

# Synopsys Simpleware Software

3D image-based analysis in Life Sciences, Materials and Industrial Applications

Kerim Genc

October 2022



# CONFIDENTIAL INFORMATION

The information contained in this presentation is the confidential and proprietary information of Synopsys. You are not permitted to disseminate or use any of the information provided to you in this presentation outside of Synopsys without prior written authorization.

## IMPORTANT NOTICE

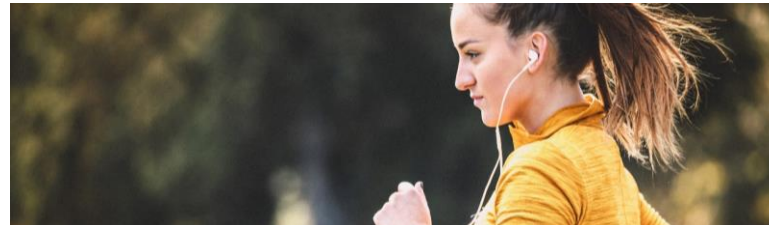
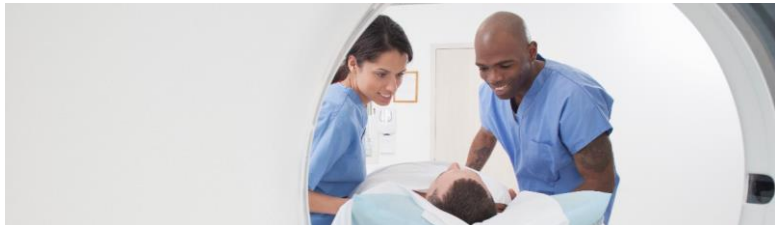
In the event information in this presentation reflects Synopsys' future plans, such plans are as of the date of this presentation and are subject to change. Synopsys is not obligated to update this presentation or develop the products with the features and functionality discussed in this presentation. Additionally, Synopsys' services and products may only be offered and purchased pursuant to an authorized quote and purchase order or a mutually agreed upon written contract with Synopsys.

# Simpleware Product Group

- Simpleware software enables you to comprehensively process 3D & 4D image data (MRI, CT, micro-CT, FIB-SEM...) and export models suitable for CAD, CAE and 3D printing.
- Use Simpleware 3D image software to visualize, analyze, and quantify your data, and to export models for design and simulation workflows.
- **3D Image → Model**



**SYNOPSYS**<sup>®</sup> | SIMPLEWARE PRODUCT GROUP



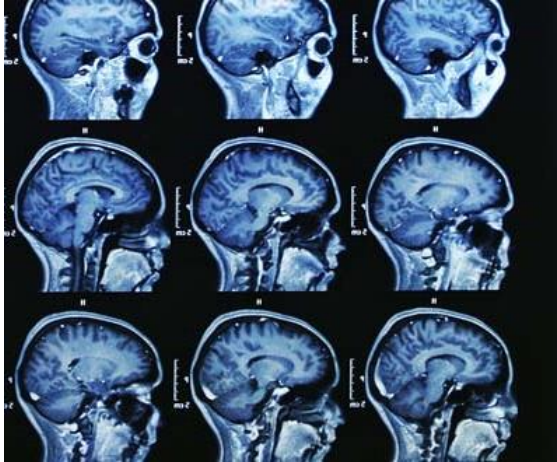
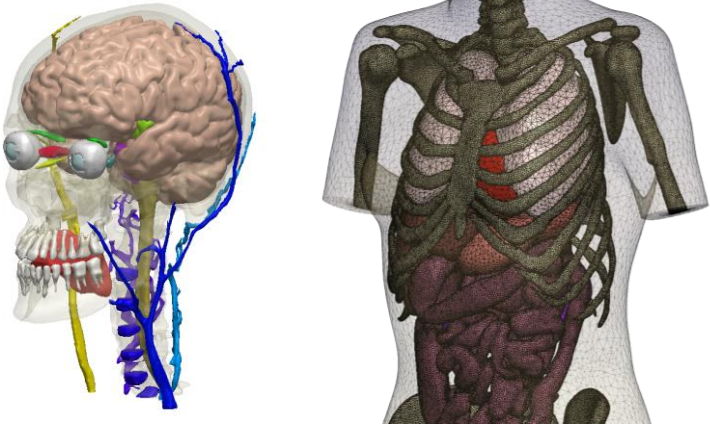
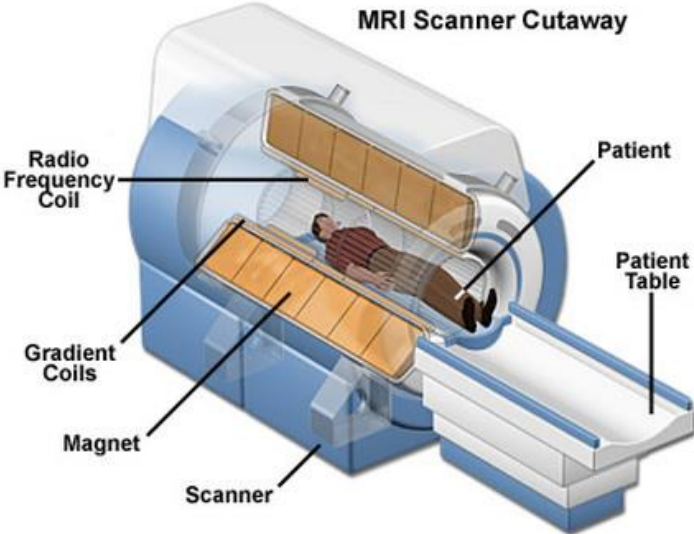
# 3D Imaging Modalities

## Life Science and Medical Applications



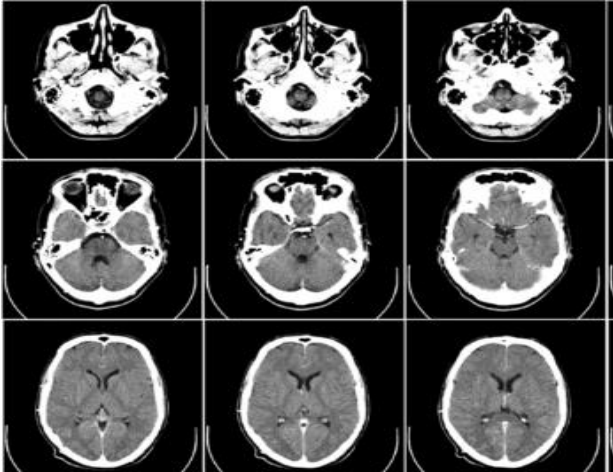
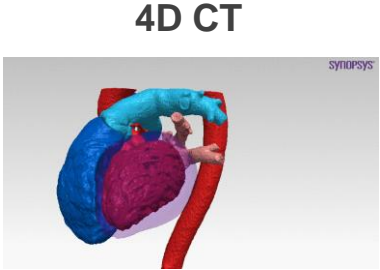
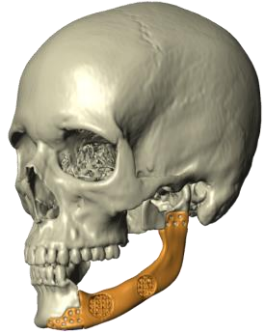
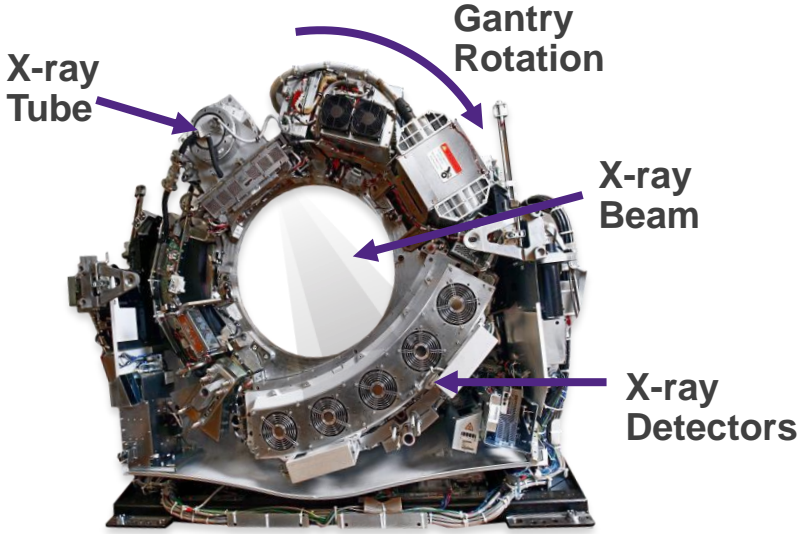
# Magnetic Resonance Imaging (MRI)

Most are familiar with Clinical MRI in a Hospital



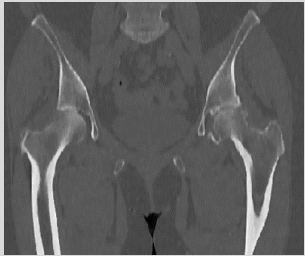
# Computed Tomography (CT)

Most are familiar with Clinical CT in a Hospital



# Medical 3D-Image Based Modelling Workflows

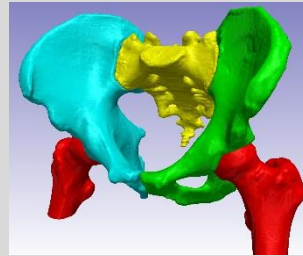
Image Processing



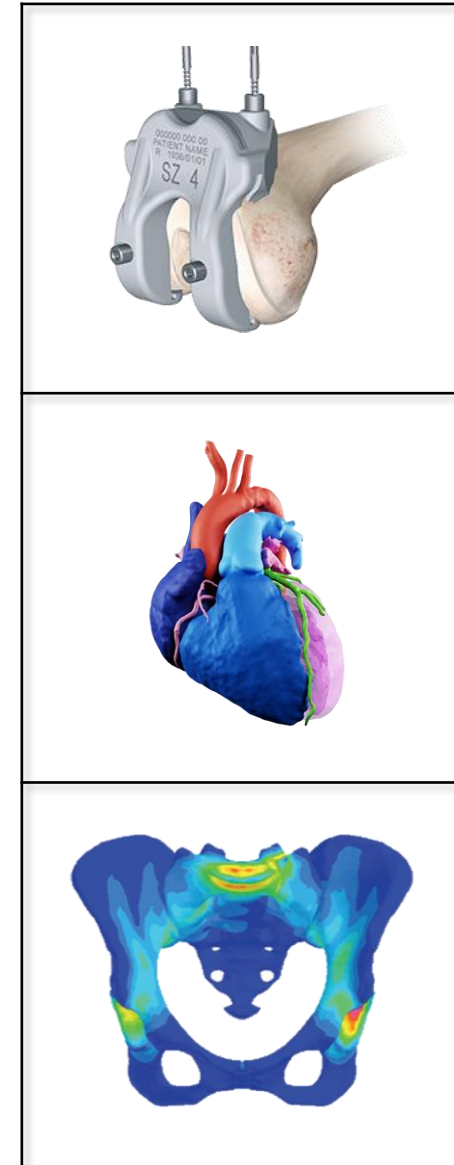
Segmentation



Model Generation



Analysis & Reporting



Implants, Guides  
& Surgical  
Planning (SP)

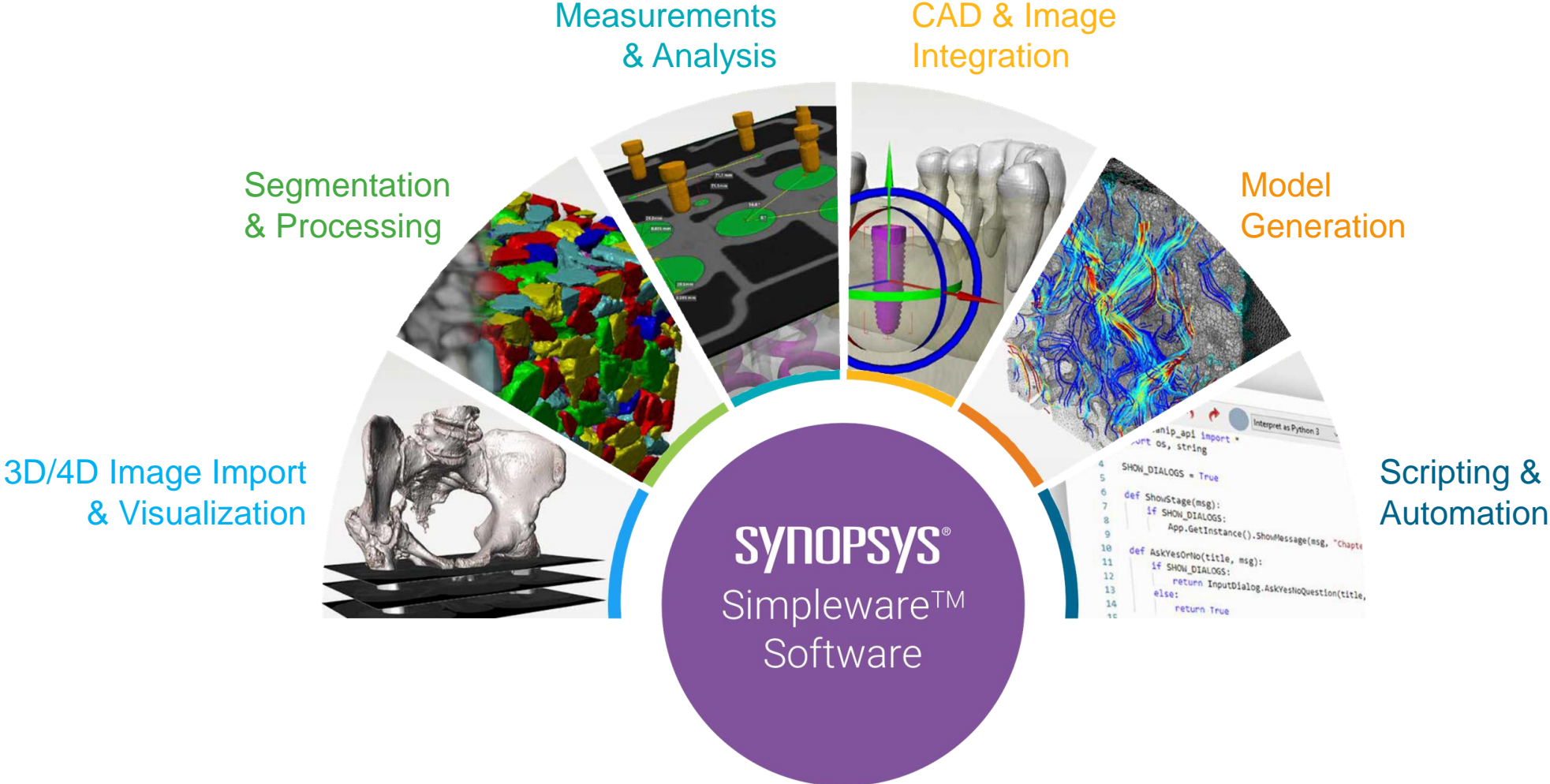
Point of Care 3D  
Printing (POC)

