INTRODUCTION

Throughout most of recorded history, there have been two primary economic classes: aristocratic rulers and peasants. This situation gradually changed between the 13th and the 15th centuries with the recognition that there were worlds to conquer and exotic products to import from abroad. The changing perception led to a new development... the traders. With the traders came mercantilism, and a middle class emerged.¹

Today’s office owes much to this rise of mercantilism. Braverman (1974) notes that capitalism itself is rooted in the Italian system of bookkeeping, with its internal checks and controls, and its concept of independently managed branch organizations. The system of supervisory control originated still earlier, from the agricultural estates of Great Britain.

The office remained relatively unchanged until the middle of the 19th century. By that time the steel nib had not yet fully replaced the quill pen. The primary tools were the ledgerbook, letter press, and green eye shade. Almost all writing was transcribed by hand, and there were at most a few dozen writing machines, each handcrafted and unique (Giuliano, 1982). Very large offices might use the services of stenographers who copied letters from dictation. Some might enlist the services of a copier (often a woman, who worked at home and was paid by the word); copies could also be made by pressing dampened letters against paper (Kleinman, 1984).

Virtually all office workers were male. The early clerks performed tasks more akin to those of today’s manager than what we now associate with clerical

¹Of course there are prior examples of mercantilism, as in the ancient Egyptian and Phoenician cultures, but our present business practices grew directly from the activities of Renaissance Europe.
work. The managers of some British industries often assumed the titles of Clerk and Chief Clerk.

The clerical position carried a great deal of responsibility and a wide variety of tasks. A clerk commonly received both recognition and high wages, and the employer frequently discussed his affairs with him. A good clerk was invariably made a partner and might aspire to marry the employer's daughter. The work week was long relative to today's standards (averaging 67 h in 1870), but short compared to those of subsequent decades.

The number of clerks was small: a U.S. census from 1870 indicates that only 0.6% of all gainful workers were so employed. By the turn of the century, the numbers had increased to 3%, but clerks still constituted the smallest occupational category (Braverman, 1974). Presently, clerical workers represent the largest occupational group in the United States (Bureau of Labor Statistics, 1984).

With the advent of the Civil War came the typewriter, produced by techniques that had been developed for the manufacture of high-precision pistols with interchangeable parts. The first workable typewriter was developed in 1867 by Christopher Latham Sholes, though it took some time for his QWERTY keyboard layout to become accepted as the standard. The first typists owned their own typewriters, and carried them to and from jobs (Margulis, 1985). By the end of the 19th century, there were dozens of manufacturers of typewriters with various keyboards and mechanisms. As the typewriters became more economical, they proliferated in the office; in fact, their influence may
help to account for the substantial growth in the number and size of offices at that time (Scott, 1982). By 1900 Edison had introduced electricity and electric lights, which reduced the dependence on daylight for accomplishing work, and a number of office machines appeared, including the telegraph and telephone.

The face of the office changed dramatically in the beginning of the 20th century. Max Weber’s notion of bureaucratic organizations as paradigms of efficiency became entrenched in the belief system of management. Proponents of Frederick Winslow Taylor’s thesis (first introduced in the 1890s) maintained that a precise analysis of work was necessary to ensure efficiency in both the office and the factory. This “scientific management” attained a near-religious status; pneumatic tubes were connected between office desks to facilitate communication, and endless conveyor belts for the movement of work became fashionable in the early 20th century. The steps required to reach the drinking fountain were counted in order to estimate the associated annual costs. Mechanisms that counted the number of words typed (via the number of times the space bar was activated) were used to time the employee’s performance,
foreshadowing complaints of some of today's clerical operators. The sedentary nature of today's office work can be attributed to such still-evident practices as locating all necessary work materials within the employees' reach to minimize movements and keep them at their work stations (Braverman, 1974).

Most experts attribute the influx of females to the office at the turn of the century to both the introduction of new office devices and to Taylorism, which segregated work between the Planners, who dictated standardized movements down to minute details, and the Workers, who were routinely allocated repetitive and boring tasks with little hope of advancement. The women's pay was low and frequently averaged 25% of that of men's (Kessler-Harris, 1981). Some employers hired only females who lived with their families, owing to a (not fully unjustified) fear that economic desperation would drive women who supported themselves to prostitution. The march of women into the office was
accelerated during World Wars I and II because of the shortage of male labor (Kessler-Harris, 1982).

Such devices as the teletypewriter, automatic telephone switching equipment, ticker tape, and adding and dictating machines were introduced later in the 20th century. These further accelerated the demand for offices and office work (Giuliano, 1982).

In 1834, a punched card system originally devised by Jacquard in 1801 to program patterns on a weaving loom became the basis for the “analytical engine” of Charles Babbage, the father of the modern computer. The machine, which featured input/output, memory and processing units, “wove algebraic patterns as the Jacquard loom weaves flowers and leaves,” in the words of Ada Augusta, Countess of Lovelace and Babbage’s colleague.

