

Worker Comfort in Cubicle Workstation Environments

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BACKGROUND DISCUSSTION

Introduction

There are a great number of factors that affect the comfort of workers, most generally the work area. For many office workers, the workday is spent within the small confines of a partitioned area that some call ‘the cube’ and occasionally and less affectionately, ‘the hole.’

Real estate and buildings are generally the largest cost items for organizations; therefore, as real estate costs rise, modular systems become more popular. Modular systems workspaces are flexible, and enable a greater number of workers to share a building than a room with four walls and a door layout can accommodate. In the United States, modular unit components are the top selling type of workspace furniture; sales exceed than \$3 billion annually (Schlosser) with expected annual increases.

It is estimated that more than 40 million American’s currently spend their day in a cubicle workspace environments (Newsham). In the very near future, more than one million Federal workers will join the millions of workers in the open space plan designs and modular unit furniture as the U.S. Services Administration (GSA) announced, releasing its new toolkit for establishing “World Class Workplaces.” which include the directive for use of open work spaces and modular work units. Open Work Space GSA 2005



This paper will examine the open plan office and modular systems, optimum designs and products with considerations of human factors engineering.

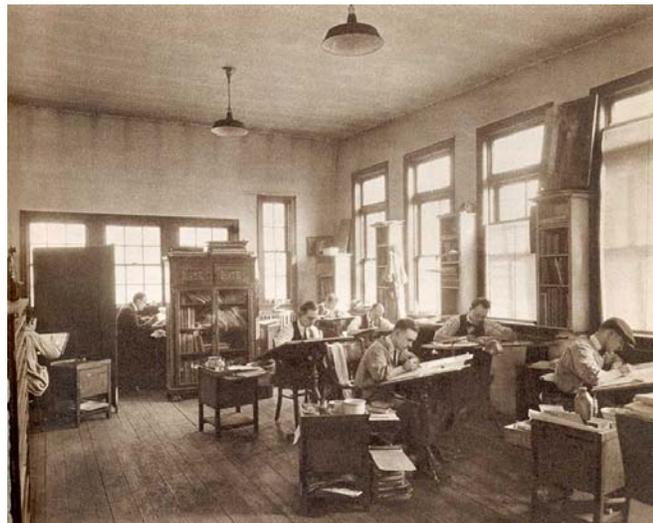
History: the open plan and development of cubicle workspace



Kidder, Peabody & Co. circa 1865 Courtesy Office Museum

Workspaces evolved over the course of history, but not as significantly as in the past one hundred years. As the primary form of work moved from agricultural to industrial, work tasks changed and business was brought indoors. Groups of people performing multiple tasks for an organization began working together in one building, or the office. The radical changes of architecture in Europe and Americans in the early 1900s, moved people to redesign with an eye for comfort and efficiency their living and working areas.

The "Bull Pen," Bertsch & Cooper, Chicago, 1921. Courtesy of ShinnType



Several individuals had a direct influence over workspaces. In the early 1900s, it was Frank Lloyd Wright in the United States who began designing buildings to mirror the great expanse of America's Great Prairie.



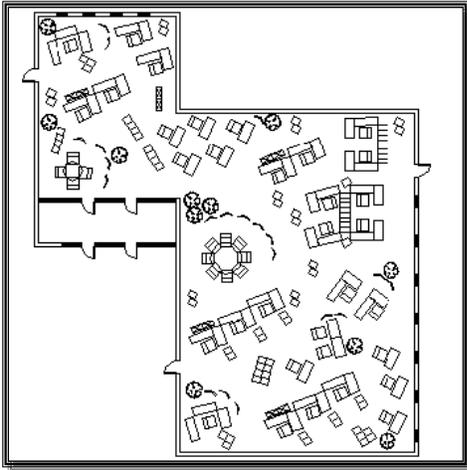
Wright's Studio Taliesin West Work Spaces 1932

Wright's interior designs were greatly influenced by Japanese interiors, and a departure from the Victorian tradition of individualized, compartmentalized spaces that he claimed, "cut the family from one another and stifled communication as men congregated in the library, women in the kitchen, children in their own rooms."



Open Plan Living 1958 Image from the Levittown Regional Library

Wright's open plan removed many of the dividing walls, resulting in large spaces that allowed flexibility in use and encouraged communion among the building's residents. From the 1930s to 1950s, Wright designed and built over one hundred homes for Usonia; a word he coined for the United States of America. Wright's designs not only incorporated the open plan for flexibility, but were also designed as modular units. Many other architects used the open plan design for home and office designs.



In Germany during post-WWII Reconstruction of the 1950s, Eberhard and Wolfgang Schnelle, developed their *Büro Landschaft*. The ‘office landscape’ design was a way to increase the flow of information between workers. The Schnelle brothers mapped patterns of communications flow in an office. Even paper flow among individuals was part of the consideration. In their design, they placed individuals according to their need to communicate. The office landscape plan included a system that incorporating lighting, acoustic control, and air conditioning. The space was to be carpeted throughout.

Büro Landschaft Floor Plan

The Schnelles’ system was introduced to Americans through the publications, *Architectural Review* and *Baumeister* (Architecture Urbanism Design Collaborative). The Office Landscape Plan was soon largely abandoned. Politically, it was too socialistic to support the bureaucratic hierarchical structure of the corporate or government office systems.