*in silico* Clinical  
Trials (*in silico*)

Our Clients Consider Simpleware to be **THE** Best-in Class Tool for:

- Image Segmentation
- AI-Enabled Automation, Analysis and Reporting
- Full Customization (Scripting, GUI, AI...)
- STL, 3MF, CAD and Simulation export for varied contexts of use

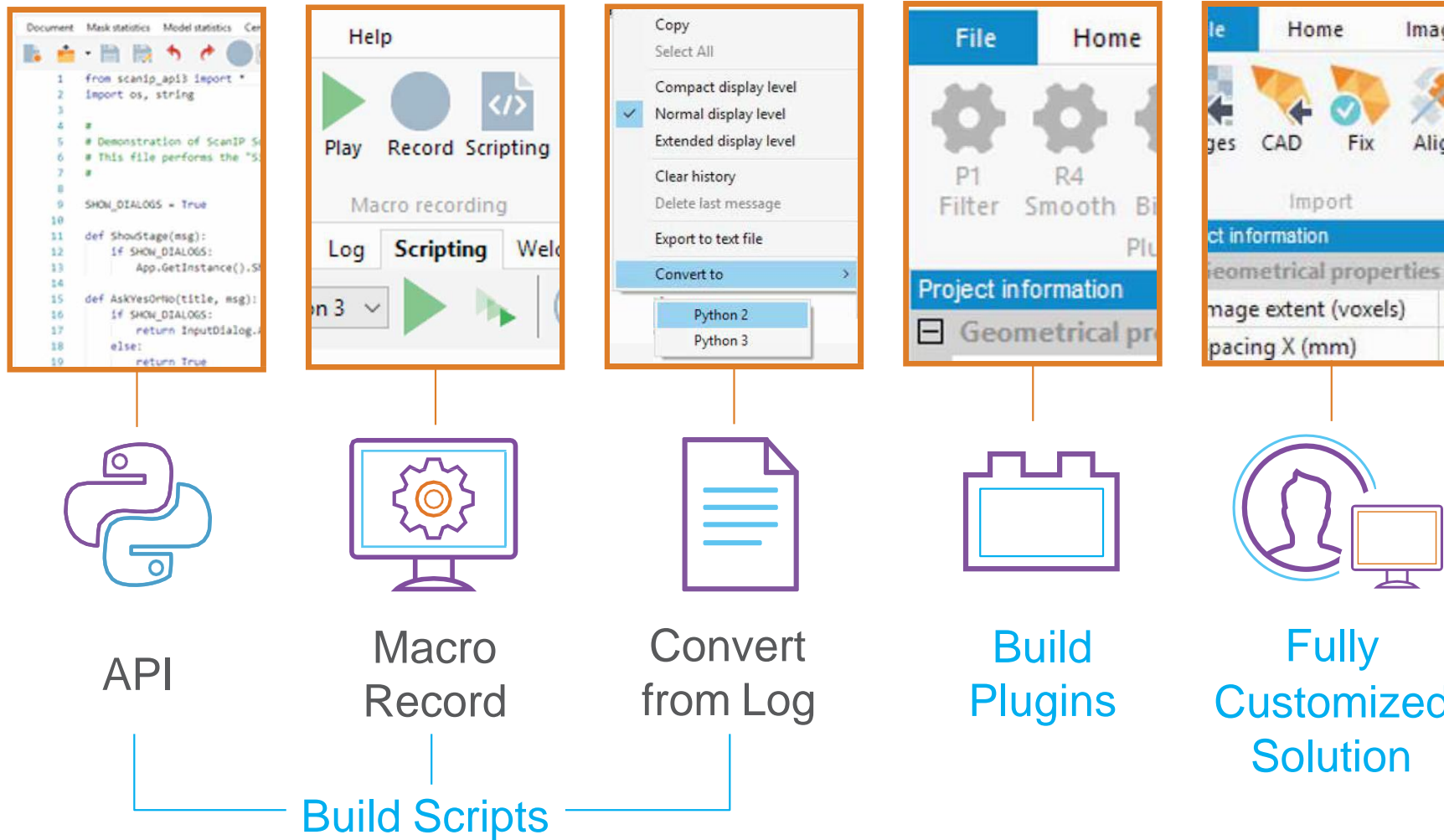
# Off-The-Shelf Software





# First Level of Automation - Scripting

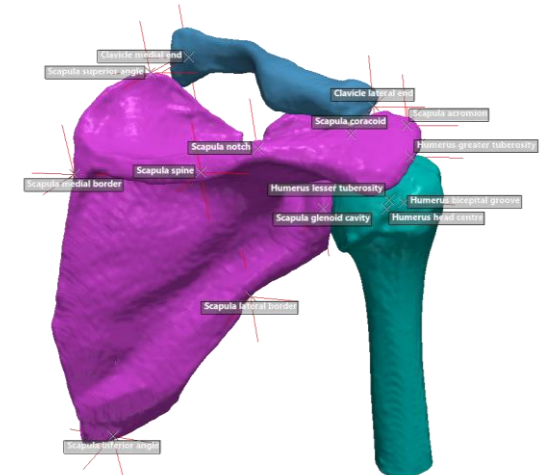
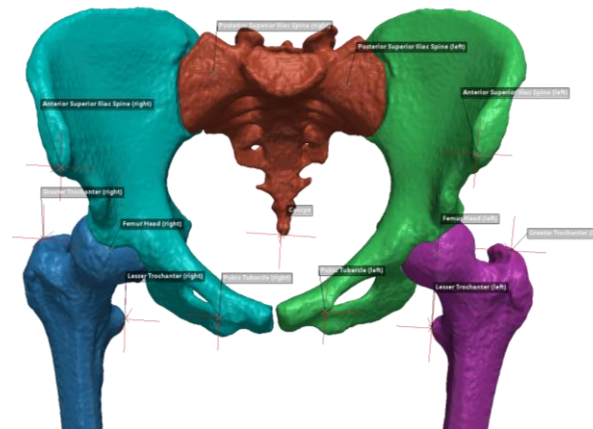
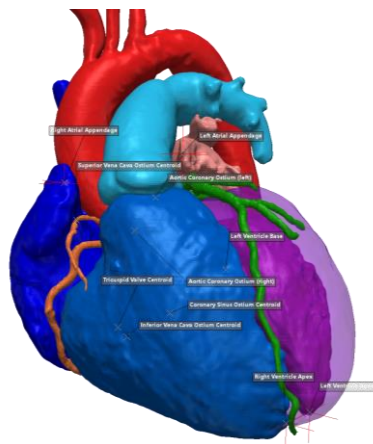
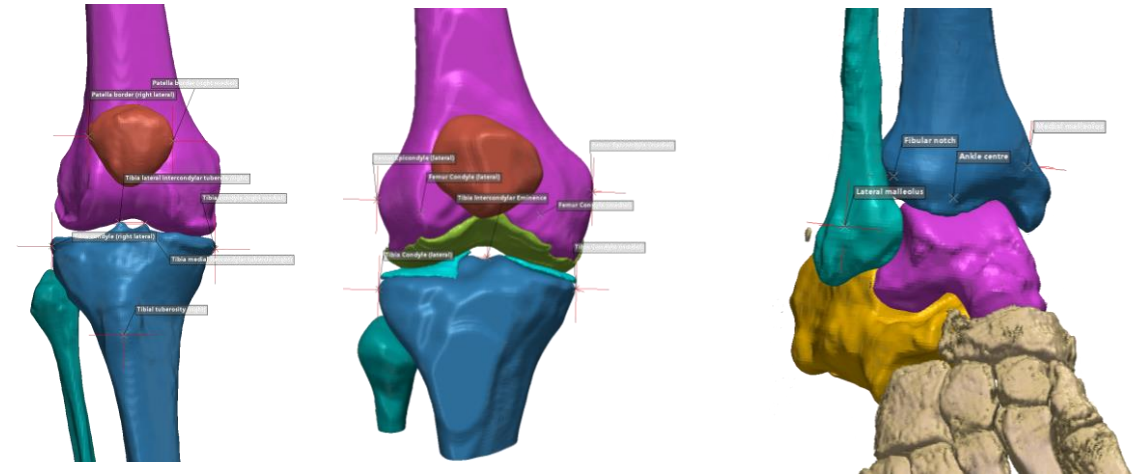
## Python and C# Scripting API



# Second Level of Automation - Simpleware AS Ortho/Cardio

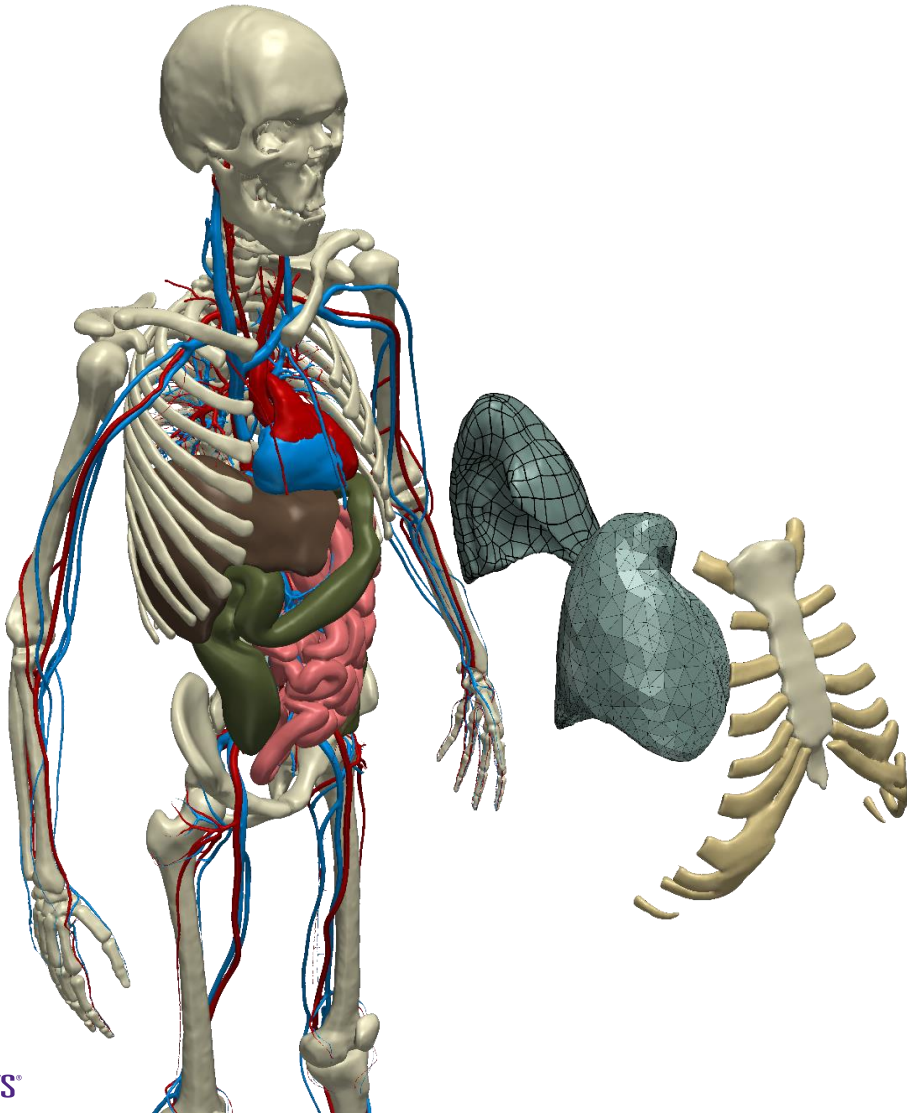
Off the shelf AI-enabled tools for automatic segmentation and landmarking

- AS Ortho
  - Automatic segmentation and landmarking for Ankle CT, Knee CT, Knee MRI, Hip CT and Shoulder CT,
- AS Cardio
  - Automatic segmentation and landmarking for 3D and 4D Heart CT
- Turnkey add-on modules for ScanIP Medical
- Speed up production time up to 100x



# Third Level of Automation – Simpleware Custom Modeler

Complete End-to-End Customized Automated Machine Learning based AI Solution



- Automated solution purpose-built for your needs
- Segmentation and Landmarking of **any** anatomy from **any** imaging modality
- Built on top of the flexible Simpleware software
- Ground truth training data either provided by Simpleware or customer who would own IP
- Current Customer Example – Corin OPS
  - Processes ~500 Hip/Knee/Ankle CT scans per mo.
  - Workflow time for each patient reduced by 94%!

<https://www.synopsys.com/simpleware/news-and-events/surgical-planning-corin.html>

# Recap on Levels of Automation

- Required level of automation will vary depending on the target application and level of current and anticipated scale.
- Synopsys Simpleware Solutions can address these varying needs to grow with the workflow as the volume of image processing scales up



	<b>Simpleware ScanIP Medical</b>	<b>Scripting</b>	<b>+AS Ortho/Cardio</b>	<b>+Custom Modeler</b>
# of Datasets/year	1-100	25-150	100's+	100's - 1000's+
Time Savings	-	30-60%	50-90%	90%+
End User	Engineers	Engineer	Engineers/ Technicians	Engineers/ Technicians

# Point of Care (POC) 3D Printing Example

## Anatomical 3D Printing in the Hospital





## Point-of-Care 3D Printing of Children's Hearts

- Models used for Surgical Planning, Intraoperative Guidance, Patient Counselling and Student Education
- Provide Increased comprehension of anatomy, more exact pathology evaluation and more precise surgical intervention with improved procedural accuracy
- Overall reduced operating room (OR) time and improved patient care
- Currently in 300+ Hospitals in US

Simpleware AI-enabled tools used to help create models in everyday workflow.



