The luminous environment

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 2 Is 2

Design and comfort in office space

Michele M. Lepore

Dipartimento di Architettura, Università degli Studi "G. d'Annunzio" di Chieti-Pescara - Italia
GdPA - Gruppo di Progettazione Ambientale

ABSTRACT

The theme of office space is of particular interest because it is a sector strongly involved by technological development. The high concentration of plant engineering systems makes it essential to the attention to environmental parameters and to research on the quality of the relationship which binds man to artificial dimension of built space. In the design of office spaces, the general objective must be to be able to achieve a new working environment relationship. A ratio in which optimal balance is always sought in terms of igrothermal, acoustic and luminous comfort conditions, without noting that the psychological and sociological component plays an important role among the environmental factors, and this significantly interferes with the conditions of physiological comfort. The following work is an essay on the subject.

KEYWORDS

Office Space, Comfort, Daylighting

https://doi.org/10.4995/vitruvio-ijats.2017.8844

1. INTRODUCTION

Designing an environment, a place of work, durably affects, the behaviors of those who live there daily and spend most of his working life there. Often the effects of such a conditioning, whether positive or negative, escape to the knowledge of the designer especially when it is called upon to deal with very fast evolutionary dynamics.
First of all it is rapidly lowering the so-called "threshold of discomfort" in respect of the environment. In part for the improvement of the standard of living, in part for the most widespread information on the environment, we condone always less noise, the inadequate lighting, the pairings strident, disorder. Any good designer can and must give satisfactory answers to these requirements.
Each one of us, both in the role of the designer and the inhabitant, goes behind positive or negative environmental ideals often linked to minor details. For clarity, it is useful to introduce the concept of "environmental energy maintenance". In other words, a certain office environment, once designed and constructed, does not automatically retain itself as such forever. Because the conditions that do define "office" evolve to we need a collective commitment, a check on the behavior in its interior, an awareness of the draft together by those to whom it is intended. Certain choices technical and aesthetic requirements can make the environment more or less tiring to dwell. Where the articulation of the environment is not clear where the lay-out of the walls and furniture appears random, where the creativity of the designer, rather than develop requirements and complex problems to which the project must constitute the solution and response, respecting and enriching its contents, instead opposes it, the energy of maintenance required by that particular behavior setting may become excessively high. Then occurs an emotional disinvestment from users-inhabitants, all the available energy is concentrated in the defense of its own territory individually; the threshold of the annoyance lowers and growing intolerance for defects even minimal, of the same environment.

In order to analyze the complexity of the confined artificial environment in which we live, we work, etc., it is necessary to disassemble in its elementary components. For the physical environment alone we can locate the thermal, acoustic, bright environment etc. Not being able to face them all here, even just superficially, we will deal with one who, though having a great influence on the degree of comfort, with both psychological and physiological repercussions and hence safety for our health, is too often not sufficiently considered since the design stage: the luminous environment with particular attention to the problems of who, though having a great influence on the degree of comfort, with both psychological and physiological repercussions and hence safety for our health, is too often not sufficiently considered since the design stage.
It is therefore obvious how it is ever more urgent to strengthen the capacity of assessment and forecasting (on the part of the designer) on expectations in terms of quality and performance required to the environment (by the user). Learning to grasp and to assess the relationship between things, their synergies, the thin quality of the environment in which we live, all we learn to always observe more critically the built environment that surrounds us and to compare to our personal life project. The work of the designer in such an ongoing context becomes even more important and delicate.