Although Herman Miller Office gives credit to Robert Propst for the design of the “Action Office” introduced in the early 1960s, it is likely that the idea was borrowed from the Schnelles and Frank Lloyd Wright.

In 1968, Herman Miller and Propst modified their ‘Action Office’ making its components mobile; the partitions, desks, and shelves were attached to panels that could quickly be configured within merely hours to build a unit or a group of units for multiple worker spaces. The new work system incorporated sufficient surface space for workers to spread out their papers and materials. Work surfaces were designed at different heights to enable workers to sit or stand to do their tasks. Additionally, there were display shelves to place work-related items to ensure that work materials were not filed away in cabinets, but accessible for quick retrieval.



Action Office Herman Miller

The panels and furniture were in neutral tones of beige or gray and plain without any distinctive features. Robert Propst explained in an interview that the intention was not to have a fashionable or stylish design not a design that could endure time.

Propst said, "We tried to create a low-key, unself-conscious product that was not at all fashionable. The Action Office was supposed to be invisible and embellished with identity and communication artifacts and whatever you needed to create individuation" (Abraham).

For the most part, the Action Office has not changed much since the late sixties. What did change was the number of modular, cubicle systems sold, and the numbers of units squeezed into buildings. Many have said that Propst's intent was not to make tiny, sterile spaces to cram a multitude of workers (Schlosser).



California State Controllers' Office or "Anywhere"

Where cubicles save space and provide order, they also create a number of issues for the employee and employer. Panel walls and modular systems have few distinguishing features; they all look pretty much the same. Organizations that do not enlist the assistance of office system designers may end up with systems that do not adequately serve their workers.

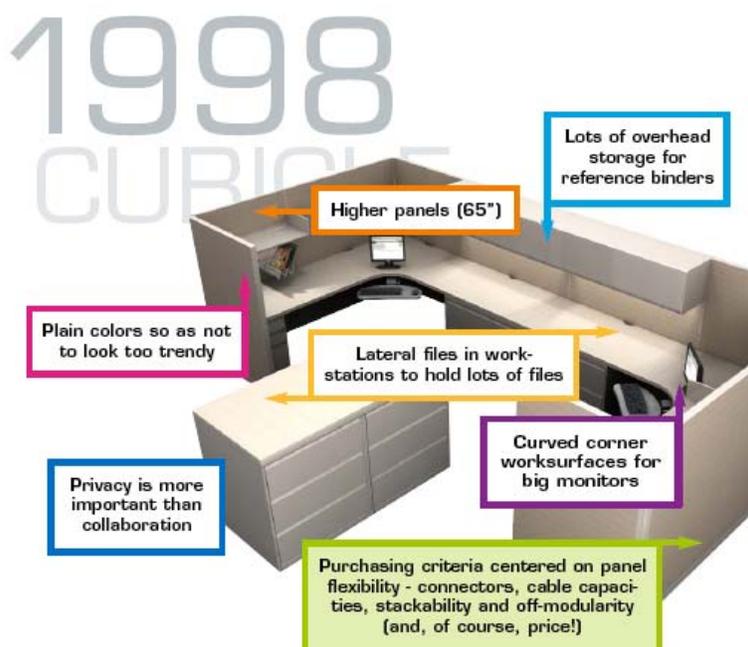
Margaret Alrutz, a consultant and a team member of Steelcase Industries (a cubicle manufacturer), has listened to hundreds of cubicle dwellers sums up the problems as having three areas of concern

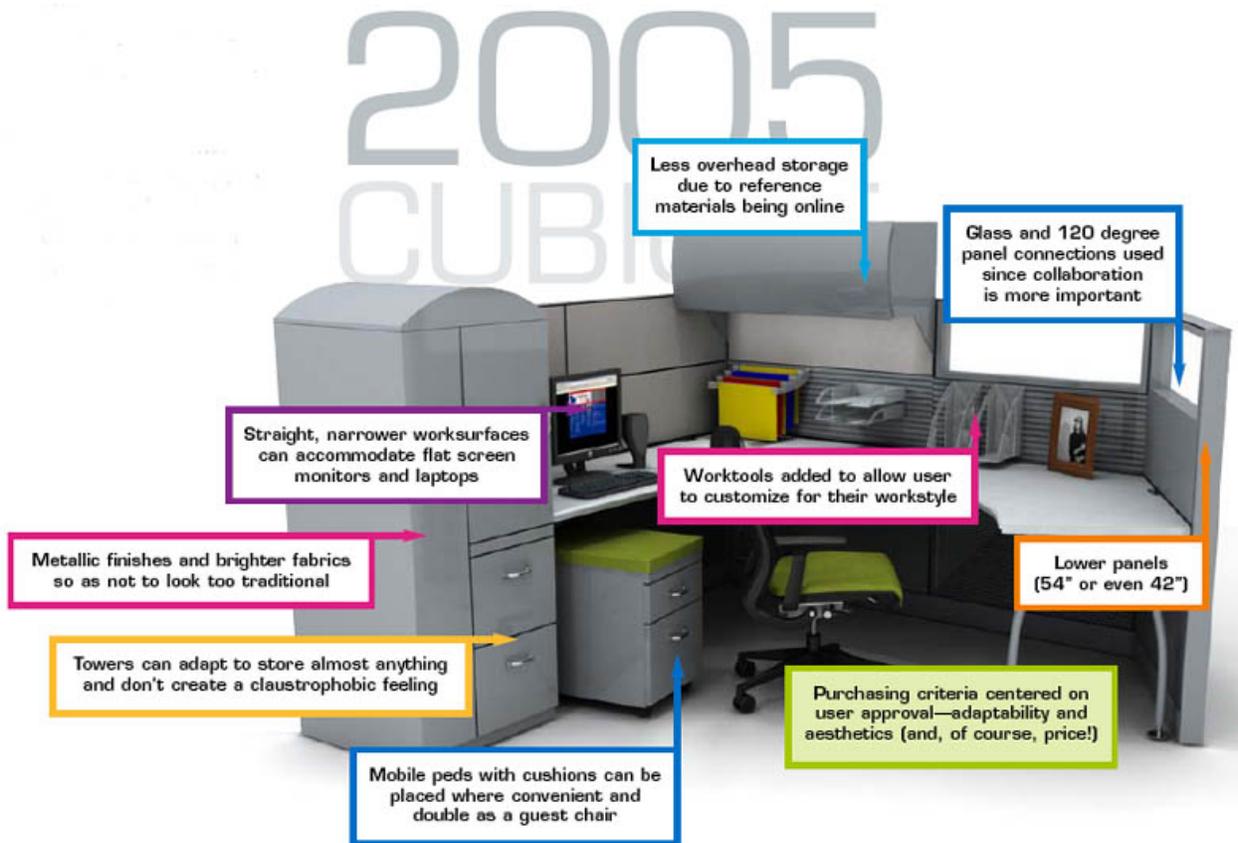
1. Resident Issues
 - Acoustic and visual privacy
 - Temperature and air circulation
 - Lighting
2. Facility Management Issues
 - Problems with moves, adds, and changes
 - One size does not fill all.
 - Warehousing the parts and pieces
3. Real Estate and Management Issues
 - Reduce the footprint and save space
 - Save money
 - Balance cost -savings with return on investment
 - Protect or evolve company culture (*Steelcase 360 Zine*)

