UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Anthropometry Database for the Primary School Furniture Design

Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing
Engineering (Manufacturing Process)

By

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JUDUL: **DEVELOPMENT OF ANTHROPOMETRY DATABASE FOR THE PRIMARY SCHOOL FURNITURE DESIGN**

SESI PENGAJIAN: JUN 2004 – MEI 2007

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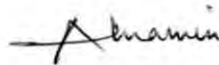Karung Berkunci 1200, Ayer Keroh
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DECLARATION

I hereby, declare this thesis entitled "Performance Studies of Development of Anthropometry Database for the Primary School Furniture Design" is the result of my own research except as cited in the references.

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ABSTRACT

This research discuss the initial efforts to build an anthropometric database for Malaysian population as a guide and reference on designing the furniture school for manufacturer beside that reducing the rate of musculoskeletal problem of the student school. For research title 'Development of Anthropometry Database for Malaysian Population'. Here, the problem statements and objectives thus research have been identified. Beside that, scope, importance of the study along with the online of the study have been reviewed and discussed. For the literature review information in reference books and internet, and from journal for histories, definitions, terminology and measuring conventions, measurement techniques. Data anthropometric surveys have been conducted and published on various populations, especially to primary school student. The results of the research carried out on the data collection by 25 part body. Then, to transfer the data collection to SPSS software for analyzed the result. The statistical variables such as percentiles mean and standard variation are used to present and describe the data.

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CHAPTER 1
INTRODUCTION

1.1   BACKGROUND

Generally, anthropometry is study of measurement of human dimension, which refers to the measurement of living human individuals for the purposes of understanding human physical variation (Wikipedia). Anthropometry is very useful for design product guideline for heights, clearance, grips, and reaches of workplace and equipment.

Anthropometric data are used to develop design guidelines for heights, clearances, grips and reaches of workplaces and equipments for the purpose of accommodating the body dimensions of the potential workforce. Example, the dimensions of workstations for standing or seated work, production machinery, and hand tools. The workforce includes men and women who are tall or short, large or small, strong or weak, as well as those who are physically handicapped or have health conditions that limit their physical capacity.

Anthropometric data are also applied in the design of consumer products such as clothes, automobiles, bicycles, furniture, hand tools and other. This design requirement is to select and use the most appropriate anthropometric database in design. Grieve and Pheasant (1982)

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1.2   PROBLEM STATEMENT

The application ergonomic principles in the workplace and products are very important to the industries. These examinations, majority the furniture school having at Malaysian unsuitable for students. For the information, maybe the students unsuitable with furniture ready to be used along time study. This problem, musculosketal pains effect always at the workers industries. The location of the data collection in area Ayer Keroh, Melaka.

This research will gathers anthropometry data on specific to primary school and will compare the data with the anthropometry data if possible. From the data will be developed, it will be used as a reference to produce a specific school furniture dimension for Malaysian student.

1.3   OBJECTIVES

The objectives of this research are such as:

1.   To understand ergonomic principles especially in anthropometry for design furniture.
2.   To measure the anthropometry data student from primary school.
3.   To develop of anthropometry database related to primary school between ages 7 until 12 years old.

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1.4 THE SCOPE

This research will conduct the data collection for specific measurement of human body parts. The body parts chosen will be related with student's primary school around age 7 until 12 years old. The furniture design of base on standard data based. This thesis will be used in the SPSS software. From the software can analyzed to get the calculation required normal distribution, mean, median and etc. This research it will provide a sample of data that can be a reference to the school furniture manufacturer.

1.5 IMPORTANCE OF THE THESIS

For this thesis, it is important to achieve the objective based on the problems occurred at uncomfortable for furniture school. Based on this database an ideal standard database available will provide a sample of data that can be a reference to the school furniture manufacturer.

1.6 OUTLINE OF THE THESIS

This research will be divided to seven chapters for complete. The first chapter is mainly about the introduction of the research, objectives, scope of study and problem statement.

For second chapter the literature reviews. This part based on the reference to journals, books, website, etc. It will also discuss the method on how to the research will be done based on the researches.