Babbage’s “analytical engine” provided the basis for the development of a machine that counted punched cards in 1885, evidencing the gradual evolution towards the first true computers of the 1940s and 1950s. These new digital computers were costly, crude, and cumbersome. In 1946 the ENIAC, the first electronic computer, contained 18,000 vacuum tubes, weighed 27 t, expended
140 kW of power, and required numerous specialists to maintain it. It was large enough to fill half a gymnasium.

Science fiction writers postulated futures in which the computer would dominate society, yet its introduction received relatively little public fanfare. Most early estimates anticipated that the market for computers would reach only 50 to 100 units (Peters and Waterman, 1982).

The first computer applications consisted primarily of data processing, as for payrolls and billing procedures, and were performed in a centralized and remote location (Connell, 1982). The heavy reliance on programmers prompted Feigenbaum and McCorduck (1984) to liken employers to the medieval nobles or Egyptian pharaohs who were illiterate and needed scribes to convey and translate their information.

The subsequent explosion of electronics in the workplace has since become commonplace. Information technology has halved in price and doubled in power approximately every two to four years since its inception. This increase in computing power means dramatic and accelerating changes in the office, as well as in society. Feigenbaum and McCorduck (1984) discuss how quantitative changes in technology bring out qualitative changes owing to the order of magnitude effect, much as the introduction of the car, which allowed us to travel at about 60 km/h (40 mph), caused a change of an order of magnitude over walking, which averages about one-tenth that speed. The subsequent introduction of the early jet plane, which traveled about 600 km/h (400 mph), resulted in a further quantum leap for humankind.

The evolution of computers is generally acknowledged to consist of five generations, each defined by the technology of the day. The first four generations of true computers (also called Von Neumann machines) were generally based on central processors and serial logic. Chronologically speaking, they were constructed with vacuum tubes (introduced in the 1940s), transistors (early 1960s), integrated circuits (late 1950s), and very large-scale integrated circuits (early 1980s). The fifth generation of hardware and software, expected within the next decade and in the labs today, will be based on new higher-speed materials and systems of computers working together to allow the handling of non-mathematical and symbolic information. This will represent a shift from the processing of data to the processing of knowledge. Computer-driven expert systems are already in place that can outperform some experts and may pay for themselves on the first consultation (Feigenbaum and McCorduck, 1984).

The extent to which these technologies may affect our lives is staggering, and the change has been, and will continue to be, dramatic and inexorable.

The technologies are also becoming increasingly integrated. A study conducted by ORBIT (1985) on the impact of future technologies indicates that many office products that used to function independently—typewriters, copiers, printers, microcomputers, facsimile machines—can now integrate with Local Area Networks, telecommunications systems, and long-distance networks. Individual work stations can communicate with other work stations in
the same building, and remotely via satellite. Technologies offering the integration of voice and data are presently available; in the next few years we will see the integration of voice, video, and data. Our electronic letters and documents will talk to us, and we may talk back. Researchers at MIT are also in the process of developing machines that will ultimately be able to recognize such non-verbal human communication as facial expressions, gestures, and body language (Bolt, 1984).

Although Charles Babbage foresaw a time when the "calculating machine" would eliminate all non-decisional work (Braverman, 1974), that era is still distant. Despite an increasingly educated and sophisticated work force, the computer has frequently caused the work to become more repetitive and fragmented, rather than the reverse. The widespread negative reaction of many office workers to the implementation of the information system is well documented. Problems associated with job dissatisfaction, such as absenteeism, are of great concern.

A report by the National Research Council (1983) concluded that most VDT operators experience discomfort; they are more uncomfortable than non-VDT
FIGURE 1.6
This is an example of a space that is repeated at every floor. Such issues as color, light, acoustics, and space definition become submerged in the monolithic character of these buildings.
(Peter Mill)

FIGURE 1.7
The random use of screens have created pockets of "dead air."
(Peter Mill)
Figure 1.8
Automation has introduced problems of wire management.
(Peter Mill)

Figure 1.9
Ironically, teleconferencing systems have accentuated the need for face-to-face meetings.
(Bell Canada)

Workers; and the frequency of their discomforts increases with exposure to VDTS.

Yet placing the blame on the information system, rather than on the physical and social milieu surrounding it, is inappropriate. Many of the problems experienced by the users of electronic systems include changes in the structure and context of work. These include poor job design, inadequate training, lack of job security, increased job pressures (but reduced autonomy), constant performance measurement, shift work, and many other factors.
Management is also in transition. Whether the middleman is truly being “squeezed out” is a subject of controversy (ORBIT, 1983). However, it appears that many managers are finding their roles in the hierarchy blurred and are performing more of the routine tasks formerly assumed by professionals, while professionals take on more of the responsibilities formerly assumed by management. Negotiation occurs at much lower levels of the organization. In addition, as new procedures are formalized, many of the informal and spontaneous exchanges that have traditionally served as invaluable channels of communication to management have been eliminated. Such status distinctions as space allocations are also disappearing or becoming irrelevant (Ellis, 1985).