The problems with cubicle systems are numerous; however, that is not to say that modular or cubicle designs cannot provide workers with comfortable and safe places to work. According to Alrutz and other designers, it is possible to provide workers with work environments that serve workers well, providing both safety and comfort. Many manufacturers' brochures address the need for fluidity, flexibility, workflow, privacy, and lighting and temperature control.

Then and Now

Corporate need and consumer response have both changed in the past through years. Considerable changes have been made in the recent years with a variety of components and products. An excellent contrast of changing needs is illustrated in Steelcase's brochure "The State of the Cubicle 2005."





Making the Case for Worker Comfort

A Financially Sound Investment

Workplace furnishings can be expensive especially when management moves from the very basic cubicle unit, such as the Herman Miller Basic Clam, to units that have more features for worker comfort. While the cost of personalized systems are more expensive than the basic ones, those costs can be offset by worker retention, productivity, fewer worker absences, and fewer worker compensation claims.



Basic Clam 2006 *Harbor Business*

Cognitive ergonomics

Numerous studies have shown that workers who are more satisfied with their workplace environment are more satisfied with their jobs. Directly related to higher job satisfaction are lower rates of employee turnover, higher customer satisfaction, greater organization or corporate commitment, better safety records. The bottom line is a quality organization where people like and want to work. “A study in *the Journal of Occupational Health Psychology* reported that job satisfaction accounted for 63 percent of variance in organization commitment, which accounted for 80 percent variance in intent to turnover. In that study, job satisfaction incorporated satisfaction with the workplace environment” (DiLouie).

Satisfaction with the Workplace Environment

Even a small increase in office worker productivity can make a positive financial impact for an organization. In one study, a Midwest insurance company realized nearly 3% productivity increase just by giving employees control over their own temperature comfort. With a multimillion-dollar annual salary base, the productivity increase resulted in a savings of thousands of dollars (Lomonaco and Miller).

Achieving satisfaction in the workplace environment is a multi-faceted task for management. If workers are to be satisfied with their workplaces, executive management must charge their design professionals to be mindful of human factors during the planning stage and during product selection.

Control in the workplace

People like to have some level of control and have the freedom to make personal choices. Having no control results in stress. Having control results in increased worker productivity. Even a small increase in office worker productivity will make a positive financial impact for an organization. The BOSTI Study of more than 13,000 workers revealed that productivity was affected by lighting, temperature, and other environmental factors and more importantly showed that when workers had choices over these factors, worker satisfaction rose (Newsham).



Addressing the Issues



Often the source of comedy, and artists, including the comic strip's, Dilbert creator, Scott Adams, who actually joined forces with IDEO a company specializing in project design.

Scott Adams in Dilbert's Ultimate Cubicle *IDEO*

Adams worked with the IDEO's team and designer Fred Dust to address to create "Dilbert's Ultimate Cubicle, an attempt to address the myriad issues connected with partition-based offices: lack of personal control, absence of privacy, inadequate space, and tools (IDEO Project Profile)

"The result was a modular cubicle that allows each worker to select the components from a 'kit of parts' and create a space based on his or her tastes and lifestyle. Practical considerations include modules for seat, a computer, and a display (complete with "boss monitor"). The floor modules lift for storage or flip between artificial grass and *tatami* mats; the light modules at the top mimic the sun's movement throughout the day. Other, more whimsical modules provide a hammock, an aquarium, and a punching bag" (IDEO). While some of the feature might seem extraneous, the point is to offer employees some choices in their workplace environments.