The third chapter is the methodology. This chapter will be discussing about the review of the research methodology. All relevant experimental, descriptive, theoretical and analytical techniques used in the research should be outlined in this chapter. This chapter also discussing the method of the choosing and the best the method selection..

Then, next chapter will be discussed briefly the data collection. This will include the setup for the data collection, the data collection table and the example of the data which had been taken.

The last chapter would be the summary and conclusion of the thesis. This includes the summary of the entire work, containing the methods, results, major conclusion as well as recommendations arising from the work.

CHAPTER 2
LITERATURE REVIEW

2.1   INTRODUCTION

Ergonomics in work environment has gained high attention from   researchers over recent decades. One main concern is that equipment should be designed according to principles of anthropometry, biomechanics and hygiene should help to reduce accidents and overuse syndromes in order to promote productivity (Grieco, 1986). Although school environment represents the work environment for billions of children, it has not attracted the proper attention from ergonomic.

Uncomfortable postures could be painful due to the prolonged periods children spend at school (AagaardHansen and Storr-Paulsen, 1995: Murphy et al., 2004) and several researchers have reported posture-related syndromes in students (Knight and Noyes, 1999: Milanese and Grimmer, 2004: Troussier et al., 1999). Moreover, it is possible that children may maintain those postural behaviors for   the rest of their lives (Cardon et al., 2004: Floyd and Ward, 1969).

Many authors have tried to establish theoretical recommendation for the principles that relate school furniture design to children's anthropometry and some have also attempted to define the appropriate dimensions for school furniture based on anthropometric measurements. In Iran (Mououdi and Choobineh, 1997), Korea (Jeong

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and Park, 1990), Seoul and Pousan (Cho, 1994), there have been studies related to school furniture design that have investigated differences in body dimensions due to age and gender. In some countries there were attempts to design desk and chair based on anthropometric data (Evans et al., 1988: Hibaru and Watanabe, 1994; Hira, 1980; Noro and Fujita, 1994: Oxford, 1969; Shih et al., 1966) studied the mismatch between furniture and student's dimensions by measuring anthropometric characteristics of American children and the dimensions of their classroom's desk and chairs.

Children spend a large part of their school days in the classroom. In every society, school furniture is used extensively by children during what is a vital period of human physical development. Storr-Paulsen and Aagaard-Hensen, 1994 noted that 8 and 9 year olds were expected to sit for more than 60 min in any 90 min period, while Dillon, 1976 observed that nursery school children were seated for 37.2% of their time in the classroom through to 78.7% for senior school pupils aged 13 to 16 years. Since school aged children might spend 30% of their waking hours at school (Linton, 1994), the amount of time they are seated is considerable. As well as varying across the age range, the amount of time children are required to remain seated in the classroom also varies from country to country and according to pedagogic fashion.

2.1.1   SITTING POSITION

The detrimental effects of improper classroom furniture on the spine have been known for a long time (Zacharkow, 1988). The dynamics of sitting can best be understood by studying the mechanics of both the relevant body parts and the external support system involved. 75% of the total body weight is supported by only 4 inch^2 (26 cm^2) of surface when sitting. This small area is under the ischial tuberosities of the pelvis. The heavy load concentrated in this area results in high compressive stresses estimated at 85-100 pounds per square inch (Tichauer 1978). Structurally, the

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tuberosities from a two-point support system which is inherently unstable, since the center of gravity of a seated person's body above the seat may not be directly over the tuberosities. Therefore, the seats alone is insufficient for stabilization, and the use of the legs, feet, and back in contact with other surfaces, as well as muscular forces, are necessary to produce equilibrium (Branton, 1969). Leg support is also critical for distributing and reducing buttock and thigh loads. Feet need to rest firmly on the floor or foot support so that the lower leg weight is not supported by the front part of the thighs resting on the seat (Chaffin and Anderson, 1991). If the major weight is to be placed on the ischial tuberosities and the proximal half of the posterior thighs, seat support should occur under and anterior to the ischial tuberosities. To maintain the weight bearing over and anterior to the ischial tuberosities, sacral and pelvis support are needed which prevent or reduce backward rotation of the pelvis and subsequent lumbar kyphosis, also known as posterior curve. Lumbar lordosis, the normal anterior curve of the lumbar vertebrae, helps to transfer some of the weight over the posterior thighs (Drummond, Narechania, Rosenthal et al. 1982).

