

International Symposium on Advanced Technology and 3D Printing in Orthopaedics

New Development of Surgeon Oriented 3D Surgical Planning System

Elvis Chui

Research Assistant Professor
Precision Orthopaedics and Innovative Technologies (POINT)
Department of Orthopaedics and Traumatology
The Chinese University of Hong Kong

Honorary Advisor, NTEC
Hospital Authority

Funded by



Content

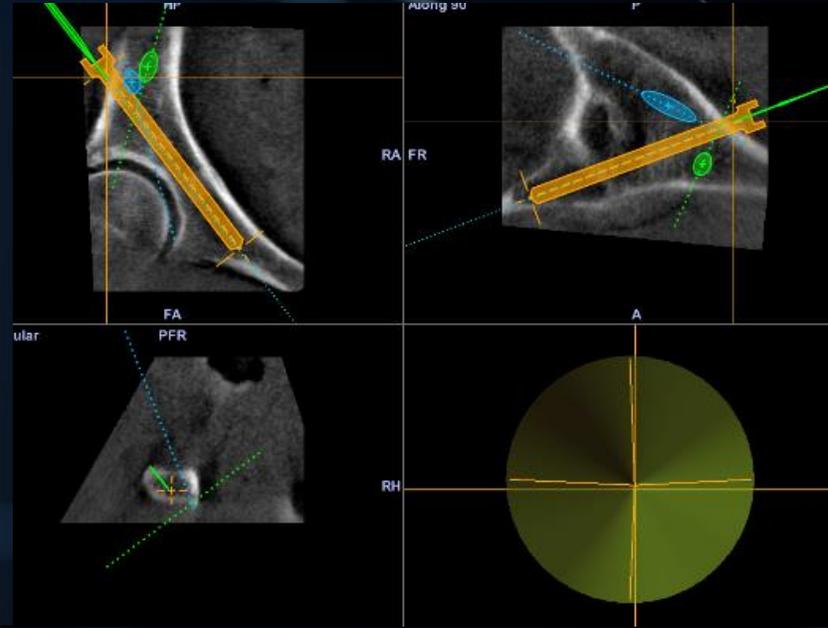
1. Background

2. Current limitations

3. Highlights

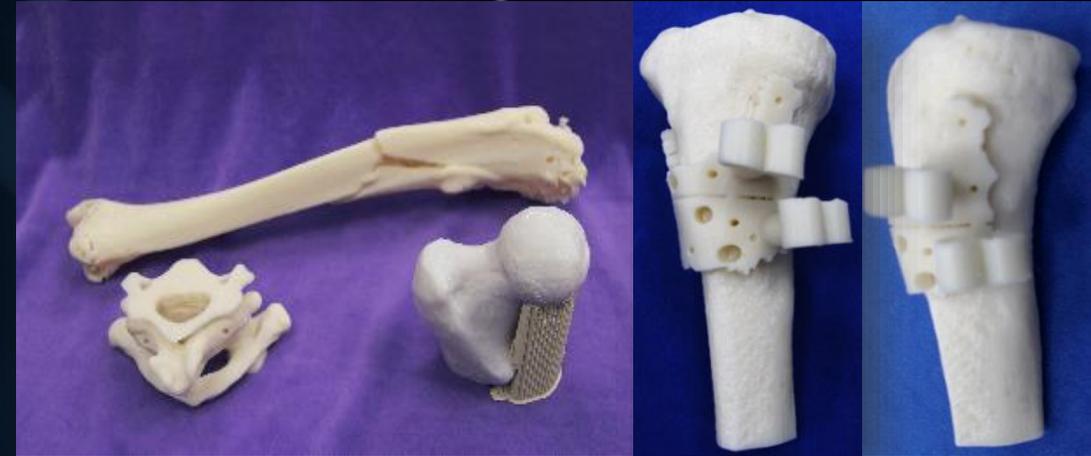
Computer Assisted Orthopaedic Surgery (CAOS) Lab

- Established in 2001
- First Orthopaedic Navigation R&D Lab in Hong Kong
 - Stryker navigation system
 - BrainLab navigation system



