Co-funded by the
Erasmus+ Programme
of the European Union

MediTec 2018
ADDITIVE MANUFACTURING IN MEDICINE

Speaker: Dr. Marek Schnitzer

Authors: **Jozef Živčák, Radovan Hudák, Marek Schnitzer**

Košice 2018

ISO 13485
LL-C (Certification)
ISO 9001
LL-C (Certification)

ADDITIVE MANUFACTURING OR 3D PRINTING?

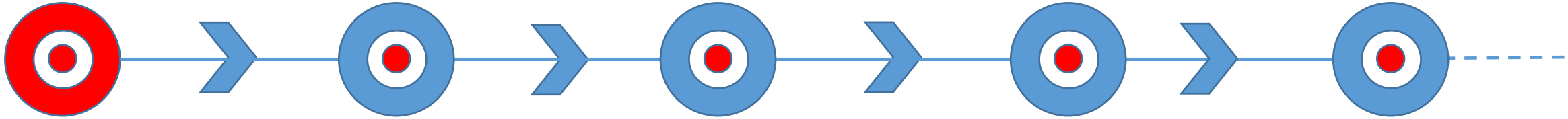
Process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies. Synonyms are additive fabrication, additive processes, additive techniques, additive layer manufacturing, layer manufacturing, and freeform fabrication (ASTM F2792).

Those from the scientific and technical communities prefer to use ***additive manufacturing*** when referring to the group of processes that build parts layer upon layer. An important reason is that it is the official standard term according to the **ASTM F42 and ISO TC261 committees** (Wohlers Associates, 2016).

3D printing is, by far, most popular term. Google displays 20-30 times more references for 3D printing (or 3-D printing) compared to additive manufacturing. Today, many individuals and organizations use 3D printing and additive manufacturing interchangably (Wohlers Associates, 2016).

.

ADDITIVE MANUFACTURING IN MEDICINE



1971

Sir Godfrey Hounsfield

invents the CT scan
(Katie Weimer, MS, 2016)

1977

Raymond Vahan Damadian

invents an apparatus and method to use NMR safely and accurately to scan the human body (now known as MRI)

1981

Drs. Jeffrey Marsh & Michael Vannier

create 3D models from 2D, milled slices

(Katie Weimer, MS, 2016)

1983

Chuck Hull

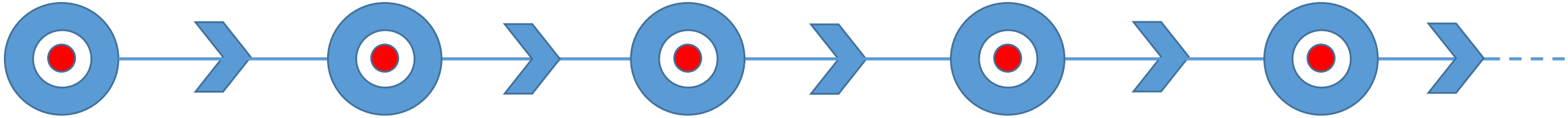
Invents 3D printing via Stereolitography

1988

Dr. Mankovich @ UCLA

The first model of anatomy is produced using 3D Printing
(Katie Weimer, MS, 2016)

ADDITIVE MANUFACTURING IN MEDICINE



1998

the first selectively colored SLA model in the US, produced in Colorado
(Katie Weimer, MS, 2016)

2000

medical applications of 3D printing date back to the early 2000s, with the production of dental implants and prosthetics
(Gross , Bethany C. at all, 2014).

2003

Dr. Kenneth Salyer

successfully separates conjoined Egyptian twins

2003

3D Printing in titanium gets its start for implants
(Katie Weimer, MS, 2016)

2007

Virtual Surgical Planning (VSP) gets it start and moves toward becoming the gold standard for surgical planning

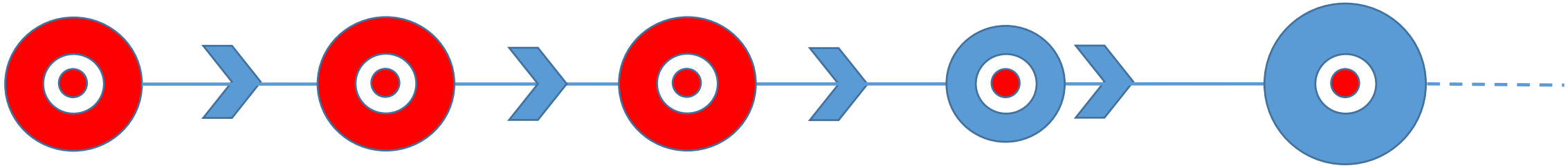
(Katie Weimer, MS, 2016)

2008

personalized surgical instruments for total knee surgery become commonplace

(Katie Weimer, MS, 2016)

ADDITIVE MANUFACTURING IN MEDICINE



2008

Radovan Hudák
Jozef Živčák

idea to produce implants by additive manufacturing in Slovakia

2010

FDA clears the first 3D printed metallic implant

2010

The company **CEIT –KE** was established, later

CEIT Biomedical Engineering s.r.o.

2013

first implant is implanted designed and produced by **CEIT Biomedical Engineering** Company

2014

anatomical models for surgical planning in hearts, kidneys and other organs becomes common

(Katie Weimer, MS, 2016)

2020 -....

3D printing as a surgery assist

the increased availability of biocompatible materials

patent expiry and the reduced cost of innovation

(Srinath, Aniruddha, June 2016)

CEIT Biomedical Engineering

Company was established in 2010 as spin-off company of Technical University of Košice (TUKE) and CEIT a.s. holding (Central European Institute of Technology).

Company employes are mostly biomedical, material and quality engineers who were students of TUKE, Faculty of Mechanical Mngineering, Department of Biomedical Engineering and Measurement.

free form modelling & development of prototypes

manufacturing of certified medical products, custom-made & in series

research & development of medical products

CEIT Biomedical Engineering

custom implants made of titanium alloy Ti-6AI-4V (Grade 5) and Ti-6AI-4V ELI (Grade 23) manufactured by the 3D printing technology

plastic and metal prototypes manufactured by the 3D printing technology, manufacture of anatomic models

3D scanning, digitalisation and modelling of medical products

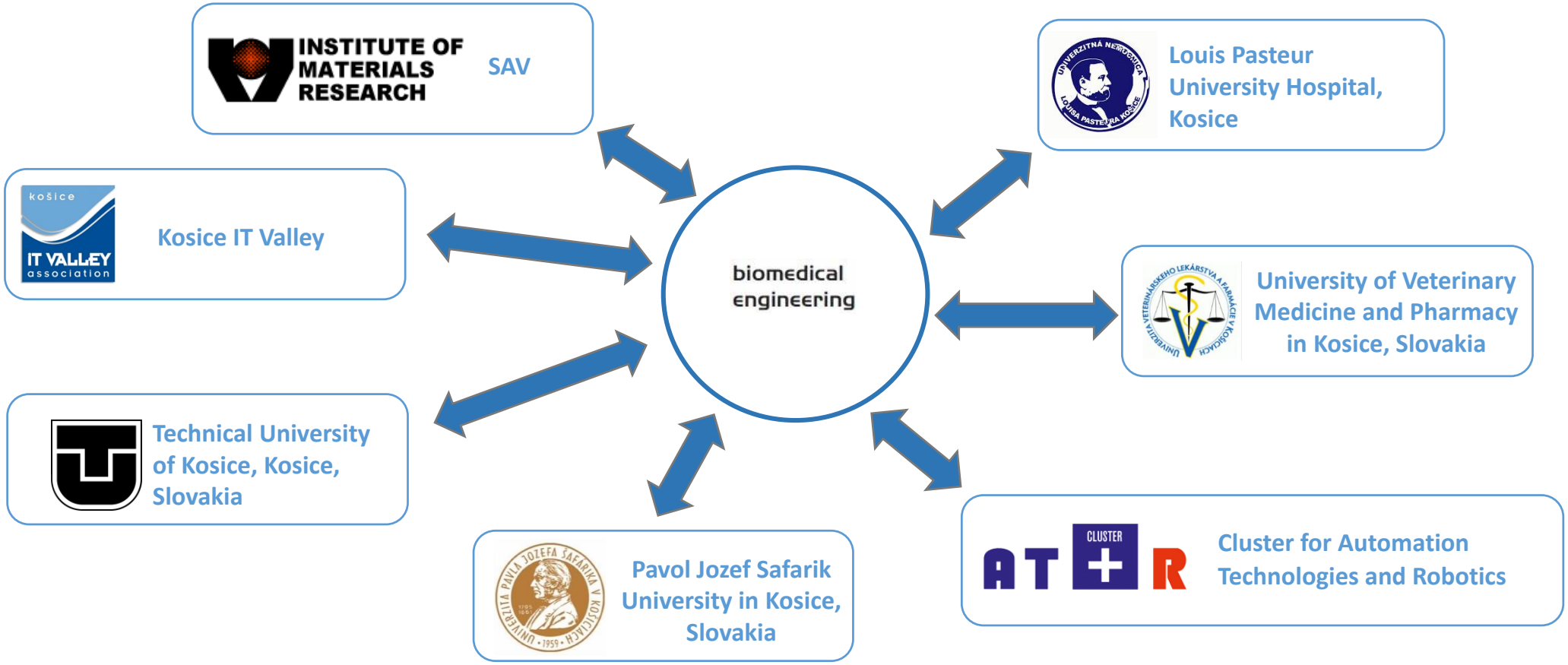
medical data processing and adjustment

verification and validation of medical products medical metrology and diagnostics

science and research in the field of implantology, implant manufacturing and medical sensorics

- Company is acredited producer of CMF custom-made implants: SIDC code – SK-13-0224
- Approved medical devices:
  - Custom-made cranial implant P91710
  - Custom-made maxillo-facial implant P91709
  - Custom-made cranio-maxillo-facial implant P91708
  - Custom implant for chest surgery
  - Custom made spinal implants

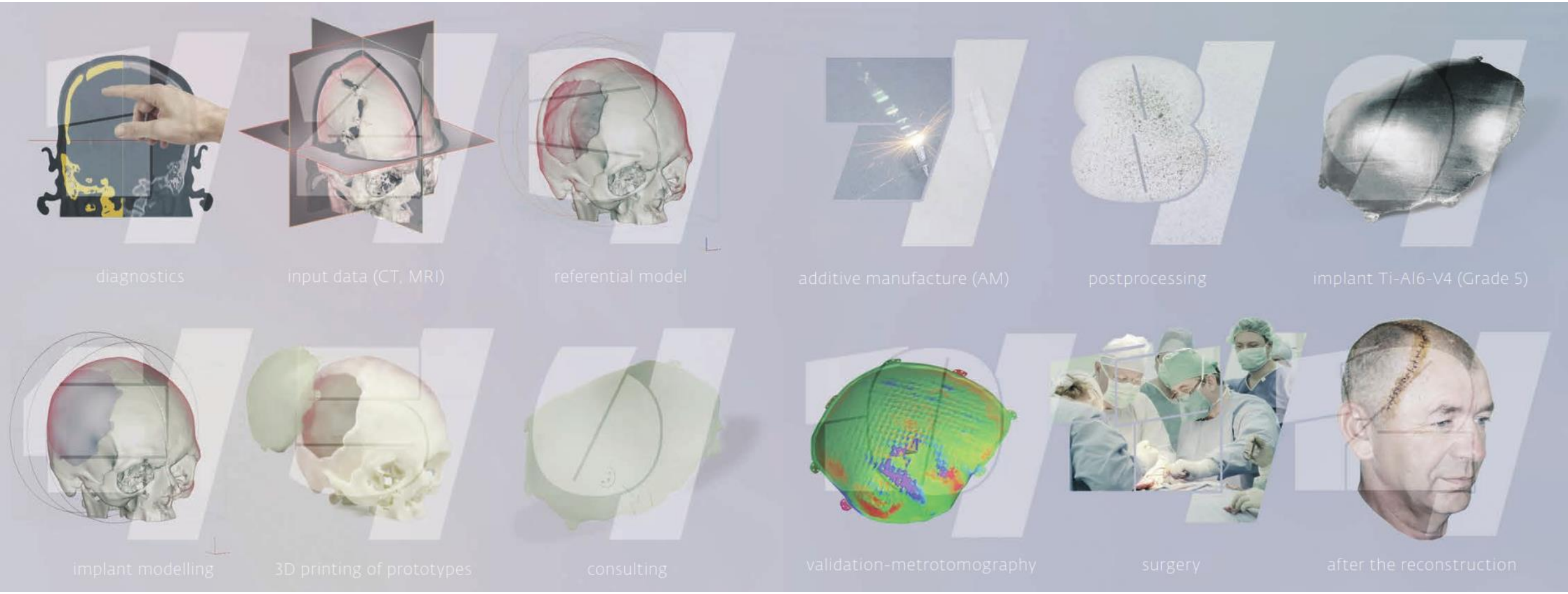
CEIT Biomedical Engineering



*AM/ step by step

process of development and manufacturing of a custom-made cranial implant applying the additive technology

