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BIOMODELS CONFECTION BY RAPID PROTOTYPING USING REVERSE ENGINEERING TECHNIQUES

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Abstract. *Bioengineering is the most recent engineering area to solve issues, needs and optimization in health field. At the same time, reverse engineering and rapid prototyping are allies in the product conception like competitive factors. In the same way, bioengineering are using the both areas – rapid prototyping and reverse engineering – to solve complex surgical cases allying with surgeons. This article showed how biomodels are produced (high fidelity prototypes of human body) to assist surgical cases, improve the accuracy of incision, time and energy expenditure. To produce them, one could used reverse engineering techniques like tridimensional digitalization, CAD/CAM softwares and the manufacturing process involved are the rapid prototyping. The conclusions about this techniques are that biomodels improved the chance of success preventing malpractice and in the same path, providing better aesthetics results and finally they are low cost sufficiently to improve surgeon profits.*
Keywords: *rapid prototyping, reverse engineering, biomodels, bioengineering.*

1. INTRODUCTION

Rapid prototyping is a term to describe several additive manufacturing processes. Basically the process decodes the surface model in many horizontal slices it will drew by head prints in a print surface (sheet lamination). Nowadays, this fabrication technique is competitive factor in product development accelerating the design process and reducing prototype costs.

1.2 Medical aplications

This paper describes the adapted process from NUTES (Núcleo deTecnologias Estratégicas em Saúde) to its health services and researchs. In surgerys preparative a 3D model (biomodel) helps surgeons to plan and simulate every process without the pacient. This technique helps surgeons decreasing malpractice and surgery time.

2. THEORIC FUNDAMENTATION

In accordance with (Meurer et al, 2009) the development of prosthesis and orthesis is benefited by rapid prototyping techniques, in other hand the aesthetics results are better to pacient. In this same path hip socket, kness, vertebral column implants and oral maxillofacial surgery. High complex surgerys is benefited too with rapid prototyping when exists high precision need like in Guatemalans twins separation, described by recent work (Tukuru, 2008).

To reach surgery goal assisted by rapid prototyping is adopted Reverse Engineering techniques to absorbs surface model described in recent work (Wang, 2011) and adapted to medical needs described in recent work (Leu et al, 2008).

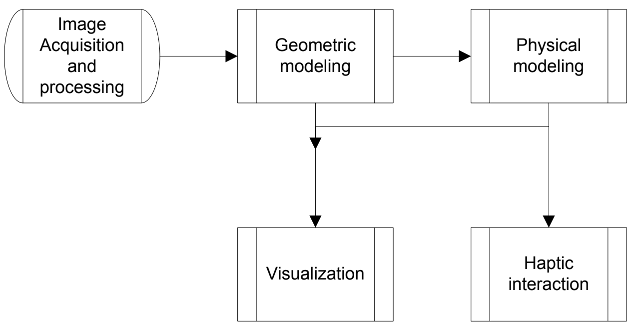

Fig 1. Key elements invoveld in bone surgery simulation.

This principles is used to assited surgeons in surgery process.

3. MATERIAL AND METHODS

In NUTES is used the Inkjet technology, method that uses the same principle of a conventional paper printers. Firstly is insert a photocurable resin in machine, the next step is start the print and the machine after heat the print heads lies object slices in the print surface involved in support material.

To absorbs surface model the Reverse Engineering to geometry acquisition is adopted was described to recent work (Raja, 2008), follows in the flowchart:

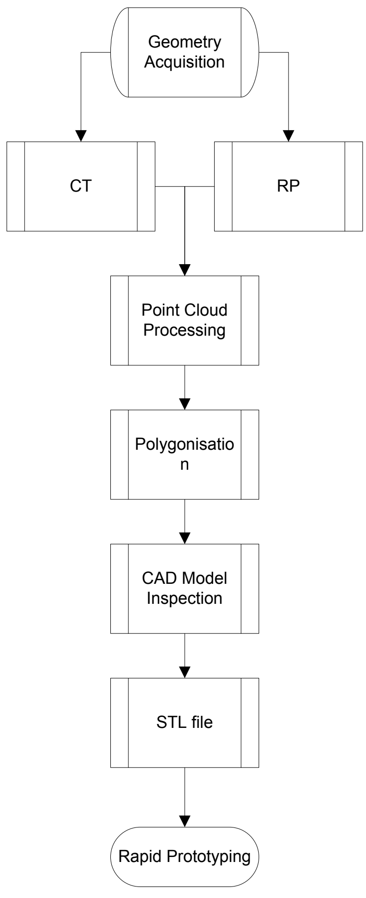

Fig 2. Geometry acquisition flowchart.

In NUTES, firstly step "geometry acquisition" is used CT and RP machines follow image acquisition adquires DICOM files, usual images to surgeon's analyses.

The next step is processed by a specific software, InVesalius developed by CTI (Centro de Tecnologia da Informação), to point cloud processing and polygonisation, exporting a STL file.