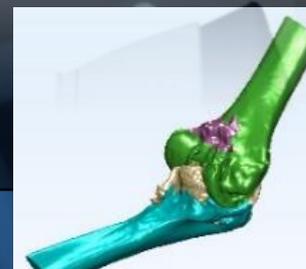
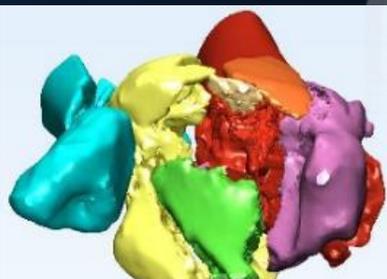
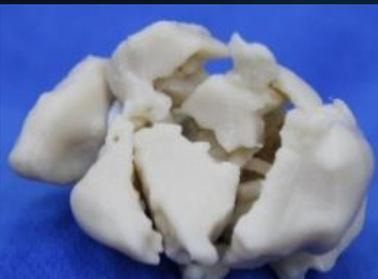
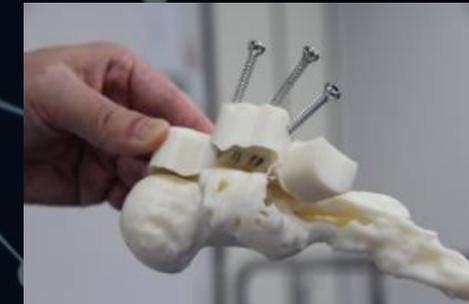
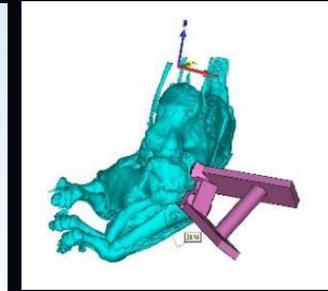
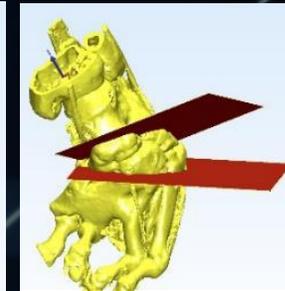
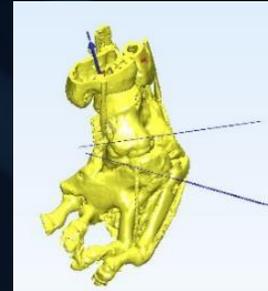
Computer Assisted Orthopaedic Surgery (CAOS) Lab

- Industrial grade 3D printer (2013)
 - Plastic
 - Biocompatible materials
 - Sterilizable
- Medical 3D printing Software
 - Mimics
 - Osirix
- 3D scanner
- → 3D printing applications



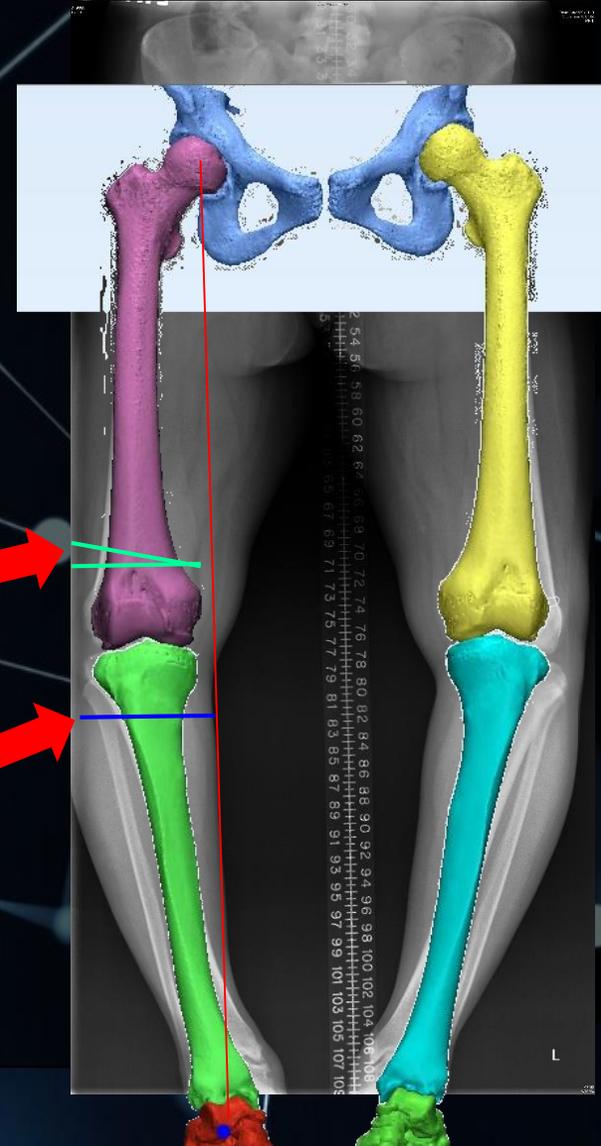
3D Printing Applications in CUHK-ORT

- >500 cases
- Bone model printing
- Preoperative planning
- Patient specific instrument
- Implant / Prosthesis design



Application of Patient Specific Instruments (PSI)

- Most helpful application
- Osteotomies
 - Complicated surgery
 - **Precise bone cut + accurate reposition of bone**
 - Can be done in almost all bones in our body
- Precise surgery planning
 - Multiple cuts
 - Realignment