MEDICAL AM WORKFLOW



MEDICAL AM WORKFLOW – INPUT DATA

Body surface:
Optical and laser scanning

Bones:
CT/MRI/ DICOM data

Inner organs:
CT/MRI/USG DICOM data

MEDICAL AM WORKFLOW – PRODUCTION TECHNOLOGY

Building volume
(including building platform)
250 mm x 250 mm x 325 mm

Laser type
Yb-fibre laser, 200 W

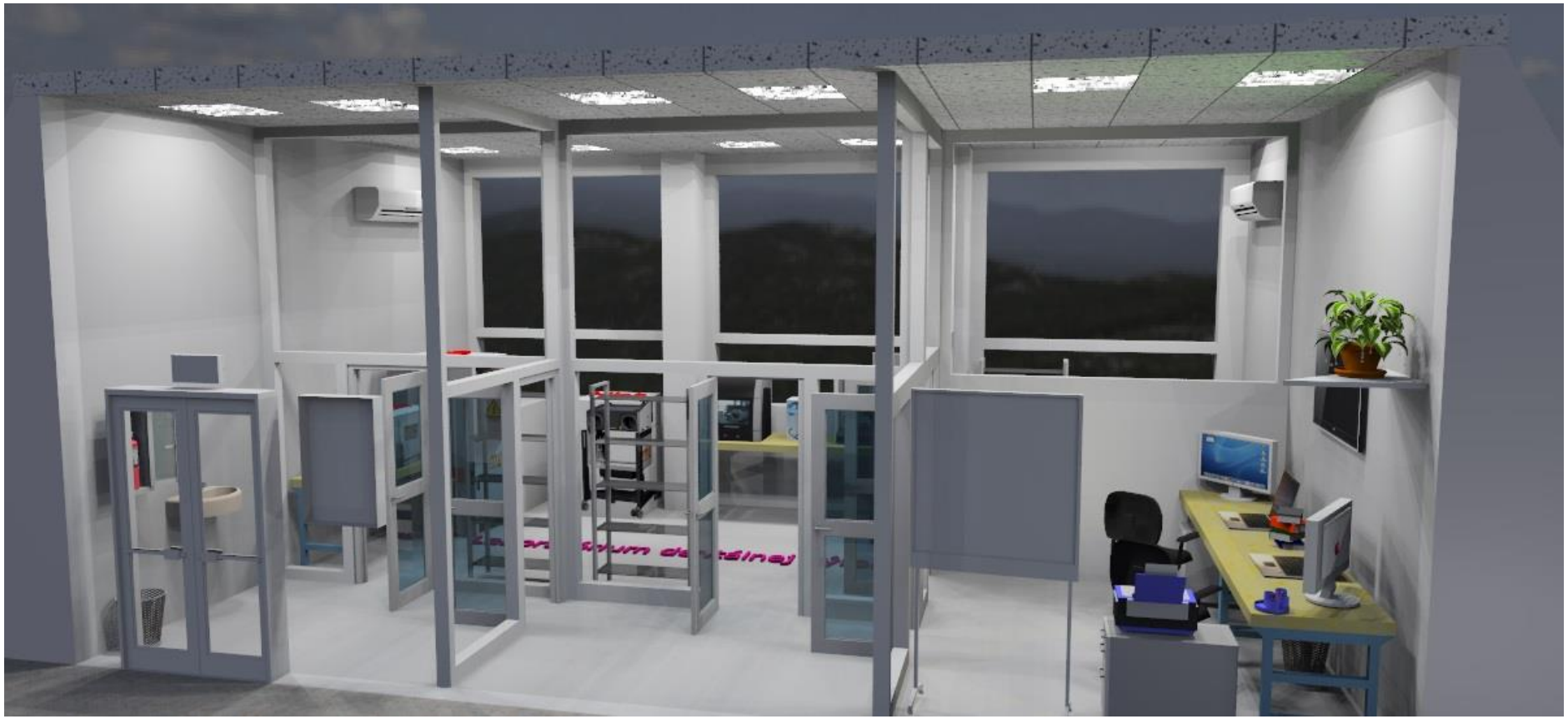
Precision optics
F-theta-lens, high-speed scanner

Scan speed
up to 7.0 m/s (23 ft./sec)

Variable focus diameter
100 - 500 µm (0.004 - 0.02 in)

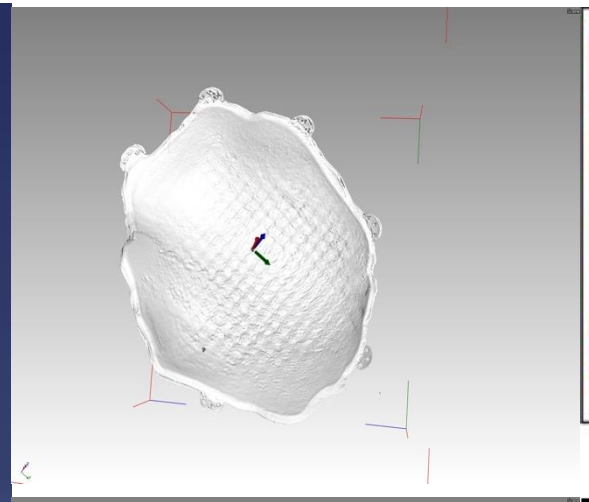
Material:
Ti-6Al-4V (Grade 5), Ti-6Al-4V ELI (Grade 23)

