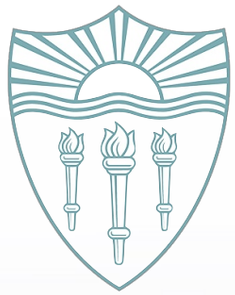
CSCI 621: **Digital Geometry Processing**

Spring 2019

Hao Li

cs621.hao-li.com



http://hao.li/

Geometric Capture [Lab]

The **Team**

Instructor

- Hao Li, hao.li@usc.edu
  - Office: SAL 244
  - Office hours: Tuesday 12:30 AM -1:30 PM

Teaching Assistant

- Zeng Huang, zenghuan@usc.edu

Grader

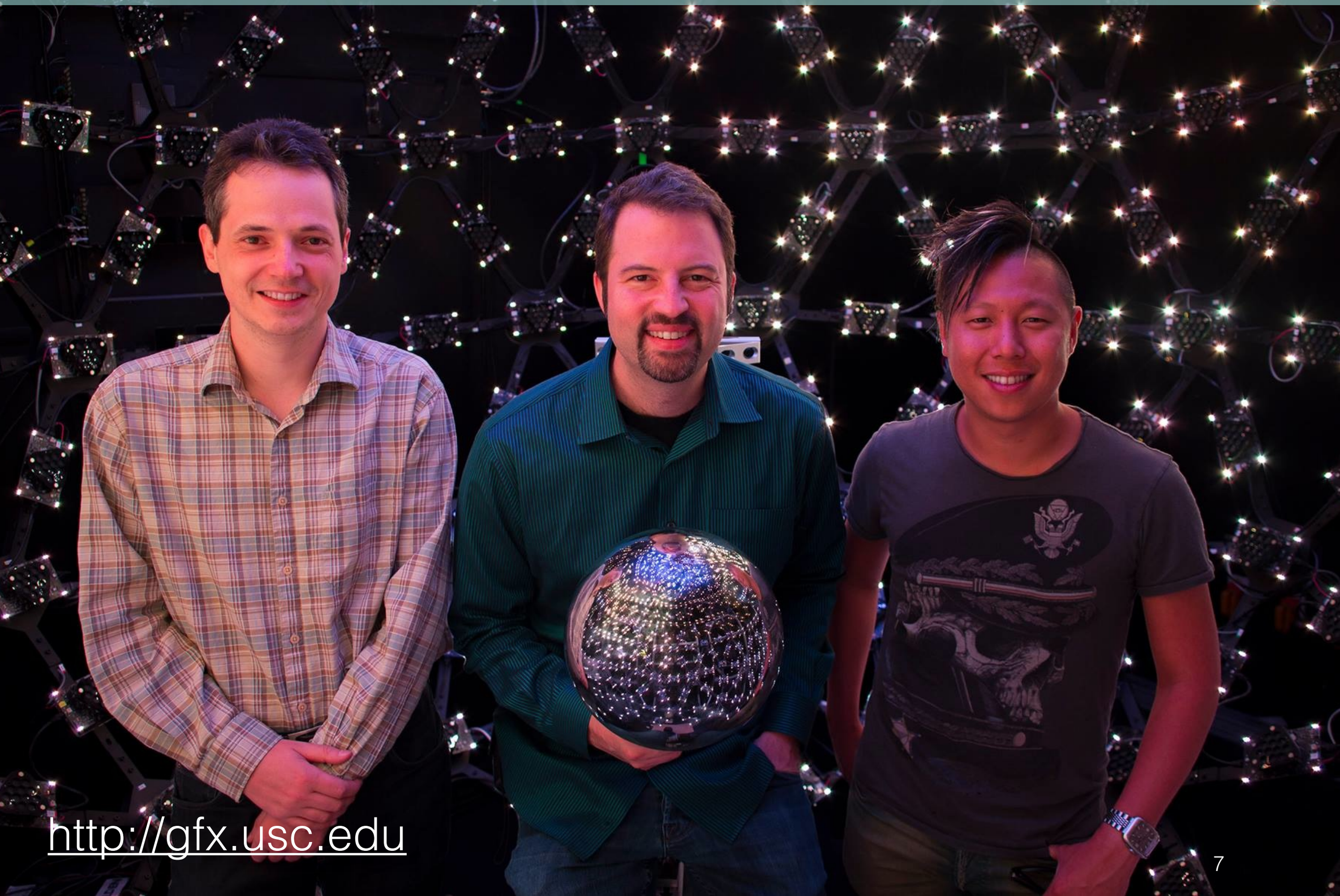
- Junying Wang, junyingw@usc.edu

About Me

Industrial Light & Magic

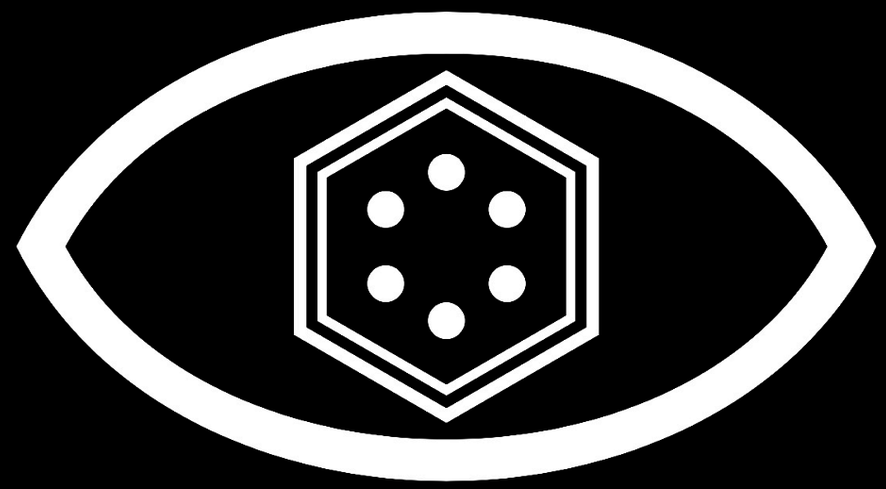
Weta Digital

USC Graphics



http://gfx.usc.edu

pinscreen



USC Institute for Creative Technologies

Science, Engineering, & Art

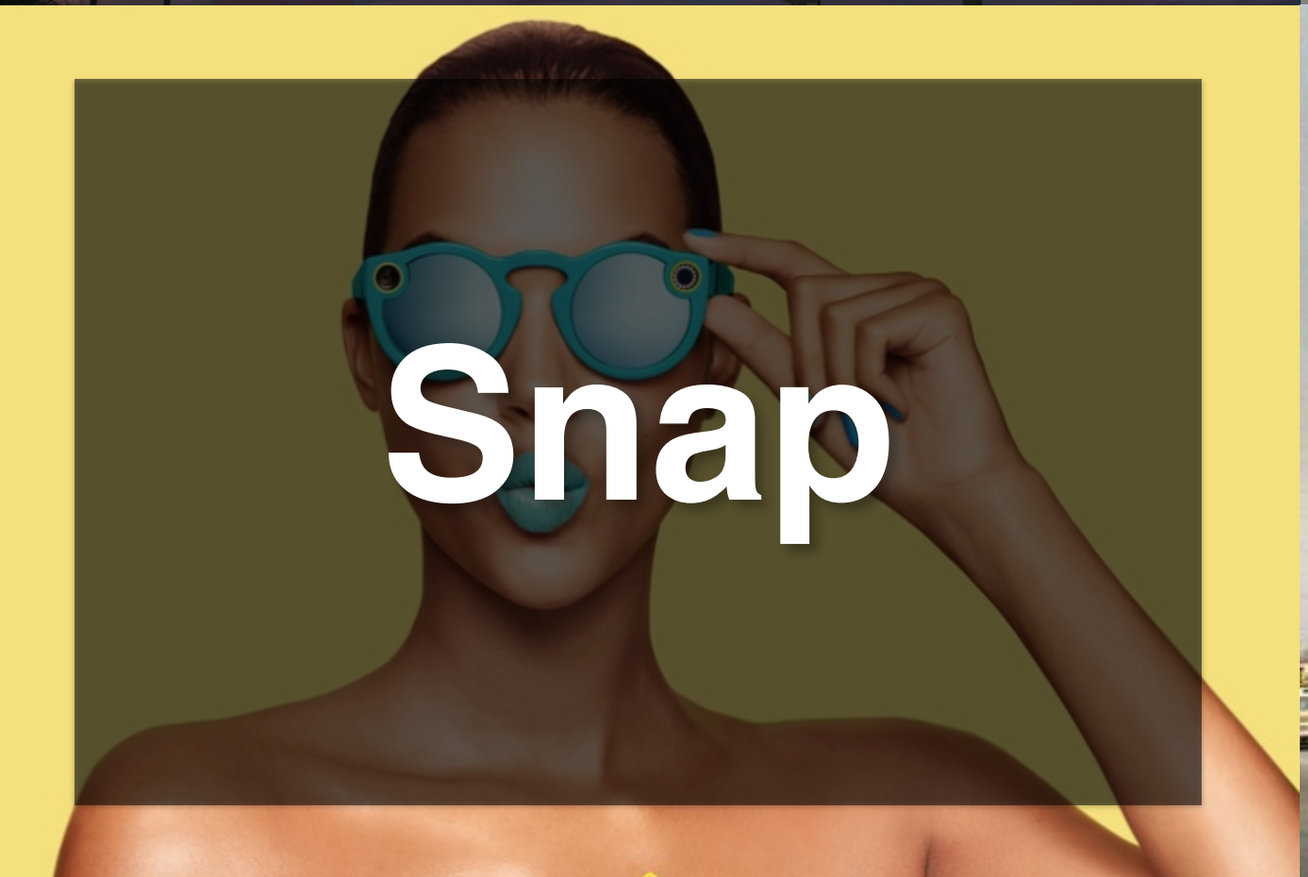
USC Viterbi
School of Engineering

USC School of Cinematic Arts

USC ICT
INSTITUTE FOR CREATIVE TECHNOLOGIES

USC Games

High Tech & Capital of Entertainment



Introduction

Target Audience

- **PhD** students, **MSc** students, **Advanced** undergraduates
- **Computer Science**, Computer Engineering, Mathematics, Physics, Game Program, Biomedicine, Bioengineering, etc.
- Computer Graphics, Computer Vision, Robotics, Machine Learning, Signal and Image Processing, Medical Imaging

Prerequisites

- C/C++ Programming
- Linear Algebra
- Numerical Optimization

- CSCI 420 Recommended

Administrative

When and where?

- Tuesday, 2:00 PM - 5:20 pm
- SOS B38

Office Hour

- Tuesday, 12:30 PM - 1:30 PM

Credits

- 4 Units

Website

- cs621.hao-li.com

Exercises

Programming assignments

- based on OpenMesh
- cover some core stages of the geometry processing pipeline
