

Complex ergonomic subsystem management on workplaces from point of light climate view

Abstract. This paper is about definition of complex light climate requirements in the work places from ergonomic point of view. Mutual interactions of each component of work system are showed and described in algorithm scheme. Manager approaches to the solution of optimal light climate on the workplaces are stressed.

Streszczenie. W artykule zdefiniowano wymagania klimatu świetlnego w miejscu pracy biorąc pod uwagę aspekty ergonomii. Pokazano wzajemne powiązania komponentów systemu oraz przedstawiono schemat algorytmu. (Kompleksowa organizacja miejsca pracy uwzględniająca aspekty ergonomiczne oświetlenia)

Keywords: light climate, ergonomics, system approach.

Słowa kluczowe: klimat świetlny, ergonomia.

Introduction

Ergonomics is interdisciplinary science that deals about optimization of human activity in the work process. Within ergonomics system, multiple subsystems are acting to the final fulfillment of the work task by the worker in the given working environment. Partial component of working environment is also influence of the non-ionization radiation, which produces light climate on the workplace.

Definition of working environment is a matter of interest for management support systems in area of quality, environment, occupational health and work safety. It can be considered as a common ground for integrated management systems. Due to the mentioned fact a system could be processed into one integrated manual of separately. There are two demands on working environment quality [1]:

- requests for the conditions that are essential for proper completion of product (e.g. cleanliness, microclimate for special technologies etc.)

- requests for conditions that are necessary for workers to conduct their work properly (e.g. light climate, order, necessary tools and equipment, etc.).

Light in its natural, artificial or combined form is very important for health, comfort and safety of the worker during fulfillment of work tasks. Projection process, implementation and operation of workplaces can not be linked just with fulfillment of technical requirements to the light as stable state. It is dynamic process, mainly in the stage of operation (e.g. production and services) that changes in the time.

The goal of this article is to define ergonomics subsystem of the light climate on the workplace with stress to the manager approaches.

Reasons for operation assessment of the light climate on the workplaces

Solving of the light conditions on the workplaces in the various stages of workplace lifecycle is qualified by changes. Causes of these changes in the stage of operation (after final building approval) are following: [2]

1. Differences in compare with projected solution occur (change of the construction components, colors, type of the light sources, etc.)

2. There is a change of interior on the workplaces (change of interior equipment, furnishing – shape, shielding, color, layout of the workplaces)

3. Changes made in the exterior can influence amount of daylight in the interior (surrounding buildings in the area, clerestory, etc.)

4. Light climate changes are also connected with process control of facility management – building administration, maintenance, cleanness, etc.

5. Changes related to worker, changes of work tasks without appropriate modification in the light climate, flexible production

6. Changes of the worker itself (sensorial changes related to the worker's age, health etc.)

7. Not respecting of individual characteristics of the worker and shielding by its own body – differences in the light distribution requirements for right and left handed workers.

Above mentioned changes and their impacts to the light climate of the workplace are often solved just in the projecting stage and very often there is no verification of the real values (e.g. measurements of daylight). In order to create general system of light climate control on the workplace, following algorithm has been proposed.

Algorithm of ergonomic light climate subsystem of the workplace

To create general algorithm of ergonomic light climate subsystem in the company, individual approach to the each work place needs have to be applied. This means that every work place and work task in relation to the worker have to fulfill individual ergonomic requirements. Mathematically ergonomic subsystem can be expressed as sum of each partial subsystem [3]:

$$(1) ESS_{LC,F} = \sum ESS_{LC,WE} = \sum \sum ESS_{LC,WP}$$

where $ESS_{LC,F}$ – is overall ergonomic light climate subsystem of the company, $ESS_{LC,WE}$ – ergonomic light climate subsystem of the working environment, $ESS_{LC,WP}$ – ergonomic light climate subsystem of the workplace.

Principle of individualization could in practice bring complexity and high costs. Within simplification of operation and light climate on the workplace it is necessary to:

- find common, joint solutions for similar groups of work tasks (grade of work) and sort them on one workplace if it can be technologically applicable. On such workplaces it is appropriate to provide light e.g. by biodynamic systems ,
- allow individual solutions on the workplace (additional lighting, shielding, regulation of light intensity, etc.),
- create areas for resting also from visual aspect, it means there, where work task is carried out under artificial light, resting should be under daylight conditions. In other words, suitable is change of the light with different spectrums,

- it is suitable for visual heavy works to avoid sensorial fatigue by use various work techniques (job rotation, job enrichment) and change or rotate workplaces,
- secure visual contact not just from inside but into exterior, where is it possible.

Proposed algorithm on the Fig. 1 is oriented to the human – worker as dominant part of the work system. Subsystem of the light climate should create conditions for optimal fulfillment of the work tasks by employee.