With numerous manufacturers, system designers have a large selection from which to choose. The most common cubicle sizes are 6' x 6', 6' x 8', and 8' x 8'. These provide enough room for a computer, desk space for paperwork, and perhaps a single chair for visitors.

Another decision to be made is the height of the walls, typically from 34 inches to 54, 67, 72, and 85 inches. Higher walls mean more privacy, but less light and less air circulation.

The task for management is to choose products that satisfy workers’ needs of comfort; to commit to making the necessary investment for their workers’ safety and well-being; and offer their workers choices from the variety of ergonomically designed products.

HFE CONSIDERATIONS

In choosing products for worker comfort and workplace satisfaction, all the following should be considered:

CONSIDERATION	REASON
Ergonomically designed furniture and office tools	(Up to 90 percent of workman’s compensation is related to musculoskeletal could be eliminated by good ergonomic design.)
Adequate space for workers to store and retrieve work materials	Workers need enough space to place their work within easy reach. Team workers need access to one another.
Workplace that allows individuality	Worker must be able to tailor their environment
Features and plans that allow privacy	Workers must feel their privacy needs are addressed
Thermal comfort at the individual level	Not everyone can be comfortable at the same temperature/
Air quality and ventilation	Productivity is affected when air quality is compromised
Acoustics and Controlled Noise	A module placement design should avoid direct pathways for sound transmission
Good lighting with individual control within the cubicle	Workers have a variety of illumination needs dependent upon task, surroundings, age of individuals (older workers need more illumination)
Adequate room to arrange work materials: storage, wall, desk, and shelf space	Productivity requires that workers can store and retrieve materials quickly.
Ergonomic furniture and tools	Musculo-skeleton and overuse disorders make of the major of injuries in the workplace
Social interaction	Employees need a place to socialize while not disturbing others
Common spaces	Areas need to be provided that encourage teamwork.

Furniture

Considering the numerous hours a person may spend sitting at a desk, a good quality, well-fitting chair should be provided. Over 50% of musculo-skelton injuries are low back injuries, but less than 4% of low back injuries are related to traumatic injuries during work (Rowe)

Chairs are designed from the following anthropometrics

- popliteal height (lower leg length)
- seat depth (buttock to popliteal length)
- hip breadth
- mid-shoulder sitting height (back height)
- elbow height
- lumbar height
- lumbar depth

Most chairs are designed to fit the 50th percentile of the population. Adjustable chairs are offered that compensate somewhat for some persons outside the middle range. Adults who are significantly less or more than the typical height or weight will need a specially sized chair. Several manufacturers do provide more than one size.

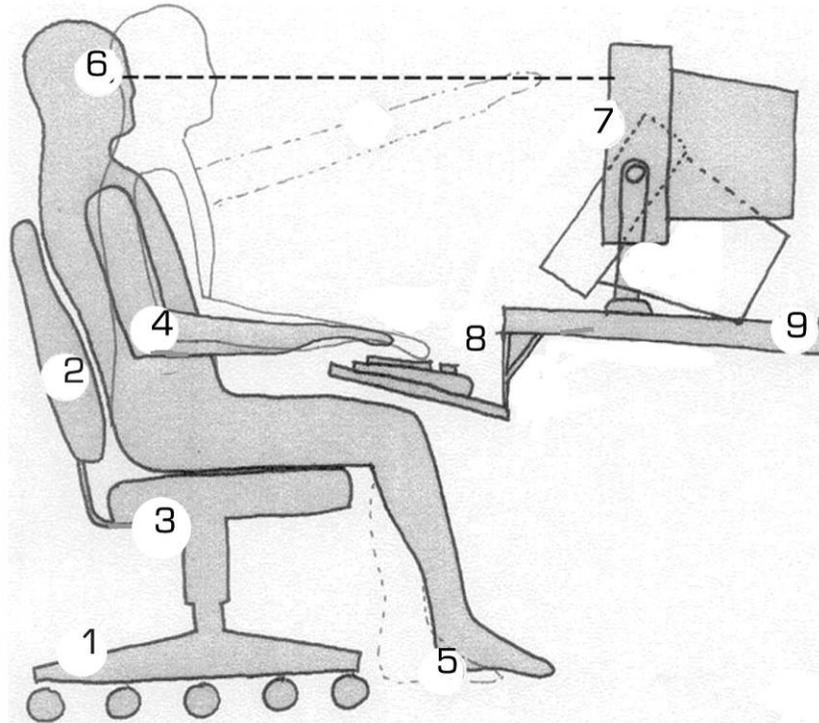
Chair Features

Note: Item numbers correspond to drawn diagram on following page.

1. Solid base: a good quality mobile chair should have a base with five casters; fewer casters are not safe; a person attempting to reach lower from the chair may fall over, and injury can occur.
2. Back: the back of the chair should low enough to support the lower back and the buttocks. It should be cushioned so that causes the lower back to arch slightly to minimize the load (strain) lumbar region of the back. The user should be positioned fully in the chair so that the weight of body is supported by back of the chair.
3. Seat pan: should be large enough that one inch on both sides is visible when a person is seated. The chair should not be so deep that the back of the legs above the knees touch the chair. Seat height should be easily adjustable. A pneumatic adjustment lever is the easiest way to do this.
4. Armrests: if included, should be adjustable enabling the arms to rest so that the shoulders are ever so slightly raised. Armrests should not interfere with positioning of the hands or arms at the keyboard.