Cardiovascular Surgery Advanced Projects Laboratory (APL)  
Dr. Robert Hannan

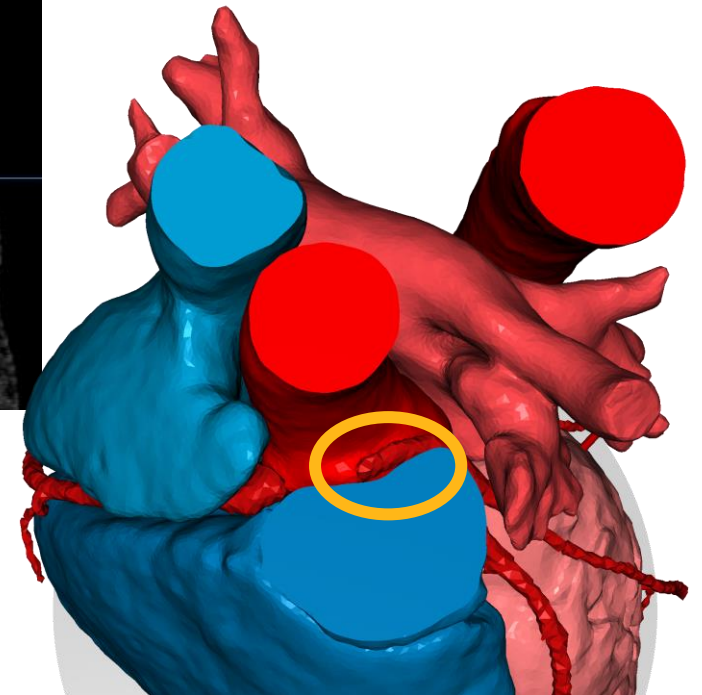
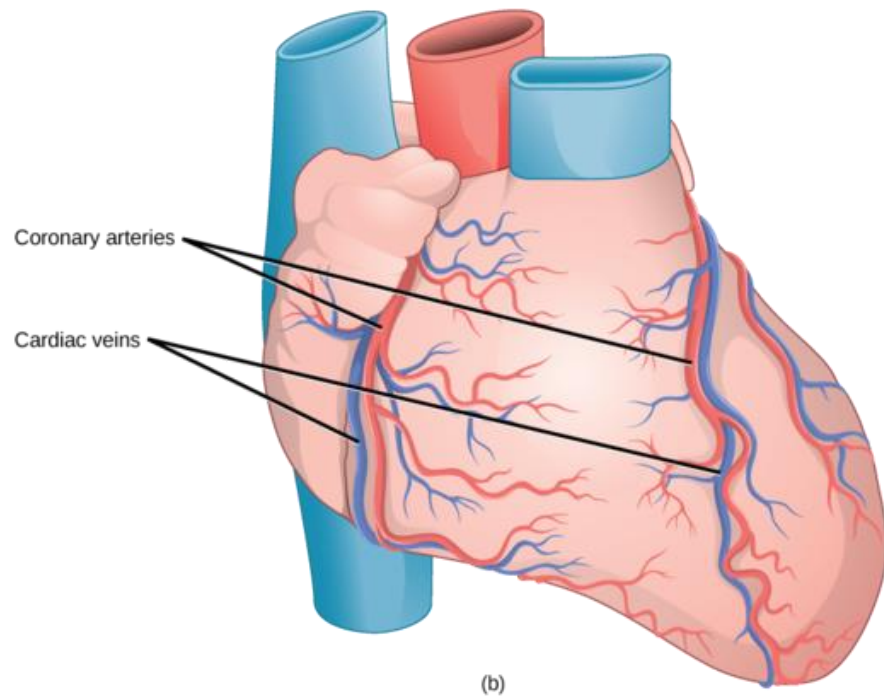


# Point-of-Care 3D Printing of Children's Hearts

## 16-year-old patient:

Anomalous origin of the left coronary artery from the R sinus of Valsavla with intramural, interarterial course.

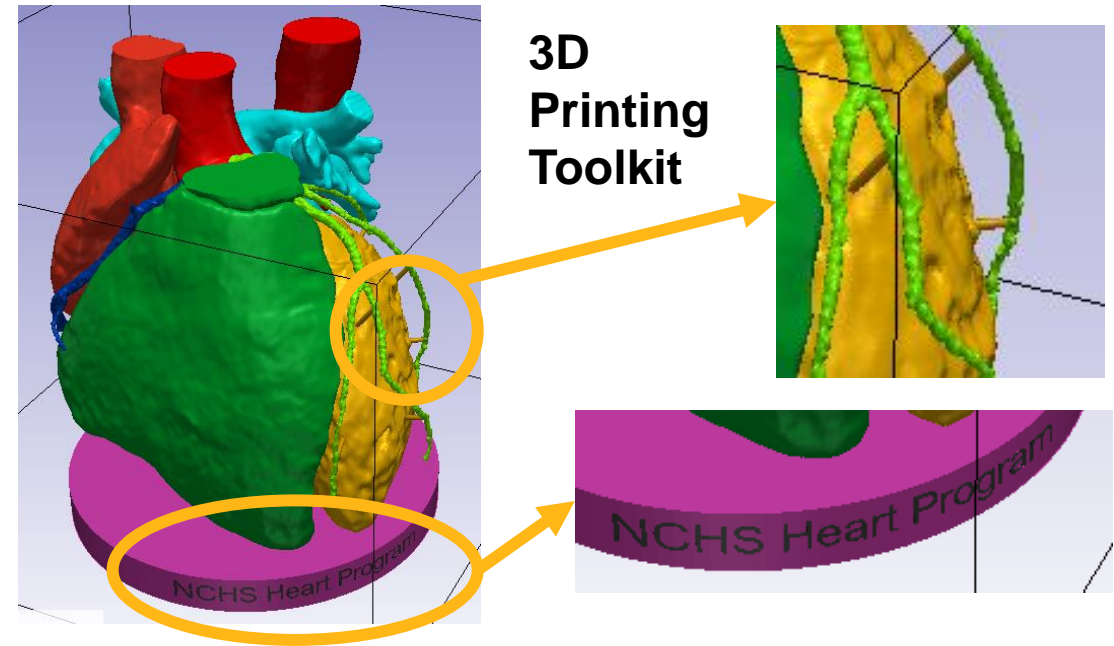
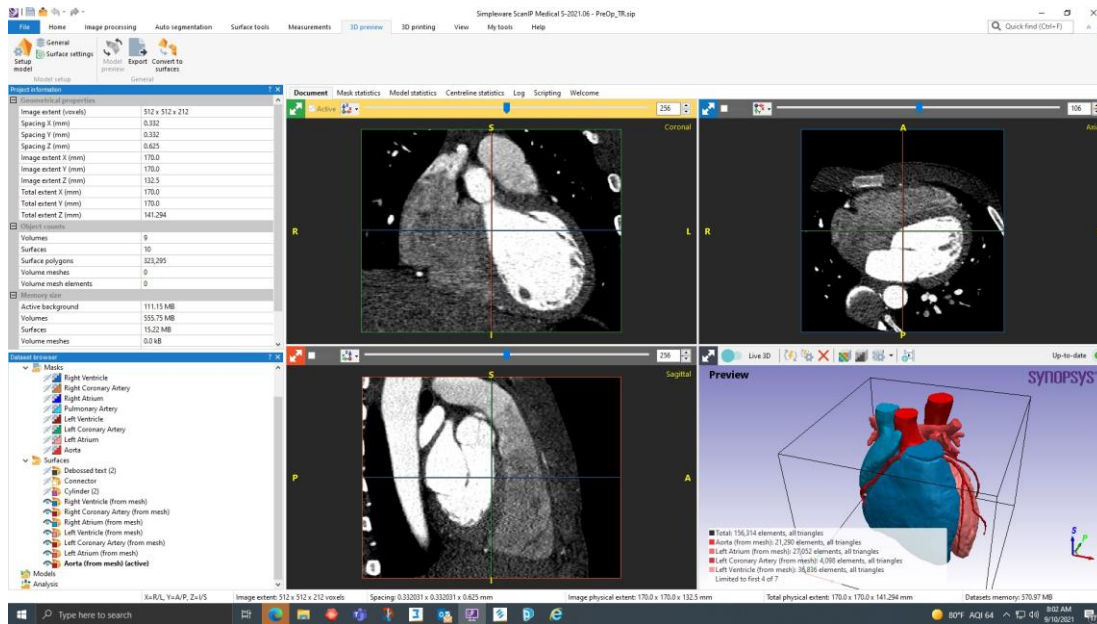
→ Left coronary artery is not in the right place and is being squeezed by the pulmonary artery



<https://courses.lumenlearning.com/boundless-biology/chapter/mammalian-heart-and-blood-vessels/>



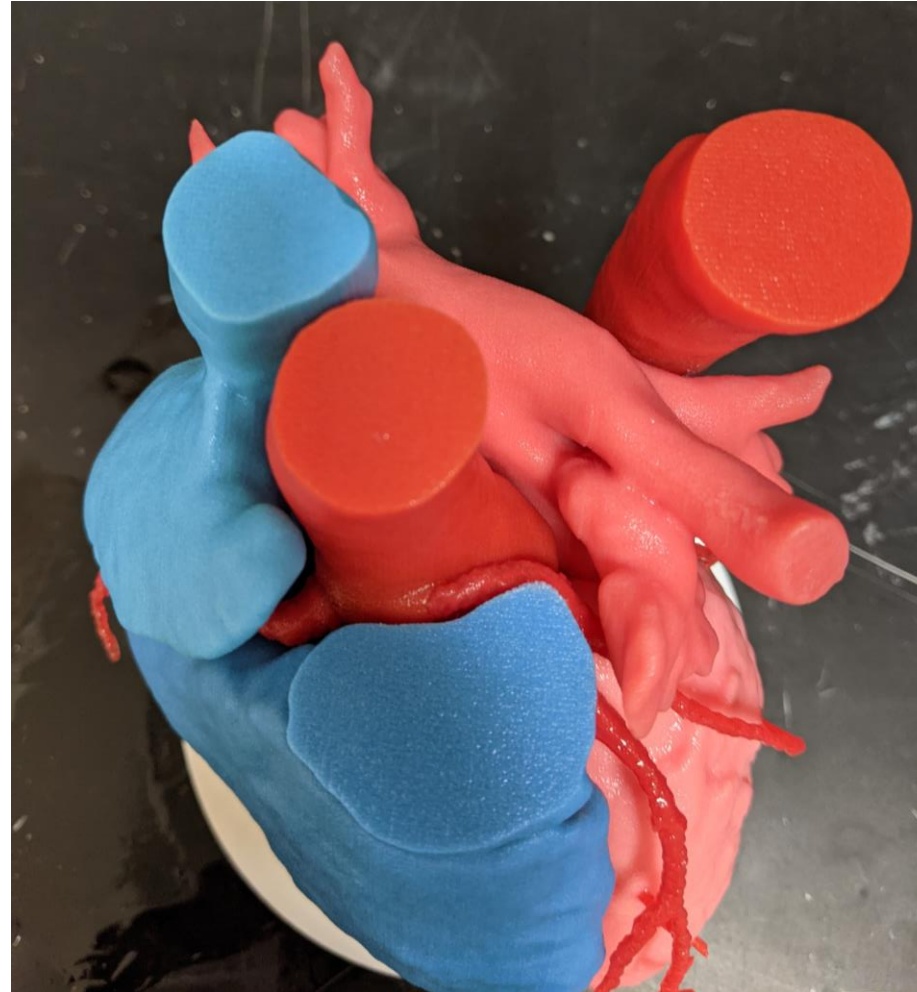
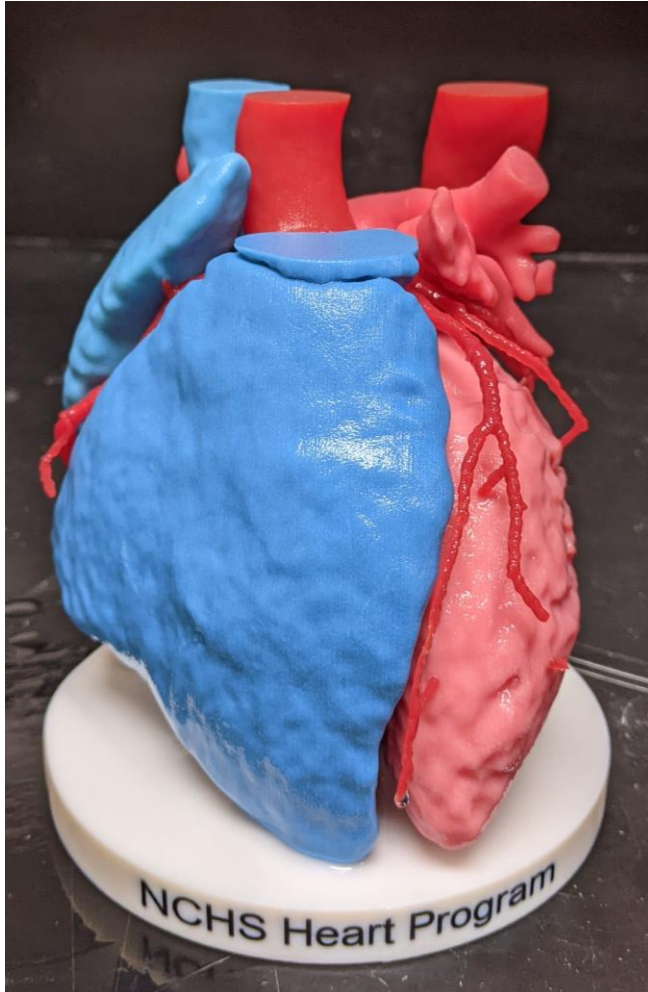
## Point-of-Care 3D Printing of Children's Hearts







## Point-of-Care 3D Printing of Children's Hearts



- Manual workflow ~2hrs
- Simpleware ~15mins
- ~**88%** Time Savings

- ✓ Simpleware AS Cardio
- ✓ Connectors
- ✓ Debossing
- ✓ Cylinder primitive

*"Our new engineer, segmented it. Well, he hit the "go" button on AS Cardio and then added the base and supports. Very quick."*