Many problems arise from the physical environment. Since the introduction of the open-plan system, lack of acoustic privacy has become a common problem. At the same time, more and more professionals in the office require high levels of concentration. Such additional sources of noise as VDTs and impact printers have presented problems that offer no ready solutions. Although many of today’s printers will be replaced by non-impact printers, other information systems, such as voice-interactive devices, will be problematic.

The electronic office has also introduced new issues in lighting, such as ensuring that the placement of windows and luminaires prevents visual discomfort and glare on the VDT screen. Lighting design must now address the conflicting requirements of both traditional paper-based work and the operation of electronic systems.

Energy conservation, which has reduced the frequency of air changes in the office and introduced new chemicals whose effects are not yet known, has generated a concern over the quality of the air that office employees must breathe for one-third of their day. VAV (Variable Air Volume) systems that reduce the amount of air to offices that require little heating and cooling have recently come into question (ORBIT-2 Report, 1985). Moreover, the open-plan system has created “dead air” spaces which heighten the impact of pollution and increase the potential for thermal discomfort.

When concentrations of electronic equipment occur, the potential exists for build-ups of heat because equipment may generate up to 40 W/m² (ORBIT, 1983). Energy conservation measures have also increased the variability in temperatures in different office areas (Brill, Margulis and Konar, 1983). In such situations, local (zoned) air conditioning with add-on capacity assumes particular significance.

With more equipment in the office, cables are all-invasive, creating a hazard as well as problems in electrical servicing. Although such advances as Local Area Networks (LANS) and fiber optics may reduce the absolute volume of these cables, these problems will continue as the equipment becomes increasingly interconnected (ORBIT, 1983).

Further, the furniture that an office has purchased may not support the task at hand. VDT operation is physically more constraining than other forms of work. Changes in the nature of the work process, such as delegating an
employee to a single task like data entry, accentuate these postural constraints. As a result, many users of electronic systems experience increased physical discomfort. The potential for chronic health problems likewise increases, unless users are provided with work stations that support their activities.

Although storage and work surface area requirements generally increase, the amount of space allocated frequently decreases. With the electronic office, the patterns of space use change, along with the kinds of spaces that are needed (Ellis, 1985). There is a greater need for such shared spaces (formal and informal) as conference, training, and other meeting rooms (ORBIT, 1983), and many of these spaces must support various forms of information systems (Stone and Luchetti, 1985). However, the individual work station will not necessarily assume the same importance; for many, office work may take place anywhere, including the home.

The introduction of information systems has probably benefited people with disabilities more than any other employees. Although many are now able to work remotely, there is also a large variety of equipment that can facilitate their activities in the office.

Yet the information system cannot guarantee productivity. Many organizations that have automated have not experienced the anticipated improvements (quite the reverse in some cases). Many businesses are understandably hesitant to invest in new technology. They find themselves caught in a double bind between acquiring a system that they cannot afford (or that may not be cost-effective) and losing their competitive edge through failure to automate. Moreover, many systems become obsolete within three years. Purchase decisions must thus be made in a constantly shifting milieu that requires great commitments of resources in the face of inadequate information. Frequently, the interests of the employee, the department, and the organization are at odds, and systems are acquired that are incompatible with those of other departments or even with others within the same department. "Turf wars" may erupt, centering around who will have control over the information and whose interests will be accommodated. "Stand-alone" mini- and microcomputers have proliferated within the office to such an extent that many facility managers are no longer able to keep track of their numbers, and information that was once centralized becomes diffused throughout the organization, with few or no available channels for access or control.

These concerns and others have become increasingly important in the electronic office, raising questions of how to design for human requirements and capabilities. The terms "ergonomic" 2 — adapting products and processes to human parameters — and "user friendly" have become buzz words. Interest in improving the quality of work life has been fuelled by many sources, inclu-

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2 The terms ergonomics and human factors engineering are used interchangeably, although the former is used more frequently in Europe and Canada, and the latter term is more common in the United States. Basically, ergonomics is the science of adapting products and processes to human characteristics and capabilities in order to improve people's well-being and to optimize productivity.
ding union activity, pending legislation, and an increasingly sophisticated work force. From another front, economic pressures force consideration of ergonomic methods to improve corporate productivity.

This book attempts to address such concerns. It is intended for those involved in designing the electronic office or in evaluating how a traditional office can accommodate new requirements more effectively. Architects, facility managers, designers, and managers alike must all ensure that the office will serve the (frequently conflicting) objectives of the employee, the department, and the organization over the short and long term.

This book is for architects, to help them understand the continuing concerns of their clients, and how their building will be used, now and over its life cycle. It is for designers, who face increasingly complex and stringent design requirements that, when not met, incur more dire consequences than ever before. It is for facility managers, who must decide how to allocate limited resources most effectively. Finally, it is for managers and supervisors, who must understand the context of the electronic office before it can be made more productive.

These interests are merging through a growing recognition that the office of the present, and that of the future, will succeed or fail to the extent that it meets its human-centered criteria.

REFERENCES


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