3D Printed Orthopedic Cutting Guide

Team Members: Andrew Knoeppel, Anuar Acosta, Chelsie Metz, Daniel Simmons, Thomas Friesch

Function:

Bone deformities in both animals and humans can often lead to future problems such as pain, infection, and loss of mobility. These issues can be exacerbated by a lack of surgical precision. Our client Jason Bleedorn, a surgeon within the UW Veterinary Department, is looking for a cost efficient way to fabricate an orthopedic cutting guide to aid the removal of bone deformities in animals. Currently, methods to obtain an accurate cutting guide can cost up to 10k, which normally is too expensive for an average pet owner. We hope to utilize 3D printing as a less expensive alternative to provide these guides to Jason Bleedorn and his colleagues and to increase the general quality of orthopedic care for animals over time.

Client Requirements: The cutting guide will be created using a pre-made CAD model specifying the specific dimensions of the specific animal bone, and we will be downloading the CAD models to a 3D printer. The client will only need a few before the end of the semester, as Jason only has a couple bone deformation surgeries scheduled.

Design Requirements: The following list is a set of requirements that must be fulfilled by the final product.

1. Physical and Operational Characteristics

1.0 *Performance requirements*: The cutting guide must be used once for each specific animal surgery. It must be able to withstand high amounts of heat and pressure from the sterilization process, as well as heat and physical stress from when the saw blade moves along its edge. Most importantly this product must be produced in a more cost efficient way than the normal manufacturing process.

2.0 *Safety*: This product will be made of a polymer so it can withstand high temperature and stress. The product must be sterilized before use in a surgical setting and the manufacturing process must be user friendly and non hazardous. Any mixing of polymers or handling of the 3D printer should be done with caution.

3.0 *Accuracy, Quality and Reliability*: The manufacturing process must reduce the cost of production by 30%. This process must be repeatable in a timely fashion to ensure maximum manufacturing efficiency.

4.0 *Life in Service*: This process will be implemented and used indefinitely if it turns out to be more efficient than the current cutting guide manufacturing process. The guide itself will be used once on each specific patient case and then recycled.

5.0 *Shelf Life*: The process does not have a shelf life however the cutting guides will maintain their appearance and performance for long periods of time, as plastic is not easily corrodible.

6.0 *Operating Environment*: The process must be operable in any location with access to a 3D printer, electricity, and the correct polymer. The guide itself must be operable in a surgical setting. The guide must be able to withstand exposure to light, bodily fluids, metal, radiation from imaging, and physical stress. The guide must also be able to withstand the 121℃ and 15 psi used in the sterilization process.

7.0 *Ergonomics*: The process is mainly computer operated. A CAD application must be accessible to create the design, and a human must import the CAD model to the 3-D printer. The cutting guide itself must be user friendly and easy to handle for the surgeon and any surgeon assistants in the operating room.

8.0 *Size*: The manufacturing process is to ideally be large scale if it is economically efficient. The cutting guide's size will vary based on the specific case, however it must be large enough to allow for an accurate cut o the animal bone

9.0 *Weight*: The process does not have a weight, however the cutting guide's weight should be light enough to be easily handled, and durable enough to withstand force.

10.0 *Materials*: The process is to be made using CAD models, a 3-D printer, and a polymer.

11.0 *Aesthetics, Appearance, and Finish*: The produced cutting guide is to be smooth and precise.

2. Production Characteristics

12.0 *Quantity*: The number of units needed during this process is one per surgical case. However, this production method will take place at a large scale.

13.0 *Target Product Cost*: The production cost of this method is to be 30% less than the standard manufacturing method.

14. *Testing*: We will test the different polymers in order to determine which is the best to use under the given stresses. We will then conduct a feasibility test in order to determine how much

more efficient a 3-D printed cutting guide is compared to the normal CNC manufacturing method.

3. Miscellaneous

15.0 *Standards and Specifications*: Cutting guides produced via this method must meet FDA regulations for use in a surgical setting.

16.0 *Customer Requirements*: This production method must be cheaper, faster, and more precise than the traditional method.

17.0 *Competition*: The current method of producing cutting guides is to mill them using CNC. (source needed)