- C/C++ framework including 3D UI will be provided

Integral part of the lecture

- important for achieving course objectives

Grading

Exercises

- Best 5 out of 6 exercises contribute to 70% of the final grade
- Each exercise counts 20 points
- Late submissions: every 5 minute removes 1 point in each exercise

Project

- Scope 1 month/person, Groups up to 2
- Implement a research paper around digital human capture but not limited to it
- Final presentation, code/documentation, contributes 30% of the final grade

Academic Integrity

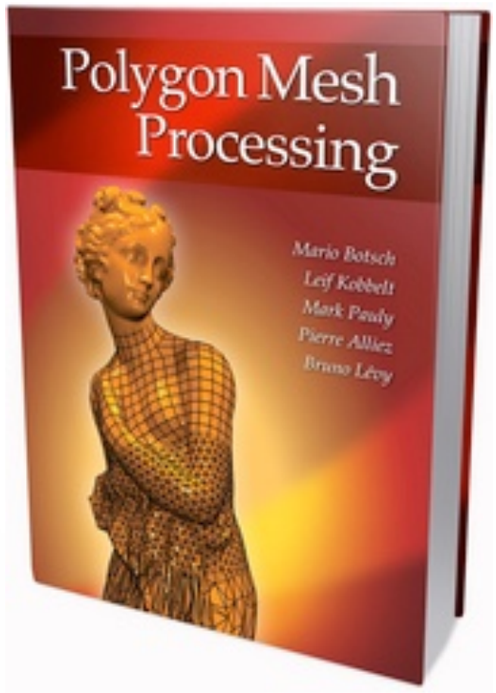
- Do not copy any parts of the assignments from anyone
- Do not look at other student's code
- Collaboration only for the project
- USC Office of Student Judicial Affairs and Community Standards (Hell) will be notified

Course **Objectives**

- **Define** and **relate** the basic concept, tools, and algorithms in geometric modeling and digital geometry processing
- Critically **analyze** and **assess** current research on surface representations and geometric modeling and apply the proposed methods in your own work
- **Design** and **implement** individual components of geometric modeling system

Recommended **Textbook**

Botsch, Kobbelt, Pauly, Alliez, Levy: **Polygon Mesh Processing**, AK Peters, 2010



Acknowledgement

Course material taught at:

- EPFL, Mark Pauly (My PhD Advisor)
- Bielefeld University, Mario Botsch
- INRIA, Pierre Alliez, Bruno Levy
- RWTH Aarchen, Leif Kobbelt