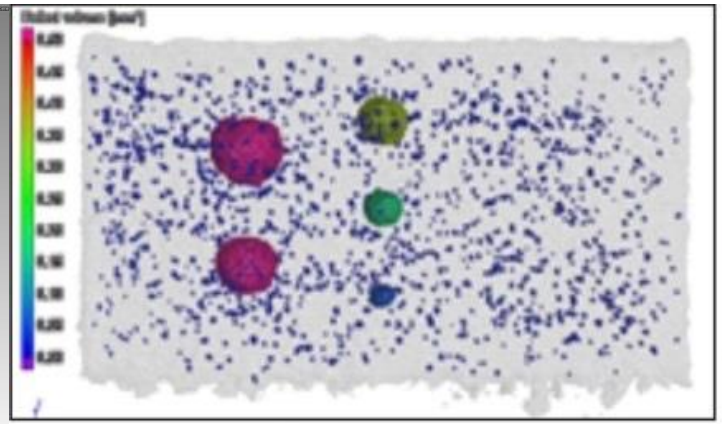
MEDICAL AM WORKFLOW – PRODUCTION TECHNOLOGY



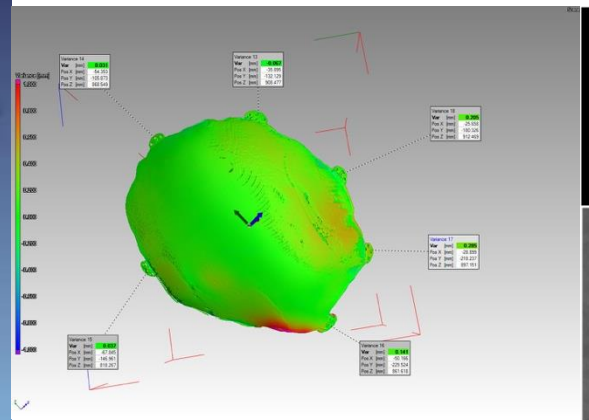
MEDICAL AM WORKFLOW – QUALITY CONTROL

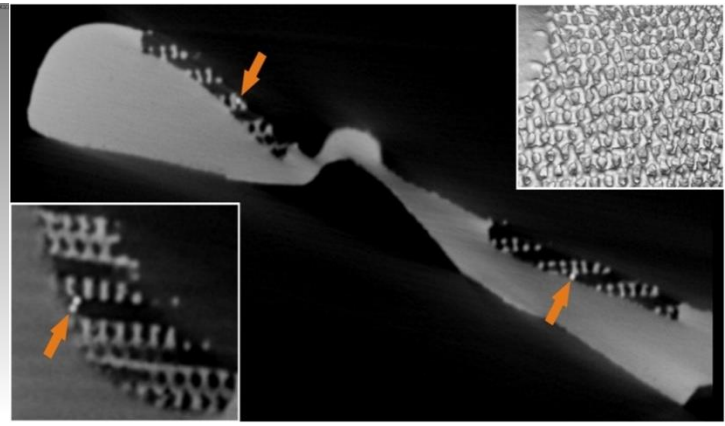
METROTOM 1500, Carl Zeiss, Germany



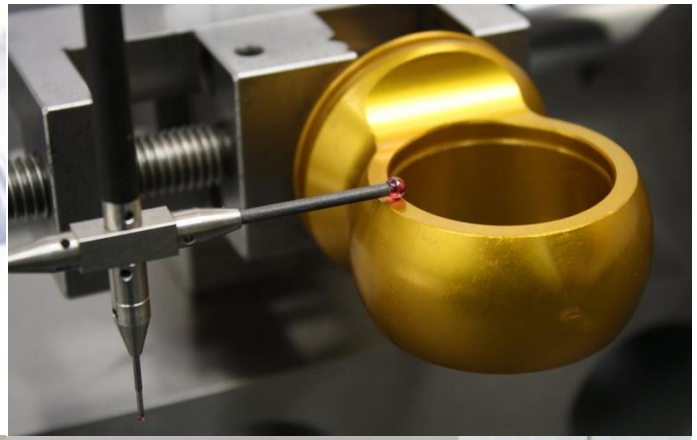


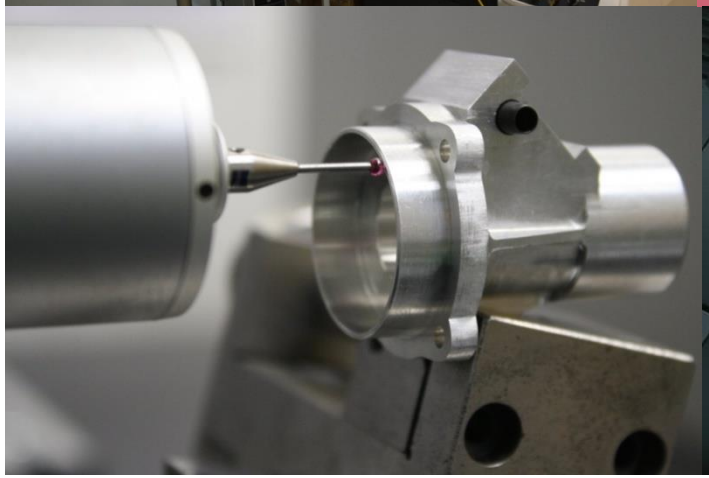
60 mm



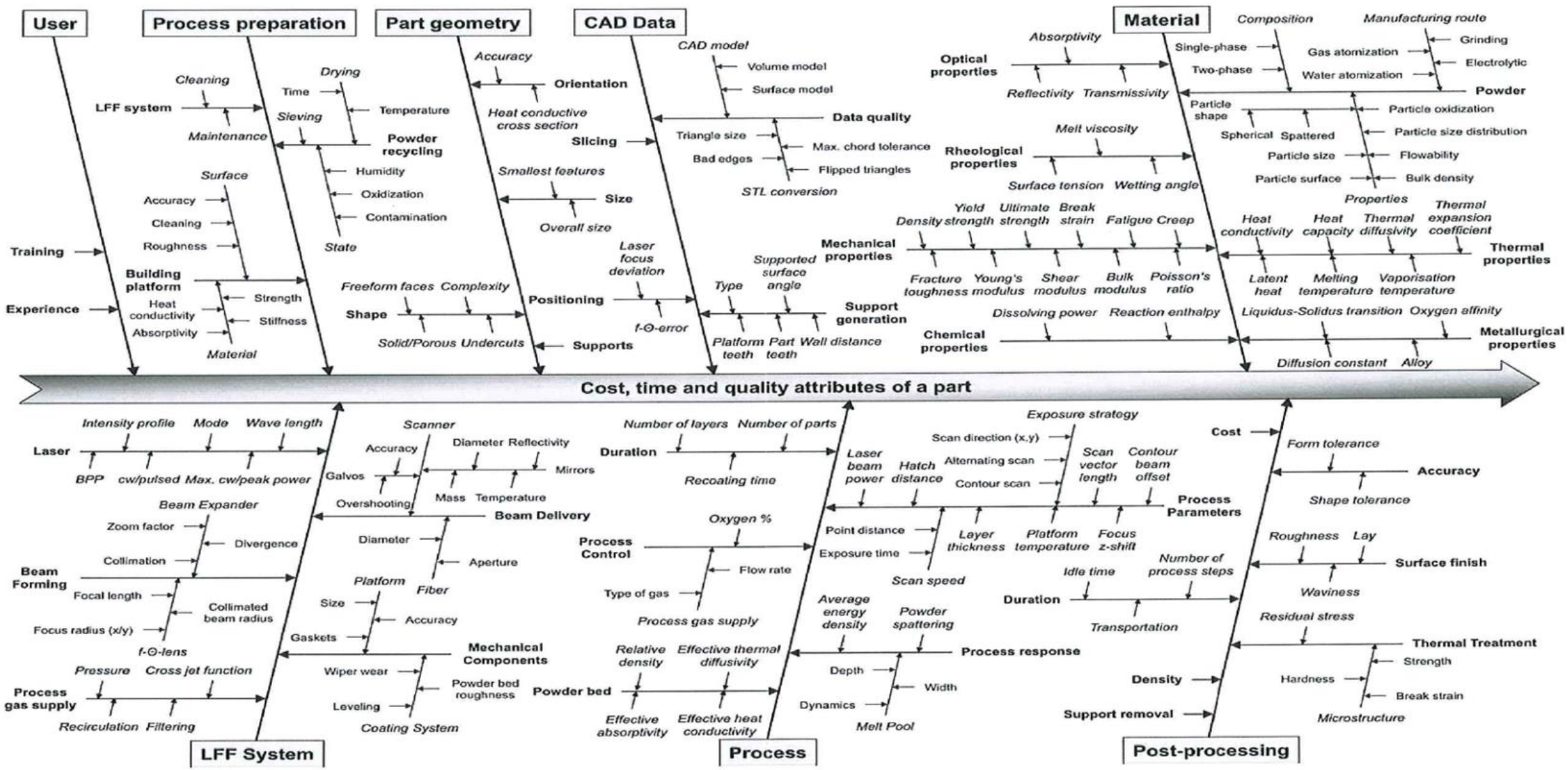


MEDICAL AM WORKFLOW – QUALITY CONTROL



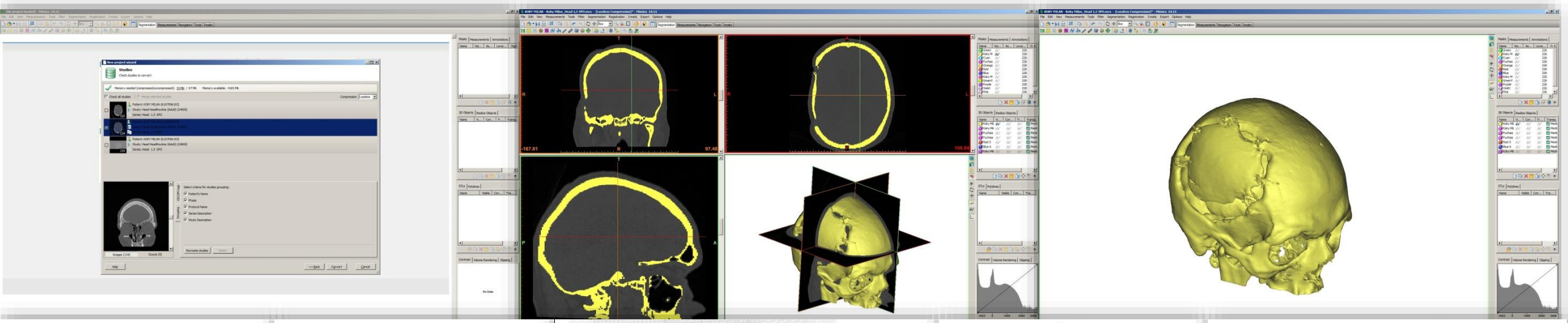


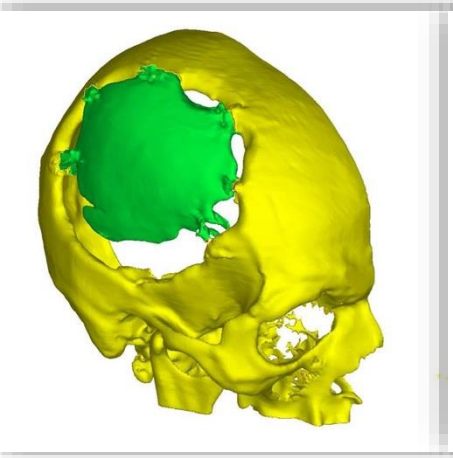
MEDICAL AM WORKFLOW – QUALITY CONTROL

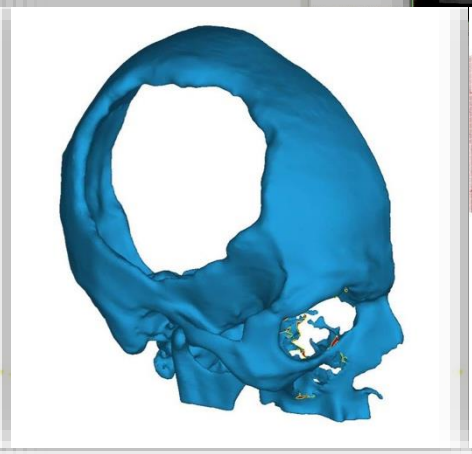


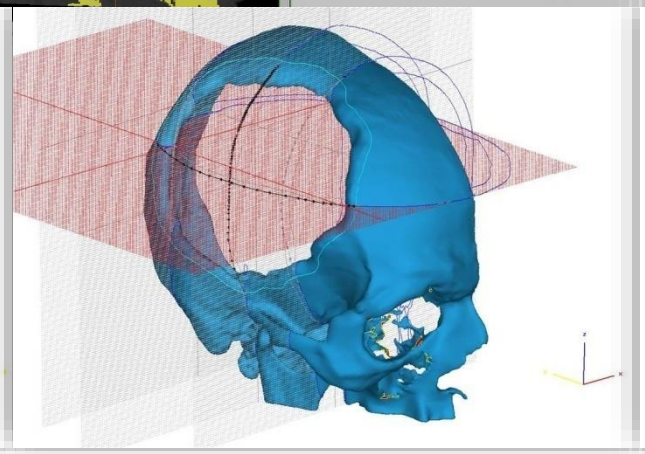
Laser Freeform Fabrication