2.1.2 SCHOOL FURNITURE

School furniture design

When designing products the criteria that defines a successful match between the products and users are commonly important include the followings (Pheasant, 1998):

i   Functional Efficiency
ii Ease of use
iii Comfort
iv Health and safety
v   Quality of working life

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In the case of designing school furniture where sitting constitutes a considerable time in the school (Dillon, 1976 and Linton et al., 1994) seat becomes important in term of comfort. All seats are uncomfortable in the long run, but some seats become uncomfortable rapidly than others, and in any particular seat, some people will be more uncomfortable than others. Comfort may also be influenced by the task or activity that the user is engaged in at that time. In other word comfort will depend upon the interaction of seats characteristics, user's characteristics and task characteristics (Pheasant, 1998).It is the principle user-centered design. To achieve the best possible match between the school furniture and children, the furniture should be designed in context of the (leaning) task and physical and mental characteristics of school children.

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┌─────────────────────────────┐              ┌─────────────────────────────┐
│ The furniture               │              │ The school children         │
│ characteristics:            │  ◄────────►  │ characteristics:            │
│   • Furniture dimension     │              │   • Body dimension          │
│   • Furniture angle         │              │   • Body aches & pain       │
│   • Furniture profile       │              │   • Circulation             │
│   • upholstery              │              │   • State of mind           │
└─────────────────────────────┘              └─────────────────────────────┘
              ▲                                          ▲
               ╲                                        ╱
                ╲                                      ╱
                 ▼                                    ▼
                    ┌─────────────────────────────┐
                    │ The task characteristics:   │
                    │   • Duration                │
                    │   • Visual demand           │
                    │   • Mental demands          │
                    │   • Physical demand         │
                    └─────────────────────────────┘
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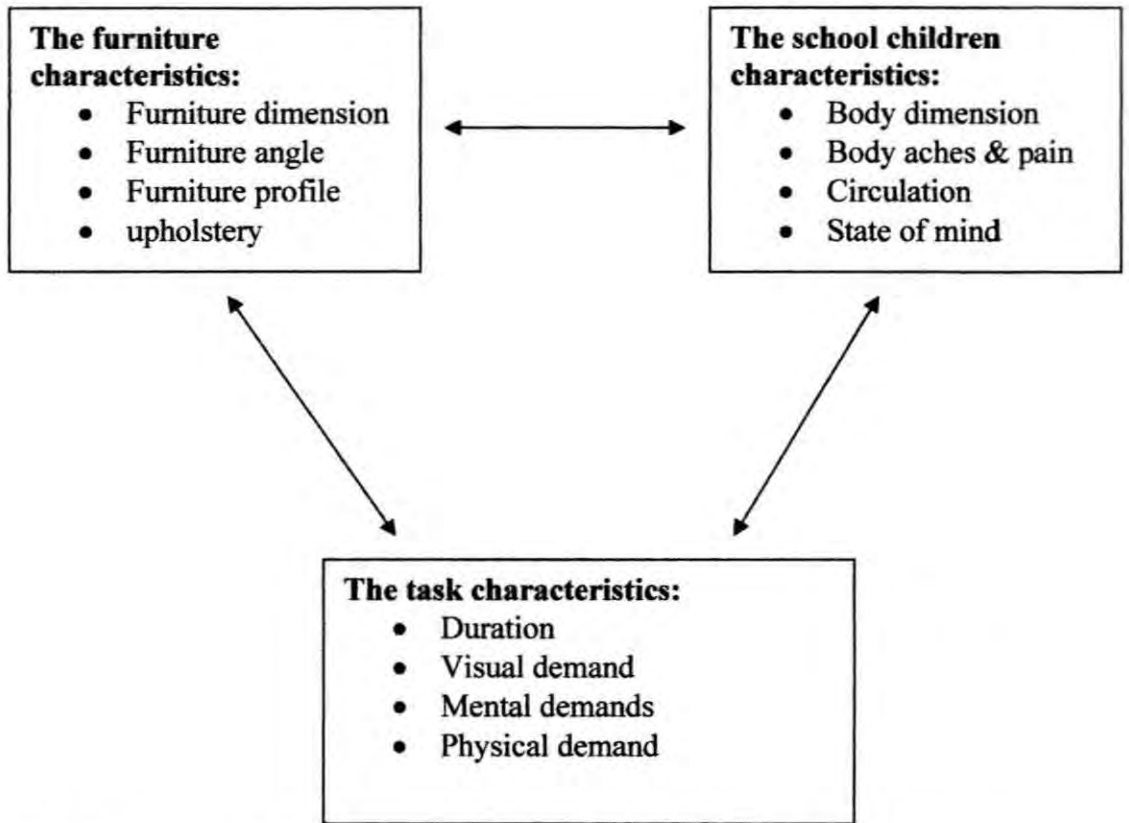
Figure 2.1: User center design: The furniture, the school children and the task