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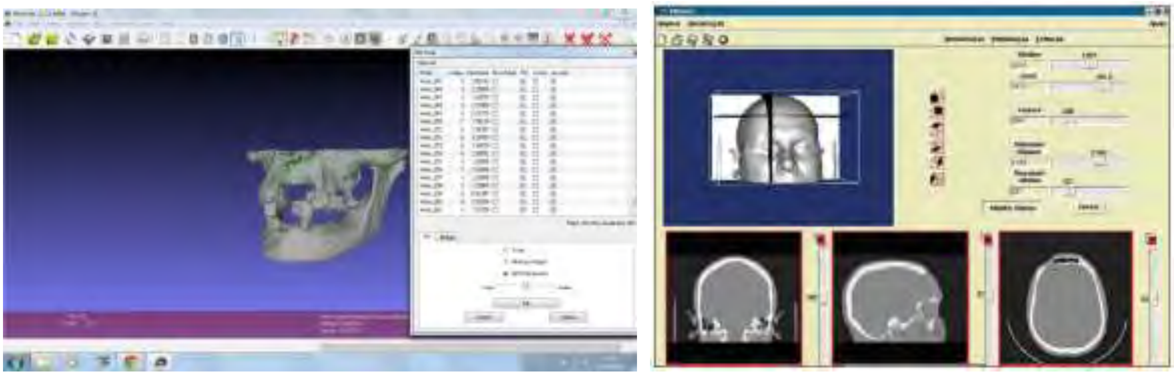

Fig 3. Meshlab and InVesalius processing.

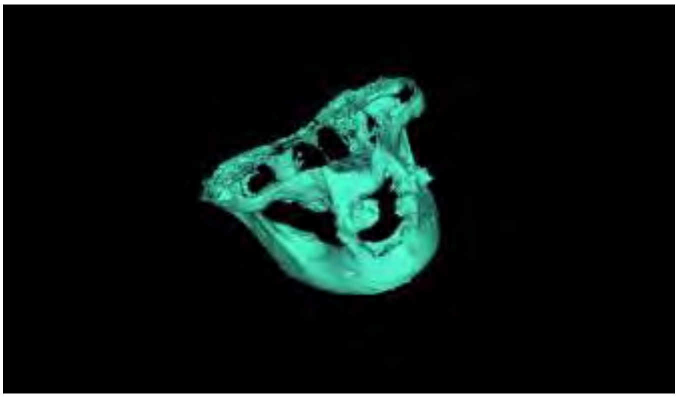

Fig 4. STL model.

The third step the user open the STL in a new software, Meshlab, to inspect the surface, fill holes and smoothing the model surface. Finally, when the software features show that STL file is in accordance, print the biomodel. So, the adapted method is described in flowchart below:

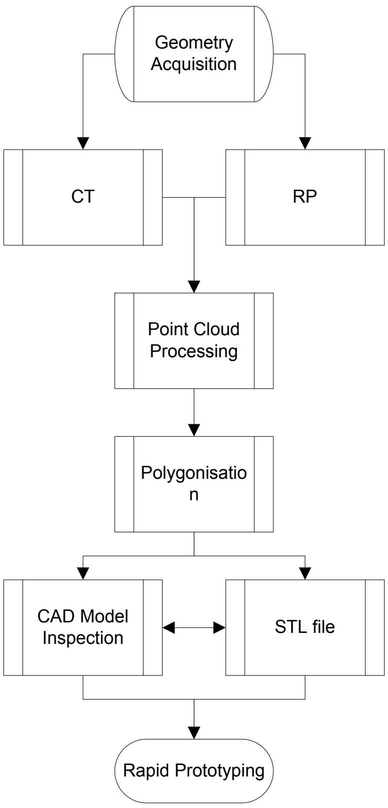

Fig 5. Adapted method flowchart.

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After this process, enters the rapid prototyping process in accordance with ASTM E1340-05 "Standard Guide for Rapid Prototyping of information Systems" in interaction with surgeons, radiologists and engineers to concept the final biomodel or health product, prosthesis for example.

