MATCH BETWEEN UMP FURNITURE DIMENSION AND STUDENT'S ANTHROPOMETRY

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ABSTRACT

Ergonomic issue is one of the important issues not only in workstation but also in educational institution since it is related to the human. Chair is one of furniture that is used widely in our daily life in purpose of sitting. Having a match chair that applied ergonomic is an important aspect to look at to avoid bad effect such as back pain and should provide comfortness and safety to the user. This project is conducted to determine whether the UMP chair in the student hostel match with the students' anthropometry or not. The seat height and seat depth of the chair is measured and the student popliteal height and buttock-popliteal length is analyzed. From the analysis, it can be concluded that the chair in student hostel did not match with the student. As a solution, an adjustable chair which applied ergonomic is designed to match the UMP students' anthropometry to optimize safety, comfort and prevent back pain.

ABSTRAK

Isu ergonomik merupakan salah satu isu yang penting bukan sahaja di tempat kerja malahan juga dalam institusi akademik memandangkan ia sangat berkait rapat dengan badan manusia. Kerusi adalah salah satu perabot yang digunakan secara meluas untuk duduk dalam kehidupan seharian. Menggunakan kerusi yang sepadan dengan saiz badan adalah satu aspek penting yang perlu dilihat untuk mengelak kesan buruk seperti sakit belakang di samping memberi keselesaan dan keselamatan kepada pengguna. Projek ini dijalankan untuk mengenalpasti sama ada kerusi yang digunakan di asrama pelajar sepadan dengan ukuran badan pelajar UMP itu sendiri. Berdasarkan analisis, didapati kerusi tersebut tidak sepadan dengan ukuran badan pelajar. Sebagai penyelesaian, sebuah kerusi baru yang boleh diubahsuai direka untuk disesuaikan dengan ukuran badan pelajar UMP dan mengaplikasikan faktor ergonomik untuk mengoptimumkan keselamatan, keselesaan dan mencegah sakit belakang.

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UMP	Universiti Malaysia Pahang
cm	Centimeter

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CHAPTER 1

INTRODUCTION

1.1 Objective

To examine match between the UMP furniture being used and student's individual body dimensions and to propose a design of chair that match with the student.

1.2 Scopes

1. To take a sample of students' popliteal height and buttock-popliteal length measurements.
2. To take dimension of seat height and seat depth of plastic chair in student hostel.
3. To study on ergonomics.
4. To measure fit or mismatch between students' bodily dimension and furniture dimensions.
5. To design an ergonomic chair which fits the UMP students' body dimension.

1.3 Background

This project discusses about the match between UMP furniture and students' anthropometry. The main purpose of the study is to determine whether UMP furniture match the student anthropometry or not. In most situations, UMP student will use the UMP furniture at least for an hour. Any mismatch will cause uncomfortable and unsafe posture. So it is important to have a suitable chair and desk to allow student to adopt a correct posture while sitting. This will lead to a better studying environment, and thus will increase the student attention and comfortness.

1.4 Problem Statement

The current chair used in student hostel often caused back pain to the students as they used it everyday. It become worst when the chair is used for long hours while doing works such using their laptops or personal computer. The most critical factor is while surfing internet which takes a long hours, the risk of experiencing back pain is high. So, this study is to determine whether the chair in student hostel match with the student body dimension or not. Furthermore, an ergonomic chair which fits the student body dimension is designed using Solidworks 2005.