(Karvonen et al. 1962, Ox ford 1966)

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2.2 ERGONOMICS AND ANTHROPOMETRY

2.2.1 DEFINITION OF ERGONOMICS

"Ergonomics is defined as the design of the workplace, equipment, machine, tool, product, environment and system, taking into consideration the human's physical, physiological, biomechanical, and psychological capabilities, and optimizing the effectiveness and productivity of work systems while assuring the safety, health, and wellbeing of the workers. In general, the aim in ergonomics is to fit the task to the individual, not the individual to the task. (Jeffrey E. Fernandez)

Karl Kroerner, Henrike kroemer, Katrin Kroemer-Elbert (2001) state that the ergonomic is the application of scientific principles, methods and data drawn from a variety of disciplines to the developments of engineering systems in which people play a significant role.

2.2.2 DEFINITION OF ANTHROPOMETRY

Anthropometry means measurement of the human body. It is derived from the Greekworks anthropos (man) and metron (measure). Anthropometric data are used in ergonomics to specify the physical dimensions of workplaces equipment, furniture and clothing so as to fit the task to the man (Grandjean, 1980) and to ensure that physical mismatches between the dimension of equipment and product and the corresponding user dimensions are avoided (R.S.Bridger).

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Anthropometry may be defined as the measurement of human beings. Factors which affect anthropometric measurements include gender differences, ethic differences, growth and development, secular trend, ageing, social class and occupation and clothing and personal equipment (Jeffrey E. Fernandez).

2.3   IMPORTANCE OF ANTHROPOMETRIC DATABASE

Data contained in anthropometric tables provide critical information with which designers can design workplaces and products. Use of the data, however, requires a through analysis of the design problem. The following procedure provides a systematic approach for the use of anthropometric data in design:-

i   Determine the user population (the intended user). People of different age groups have different physical characteristics and requirements. Other factors that must also be considered include gender, race, and ethnic groups; military or civilian populations.

ii   Determine the relevant body dimension. To design a workplace or a products the relevant or related body dimensions must be determine to maximized their function and effectiveness

iii   Determine the percentage of the population to be accommodated. Accommodation of 100 percent of the population is not practical or desirable in many design situations because of various financial, economical and design constraints.

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iv   Determine the percentile value of the selected anthropometric dimension. The percentage of the population to be accommodated determines the percentile value of the relevant anthropometric dimension to be used in design. However designers need to be clear whether they are designing a lower or an upper limit for the physical dimensions of the system or device.

v   Make necessary design modifications to the data from the anthropometric tables. Most anthropometric measures are taken with nude or nearly nude persons, a method that helps standardize measurements but does not reflect real-life situations. Clothing can change body size considerably. Another important reason for data adjustment is that most anthropometric data are obtained with persons standing erect or sitting erect. These considerations are critical for designing.

vi   Use mock- ups or simulators to test the design. Designers often need to evaluate whether the design meets the requirements by building mock-ups or simulators with representative users carrying out simulated tasks. This step is important because various body dimensions are measured separately in a standardized anthropometric survey, but there may exist complicated interactions between the various body dimensions in performing a job. Mock-ups can help reveal potential interactions and help designers make necessary corrections to their preliminary design. A limitation of mock-ups is often encountered because the available human users for evaluation may not span the anthropometric range of potential users. This limitation points again to the potential advantages of anthropometric models, where such users can be simulated.