Fluorescent Fields: Electric Lighting and the Rationalization of the Modern Corporate Workplace

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ABSTRACT
This study investigates the implications of the introduction of electric lighting systems, building technologies, and theories of worker efficiency on the deep spatial and environmental transformations that occurred within the corporate workplace during the twentieth century. Examining the shift from daylighting strategies to largely artificially lit workplace environments, this paper argues that electric lighting significantly contributed to the architectural rationalization of both office work and the modern office environment. Contesting the historical and critical marginalization of lighting within the discourse of the modern built environment, this study calls for a reassessment of the role of artificial lighting in the development of the modern corporate workplace.

Keywords: daylighting, fluorescent lighting, rationalization, workplace design

1. INTRODUCTION
The twentieth century witnessed innumerable changes driven by technological advancements—from the development of the assembly line to the introduction of the fluorescent lamp. While the social, cultural, and economic effects of mass production are finely addressed in a diversity of studies, the impact and implications of the rapid development of electric lighting systems in the first half of the twentieth century are much less understood. This is particularly true of the existing literature on the modern white-collar workplace, despite the significant and lasting effects of electric lighting—from the economies of office building construction to the health and well-being of office workers. While the technological developments of artificial lighting for the workplace are reasonably documented in professional trade journals, such as the North American Journal of the Illuminating Engineering Society [1], the human and architectural effects of the introduction and integration of electric lighting into the modern office largely have been overlooked. This elision suggests the need for a more thoughtful and critical investigation of the corporate office environment as a cultural space regulated by rigorous and complex architectural and technological systems. As Donald Albrecht [2] has argued, “The office is a microcosm of American social transformation and a yardstick of cultural progress….The shifting interaction between building design, technology, finance, and employees has yielded a dynamic environment whose significance extends beyond its physical boundaries.” Despite the sophistication of Albrecht's study, nowhere does he address lighting specifically. This omission is common; throughout the literature on the built environment lighting simply is not discussed as a critical factor—architecturally or socially. There are a few important exceptions, particularly the re-
search of Neumann [3] and Oeschslin [4], although neither scholar has looked extensively at office lighting. The present study argues for a critical reevaluation of the role of lighting in the development of the modern corporate workplace.

2. THE ORIGINS OF THE MODERN OFFICE
The history of the modern office begins in the late nineteenth century as the production of the industrial revolution spawned unprecedented growth in clerical and financial industries. The typical Victorian office was designed and decorated according to a domestic aesthetic. Heavy fabrics, area rugs, artwork, and decorative lighting fixtures were common (Fig. 1). However the formal and social distinction between the domestic interior and the place of work began to be articulated in the latter nineteenth century, as historian Charles Rice [5] suggests, “the [domestic] interior emerges as a space separated from sites of work and productive labor, and becomes a place of refuge from the city and its new, alienating forms of experience.” This polarizing of public and private spaces was accompanied (and exaggerated) by the rapid development of modern construction and building systems technologies in the mid- to late nineteenth century. The introduction of steel frame construction and the passenger elevator in the late nineteenth century ushered in a new age of office towers and a proliferation of office space for the emerging white-collar industries, as suggested by Pelégrin-Genel [6]. Office space was in high demand; the United States witnessed enormous growth within the managerial sector in the last quarter of the nineteenth century from roughly 750,000 individuals holding professional and commercial managerial positions in 1860 to 2,160,000 in 1890; with this figure doubling again by 1910 [7].

2.1 Daylighting and Early Twentieth-century Office Tower Design
Fueled by speculative building and expanding clerical industries new office towers proliferated in American cities like New York and Chicago after the turn of the twentieth century. Daylight was critical in the architectural design and organization of the office tower in this period, as electric lighting technology was inadequate for the workplace. Following traditional daylighting practices, office plans typically included: high ceilings, tall, operable windows, and a depth of...
less than 28 feet from window to corridor. Efficient daylighting and natural ventilation was essential to both the rent-ability and profitability of the speculative office tower, as Willis suggests [8]. Furthermore, the economies of building design encouraged standardization of the basic office unit; therefore offices were generally small in scale and held a direct connection to natural environmental conditions.

A typical clerical office from this period reveals the close relationship between daylighting and natural ventilation in the design of the early modern office (Fig. 2). In this image the open windows on the left are echoed in the ventilating interior transom windows on the right. Similarly the high ceilings, large windows, and shallow office depth ensure that daylight penetrates the workspace. Less obvious is the relationship between the electric lighting and the office furniture. Each worker has a tall, enclosed desk and above which hangs a single incandescent downlight suspended on a knotted cord—seemingly tied individually to accommodate worker preference. The solitary lamp above each worker’s head emphasizes the spatial and psychological privacy afforded by the semi-enclosed desk. These customizable conditions—operable windows, natural ventilation, individual light sources—present a stark contrast to the rationalized design of the early twentieth-century office. However, the seeds of standardization are visible even here and illustrate a definitive move away from earlier domesticized offices.

