UNIVERSITÀ DEGLI STUDI FIRENZE
DIEF DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

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CAD AND 3D PRINTING IN PREOPERATIVE SURGICAL PLANNING

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ADDITIVE 4 BIOMEDICAL

SC 09/A3 CoCo AM Additive Manufacturing

ASSOCIAZIONE NAZIONALE DISEGNO E METODI

COMET

aias

AIM

Complexity of the clinical case

- Rare and/or unique malformations
- Growing corrections
- Bone and soft tissue surgery

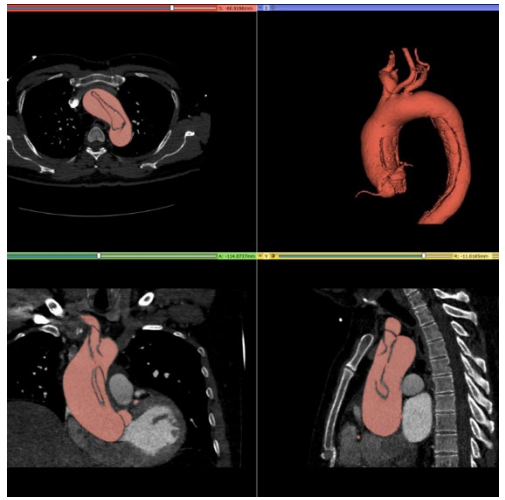
Difficulty in predicting outcomes

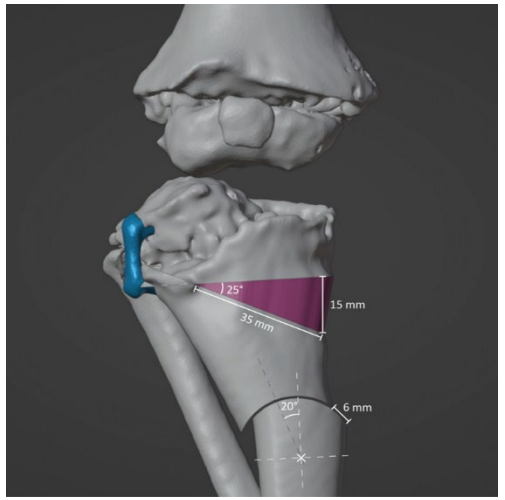
- Multiplanar corrections
- Customized procedure
- Non-standardizable

Patient-Specific CAD Modelling and 3D Printing
for Surgical Planning and Simulation

