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FLEXIBLE OFFICE ENVIRONMENT: PSYCHOLOGICAL AND ERGONOMIC REQUIREMENTS FOR DESIGN LANDSCAPE OFFICE

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Abstract

This paper reports on a longitudinal research carried out in landscape office environment. The basic goal of the survey was to support the work of internal designers and architects responsible for the new central office of MATÁV Rt. Hungarian Telecommunication Company at 55 Krisztina, Budapest.

The paradigm of interaction between humans and their environment is the core of research both in ergonomics and environmental psychology, recently. These overlapping disciplines provided theoretical and methodological basis for the 3 years overarching research.

Work efficiency and well being or satisfaction of employees are the most important outcomes of the working activities in offices. Effects moderating them are of two types. Motives such as Performance, Appreciation of individual performance, the Work itself, Responsibility and Development have direct influence on efficiency and satisfaction. Hygiene factors as Leadership style, Status, Work safety and Work environment have negative effect in case of dissatisfaction, however, do not result higher level of performance and enhanced well being otherwise [1]. Taking into consideration the role of hygiene factors in the motivation system at workplaces environment is often a neglected area of investors' field of interest.

The key of the counter-relation between performance, well being and hygiene factors is attention. Given the limited capacities of information processing of humans, environmental stimuli stemming from inadequate Lighting, Temperature and Climate, Noise, Furniture and Working Chair reduce mental resources to be devoted to the working task itself.

Other aspect of the stimuli control is the basic need of being alone, that is privacy. In open office environments this aspect often leads to dissatisfaction because of the nature of these settings.

The longitudinal research covered all the above mentioned variables of the system of working environments by use of individual and group interview and questionnaire techniques and served as design guide in the subsequent steps.

To sum up the experiences of the three-year work it is also necessary to mention that cooperation between representatives of disciplines like architecture, ergonomics and psychology the approach and general aim of building design has gained a more versatile and colourful feature that as contributors hope leads to good working performance and satisfaction amongst all employees working in the new offices.

Keywords: ergonomics, environmental psychology, offices, participation, user satisfaction.

1. Research on Environmental Psychology

Environmental psychology examines the relation between the sociophysical environment and human behaviour. This field of research is a new area at the university, however, research traditions like ergonomics and architecture provide an experimental basis from the very beginning.

The current elements of environmental psychology are overarching a relatively wide range in the professional literature [2]:

1. Attention: understanding how people notice their environment, including voluntary and involuntary perception of stimuli.
2. Cognitive maps: learning how people image the natural and built environments.
3. Preferred environments: determining what make people seek out certain places where they feel comfort and confident.
4. Environmental stress and coping: defining stress as failure of preference, mapping what factors of environment contribute to fatigue, illness, diminished altruism and criminality.
5. Participation: enhancing citizen involvement in environmental design and management.
6. Conservation behaviour: bringing psychological knowledge to develop an economically sustainable society.

The paradigm system of environmental psychology fits well with the borderline of ergonomics. Especially Preferred environments and Environmental stress and coping have their origins within the discipline of ergonomics. However, at this point it is important to refine the figure. Ergonomics is dealing mainly with measurable aspects of environment (for instance measuring lighting, noise and anthropometrics) while environmental psychology aims to map the softer attributes of environmental perception.

In the spirit of these ambitions research program has launched on working environments.

2. Background of Research

In co-operation with MATÁV Hungarian Telecommunications Company a longitudinal research serial is being conducted on working conditions in open office environment since 1996. The aim of the research program is to map the effects stemming from work environment that contribute to and modify the perceived well being of employees in these environmental settings.

As Herzberg's basic theory on work motivation [1] indicates, there are two kinds of effects that modulate employees' feelings and attitudes towards their jobs. In one hand **Motivators** operate on the 'the more the better' principle. That is,

in case the Working task, the Responsibilities of the Possibilities for development grow, there is a positive outcome in workers' behaviour.

On the other hand, **Hygiene** factors only cause negative satisfaction. In the case everything is fine with the Leadership style, the Relationship between colleagues, Status safety and Work environment, it has no enhancing effect on performance and satisfaction (*Table 1*).