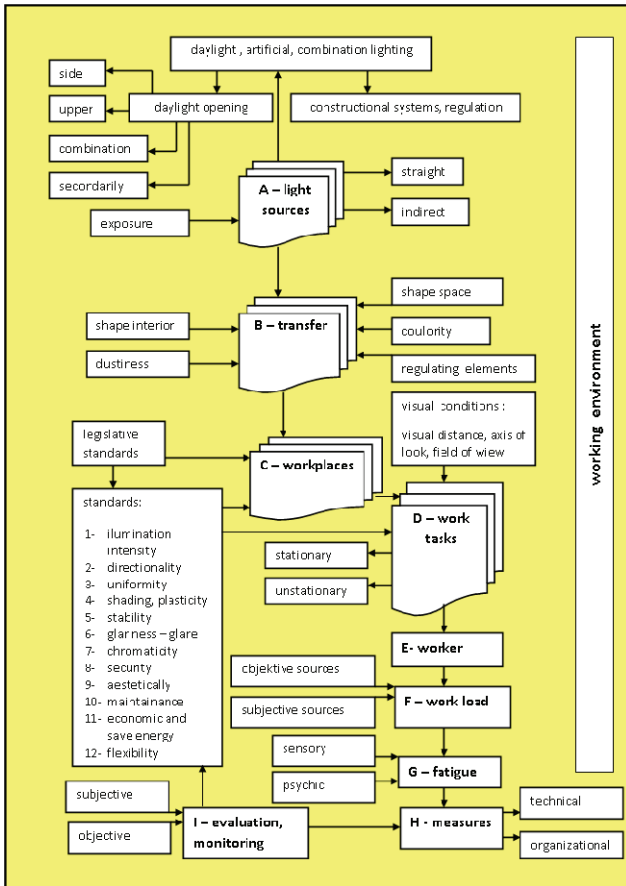


Fig.1 Example of general algorithm of light climate subsystem in workplace [2,4]

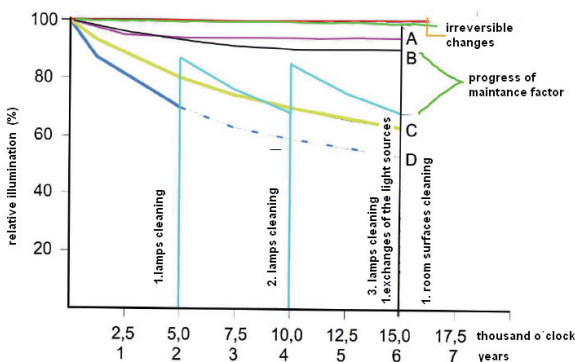


Fig.2 Changes of lighting in progress of durability system [5]

On the figure no.1, there are 12 legislative standards for light climate on workplace. It is necessary to analyze each of them – for example, it is necessary to evaluate illumination intensity for daylight, artificial and combinative lighting. At the artificial lighting, there is a demand to achieve maintain lighting E_m (lx) according to requirements

of European norm for given job. It is influenced by cleanness and servicing of lights according to their durability – figure no.2.

Process of working environment evaluation in dependence on light climate

Systematic approach to evaluation of work environment in dependence on environmental factors gives the user a guide for solution of existing and future affairs. During the working environment purposal stage user approach is very important since individual experiences of employees allow to avoid half-measures and non-optimal solutions. Due to the mentioned fact an algorithm in Fig.3 depicts possibilities of individual employees participation on different phases of work environment evaluation.

Aim of the presented evaluation is to secure the cyclic monitoring and improvement of processes from identification of risks (of environmental factors inside the workplace) up to realization phase.

Process participants participate by following actions [6]:

a/ employer :

- ✓ provides measurements and evaluation of environmental factors (noise, vibration, light, dust, chemical factors etc.) by own resources or by outsourcing (by authorized persons and organizations) or a combination of both. Before beginning of measurements the time schedules for individual professions are created and conditions for regular evaluation outcome are secured. Presence of direct superior and labour union representative is essential during the measurement.

- ✓ registers individual measurement protocols of environmental factors ,

- ✓ registers the technical and organizational measures conducted for improvement of work environment and achieved results,

- ✓ develops proposals for internal management documentation in appropriate area ,

- ✓ cooperates with individual departments and company medic during the evaluation of health risks,

- ✓ cooperates with regional Public health organization (sanitarian) during the implementation of new methods of measurements and evaluation of work environment factors, categorization and occupational illness investigation,

- ✓ follows the legislation and internal management documentation takes part in education and consulting courses in scope of work environment factors impact.

b/ employees :

- ✓ cooperate on measurements and time schedule design during the work shift ,

- ✓ take part in proposal for improvement of environmental factors,

- ✓ follow the internal regulation, safety measures a appropriately use the protection accessories,

- ✓ take part in subjective evaluation (questionnaires),

c/ expert team (authorized persons, company medic, national health authorities etc.):

- ✓ take part in different measures by request of employer,

- ✓ conduct risk factors control personally if appropriate state regulation is issued.