An **Example**

Computer Graphics

Performance Capture

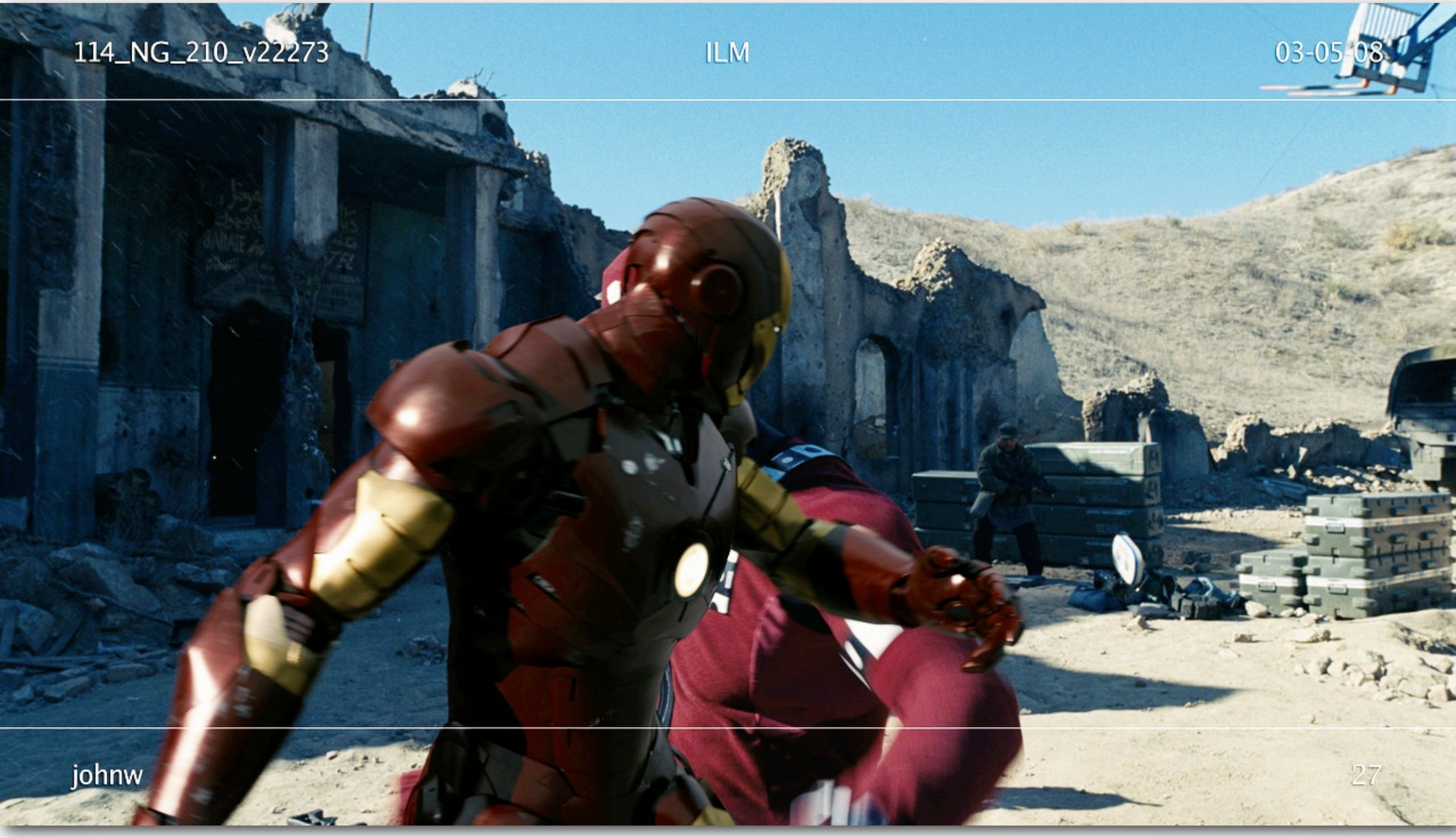
The Vision

IMocap

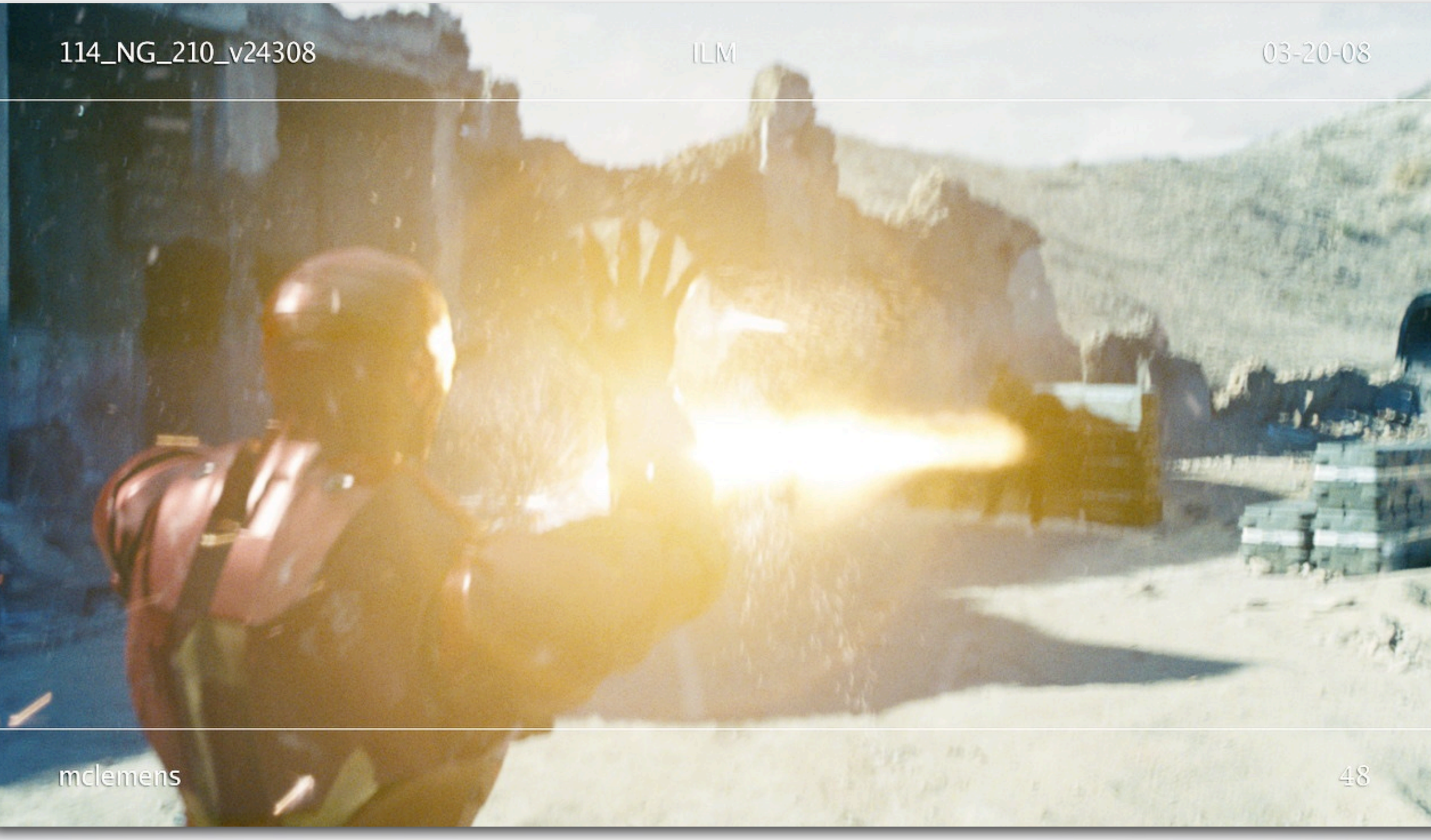
IMocap


2008-03-13 16:32
NG210
talmage
114_NG_210_v23778
ILM
03-13-08
70
75
80
talmage
30
30
layout v2.2
ng210.layoutCamera
20.92 mm