METHODS

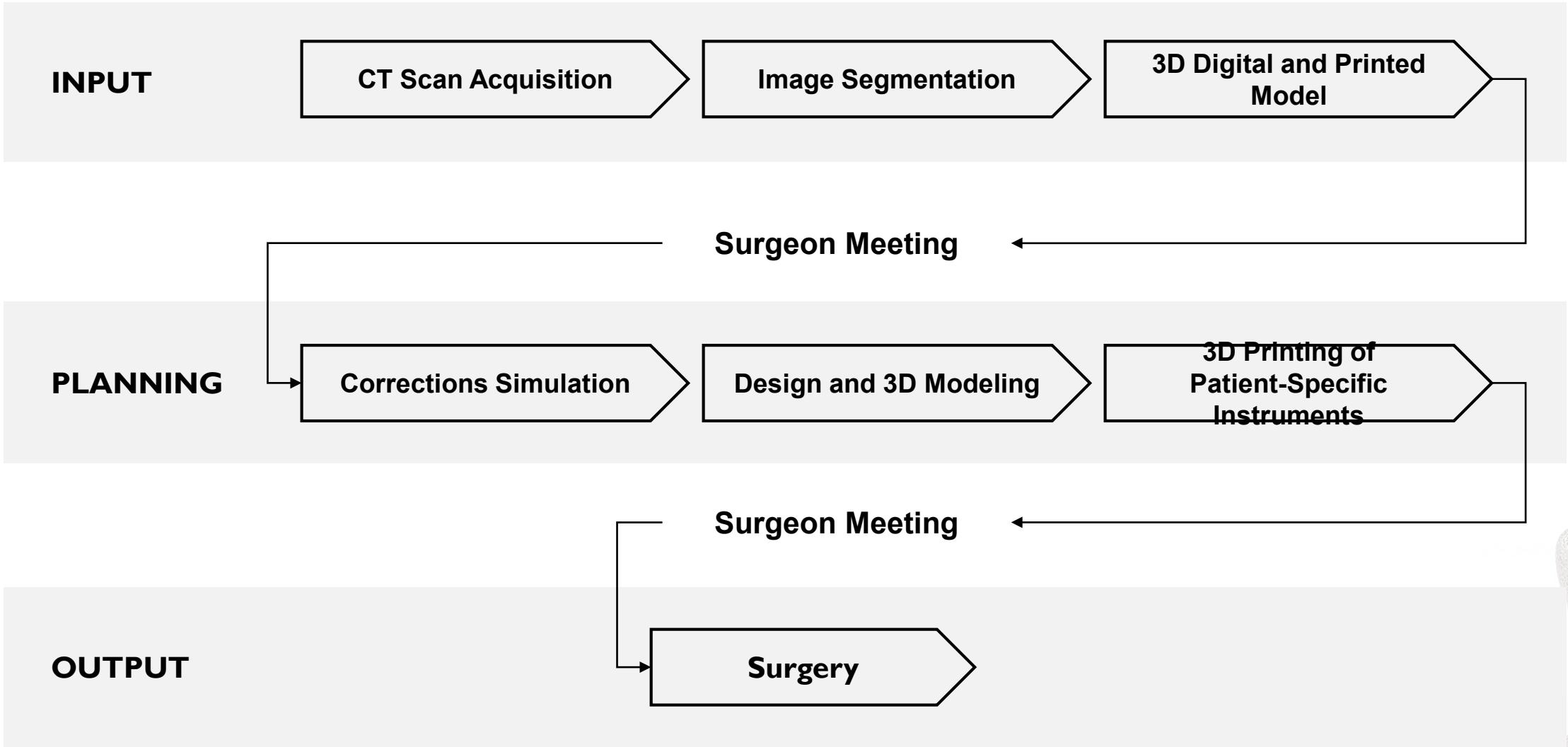
CT Scan → **Surgical Simulation** → **3D Printing** → **Customized Models**





ADDITIVE 4 BIOMEDICAL

METHODS


INPUT
CT Scan Acquisition
Image Segmentation
3D Digital and Printed Model
Surgeon Meeting
PLANNING
Corrections Simulation
Design and 3D Modeling
3D Printing of Patient-Specific Instruments
Surgeon Meeting
OUTPUT
Surgery

