to take adequate account of local political and school culture, together with the need to train teachers in the operation and use of computers in the classroom, doomed the experiment.

As mentioned in the section on work, ChatGPT poses a problem for teachers. Grading essays and other homework has become challenging. There exists software to detect essays written by ChatGPT, but that just sets up a cops and robbers scenario where advances on one side are matched by advances on the other. Teachers are faced with the dilemma of embracing large language models in the classroom and modifying the

curriculum, or reverting to oral presentations and exams for purposes of grading student work.

Health Care (See Chapter 7)

> "Increased demand for medical services has placed severe strains on existing resources, and there is widespread concern over mounting costs and inadequate health-care for large segments of American society. … Structural changes in the medical profession have also affected the availability of health-care. The trend toward professional specialization and centralized facilities in the form of clinics, group practices, and large hospitals tends naturally to concentrate resources in urban areas, leaving sparsely populated regions with inadequate services. In addition, advances in medical technology lead to increased costs as a result of the large capital investment required for sophisticated devices and associated expenses for supporting personnel."

Advanced technology has long been expected to improve the quality of health care and to reduce costs. Computer based patient record systems and testing has made it possible for physicians to delegate some of their traditional tasks to technicians and medical assistants. Moreover, automated processing of test specimens in medical laboratories has reduced the time to obtain test results. In theory these advances in medical practice should free the physician to devote more time to diagnosis and treatment. However, advances of this nature also make it possible to increase patient throughput. Since income in medical practices is controlled in large measure by insurance companies, administrators may push physicians to increase case load. So, gains derived from delegation of tasks and increased laboratory efficiency, may not always benefit patients. This is a case of certain technological possibilities being trumped by entrenched interests, practices and beliefs.

Additional possibilities have been realized in the past half century. In particular, computer applications have been developed in biochemistry, biomedical engineering, and robotics that could revolutionize medical practice. There are prosthetic devices that enable patients to regain

mobility or reduce visual impairments. Telemedicine and computer-controlled surgery can extend physicians' reach beyond the traditional office. New and improved drugs are continually coming on stream as a result of advances in biochemistry made possible by computer applications. A recent development in bioengineering is a generalized, microchip interface implanted in the brain designed to enable a paralyzed person to regain mobility. Other innovative methods for treating infirmity and disease are based on genetic engineering, also highly dependent on computer technology.

The proportion of United States GDP devoted to health care has increased from 8.11% in 1976 to 19.7% in 2020. Despite this expenditure of resources and extraordinary technological achievements, life expectancy in the United States has declined in the past few years. No doubt this is due in part to the Covid 19 pandemic that ravaged the world. However, skepticism in 1976 about realizing the promise of computer applications to deliver improved health care to the community at large continues to resonate.

The Computer Utility (See Chapter 8)

> "The potential impact of computer utilities on society is difficult to exaggerate. Even for a world grown accustomed to global transportation and communication, the possibilities of universally accessible computer networks are truly revolutionary. Thus far the computer has impinged on everyday life in a somewhat abstract and indirect fashion. The computer utility proposes to bring the computer into the home, to eliminate cash as a medium of exchange, and to transform government into an omniscient and ubiquitous force. Social control is the keynote of this eventuality. Home terminals may allow for a wider choice of entertainment, make possible an electronic form of catalogue shopping, and even provide the means for continual education; but the principal social effect lies in the concentration of information in the hands of bureaucrats and officials."

Most of the services of the computer utility envisioned in the 1970s are now offered on the Internet. Moreover this universally accessible network is indeed revolutionary. Cash has not been eliminated as a medium of exchange, but commerce on the World Wide Web where payments are made electronically accounted for nearly 15% of all retail sales in the United States in 2022. However, predictions of the emergence of omniscient government have yet to be realized. National, regional and local government information is available online, but the Orwellian nightmare of inescapable visual surveillance has not yet come to pass.

Nevertheless, it is true that information has been concentrated in the hands of bureaucrats and business managers. As noted earlier, a major theme of my book concerned the role of computers in augmenting centralized governmental power. Not emphasized enough was the possibility and danger of posed by concentrated power in the business world. Data on consumer behaviour from online transactions constitutes a treasure trove of information for advertising and marketing, and a new discipline, Data Science, has emerged to make sense of it. Manipulation of public tastes and conduct through advertising has long been studied by sociologists. The information utility, alias Internet, has advanced the possibility of such manipulation.