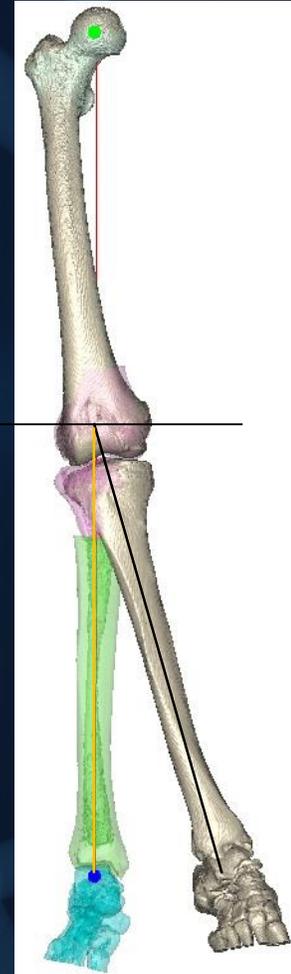
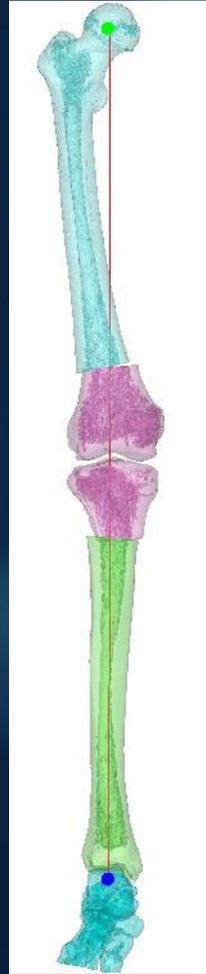
3D pre-operative surgical planning



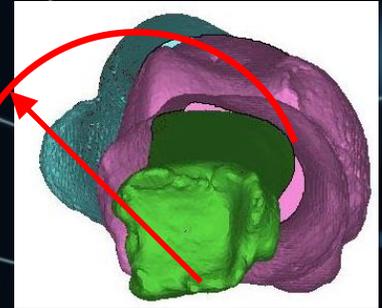
Pre-op



Post-op
(Simulated)



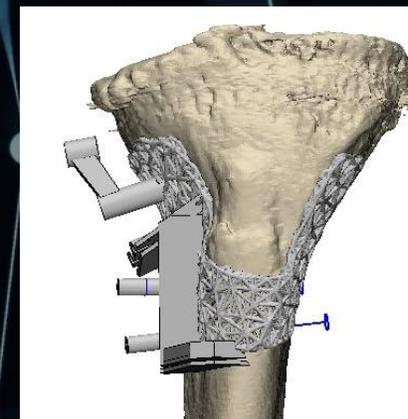
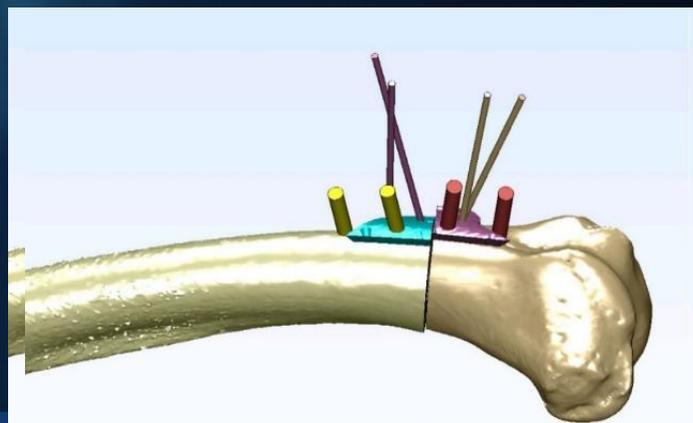
30° External rotation



~19°

Patient Specific Osteotomy Jig

- 3D print
- Bone surface match feature
- Cutting guidance
- Realignment guidance
- Bring the surgery plan into operation



3D Printing Assisted Surgery Workflow



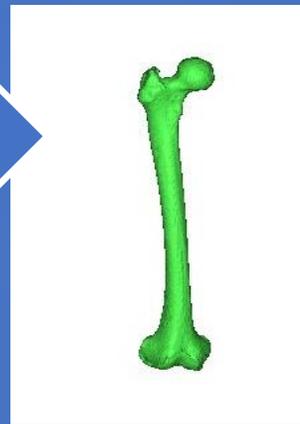
Collect CT/MRI data



Segmentation



Export in 3D model



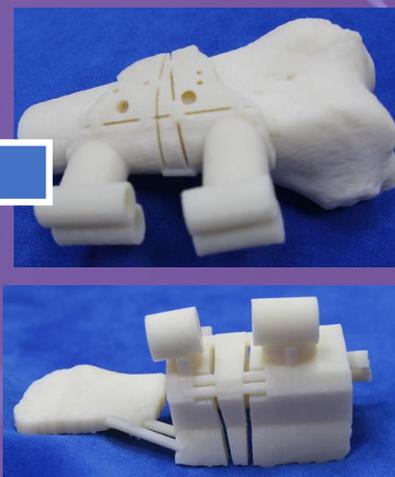
3D pre-operative surgical planning



Surgery



3D printing

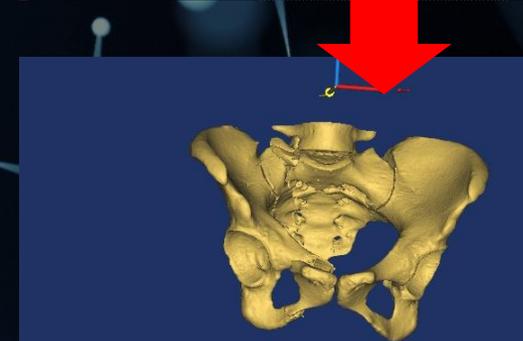


Patient specific surgical instrument (Jig) manual design and generation



Segmentation

1. Manual selection of anatomical region
2. Multiple slides
3. 3D reconstruction





Content

1. Background

2. Current limitations

3. Highlights

Application of PSI in Orthopaedic Surgery

- Improve surgery accuracy
- Reduced surgery time

But...