*– Thomas Haglund, Biomedical Engineer*

Model 3D Printed on Stratasys J750 Anatomical Printer

# Implants, Guides & Surgical Planning (SP) Example

## Scaling up to Serve Thousands of Patients



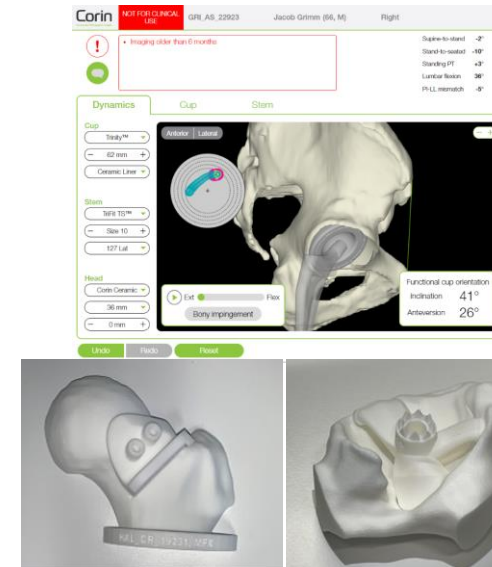
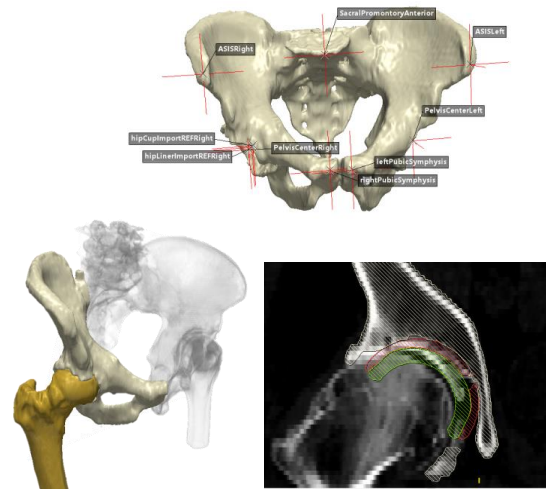
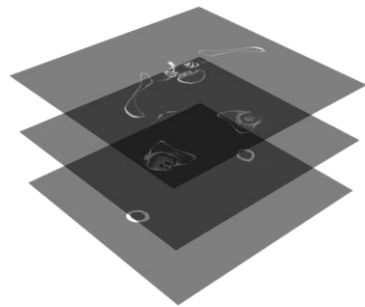
# Patient-specific Total Hip Replacement Planning

- Total hip arthroplasties (THAs) that include patient-specific implants, guides and surgical plans have been rapidly increasing in frequency over the past decade
- Reduce overall procedural costs, minimize surgical time, and maximize patient outcomes by achieving better biomechanical implant fit.
- Synopsys and the Corin have been working together for over 10 years to develop and streamline their OPS workflow for THAs
  - Available in **13** countries and used by almost **280** surgeons around the globe
  - OPS in **26** peer-reviewed publications, supporting the clinical relevancy and value of this technology.
  - **Corin: 6k/year and 20k+ cases total worldwide.**



# Patient-specific Total Hip Replacement Planning

- The Optimized Positioning System (OPS™) is a process of planning the position of implants for each patient to optimize functional implant alignment and improve surgical outcomes.



Patient Imaging

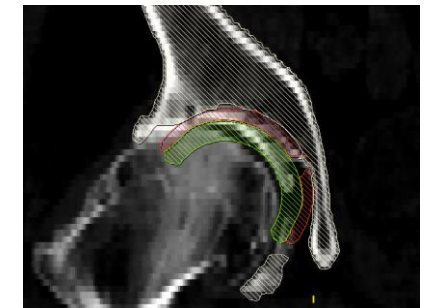
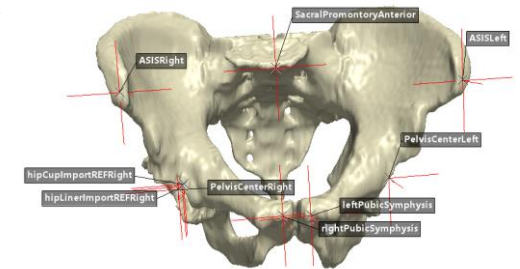
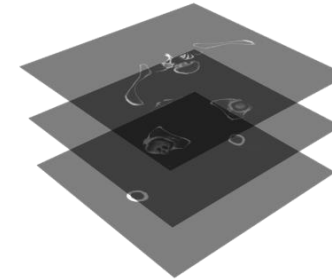
OPS™ Analysis  
Powered by Synopsys  
Simpleware

Surgical Plan and  
Guides

Surgery

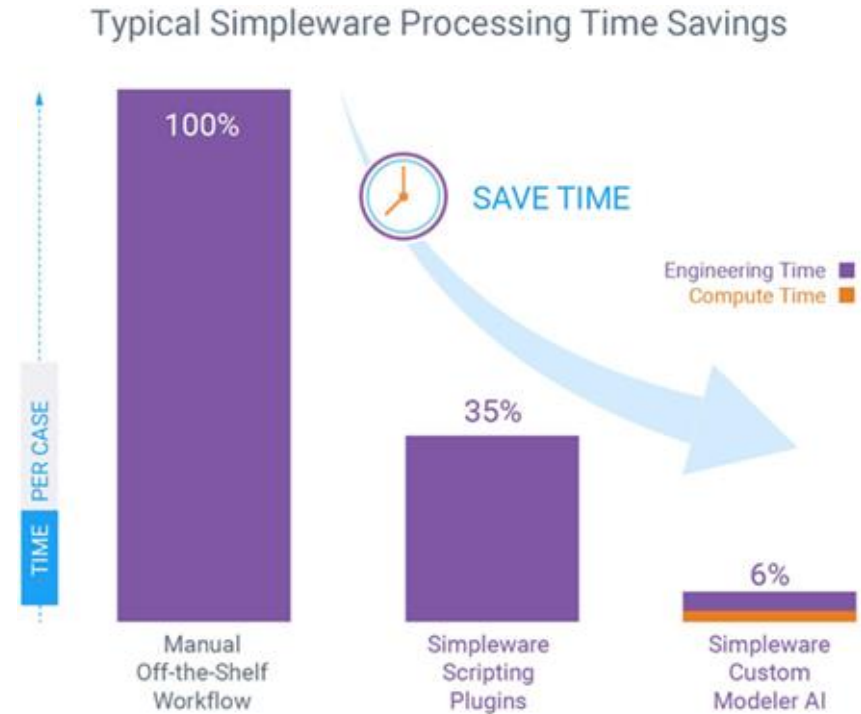
# Patient-specific Total Hip Replacement Planning

- Challenges when optimizing patient-specific workflows:
  - Turnaround time for planning cases
  - Maintaining clinical accuracy, repeatability etc.
  - Regulatory compliance. (CE, FDA, ISO etc.)
- Synopsys Simpleware solution
  - Standardizing workflows across many production engineers
  - Automating implant positioning but allowing for fine tuning
  - Allowing fast segmentation and landmarking
  - Exporting high quality models for analysis and guide preparation



# Patient-specific Total Hip Replacement Planning

- 2020 - Deployed an AI/ML “Custom Modeler” solution to Corin’s OPS workflow to automate segmentation and landmarking
- Version 1 (2020)
  - Corin provided ~100 ground truth datasets
  - Simpleware team trained an AI/ML model
  - Reduced time per case by **80%**
- Version 2 (2021)
  - Identified groups of pathologies that needed improvement
  - Added more ground truths to the AI/ML model
  - Reduced time per case by **94%**



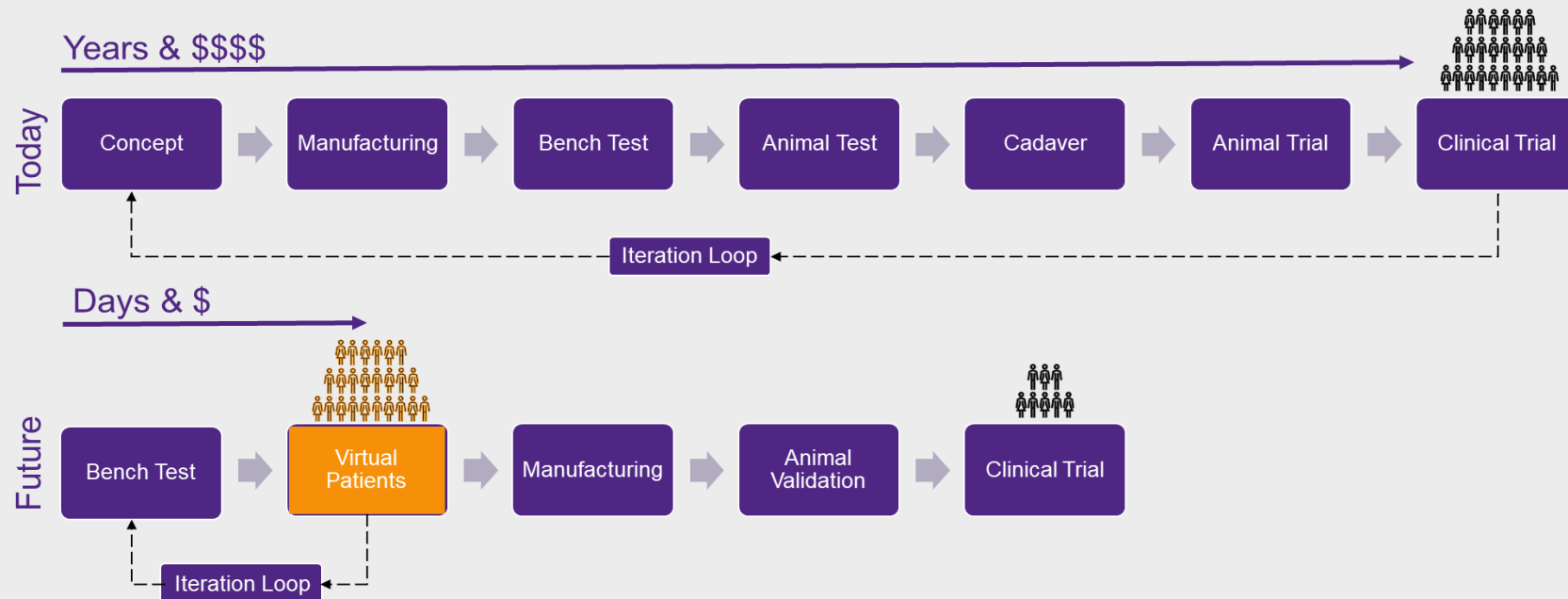
# *In silico* Clinical Trials Example

Establishing, then Scaling the Image to Simulation Workflow



# In-Silico Clinical Trials

“Reduce, Refine, (partially) Replace” Slow and Expensive Development Process



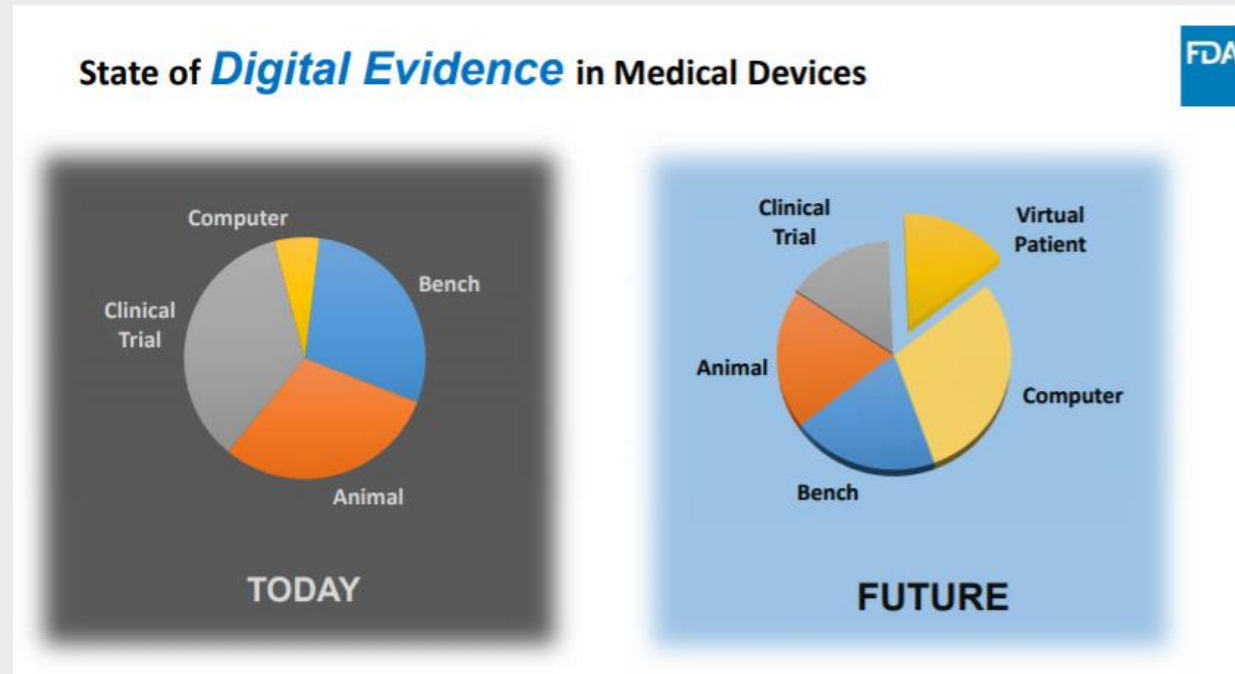
Traditional regulatory evidence still in majority but ISCT is growing because it....