METHODS

3D Printed Models

Short pipeline

Process Flexibility

IN-HOUSE

Production

LOW COST

Open Source software

3DSlicer

AUTODESK MESHMIXER

blender

FDM 3D Printed

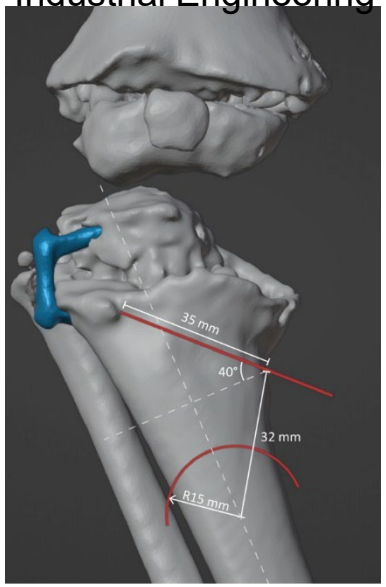
Delta AnyCubic Predator

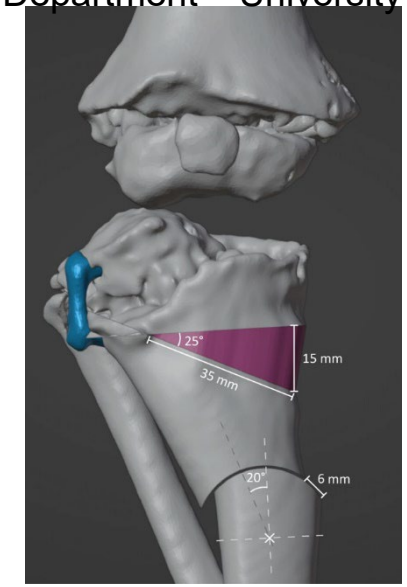
APPLICATIONS

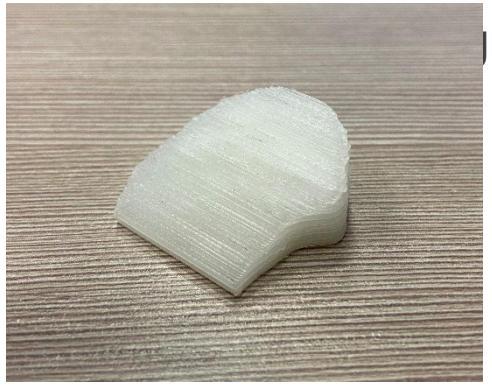
Orthopedic Surgery

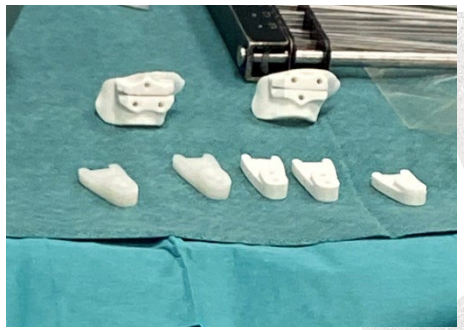
Collaboration
Pediatric Orthopedics and Traumatology – Rizzoli Orthopedic Institute
Musculoskeletal Tissue Bank – Rizzoli Orthopedic Institute
Industrial Engineering Department – University of Bologna

Complex bone deformities
Patient-Specific Instruments
Patient-Specific









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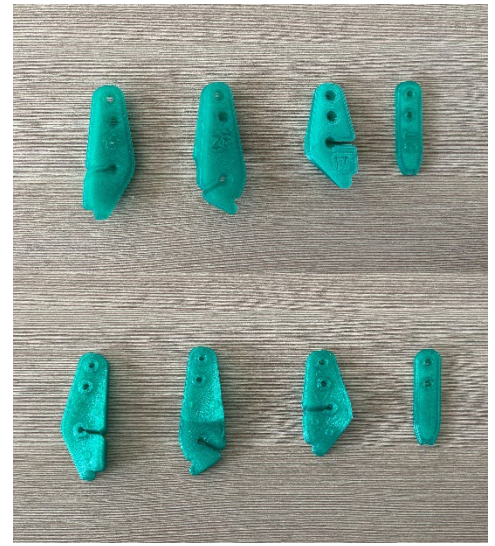
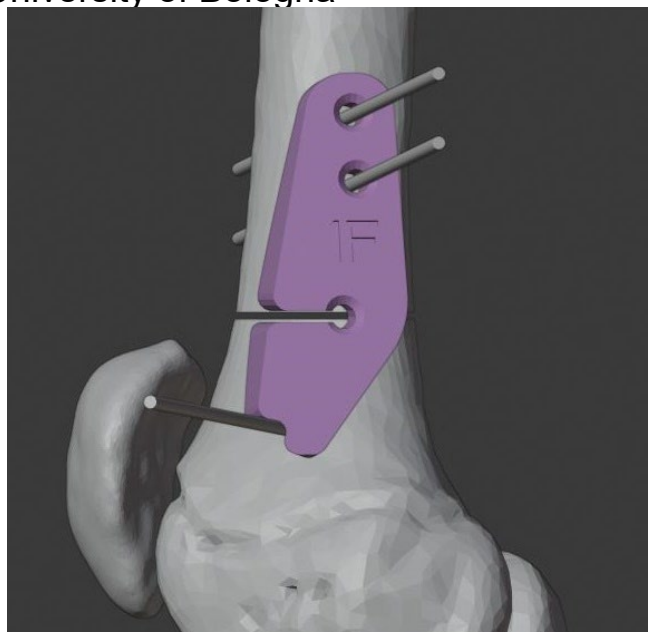
APPLICATIONS