Table 1. Herzberg's two factors theory on work motivation

Motivators	Hygiene factors
Performance	Leadership style
Acceptance of individual performance	Employment policies
The working task	Working environment
Responsibility	Social relation with superiors and peers
Possibilities of development	Status
	Work safety
	Individual work related characteristics

In these circumstances it seems to be reasonable to make improvements and enrichment on the Motivations so to create more pleasure and stimulating working conditions. As examples show the Hygiene factors are only taken into consideration when serious complaints have appeared spontaneously.

Open office or **landscape office** are generic terms, referring to all those working environments that are designed for both traditional paper based and computerised office working activity to be done in large rooms for more than 6 persons.

The preference for open offices to traditional ones is first of all due to economical reasons. The growth of the role of the **service sector** has resulted consequences in change of structure of employment as well. Following the well known pattern of increasing rate of office workers in western European countries, the phenomenon has appeared in our country recently.

Second, in most cases workers familiar with to traditional working tasks and conditions face challenges of **new technology**. Computer networks, shared working tasks via use of Internet and Intranet allow to provide more flexible services, especially within the field of telecommunication. For instance client service has new meaning, e.g. users use their phone devices or PC equipment to arrange modifications in their personal contract, to order further services and even new line can be hired on-line.

The third reason is appearance of **multinational organisation cultures**. The notion refers to the collection of written and hidden rules of a certain firm or organisation. This set of rules helps the normal daily operation of the company, determines the interpersonal relations between employees of different and identical levels of the hierarchy and contains the unspoken working norms of the firm. Entering the firm new employees usually feel boundaries of the organisational culture in the climate.

Multinational companies are pressed to implement their cultures and standards on the local context using open offices as mediators for the changes desired. This environmental change is believed to support adjustment to the modern standards of working style and behaviour.

3. Effects on Users

Working in open offices leads to the need of learning new behavioural norms like appreciation of claim to privacy of colleagues, communication and work in public and adjustment to the group norms in general.

General experience is that simply the **idea of moving** to open office implies modifications in perception in working conditions. The value of traditional settings is increasing and persistence against open offices grows.

New ways of **change of information** instead of face-to-face communication result weaker competencies either on technical or on interpersonal level. One may lack experience of use of computers, has difficulties in handling E-mail programs or is unable to perform a data search on a digital database. Others talk on the phone extremely loud loudly in public or lead intimate conversations that can be overheard from the neighbourhood.

The **structure of hierarchical cues** is changing as well. Workers in higher positions usually possess separated individual workplaces, however, in open offices these boxes are only auditorily but not visually separated. That is, supervisors may feel to be under observation by employees. Location of individual workplaces may result distortions, too. For example having a working table in the corner, far from main internal traffic routes are more popular than those located right near the coffee machine or back to the door [3].

4. Role of Privacy

The basic idea of designing open offices has been built on the assumption that the stronger the supervision is the better employees perform their tasks. However, this used to be a valid statement, more recent studies falsified the thesis.

The key to efficiency is attention. Experiments show there is an optimal level of attention for each working task. In case lack of stimuli we feel monotony and get sleepy (for example driving a car in a long straight low traffic highway). In case of over-stimulation collapse of behaviour occurs (for instance feeling being blocked at exams) (*Fig. 1*).

Environmental stimuli bring about changes in the system responsible for the mechanism of attention in the brain. This mechanism operates by the principle of additivity,e.g. stimuli of environment and the working task together result the general level of excitement of brain. The richer the environment in stimuli the less resources are available for conducting the work task.

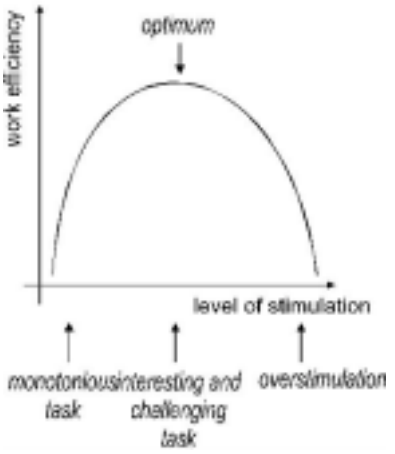

Fig. 1. Interdependence between stimulation and working performance

Considering two types of office work like stamping documents or composing a letter by the computer, the former is less demanding than the latter one, therefore it requires less attention resources. To make an employee feel comfortable, more environmental stimuli in the first case, less in the second case are beneficial.