2. COMFORT AND ENVIRONMENT

The environment enfolds us and engages us, constantly engaging our perceptive system in a job of selection and discrimination on the infinite amount of information that transmits us, work that always has as our starting point and arrival our past actions and actions that we propose for the future. This kind of perception is to be attributed to the radical cultural dichotomy that is found between the designer and the inhabitant (Origlia, 1990). Each of them has its own perceptive model, functional to the different purposes and modes of action in the environment. Designer and inhabitant personify to the limit the two

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 2 Is 2

opposing models among which the behavior of every human being oscillates: on the one hand, the action of adapting (transforming what exists in function of a behavioral project), on the other hand the action of adapting (transforming its behavior in function of the project of what already exists).
These opposing models of relationship with reality correspond to non-opposing perceptual models that sometimes lead the designer to be bothered by the unplanned behavior of the occupant, feeling misunderstood in his creative commitment, and symmetrically lead the inhabitant to not respect the project because it is inconsistent with his expectations. But let us not forget that each of us, whether it's an architect or not, constantly modifies and designs the space around it to suit its needs: these two different perceptual models, which we bring in, need to constantly communicate with each other. The key language is what you could call the "collective project" of the environment. It is what remains in the typologies of environments, furnishings, tools and objects, in its formal and functional aspects, the result of a millennial work of setting up what constitutes a scenario and support to habit behaviors. And it is the learning process of this "collective project", that each of us develops and customize according to the context and their own inclinations which provides us with those indicators-limit which are called, according to the cases, "threshold of annoyance" or "threshold of adequacy". It is the learning of these different perceptive markers or selectors that allows us to behave adequately during a mass or, more simply, cross the road without being invested. They act as valves that direct our behavior towards the action of adapting or adapting to action. Certain environments confuse, rather than favor, the social regulation of behaviors, leaving doubts about who can or should do what. But how and why does this happen? How to use, for example, the notion of disruption threshold to design environments that do not stimulate conflict or reaction?
The population is considered to be an integral part of the environment itself, which is defined as the behavioral scenario (Fig.1). According to this point of view the same physical space, a large open plan office, seen at ten o'clock by the cleaner, is a completely different environment than the one seen by the employee working there eight hours a day together with fifteen colleagues.
As we mentioned previously, a specific office environment, once designed and realized, does not automatically maintains as such for ever. Because the

Figure 1.

Central Beheer, Alpendoon, Olanda 1972 - H. Hertzberger, This building is still today, over forty years after its completion, one of the most important examples in Europe of unconventional design of office space. (Continenza R., 1988, Architetture di Herman Hertzberger, Gangemi, Roma).

conditions that make it "office" continue to occur, a collective commitment, a control of behaviors within it, requires a non-superficial understanding of its overall design by those who are destined (environmental maintenance energy). The designer should always realize that certain technical or aesthetic choices can make the environment more or less tiring to live. Where the articulation of the environment is unclear, where lay-out of walls and furnishings appears random, where the creativity of the designer, instead of developing from the "collective project" respecting and enriching its contents, opposes it, the maintenance energy required by that particular behavioral setting may become excessively high (Carver, 1981). There is then an emotional disinvestment towards the parts of collective interest, all the available energy is focused on the defense of one's own territory, the threshold of discomfort decreases and intolerance grows for even the slightest defects in the environment.

3. THE HOLDING CIRCUITS, CONTROL AND REJECTION

The need for a certain energy to maintain the office setting behavior is physiological and positive. What worries more about who works in the office environment is not so much the energy needed to maintain the behavioral setting, but the risk that frequent so-called "stress circuits" are set up, or even "waste circuits" for the environment.
The control circuit is set when you have to observe someone, or you have to constantly raise to close a door that others leave open, or you have to turn off a light because it is reflected on the monitor. When the control circuit in an environment entails levels of stress there is definitely a mistake, either in the design choice, or in the information given to the designer or, more often than not, of the maintenance of the project. It is a grave and typical mistake of many companies to consider the intervention of the designer as a one-off performance, ignoring the fact that in a living and constantly transforming office the organizational scenario can change completely over a couple of years, and that this would require an equally complete redesign of physical space.
Even the "waste circuit", especially as interpersonal dynamics turned against members who do not integrate into the setting, can be turned against the environment. For at least two decades, the *office landscape* has been synonymous with democracy, open mindedness, modernity, in spite of the high maintenance required, so as to inhibit the waste stream towards the environment: the environment is good, bad is who does not democratically accept sacrificing their own egoistic need for privacy. In fact, the landscape office model has been well received by cultures more used to self-control, the Melteleuropean and Scandinavian, while never captured in the Latin countries (Fig.2). In Japan, the office landscape has remained an exotic curiosity, probably because the problem of offering countervailing values to self-control has never occurred. All this to observe that conceptions of the *type of discomfort, control circuit, waste circuit,* have very variable values and connotations in the different cultural areas.