IMocap



IMocap

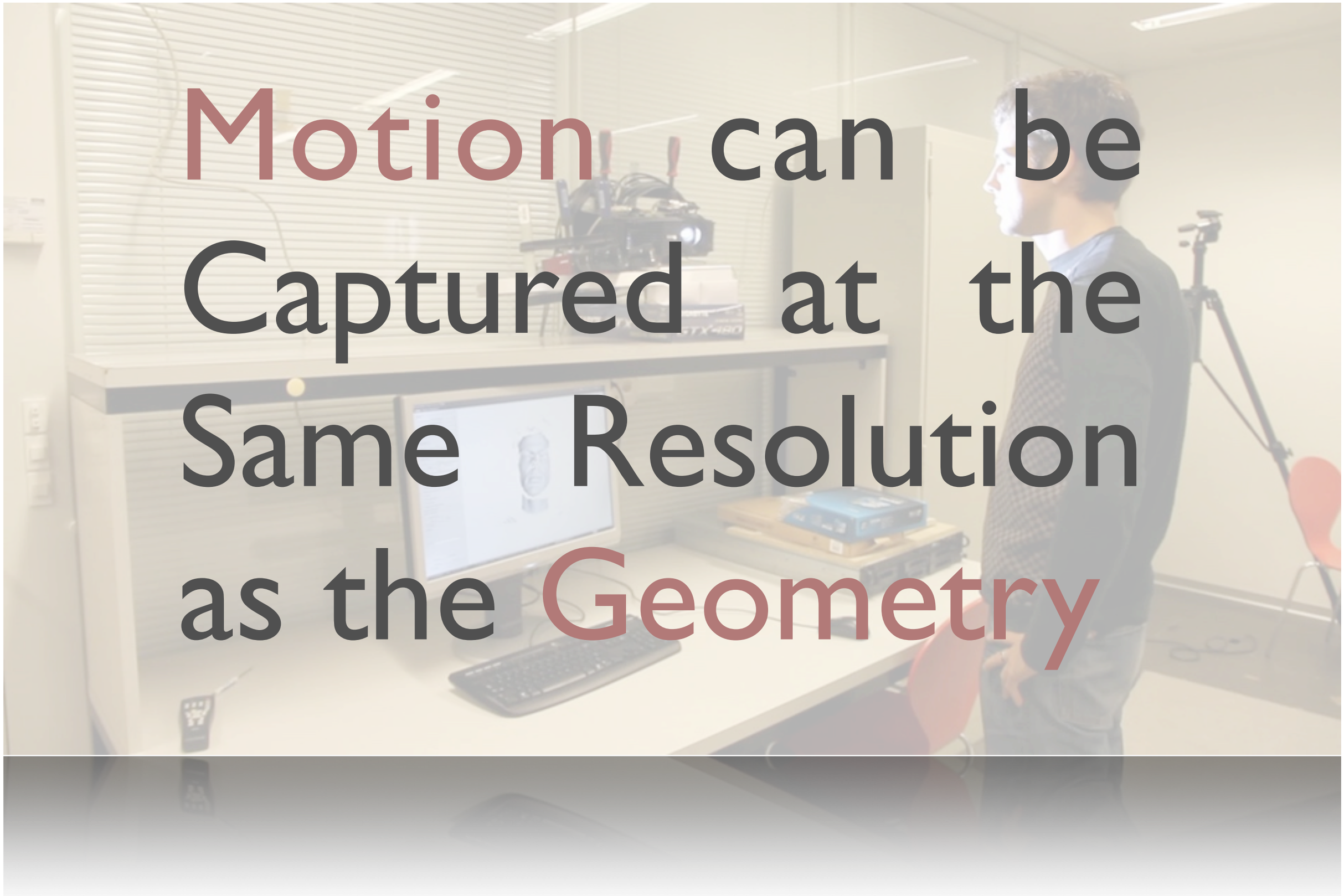


Facial Perfomance Capture

3 weeks for

10 seconds

Geometry Capture

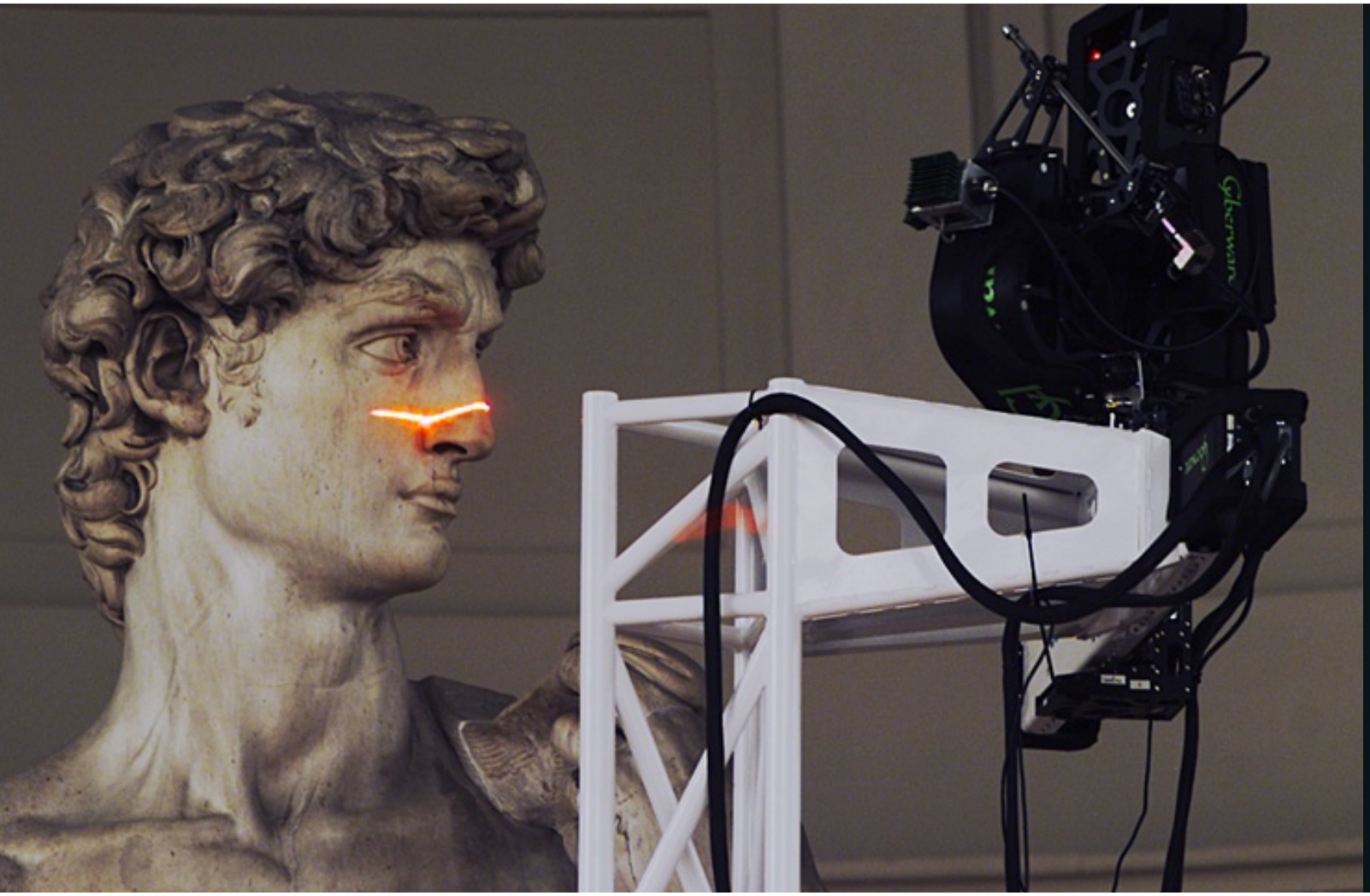


Realtime Facial Performance Capture

Capturing Geometry

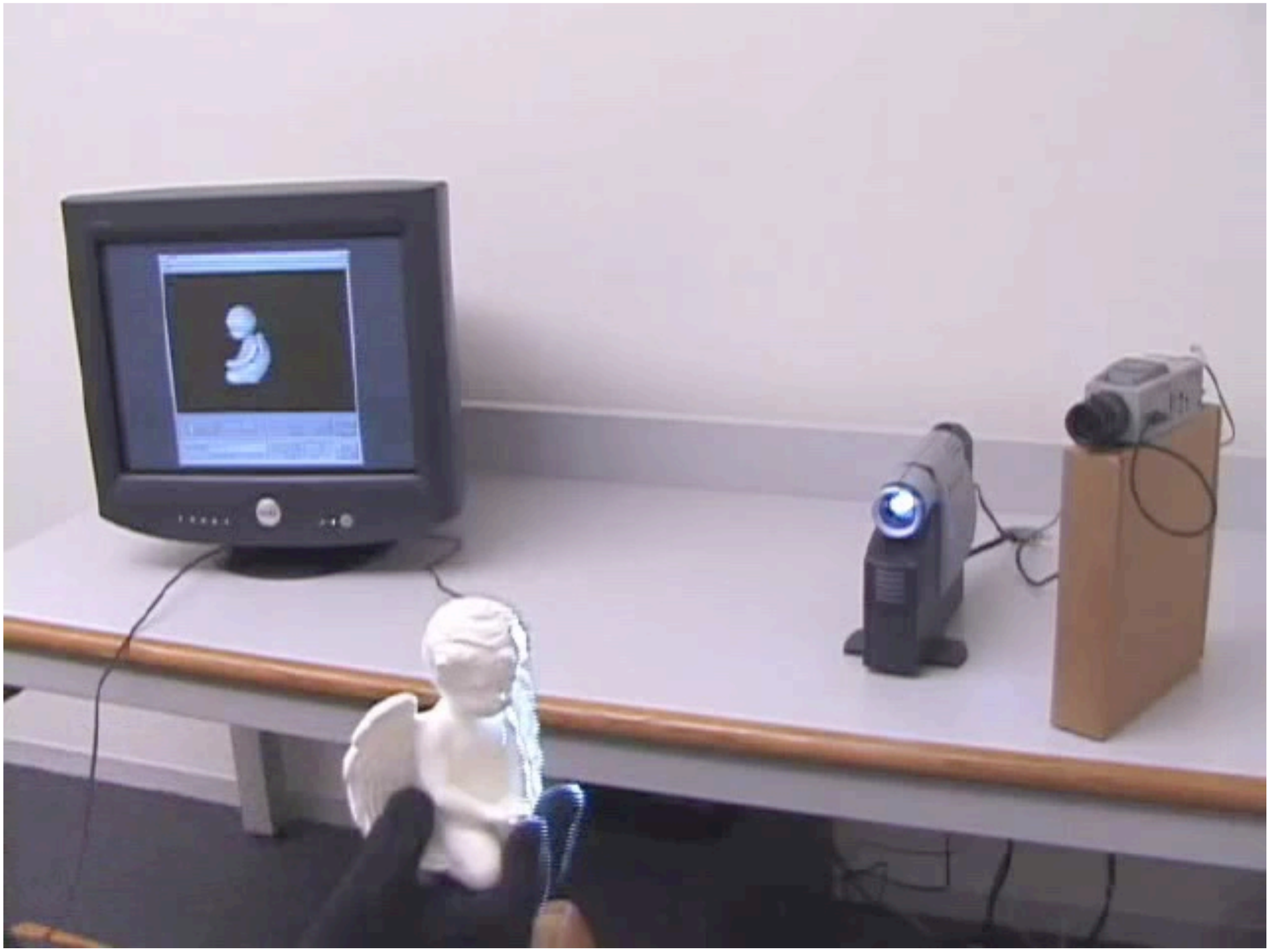
Static 3D Capture

Stanford 2002



Dynamic 3D Capture

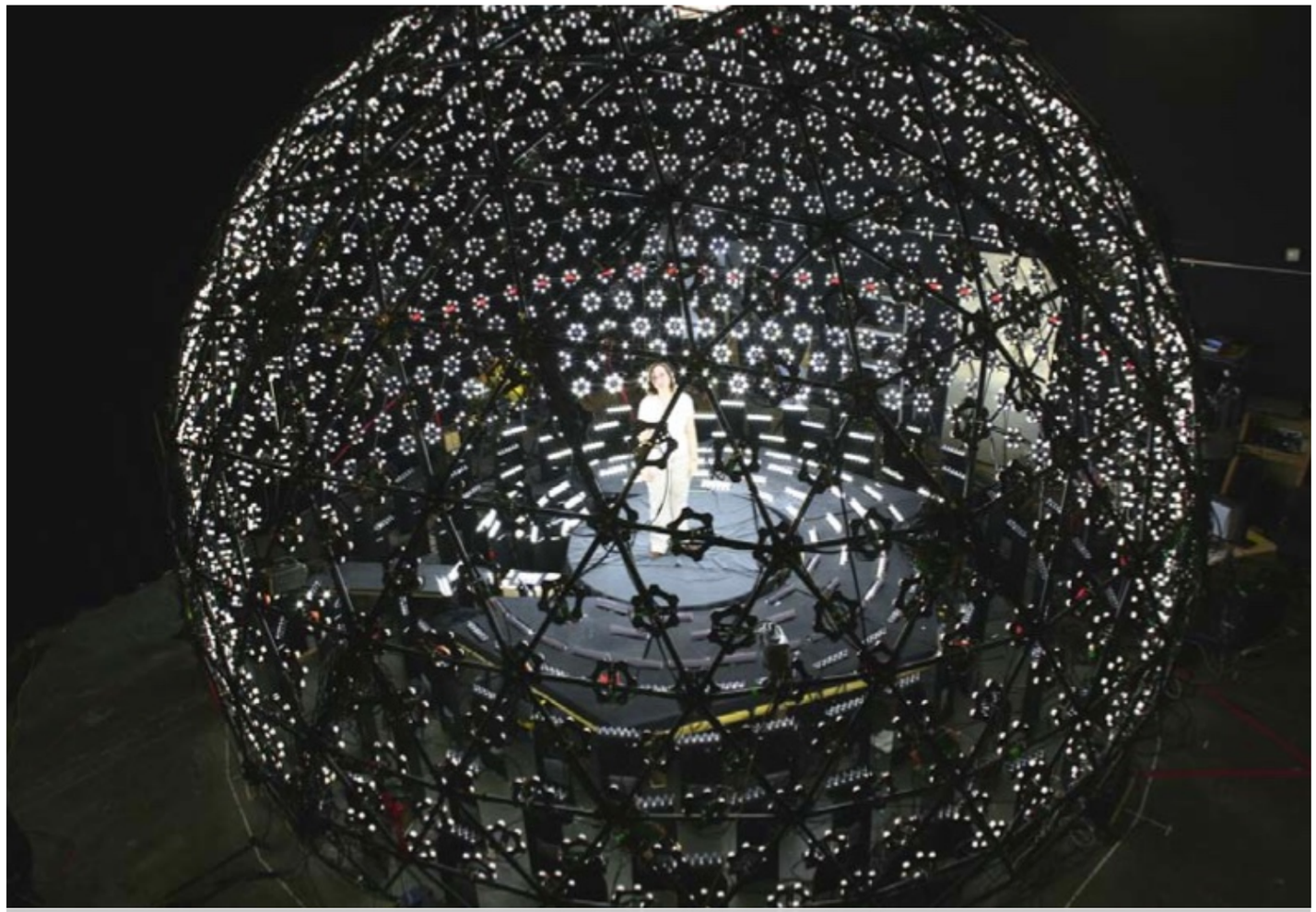
Stanford 2002



Commercial 3D Capture

Artec Group

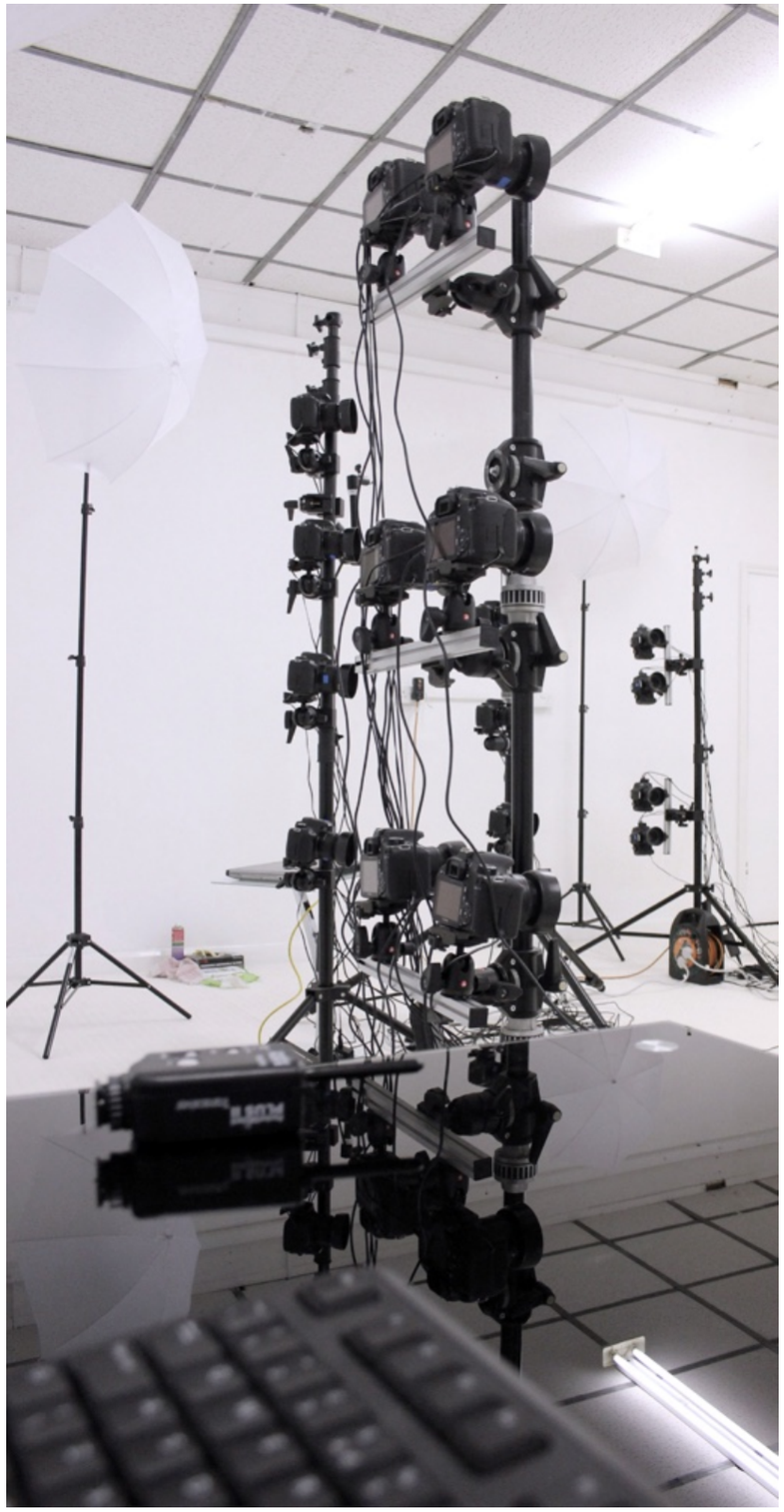
Full Body Capture



3D scanner

3D acquisition

Multi-View Stereo



