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STRUCTURAL ANALYSES OF MORPHO-FUNCTIONAL ELEMENTS FOR ESTABLISHING THE BIO-BEHAVIOR HUMAN PERFORMANCES

Mihaela Baritz[1], **Luciana Cristea**[1], **Diana Cotoros**[1], **Liliana Rogozea**[1]
[1] University TRANSILVANIA from Brasov, Romania,
mbaritz@unitbv.ro, lcristea@unitbv.ro, dcotoros@unitbv.ro, r_liliana@yahoo.com

Abstract: *In this paper we presented some theoretical and experimental considerations connected to the structural analyses of the morpho-functional elements in the human body in order to establish the behavior in normal activity conditions or in performance conditions. Thus in the first part of the paper we overviewed the anthropometric typo-dimensional classes involved in the bio-behavior performances analysis, considering the occupational standards and the health ones. As a follow of this analysis, we obtained a series of conclusions which were at the fundament of the systemic approach of morpho-functional structures assessments for various behaviors (static or dynamic, random or periodic, simple or combined). In the last part of the paper we proposed a first variant of structural analysis methodology in order to evaluate the human behavior performances.*

Keywords: *anthropometry, bio-behavior, human performances.*

1. INTRODUCTION

Out of the multitude of possible situations manifested in the global population and could present a negative significance, one of the most important is the health state due to its impact at social level of social security, direct and indirect costs of its maintenance, life quality, economical development and maybe not least the natural evolution. This is why it is absolutely necessary that the orientation of the fundamental research processes follows together with other areas, the development and implementation of some investigation techniques based on computerized and interconnected systems, in order to accomplish assessments and studies upon the human bio-behavioral performances. Presently, at global level, they exert a tendency of modular development of all the biomechanical structures and their computerization; designing systems with non-invasive investigation structures which using bio-behavioral modeling and simulation allow the accomplishment of interconnections between the real environment and the human factor without an “aggression” on any part of the system. Also knowing and understanding the connections and morpho-functional typo-dimensions of the human body “modules” involved in dynamic or static activities represents a complex and necessary action in order to establish and obtain behavioral performances.

2. ANTHROPOMETRIC STANDARDS

In this respect some statistic researches upon various samples of population were performed, obtaining thus a series of anthropometric standards and typo-dimensional classes used for references in any activity on behavioral analysis in order to reach performance and occupational capacity.

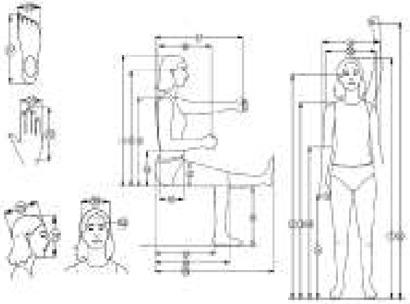


Figure 1 Belgian standard for morpho-functional typo-dimensions evaluation [2]

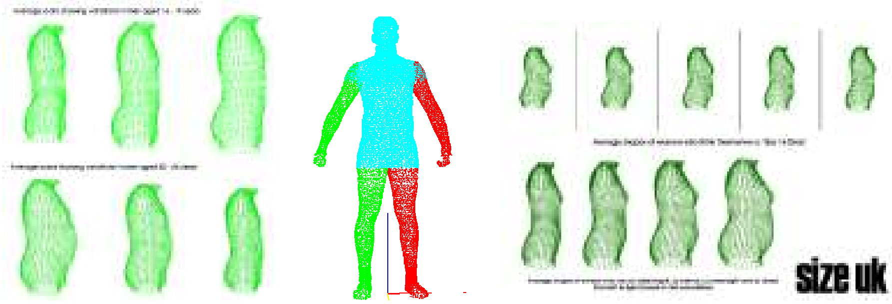


Figure 2. British standard for morpho-functional typo-dimensions evaluation (samples based on age groups)[4]

