



# The design of the patella os with wireframes in the direction of the coordinate axes utilizes a multilayer strategy

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## ARTICLE INFO

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## ABSTRACT

Osteology is the science of anatomy in the field of medicine, which includes studying the structure and shape of bones, especially the anatomy of human bones. One of the learning methods is observing and analyzing human bone replicas, this requires that the design of the bone replicas must be similar to the original form. Model design using computer technology, namely CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) is now widely used in the field of design and engineering. Complex and precise modeling can be done in a short time with uniform results. PowerSHAPE software as a CAD application program is capable of creating complex and precise models. By using multiple layers, The patella bone wireframe produced by the rapid prototyping method can be processed easily so that it is hoped that a replica of the patella bone can be made close to its original shape. From the design results, molds and machining simulations can be made using the CAM application program, namely PowerMILL software.

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## 1. INTRODUCTION

Increasingly complex human needs have encouraged humans to create and develop technology with the aim of helping all human activities. One technology that has developed so rapidly is computer technology. Utilization of computer technology can already be felt in all fields and disciplines, including the field of design (design and engineering). Osteology is the science of anatomy in the field of medicine, which includes studying the structure and shape of bones, especially the anatomy of human bones. One of the learning methods is observing and analyzing human bone replicas, this requires that the design of the bone replicas must be similar to original form

The method used in the design is a multi-layer method. The basic principle of the multi-layer method is to cut the model that has been obtained through the rapid prototyping method into several parts with a certain distance where each path that cuts the model is placed in a separate layer. In this study, PowerSHAPE software was used to design patella bones because this software

is easy to use and capable of making image objects with a good level of accuracy and PowerMILL software for machining simulations of patella bones.

## 2. RESEARCH METHOD

Osteology is the science of anatomy in the field of medicine, which includes studying the structure and shape of bones, especially the anatomy of human bones. One of the learning methods is observing and analyzing replicas of human bones. The next problem is how to use computer technology to design complex bone shapes in order to approximate the original bone shape so that later it can be used in the medical field. In the previous study, namely the Design of a Hamatum Os Replica

using the Rapid Prototyping Method has produced a 3D wireframe that is close to the shape of the original bone. The basic principle of previous research is to cut the components to be modeled into several layers with a certain depth. In each of these layers there are paths of cut components and with the help of the PowerSHAPE software these grooves can be compiled into a model (Arif, 2006). Continuing this research, this research focuses on finding better methods in bone design. The method used is the Multi Layer method. The basic principle of the multi-layer method is to cut the model that has been obtained through the rapid prototyping method into several parts with a certain distance where each path that cuts the model is placed in a separate layer.

To get optimal results it takes several data trials. The data obtained will be analyzed to obtain the most effective method in producing a replica of the patella bone.

The steps involved in designing a patella bone replica can be seen in picture Figure 3.1.

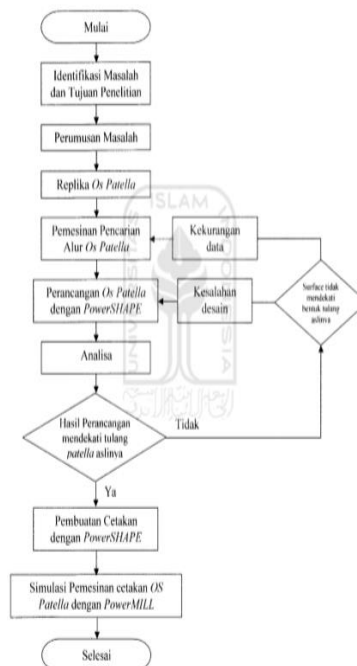


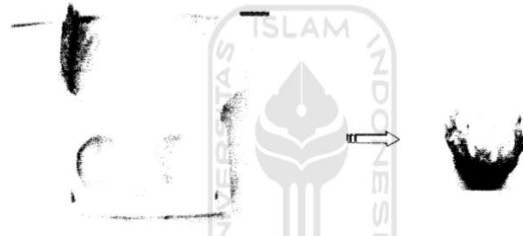
Image 1 Research flow chart

### Research / Design Objects

The bone used in this study is the patella bone. The research was conducted at the CAD/CAM/CAE Laboratory, Department of Mechanical Engineering, Faculty of Industrial Technology, Islamic University of Indonesia using PowerSHAPE software, PowerMILL software, and a Roland EGX 600 CNC Engraving machine.

### Making a Replica of the Patella Os From Wax

The purpose of making a patella bone replica is to make it easier to search for bone grooves, where the grooves obtained can be used for the process of designing a patella bone replica. To make it, a patella bone replica mold made of silicon rubber is used with the original bone as the master (imprint core) as shown in the following figure.



**Figure 2**Patella os replica mold

The Patella Bone Replica Mold is made of Silicon Rhodorsil RTV 585 and Catalyst 60 R. Patella bone replica printing is done by slowly inserting wax into the mold and then removing it carefully, this is due to the wax's soft nature and easy to shape.

#### **Embedding the Os Patella Replica into Gypsum**

To get the patella bone groove, a wax replica of the patella bone is implanted into the gypsum. In this way the shape of the wax replica can be maintained. Figure 3.3 shows a replica of the patella bone cast in gypsum.