Lee Perry-Smith, **Infinite Realities + Agisoft**

Capturing Cities

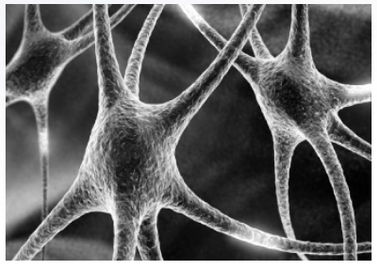
Google Earth

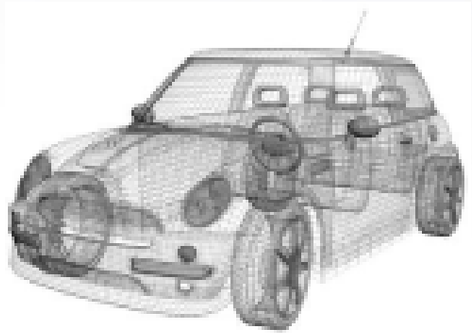
Geometry

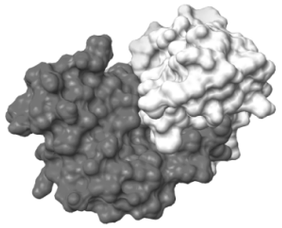
γεωμετρία

geo = earth

metria = measure

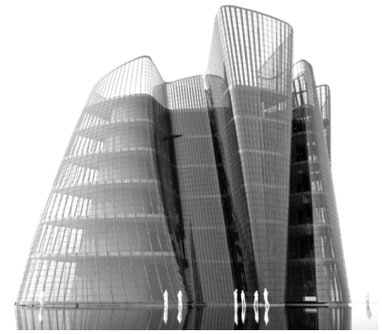


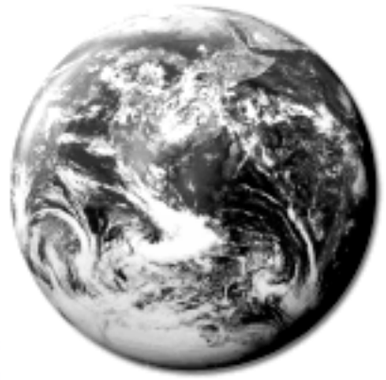




Geometry

γεωμετρία





microscope

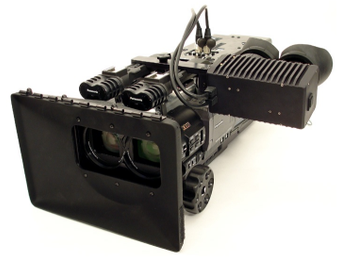
ultrasound

MRI scanner

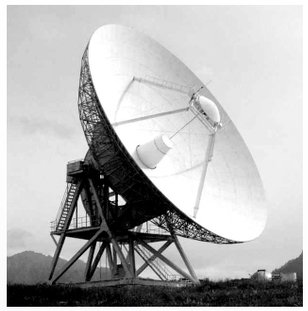
x-ray diffractometer

Geometry

γεωμετρια