- Reduces **cost**, reduces **time to market**, increases **quality of results** and enables **innovation**
- While...reducing **risk to patients** and reducing **animal suffering**



# In-Silico Clinical Trials

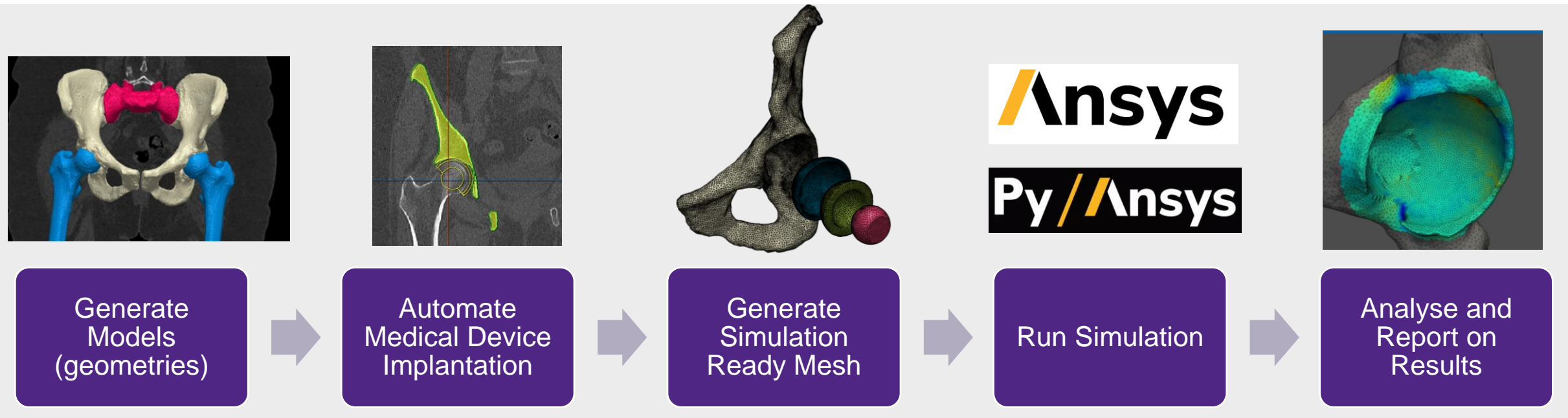
“Reduce, Refine, (partially) Replace” Slow and Expensive Development Process



Industry expectation for shift from clinical trial, animal and bench testing towards virtual patients and computational modelling, supported by regulatory bodies through initiatives, and investment in research and standards publication

# Explore Influence of Surgical Approach on Patient Outcome

Fully Automated Study on 40 Patients Completed in Hours



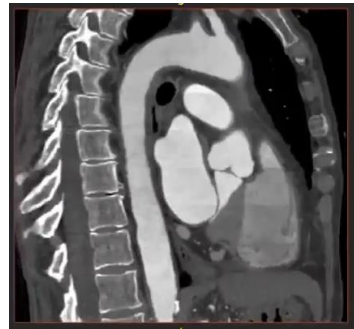
- Robust, automated workflow to generate and analyse FE ready models
- Easy to expand to more subjects, adapt to different applications or compare devices
- ISCT's able to demonstrate subtle differences between methodologies/designs in smaller cohorts due to paired comparison in each subject

# Medical Image to Simulation Ready Cardiac Models

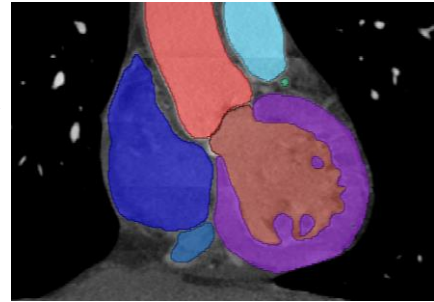
Synopsys → Ansys - Automated Workflow in Minutes

Simpleware

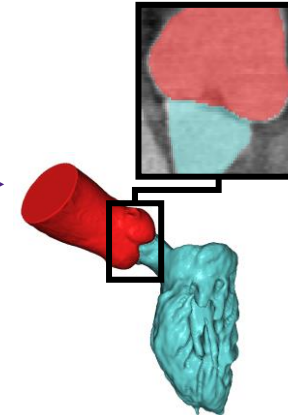
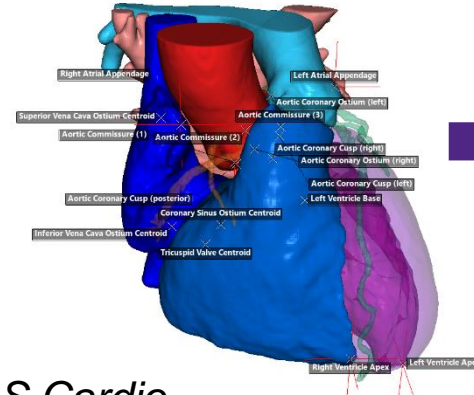
Image Processing



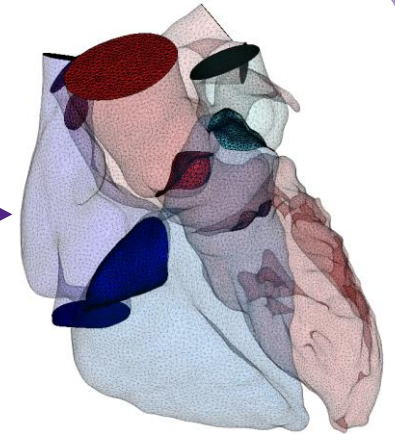
Heart CT scan



AS Cardio



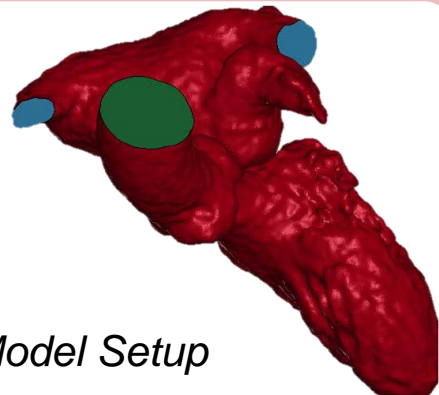
Model Preparation



Export Nastran

Setup and Simulation

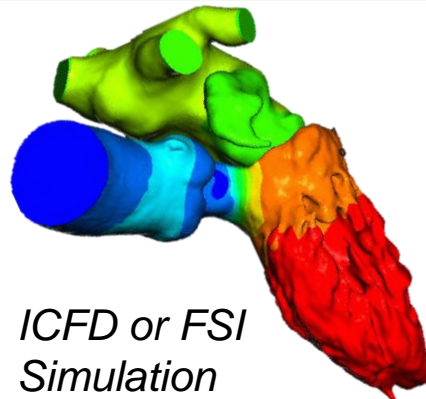
LS-Prepost



Model Setup



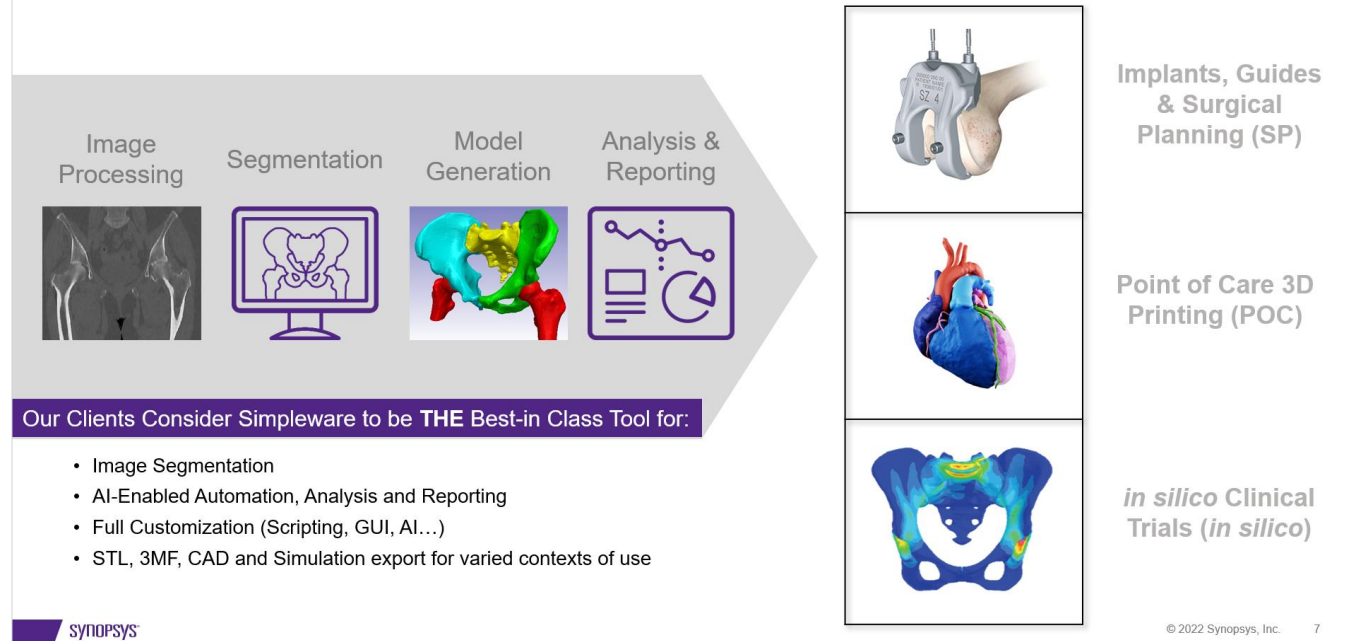
LS-DYNA



ICFD or FSI Simulation

- Automated workflow from medical images for ICFD or FSI analysis
- Can be applied to different heart geometries with minimum manual effort, and the
- Total preparation time < 20 minutes.