1.5 FLOW CHART

1.5.1 Flow Chart for FYP 1

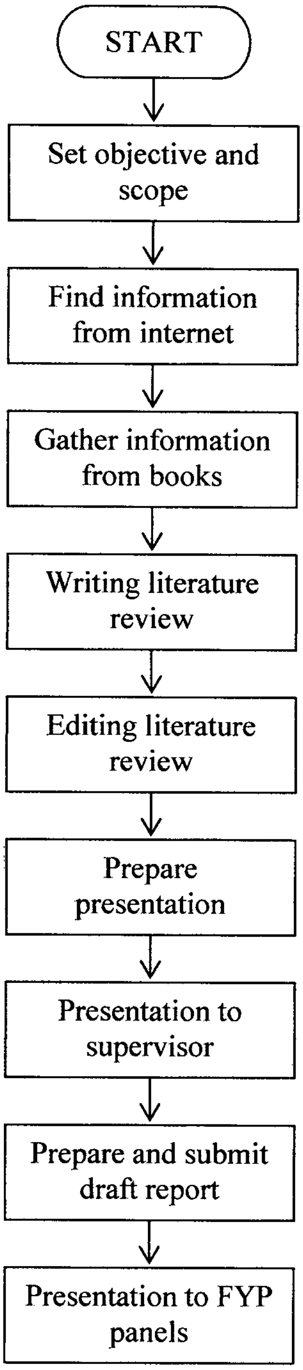

Figure 1.1 Flow Chart for FYP 1

1.5.2 Flow Chart for FYP 2

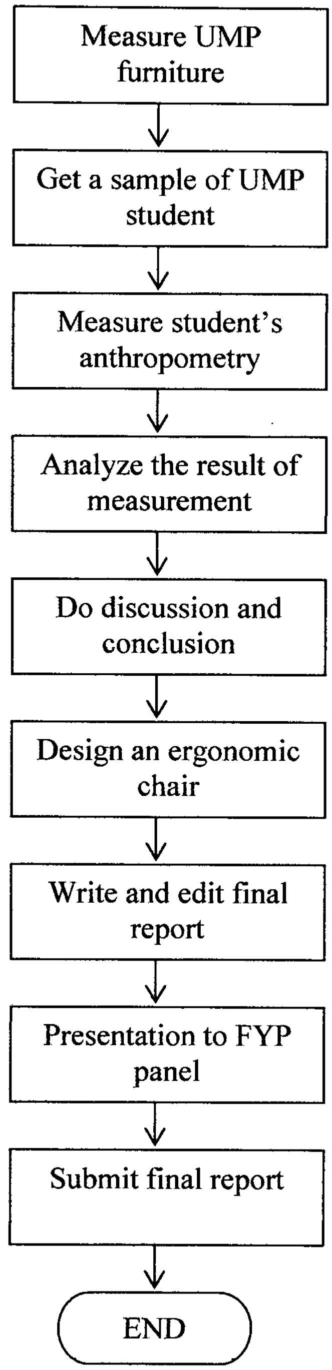

Figure 1.2 Flow Chart for FYP 2

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Ergonomics

Ergonomics is the science of work: of the people who do it and the ways it is done, of the tools and equipment they use, the places they work in, and the psychosocial aspect of the working situation [1].

The word *ergonomics* comes from the Greek *ergos*, work, and *nomos*, natural law. The word was coined by the late Professor Hywell Murrell, as a result of a meeting of a working party which was held in Room 1101 of the admiralty building at Queen Anne's Mansion on 8 July 1949, at which it was resolved to form a society for 'the study of human beings in their working environment'. The members of this working party came from backgrounds in engineering, medicine and the human sciences [1].

During the course of the war, which has just ended, they had all been involved with research of one sort or another into the efficiency of the fighting man, and they took the view that the sort of research they had been doing could have important applications under peacetime conditions. There did not seem to be a name for what they had been doing, however, so they had to invent one and finally settled on ergonomics [1].

The word *work* admits a number of meanings. In a narrow sense it is what we do for living. Used in this way, the activity in question is defined by the context in which it is performed rather than by its content. Unless we have some special reason for being interested in the socioeconomic aspects of work, however, this usage is arbitrary. Some people play the violin, keep bees or bake cakes to make a living; others do these things solely for pleasure or for some combination of the two. The content of the activity remains the same [1].