4. COMFORT AND DESIGN: THE LUMINOUS ENVIRONMENT

The luminous quality of a confined space can not be defined, represented and evaluated with quantitative terms. A good light around must be at the same time comfortable, pleasing, relevant, and appropriate for the uses for which it is used. The natural lighting of a confined space is important not only for energy savings that may result from its proper use, but also for its chromatic quality, its variability linked to time scanning and its stimulating effects.
From a biological point of view, natural light stimulates human metabolism and helps, for example, regulate blood pressure, while lack thereof causes increased melatonin secretion by some internal glands.
Subjects forced to stay in an environment free of view toward the outside or with constant artificial lighting will experience visual fatigue in a shorter time than subjects subjected to variable sensory stimuli and need higher levels of illumination to perform equally

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 2 Is 2

Figure 2.

A typical example of hot desk typology, to solve the nomadic needs of collaborators, organizing the space of maximum organizational flexibility and non-territoriality.

accurate visual tasks. The search for optimum indoor lighting conditions for each visual task was supported by the conviction that by artificially achieving and maintaining the "best" possible living environment in a building, the best possible performance would be obtained from the users. This hypothesis comes from some studies carried out at the end of the last century that linked the increase in productivity in working environments with the increase in the internal brightness level.
Already in the '20, subsequent and more extensive research conducted at Harvard University has shown how the productivity increase produced by the rise of the luminous level remains constant even with its subsequent decline. Studies (Canazei, 2014) have shown that any company's alleged concern for workers' health and the working environment translates into a rise in productivity and that this increase could have been more easily achieved and at lower costs by acting on the quality of the light field rather than on the intensity.
The planning process, attentive to the lighting issue, can no longer rely solely on the list of luminous levels to be reached in the different rooms, and therefore on the size of the windows, but should carefully consider the activities that are to be carried out within them and the needs biological ones by identifying their implications with the enlightened environment that comes to be determined (Fig.3).
Another consideration to be made is that of the "meaning" of the light field, namely its ability to communicate information and feelings, for this ability to interact with the structure of the space by exalting or limiting some relationships: an interesting, varied