2.2 Taylorism and the Rationalization of the White-collar Office

The radical shift in the cultural and spatial construction of the modern office is exemplified by the application of Taylorism to office design as well as to the management of white-collar workers. Frederick Winslow Taylor [9] codified his theories of worker productivity in the 1911 book, The Principles of Scientific Management, which then were broadly applied across American industry. A photograph of a Sears Roebuck’s mail order room from 1913 reveals Taylorist principles in the organization of equipment, furniture, and workers (Fig. 3). The typists in these rationalized conditions were closely monitored for productivity, as Pelégrin-Genel [10] describes in her study of the origins of the modern office. Control and regulation of both bodies and space was central to the Taylorist approach to worker management, as communicated by the stern posture of the floor supervisors. The growing role of managerial surveillance is expressed in the design of workplace lighting as well. In this period, individual task lighting was largely replaced by ambient lighting systems that harnessed the diffusing properties of reflected artificial light—as seen in the Sears Roebuck office’s suspended uplights. This shift had significant implications for the development of the modern office. The expanded volume and depth of the Sears Roebuck mail order room as compared with the previously illustrated office, suggests the growing reliance on electric light. Gains in the efficacy of electric lighting allowed for higher and more efficient levels of artificial illumination. As Architectural Record [11] summarized in 1940, “today…natural light is a competitor of artificial illumination, asked to show cause why it should not be replaced by its younger brother.” However, this increasing reliance on artificial lighting had drawbacks for the experience of the individual worker as David Lyon [12] has argued, “From toiling in relative independence, and according to the traditional rhythms of seasons, day-to-night, and holy days, workers found themselves laboring to an increasingly ridged timetable, within enclosed spaces, ever observed by a supervisory eye.”
Electric lighting represented both control over nature—the workday was defined by artificial lighting, rather than the duration of daylight—and control over worker productivity. Throughout the first half of the twentieth-century many sociologists and efficiency experts argued that higher light levels in the workplace directly contribute to the productivity of workers. The famous Hawthorne Works study of 1924, for example, was conducted to measure the effects of increasing or decreasing illumination on productivity [13]. Numerous studies released in the 1940s-50s presented similar arguments, such as “Better Light Means Better Office Production,” appearing in American Business in 1946 or “Improved Lighting Increases Production,” appearing in Electrical Construction and Maintenance in December 1947; or as Architectural Forum [14] proposed in 1950, “A carefully chosen lighting system can bring greatly improved physical comfort to personnel and also provide a genuine increase in work efficiency. Personnel and office managers have learned from factory experience that lighting is a production tool.”

3. FLUORESCENT FIELDS

The distancing of the average office worker from natural light and air reached levels of total artificial suspension in the boundless office landscapes of the postwar modernist glass tower. Technological advances in the performance of fluorescent lighting and HVAC systems removed the spatial limitations of natural systems. Although fluorescent lighting had been introduced in the late 1930s, it was not until the postwar building boom that it was widely adopted into the workplace. The higher output, cooler fluorescent
lamps of the 1950s became the preferred illumination source for the office environment. As Architectural Forum [15] suggested, “As to a choice of incandescent or fluorescent lights most building owners or office managers do not hesitate: modernization means fluorescent.” Modernization also meant glass. Without question, in the postwar era the glass-sheathed tower represented corporate excellence in the United States. Even in the suburbs where high-rise buildings were unnecessary, architects simply reoriented the glass-box horizontally, designing long, low-slung glass-skinned corporate campuses. Common to all were extensive electric lighting and HVAC systems that supported the closed ecosystem of the open-plan office.

The artificial environment of the midcentury corporate office was praised for its stability and flexibility; it transposed the fluctuations of natural systems with a controllable set of environmental conditions. Fluorescent lighting in particular was celebrated for its capacity to mimic the intensity, distribution, and color temperature of natural light—but without spatial or diurnal limitation. This notion of creating ‘artificial daylight’ was closely associated with the introduction in the 1940s of the luminous ceiling, which was seen as not only a replacement for daylight, but an improvement upon it. Providing consistent and high levels of ambient light, the luminous ceiling provided a counter balance to the glare produced by the solar exposure of the glass-curtain wall [16]. With many variations available, luminous ceilings became a popular office lighting solution in the latter 1950s producing light levels of 100 footcandles or more while simultaneously camouflaging the lamps, water pipes, electrical conduits, and other ceiling-bound building services (Fig. 4). As Interiors suggested in 1958, “In the modern office or area of concentrated work, full scale illumination with wall to wall lushness at ceiling level has been a successful solution. Shadowless light and even brilliance, free of glare, are achieved by diffusing elements which create low brightness at the source and provide minimal contrasts in areas of peripheral vision.” [17]