stereo camera



radio telescope

laser scanner

time-of-flight scanner

Overview

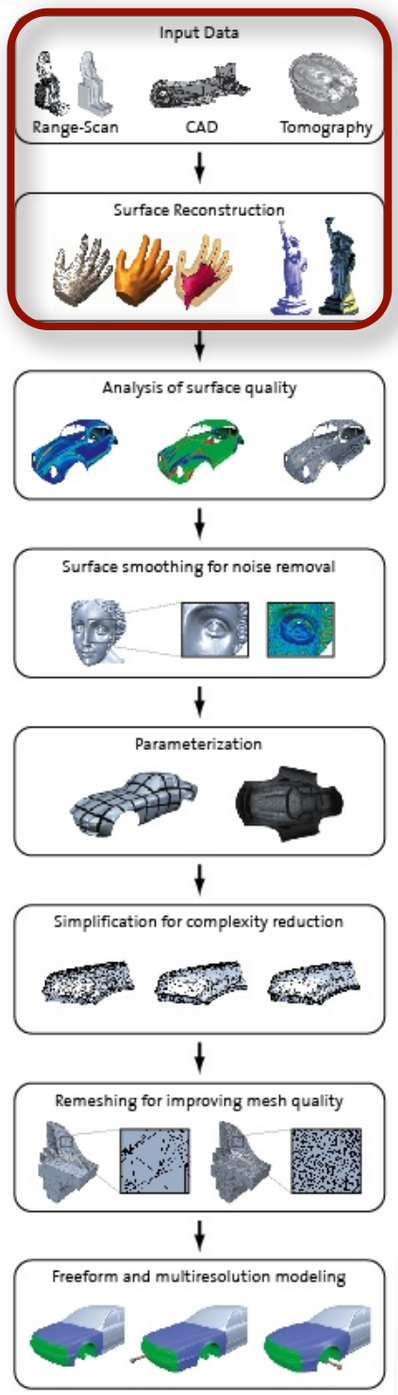
Geometric Modeling

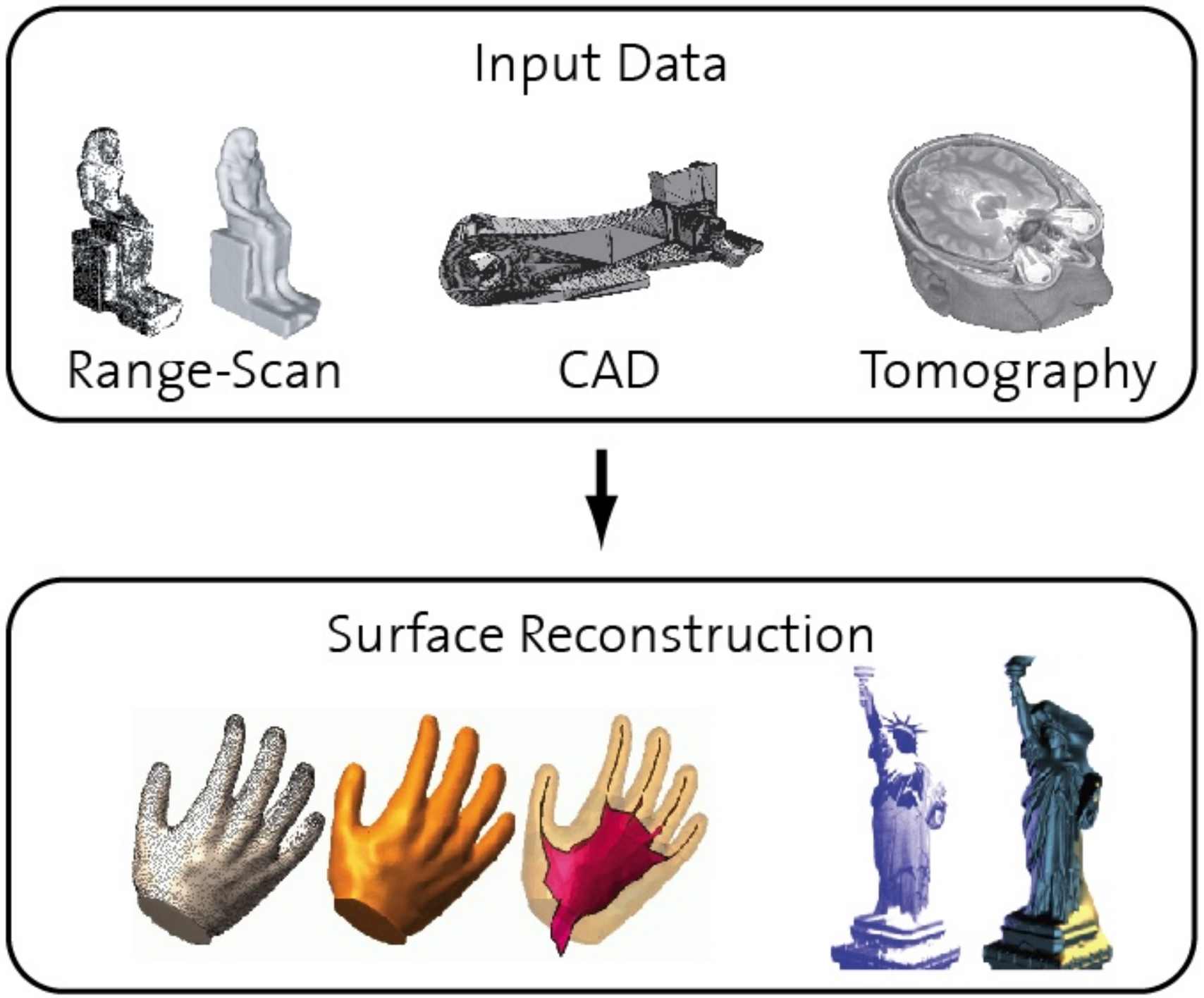
- Techniques and algorithms for representing and processing geometric objects

We will focus on *triangle meshes*

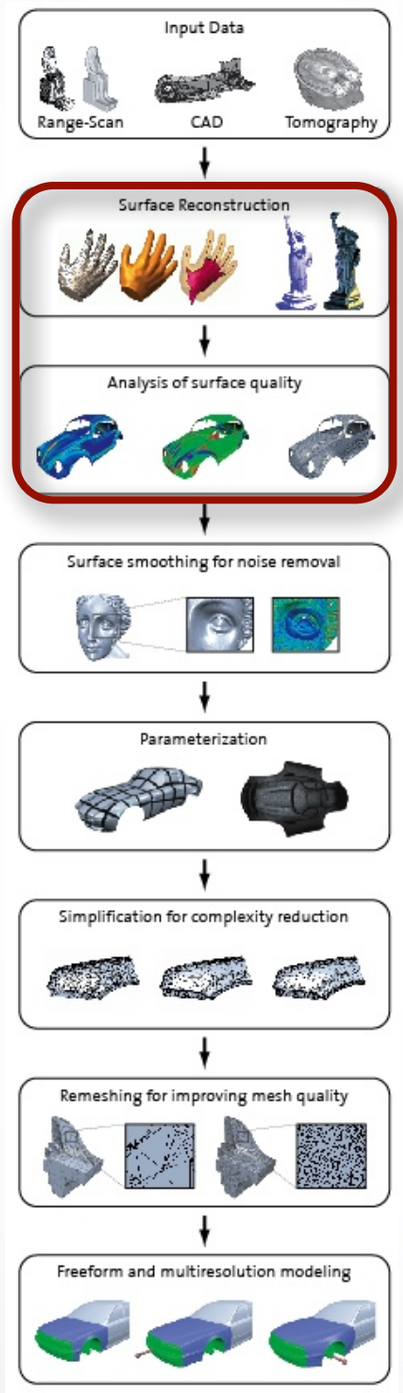
- main questions:
  - **why** are triangles suitable representations for geometry processing?
  - **what** are the central processing algorithms?
  - **how** can they implemented efficiently?