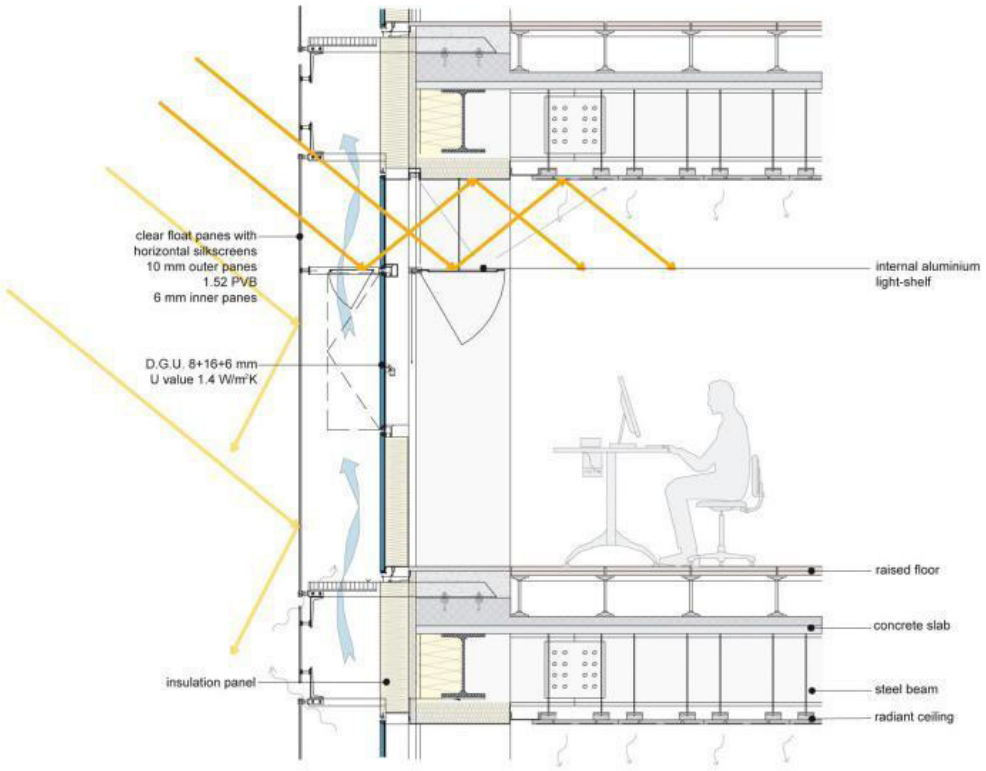

Figure 3.

SIEEB Building, Mario Cucinella, architects (https://divisare.com/projects/153709)

and stimulating luminous circle. It will therefore be much more "efficient", at the same luminous level, of a matte gray and constant brightness. There is also a relationship between the desktop daylight illuminance and the preferred colour temperature (Galasiu, 2006), which suggests that at low daylight levels (500 lux) the average preferred colour temperature was around 3300 K, while at higher daylight levels (1500 lux), the preferred colour temperature increased to 4300 K.

5. ARTIFICIAL LIGHT AND NATURAL LIGHT

Exposure to natural light from which man, a daytime animal, had made and depends on the regulation of many of its metabolic processes, is gradually decreasing until reduced to our days, in some cases, to a few tens of minutes day. What can be the consequences of such a dramatic change in the human body is not yet possible to say precisely.
However, in physical and temporal terms, what are the main differences between current exposure to natural and artificial light? The parameters that specify these differences are three: light intensity, light spectrum, time and rhythm of exposure.

6. INTENSITY AND SPECTRUM DIFFERENCES

The intensity of sunlight here understood as illumination on the ground, varies with the season, the day of day and the atmospheric conditions, oscillating between 20.000 and 100.000 lux; For artificially lit environments, lighting levels are considerably lower, with values generally ranging between 40 and 2.000 lux. The solar spectrum can be assimilated to the spectrum of an ideal incandescent source at a temperature between 5.500 and 6.800 degrees (Kelvin); is of a continuous type for wavelengths between 290 nm and 700 nm and includes a portion of medium to long wave UV. Artificial light, on the contrary, has a limited and variable spectral distribution depending on the type of lamp, among those typical of the civil sector:

- incandescent lamps have an emission moved to 80% of the total emission toward the red (770 nm) and have always been mostly used in homes, on average 2.800 °K. Today have been superseded by those with low consumption;
- discharge lamps of most common use very frequently present in work environments because of their low power consumption, emit in the region

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 2 Is 2

of the yellow-green, i.e. around 550 nm; other instead, reaching a color temperature of 6.000°K, are equipped with a good spectral continuity and emit a light more similar to solar energy;
• the compact fluorescent lamps, with the same levels of color temperature up to 6.000°K, but with a somewhat higher efficiency with respect to the tubular fluorescent. Equipped with hitch a E27 standard;
• LED lamps, with the possibility to have them with color temperature quite warm of fluorescent, have an efficiency four times greater than fluorescent, fifteen times those incandescent and with an average life of 100.000 hours against the 1.000 of those incandescent and 6.000 of the compact.