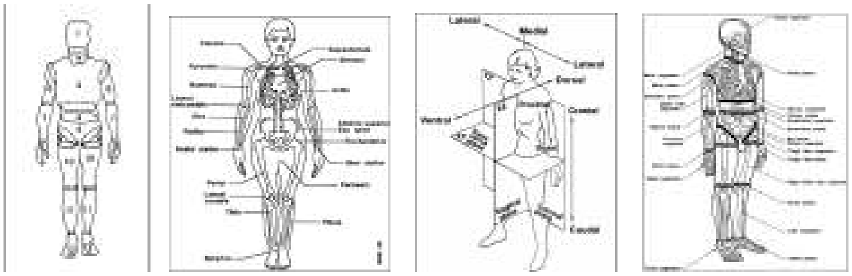
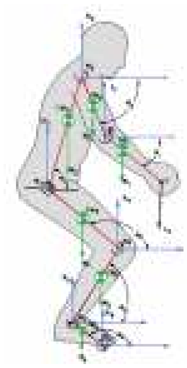


Figure 3. Morpho-functional modules component, axes, planes and main sections of the human body [4]

To develop a biomechanical link segment model, we need to know: location of joint centre of rotation, segment mass, segment length, location of segment centre of gravity, the segment moments of inertia. In obtaining this data it is crucial that we know which bony landmarks to use and how to identify them. The body can be modeled as a series of rigid segments linked by hinge joints.

These models vary greatly in complexity and by these researches the following model to study the bio-behavior human body is proposed, because it has an unstable position and all its components can be described with an own coordinate system, forces and moments. (fig.4.)



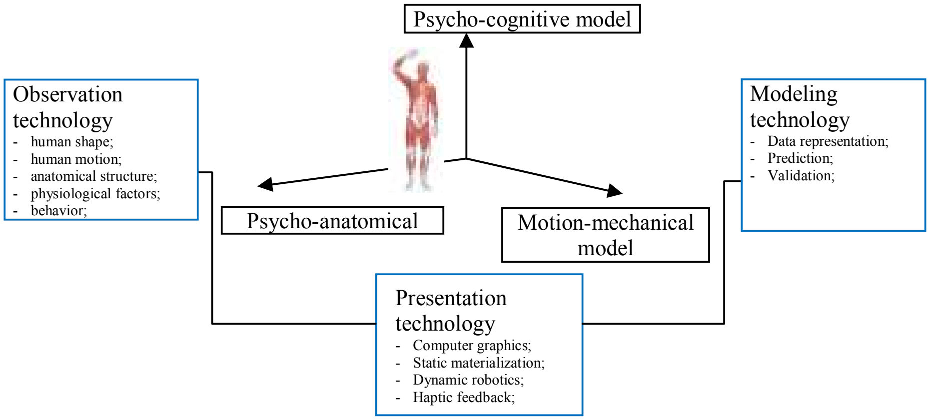


Figure 4. Model of human body in unstable bipedal position

Figure 5. Interconnected modules of the bio-behavioral analyses

To build a biomechanical human structure, the skeletal model should resemble the human body.

For example, rotational joints are usually assumed to have a virtual center about which the adjacent body segments move (fig4), but such simplifications would not be appropriate for knee prosthesis design; there appears to be little harm in variations on the order of a centimeter or so.

In applied anthropometry, the dimensions can be used for various design tasks and the type of dimension that should be used depends very much on the specific design task.