- **Long preoperative planning time**





3D Printing Assisted Surgery (limitations)

Time Burdens

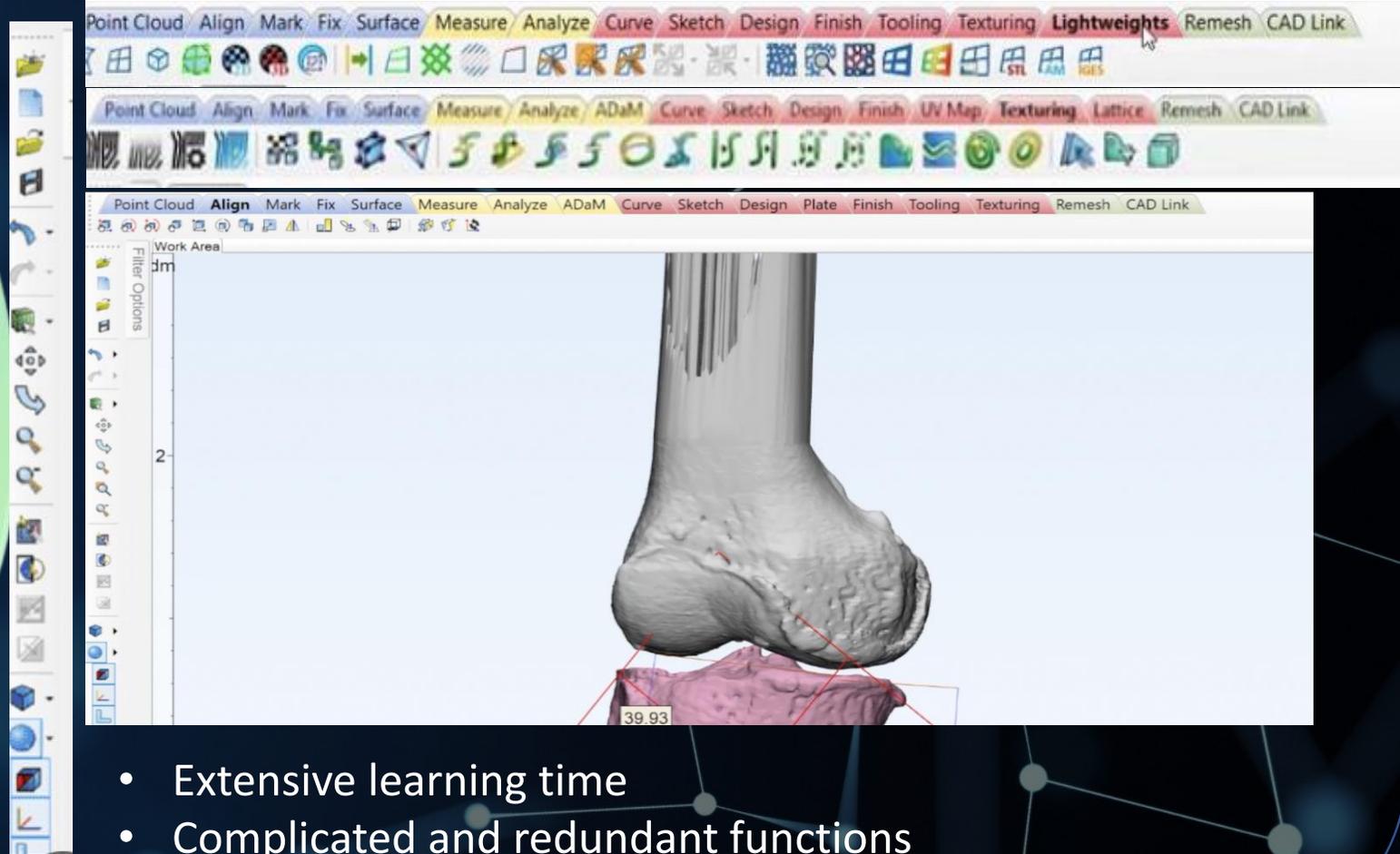
- **Software learning time**
- Unnecessary Complicated design procedures
- Long Segmentation time
- Exhaustive time spend between parties





3D Printing Assisted Surgery (limitations)

Software learning time





3D Printing Assisted Surgery (limitations)