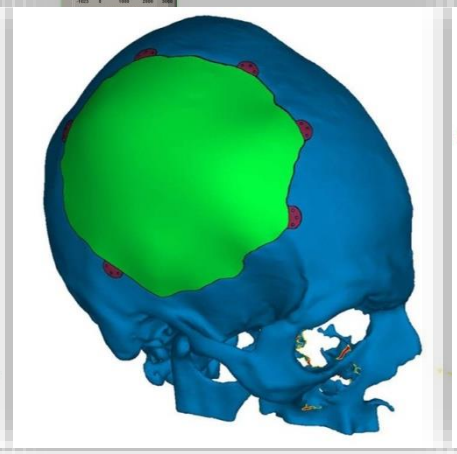
MEDICAL AM – CASE STUDY 1

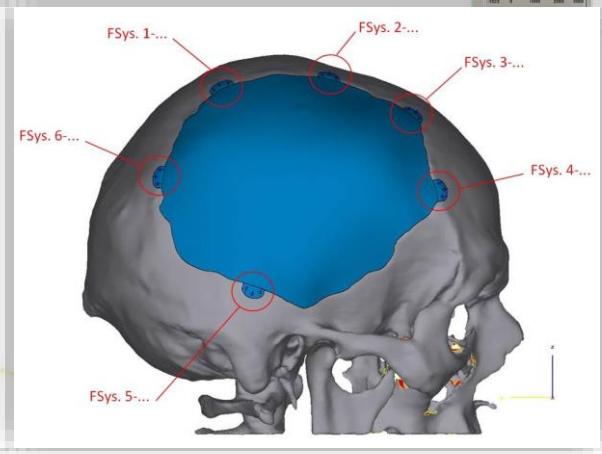




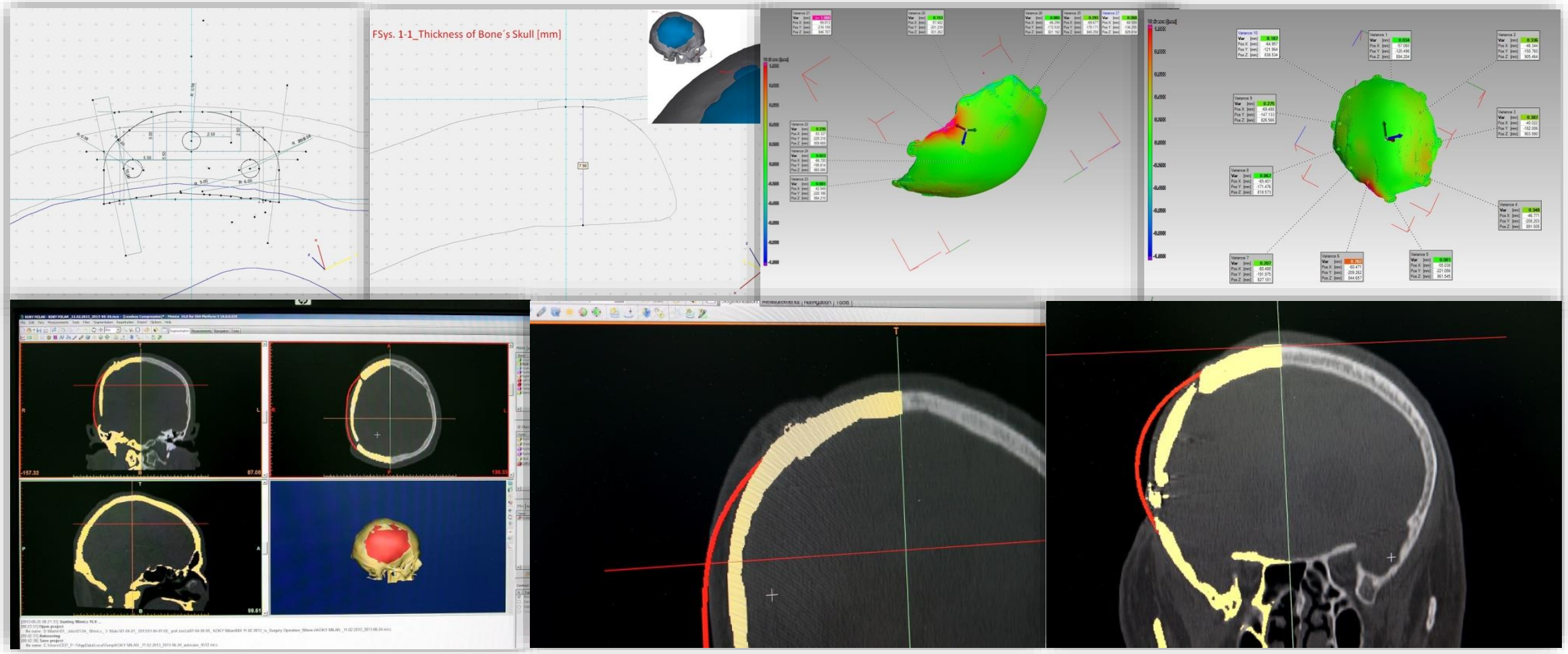




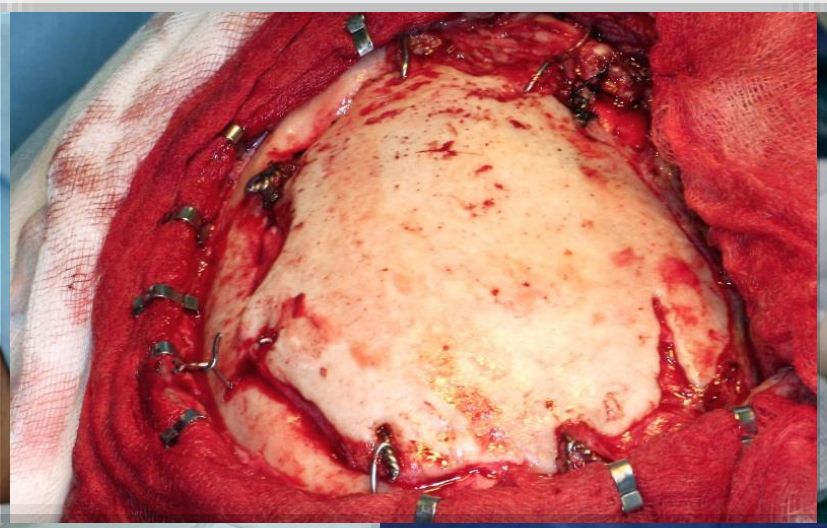


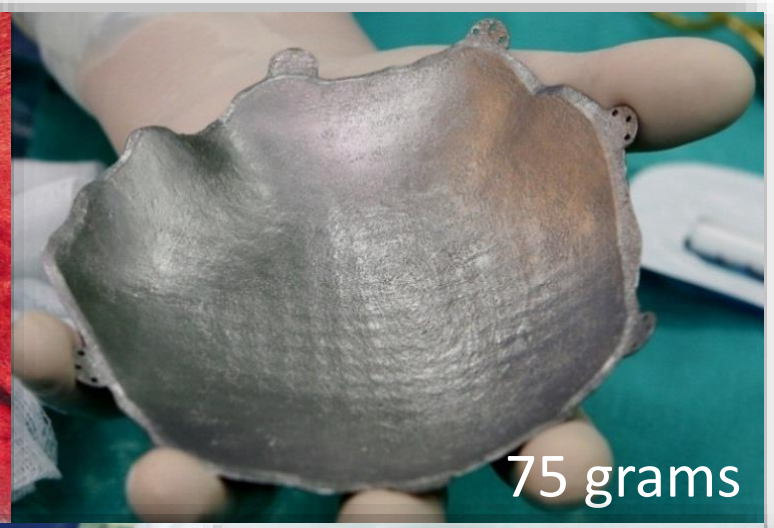


MEDICAL AM – CASE STUDY 1



MEDICAL AM – CASE STUDY 1

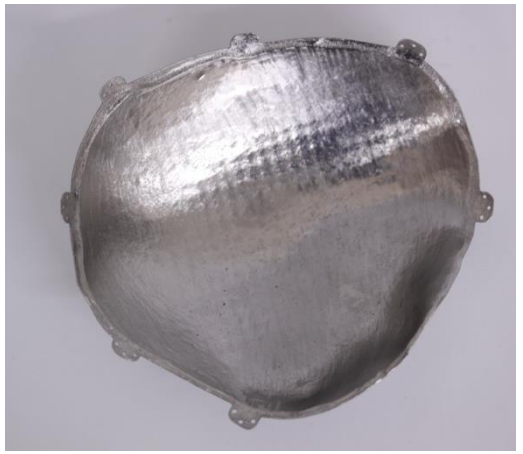




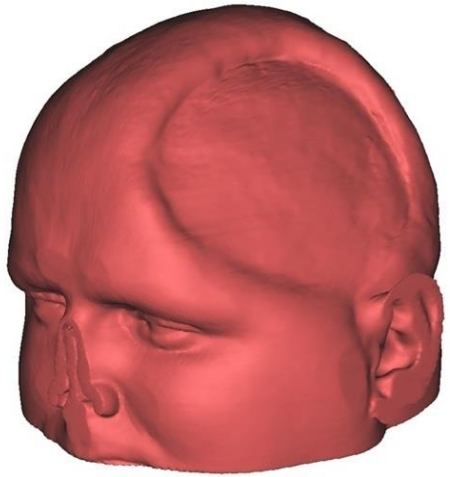
MEDICAL AM – CASE STUDY 1

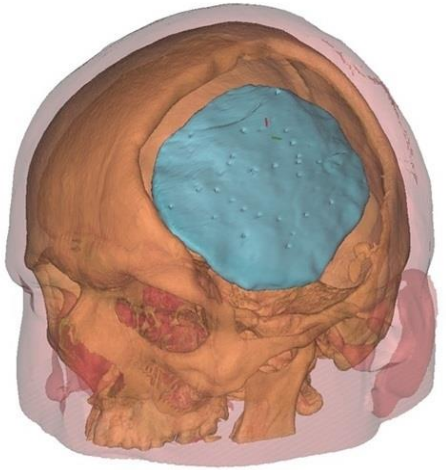
MEDICAL AM – CASE STUDY 2

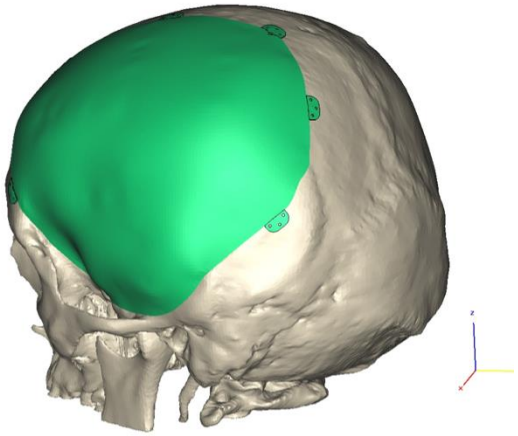
Age: 30
Cause of the injury: fall from the building (9 year ago)
In coma after the accident
Difficulty to walk and speak
Large cranial deffect: 33,8%