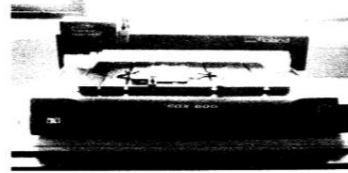


**Figure 3**Replica of wax printed in gypsum

#### **Patella os groove search with the help of Roland's CNC Engraving machine EG X 600**

To get the patella bone groove that has been implanted into the gypsum, a cutting process is carried out with a depth of 0.5 mm and the position of the patella bone replica is facing up / looking up. The reference line was made using an HSS End Mill chisel with a diameter of 6mm. After each slicing process is completed, a reference line is made using a chisel, namely by eating the gypsum sides that have been sliced in the x and y directions intersecting each other.

and perpendicular to a depth of 1 mm. The first slicing process that produces replica grooves of sliced bone is assumed to be the stage of first layer formation. The slicing process is continued until the entire patellar model is completely sliced and produces several layers. In this way, the grooves obtained can be arranged and positioned properly. The process of slicing gypsum can be seen in Figure 3.4 below.



Gambar 3.4 Proses pengirisan gipsum

Figure 4Gypsum slicing process

**Taking Pictures of the Groove of the Patella Oss with a Digital Camera**

Using the rapid prototyping method, the replica of the patella bone and the wax printed on the gypsum were sliced at a certain distance with the help of a Roland EGX 600 CNC Engraving machine. Each slice was taken with a digital camera to obtain a JPEG file. The results of taking JPEG images can be seen in Figure 3.5 below.

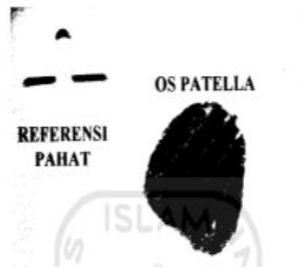


Figure 5Ospatella grooves shown above with chisel reference

**Making a Patella Os Replica Wireframe**

The purpose of the rapid prototyping method used to design a replica of the patella bone is to obtain a wireframe from the bone which is then rearranged into a three-dimensional framework.

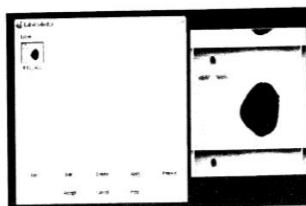


Figure 6Import photos into PowerSHAPE

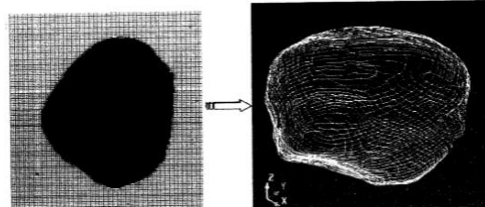


Figure 7Making ospatella wireframes

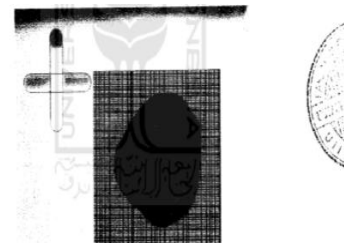


Figure 8Grid auxiliary lines

**3. RESULTS AND DISCUSSIONS**

**Patella Os Replica Design Results**

The application of the rapid prototyping method to design a replica of the patella bone and the use of the multi-layer method in cutting wireframes obtained through the rapid prototyping method have

resulted in a patella bone model that is close to the original patella bone. Surfaces with complex indentations can be made with a more precise approach to the wireframe cutting process. The main thing that must be considered in designing a patella bone replica to produce a good shape is to keep the wireframe obtained through the rapid prototyping method in accordance with its original shape and position, so that during the wireframe cutting process, the resulting wireframe will follow the shape of the reference wireframe.

### Patella Os Mold Making

So that the design of the patella bone replica can be realized in a real form, it is necessary to design a mold according to the results of the design. The steps for making a patella bone mold are as follows: a. Changing the surface of the patella bone to be solid With the solid command, namely create solid from selected surfaces t, the surface parts of the patella bone will merge into one solid shape. b. Create solid blocks ^ .

Block size is 70 mm long, 35 mm wide and 40 mm high. This size is obtained by adjusting the dimensions of the patella bone design. Block settings can be seen in Figure 4.8

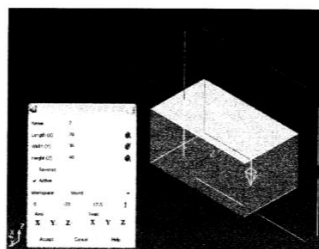


Figure 9 Block settings

c. Joins A/o£ .vo//J with the first part of the patella (for medial view) d. Joins the solid block with the second half of the patella (for lateral view impressions) e. With the command remove the selected solid, solid or symbol from the active solid.

Maka a combination of a solid block with a patella bone design will produce an impression as shown in the image below.

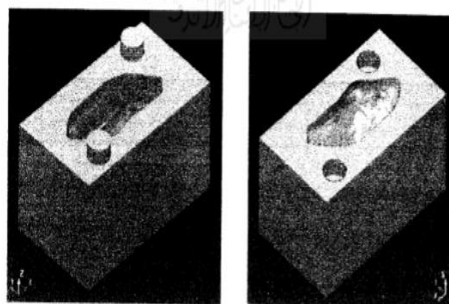


Figure 10 Moldospatella

## 4. CONCLUSION

In this study the method used is the multi layer method. The basic principle of the multi-layer method is to cut the model that has been obtained through the rapid prototyping method into several parts with a certain distance where each path that cuts the model is placed in a separate layer. While the basic principle of the rapid prototyping method is to cut the components to be modeled into several layers with a certain depth. In each of these layers there is a path of cut components and with the help of the PowerSHAPE software these grooves can be arranged into a 3D wireframe. The 3D wireframe replica of the bone is then cut in the direction of the cut in the x-axis and y-axis directions for the purpose of making a surface.

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