Ergonomic Chair *Human Scale*



5. A seat height that ranges from about 16 to 21 inches off the floor should work for most people. This allows the user to have his or her feet flat on the floor, with thighs horizontal and arms even with the height of the desk. A footrest can support the weight of the legs, if needed.
6. Position of chair and monitor should allow head to be positioned straight with chin parallel to the desktop.
7. Sit at arms length from monitor. The top of monitor casing should be no more than two to three inches above eye level to keep the head level and not tilting down or up.
8. The keyboard should be positioned under the line of the bottom of the forearms. A negative tilted keyboard tray can help the worker achieve an ergonomic position for the arms and wrists. The keyboard tray should be of sufficient size to accommodate both the keyboard and mouse on the same plane, or very close together.
9. The desktop should be at a level with the user's elbows when the forearms are parallel to the floor. The surface should not be shiny, which would cause a glare. In

addition to desktops, work surfaces to be use when standing should be provided, also.

Posture

Seated Posture

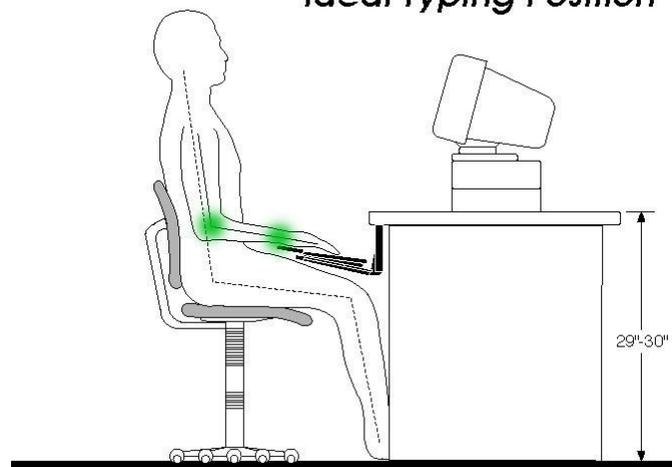
The worker should maintain a posture, which contribute to healthy seating which has the following main aims:

- To rotate the pelvis forwards
- To extend the spinal column
- To distribute weight evenly through the spinal column and soft tissue structure of the back
- To open up the diaphragm and allow full breathing function
- To de-constrict the lower abdomen and aid digestion
- To aid and assist blood circulation around the body
- To provide the user with the full range of body movement
- To ensure that muscle tone is maintained by exercising the muscles
- To ensure that all parts of the body can move independently
- To aid efficiency by ensuring that the user is comfortable and relaxed (Posture Point).

Typing Posture

In the ideal typing posture, both static and dynamic muscle loads are minimized. This posture is achieved when the keyboard is below seated elbow height and the keyboard base is gently sloped away from the user so that the key tops are accessible to the hands in a neutral posture. In this position the arms, shoulders, neck, and back can relax, especially during brief rest pauses. Also, in this slightly reclined sitting position the low back rests against the lumbar support of the chair, the elbow angle is opened to promote circulation to the lower arm and hand, the abdominal angle, and the popliteal angle (behind the knees) are opened to promote blood circulation. The feet rest firmly upon the floor.

Ideal Typing Position



Lighting

Proper lighting makes all work tasks easier. Appropriate lighting, without glare or shadows, can reduce eye fatigue and headaches. The ability to "see" at work depends not only on lighting but also on:

- the time to focus on an object - fast moving objects are hard to see.
- the size of an object - very small objects are hard to see.
- brightness - too much or too little reflected light makes objects hard to see.
- contrast between an object and its immediate background - too little contrast makes it hard to distinguish an object from the background

Environmental Experience	Productivity Impact
Basic Illumination level/distribution	Performance decreases when too dim or too bright.
Illumination for tasks	Workers over 50 years of age require twice the light levels of young adults for comfortable work.
Glare	Performance decreases when too glaring.
Ambient/task lighting systems	Users have control over their area and have access to task lighting
Shadows	Disrupts visual inspection and human interaction
Color temperature	Light of a high color temperature, containing more blue, is more visually efficient for perceived brightness and visual acuity
Personal Control/stress	Performance decreases with no control, perceived or real.

A recent study of the influences of lighting on the health of office workers found that the types of inadequate lighting used by workers resulted in health disturbances that included visual impairment, burning eyes, fatigue, and headaches (Cakir)

Basic and Task Lighting

Workers need basic lighting (general illumination) and task lighting. General, overhead lighting cannot provide the major source of light for offices, especially now that computers are the focus of many people’s jobs. General light needs to be lower than task light, and complementary to



Poor illumination *Finelite*

it. Twenty-five to fifty foot-candles, supplemented by task lighting of an additional twenty-five to seventy-five foot-candles, is now thought to be the extent to which direct or indirect general lighting should be used. However, at this level of general lighting, additional task lighting must be provided to workers.

Task Ambient Lighting Systems

Task-ambient lighting systems are preferred over single light source. This system uses a combination of basic, local, and task lights.

Task lighting

Task lighting may provide significant energy savings, optimal performance, visual comfort, energy efficiency, healthy lighting, and high standards in aesthetics, all at the same time. Well-designed task lights may help alleviate problems with glare from overhead lights and give additional illumination for specific tasks.



