Ergonomic Evaluation of Workstations for International Students at Universities: a Case Study

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ABSTRACT
In this paper the attention is paid to the problem of adjustment of workstations to European students who are more and more willing to enrol at education exchange programs in universities all around Europe. With this aim, six classrooms and six auditoriums in two universities were evaluated considering the anthropometric data of the students. The results of the investigation showed that most of workstations in both universities are not appropriate for 5^{th} and 95^{th} percentile of the analysed populations. Thus, there is a need to adjust these workstations to their potential users and, accordingly, to eliminate the mismatch and provide students with workstation able to allow them to adopt natural resting postures.

KEYWORDS: anthropometrics; workstation, measurement, student, university

1. INTRODUCTION

Human capabilities and limitations provide the basic data for effective design of technologies and systems. Understanding the need of their incorporation in the design stage allows to elaborate products which can be adjusted to its users to maximize usability and reduce the negative effects (Hanson 2009, Mrugalska & Arezes 2015). However, in order to achieve it, it is necessary to refer to anthropometry, which deals with measuring and quantifying human physical traits, such as: size, weight, reaches, proportion, mobility, and strength. All products need to be adjusted to user anthropometrics, however, in practice it often appears that the fit, or match, between products or workplaces and their users is not always achieved (Wichansky 2000, Górny 2011, 2012). The incorrect adjustment to anthropometric characteristics can lead to discomfort, pain and, in more critical cases, to musculoskeletal disorders. To be able to maximize the relation between product/workplace and users, the designers have to refer to the appropriate and updated anthropometric measurements for each target group (Castellucci et al. 2014).
Nowadays, more and more universities are becoming open to education exchange programs involving international groups of students. It is possible to find hundreds of scholarships to study abroad, including general and more specialized funding schemes. Some of them are offered by government agencies, some by individual universities, and others by external funding organizations and charitable enterprises. For example, until 2020, the programme Erasmus Plus will provide opportunities for over 4 million Europeans to study, train, gain work experience, and volunteer abroad (European Commission, 2015). All these opportunities make people pursue knowledge and experience in different parts of the world. However, there is a question if the institutions or organizations are prepared to accept these diverse multinational groups as far as workstations adjustment is concerned.

2. MATERIALS AND METHOD

The objective of the research reported in this paper was to determine workstation adjustment to international students' anthropometric dimensions at Poznan University of Technology in Poland and University of Minho in Portugal. For this purpose, two primary activities were undertaken: a literature review and a dimensional study of the existent workstations. On the basis of the literature review it was possible to collect anthropometric data from such countries as: France, Germany, Great Britain, Holland, Italy, Norway, Poland, Portugal and Sweden (Table 1).
In the presented investigation, 6 classrooms and 6 auditoriums were analysed in both universities. They were mainly equipped with separate chairs and tables with wooden surface (Figure 1), but it was also possible to find a table set (Figure 2).

Figure 1 - Chair and table.

Figure 2 - Table set.

Table 1 – Anthropometric dimensions of different European nations (Adapted from Jarosz (2003) and Hanson et al. (2009)).

Measurement		HW	BKL	BPL	PH	SEH	TT
France:	5th percentile	333	458	354	458	185	141
	95th percentile	432	576	432	576	290	211
Germany:	5th percentile	325	462	351	462	191	117
	95th percentile	451	574	480	574	280	173
Great Britain:	5th percentile	342	450	398	450	191	117
	95th percentile	478	591	494	591	288	198
Holland:	5th percentile	340	450	370	450	195	120
	95th percentile	450	610	495	610	280	175
Italy:	5th percentile	296	450	380	450	196	106
	95th percentile	393	590	521	590	301	157
Poland:	5th percentile	319	471	361	471	194	115
	95th percentile	410	606	488	606	301	171
Sweden:	5th percentile	326	539	431	397	192	126
	95th percentile	463	667	545	534	292	184

where: Hip width (HW) - Horizontal distance between the most protrudent parts of the right and left in sitting posture, Buttock-knee length (BKL) - Horizontal distance from the foremost point of the knee-cap to the rearmost point of the buttock, Buttock-popliteal length (BKL) - Horizontal distance from the forward of the sitting surface to the rearmost point of the buttock, Popliteal height (PH) - Vertical distance from the foot-rest surface to the tendon of the relaxed biceps femoris muscle immediately behind the knee, Sitting elbow height (SHE) - vertical distance from a horizontal sitting surface to the lowest bony point of the elbow bent at a right angle with the forearm horizontal, Thigh thickness (TT) – vertical distance from a horizontal sitting surface to the highest point on the thigh (ISO 7250-1:2008).

In order to measure the dimensions of the auditorium and classroom workstations a metal tape measure was used and the collected data is presented in Table 2.

Table 2 – Measurement data of workstations.

