

# Ergonomics Leg Prosthetic Redesign Using An Anthropometric Approach

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**Abstract.** There are several factors and conditions that need attention such as patient health, different sizes and components used in manufacturing leg prosthetic. During this time, Mr.X has used prosthetic leg but with an inappropriate size, the prosthetic leg is longer than the original size of MR.X's foot so that it results in discomfort when use until complaints of injury. One ergonomic approach that can be applied in the design of an equipment to produce optimal products according to the dimensions of the user's body is anthropometry. Measurement of anthropometric data according to the body dimensions of Mr.X for the redesign of prosthetic leg by paying attention to the work activities of the user including the body dimension of D6 of 87.5 cm, D7 of 64 cm, D11 of 38 cm, D12 of 11.8 cm, D13 of 39 cm, D14 of 37 cm, D15 is 52 cm, D16 of 40.2 cm, D30 is 20.5 cm and D31 of 8 cm. In the trial redesign of Leg Prosthetic obtained a better sense of comfort, lighter than the previous prosthetic leg, and no need to use tools in the form of sticks when walking.

**Keywords.** Redesign, Prosthetic Legs, Anthropometry

## 1 Introduction

The need for tools for persons with disabilities is very important as in people with foot amputations. Equipment in the form of leg prosthetic serves to help sufferers of foot amputations to make it easier to move, but not everyone is a good candidate for prosthetic legs as experienced by Mr.X. During this time, Mr.X has used the leg prosthetic but with an inappropriate size, namely the leg prosthetic is longer than the original size of Mr.X's leg. This discrepancy can cause body stress in use for a certain time in the form of fatigue, dizziness, pain to other injury complaints. There are several factors and conditions that need to be considered in making leg prosthetic such as the health of the patient, the suitability of the size of the user and the component of the tool. In product design that is very important to note is the design of the wearer who is centered on humans or the design of humans [[15]].

Comfort using a tool depending on the suitability of the size of the tool with the size of the human user. Inappropriate design can reduce the productivity of the use value or facility that is designed, one of the causes is the discrepancy between the design with limited anthropometric data, so that the design made is based only on the size of the existing design [[13]]. Pheasant (2003) also added that anthropometry is a very important part of ergonomics. Based on this, this research focuses on the prosthetic redesign of the foot

on persons with disabilities (Mr.X) ergonomically with anthropometric approaches

## 2 Research Methods

Ergonomics is a systematic branch of science to utilize information about human nature, human ability and its limitations in designing a good work system so that goals can be achieved effectively, safely and comfortably [[15]]. The main focus of ergonomics considerations according to McCormick and Sanders (1992) is to consider the human element in the design of objects, work procedures and work environment. The basic essence of ergonomics evaluation in the design process is as early as possible to think about human interests so that they can be accommodated in every creativity and innovation of a 'man made object' [[16]]. The focus of attention from an ergonomic study will lead to efforts to achieve a design of a product design that meets the requirements of 'fitting the task to the man' [[1]].

Various studies in the field of anthropometry show that all tools must be adjusted to the anthropometry of its users. Anthropometry as the science of measurement of body dimensions and become an important factor in considering the process of designing facilities or equipment, because anthropometry is used as an adjustment to tasks with humans [[3]]. Dimensions anthropometry dimensions of the human body with 36

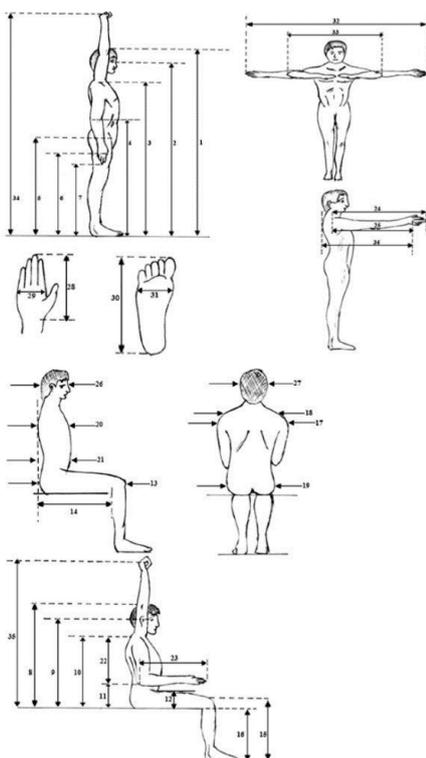
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dimensions of the body as proposed by Pheasant (2003) as in Figure 1.

Three principles in applying anthropometric data to design various products that depend on the type of product. The first principle of the design principle for extreme individuals, which is made in order to be used by extreme individuals, which are too large or small compared to the average to meet the target, large percentage used (90, to 95 or percentile 99) or small percentile (percentile First, 5 or 10). The second principle of the design principle that can be adjusted, in the form of design products that can be tailored to the desires of consumers. The last principle is the principle of designing the average size, in the form of design based on the average human size. This principle is used if the designed design must be used for various human body sizes [[16]].

Creating a product design concept that supports efficiency and safety in the use of product designs made. The design of this concept aims for reliability, comfort, duration of use, ease of use, and efficient in use, so that each product design to meet the user's desires must be done through several approaches including, [[14]]:

- a. Knowing the needs of users. User requirements can be defined based on the needs and market orientation, interviews with potential product users and use personal experience.
- b. Product function in detail. Specific function products that can satisfy users must be explained in detail through the list of items for each product function.
- c. Analyze the product design task.
- d. Developing products.
- e. Test product users.



**Fig. 1.** Thirty-Six-Dimensional Image Of The Body

### 3 Results and Discussion

This research was conducted at the residence of Mr.X, as a footsthetic user, who was located at Jln Raya Sabiyan, Bangkalan, East Java, Indonesia. Starting from July 2021 until September 2021. Mr. X is a person with foot amputation. The 61-year-old man his right foot must be amputated due to the accident he experienced. Mr.X has used leg prosthetic aids to help daily activities, but complaints of discomfort and injury are often felt. The inconvenience complained by Mr.X includes the leg prosthetic that is used at this time is higher than the original feet, so to do work activities such as walking still requires aids in the form of sticks.

To reduce complaints of discomfort and injury, one of which is by redesign of leg prosthetic tools in an ergonomic according to the user's anthropometric data. The following is the process of taking the Mr.X anthropometry data static (Figure 2), as well as MR.X anthropometry data in the body's dimensions used as a reference for making prosthetic tools, as shown in table 1.

**Table 1.** Anthropometric data in the body dimensions of Mr.X

Body Dimensions	Information	Size (cm)
D6	The height of the elbow in a standing position upright (elbow perpendicular)	87.5
D7	The length of the thigh measured to the tip of the knee	64.7
D11	The height of the elbow in a sitting position (elbow perpendicular)	38
D12	Thigh thick or width	11.8
D13	The length of the thigh measured from the buttocks to the tip of the knee	39
D14	The length of the thigh measured from the buttocks to the back of the knee/calf	37
D15	Knee height that can be measured both in a standing or sitting position	52
D16	Body height in a sitting position measured from the floor to thigh	40.2
D30	The length of the foot is measured from the heel to the tip of the finger	20.5
D31	The sole of the foot	8

Based on the user's anthropometry data, using 95% percentile, a more ergonomic prosthetic redesign of the footstetic for Mr.X is carried out to support efficiency and safety in the use of product design. This concept is designed for comfort, duration of use, ease of use, and efficient in use.



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