Material: Ti-6Al-4V (Grade 5) titanium alloy
Weight: 125 g
Size: 120 cm^2
Technology: DMLS
Fixation: 21 screws, f 1,2 mm

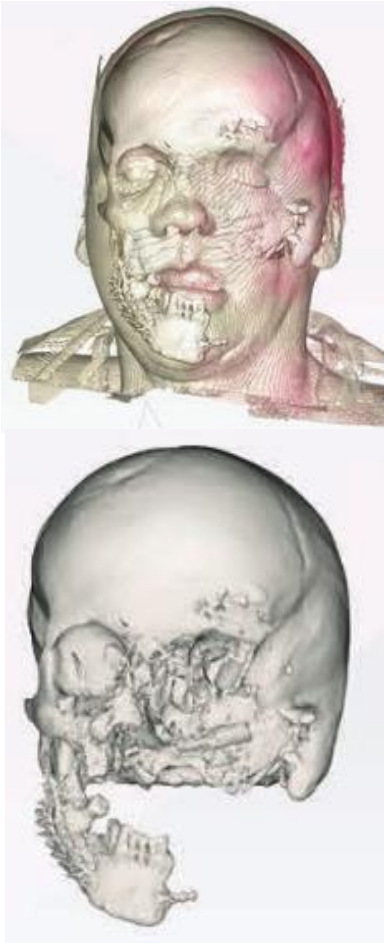


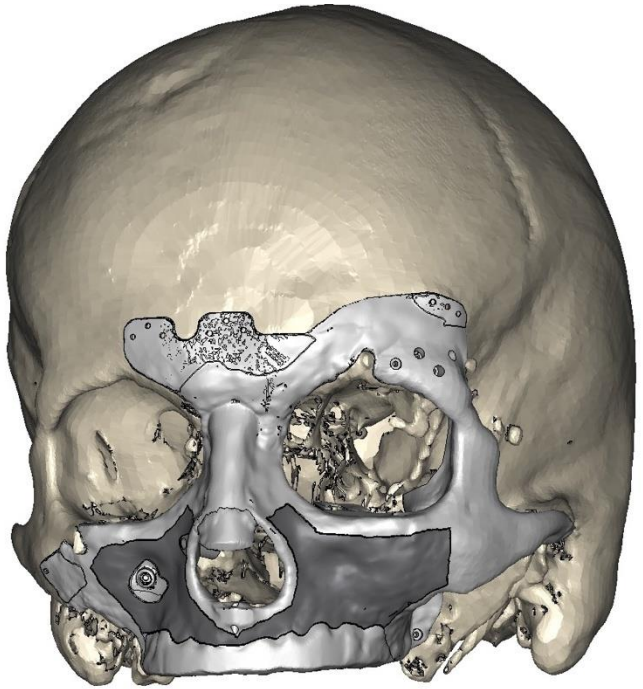


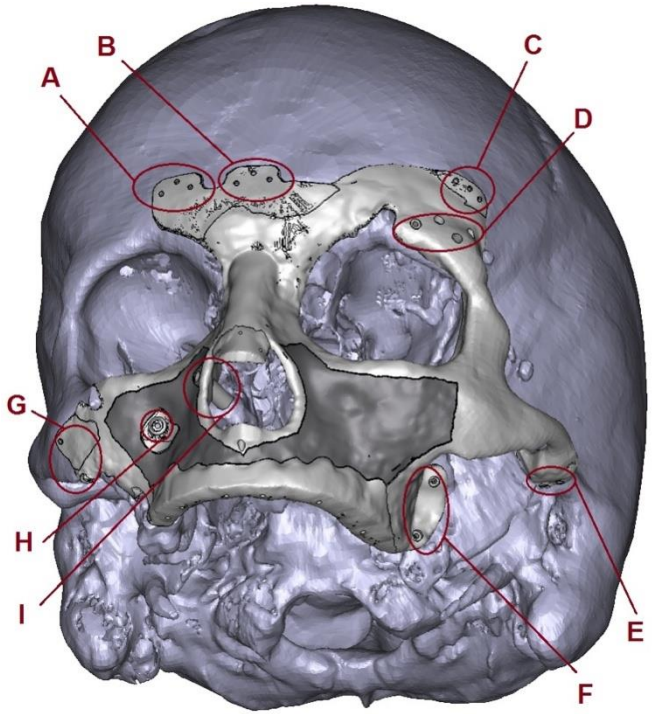


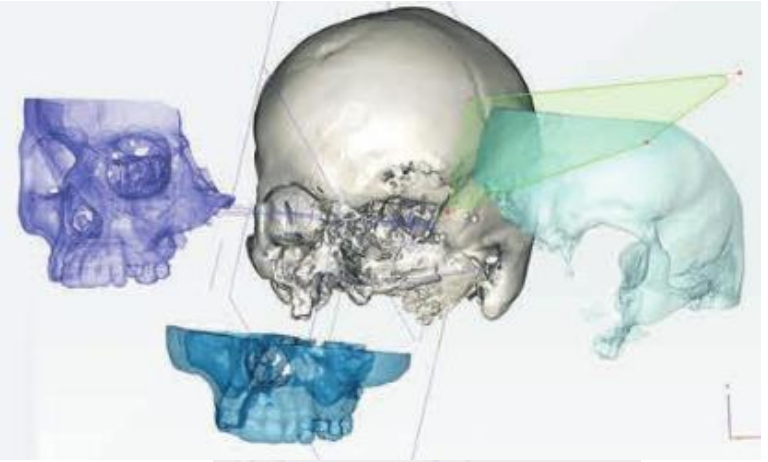
MEDICAL AM – CASE STUDY 2

MEDICAL AM – CASE STUDY 3





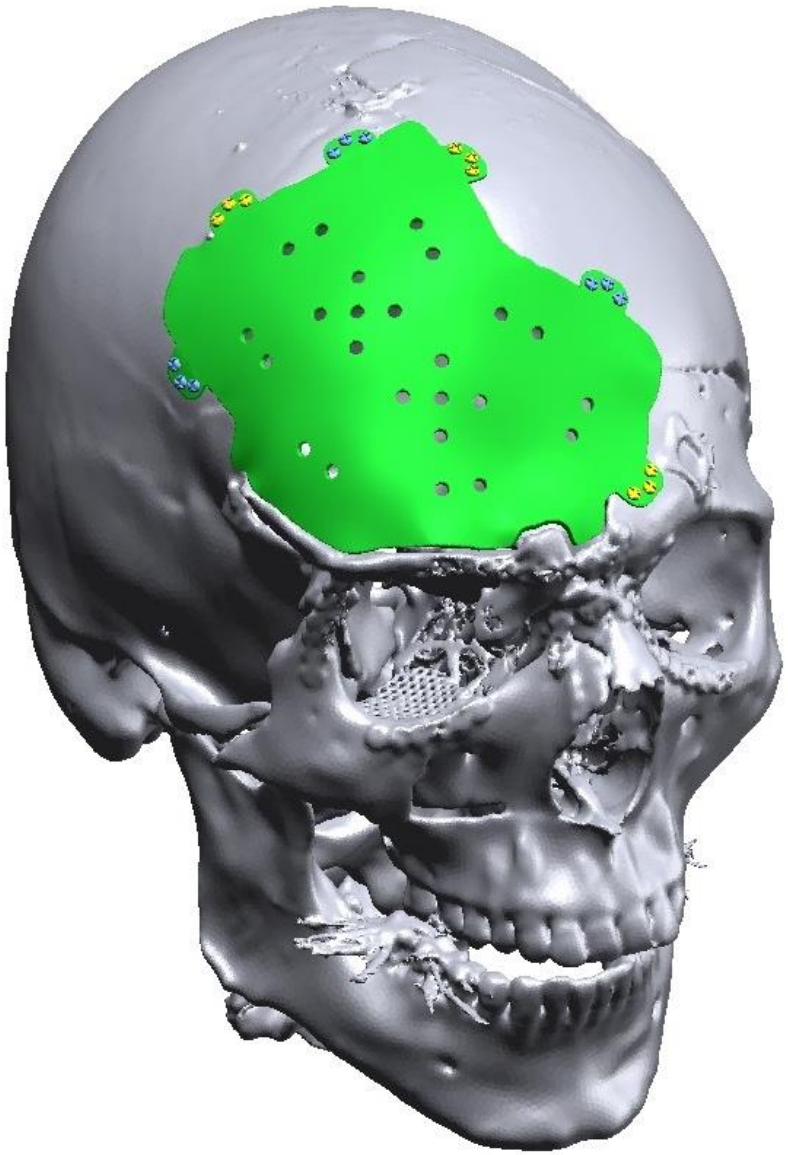


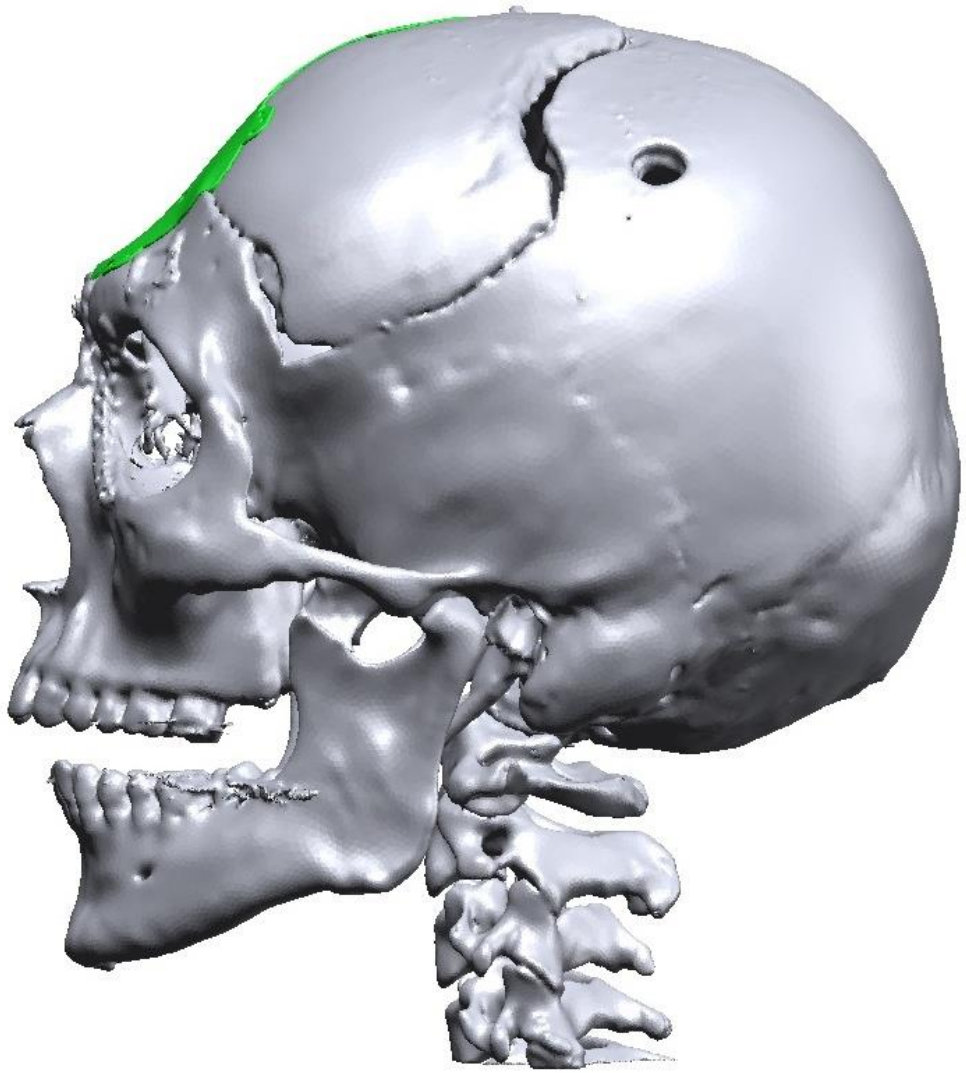


MEDICAL AM – CASE STUDY 3

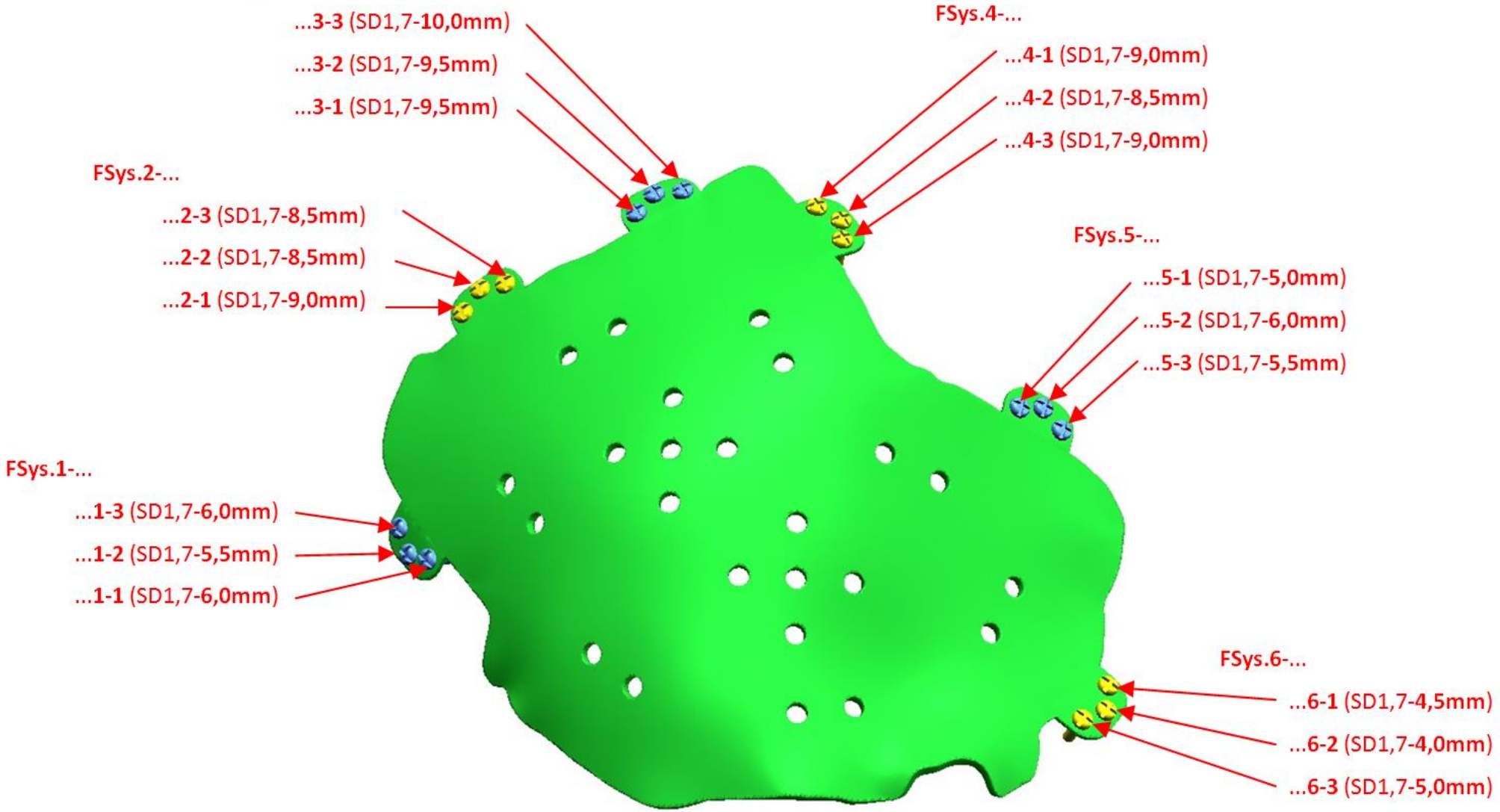
MEDICAL AM – CASE STUDY 4 – Large Cranioplasty

MEDICAL AM – CASE STUDY 4 – Large Cranioplasty

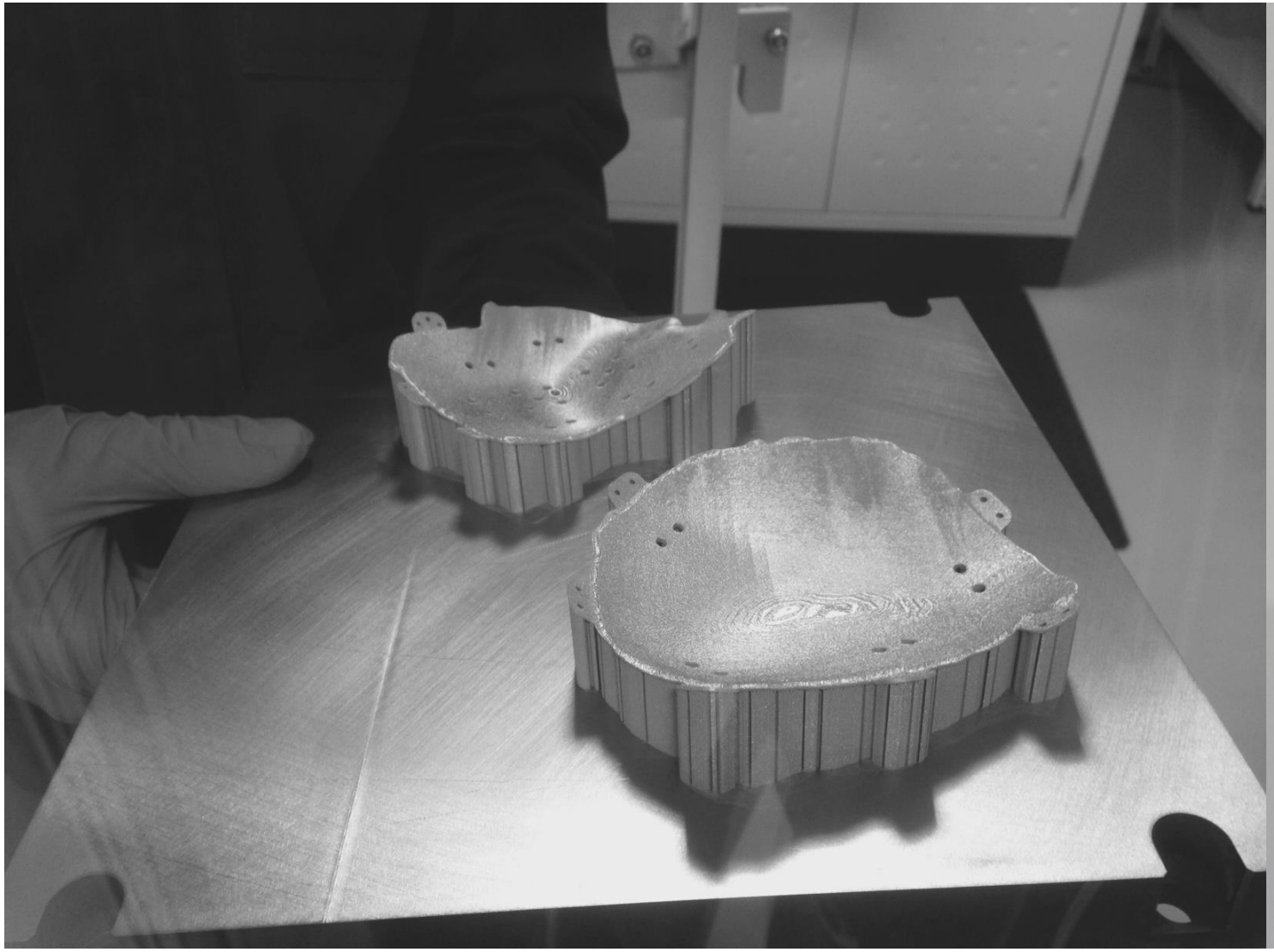




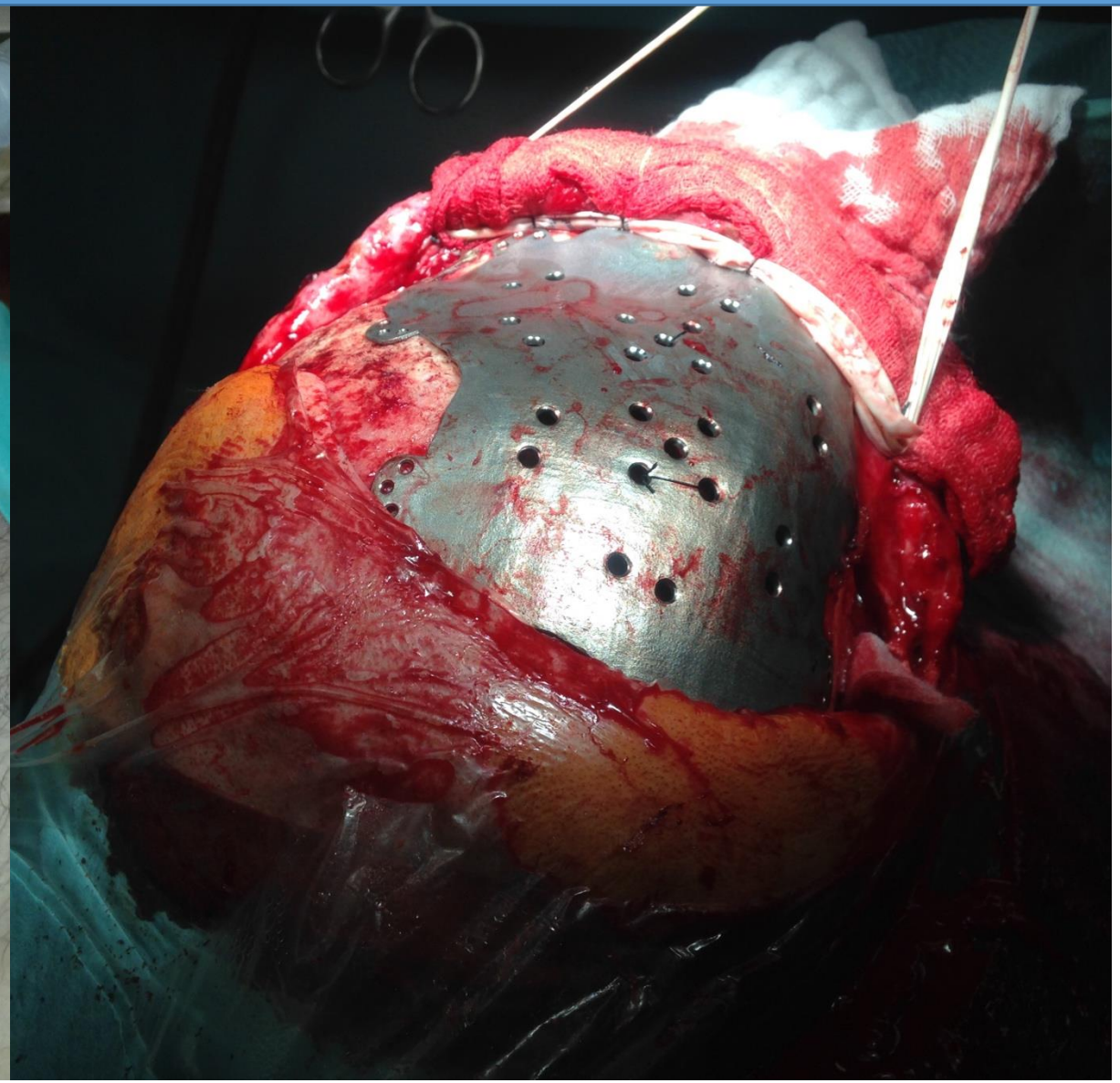
MEDICAL AM – CASE STUDY 4 – Large Cranioplasty