Measurement	SH	SD	SW	SDC	SDH
Poznan University of Technology					
Auditorium 1	462	400	385	260	300
Auditorium 2	476	400	450	203	231
Classroom 1	460	400	362	263	304
Classroom 2	458	400	361	264	304
Classroom 3	460	400	368	263	300
University of Minho					
Auditorium 3	460	435	460	250	310
Auditorium 4	470	450	450	280	330
Auditorium 5	455	370	470	150	300
Auditorium 6	450	490	450	235	290
Classroom 4	465	430	445	180	260
Classroom 5	445	400	380	245	315
Classroom 6	440	390	400	205	260

where: Seat Height (SH) – vertical distance from the floor to the seat, Seat Depth (SD) - distance from the back to the front of the seat, Seat Width (SW) – horizontal distance between the lateral edges of the seat, Seat to Desk Clearance (SDC) - distance from the top of the front edge of the seat to the lowest structure point below the desk, Seat to Desk Height (SDH) – vertical distance from the top of the middle of the seat to the top of front edge of the desk (Castellucci et al. 2014, EN 1729-1: 2015).

To be able to evaluate the match or mismatch of student's workstations, it is necessary to refer to the following criteria (Castellucci et al. 2010, 2014, Dianat et al. 2013):

$$(PH + 30)\cos 30^0 \leq SH \leq (PH + 30)\cos 5^0 \quad (1)$$

$$80\%\ BPL \leq SD \leq 95\%\ BPL \quad (2)$$

$$HW < SW \quad (3)$$

$$TT + 20 < SDC \quad (4)$$

$$SEH \leq SDH \leq SEH + 50 \quad (5)$$

3. RESULTS AND DISCUSSION

On the basis of the analysis of the workstations in both universities, it can be noticed that there is a quite big discrepancy in their size what leads to the achievement of different results concerning their evaluation for the use by European students. As far as sit height is concerned, its value is correct for all the analysed nations, besides the 5th percentile of Swedish. The detailed results of the investigation of seat depth and seat to desk height are presented in Table 3.

Table 3 – Seat depth and seat to desk height.

80% BPL	SD							95% BPL	SEH	SDH								SHE +50
283.2	*370*	*390*	*400*	*430*	*435*	*450*	*490*	336.3	185	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	235
345.6	370	390	400	*430*	*435*	*450*	*490*	410.4	290	*231*	*260*	290	300	304	310	315	330	340
280.8	*370*	*390*	*400*	*430*	*435*	*450*	*490*	333.5	191	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	241
384.0	*370*	390	400	430	435	450	*490*	456.0	280	*231*	*260*	290	300	304	310	315	330	330
318.4	370	*390*	*400*	*430*	*435*	*450*	*490*	378.1	191	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	241
395.2	*370*	*390*	400	430	435	450	*490*	469.3	288	*231*	*260*	290	300	304	310	315	330	338
296.0	*370*	*390*	*400*	*430*	*435*	*450*	*490*	351.5	195	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	245
396.0	*370*	*390*	400	430	435	450	*490*	470.3	280	*231*	*260*	290	300	304	310	315	330	330
304.0	*370*	*390*	*400*	*430*	*435*	*450*	*490*	361.0	196	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	246
416.8	*370*	*390*	*400*	430	435	450	490	495.0	301	*231*	*260*	*290*	*300*	304	310	315	330	351
288.8	*370*	*390*	*400*	*430*	*435*	*450*	*490*	343.0	194	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	244
390.4	*370*	*390*	400	430	435	450	*490*	463.6	301	*231*	*260*	*290*	*300*	304	310	315	330	351
344.8	370	390	400	*430*	*435*	*450*	*490*	409.5	192	231	*260*	*290*	*300*	*304*	*310*	*315*	*330*	242
436.0	*370*	*390*	*400*	*430*	*435*	450	490	517.8	292	*231*	*260*	*290*	300	304	310	315	330	342

As it can be noticed (the discrepancy is shown by italic) the size of the seat depth is mainly adjusted to the 95th percentile when it is between 400-450 mm. However, it does not correspond to any country for both percentiles. SDH is always correct for the 95th percentile when its value is 304 mm or more. Furthermore, SW is appropriate for all 5th percentile but it is often too small for 95th percentile. For example, it starts to fulfil requirements for Italian when it is at least 400 mm. Similarly, SDC is enough for all people of 5th percentile except French. On the other hand, the space between chair and table should be at least 180 mm to let the 95th percentile of Italian to seat in spite of the fact that the size of their tights is the smallest among the analysed populations. Even if this study was focused in the match between furniture dimensions and students' anthropometry, it is important to acknowledge that other factors are also expected to affect this match or compatibility, such as the importance of dynamics of sitting and the seat surface characteristics.

4. CONCLUSIONS

The body dimensions of European inhabitants are different, in particular for the analysed EU countries. Thus, it is very vital to refer to the current and appropriate anthropometric data while designing products. Only by using these data it will provide products/workstations according to their body characteristics, friendly environment and limit the negative effects on health. The analysis of the research study showed that the workstations used in particular universities are not universal and appropriate for other European nations. They are often not adjusted to the 5th and 95th percentile of the analysed populations. Therefore, and considering that more and more international students are becoming enrolled for studies at different European universities, there is a need to adjust the workstations to all their potential users.

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