ERGONOMIC REQUIREMENTS AND FURNITURES SPECIALITY OF CLASSROOMS

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Abstract: *The report examines the most important aspects in the furnishing of classrooms in the context of modern ergonomic requirements. Object of the study are furniture and tools in an academic learning environment.*
Classroom is a workplace for both students and teachers. It may be a risk factor that can affect human health and work ability of participants in the process. Improper arrangement of furniture may cause the staff to: suffer injuries, feel fatigue in certain muscles, lose concentration, reduce speed and quality of their work, developing musculoskeletal disorders from awkward postures, etc.
Measurements were made and equipment in the classrooms is analyzed. The results are described and summarized in the report.
In order to enhance the retirement age, health care of people seen through the ergonomics of the furniture of their jobs is a current topic nowadays.

Keywords: ERGONOMY, FURNITURE, CLASSROOMS

1. Introduction

Youth's education is a basic concern of the contemporary society. In the nowadays technological world, awareness and the knowledge reserve are important for the future development of growing young people. Undoubtedly, the way to knowledge is related and passes through the school benches and the university desks.

Subject of the present research is the furniture and the implements in an academic classroom. The term „implement" we shall use to designate all implements necessary for the training – o aids, items, furniture – a chair, a table, a cupboard, a black board, multimedia, computer etc. [1]. All they show considerable influence on concentration, perception and reproduction of the educational material from the training process.

A classroom appears a working place for students and their lecturers. The equipment in those room can be a crucial factor which could influence the health and the performance of the persons participating in the educational process. Upon incorrect choice and arrangement of the working furniture, the following problems may appear:

- Loss of concentration;
- Starting of fatigue and weakness;
- Distraction or need of changing the environment;
- Reduced quality and speed of work;
- Injuries on sharp edges or worn surfaces and/or elements (bolts, nails, clout-nails, wooden particles etc.);
- Injuries from narrow passages, non-designated edges of podiums and stairs, from insufficient space for body extremities etc.

All those factors have complex causers. In this report we will only take a look at the comfort and, respectively, the discomfort of used furniture and the equipment in a conventional classroom..

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The report considers the most important aspects upon furnishing of classrooms with a view to modern ergonomic requirements. Attention is paid to the type of used furniture and their attitude to anthropometric indicators of students. Concerned is the moment of safety from point of view signalling or securing of hazardous edges, angles, providing of sufficient width of transport hallways, analysis of the psychological influence of the arrangement of furniture etc.

2. Peculiarities of the furniture in an academic classroom

Each educational institution is proud of its history, paying the deserved tribute to its founders and ancestors, and marking with pride all its anniversaries. This year, the Technical University – Varna marks its 50th anniversary. Undoubtedly, past year have had their influence on the furniture of classrooms. Fig. 1 and fig. 2 show images of classrooms for lectures and seminars. Traditionally, all „working" places of the students are directed to the white, green or still black board.

Fig. 1. *View of a conventional lecture room*

It is obvious that throughout the years, wooden benches, desks and tables have lost even their good appearance and need renovation.

Fig. 2. *View of a conventional classroom for seminars and laboratory classes for general engineering disciplines*

An auditorium is the place where students spend most of their time during the educational process. Average daily, they spend between 6 and 8 class hours in there. This makes between 4 ½ and 6 astronomic hours. There they listen to lectures, participate in seminars and laboratory exercises, making certain movements for writing, drawing, connecting, measuring etc. In this relation, the hall auditorium appears working place for students and their lecturers.

As per Runge and Manusevich [2] the working place is related to part of the space, where one implements his working activity and spends most of his working time. As per both of them, it is the smallest whole unit of performance and life functions in which there have been three basic elements present: object, means and subject of work. In our case, we determine notebooks, handbooks and textbooks of students as object. Means are the various methods and approaches for demonstration and studying of technical knowledge accumulated by future engineers. Subject of work appears the man– himself, trained with all physical and psychological restrictions, specific for the individual.