7. THE RELATIONSHIP BETWEEN LIGHT AND METABOLIC FUNCTIONS

Already in 1805, a scholar Christof Ebermaier (Ebermaier, 1805) published a treatise containing a precise description of the correlation between cyclic variability of some biological functions in humans (fourth chapter) and equally cyclical changes in ambient light, hypothesising health damage from a low exposure to sunlight. On this basis it is considered that the light that strikes the retina is sent, by means of nervous structures present in the optical paths, at different centers from those deputies to the vision. It is from these studies that we have come to the current norms that provide adequate levels of natural lighting in confined spaces, and therefore also in working environments. In fact, from these first observations, the researches have developed in many directions, gathering data demonstrating the presence, in many animal species and humans, of a complex neuro-endocrine system in which the pineal gland plays a primary role and appears to be the ability to acquire information about the environmental light conditions so that they can adapt to them many physiological and behavioral activities.
The pineal gland, or epiphysis in humans weighs about a tenth of a gram and is placed at the intersection of the two cerebral hemispheres on the floor of the third ventricle; It, despite being partially calcified at puberty, maintains an endocrine activity throughout the course of life. In mammals the pineal is no longer directly sensitive to light, as occurs in the lower vertebrates, in which the "third eye" is called, but assumes the role of a *neuro transducer endocrine* capable of converting the nervous input coming from the retina into a output consisting of hormonal substances, the most studied of which is *melatonin*.

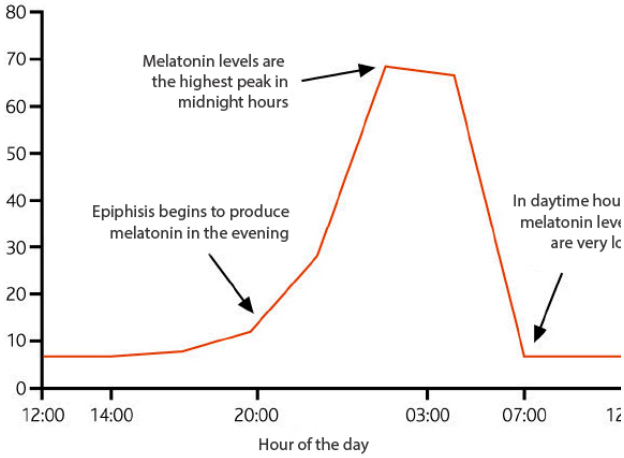

Figure 4.

Melatonin levels in the 24 hours (http://ghiandolapineale.blogspot.it)

Melatonin has a circadian rhythm characterized by high night levels, with peak amplitude at 2 am and low daytime levels (Fig.4). Melatonin synthesis times and rhythms seem to be determined by the integration of two factors: the first is light-dark alternation, while the second appears to be self-generated by an endogenous system. The latter should normally be subordinate to the previous one, but can be activated if, for environmental anomalies or of another nature, the first is less. Numerous studies have shown that light inhibits night-time melatonin secretion in all animal species to be studied, including humans. In particular, human studies seem to show that for our species we need higher light levels than other mammals because of inhibition of pineal activity. From these studies it

emerges that the light produced by fluorescent lamps similar to the solar spectrum, with illumination values of 500 lux - which is the average illumination found in most offices and homes - does not inhibit the night-time secretion of Melatonin, while a light of 2.500 lux, that is equal to measurable illumination near a window of a clear summer day, has a marked inhibitory effect; Intermediate values (1.500 lux) seem to cause an intermediate inhibitior.
Some data also suggest that the body's response to light is closely related to its previous light exposure story.
Melatonin and alterations of the circadian rhythms
It is well known that there is a pathology of circadian rhythms defined as *Jet Lag Syndrome*: it occurs in subjects transcontinental air travel that involve a marked change in time zone and consists of disorders of sleep and of the psychic sphere such as irritability, fatigue and decreased psychomotor performance.
In conclusion, it is possible to say that the already proven existence in the man of extra-visual effects of light, mediated optical pathways gives Labor Medicine a new area of study and research of great interest for a better understanding of the effects that professional activities, carried out under low or no exposure to natural light, can cause the operator to metabolic rate. Furthermore, for artificial light, in some studies (Baron, 1992), subjects exposed to warm white light reported stronger preferences for resolving conflicts through avoidance than subjects exposed to cool-white light.