There is a broader sense, however, in which the term *work* may be applied to almost any planned or purposeful human activity, particularly if it involves a degree of skill or effort of some sort. In defining ergonomics as a science concerned with human work, we will in general be using the word in this latter and broader sense. Having said this, it would also be true that throughout its 50 years of history, the principal focus of the science of ergonomics has tended to be upon work in the occupational sense of the word [1].

Work involves the use of tools. Ergonomics is concerned with the design of these, and by extension with the design of artifacts and environments for human use in general. If an object is to be used by human beings, it is presumably to be used in the performance of some purposeful task or activity. Such a task may be regarded as work in the broader sense [1].

Thus to define ergonomics as a science concerned with work or as a science concerned with design means much the same thing at the end of the day. The ergonomic approach to design may be summarized in the principle of user-centered design which is if an object, a system or an environment is intended for human use, then its design should be based upon the physical and mental characteristics of its human users (insomuch as these may be determined by the investigative methods of the empirical sciences) [1].

The object is to achieve the best possible match between the product (object, system or environment) being designed and its users, in the context of the (working) task that is to be performed (Figure 2.1). In the other words, ergonomic is the science of fitting the job to the worker and the product to the user [1].

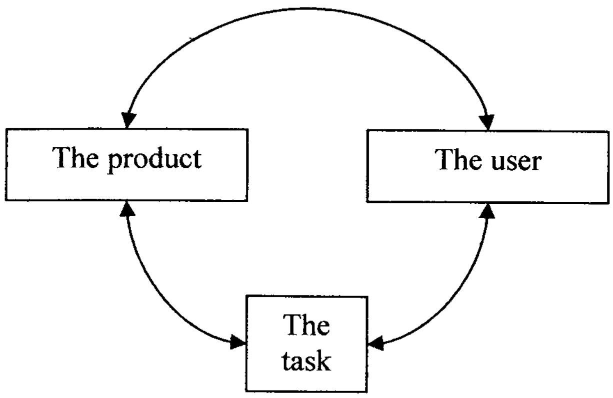

Figure 2.1 User-centered design: the product, the user, and the task.

2.2 Introduction to Anthropometry

According to the American Heritage Dictionary, anthropometry is defined as the study of human body measurement for use in anthropological classification and comparison. Today, anthropometry plays an important role in industrial design, clothing design, ergonomics, and architecture, where statistical data about the distribution of body dimensions in the population are used to optimize products [2].

Based on a book titled "Human Factors in Engineering and Design" by the author Mark S. Sanders and Ernest J. McCormick, it stated that anthropometry deals with the measurement of the dimensions and certain other physical characteristics of the body such as volumes, centers of gravity, inertial properties, and masses of body segments. We confine our discussion to measurement of dimensions because such data are fundamental to the wider range of design problems.

Anthropometry consists on the measurement of body characteristics such as reach, body segment length and circumferences, widths, and heights, among others.

This information can be used to inform the design of tools, equipment, workstations and clothes. Appropriate use of anthropometry in design may improve well-being, health, comfort, and safety [2].

There are two primary types of body measurement: static and dynamic (functional). What is sometime called engineering anthropometry is concerned with the application of both types of data to the design of the things people use. We briefly discuss static and dynamic anthropometry before discussing how such data are used in the design of workspace and equipment [1].

In the use of anthropometric data for designing something, the data should be reasonably representative of the population that would use the item. In many instances the population of interest consists of "people at large", implying that the design features must accommodate a broad spectrum of people. When items are designed for specific groups (such as adult females, children, the elderly, football players, and handicapped, etc), the data used should be specific for such groups in the country or culture in question [1].

Considering human variability in design is important. Human vary in several aspects such as age, sex, racial or ethnic group, occupational, generational or secular, and transient diurnal [3].

Many body dimensions can be measured with simple devices. Tapes can be used to measure circumferences, contours, and curvature as well as straight line. Anthropometric data collected by different measures usually requires clearly identifiable body landmarks and fixed points in space to define the various measurements [3].

2.3 Principle in the Application of Anthropometric Data

There are three general principles for applying anthropometric data to specific design problems; each applied to a different type of situation.