Robert Bruegmann [18] argues that postwar glass-skinned office towers represented the United States’ desire to “present a cool, technologically advanced image to the world.” Uniformity was a central aspect of America’s modern image. Jürgen Joedicke’s 1962 survey Office Buildings [19], warns against deviation from such unified ambient
lighting systems in the open-plan office, suggesting that, “In a large office of the open-layout type, localized lamps mar the overall visual aspect of the office and will convey a restless impression.” Joedicke’s concern to minimize the visual disruption of localized light confirms the popular image of the modern office as one of uniformity and control. As Stanley Abercomie [20] humorously describes, “Union Carbide’s structural system, its fenestration, its luminous plastic ceiling panels, its metal partitions, its filing cabinets, and its desks—all these were ordered by a single module of thirty inches. It may once have occurred to the designers that only sixty-inch-tall workers should be employed, but some exceptions to the module were finally allowed.”

With criteria including visual uniformity, ever increasing worker productivity, and round-the-clock brightness, in the postwar era cool, shadowless fluorescent light governed the great expanses of the white-collar workplace (Figs. 5, 6). However, such environments soon came to be seen as symptomatic of the pervasive sterility and artificial homogeneity of the modern office. By the mid 1960s, architects, designers and office planners began to question this model, as John Pile has described [21]. Eberhard and Wolfgang Schnell, for example, developed the bürolandschaft or office landscape according to patterns of communication, rather than principles of standardization or power hierarchies (Fig. 7). The bürolandschaft aimed to reintroduce nature to the workplace and provide a more fluid approach to the organization of workers and work. However, this reevaluation did not extend to lighting systems. Images of these new office landscapes reveal little change in the ceiling plane or access to daylight (Fig. 8).

3.1 Task Lighting: “A Quite, Soft Character”

Not recognized broadly as an independent design discipline until the 1960s, the late development of professional lighting further confounded the advancement of office lighting. Prior to this guidelines regarding ideal light levels for various tasks, including office work, were largely determined by committees or associations sponsored by lamp and fixture manufacturers or electric power companies. Under such guidance, standard recommendations for office lighting levels soared from 30 footcandles to 80, 100, or even 120 footcandles in the latter midcentury. However, the energy crises of the 1970s forced a reevaluation of standards for office lighting design. In this new environment it was fiscally and politically irresponsible to continue to light floor after floor of office space to 100 or more footcandles. Task lighting was reintroduced as a way to mitigate the excessive energy consumption of ceiling-bound ambient light.
sources. Light sources were integrated into the modular office furnishings introduced in this period. Importantly, this integrated approach to task lighting brought individually controllable light sources back to the worker. The reception of even this small shift in the illumination of the corporate office is telling of the human need for varied light conditions. As Pile’s [22] 1978 office planning handbook suggests, “Users’ reactions to task lighting are highly favorable. The space so lit tends to have a certain quiet, soft character suggesting residential lighting.”

4. CONCLUSION
Today ‘residential’ elements in the corporate workplace are increasingly common, as the nineteenth-century bifurcation of the home and office begins a process of reversal. High-speed communication technologies, wireless networks, and the practice of telecommuting have had significant impact on social expectations of the workplace. Many companies now reach out to potential employees with non-traditional workplace amenities as day care centers, laundries, and cozy reading-nooks, as well as basketball courts and gaming stations, as Steve Lohr [23] has noted in the New York Times. Along with the ‘domestication’ of the modern office, the twenty-first century has seen a return to a greater reliance on daylighting. Researchers and designers, such as the Heschong Mahone Group [24] have illustrated that sustainable buildings that incorporate and respond to the unique conditions of site and environment foster a healthier and more productive workforce. They have found that daylighting not only offers significant economic advantages to management, but also contributes to the well-being of office workers. Along with the decentralizing of power in many organizations has come democratizing access to daylight and views, as well as an abandonment of the fluorescent fields of the twentieth-century workplace and the artificial rhythms they engendered. Looking at the future of the twenty-first century office, we see the development of workplace lighting with a new emphasis on the health and well-being workers and the sustainability of the building as a holistic ecology.
REFERENCES

7. Albrecht, p.18.
15. Ibid.
22. Ibid., 125.