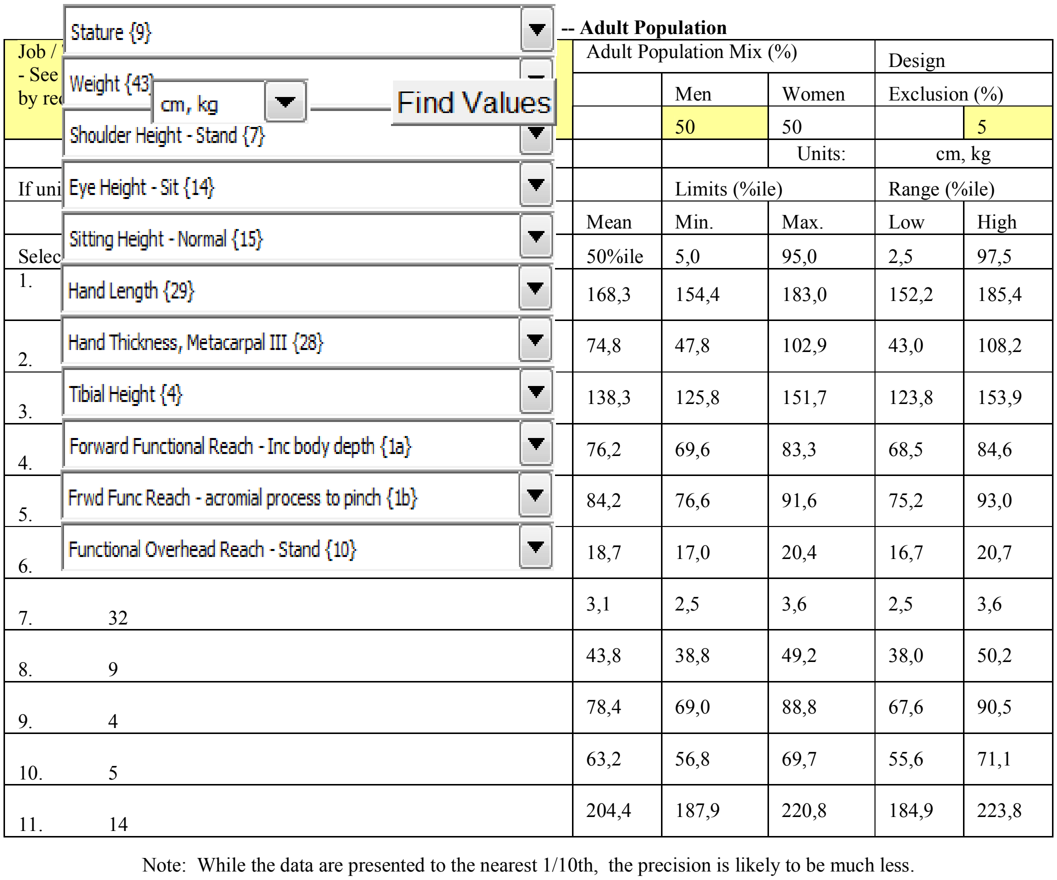
Posture, also human behavior in activities and anthropometry are completely linked with environmental conditions, interactions with other subjects or objects.

The posture of the subject directly influences anthropometric values when data are collected.

The user of anthropometric data should verify the posture of the subject during data collection before the data are used. Further, when using data from a number of different sources-as when international standards are developed, for example - it is important to understand any differences in subject posture before combining or comparing data.

The application of anthropometric data to work space design can be done with direct use of one-or two-dimensional measures or it can be done through the use of digital human models.

The study models can be structured in operational hierarchies, with univocal or bi-univocal connections to determine the analysis “trajectory” or modeling-simulation of human behavior in certain conditions or conditions occurred during the activity. In the table above we presented an automatic calculus model of the anthropometric dimensions on a human factors sample (50 men, 50 women) and respectively the determination of maximum and minimum of the chosen quantities. This modular structure allows the fast identification of the measured typo-dimensions and getting a complete database. [3]