Time Burdens

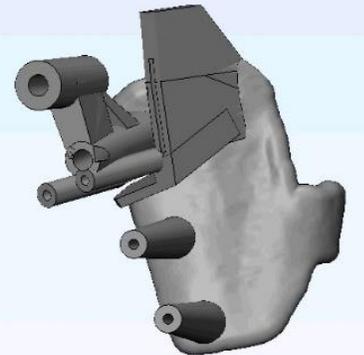
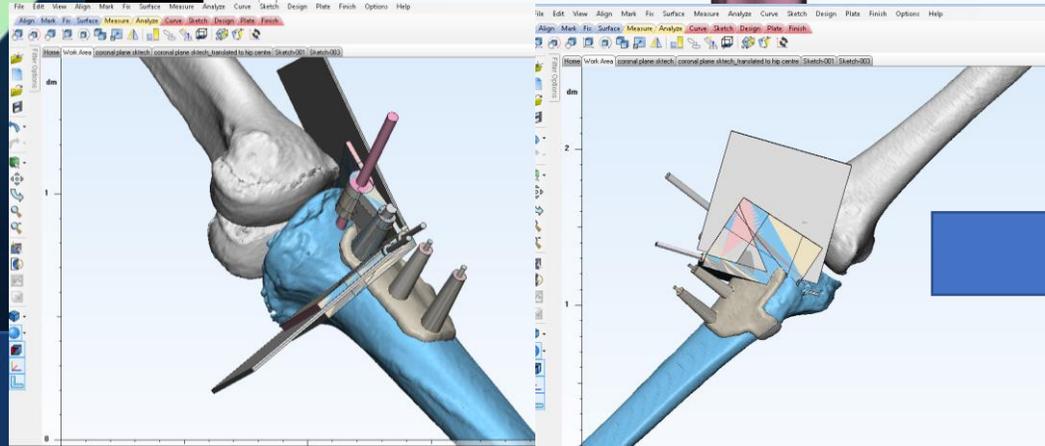
- Software learning time
- **Unnecessary Complicated design procedures**
- Long Segmentation time
- Exhaustive time spend between parties



Unnecessary complicated design procedures



3D Printing
Assisted
Surgery
(limitations)





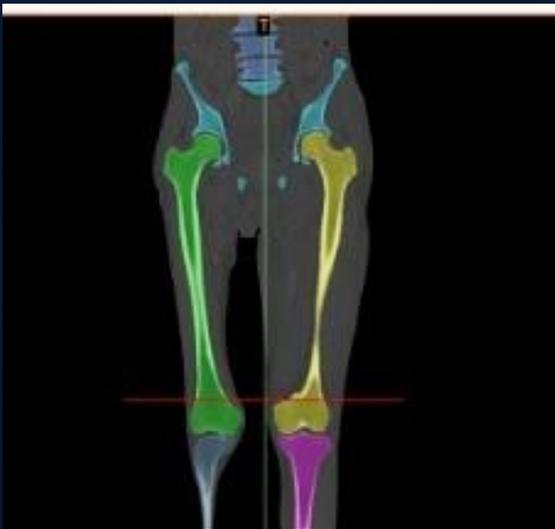
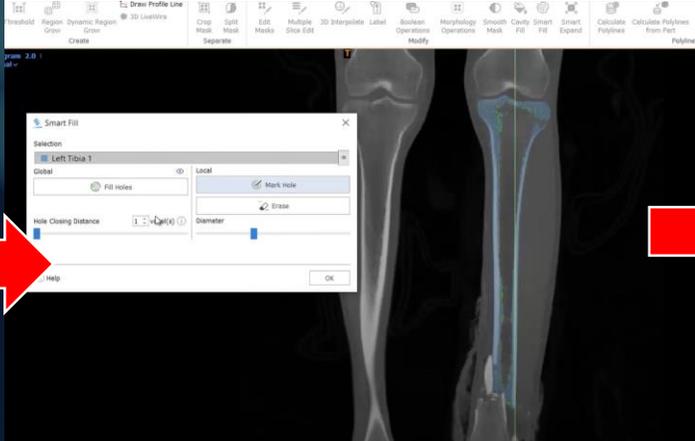
3D Printing Assisted Surgery (limitations)

Time Burdens

- Software learning time
- Unnecessary Complicated design procedures
- **Long Segmentation time**
- Exhaustive time spend between parties



Long segmentation time





3D Printing Assisted Surgery (limitations)

Time Burdens

- Software learning time
- Unnecessary Complicated design procedures
- Long Segmentation time
- Exhaustive time spend between parties





3D Printing Assisted Surgery (limitations)

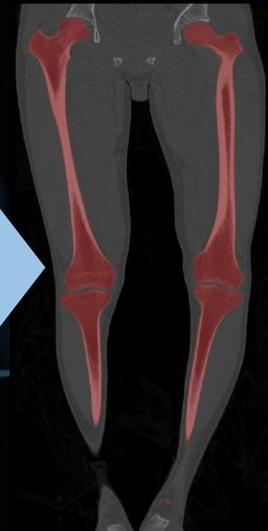
Exhaustive time spend between parties



CT-image



Discussion



Segmented

Content

1. Project Background
2. Current limitations

3. Highlights

Designed by Surgeons
Used by Surgeons

Innovation

- Revolutionise pre-operative and post-operative surgery in osteoto
- Advancement in accuracy and time using advanced algorithm
- Surgery oriented function and modules
- AI assisted segmentation and jig generation