2.3.1 Design for Extreme Individuals.

In designing certain features of our built physical world, one should try to accommodate all the population in question. In some circumstances a specific design dimension or feature is a limiting factor that might restrict the use of the facility for some people; that limiting factor can dictate either the maximum or minimum value of the population variable or characteristic in question [1].

Designing for the maximum population value is the appropriate strategy if a given maximum (high) value of some design feature should accommodate all people. Example include the height of doorways, size of escape hatches on military aircraft, and strength of supporting devices such as a trapeze, rope ladder, or workbench. In turn, designing for the minimum population value is the appropriate strategy is given minimum value of some design feature has to accommodate all people. Example includes the distances of a control button from the operator and the force required to operate the control [1].

Usually there are reasons for accommodating most, but not hundred percent, of the population. For example, it is not reasonable to have all doorways 9ft high to accommodate circus giants. Thus, it frequently is the practice to use the 95^{th} male and 5^{th} female percentiles of the distributions of relevant population characteristic as the maximum and minimum design parameters [1].

2.3.2 Design for Adjustable Range

Certain features of equipment or facilities can be design so they can be adjusted to the individual who use them. Some examples are automobile seats, office chairs, desk heights and footrest. In the design of such equipment, it frequently is the practice to provide for adjustment to cover the range from the 5^{th} percentile female to the 95^{th} percentile male of the relevant population characteristic (sitting height, arm reach, etc.).

The use of such a range is especially relevant if there could be technical problems in trying to accommodate the very extreme cases (i.e., 100 percent of the population); frequently the technical problems involved in accommodating the extreme cases are disproportionate to the advantages gained in doing so. Note that using a range from the 5^{th} percentile female to the 95^{th} percentile male will result in accommodating 95 percent of a 50/50 male/female population, not 90 percent, because of the overlap between male and female body dimension. Generally, designing for an adjustable range is the preferred method of design, but of course, it is not always possible [1].

2.3.3 Design for the Average

First of all, there is no "average" individual. A person may be average in one or two body dimensions, but because there are no perfect correlations it is virtually impossible to find anyone who is average on more than a few dimension. Often designers design for the average as a cop-out so that they do not have to deal with the complexity of anthropometric data. This is not to say that one should never design for the average.

On the contrary, a thorough analysis of the situation may prove that an average value is acceptable. Such a situation would probably involve non critical work where it is not appropriate to design for an extreme and where adjustability is impractical. For example, a checkout counter at a supermarket built for the average customer would probably inconvenience the majority of customers less than one built for either jockey Willy Shoemaker or basketball player Wilt Chamberlain. Designing for the average should only be done after careful consideration of the situation and never as an easy way out [1].

2.3.4 Discussion on Anthropometric Design Principles

The discussion of the above principles refers to the application of anthropometric data for single dimensions (such as height or arm reach). The design problem becomes more sticky when one needs to take into account combinations of several dimensions. For example, the setting of limits such as the 95^{th} and 5^{th} percentiles on each of several dimensions can eliminate a fairly high percentage of population. For instance, Bittner (1974) found in one situation the 95^{th} and 5^{th} percentile limits on each of 13 dimension would exclude 52 percent of the population instead of the 10 percent implied by the 95^{th} and 5^{th} percentile limits of the individual dimensions [1].

This occurs because body dimension are not perfectly correlated with each other. For example, people with short arms do not necessarily have short legs. Not all the people excluded because they are outside the 5^{th} to 95^{th} percentile range on one variable will be the same people who are excluded on another measure. It is important, therefore, to consider the relationship (correlations) between body dimensions in the design of things based on combinations of dimension [1].