Task Light *Universal Design*



Elsa Steel Case

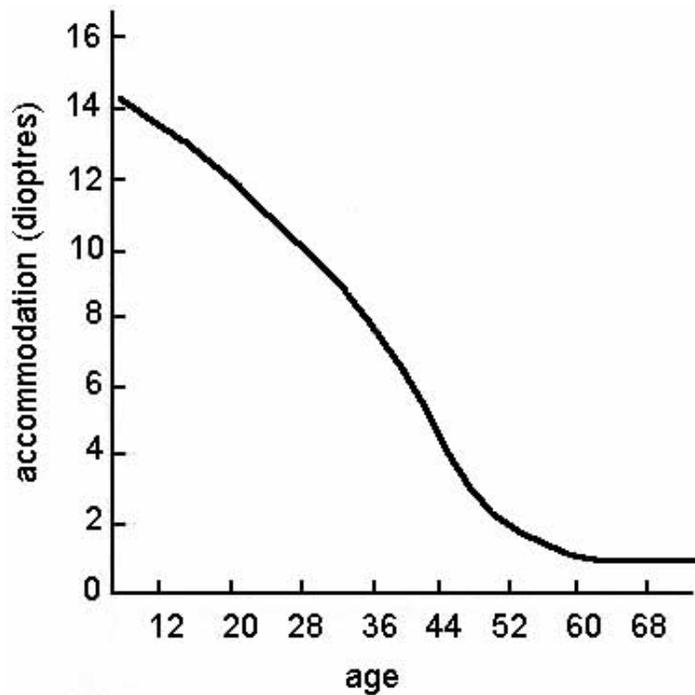
The best task light is one that gives the user control over position and intensity so that it can be located to minimize glare and altered to match the worker's changing needs. In addition to a variety of desk lamps, there are several other types of task specific lighting offered for cubicles. One type is recessed - built into the module above work areas.

When placing task lighting for the cubicle, it is important to consider where the illumination falls. When the task light is placed at a common lamp height of 16 inches (410 mm), it means that those people whose seated eye height is below 410 mm will experience direct glare from the illumination source.

The following table was from a study of males and females: It was found that due to their smaller stature, more than 50 percent of females would look directly into the light source placed at the common lamp height of sixteen inches, while only 5 percent of males would experience the same problem (Japuntich).

Seated eye height, H, above 737.6 mm desk surface (mm)	Image viewing angle, I (Deg) Image distance from front desk edge, D (mm)	Image distance from front desk edge, D (mm)
315.4	6.3	232
391.4	33.6	260
471.4	31.2	285
409.4	33.1	266
490.4	30.6	290
569.4	28.6	310

Another consideration is the amount of amount of light needed. This requirement is dependent upon the task and the individual. People over 50 need twice as much light as those who are 30 years old.



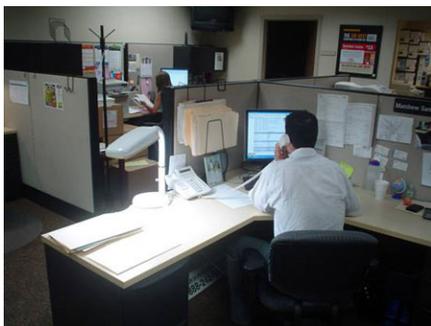
Light & Eyes *Boroditsky*

Nature of Virtual Task

High contrast, Large size
Medium contrast, small size
Low contrast, very small size

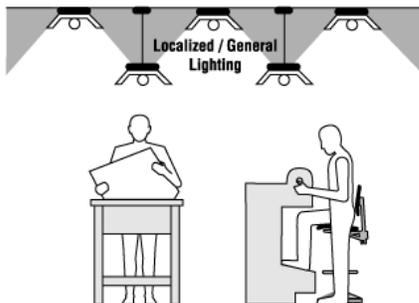
Foot-candles Recommended

20-50
50-100
100-200



Task Lighting *Full Spectrum Solutions*

Basic Lighting



General illumination needs have changed since primary tasking moved from paper reading to computer terminal use. General illumination needs are usually satisfied with fluorescent in-ceiling or pendant fixtures and do not need to be as bright as when workers' primary tasks were viewing paper documents.

Basic lighting



Open Plan *Holmes Design*

Individuality in Worker Environments

One of the chief complaints for workers in open space modular system offices, is that the entire area looks the same. Many workers feel their creativity is stifled by lack of comfort and absence of familiar objects in cubicle environments.

Office workers should be allowed to individualize their work areas as long as safety is not compromised and there is no encroachment upon others' spaces.

In addition to small plants, photographs, and personal mementos that an employee could display, there is a plethora of products designed to enhance workspaces.



Cal's Cubicle

Corrugated paper, color paper with scenes and patterns can brighten walls. Several companies offer cubicle and wall panel accessories that are functional.