Privacy and Surveillance (See Chapter 9)

> "Privacy has long been recognized as an important component of life in a democratic society. It is essential to the physical, psychological, and spiritual integrity of the individual. At the same time, the general welfare of society requires the imposition of limits on individual behavior. The evolution of social institutions reveals a series of compromises between autonomy and coercion. Naturally, the particular balance achieved depends in part on the instruments available for exercising coercion. Throughout most of human history, these instruments were severely limited in scope. Time and distance thwarted the designs of the most ambitious rulers. The development of technology in the modem period has required the elaboration of institutional safeguards to restrict the growing power of social authority."

The computer's threat to privacy has stirred controversy since the first mainframes appeared in government offices in the 1950s. A proposal by the U.S. government to create a cross agency statistical database in the mid-1960s sparked debate in Congress and brought the issue home to the general public. This led to the development and adoption of so-called Fair Information Practice rules in the U.S. and many other countries beginning in the 1970s. These rules placed restrictions on the management of government databases. Access to and dissemination of personal records were restricted, and data subjects were given the right to inspect and request correction of errors or omissions in their records.

This all occurred before the Internet and the World Wide Web (WWW) came into being in the 1990s. The commercial venue of WWW created new and largely unanticipated challenges for privacy protection. No longer was personal information maintained exclusively in the databases of large organizations. First it was transaction data required for buying items online or for obtaining information on Websites that increased the exposure of personal information. That was followed by social media in which individuals expose even more personal information. Fair Information Practice affords relatively little protection in this new information environment. Efforts to deal with the new threats to privacy include measures designed to restrict the circulation of personal identifiers such as Social Security numbers. However, such measures fall short since personal information gathered from several different sources can serve to identify an individual uniquely without personal identifiers.

Now the thinking about how to protect privacy has shifted to controlling the use of personal data, rather than restricting access, dissemination or circulation. This approach would, for example, hold organizations responsible for misuse of personal data that they require for transactions. Practical measures to implement this idea have yet to be realized.

Discussion in the mid-1970s of the computer's threat to privacy focussed almost exclusively on personal data records held by large organizations in the public and private sectors. Computer networks were not unknown, but the ramifications of their widespread use for sharing information and conducting commercial transactions were ill understood. This is another

instance of energizing a kind of Sorcerer's Apprentice, with no controlling magician in the wings.

Computers and Government (See Chapter 10)

> "Like private corporations, government bureaucracies are hierarchically structured and exhibit a spectrum of problem-solving and decision-making functions ranging from routine administrative tasks to strategic policy formation. Payrolls must be met, resources accounted for, jobs scheduled, policies elaborated, and plans devised for their implementation. But there is one obvious and critical difference between governments and private organizations. Ideally, the former aim to secure the public good, rather than the particular interests of any special group. This distinction is especially important for planning and policy formation. Since the public interest is at stake, the needs and desires of ordinary citizens must somehow be incorporated into the decision-making environment. It is in this area that computer-based information systems may make their most distinctive contribution to government administration."

Citizen participation in government decision making was enthusiastically anticipated in the mid-1970s. Computer systems facilitating dialogue on public policy between ordinary citizens and government decision makers was expected to become reality in short order. Many observers believed that a new era of town hall type discussions, allowing for citizen input into matters affecting the public, was about to emerge. However, government officials and decision makers had other ideas. National, regional and local governments have paid homage to the issue of citizen participation by installing websites that offer easy access to information about events and services. This is a welcome development but a far cry from town hall democracy. The idea of direct citizen participation in decision making has quietly faded away.

National governments still control armed forces, but the wealth of nations is largely under the control of private actors. Post COVID-19 pandemic, global business is being challenged. Supply chain disruptions during the

pandemic brought home the shortcomings of dependence on far away suppliers of critical goods. However, this challenge is likely to be short lived. Eventually the ever-increasing wealth of business enterprises will stimulate a shift in government power and authority to the business sector. Virtual organizations made possible by advanced technology will gradually assume governmental functions. However, the relationship between national governments and private corporations may very well be the reverse of the arrangement in the heyday of the British East India Company which was nominally subservient to the British Crown.