Designed by Surgeons
Used by Surgeons



Cloud-base

👍 Compatible to tablet and mobile

👍 Access from any secure devices

Commercial Planning Software

👎 Required powerful computer

👎 Access from single device only



Designed by Surgeons
Used by Surgeons

AI Segmentation

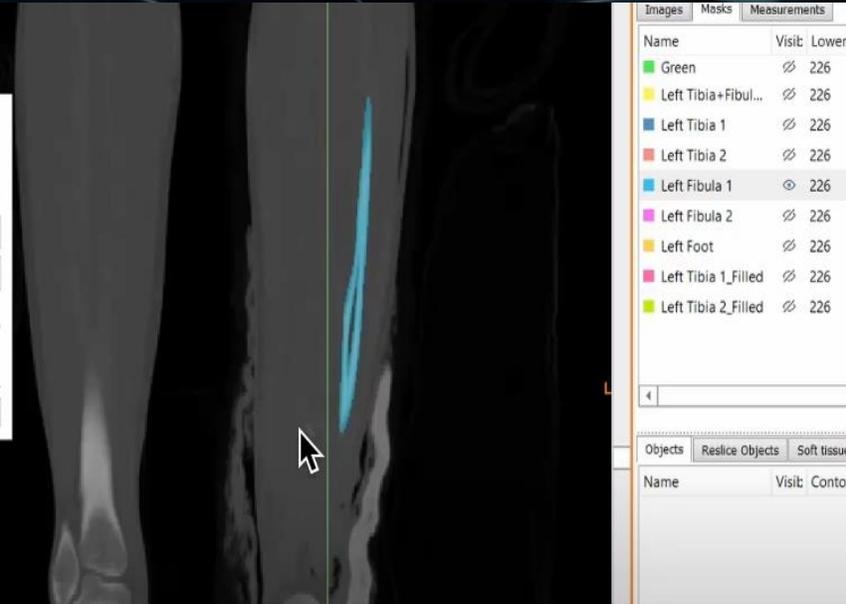
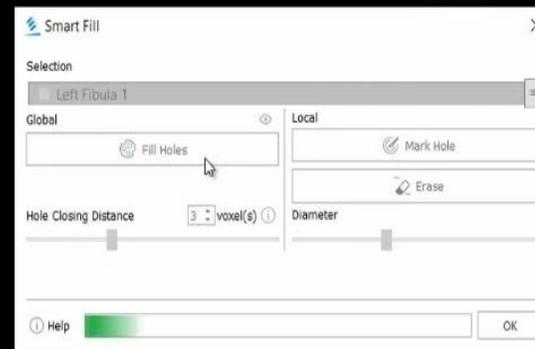
- 👍 Single bone : 2 mins
- 👍 Whole limb : 2 mins
- 👍 High accuracy (Avg 95%)