In open office working situations, tasks to be performed are sophisticated and difficult, and attention demanding. At the same time environmental stimuli bomb employees' senses and brain, either sense of perception (increased noise level for example) or socially (being in a closed room together with other employees). This coincidence results in extra stimulation and can lead to decreased working performance and disorganised behaviour.

To sum up the lesson of attention resources, given the increased complexity of office work recently, open offices must be designed to ensure as much separation and privacy as possible.

5. Aim of Research

The reconstruction work of MATÁV central office between 1996 and 1999 required contribution of different professional areas like designers, architects, psychologists and ergonomic experts working together as a team. The basic idea was to map advantages and disadvantages of open offices and provide assistance to internal architects in order to create healthy, comfortable and work supporting conditions in the new office building.

The sub-tasks were the following:

– To gain information on what workers think about these offices.

– To find out whether individuals and groups think in the same way about landscape offices.

– To collect suggestions for further improvements with special attention to the ergonomics of the workplace.

– To change attitudes towards open offices if it is needed.

6. Method of Research

Longitudinal research methods have been used to follow the changes in opinions.

A pilot study based on interview techniques has been carried out first to find out the basic values related to offices ($N = 20$).

A questionnaire-based survey aiming at comparison between three open office environments was carried out to get information on what factors determine the overall evaluation of work settings ($N = 107$).

Detailed questionnaire and a focus group have been used for making an in-depth survey on the individual and group demands regarding the expectations towards the new central office building ($N = 428$).

After the design phase different versions of furniture have been compared. Members of a focus group have developed a system of criteria for evaluating office furniture. The criteria were different for operative, clerical and management positions. Comparison has been made between different versions by ranking furniture. Results of a parallel expert evaluation have been compared to that of the focus group and the best option has been chosen by taking into consideration the results of both groups.

After moving back to the reconstructed building, a post-occupancy evaluation has taken place to learn if workers are satisfied with the working conditions and if the new offices fulfil the initial expectations (*Fig. 2*).

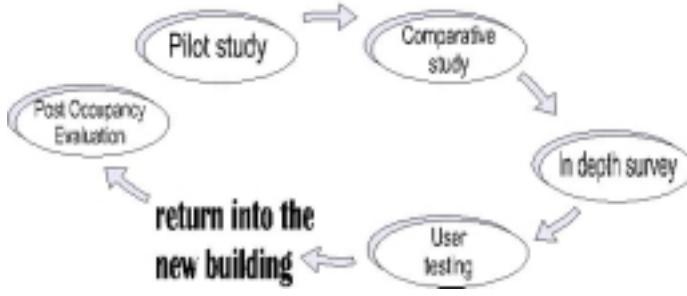

Fig. 2. Steps of the research program

7. Main Findings and Conclusions

7.1. Pilot Study

The serial of interviews was the first facing of research team with open offices. Although the characteristics of the particular building which was in focus in this case are worse on average, than the ones of those being under examination later on, the experiences lead to general conclusions.

Employees working in open offices are operative staff members in general. Given their subordinate position in the hierarchy of the firm, their tasks are mainly traditional paper-based work, computer-based data processing and client service. Except the first type of work activity, use of PC and other technology related devices are common. Team work was also found to have an important role.

By literature reviews and interview-based data collection advantages and disadvantages of open offices have been set to a system (*Table 2*).

Table 2. SWOT analysis on landscape offices

Advantages	Disadvantages
– decreased costs of cleaning and maintenance	– decreased privacy
– in case of simple tasks effect of social facilitation	– increased noise
– efficiency of use of space	– safe of properties

As figures show, there is a conflicting interest between employees and employers. Open offices are beneficial for the organisation and lead to worse working situation for the operative staff.

Regarding questions related to general ergonomic factors, like Furniture, Working chair, Lighting, Climate and Air temperature and Noise, respondents seemed to be dissatisfied with their working situations in all. Especially the results of climate and lighting proved to be the most determining factors of overall satisfaction.

This survey highlighted those ambiguities that have been found in each latter survey. There was a huge discrepancy between the interest of the organisation and that of employees. The more the building has been suited to the demands of the company, the more likely the individuals are dissatisfied with it.