Systems Analysis and Modelling (See Chapter 11)

> "The systems approach is perhaps the most promising analytical framework yet devised for the study of complex social phenomena. Its principal contribution to scientific method lies in its insistence on conceptualizing interacting events as a totality or unified whole. ... Several allied techniques for analyzing complex systems have been developed. The term "operations research" was first used to describe the analytic methods applied to military problems during World War II by Great Britain and the United States. Since the war, these techniques have been elaborated and refined in both military and industrial applications. The computer has, of course, played a central role in this development, providing the computational power needed to transform conceptual schemes into practical instruments."

Computer based models of physical systems using methods of operations research, simulation and game theory have proven useful and effective. Weather forecasting is an example of an exceedingly complex problem for which considerable success has been achieved. Forecasts are now much more reliable than they were fifty years ago. Moreover, computer applications have been used successfully to design complex aircraft, spacecraft, factories, etc. When it comes to social systems, the story is more mixed. A critical element that has vexed modellers and critic alike since the 1970s is justification for underlying assumptions. A case in point is modelling a large-scale urban transportation system. Assumptions must be made about areas of growth, demand for transport in each area, costs

of designing and implementing a system, and many other critical issues. The giant elephant in the room with modellers is bias. Some may favour rail links for mass transport, others, roads for automobiles, and never the twain shall meet.

Many studies of large-scale social system modelling were conducted in the 1970s. A major conclusion of such studies was that the weakest component of social system modelling is the choice of underlying assumptions. We are now faced with an even greater challenge on this point with models based on machine learning, deep learning, and generative artificial intelligence (AI). The issue is more subtle and elusive than ferreting out bias, intended or otherwise, in more conventional operations research models. This is due in part to the nature of the AI tools which depend, for example, on the data selected for training the tools. What is more, explanations of how the solutions are obtained through the application of such tools may be elusive.

Simulation has long been a modelling tool. The latest development in simulation is the digital twin. This is an ongoing simulation coexisting with and functioning as the twin of a real-world system. It is designed to answer questions and explore alternative hypotheses about products and services to provide guidance for its real-world twin. Industry is ripe for computer applications of this sort. The digital twin idea makes it possible to go beyond applications such as Computer Aided Design (CAD) and Computer Aided manufacturing (CAM) which have been used for decades. Production operations like aircraft manufacturing could incorporate immersive technology in design and planning. This gaming related technology can be used to create virtual environments allowing a number of employees to cooperate in performing complex tasks involving many different components. The expectation is that such environments will stimulate innovation, speed up development and production, reduce errors and minimize the need for re-work.

The Myth of Complexity (See Chapter 12)

> "The computer and the large-scale information-processing systems spawned by it emerged at a time when pyramidal social

> organization seemed to require ever increasing direction from the apex. What could be more natural than the birth of a technique for processing massive amounts of information, just when our highly complex and differentiated society required such a capability for its continued functioning. … The appeal to social complexity as an evolutionary principle which necessitates the growth of central power is a modern equivalent of the theory of the divine right of kings. History makes it abundantly clear that power cannot be exercised for long without a cogent claim to legitimacy. Whether authority be sanctioned by divine providence or as an expression of a collective will, it seeks justification in moral agency. Through the replacement of the active hand of God by natural law, scientific rationalism has contributed to a shift in the basis of legitimacy from divine to natural or social necessity."

Discussion of information, power and complexity was prominent in the literature on computers and society of the 1970s. Many observers drew analogies between management and control in large social organizations and hierarchical systems found in nature. Those observations reflect a desire to seek moral justification for hierarchical structure in social organization. Philosophers have been singing in the same key for centuries. Recall the notion of divine right used to justify absolute monarchy. I continue to reject that kind of argument applied to computer-based systems that support absolutism in corporate management and other large social organizations. The danger of abuse outweighs its potential advantages.