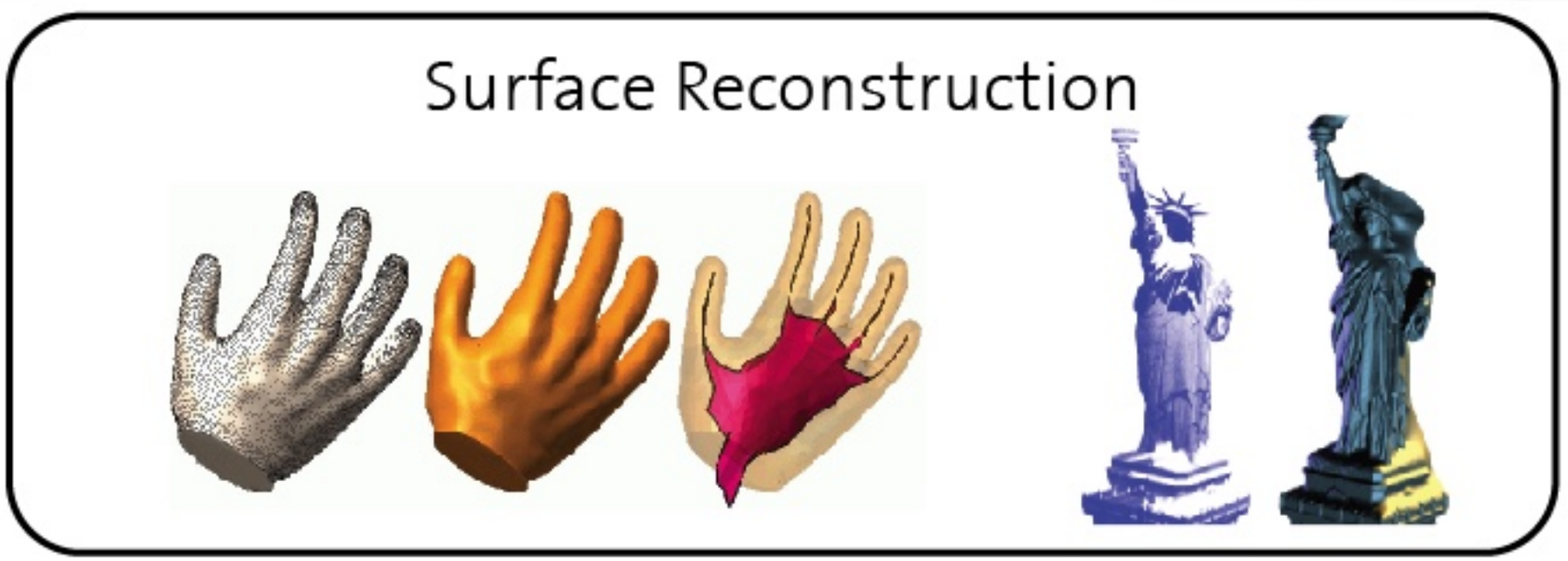
Geometry Processing Pipeline

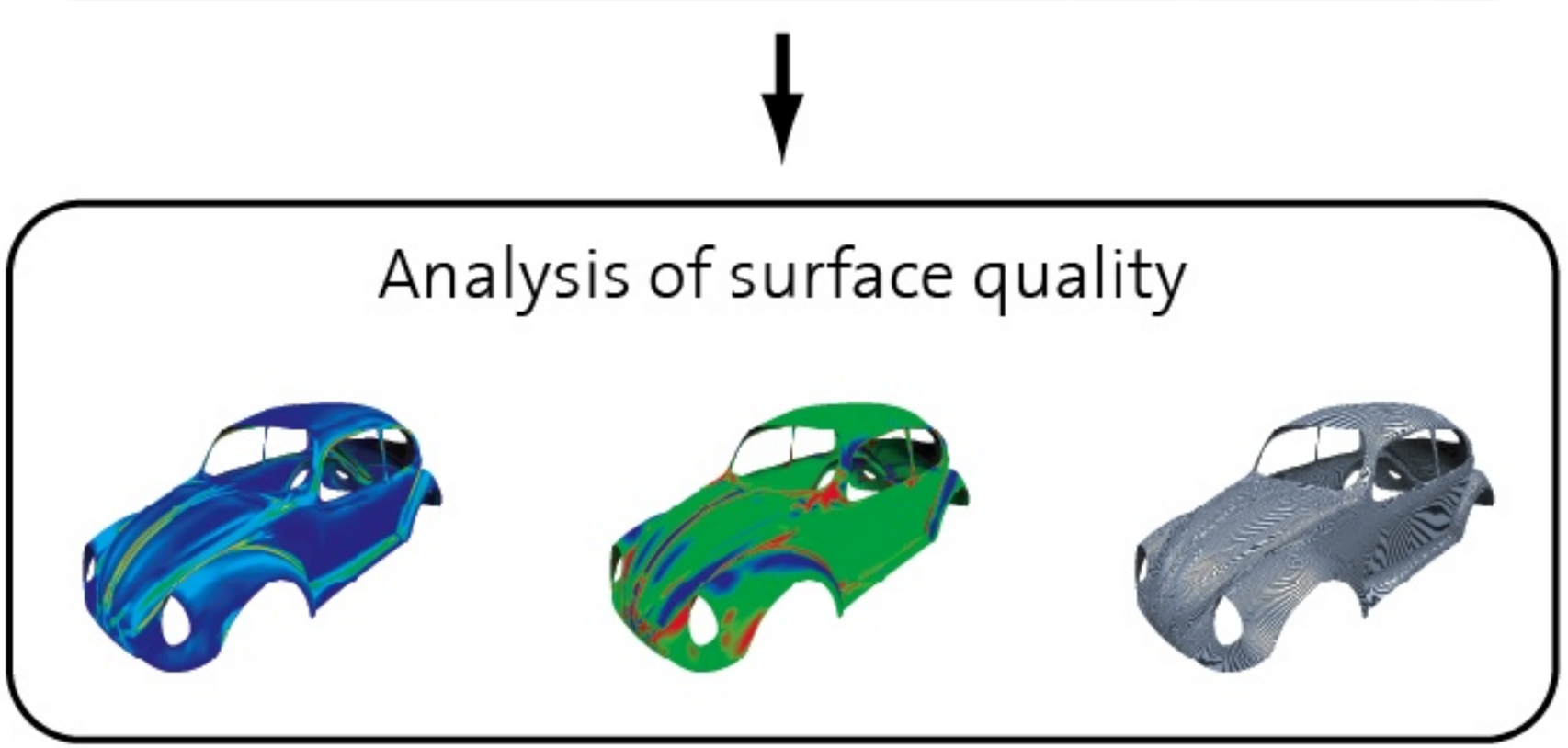




Geometry Processing Pipeline







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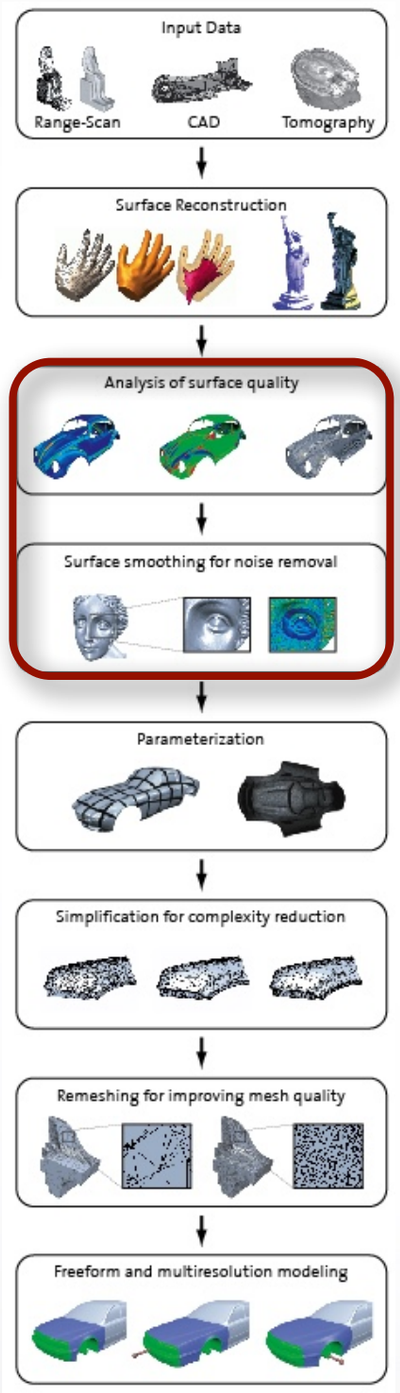