Commercial Planning Software

- 👎 Single bone : 15-20 mins
- 👎 Whole limb : 60-90 mins
- 👎 Human error



Designed by Surgeons
Used by Surgeons

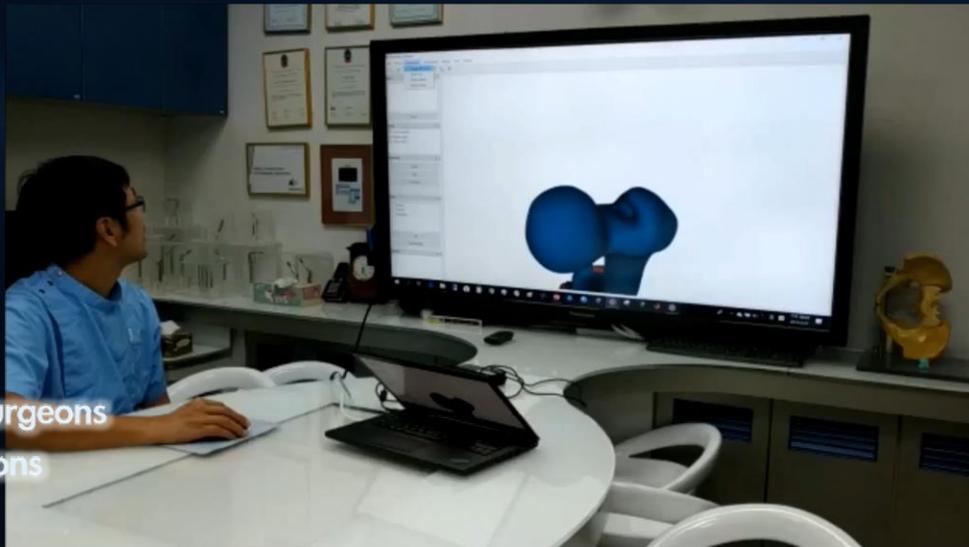


Surgery Oriented Planning Modules and Functions

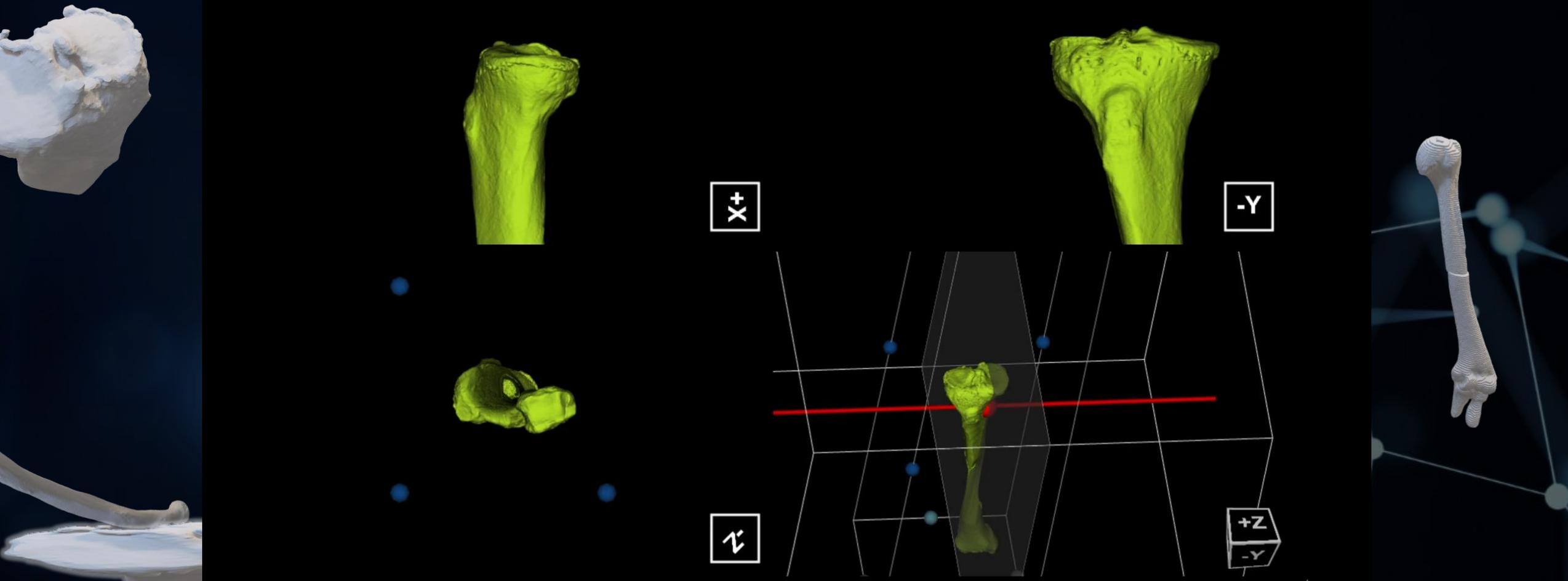
- 👍 Learning time <30 mins
- 👍 Surgeon practise
- 👍 Up to 20 useful functions
- 👍 Surgeon friendly interface
- 👍 Minimal Communication error

Commercial Planning Software

- 👎 Extensive learning time required
- 👎 Complicated and redundant function
- 👎 Engineer and specialist required
- 👎 Tedious collaboration



Surgery Oriented Planning Modules and Functions



Cutting plane in customized views

Surgery Oriented Planning Modules and Functions

The screenshot displays a web-based surgical planning interface. The top navigation bar includes links for Dashboard, Account, Projects, Preview, Segment, Spine, HTO, Upper Limb (selected), Automatic Jig, and 3D Printing. The CU Medica logo is visible in the top right corner.

The main interface is titled "Upper Limb" and features a control panel on the left with the following sections:

- View**: A dropdown menu.
- Coordinates system**: A dropdown menu.
- Cutting Plane**: A dropdown menu.
- Cutting Planes View**: A toggle switch.
- Planes offset**: A slider set to 50, with minus and plus buttons.
- Objects**: A dropdown menu set to "Upper limb".
- Cutting**: A blue "Cut" button.
- Alignment**: A dropdown menu.
- Transform**: A dropdown menu.
- Registration**: A dropdown menu.

The central 3D view shows a forearm model with a red cutting plane. Surrounding the model are navigation icons: a square with a crosshair and plus/minus signs, a square with "-Y", a square with a rotation symbol, and another square with "-Y". A 2D wireframe view of the forearm is shown in the bottom right corner.