During the most of the educational process, students don't have the possibility to move their bodies and they occupy a definite immobile posture. In most of the cases this posture is sitting. It was so far believed that this was the best posture for work [3], but the latest trends in the design of working environments and processes prove the need of change. More and more researches prove that less physical energy is lost in standing posture work. The possibility for easy change of the working posture not only gives a chance for working, but also acts psychologically calming in the working person, so that he decides what posture to occupy without being imposed any restrictions [4].

For the purposes of this research measured were the sized of the basic furniture for sitting and work (chairs, tables, desks, benches) in two lecture rooms and seven classrooms for laboratory and seminar exercises. Two of the auditoriums have had renovated tables, two of the auditoriums have had desks for computers, purchases within the last 3-7 years. In two of the auditoriums, chairs have been purchased within the last year.

Use of computers in any field of activity is not a novelty but a practical need. Fig. 3, 4 and 5 show solutions for classrooms where computers are used. An important requirement upon furnishing is providing of minimum 90 cm transport hallway for movement to and from working place. Upon arrangement of the tables/desks in several rows, the distances between them must also be not less than 90 cm. This size is also complied with the requirement for accessibility of the environment for people with disabilities. The discomfort observed in fig. 5 is the lateral situation of the blackboard towards thew working places. This arrangement is only allowed for short periods (10 – 15 min.) of use of the blackboard. Otherwise, turning the head at more than 20° awry, falls withing the danger – red zone for working movements and has to be avoided or to seek for possibility for another posture or another working organization [5].

Fig. 3. *View of a classroom with computers – with one wide central transport hallway*

After analyzing the sizes, the type and the materials composing the tables in computer labs, it becomes clear that everywhere they have adjustable height. In some places, there lacks a lower platform for keyboard, and where it is present – it is not used. Part of the monitors don't have the possibility for adjustment of the height of the screen, but all of them have the possibility for adjustment of the tilting angle for good visibility of the user. Chairs are wooden, not upholstered, or of „visitor“ type.

Fig. 4. *View of a classroom with computers – with two lateral transport hallway*

Fig. 5. *View of a classroom with computers situated around a central straight line*

Part of the analyzed furniture has a need to be renovated or refurbished. The podium in front of the blackboard has to have a clearly visible edge. Furniture situated too close to each other create a suppressing feeling and increase the risk of injury. It has been proven that the seat has to be upholstered in order to not impede blood flow of the lower extremities. The back has to be propped in the lumbar area, and the working surface has to be at the level of the elbows bent at a right angle.

Interior, as an entirety of object – space environment influences the psychophysiology of human perceptions:

- hearing – perception of a live speech and information from technical media;
- vision – perception of information and colours;
- tactile sense – sense for matters and materials upon touch.

Upon poor hearing, poor vision and unpleasant feelings upon touch, one intuitively seeks for a change, desiring to change his place or loses concentration of his actions. He can be injured or to make his presence in the classroom senseless.

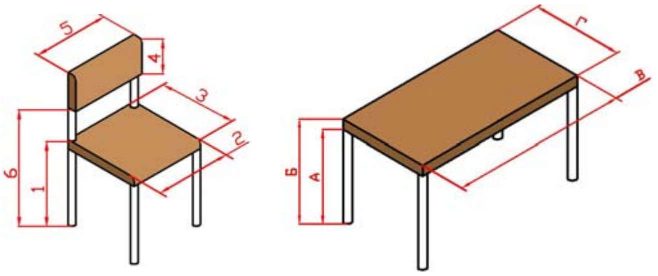
As per Pisareva [6], a designer has to put an accent of his attention towards the area, the shape, the arrangement and the lighting of a classroom. Her opinion is that the development of technologies conditions the changes in the functional and visual building of the furniture.

The colours in the interior also influence the overall perception of the environment. Of interest is the fact that working surfaces are wooden or made of wooden particles, and their colour resembles the natural colour of timber. The composition interactions of the colour with the furniture can help or affect the educational process. With well selected colour solutions one influences the perception and human self – feeling [7]. Creation and arrangement of shapes in one working environment is based on „The great theory of beauty“, created by ancient Greeks. It is founded on the order and the proportions which are the skeleton of a composition in contemporary design. The combination and application of this knowledge through building of a project culture [8-10], favours the efficiency of the educational process and can increase the motivation of the persons participating in it.