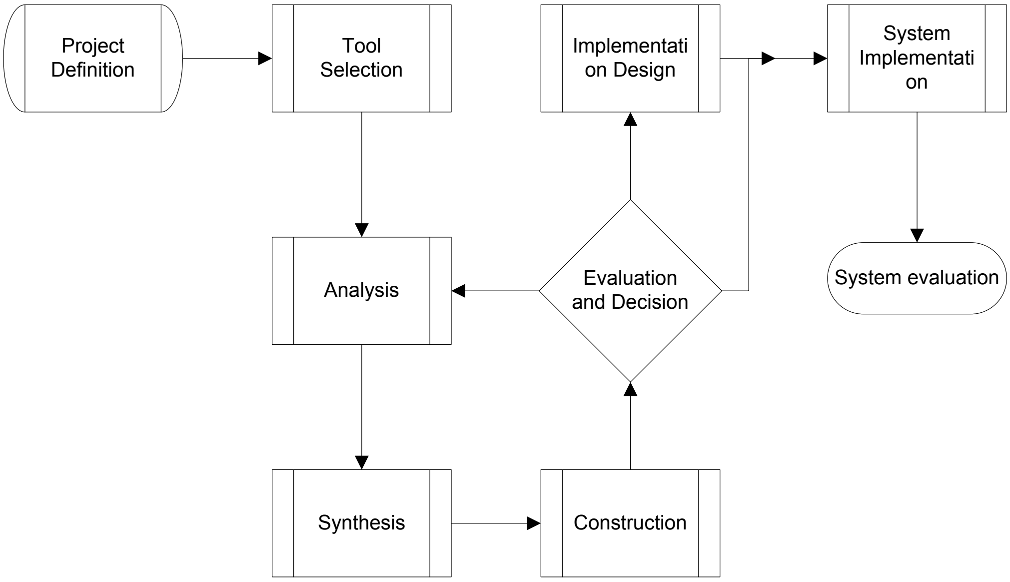

Fig 6. ASTM standard flowchart.

The standard method was adapted too replacing the two first steps, "project definition" and "tool selection" by the method in figure 3. Finally the biomodel are printed in a Objet/Stratasys connex 350 in 16μm resolution and cleaned in a Balco WaterJet Unit and in a caustic soda solution 2:8.

Fig 7. 3D printer in NUTES.

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Fig 8. Waterjet unit.

Fig 9. Printed biomodel.

4. RESULTS AND DISCUSSION

Finally its obtained a complete method applicable to health and surgeon needs in accordance with rapid prototyping and health literature, reverse engineering techniques and ASTM standards. In the final is obtained the biomodel. Printed model is evaluated by surgeon and apply haptic evaluation and modeling bone cement over the biomodel. The inspection consists in evaluate the dimensions by comparison with DICOM, patient and CAD software data.

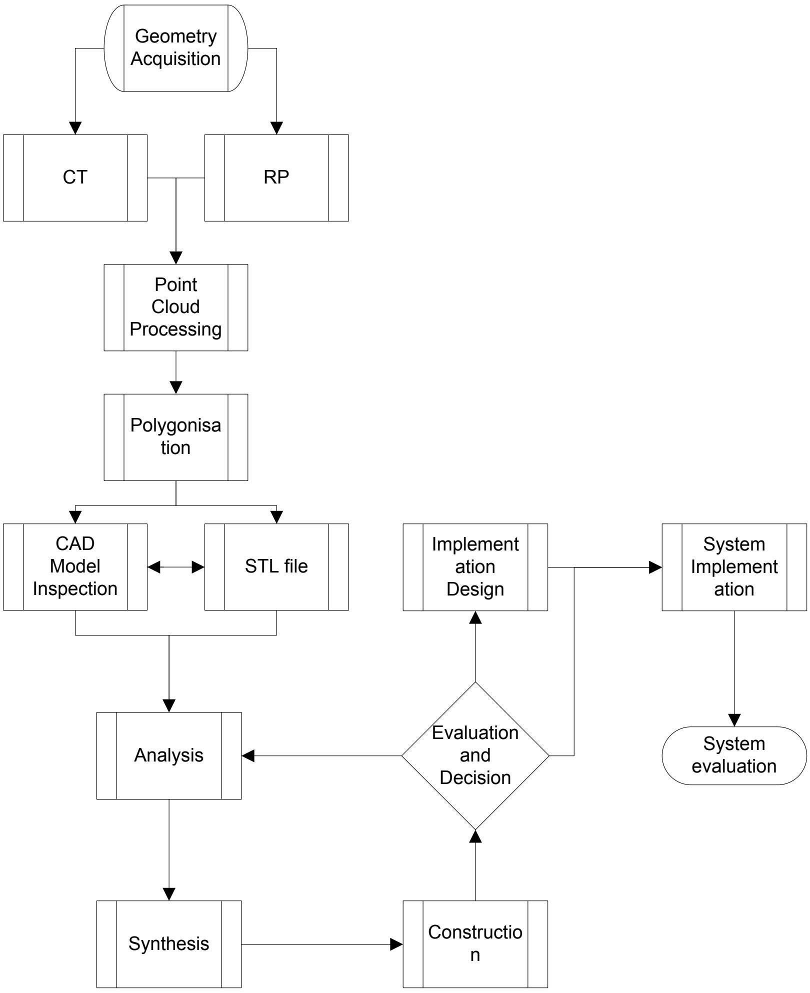

Fig 10. Adapted method to NUTES flowchart.

5. CONCLUSIONS

In accordance with literature and the process adopted the geometry acquisition by Reverse Engineering techniques are enough to dispense open patient body, decreasing surgery time and malpractice chances. At the same time the adaptation of method allows better aesthetics results to patients and reduces risks to patient.

The adopted method is use to de date.

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