-- Adult Population

	Adult Population Mix (%)			Design	
Job / - See by re		Men	Women	Exclusion (%)	
		50	50		5
			Units:	cm, kg	
If uni		Limits (%ile)		Range (%ile)	
	Mean	Min.	Max.	Low	High
Selec	50%ile	5,0	95,0	2,5	97,5
1.	168,3	154,4	183,0	152,2	185,4
2.	74,8	47,8	102,9	43,0	108,2
3.	138,3	125,8	151,7	123,8	153,9
4.	76,2	69,6	83,3	68,5	84,6
5.	84,2	76,6	91,6	75,2	93,0
6.	18,7	17,0	20,4	16,7	20,7
7. 32	3,1	2,5	3,6	2,5	3,6
8. 9	43,8	38,8	49,2	38,0	50,2
9. 4	78,4	69,0	88,8	67,6	90,5
10. 5	63,2	56,8	69,7	55,6	71,1
11. 14	204,4	187,9	220,8	184,9	223,8

Note: While the data are presented to the nearest 1/10th, the precision is likely to be much less.

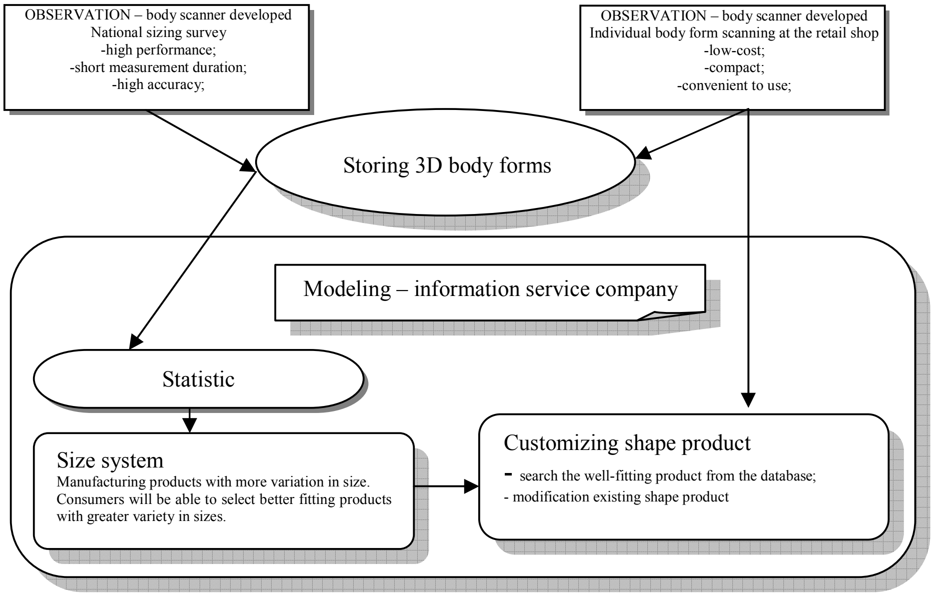


Figure 6. Analysis strategy of the anthropometric models connected to the products shape

For the European population and world population groups there are no concrete and available information on the last period or in different countries. Based upon these aspects, the following recommendations have been formulated for further improvements to the body of standards in the area of anthropometrics, biomechanics studies or ergonomic analyses:

- **Generic standards:** It would be desirable for all anthropometric values and definitions to be made available within a small number of generic standards. To date, the generic European and international standards contain only a subset of the anthropometric data required for standardization. As a result, product standards often refer to data which are out of date or of uncertain origin.
- **Product standards:** During the development of product standards, anthropometric data should wherever possible be taken from the generic standards; where this is not the case, at least the source, the point in time of the survey and the user group studied should be stated.
- **DIN Technical Report:** A DIN Technical Report should be produced to assist in the application of anthropometric data. It should provide an explanation to all standards experts and designers of how anthropometric factors are to be considered for certain purposes. This includes, for example, allowances for clothing (e.g. for safety footwear or protective helmets), room for movement or special groups of persons.
- **Updating:** Standards containing anthropometric data which were published over 10 years ago should be brought into line with up-to-date anthropometric data. For this purpose, all available anthropometric data should be employed, or if appropriate new data obtained. [4]

At the same time we need to analyze for the local, zonal, extended or global anthropometrical database, the environmental influences, physiological state of the chosen population sample but also the geographical distribution of some climatic manifestations, which may trigger adaptation mechanisms of the human factor.