Man-Machine Interaction (See Chapter 13)

> "Speculation on the future use of computers as intellectual aids raises some important general issues. The question of social need may be spurious, but the tendency toward greater and greater interdependence of men and machines is quite real. Scientists, managers, and government decision-makers already make considerable use of computing systems to assist in the solution of problems. The probable consequences of forging closer ties between men and machines are unclear. Is the outcome likely to be a

> symbiosis involving the intimate cooperation of two dissimilar entities; or will it end in parasitism, with the host's identity a contentious matter?"

The relationship between people and machines grows ever closer. As mentioned in the section on health, we are now beginning to interface brains and machines. That brings us one step closer to the cyborg concept of science fiction. Progress or evolution in this direction depends heavily on advances in artificial intelligence, which has jumped from the lab to the boardroom. Commercialization of AI applications is now, after several failed attempts and major scientific advances since the 1970s, in full swing.

With the advent of large language models and ChatGPT, much public attention has focused on AI. Investments are being made and companies are trying to figure out how to use the technology profitably. At the same time governments are worried about potential harm that could come from it. The danger of relying on AI in decision making was recognized in the 1970s by some computer scientists. Joseph Weizenbaum in particular, whose interactive program Eliza marks the origin of the Chatbot, argued against using computers to make critical personal or social judgments. His warning has already been thrust aside with the adoption of algorithms used in bail and sentencing hearings. AI programs with built in bias are now poised for extended use as judges, making decisions that directly affect people's lives.

Machine Intelligence and Human Identity (See Chapter 14)

> "The computer has made it possible to realize intelligent behaviour in an artificial medium. In the past two decades programs have been developed which perceive configurations, draw inferences, solve problems, and even exhibit a rudimentary understanding of natural language. It must be noted, of course, that intelligent machines are in their infancy and do not begin to match human capabilities except perhaps in certain highly restricted domains."

Since 1976 AI has made great strides in the understanding and manipulation of natural language, as well as in applications of machine

learning and deep learning in many domains. Machine learning begins with a training process using data or examples enabling the program to learn to distinguish classes of things. Deep learning is based on neural networks first conceived in the mid-1940s. The concept was an early example of formal models inspired by biological systems and the brain in particular. Neural networks used in machine learning consist of layered sets of nodes. A node may receive data from nodes beneath it and transmit data to nodes above it in the layered structure. “Deep” refers to the depth of the layers in the model.

Human capabilities have been matched in game playing, notably chess and go, and in other pursuits. AI programs are being used successfully in medical diagnosis, police and intelligence work, military operations, and many other challenging areas. Intelligent, autonomous software agents prowl the World Wide Web for information and negotiate with each other over business transactions. Claims that AI will never be able to do this and that have been proven wrong repeatedly.

Computer based artefacts demonstrating capabilities long thought to be uniquely human pose a challenge to human identity. This challenge was certainly discussed fifty years ago, but has acquired greater urgency in the intervening years. Some in the AI arena have recently spoken of an existential threat to humanity and argue for regulation to forestall negative consequences of further development. This is the stuff of science fiction, as in stories of robots taking over the world. Possibly this extreme fear is unfounded, but the social consequences of the challenge to human identity are quite real.

Intellectual, as well as physical, skills need to be practiced or they will wither away. Many craft skills evaporated through disuse as industrial age manufacturing replaced handicrafts. Ironically, work may become a sought after privilege rather than the burdensome necessity it has been for millennia. If so, many people will be hard pressed to survive unless there are changes in the ways income and wealth are distributed.

Conquest of Will (See Chapter 15)

> "The conquest of nature, space, and time is seen [in literary fiction] as a paradoxical victory over the human ego. As man extended his dominion over the natural world, he became alienated from the sources of his vitality. Through obsessive exercise of the will to power in the elaboration of technique, the will itself became enfeebled and subject to control by autonomous forces linked to mechanical progress. The process by which this came about is exceedingly complex, but science and technology are dominant factors."

The preposition "of" in the title of my book was chosen deliberately to encompass the dual meanings "over" and "by." Human beings have unleashed computer technology to achieve coordination of diversity and control of disorder. The same technology encroaches on the creative power of humans. Builders of the technology argue that intelligent artifacts will make humans more productive and support creative activity. At best this may be true for the elite few. Most people will simply struggle to compete with the creations of the elite.