8. CONCLUSION

In the design of office spaces, the general objective must be to be able to achieve a new working environment relationship; A ratio in which optimal balance is always sought in terms of igrothermal, acoustic and luminous comfort conditions, without noting that the psychological and sociological component plays an important role among the environmental factors, and this significantly interferes with the conditions of physiological comfort (Lepore, 2004). As we have seen, the natural light / artificial light is closely tied to this. If it is true that artificial light with minor control problems is also true that depriving natural light, as well as causing the lack of a real, concrete energy saving, ultimately results in an extremely dangerous and damaging decision from the point of view of a psycho-physical balance of a man working at his workplace for eight hours a day. In fact, the need for man to remain stable, at all times of his working day, the relationship with the outside, with the other by himself, with the dynamic fluidity of life with which he can continue to tune in from the windows of their work space

REFERENCES

Baron R.A., Rea M.S., Daniels S.G. Effects of indoor lighting (illuminance and spectral distribution) on the performance of cognitive tasks and interpersonal behavior, The potential mediating role of positive affects. Motivation and Emotion, 16:1, Springer New York, USA. 1992.

Carver C. S. Attention and self-regulation: A control-theory approach to human behavior, Springer-Verlag, New York, USA. 1981.

Canazei M., Dehoff P., Staggl S. e Pohl W. Effects of dynamic ambient lighting on female permanent morning shift workers, Lighting Research & Technology, vol 46, iusse 2, pp. 140-156. 2014.

Ebermaier C. Saggio storico della luce in riguardo alla sua influenza sulla complessa natura e particolarmente sul corpo umano oltre alla visione, Giustino Pasquali, Venezia. 1805.

Galasiu, A. D. and J. A. Veitch. Occupant Preferences and Satisfaction with the Luminous Environment and Control Systems in Daylit Offices: Energy and Buildings. 38: 728–742. 2006.

Lepore M. Evoluzione dello spazio ufficio nell'era della "information technology", Aracne, Roma. 2004.

Origlia G. Abitare l'ufficio: percezione e ambiente, (prima parte), in Habitat Ufficio n°42. 1990.

INSIGHTS

Fuller, M. Concept and practice of architectural daylighting, Van Nostrand Reinhold Company Inc., New York. 1985.

Heerwagen J.H. ,Heerwagen D.R., Lighting and psychological comfort, Lighting Design and Application 16 (4).1986.

Origlia G. Abitare l'ufficio: la psicologia dell'ambiente di lavoro, in Habitat Ufficio n°43. 1990.

Piccoli B., ed altri, Effetti extra visivi della luce, in Edifici Intelligenti n°3. 1994.

Raiteri S. Ambiente luminoso e parametri socioculturali, in Office Lay-out n°52. 1993.

Reinhart, C., J. Mardaljevic, and Z. Rogers. Dynamic Daylight Performance Metrics for Sustainable Building Design. National Research Council Canada. 2006.

Rogora, A. Il progetto illuminato, in Modulo n°191.1993.

Scuri P. Vederci non basta, in Costruire n°135. 1994.

Slater, Lighting controls in offices: How to improve occupant comfort and energy efficiency, in: Proceedings of the CIBSE National Lighting Conference, Bath, London, UK: CIBSE,, pp. 178–184. 1996.

Tuaycharoen, N. and P.R. Tregenza . View and Discomfort Glare from Windows. Lighting Research and Technology, 39: 185–200.

Veitch J.A., Psychological processes influencing lighting quality, Journal of the Illuminating Engineering Society 30 (1). 2001.

Zelenay, K., Perepelitza M. and Lehrer D., High-Performance Facades: Design Strategies and Applications in North America and Northern Europe. California Energy Commission 51. 2011.