## Medical 3D-Image Based Modelling Workflows



R&D

Machine Learning Based AI

Production

**Thank You**



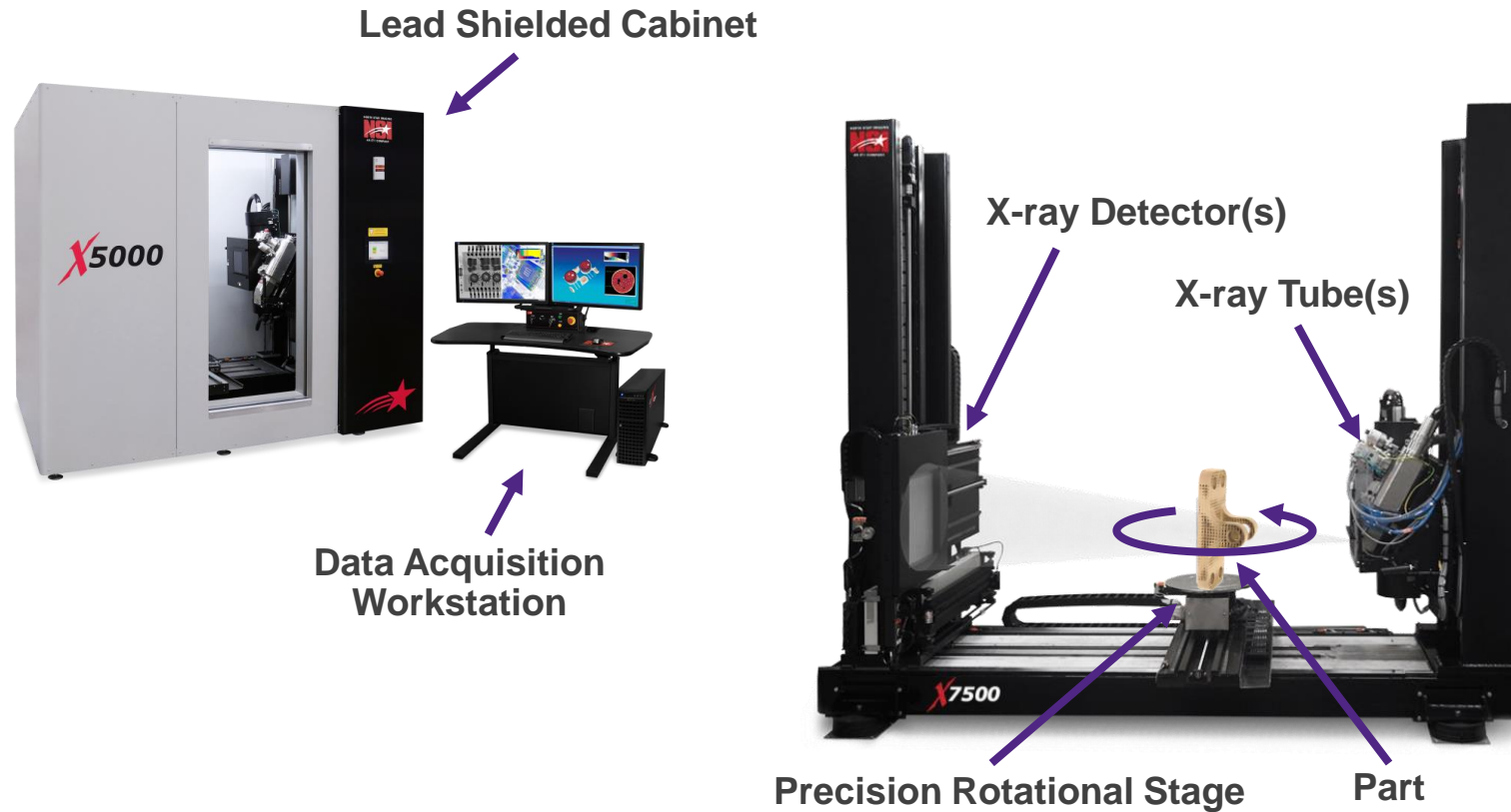
# 3D Imaging Modalities

## Industrial and Materials Applications

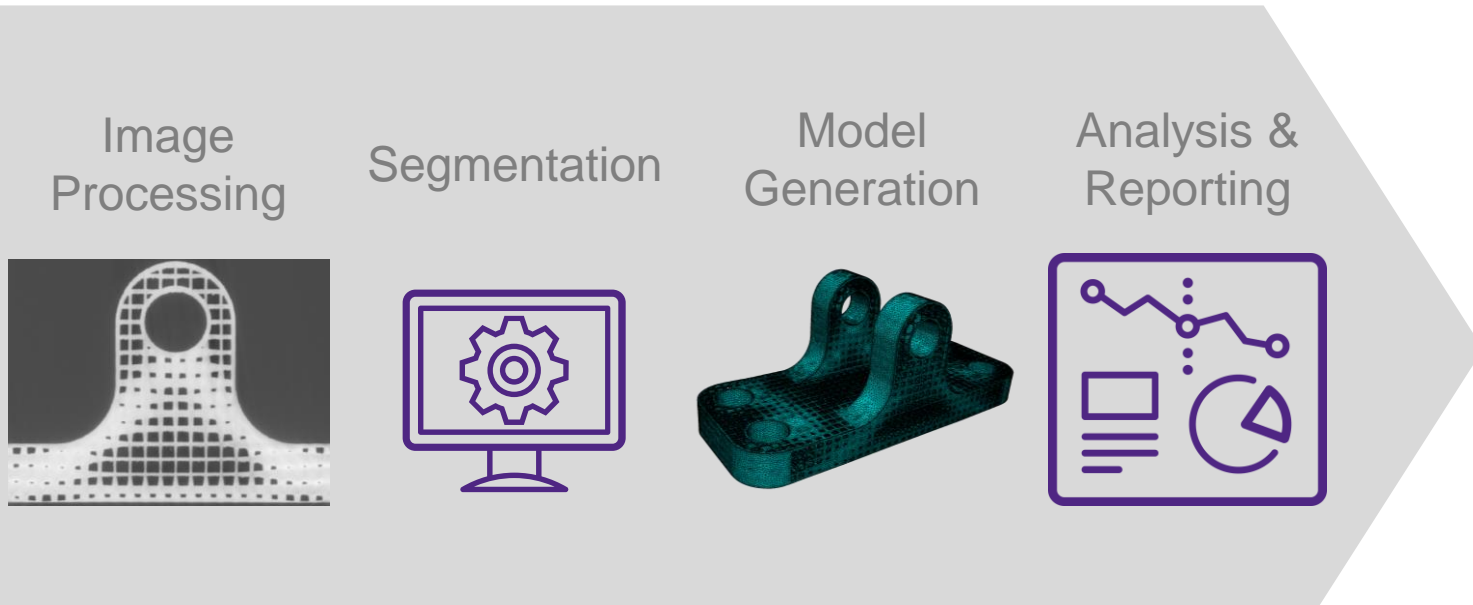


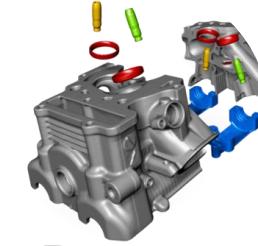
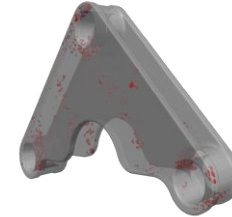
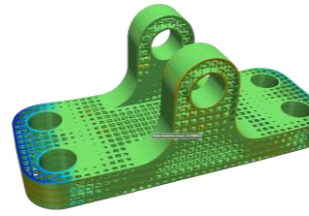
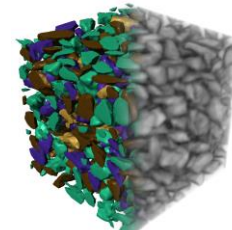
# Industrial or Micro Computed Tomography (CT)

Scanning industrial parts and materials at millimeter to micron resolution



# Industrial/Materials 3D-Image Based Modelling Workflows



 <p>Reverse Engineering</p>	 <p>Inspection &amp; NDT</p>
 <p>Metrology &amp; Deviation</p>	 <p>Materials Analysis</p>

Our Clients Consider Simpleware to be **THE** Best-in Class Tool for:

- Image Segmentation
- AI-Enabled Automation, Analysis and Reporting
- Full Customization (Scripting, GUI, AI...)
- STL, 3MF, CAD and Simulation export for varied contexts of use



# Quality Inspection

- Differences
- Internal Intricate Structures
- Porosity
- Manufacturing Tolerances



**As-Designed**



**VS**



**As-Built**

How will these differences affect **performance** in the real world?

# Computed Tomography (CT)

How to capture the internal structure of your part



High Value Part

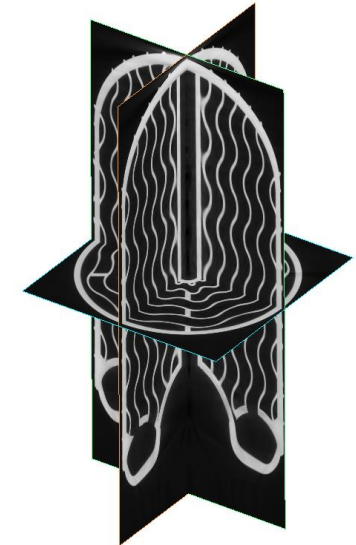
Example:

- Turbine Blades
- AM Parts
- Composites
- Ceramics etc.



Industrial CT Scanner

- R&D groups examining Materials or AM
- Production workflows for QA

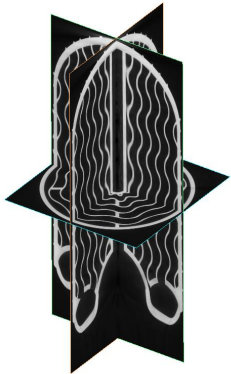


3D Image Data

Visualize internal structures for various analysis workflows.

# Converting 3D Images to Models

## 3D Image Data



Simpleware  
Software  
Platform

## Model



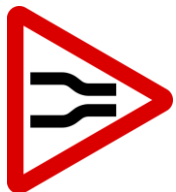
Reverse  
Engineering

Non-Destructive  
Analysis

Metrology & CAD  
Comparison

As-Built  
Simulation

## Automation

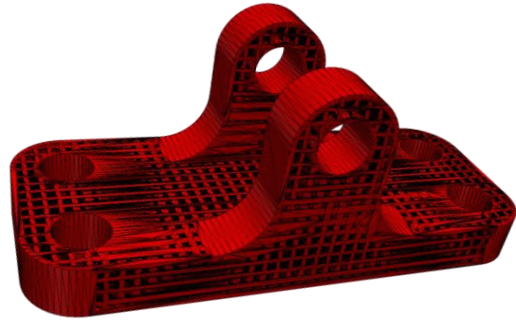


Typical Bottleneck of scaling up workflow from R&D to production level efficiency is image segmentation and landmarking

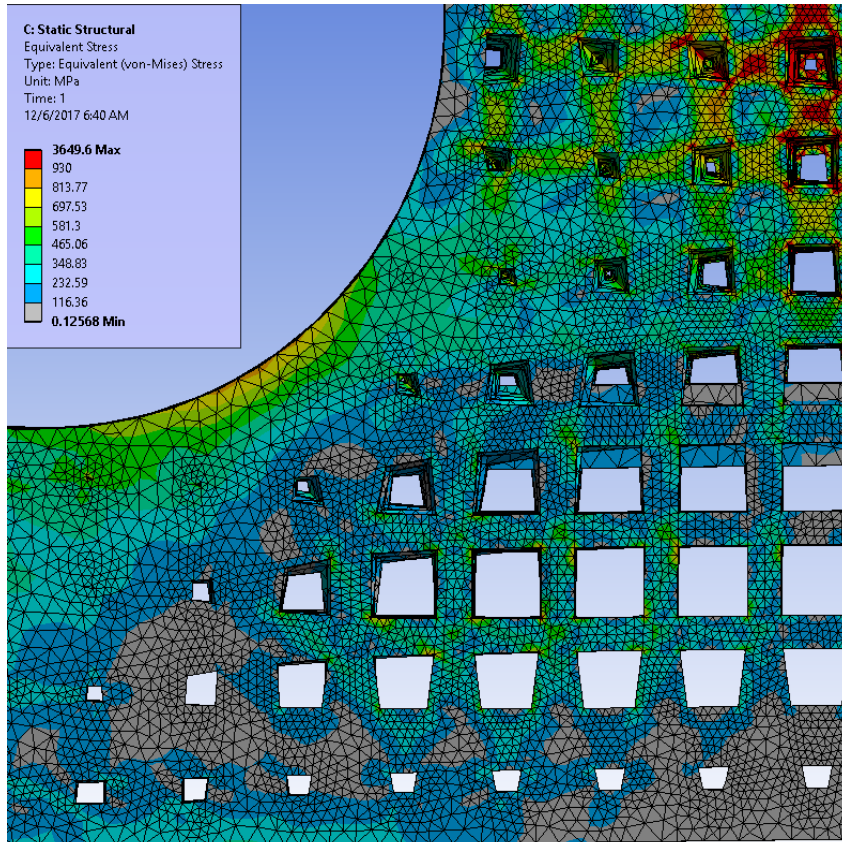
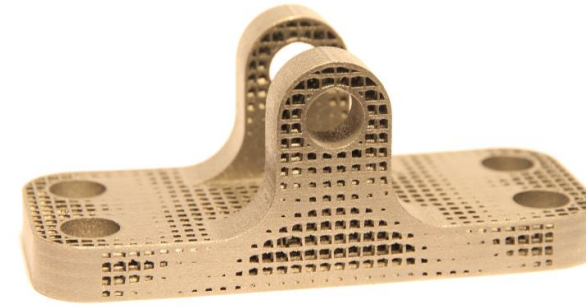
Simpleware AI-based solution for complete automation

- Process hundreds to thousands of CT scans per month
- Scaling up is only limited by compute power