Evaluation system specifics are determined by specific company conditions which will implement the system and processing methods. They could be classified at two distinct levels:

1. at the content level:

- system is adjusted for two subprocesses: process monitoring and analysis of environment condition data (aim for reduction of costs in production process) and process of work environment evaluation in relation to environmental

factors (aimed for improvement of health, safety and wellbeing of employees at the workplace) ,

- system works at one level only or it is not defined as all and it should be implemented,
 - system should be periodically verified following the updated legislation for work environment,
 - system will function properly if feedback is secured to analyze the impact on production process (equipment and workforce),
 - system should positively influence the economical results of the company,
2. at the formal level:
- exact methodology is not defined, therefore many realized processes in the mentioned area are different not only in content but also in formal way,
 - responsibility for realization of mentioned process depends on organizational structure of the company.

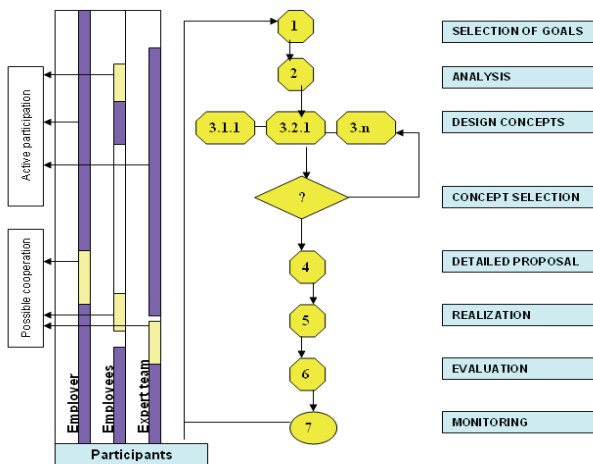


Fig.3 Common algorithm of work environment evaluation system



Fig.4. An example of work space shielding by the mass of diagnostic machine

Economical effects of health and safe working environment in companies are presented mathematically follows:

$$\text{A: health and safety for uninterrupted shifts} = \frac{\text{B: costs of health and safety}}{\text{C: number of interrupted shifts}}$$

Presented relation A (e.g. for monthly or annual time period) is possible to update with:

- include personal costs into the B - value if risk occupation is involved and refund should be paid,
- include personal into B -value if occupational illness is involved caused by environmental factors,
- employee inoperability is projected to the C- value if substitution is not found.

Conclusion

The need of continual monitoring and assessment of the light climate is stressed in this system approach by use of measurements or by assessment of the worker's health condition. Assessment has to be carried out after each 7 above mentioned changes. During periods in-between it is suitable to monitor eyesight of the workers by doctor and evaluate sensorial load by use of questioners – subjective assessment. Mentioned ergonomic subsystem should be examined also from worker position and movements towards light sources to ensure that shielding of the light is not happening during the work task (by own body or technology).

Manager approaches in this area should be focused on:

- inspection of technological state of transparent constructions and light systems,
- preventive maintenance of the light systems and cleanness of the light systems, windows and work places,
- informing of the workers with sensorial work risks,
- continual monitoring of the light climate quality and taking measurements for its optimization and save energy.[8]

The outcome effect should be satisfaction of the employees with the work environment and achievement of required work tasks with acceptable health risks.

Mentioned system has to be elaborated to the specific conditions and should be implemented into ISO 9000, 14000 and 18000 quality systems within integral management systems in the particular company.

REFERENCES

- [1] Veber, J. a kol.: Řízení jakosti a ochrana spotřebitele, *Grada publishing 2002*, p.26
- [2] Flímel M., Systémové hodnotenie osvetlenia pracovísk denným svetlom, *Inovace (2009) nr 3*, p.22 - 25
- [3] Flímel, M., Ergonomics and system approach to the light climate on workplaces, *Illrd Conference of the Visegrad Countries on Lighting LUMEN V4*, Brno 2010, p.36-37,
- [4] Chundela L , Ergonomie, *ČVUT Praha (2005)*
- [5] Gašparovský D.,Mácha, M.: Zmena fotometrických vlastností svietidiel v dôsledku znečistenia prostredím, *Illrd Conference of the Visegrad Countries on Lighting LUMEN V4*, Brno 2010, p.45,
- [6] Flímel M. Špecifiká tvorby systému hodnotenia pracovného prostredia vo vzťahu k faktorom prostredia, in:conf. Svetový deň kvality 2006, p.163-168,
- [7] Quality of the working environment and productivity, Europa Agency for Safety and Health at Work, 2004, p.16,
- [8] Darula S., Gašparovský D.,Denné osvetlenie v budovách: Posúdenie podľa STN 73 0580 a STN EN 15 193., *Projekt a stavba 1-2*, (2008), p.27 - 34.

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