In addition to making workers feel better in their workspaces, individualizing the workspace can also help worker relationships. Dr. Maynard Brusman, a psychologist says, "By having things in your office, whether a cubicle or workspace, it allows people to get to know each other and develop relationships" (Temple)

INDOOR ENVIRONMENTAL CONDITIONS

In employee satisfaction surveys, environmental conditions are rank as top concerns. When organizations provide interiors that support employee needs, they realize significant gains. "Even a small increase in office worker productivity will make a positive financial impact for an organization. A Midwest insurance company realized nearly 3% productivity increase just by giving employees control over their own comfort. With a multimillion dollar annual salary base, the increase amounted to a savings of thousands of dollars." (Lomonaco and Miller)

Environmental experience	Productivity Impact
Thermal comfort	Performance decrease when too hot or too cold
Air quality	Performance decrease in polluted air
Circulation of air, air vent location	Performance decrease in stuffy rooms, or when air blows directly on worker
Noise	Performance decrease in noisy rooms
Mechanical vibrations	Performance decrease by noise and distraction
Personal control of temperature, air circulation	Performance decrease with no control, perceived or real.

Air Quality, Ventilation, and Temperature control

The standard temperature for office buildings is a fixed temperature of 72° F. Individual differences in reactions to environmental conditions can be due to age, sex, personality, metabolism, allergy, or hypersensitivity. Women generally prefer warmer temperatures. In addition, because tasks for some employees require them to be at their desks for much longer periods than others, the impact of these comfort levels variances are not equal (Lomonaco and Miller). Newer HVAC systems allow for individuality and cost savings: within the individual workstation, an occupancy sensor detects when a person leaves the area and shuts down the system, saving more energy and reducing the cooling/heating load.

Acoustics and Noise Control

Environmental experience	Productivity Impact
Background noise	Performance decrease with loud and annoying noises

Privacy for conversations	Performance decrease with compromised privacy
Noise stress	Performance decrease with noisy rooms
Personal control	Performance decrease with no control, perceived or real

Privacy

In research conducted by BOSTI Associates between 1994 and 2000 involving 13,000 office workers, the ability to do distraction-free solo work was ranked number one for productivity, team performance and employee satisfaction (ASID).

There are several ways to control noise: absorb, block, cover, and mask. Acoustic ceiling systems, carpeted floors, and padded, acoustic absorbing cubicle panels are the chief means for sound absorption. Cubicles can be laid out in a configuration to avoid long aisles and door-to-door alignment where sound can travel and even magnify. Within the cubicle, components such as drawers, trays, overhead storage with surface padding, not only give workers places for storage, but will also absorb sound within the cubicle.



Storage Clone Cubicles

White or pink noise generators are useful for negating distracting noises. Sound masking can be useful for dealing with privacy needs for people in cubicles. These electronic sound-masking systems render speech unintelligible without being distracting to nearby occupants.

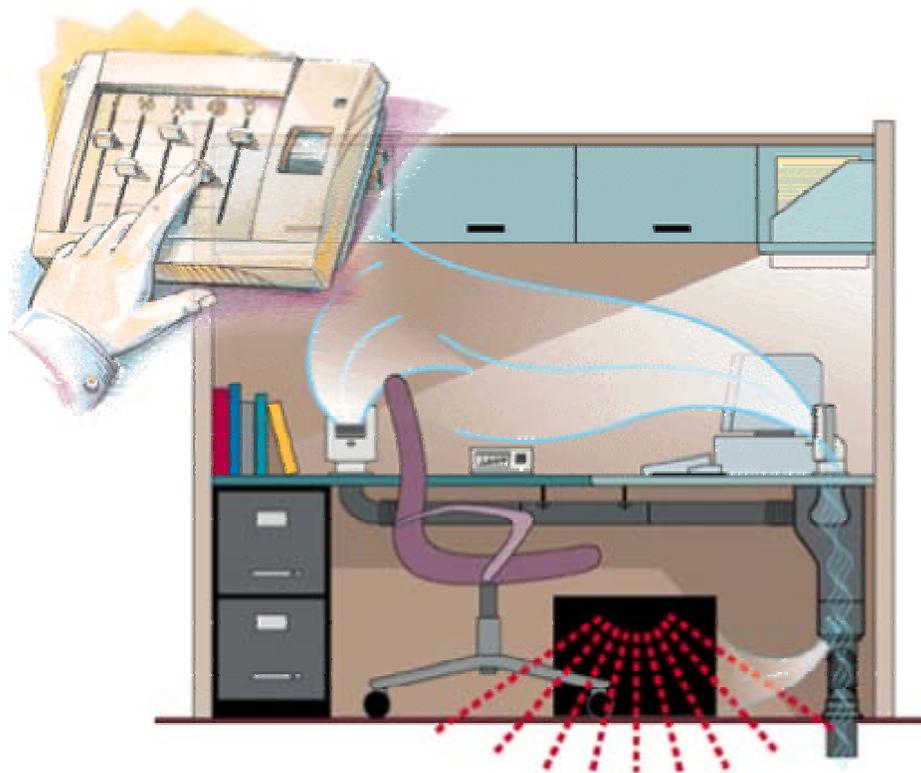


Babble by Sonare Designer

Integrated Solutions for the Environmental Experience

Personal environmental systems are now offered by several companies. Johnson Controls' Personal Environments are designed to be responsive workstations allowing employees in open office designs to use a desktop controller to adjust their individual workstation environments, including temperature, filtered outside airflow, lighting, and background noise masking.

A radiant heat panel located below the desk is adjusted at the controller to warm the lower body. Temperature, airflow, and sound masking are adjusted at the controller and distributed by two adjustable desktop diffusers. The control unit is small and hung inside the cubicle.