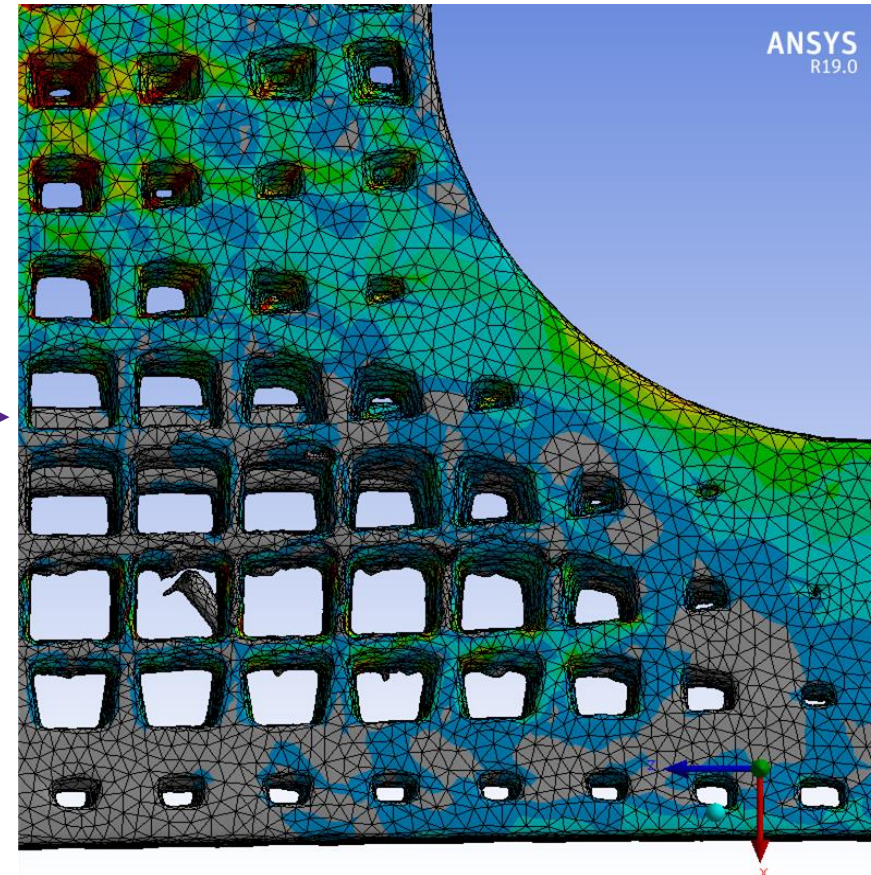
# As Designed Stress



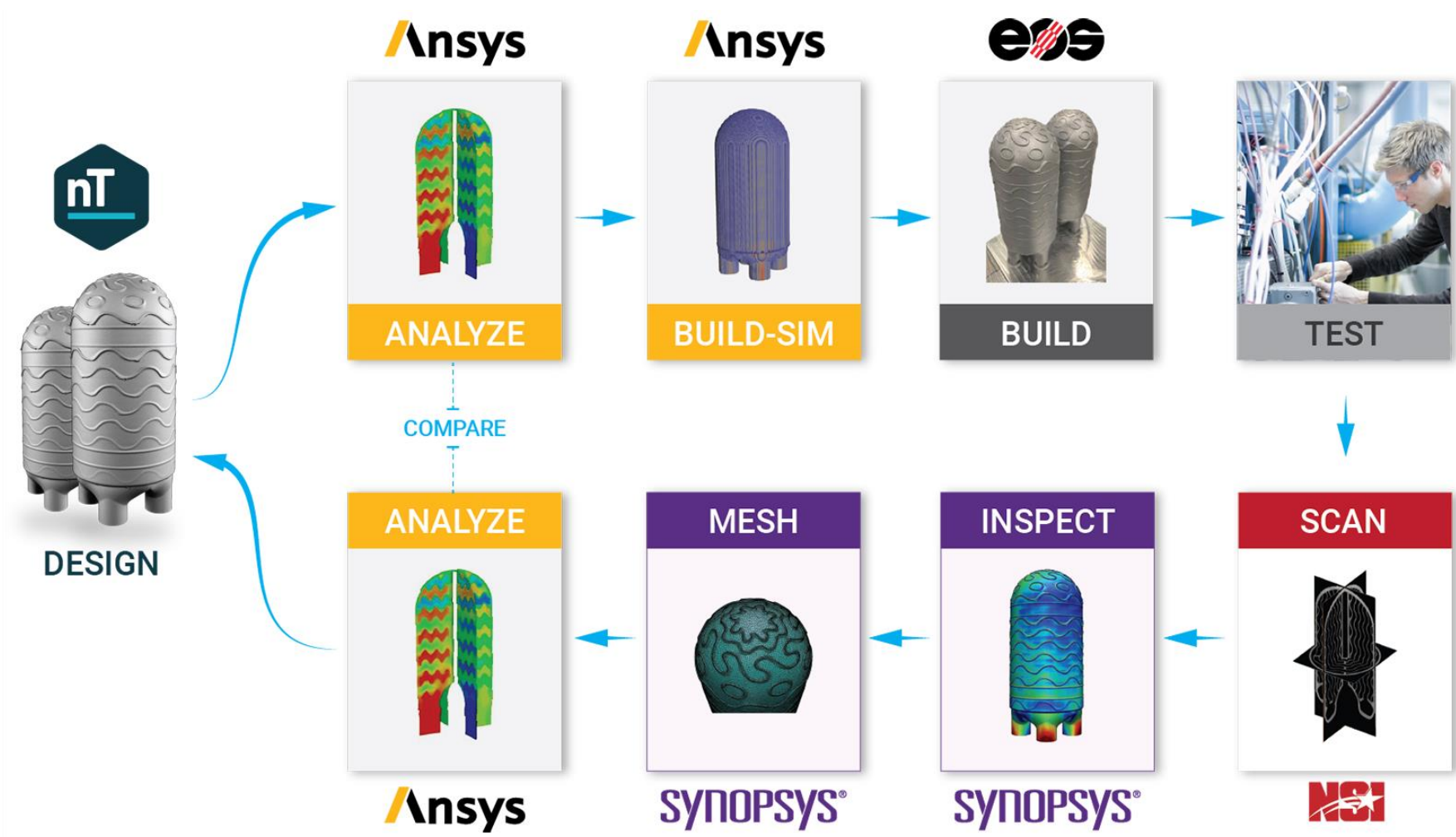
# As Built Stress



Compare

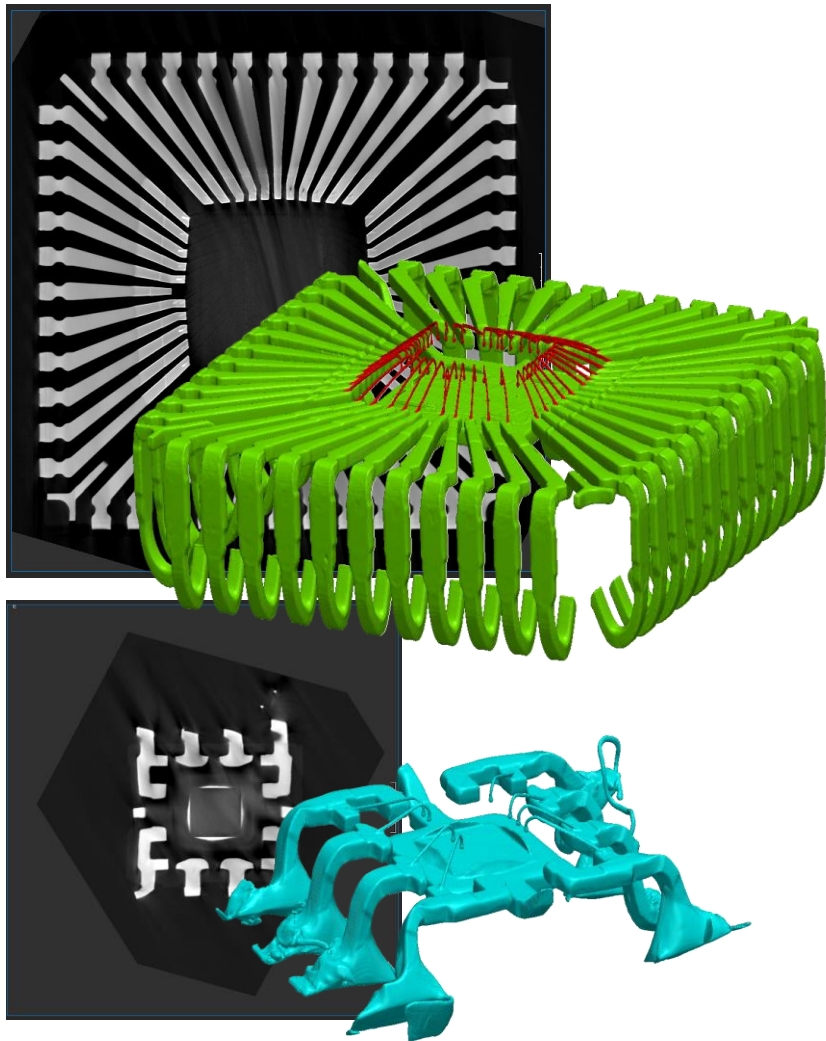


# Advanced Manufacturing Workflow

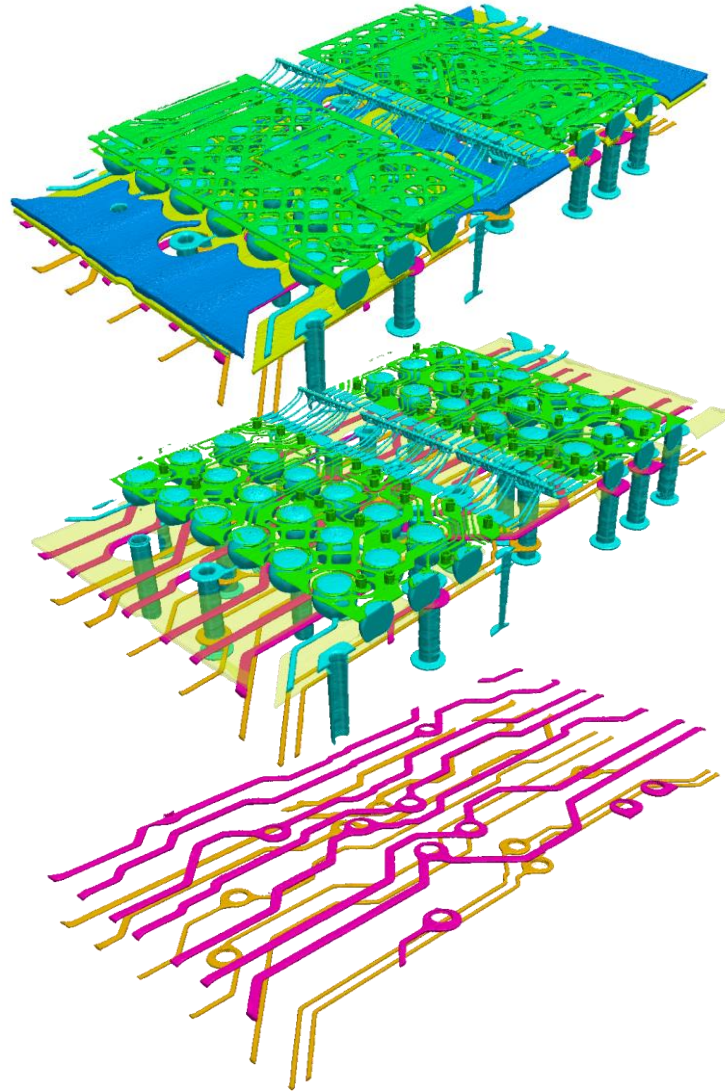


# Electronics Examples

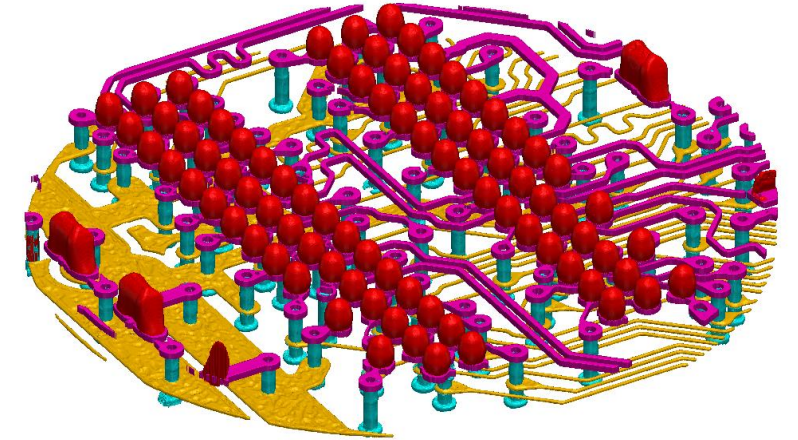
## PCB Components



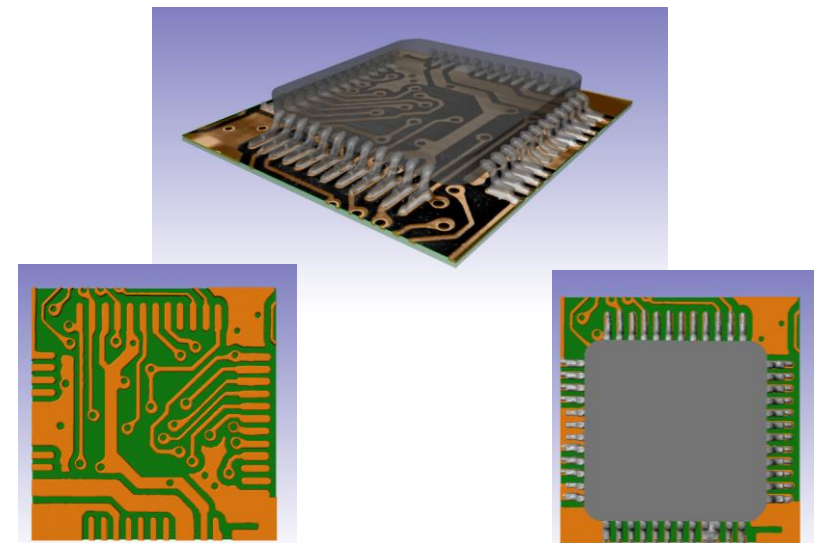
RAM DIMM module



Xtract BGA



USB flash drive board



# Backup

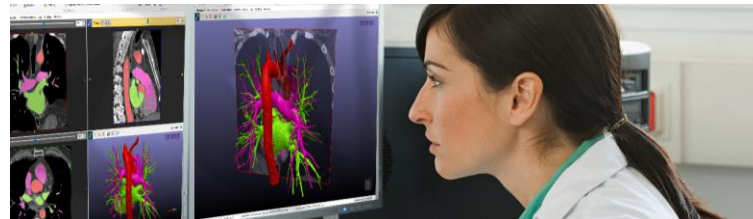
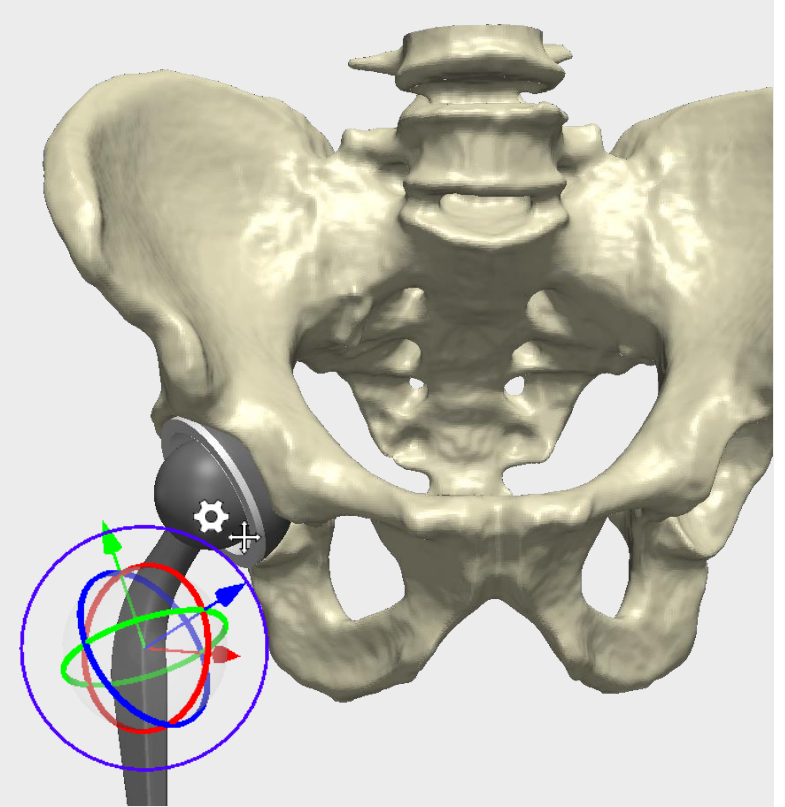


# Implants, Guides & Surgical Planning (SP)

Based on patient CT and/or MRI scans (DICOM)

- Generate an accurate and complete model of the patient anatomy
- Tailor devices/guides to the patient requirements
- Integrated 3D Printing Toolkit to speed print prep
- Export STL or 3MF files for 3D Printing

→ *Build the ideal model for your patient from **single** platform*



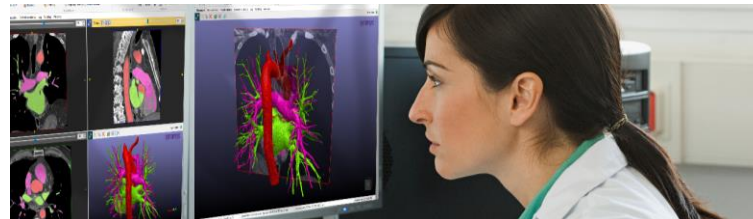
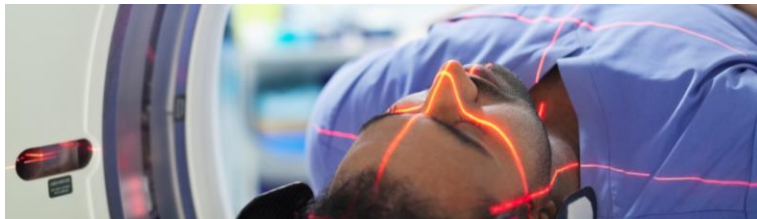
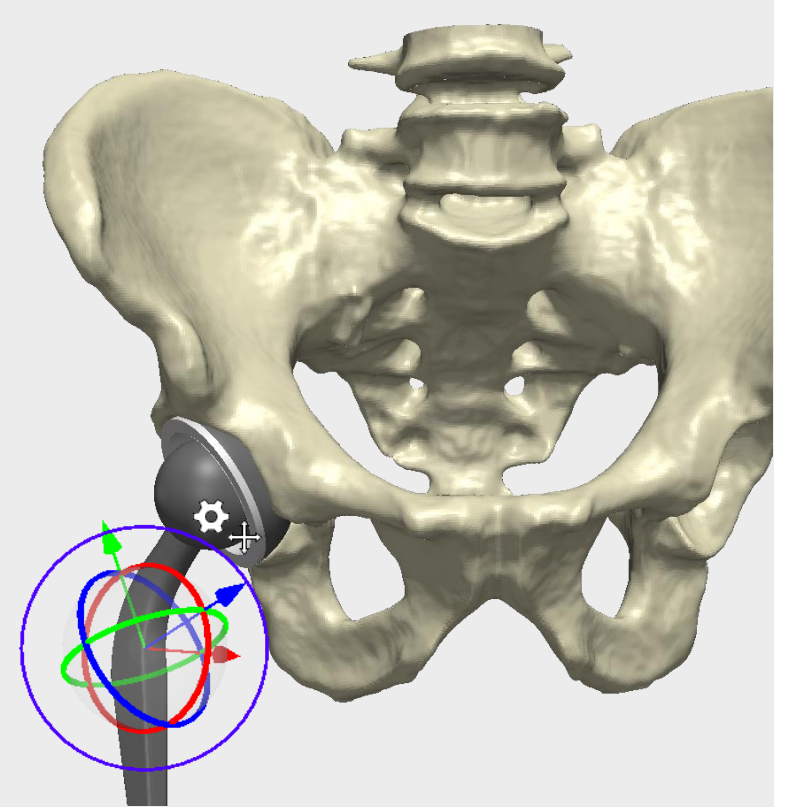