Fig. 6 shows images of used chairs, and fig. 7 shows the schemes of measurement. Dimensions are taken in a straight line, without exerting pressure on soft parts of the chair and without reporting the curve of the backrest. All dimensions are reported on the axes of symmetry of the specific geometric shape and are presented in table 1 and table 2

Chair-1-not upholstered *Chair-2-upholstered* *Chair-3-„visitor“ type*

Fig. 6. *Images of commonly used chairs in classrooms*



„Chair“ diagram „Table“ diagram

Fig. 7 Scheme of measurement of the dimensions of the equipment

Table 1: Dimensions of commonly seen chairs at the Technical university–Varna

Dimensions as per „Chair” type	Chair-1	Chair-2	Chair-3	Desk backrests
1 [mm]	420	430	470	460
2 [mm]	390	370	470	480
3 [mm]	360	380	410	450
4 [mm]	225	240	330	200
5 [mm]	400	370	480	3890 *
6 [mm]	550	560	520	540
*	Desks' backrest is one per 7 seats			

Table 2: Dimensions of commonly seen tables, desks and benches at the Technical University – Varna

Dimensions as per„Table” scheme	Table for 1	Drafting table	Table for 3	Desk	Bench
A [mm]	740	780/860 **	780	740	795/830 **
Б [mm]	720	760/840 **	760	640	815/850 **
В [mm]	1200	1300	1800	1200	3890
Г [mm]	750 (700*)	900	790	590	325
*	Dimension in the middle of the curved part of the table				
**	Dimension in the beginning and at the end the tilt of the table surface				

Where there is not enough space for free movements of the extremities, the quality of the performance is deteriorated, because one starts feeling claustrophobia. If soft tissues are pressed, and blood flow is impaired in them, there may occur limb numbness, headache and fit.

Upon incorrect and irregular leaning of the back in “sitting“ posture, spine curvature appears, as well as back pains, changes in the discs between the spinal vertebrae, pressure of the nerves (discopathy) etc.

Table 3 shows basic anthropometric indicators as base dimensions for assessment of furniture with the physical parameters of people. Data relate to the smallest, average and largest man or woman, and have been taken from BSS 15592:1982 and BSS 15591:1982. The places of the dimension indicators are presented in fig. 8.

Table 3: *Dimensions of P5, P50 and P95 for men and women from BSS 15592:1982 and BSS 15591:1982*

№: Indicator Dimensions are in mm	Women			Men		
	P5	P50	P95	P5	P50	P95
36: height of 3th lumbar vertebrae	168	198	227	178	204	234
37: popliteal height	369	402	439	407	450	494
38: elbow height	218	252	288	226	262	295
40: knee – floor height	444	485	529	488	531	577
41: hip thickness	118	140	170	118	138	161
44: sitting depth	436	474	518	444	481	524
45: width of leaning until the knee	526	570	621	545	592	640
50: bottom width	314	368	424	302	341	383
51: elbow width	359	422	496	388	454	519
52: knee width	158	188	233	164	188	222
53: hip width	328	374	429	299	333	375

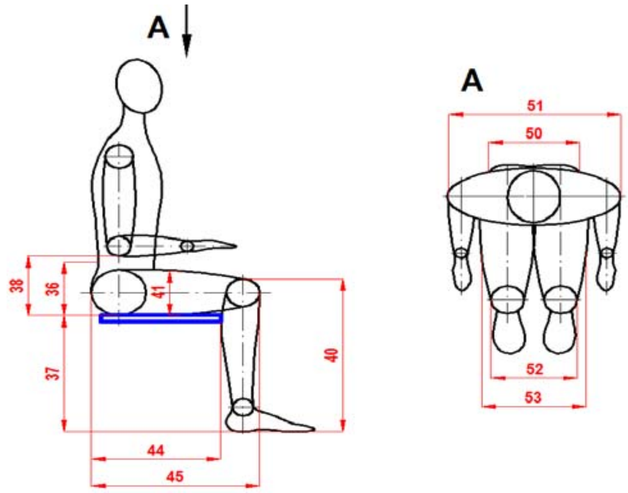


Fig. 8 Anthropometric indicators of a man in „sitting” posture

As per the requirements for ergonomics, working furniture is desirably to be adapted as per the anthropometric and physiological indicators of students with the purpose of providing comfort, security and safety. It is necessary to provide preconditions for increase of the performance, the aesthetics and the modern appearance during the educational process [11].