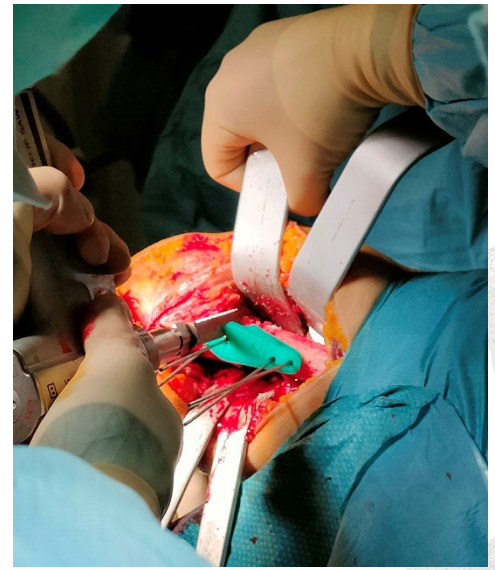
Orthopedic Surgery

Complex bone deformities
Patient-Specific Instruments



Collaboration
Pediatric Orthopedics and Traumatology – Rizzoli Orthopedic Institute
Industrial Engineering Department – University of Bologna



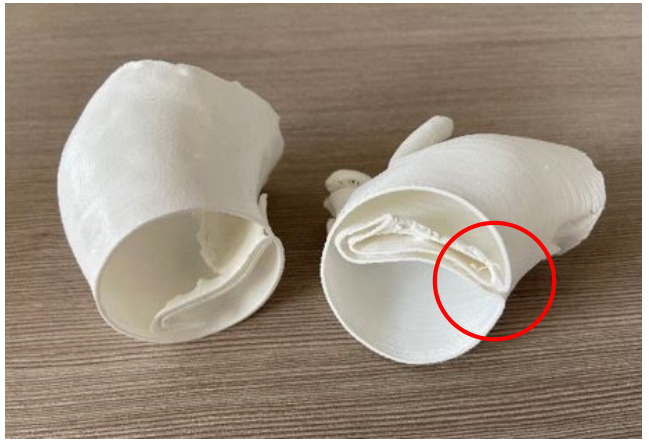


ADDITIVE 4 BIOMEDICAL

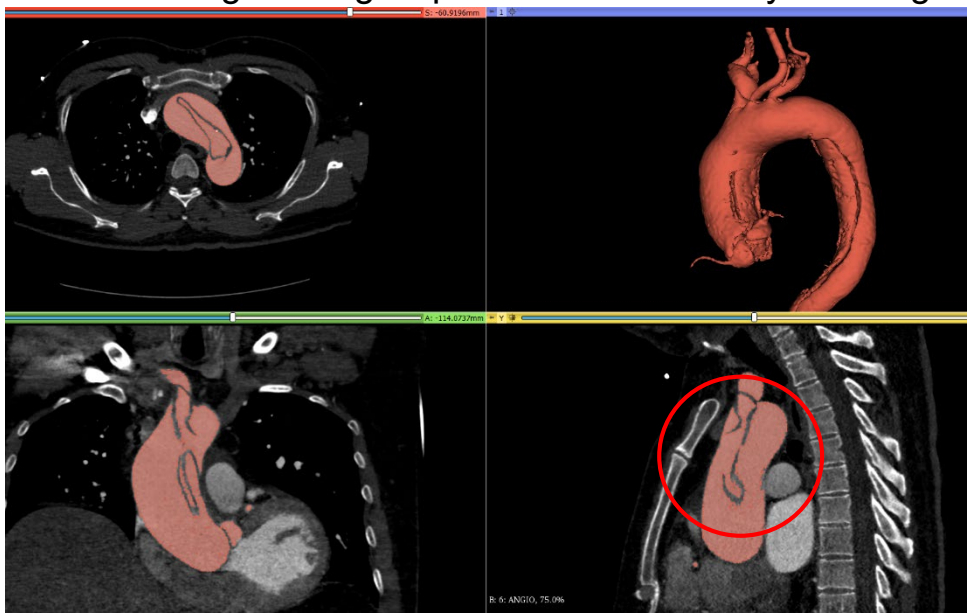
APPLICATIONS

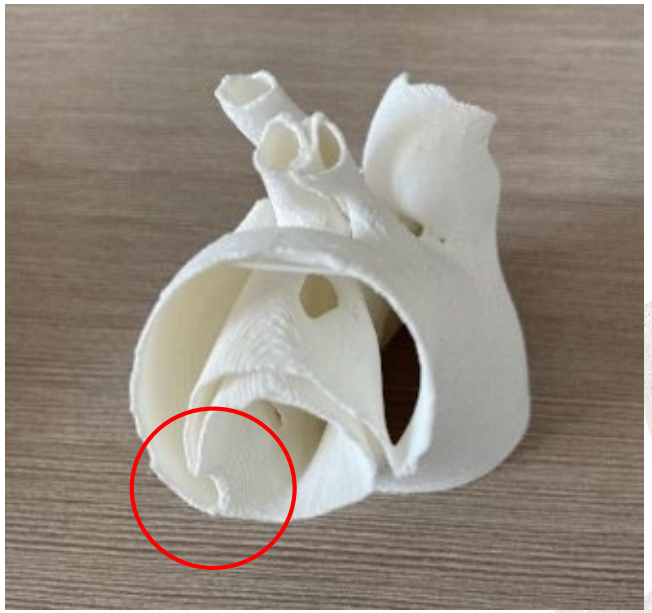
Cardiac Surgery

Aortic Dissection



Collaboration
Cardiothoracic & Transplant Surgery Unit – Sant'Orsola-Malpighi Polyclinic
Industrial Engineering Department – University of Bologna

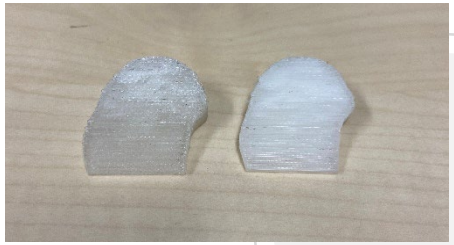


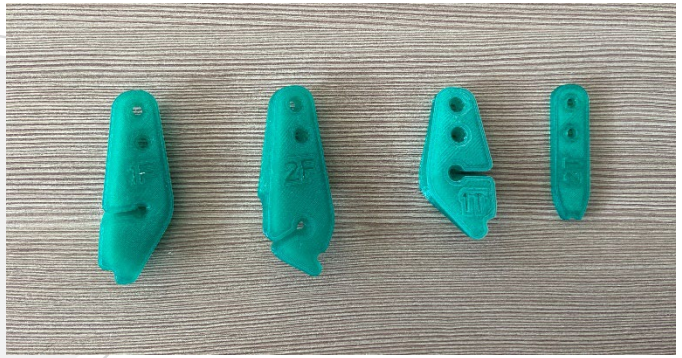


ADDITIVE 4 BIOMEDICAL

MATERIALS

PLA





HTPLA

TPU

WIP

ADDITIVE 4 BIOMEDICAL

- Expansion of AM into other areas of medicine (e.g., Spinal Surgery)
- Research of new materials and infill for a realistic representation with AM (e.g., Variable density, complex infill geometries)
- 3D models that can performed surgically like the real counterparts
- 3D implantable objects with attached sensors
- 3D objects as markers for AR/VR

CONCLUSIONS

- **Personalization of the surgical approach**
- **Accuracy of preoperative planning**
- **Visual and tactile feedback**
- **Flexibility of technology**

COLLABORATIONS

Industrial Engineering Department – DIN
Università di Bologna

IRCCS ISTITUTO ORTOPEDICO RIZZOLI
SERVIZIO SANITARIO REGIONALE
EMILIA - ROMAGNA
Istituto Ortopedico Rizzoli di Bologna
Istituto di Ricovero e Cura a Carattere Scientifico

Pediatric Orthopedics and Traumatology and Musculoskeletal Tissue Bank
Rizzoli Orthopedic Institute

POLICLINICO DI SANT'ORSOLA
SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA
Azienda Ospedaliero - Universitaria di Bologna

Cardiothoracic & Transplant Surgery Unit
Sant'Orsola-Malpighi Polyclinic