# Point of Care 3D Printing (POC)

Based on patient CT and/or MRI scans (DICOM)

- Generate an accurate and complete model of the patient anatomy
- Integrated 3D Printing Toolkit to speed print prep
- Export STL or 3MF files for 3D Printing

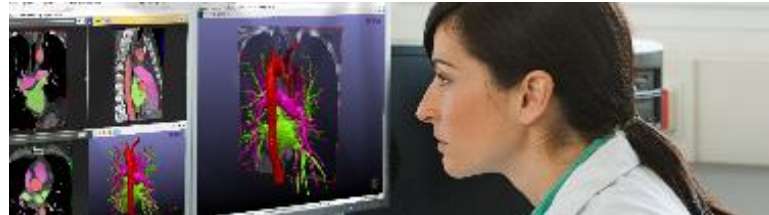
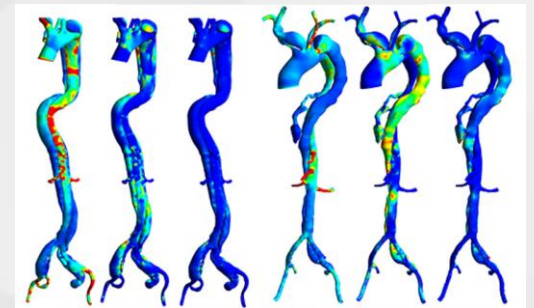
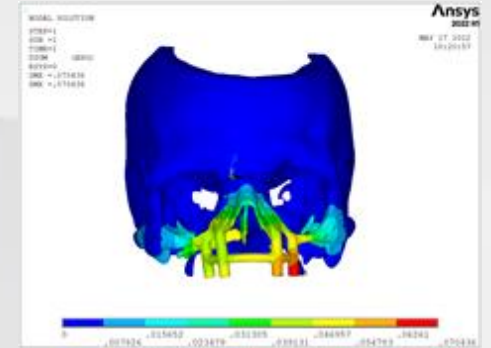
→ *Build the ideal model for your patient from **single** platform*



# *in silico* Trials

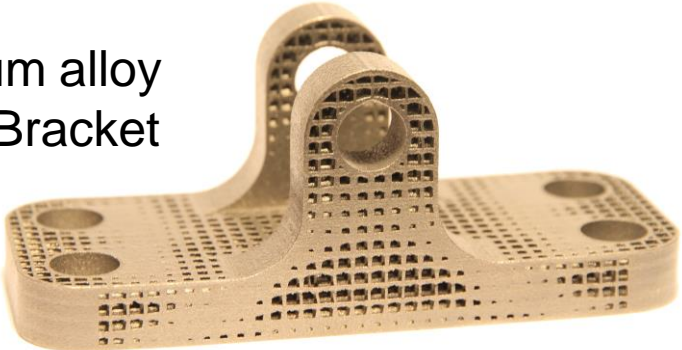
Based on patient scans (e.g. 3D & 4D CT, MRI)

- Use automated techniques to process large numbers of datasets
  - Create, position or optimise devices
  - Create *in silico* models for analysis and simulation
  - Explore device design or positioning to understand device performance and/or post operative outcomes
- *Speed up in silico trials*



# CT Scan of AM Part

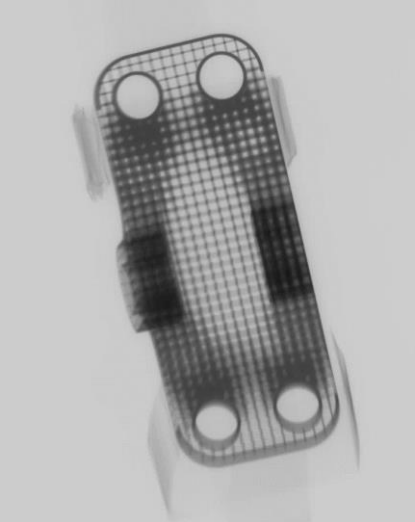
AM Titanium alloy (Ti6Al4V) Bracket



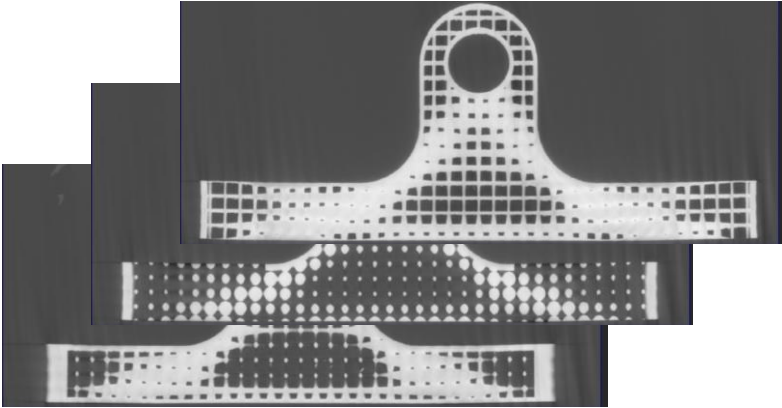
North Star Imaging (NSI) CT Scanner



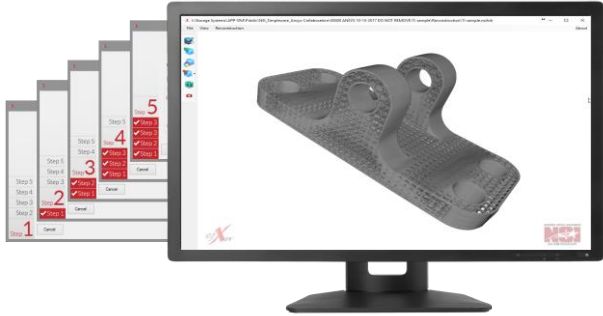
Radiographs



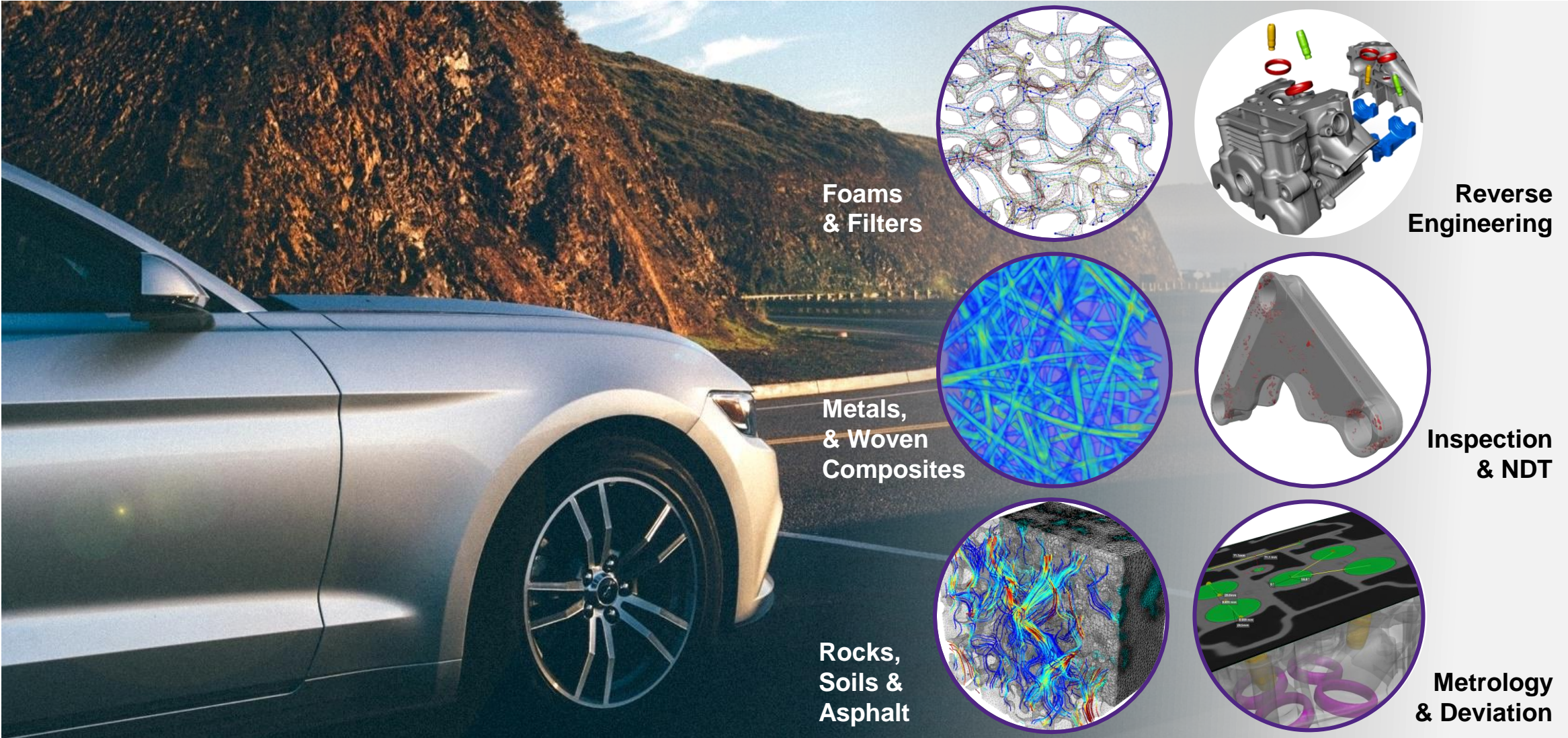
Exported Slices



Reconstruction



# Applications in Materials & Manufacturing



The image features a silver car on a road with a rocky hillside in the background. Six circular callouts are overlaid on the right side, each representing a different application of the technology:

- Foams & Filters:** A circular callout showing a complex, interconnected network of blue and white lines, representing a porous material structure.
- Reverse Engineering:** A circular callout showing a 3D model of a mechanical engine component with various colored parts (red, green, blue) highlighted.
- Metals, & Woven Composites:** A circular callout showing a dense, interwoven network of blue and green lines, representing a composite material structure.
- Inspection & NDT:** A circular callout showing a 3D model of a mechanical part with red and white spots, representing non-destructive testing results.
- Rocks, Soils & Asphalt:** A circular callout showing a 3D model of a porous material structure with blue and red lines, representing a material structure.
- Metrology & Deviation:** A circular callout showing a 3D model of a mechanical part with green and purple lines, representing metrology and deviation analysis.

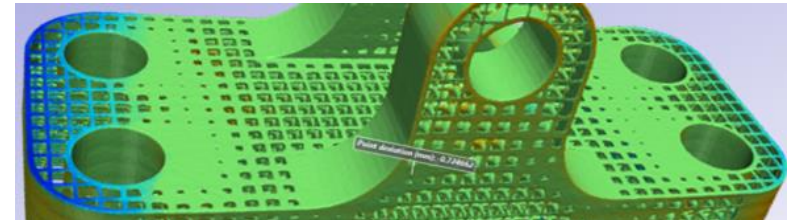
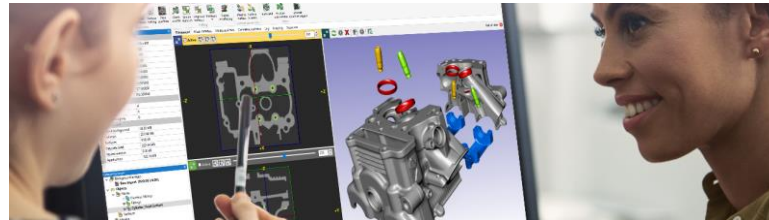
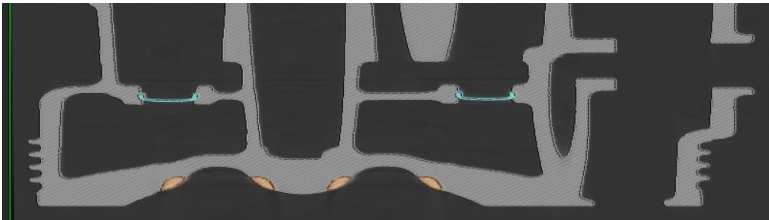
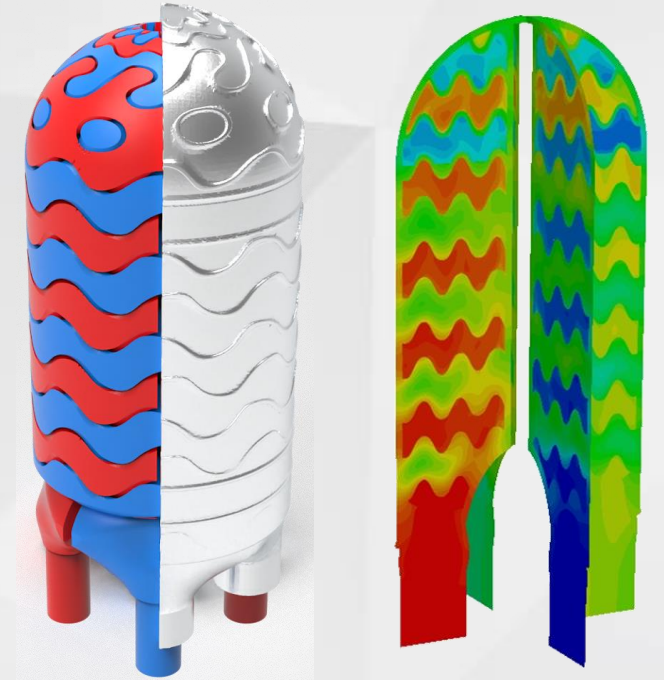
# Relevant Applications

## Industrial reverse engineering

Based on industrial CT scans

- Take scans of a manufactured part, e.g. casting, AM, injection moulding...
- Register CAD to scanned parts, to perform metrology, measurements, and deviation analysis
- Facilitate simulation on as built or damaged part to check performance and fit for purpose

→ *Improve quality assurance and reduce time to market*



# Relevant Applications

## Materials Analysis

Based on micro-CT scans, FIB-SEM...

- Understand or improve performance of a microstructure, e.g. filter, foam, composite, textile, soil, asphalt...
- Visualise internal structure from scans or synthetic data
- Calculate porosity, surface area, pore/particle distribution, fibre orientation...
- Analyse network structures, e.g. centrelines, shortest routes...

→ *Improve efficiency and depth of understanding in material characterization*