A passage in George Eliot's epic novel *Middlemarch*, set in the early days of railroad expansion in England, captures the skeptical view of technological progress. The following conversation takes place between land manager Mr. Garth and laborer Timothy Cooper after a spontaneous attack on a railroad survey crew by a group of farm workers.

> "Somebody told you the railroad was a bad thing. That was a lie. It may do a bit of harm here and there, to this and to that; and so does the sun in heaven. But the railway's a good thing."
>
> "Aw! good for the big folks to make money out on," said old Timothy Cooper… ;—"I'n seen lots o' things turn up sin' I war a young un—the war an' the peace, and the canells, …—an' it's been all aloike to the poor mon. What's the canells been t' him? They'n brought him neyther me-at nor be-acon, nor wage to lay by, if he didn't save it wi' clemmin' his own inside. Times ha' got wusser for

> him sin' I war a young un. An' so it'll be wi' the railroads. … But yo're for the big folks, Muster Garth, yo are."

Middlemarch, George Eliot, Book 6, Chapter 56

The more things change, the more they stay the same.

Conclusion

The foregoing shows there were many things we got right in the mid-1970s about the social effects of computer technology. The other side of the ledger is also quite full. Finger pointing at the dangers of centralized power, control and decision making focused too much on government and not enough on the private sector. Fifty years ago there was no Internet, no World Wide Web, no online commerce, and no online social media. Thus, there was no big data for marketers to mine for nuggets enabling manipulation of consumer behaviour. We are all consumers, so the possibility of manipulation and control by business is at least as concerning as that by government. Businesses can exercise direct control on consumers by inducing them to incur debt obligations thus limiting their choices. This is already apparent for those who are saddled with virtually unpayable student debt, turning many into latter day indentured servants with a questionable path to freedom.

We also failed to anticipate technological innovations that would make Fair Information Practice rules for privacy protection obsolete. The Internet and mobile computing were perceived dimly on the horizon, but no one predicted the rise of social media and the challenges to personal safety and wellbeing that have come in their wake. IoT and related technologies were imagined possibilities but their consequences, intended and unintended, were not part of the story. Not only is the dominant protocol for privacy protection obsolete, but privacy itself has all but disappeared from modern life. Society has apparently come full circle from the intrusive neighbourhood control of the past to the impersonal, computer network control of today.

The National Science Foundation initiated commercialization of the Internet in 1992. By 2003 nearly 55% of homes in the United States had

Internet service. Ninety-five percent of homes have such service in 2024. So, it has taken a mere thirty-two years for the diffusion to reach saturation. The story is similar for the mobile phone. Ninety-seven percent of Americans were using smart phones in 2022, just forty-nine years from the invention of the mobile phone in 1973.

Contrast these rapid adoptions of new technology with telephone and radio. The first telephone line was constructed in 1877. By 1920 thirty-five percent of housing units in the United States had telephones. It was not until 1990 that this percentage rose to 95%. So, the diffusion of the telephone occurred over a period of 113 years. Household penetration of radio reached 95% in 1971, sixty-four years from the beginning of audio transmission by radio in 1907.

The time compression for the spread of Internet service and smart phones is quite remarkable in view of the complexity of these technologies compared with telephone and radio. It is not surprising that observers in the 1970s failed to predict the social changes brought about by the Internet and mobile computing. Speculation about the shape of a national computer utility was far removed from experience of the new social reality ushered in by these technological innovations. The accelerated pace of technological change in the past fifty years has created significant problems of adjustment to economic and social realities. If history is any guide, these problems are likely to become more challenging in the coming decades.

With technological development running at breakneck speed something is bound to break. When new things are developed, the old don't disappear immediately. This gives rise to a phenomenon known as *technical debt*, accumulated unfixed problems stemming from rapid innovation. Legacy systems remain in use and are called upon to do things they were not designed to do, and thus become vulnerable to hacking, breaches and failure. Society dodged a bullet with the so-called Y2K date crisis that unfolded in the lead up to the new millennium, but continued stress may have a different outcome in the future.