7.2. Comparative Survey

In order to review the results of the previous examination, a comparison has been made between three different open office settings. The questionnaire method was used.

The aim of this survey was to make ergonomic assessment on each experimental site, and to check, if results of role of lighting and climate are identical independently from local characteristics.

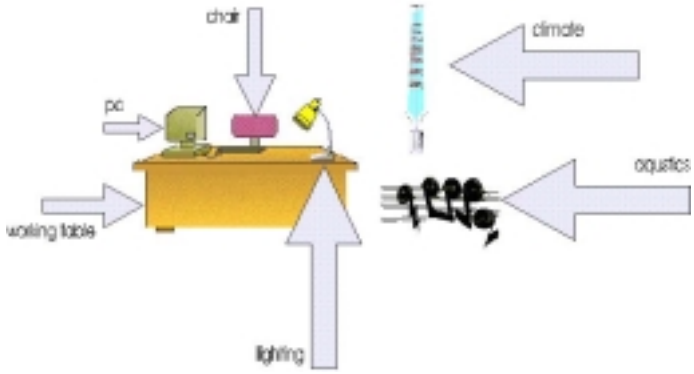

Fig. 3. Factors contributing to overall satisfaction

Results highlighted a complex evaluation mechanism involved in perception of environment (*Fig. 3*). The system of environmental factors is built on three main groups of effects. The strongest influence on overall satisfaction has fixed or built elements of the environment. These are Climate, Noise and Lighting. Special feature of these is that they are high cost and difficult to modify systems. In case changes are needed in one of them, high investments must be made.

The second contributing factor was mobile elements of environment like working table, furniture and chair. Given their relative lower prices, modification can be made with less effort following needs of users.

Third class of the system is contribution of computer to the overall satisfaction. Results show, this factor is considered as working tool rather than part of the environment.

These findings are identical to other surveys done on perception of and satisfaction with working environment [4].

Comparison between different sites pointed out an interesting phenomenon. Namely, the principle of weakest element of change is valid in case of office environment as well. Thus, one element of environment that had proved to be less satisfying than others, results lower rating in evaluation in general. For example, despite of the fact that one office was equipped with the latest technology, the overall satisfaction was totally different between levels of the building. The explanation was the quality of the working chair. That is, those workers who had old fashioned wooden working chair rated their environment much below to those having modern and comfortable seating.

This finding had proved to be an important one. The lesson investors must learn is that the environment results the best satisfaction if its elements are designed to a general common level of satisfaction. Of course, one can say, it is extremely

difficult to determine what this notion means, but designers have nothing else to do in this case than use their experience and common sense [5].

7.3. In Depth Survey

The next step of the longitudinal study was to make a more detailed survey, focusing on individual and group demands related to their new working place.

A set of questions regarding working activities has been put. Answers resulted a sequence of likelihood of mentioning work types as first or second most important ones (*Table 3*).

Table 3. Types of working activities ranked

Type of work	Likelihood rate
Computer based work	72.6%
Paperwork	53.1%
Teamwork and meetings	29.5%
Work activity outside of the building	7.6%
Face-to-face client service	3.3%
Communication via phone	26.7%
Teamwork by use of computer networks	4.0%

The most astonishing answers are related to rates of Computer based work and Paper work. The high rate of paperwork is parallel to the results of rates of computerised work. Figures show that although each employee has computer access at his or her working table, about two third of them do not use it regularly at work.

Phone and mobile communication have also special importance. Given the free use of the national network of MATÁV, this type of communication is very popular amongst employees.

Modern forms of work like computer based teamwork have proved to have moderate but already measurable importance.

As regards mapping individual and group demands in the same system, the aim was to filter those of them, that are of special in terms of comfort and efficiency. Cluster analysis pointed out two dimensions that are exceptional in both evaluations. These are natural lighting and smoking.

Special role of lighting in harmony with result of the pilot study confirmed the appropriateness of the ambition of creating as much working places as possible located in the naturally lighted zone. Spreading of naturally lighted zone by opening extra windows has also been a practical implication of the survey.

In accordance with smoking, it proved to be either to smokers or non-smokers of special importance. Rate of smoking employees also surprised designers. Obviously, amongst workers of the new building there were much less smokers than

the national average. This phenomenon might be due to the fact that most of the workers are well educated and take good care about their health in general. Therefore designers made revision on the initial plans and created closed dining rooms for smokers taking into consideration the exact number of smokers.