3. EXPERIMENTAL SETUP AND RESULTS

On purpose of developing experimental researches we designed a set of modules of human bio-behavioral analysis in normal auditory and visual stimulation conditions, in order to determine the stability component of the human body standing on a *Kistler* force plate and a foot-scan pressure plate. These two systems are part of the modular structure by means of which the experimental data are correlated to those modeled by behavioral modeling software like *LifeMod* and the database *PeopleSize.*

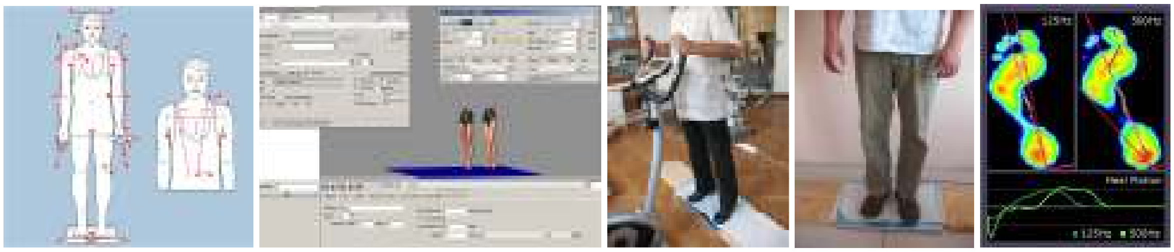


Figure 7 Structural analyses modules of people to establish the anthropometrical database

The performed analyses allowed the recording of the stability component on vertical direction (Fz force and stability area) correlated to the anthropometric dimensions of a sample of 20 human factors and the results presentation for two of them. The first one, male, height 170 cm, weight 76 kg and the second one, female, height 153 cm, weight 62 kg. We may notice a significant difference concerning the variation of the force on Oz (both as values and as evolution during recording time) but expressing a way of manifestation similar as far as the stability area is concerned. Also the recordings were performed 7 times for each case in order to be able to observe the environmental influence, th visual and auditory stimuli upon the human behavior when standing.

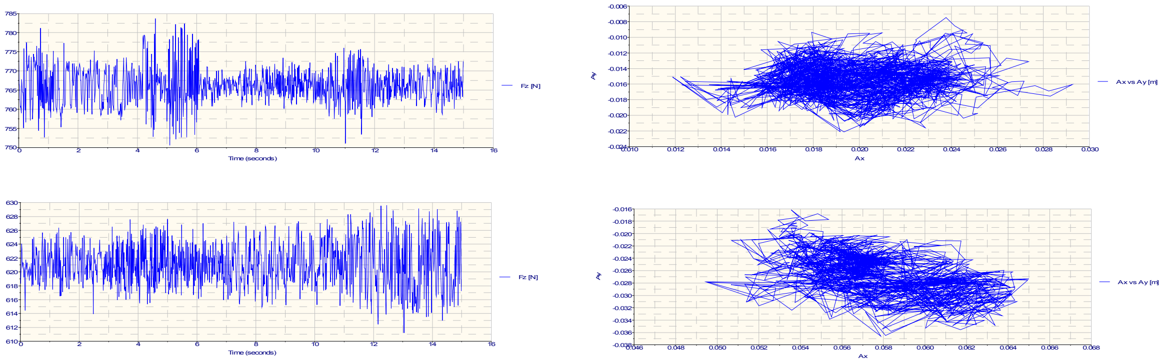


Figure 8. Graphical representation of the force along Oz and the stability area for two human factors

The designed analysis method applied for the chosen sample and the values determined by experiments fills in the anthropometric database (dimensional, static, dynamic) having also the possibility of preliminary evaluation of the human factor behavior in situations of ergonomic-postural analysis or for obtaining higher performances of the human factors.

4. ACKNOWLEDGMENTS

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