3. Results and discussion

Furniture measurements show that their dimensions do not comply with the individual properties and anthropometric characteristics of each single student. Fulfillment of this conditions is of extreme difficulty because dimensions of individuals are absolutely not uniform. That is why, more and more manufacturers offer adjustable furniture. For instance, chairs with a possibility for individual adjustment of the sitting level, height and the tilt of the backrest etc. Offered are also desks/tables with possibility to adjust the level of the surface height.

The good look of the surrounding working environment favours the motivation to work. The correct arrangement of furniture, their appropriateness and safety are part of the care of the health of people. Due to the growing threshold of retirement age, each manager should pay attention to the working conditions and the comfort at the working place with a view of providing quality of life and preconditions for continuous performance. This way would prevent pains and injuries in muscles and joints, known as musculoskeletal disorders (MSD).

The furnishing of a class hall has to be complied both with the contemporary conditions for organization of a quality educational process (using implements – computers, multimedia projector, interactive board), and with individual indicators of students. In order to have an academic and complete educational process, a working place has to cover the following requirements:

- providing of necessary space (for hands, legs, place for sitting) of the studying person, regardless of his/her height;
- possibility for occupying a safe and suitable working posture – sitting with propped waist, or standing without bowing at more than 30° forwards;
- providing of sufficient lighting of the working surface of 500 lx, and avoiding of glare and reflections in the monitor;
- providing of space for teamwork – round tables or arrangement of the desks around one centre;
- possibility for matching of the equipment with the anthropometric characteristics of people – adjustable chairs, table surfaces, level of monitors etc.

The expectations of the specialists in the near years are related to the mass integration of interactive technologies in the educational process. This could change not only the furnishing itself, but also the way of training, because students will be able:

- to quickly, easily and accessibly find information on a given topic;
- to communicate with colleagues of other universities;
- to be educated through teamwork in real time;
- to visualize the educational material through virtual laboratories etc.

4. Conclusion

In conclusion, we can mark that the dimensions of the furniture do not correspond completely to the individual needs and the anthropometric characteristics of each single student. This we explain with the acceleration in the last years, one hand, and the lack of profound studies concerning the anthropometric characteristics of young men and women, on the other hand. This issue should be paid special attention, as furniture and interior appear an important part of the studying environment which is also working environment for students themselves.

Our opinion is that the ergonomics upon furnishing will increase the motivation for attendance of lectures and exercises, as well as it would increase the interest in studied subjects and will positively affect the professionalism and quality of future engineering staff.

In order to cover ergonomic requirements, working space of students has to be sufficient for:

- possibility for making working movements with a view to the needs during the needs of the educational process – writing, drawing, seeking information in implements, work with computer etc.;
- maximum perception of information from a visual source, presentation from multimedia, a large TV screen etc.;
- change of the working posture: upon carrying out presentation – from sitting into standing posture, upon implementation of tasks – drawing or writing etc.

An ergonomic working place is a combination of correctly selected furniture, comfort microclimate and calm psychological environment. Upon designing of ergonomic furniture, designers have to take into account anthropometric, physiological, clinical and age characteristics of students. This way will increase the efficiency of the working process and will reduce the fatigue in students. The quality of training will be improved.

The conclusions and the recommendations which we can do, are as follows:

- it is recommended to use adjustable furniture (chairs, tables/desks) with a view to the possibility for individual adjustment by each user as per their anthropometric peculiarities;
- it is necessary to take into account the factors like noise, lighting, colour combination upon arrangement of a classroom with the purpose of reducing the stress and providing a more effective educational process;
- the provision of ergonomic furniture and equipment helps both for the prevention of occupational diseases like spinal curvatures, discopathies, and for reducing the performance .

The recommendations and conclusions made are topical for the ergonomics and are useful and applicable upon furnishing of classrooms and implementation of the educational process.

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