Detailed questions had focused on individual and group demands such as accessories of working table (separators, keyboard holder, etc.), habits of usage of archives, making photocopies, sending fax and attitude towards teleworking. These result has been used by designers in the latest phase of planning.

7.4. Testing Furniture

It is well known that a new workplace cannot meet the different needs of all the users, but **the higher** the level of their **participation** is in the design and implementation phases **the higher** is their average **satisfaction**. The wide range of office furniture in price and in quality makes it difficult to find the proper desk and chair that fits to the current tasks, to the image of the firm, and at the same time to the budget, and nevertheless, are accepted by users. From this point the economic aspects will be ignored nd the recent chapter focuses on methods of evaluation of ergonomic quality of office furniture, first of all the chair.

Although the chairs are supposed to serve for long, thus the long term characteristics would be taken into consideration, too, usually only a short time is available to make a decision. The 'pilot site' is a sophisticated long term method to support the supplier strategy, the other methods below are immediate to help the current investment.

The 'focus group' method should be used when users are involved in the quick evaluation, otherwise computer supported databases and evaluation forms help the work of the experts.

In case of **'Pilot site' methods** users have time enough and possibility to get familiar with the characteristics of the chairs and desks to be evaluated, and their deep knowledge enables them to count with the long term effects of usage in the selection phase. Main steps are the following:

- **Selection of chairs and desks** to evaluate. It is the responsibility of human factor specialists that these elements meet a minimal level of ergonomic quality.
- **Build up a sample work place**. The selected furniture is to be arranged in the site identical to the future work situation. This test site consists of several individual workplaces but has an eclectic feature since there are no two identical chairs or desks amongst them.
- Working phase. A sample group of users are to **work in the test site**, their job is the same in case of each furniture: evaluation. Users occupy the workplaces randomly so each test person works a couple of days at every site.
- Evaluation phase. Each test user picks the best chair and desk, and the distribution of the answers indicates the preference structure of the group.

The **advantages** of this method are that (a) can handle the durability components, (b) refers to the real work activity, (c) the selection based on overall opinions so there's no need of manipulating with scores and weights, (d) since it's a comparison of products it gives a direct guide to the investment.

By use of **'Focus group' method** the preferences of a group of potential users can be scanned through and only a few elements of office furniture can be evaluated and compared by them. Workers meet the product only for a short period of time, thus long-term factors must be ignored or estimated. Main steps are:

- **Selection** of the focus group. It is important to make a representative sampling considering gender, age, job, positions in the organisation, etc.
- **Lesson**. The participants' ergonomic knowledge should be developed to raise the reliability of their judgements. The at least one-hour course covers the basics of anatomy of sitting, anthropometrics, product ergonomics and characteristics of office work.
- **Setting system of criteria**. Following the lesson the participants collect the most important dimensions of use of a particular product family together by for instance a brain storming session. It is advisable to keep the number of dimensions between ten and twenty.
- **Weighting**. Every participant weights the importance of the criteria, the averaged weights refer to group preferences. The range of importance should be from 1 meaning 'it has no impact on the safe, comfortable, healthy work at all' to 5 meaning 'its impact on the safe, comfortable, healthy work is very high'.
- **Scoring**. The second meeting of test users takes place on the test site where the furniture applied for the tender is arranged like in the 'pilot site' method. In the first hour, participants become familiar with the furniture, afterwards all score independently the furniture by a scoring leaflet criterion by criterion. The range of satisfaction should be from 1 meaning 'the product seems to be very poor according to the dimension' to 5 meaning 'the product seems to be perfect according to the dimension'.
- **Summary**. The average satisfaction, indexes, and ranks are to be computed with or without taking weights of importance into consideration, then the results can be presented in a box-plot for a single or for all the products evaluated.
- **Decision**. The board of representatives of investors analyses the results and makes the final decision considering other factors like financial, too. Participants must get feedback and be assured that the opinion of the focus group had a main role in the final decision.

The **advantages** of this method are: (1) it is fast and can be done with contribution of less than 20 participants, (2) compares the products in detail, (3) refers to the preferences of the focus group, (4) has an impressive result (*Fig. 4*).