MEDICAL AM – CASE STUDY 4 – Large Cranioplasty

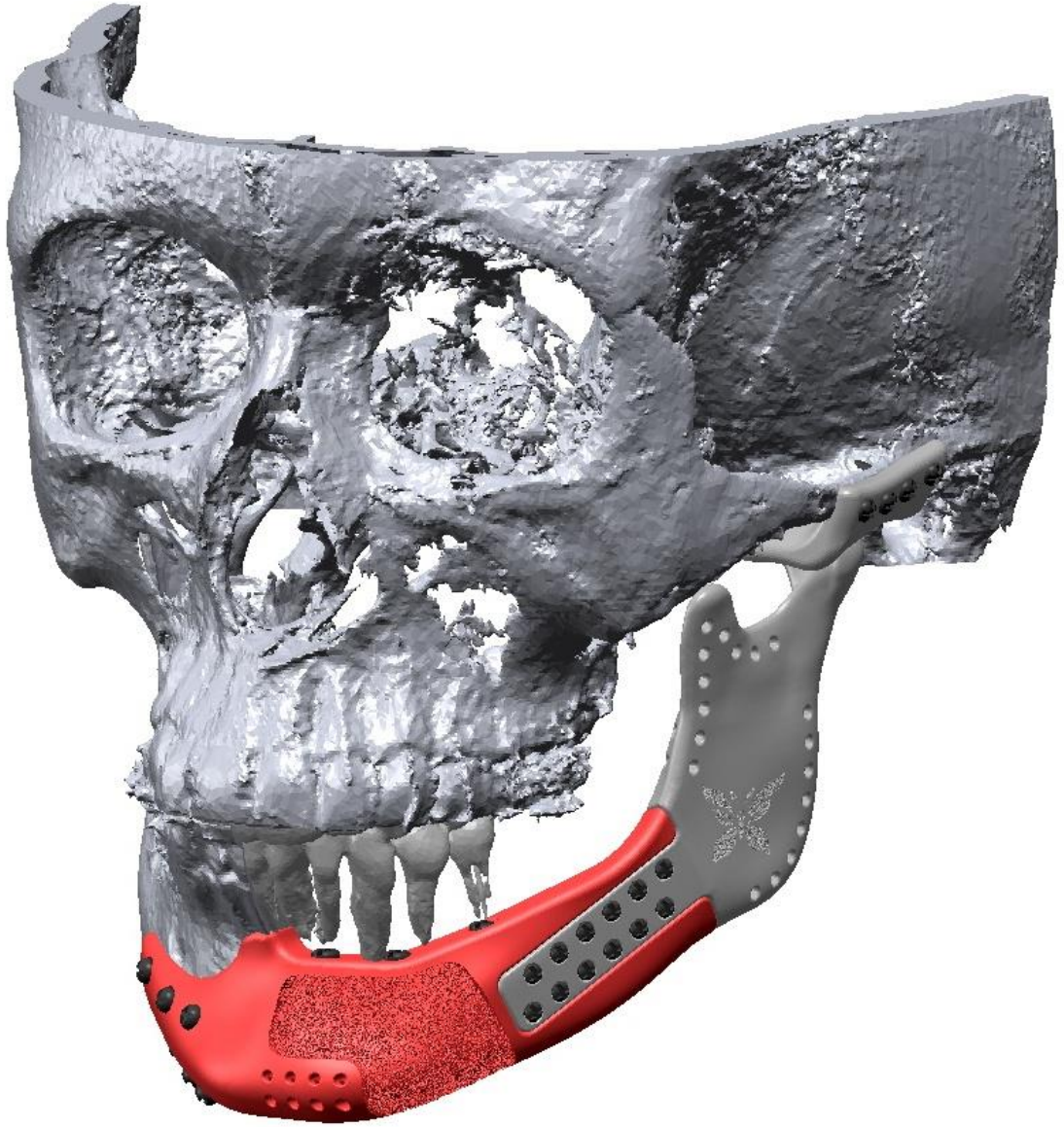


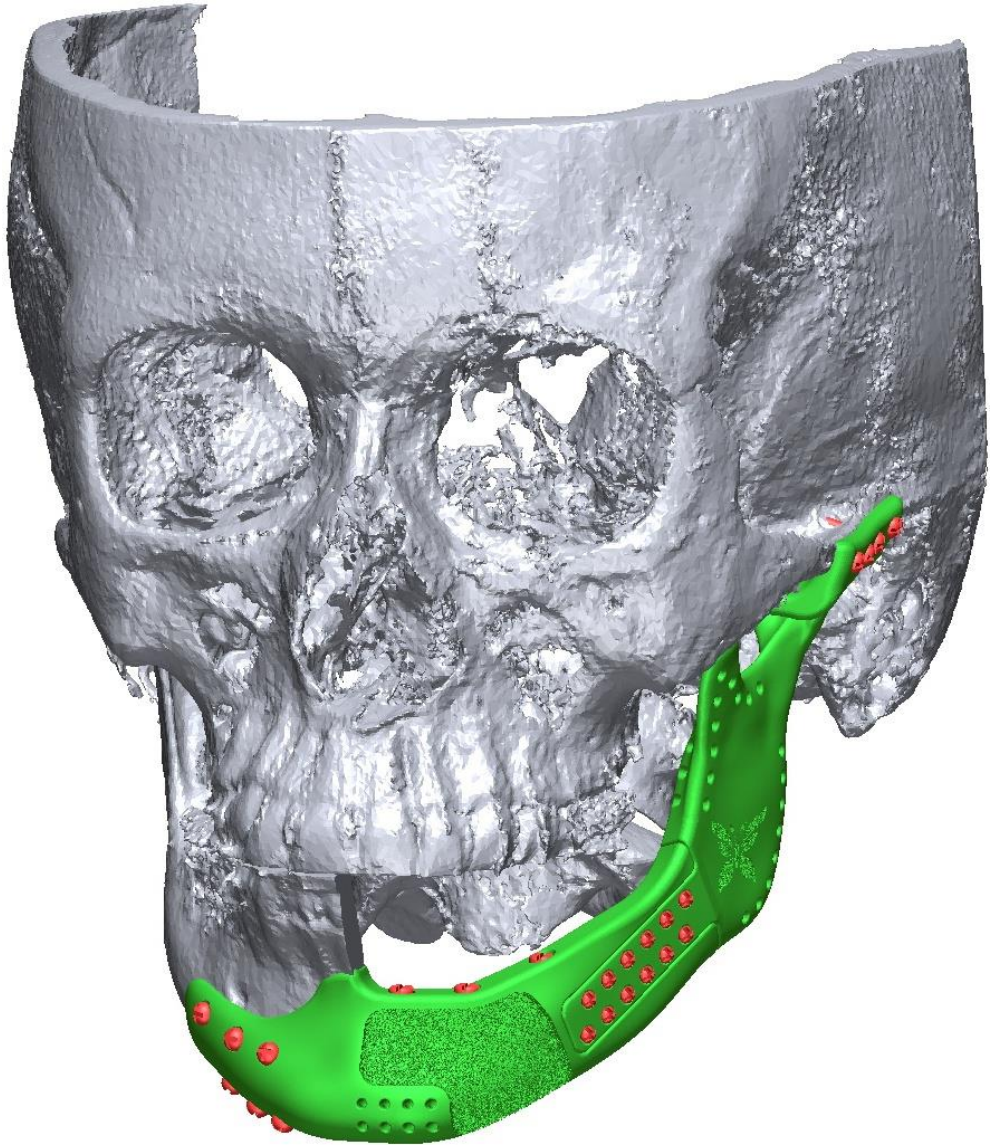
MEDICAL AM – CASE STUDY 4 – Large Cranioplasty



MEDICAL AM – CASE STUDY 4 – Large Cranioplasty

MEDICAL AM – CASE STUDY 5 – Extendable Mandibular Implant

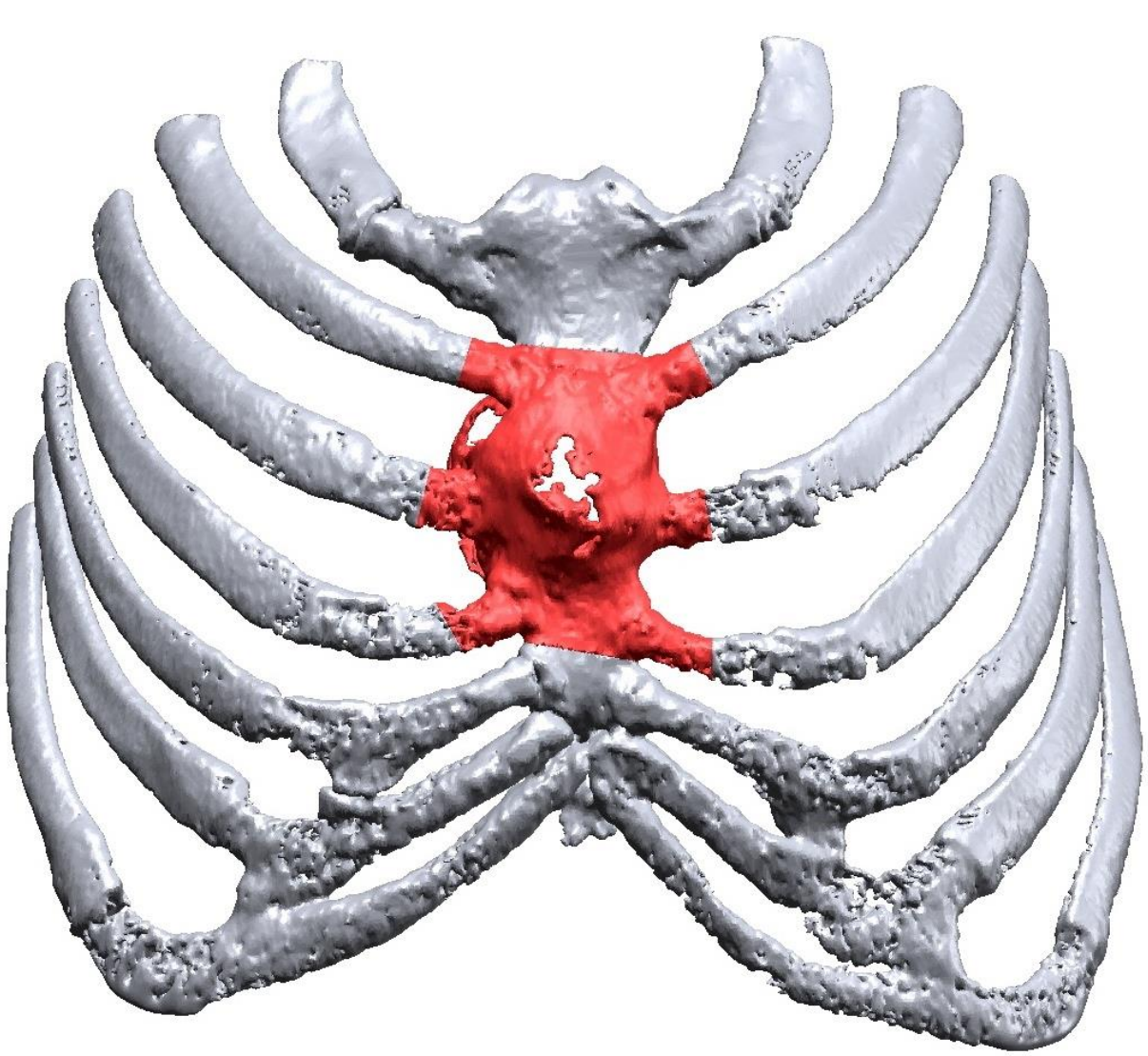


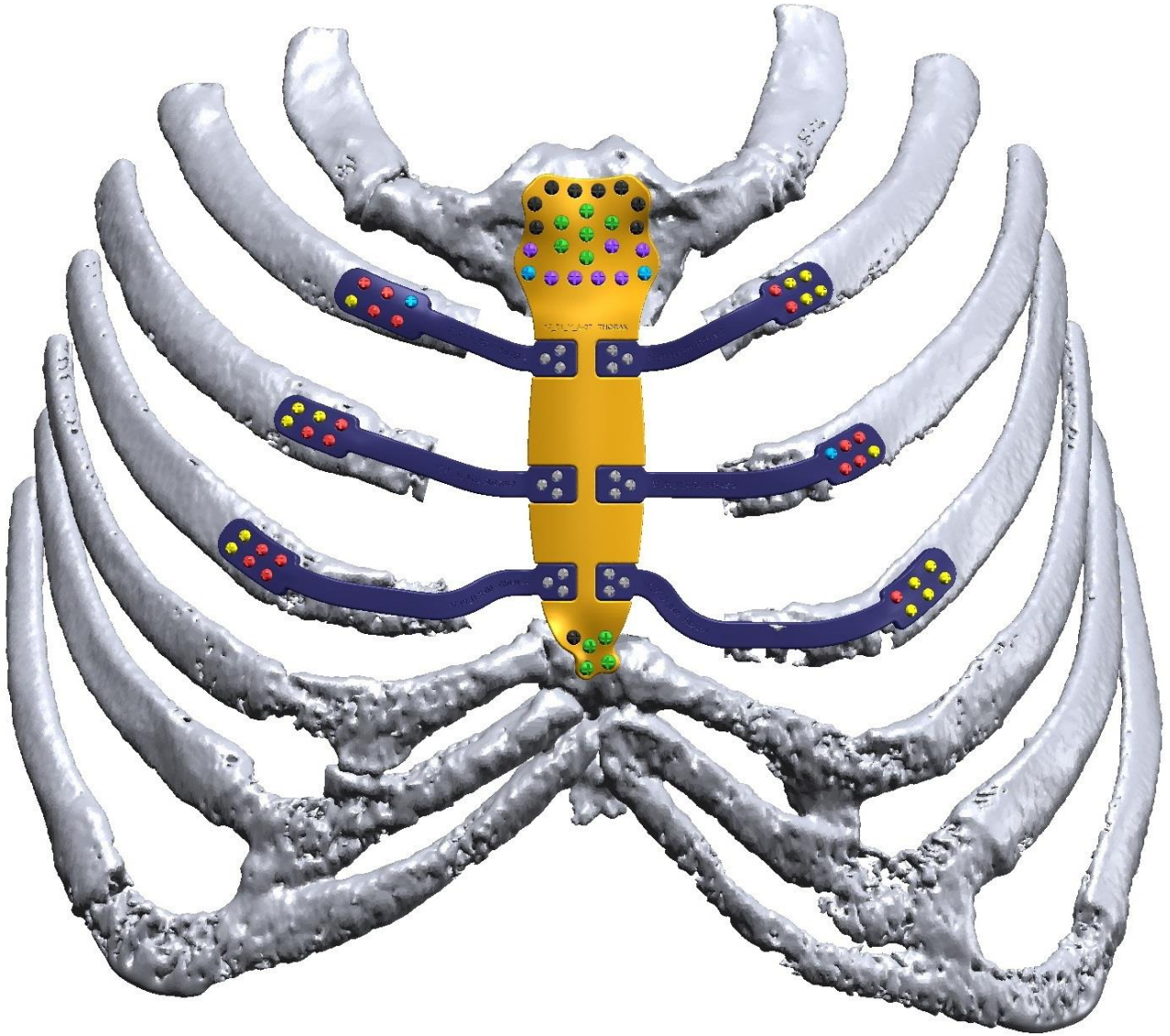


MEDICAL AM – CASE STUDY 5 – Extendable Mandibular Implant

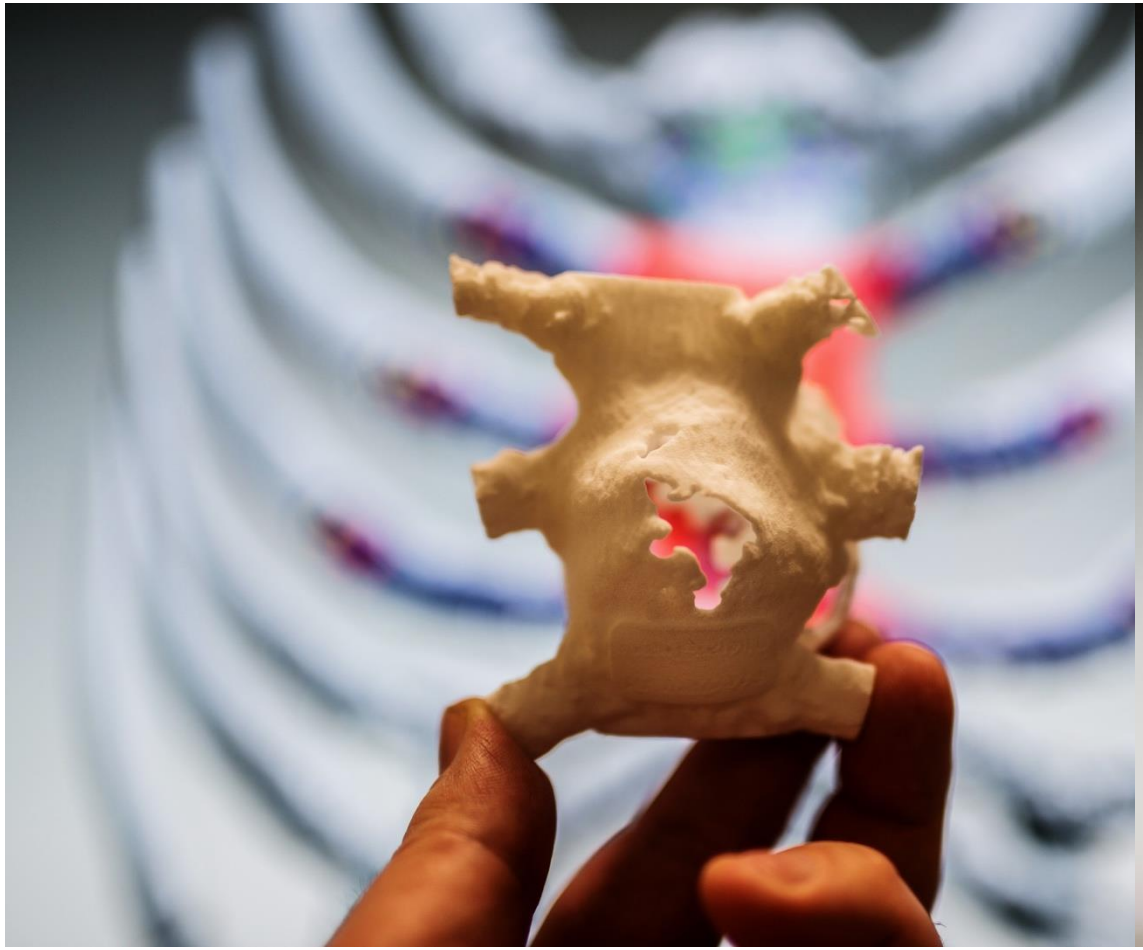
MEDICAL AM – CASE STUDY 6 – Chest Implant