Personal Environmental System *Johnson Controls*

Workers with special needs: physical and cognitive

Extra consideration should be given to accommodate workers with special needs; those with physical disabilities, sensor disabilities, mental disabilities, chronic or systemic conditions, and cognitive disabilities. More than 32 million disabled Americans are in the United States workforce (Barchacky), and an estimated twenty percent of workers have

These workers make worthwhile contributions to organizations if accommodation is made. There are numerous ADA regulations (1990 Americans with Disabilities Act) that make basic requirements reasonable accommodations.

Accommodations for Physical Impairments

ADA regulations require clear width of 36 inches in aisle between cubicles, and a doorframe clear width of at least 32 inches, allowing adequate room for wheelchair movement. Cubicles intended for wheelchair use should contain work surfaces no deeper than 24 inches and between 28 and 34 inches high. To accommodate side reach from a wheelchair, nothing in the cubicle should be lower than 9 inches or higher than 54 inches off the floor. Areas that require forward reach from a wheelchair should locate nothing lower than 15 inches and nothing higher than 48 inches. Overhead doors should not be able to slam shut. Doors should have levers that can be operated with a closed fist. (Barchacky)

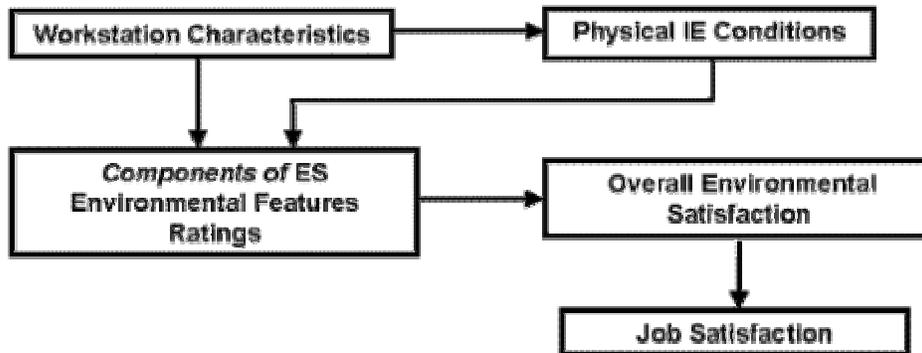
Accommodations for Cognitive Impairments

Employees with cognitive impairments may experience a variety of difficulties when performing job duties in a cubicle environment. These impairments include may be temporary or permanent and may affect overall work performance, including quality of work, conduct, and productivity:

- Attention deficit disorder or attention deficit hyperactivity disorder,
- Asperger Syndrome, a neurobiological disorder
- bipolar disorder
- brain aneurysm
- cancer, chronic fatigue syndrome
- depression
- epilepsy
- fibromyalgia
- head injury
- learning disability,
- migraine headache
- mental retardation
- multiple sclerosis
- post-traumatic stress disorder
- sleep disorders
- stroke

Employees with cognitive impairments can be protected from stressful auditory and visual stimuli by placing workspaces in low-traffic areas, active areas, away from printers and other noisy equipment. Privacy needs may also be higher for those with certain medical conditions, or those who use screen reading software or other assistive technology.

Expected Results



National Research Council Canada

When human factors are considered in workplace design, the result is a gain in productivity and cost savings for the employer.

Carol Lomonaco and Dennis Miller in their research studies found numerous studies demonstrating that when employees were satisfied with environmental conditions there was a direct correlation to satisfaction and productivity.

The following table outlines their research findings:

Analysis of Environmental Satisfaction-Productivity Studies		
Study	Environmental Condition	Result
Greening the Buildings & Bottom Line 1994	Lighting Noise & Day lighting New Building	6% prod. gain, reduced defects, \$25k increase in product quality, 13% prod. gain, 25% less absenteeism 15% prod. gain + 15% less absenteeism 15% less absenteeism
West Bend Mutual 1992	Individual Control	2.8% prod. gain/could be up to 6% 12.8% prod. drop when disconnected
Mau-Lin Chiu/Carnegie Mellon 1991 According to Chiu, six factors influence office productivity: (1) Spatial Quality (2) Thermal Quality (3) Visual Quality (4) Acoustic Quality (5) Air Quality (6) Long-Term Building Integrity	Lighting Noise Temp & Air Quality	Cites 4 Studies Cites 5 Studies Cites 5 Studies

Economic Benefits of a Healthy Indoor Environment (Wyon)1994	Thermal Air Quality Individual Control	5-15% incr. efficiency in concentration 34% improvement in Sick Building Syndrome
Predicting the Effects of Individual Control on Productivity (Wyon) 1995	Individual Control	3-25% efficiency gains 3-15% for concentration and 7-25% for routine office tasks
Indoor Air '96 Conference (Wyon)1996	Individual Control	2-10% increase in group efficiency
BOSTI 1984	Noise Temperature/Air Quality Lighting Comfort	These have dollar figures for 3 job types representing improvements to absenteeism and turnover.
Center Core 1993 Lomonaco and Miller		

Conclusion

The fundamental task for organizations is to “generate tolerable working conditions that do not pose known dangers to human life or health,” and the next goal is to provide working environments that contribute to the optimal conditions that are conducive to health and worker productivity. If organizations expect more from their employees, then they will need to utilize the technologies that have engaged ergonomics in the design process. Those “resultant designs incorporate features that take advantage of unique human capabilities as well as building in safeguards to avoid or reduce the impact of unpredictable human error” resulting not only in better performance of employees, but also in improved quality of human life. (Kromer, et al)

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