Summarising some 'focus group' criteria several common dimensions related to office furniture can be identified. A 'evaluation form' is created by these and

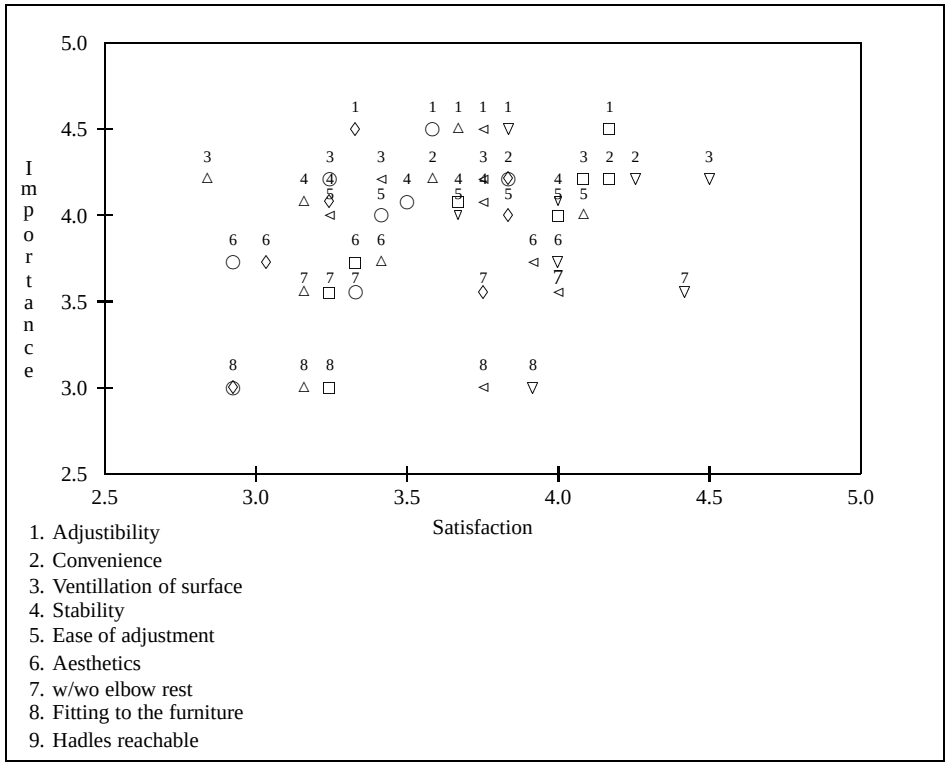

Fig. 4. Importance – satisfaction box plot of a chair

the former test users can become experienced with its use by practice, that is their judgement is becoming more reliable by time.

The **'evaluation form'** method requires longer preparation to create a reusable evaluation form and the assessment is fast, reliable and valid. The 'evaluation form' can be used with all the users, with test users or with 'experienced users', but unfortunately in the latter case active participation is missing. The steps are the following:

- **Gathering criteria**. Criteria should be cut into subgroups because the number of the dimensions might exceed a hundred.
- **Weighting**. Like in the 'focus group' method the criterion should have a weight of importance. In this case first the subgroups get a weight, then the dimensions get an internal weight in the subgroups. The weights range from 0 to 1 so the average final weight can be computed in percent by the multiplication of the weight of the subgroup and the internal weight of the criterion.

– **Scoring** is similar to the one shown in the 'focus group' method, but since some of the dimensions are based on technical data (e.g. height, weight of the chair) these scores come from different sources, e.g. measurement, anthropometric models, etc.
– The **summary** is similar to the previous one, but in this case results are between criterion subgroups and within the subgroups. The numeric results should be completed with the enumeration of the weakness and strangeness of the products (*Table 4*).

Table 4. Sample part of an evaluation form

Criterion	Importance	Parameter	Score
Stability	0.12		2.3
Angle of tilt to the side	0.03	21°	2
Angle of tilt to back	0.03	19°	1
Possibility of tilting (the lower ends of the legs are in the same plane)	0.03		3
Slipperiness	0.03		3
Comfortable usage, anthropometric suitability	0.16		4.4
. . .			
No danger of injuries of the user, the environment or the product itself	0.10		4.2
. . .			
Total	1		32

Once the evaluation form is ready the **advantages** are that (1) covers all the possible issues of the product, (2) can be used with users or experts, (3) can be automated with PCs, (4) can be used for different purposes, e.g. ranking the products or making a follow up, (5) can be simplified to a check-list setting all the weights to 1 [6].