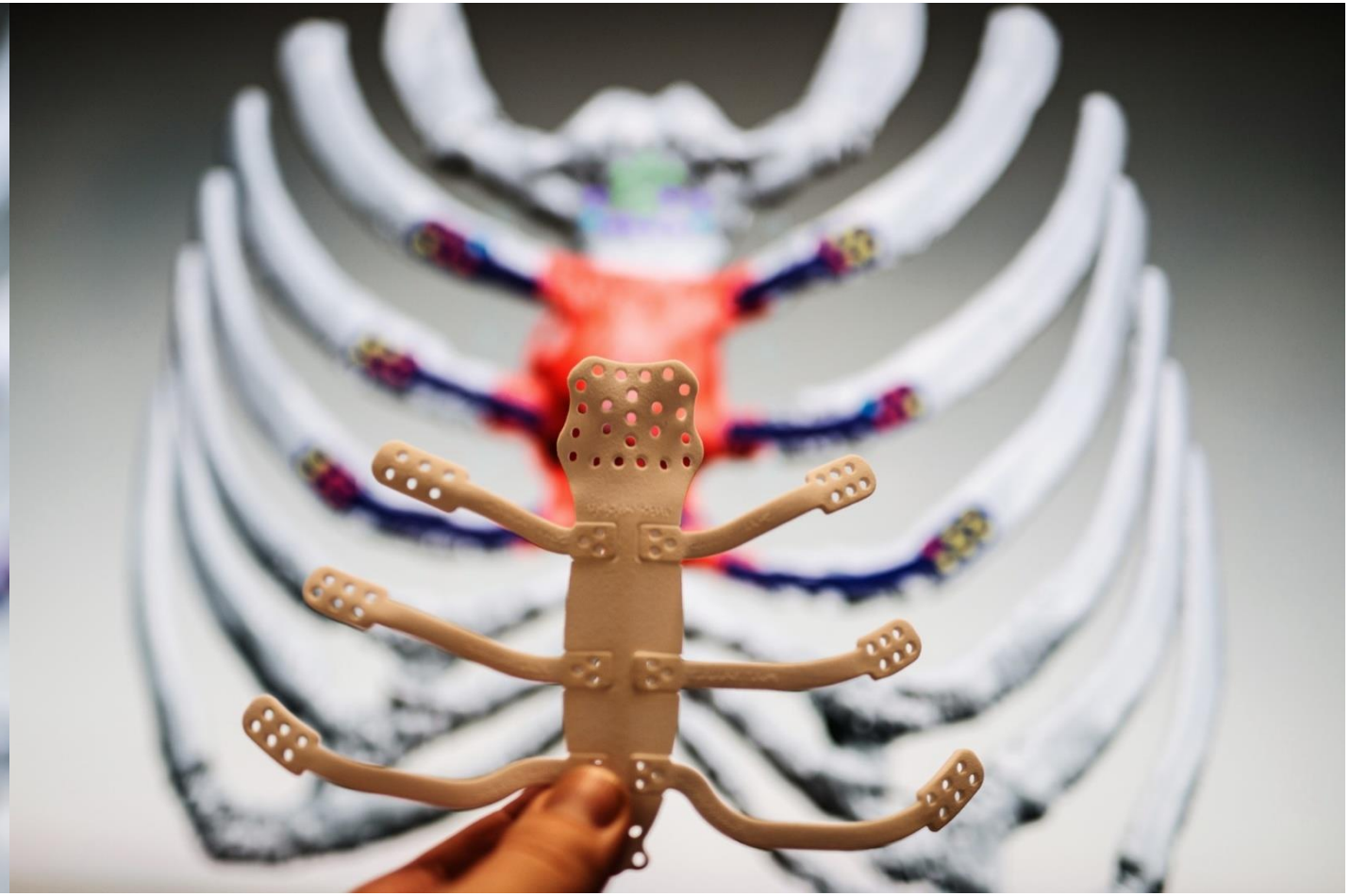
MEDICAL AM – CASE STUDY 6 – Chest Implant



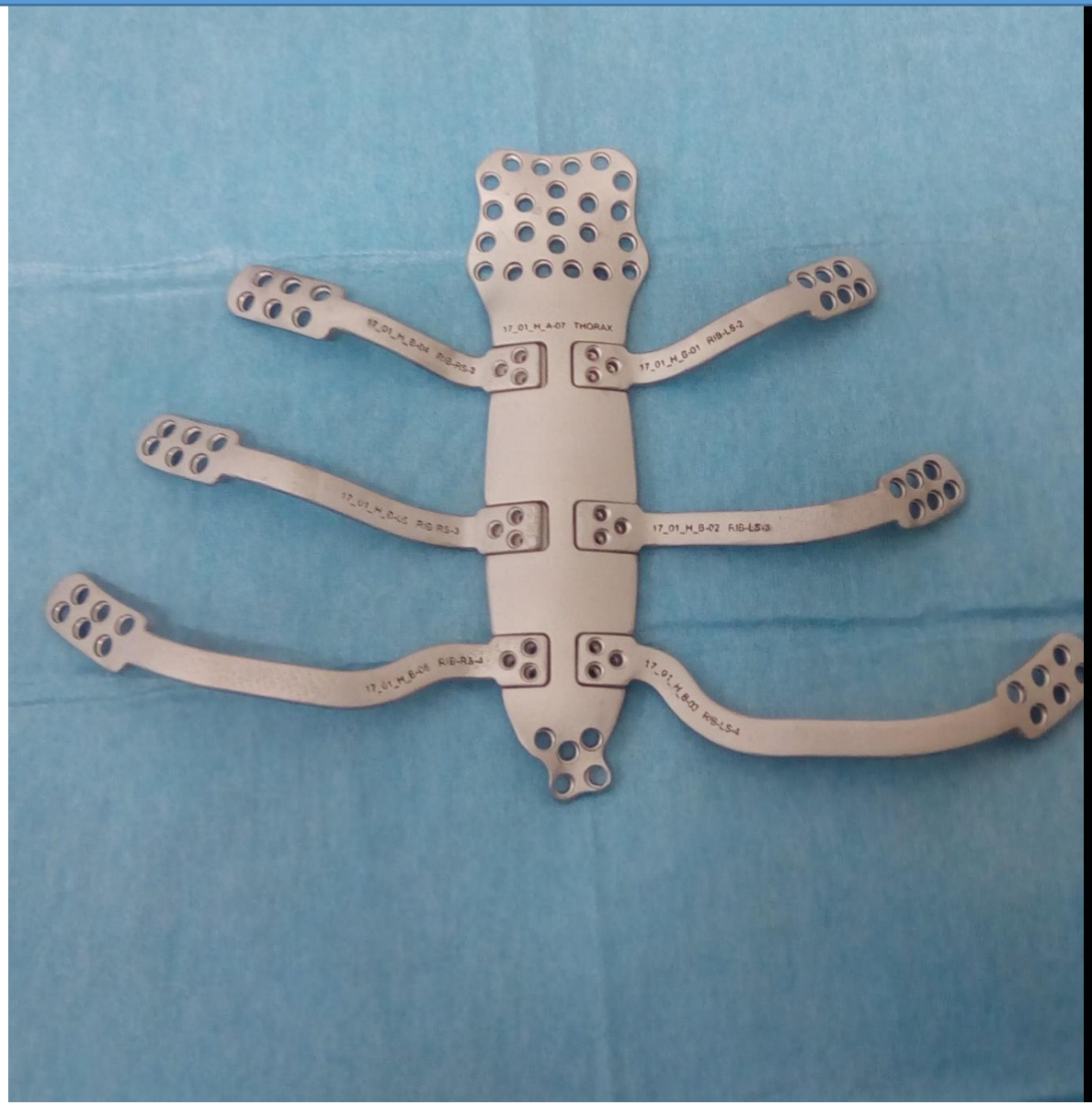


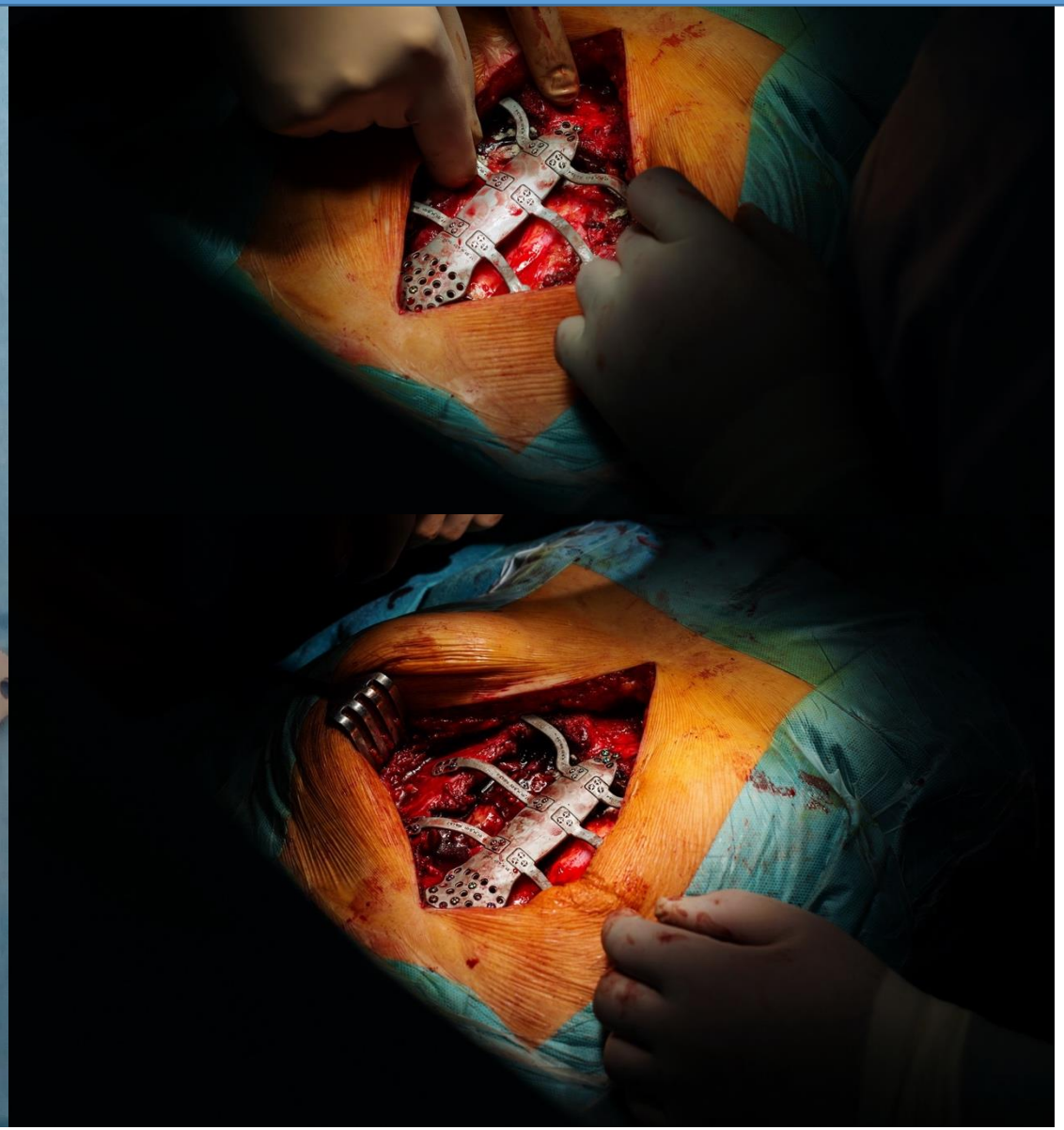
MEDICAL AM – CASE STUDY 6 – Chest Implant