Adding the 5^{th} or 95^{th} percentile values of body segments (eg. fingertip to elbow and elbow to shoulder lengths) will not produce the corresponding percentile value for the combined dimension (eg. fingertip to shoulder length). Once again this is because of the imperfect correlation between body dimensions. Robinette and McConville (1981) demonstrate this by building a 5^{th} percentile female out of 5^{th} percentile body segments (ankle height, ankle to crotch, crotch to buttock, etc) The resulting female was 6 in (15.6cm) shorter then the actual 5^{th} percentile value for stature. To derive composite measures requires taking into account the imperfect correlations between the segments being added (or subtracted) by using regression analysis [1].

In the application of anthropometric data, it is sometimes the practice to use physical models, such as the articulated model shown in Figure 2.2.

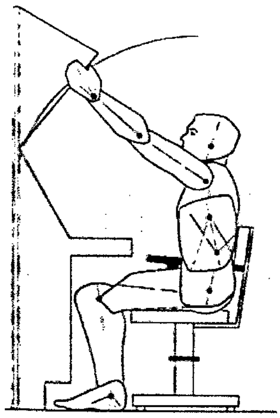

Figure 2.2 An articulated anthropometric data scale model, such as used in the design of work spaces (Meyer, 1979).

Such models usually represent a specific percentile of the population. In addition, there are computer programs available that asses the adequacy of tentative work-space design in terms of anthropometric considerations [1].

In the application of anthropometric data to specific design problems, there can be no nicely honed set of procedures to follow, because of the variations in the circumstances in question and in the types of individuals for whom the facilities would be designed. Using anthropometric data in design involved art as well as science. As a general approach, however, the following suggestions are offered [1]:

i. Determine the body dimensions important in the design (e.g., sitting height as a basic factor in seat-to-roof dimensions in automobiles).

ii. Define the population to use the equipment or facilities. This establishes the dimensional range that needs to be considered (e.g., children, women, U.S. civilians, different age groups, world populations, different races).

iii. Determine what principle should be applied (e.g., design for extreme individuals, for an adjustable range, or for the average).

iv. When relevant, select the percentage of the population to be accommodated (for example, 90 percent, 95 percent) or whatever is relevant to the problem.

v. Locate anthropometric tables appropriate for the population and extract relevant values.

vi. If special clothing is to be worn, add appropriate allowance (some of which are available in the anthropometric literature).

vii. Build a full-scale mock-up of the equipment or facility being design and, using the mock-up, have people representative of large and small users walk through representative tasks. All the anthropometric data in the world cannot substitute for a full-scale mock-up.

The dimension to be considered is such as eye height sitting, elbow rest height, forearm-hand length, buttock-popliteal length, buttock-knee length, popliteal height (no shoes), and knee height sitting (no shoes) as shown in Figure 2.3.

Figure 2.3 Body Dimension

(A) Eye height sitting

(B) Elbow rest height

(C) Forearm-hand length

(D) Buttock-popliteal length

(E) Buttock-knee length

(F) Popliteal height - no shoes

(G) Knee height sitting - no shoes

2.4 Importance of Ergonomics

In an article titled "The Importance of Being Ergonomic", it state that ergonomic is the science of designing products, machines and systems to maximize the safety, comfort and efficiency of users. Ergonomics applies to almost any physical human task, from operating machinery to using cutlery. While the majority of people act instinctively to minimize self harm while working, the science of ergonomics goes further in considering quite specifically how task configuration and tool design can decrease the likelihood of injury [4].

Ergonomics or human factors are graphically illustrated by breakdowns in the interactions between humans and the system with which they work. It is more the case that interactions between human and the system work well, often exceedingly so. However, it is characteristic of human nature that we notice when things go wrong readily than when things go right. Furthermore, it is the situation when things go wrong that triggers the goals for diagnosis and solution, and understanding these situations represents the key contribution of human factors to design system [3].

We may define the goal of human factors as making the human interaction with system one that enhances performance, increases safety and increases user satisfaction. Human factors involve the study of factors and development of tools that facilitate the achievement of these goals [3].

The term "ergonomics" first appeared in 1857, but it was almost 100 years later, during World War II, that interest in the concept intensified. Many war-time