7.5. Flexible Office

Before occupying the new central office, the notion of Flexible office was introduced to the workers (*Fig. 5*). The expression refers to the desire of planners that from the very beginning through the daily operation of the new building, it should serve the demands of the organisation [7].

The conception stems from the idea of Intelligent Buildings Group, a team of practitioners and researchers from the UK. Their aim was to determine those factors that contribute to the successful operation of an office building during decades. The

Fig. 5. Logo of campaign Flexible Office

main idea was to learn the main challenges a building has to answer during years of its operation.

The main three factors found are the followings:

1. Organisations change faster than buildings. Life cycle of a firm is about 10 years recently, meaning reorganisations in each decade.
2. The change of the structure of work requires a changing environment.
3. Widespread use of information technology will determine the quality and quantity of work in the next century.

Taking into consideration this prophecy, the structure and the operation of the new building the following are to be included:

1. Service network is being built into the system to provide access to its sub-systems from each point of the rooms.
2. Walls of offices are mobile ones, that is merging or separation of units can be managed by little effort. (These two aspects comprise the core of the LEGO philosophy in architecture.)
3. There are support services available around the clock, including computer network specialist, mechanics and security service.
4. There are new demands existing toward office buildings beyond traditional operation, such as offering worksite health promotion, serving as recreation area, hosting cultural events, nevertheless communicating a firm image and organisational values.
5. Systematic mapping on employees' feeling of comfort, safety and well being by use of questionnaire and interview techniques, twice a year.

Last but not at least there is an important rule in design: to measure what is measurable. That is, environmental factors, such as Lighting, Climate and Noise, have characteristics that can be turned easily into numbers. As for lighting, intensity, homogeneity and spectral analysis can be carried out. Beyond the temperature and humidity of the air, the exact rate of emission by office equipment must be taken into consideration. In case of noise, loudness and spectral carried out before occupation of work places.

The above mentioned effects might have enormous influence on employees' health, especially in long term. Therefore involvement of experts in acoustics, lighting, etc. is necessary.

7.6. Post Occupancy Evaluation

Since the return to the new offices had taken place only two months ago and the occupancy is in progress right now, there is not much to say about this point so far. The team members sum up the experiences gained during the design phase to use then as basic knowledge in the following construction works.

After 6 months operation time, dimensions of services provided by the building, basic ergonomic dimensions and attitudes towards the new working situation are planned to be evaluated.

8. Conclusions

The case of the MATÁV central office was the first opportunity to set up an evaluation system to support the work of building designers.

The main steps to be done are the following:

1. Setting up a research team. The basic goal of this team is to find out the local characteristics of office work and support the work of designers. The team must consist of both local and external staff, engulfing all the professional areas related, like architects, psychologists, experts of architectural mechanics and ergonomics, PR specialists and representatives of investors and employees.
2. Mapping the basic features of structure of work activity, with special attention to the mental demands and group work.
3. Building up a vision of the firm, with representatives of employers, architect involved in order to anticipate the future of offices on two or three decades range. An important aspect is use of information technologies and their role in the life cycle of the organisation. To follow the changes so called LEGO system is to be used.
4. Survey on the recent demands of individuals, groups and the organisation, by traditional methods like interviews, paper and computer based questionnaires.
5. Measuring capacity related demands, like parking places, rate of smokers and file storage, archives.
6. The use of simulation methods is as much as possible to test the work environment and make modifications before occupation if it is necessary. Methods can test furniture and architectural measurements.
7. Post occupancy evaluation to learn to what extent does the new workplace fulfil employees' initial expectations.
8. Parallel to the design process bilateral change of information is necessary. That is, not only gathering information on user demands but providing with the latest results are inevitable. It is impossible to fit a workplace to the firm perfectly, the organisation itself must get adjusted to its work environment. The methods of providing information are identical to those of traditional internal PR.

To sum up the teaching of the three years' work, the most important factors are interdisciplinary co-operation and having a vision about the possible future of work and offices. As this was the first step in this field in the Hungarian context we do hope to meet other such initiations in the coming years.

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