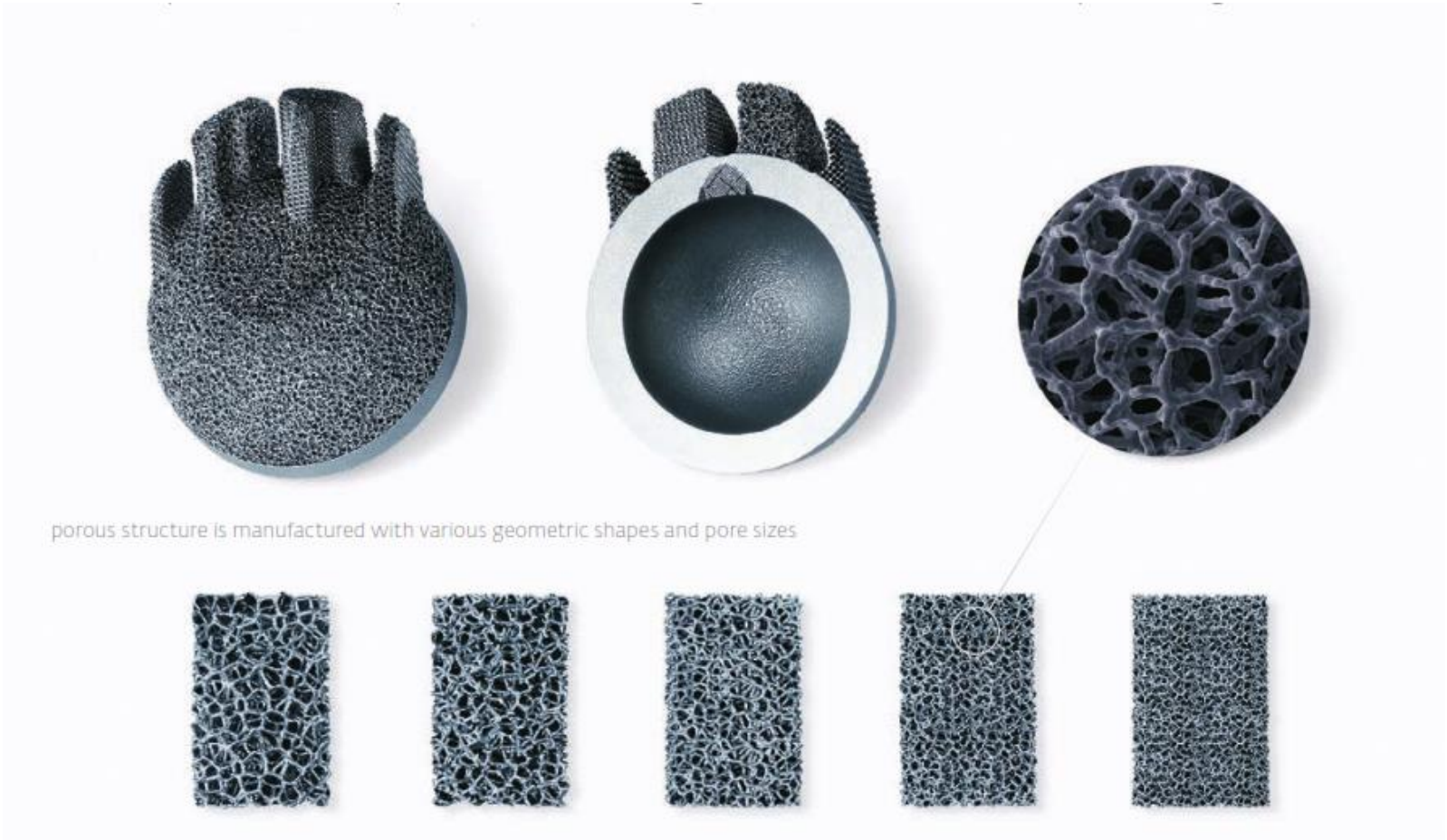


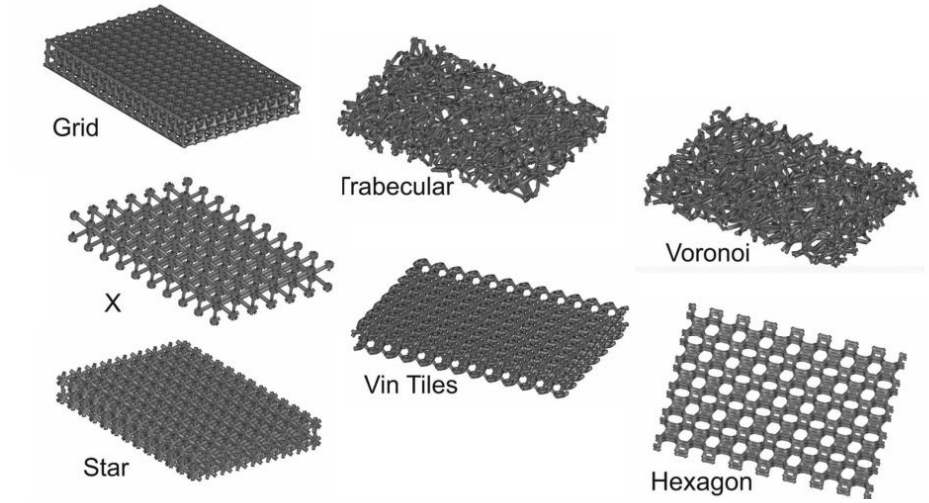
MEDICAL AM – CASE STUDY 6 – Chest Implant

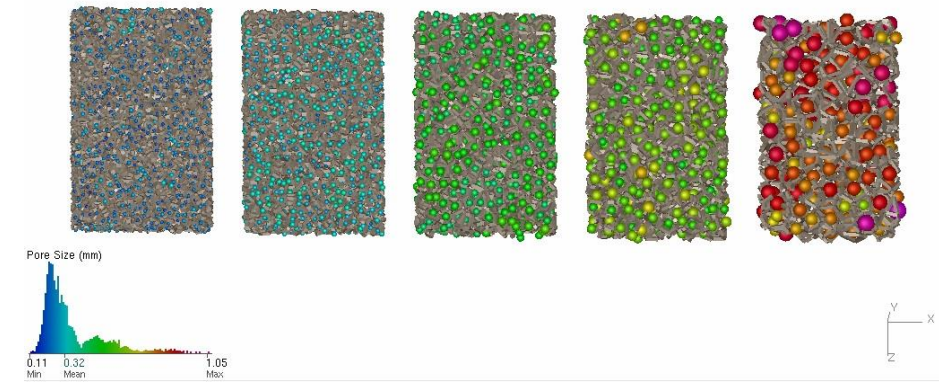




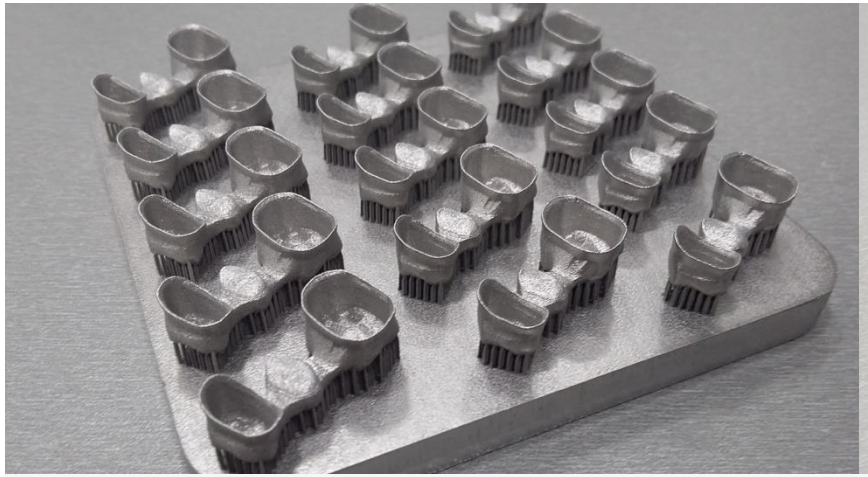
MEDICAL AM – POROUS STRUCTURES

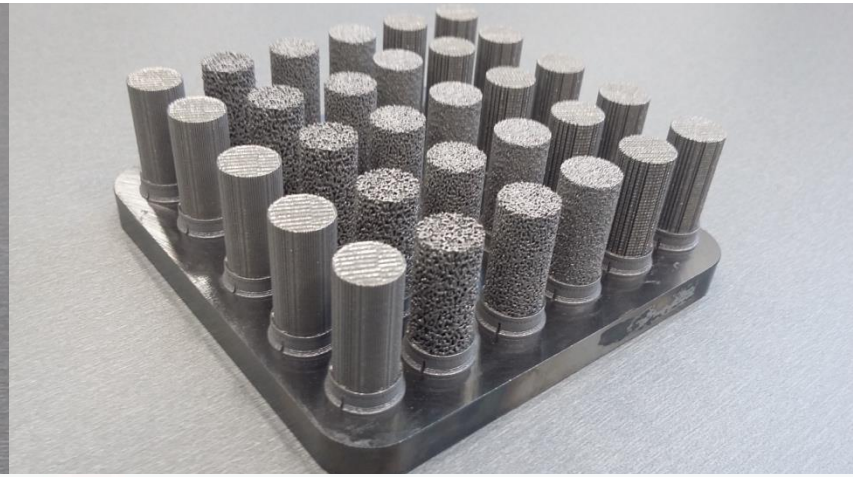


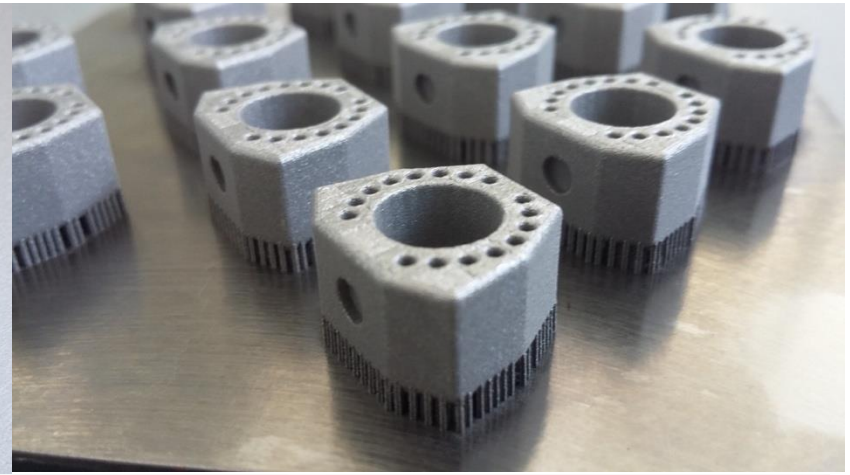




MEDICAL AM – R&D&CO-OPERATIONS







e-Manufacturing Solutions

ProSpon

ZEISS

WITHIN

BEZNOSKA

Materialise
innovators you can count on

enbicore

FUTURE OF MEDICAL ADDITIVE MANUFACTURING

ACTIVE PROJECTS

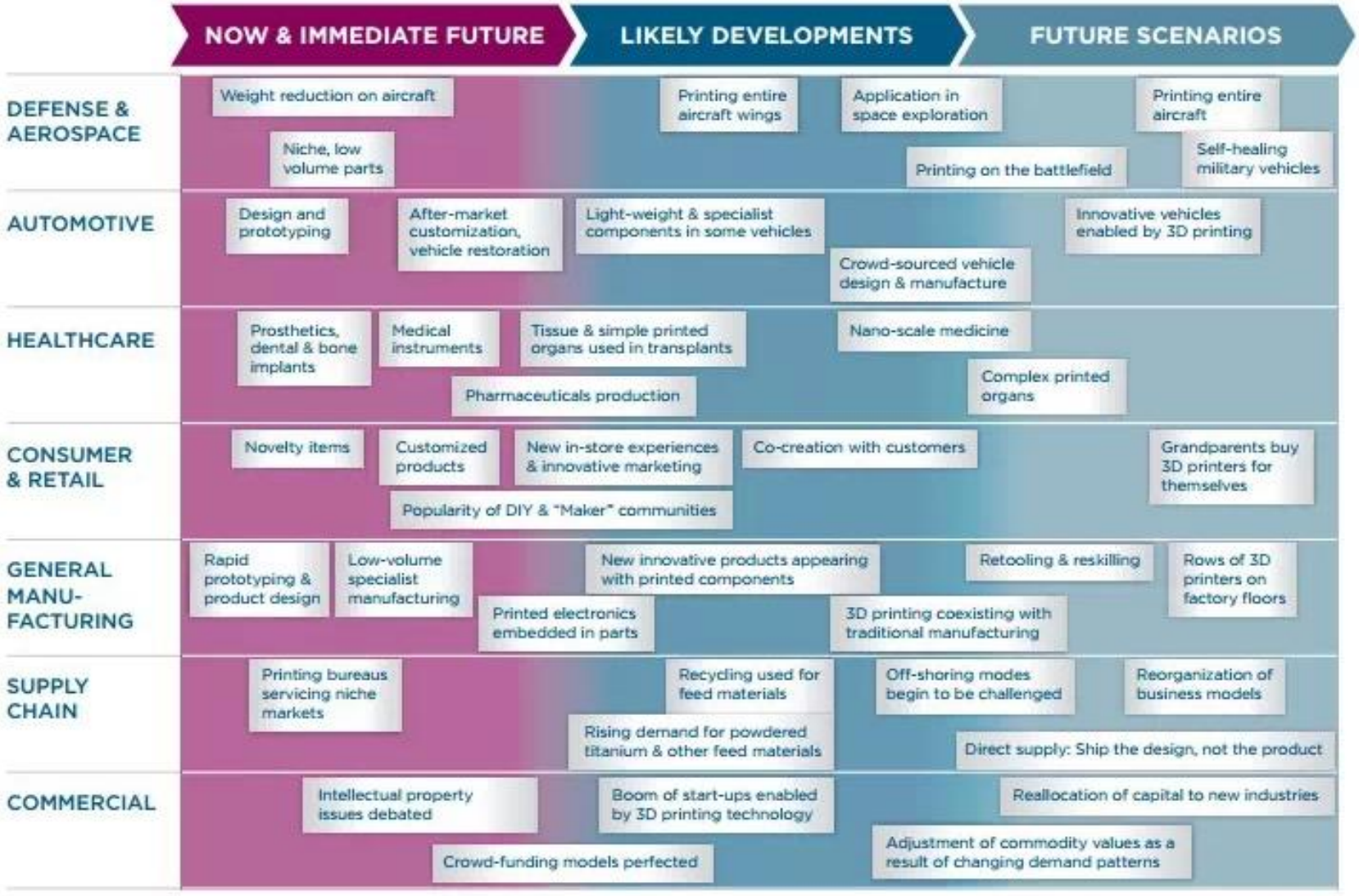
Manufacturing and testing of custom made bone scaffolds made of hydroxyapatite (HA) by use of 3D printing technology
(Budget: 250k €)

Analysis of the PEEK polymer and the additive manufacturing possibilities
(Budget: 250k €)

Design and complex characterization of biocompatible tubular 3D-scaffolds made of biosynthetic extracellular matrix intended as potential substitutes of damaged human urethra
(Budget: 250k €)

All projects are supported by Slovak Research and Development Agency (SRDA), Ministry of Education, Science, Research and Sport of the Slovak Republic

FUTURE OF MEDICAL ADDITIVE MANUFACTURING



Source: CSC

THANK YOU FOR YOUR ATTENTION!

CONTACT INFORMATION

Ing. Marek Schnitzer,PhD.

E-mail: marek.schnitzer@tuke.sk

Tel.: +421 915 249 725