Cutting plane generation

AI Assisted PSI Design and Generation



Used by Surgeons

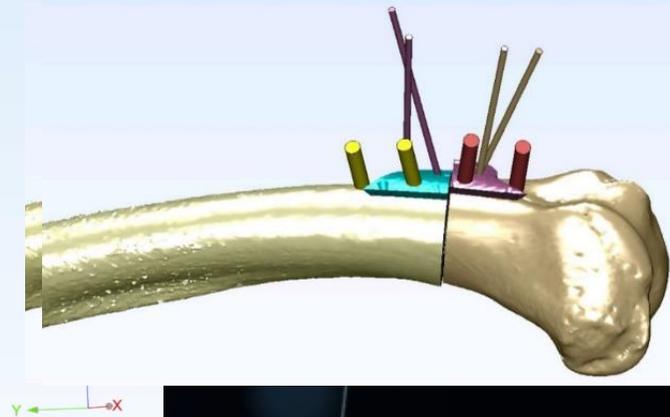
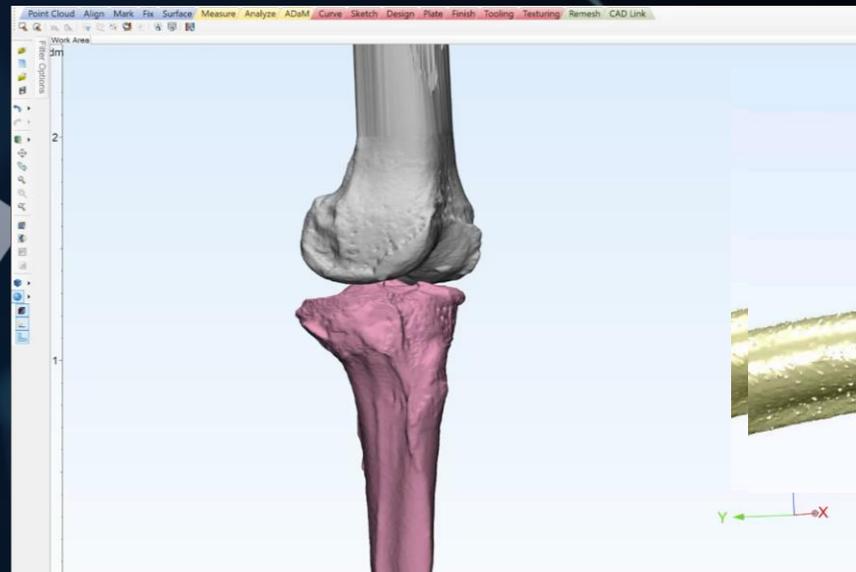
Personalized Surgical Instrument Generation

AI Assisted Jig Design and Generation

- 👍 No communication required
- 👍 Auto jig design
- 👍 Design time less than 5mins
- 👍 Enhanced efficiency

Commercial Planning Software

- 👎 Time consuming in communication
- 👎 Manual design required
- 👎 Design time more than 2hrs



Impact

- **Surgery oriented function and modules**
 - **AI assisted segmentation**
 - **AI assisted PSI generation**
- Reduce Planning Time**

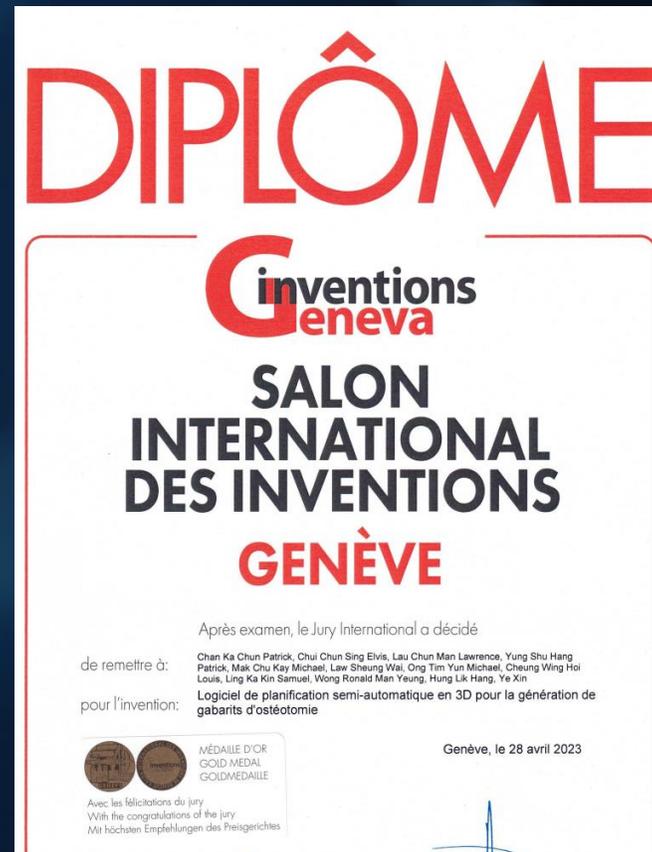
- ✓ Reduced planning time
- ✓ Reduce human error
- ✓ Shorten surgery time
- ✓ Reduced patient anesthesia time

- ✓ Increased OT rooms availability
- ✓ Surgeons friendly interface
- ✓ Highly reliable AI assisted functions
- ✓ Easy to use

Design by
Used by **Surgeons**

Recent Awards

- 第四十八届日内瓦国际发明展评审团嘉许金奖
 - Semi-Automatic 3D Planning Software for Osteotomy Jig Generation



Acknowledgement

Innovation and Technology
Commission

Leetai Precious Metal Company
Limited

- Mr. Patrick Chan

Koln 3D Technology (Medical)
Limited

- Mr. Edmond Yau

Asahi Group Co. Ltd

- Miss Ada Fong

Department of Orthopaedics and
Traumatology,

The Chinese University of Hong Kong

- Prof. Patrick Yung
- Prof. Elvis Chui
- Prof. Michael Ong
- Prof. Samuel Ling
- Prof. Ronald Wong
- Prof. Kevin Ho

Department of Orthopaedics
Traumatology,

Prince of Wales Hospital

- Dr. Sheung-wai Law
- Dr. Michael Mak
- Dr. Lawrence Lau

Thank you

The background is a dark blue gradient. On the right side, there is a network of white lines and dots of varying sizes, creating a complex, interconnected pattern that resembles a molecular structure or a data network. The dots are connected by thin white lines, forming various geometric shapes and paths across the right half of the image.