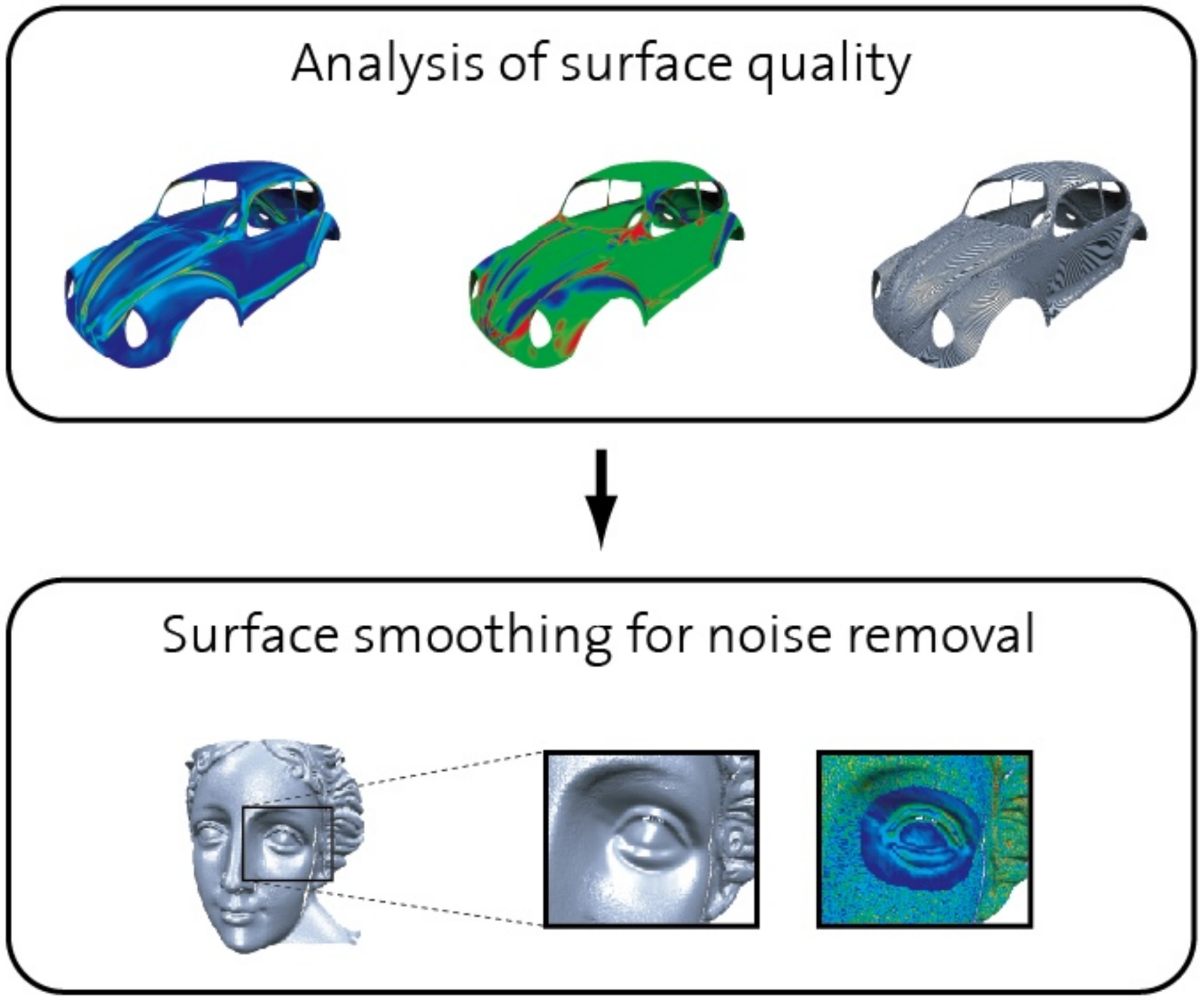

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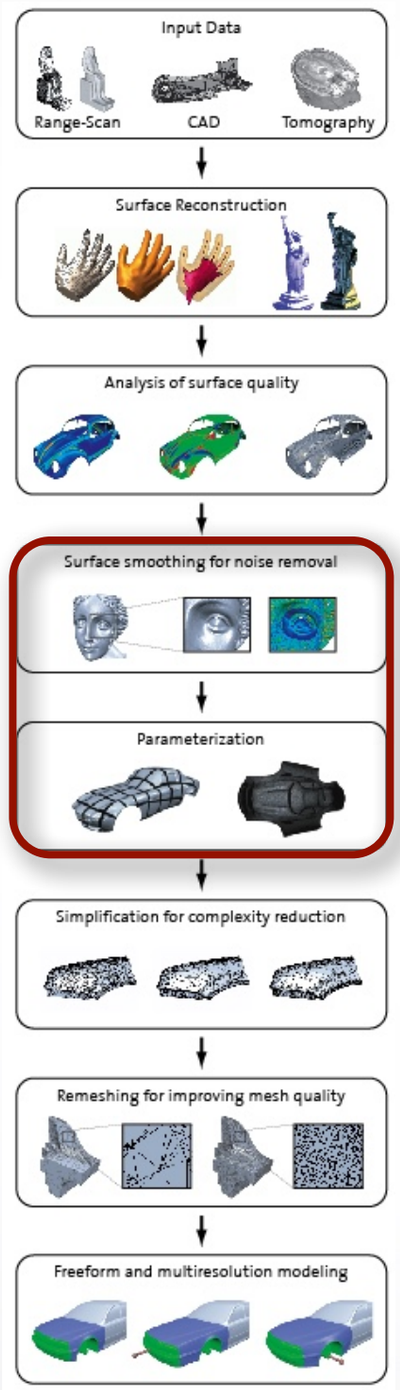
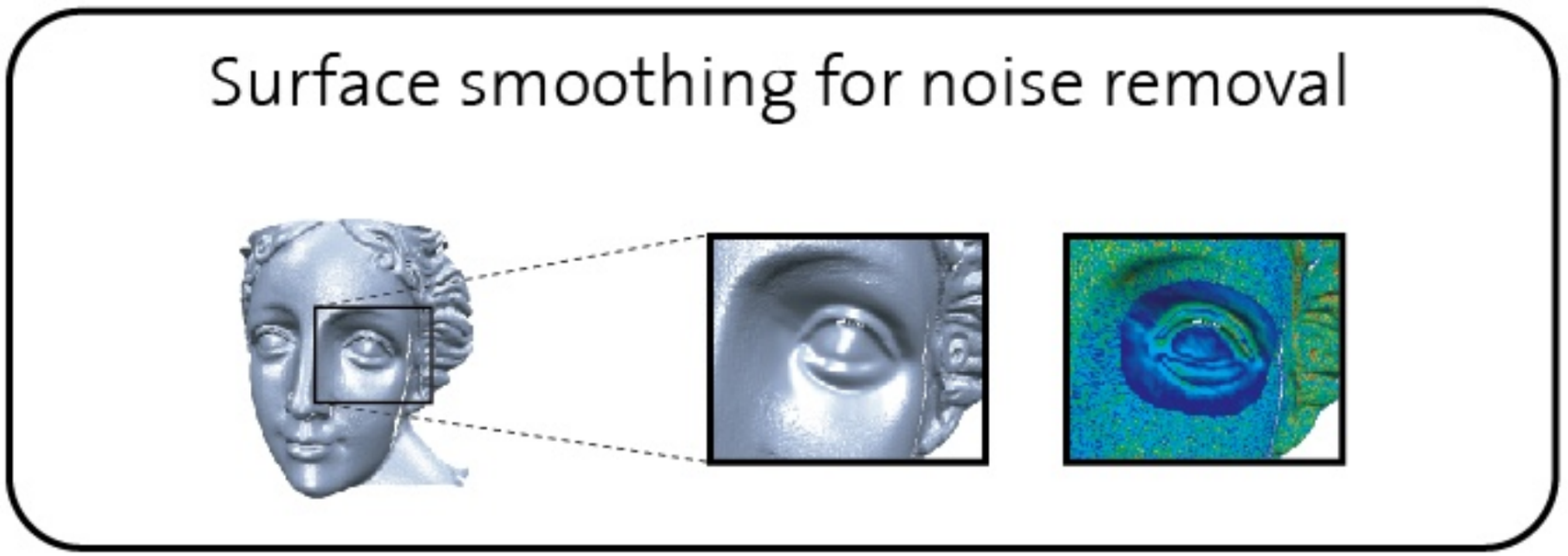
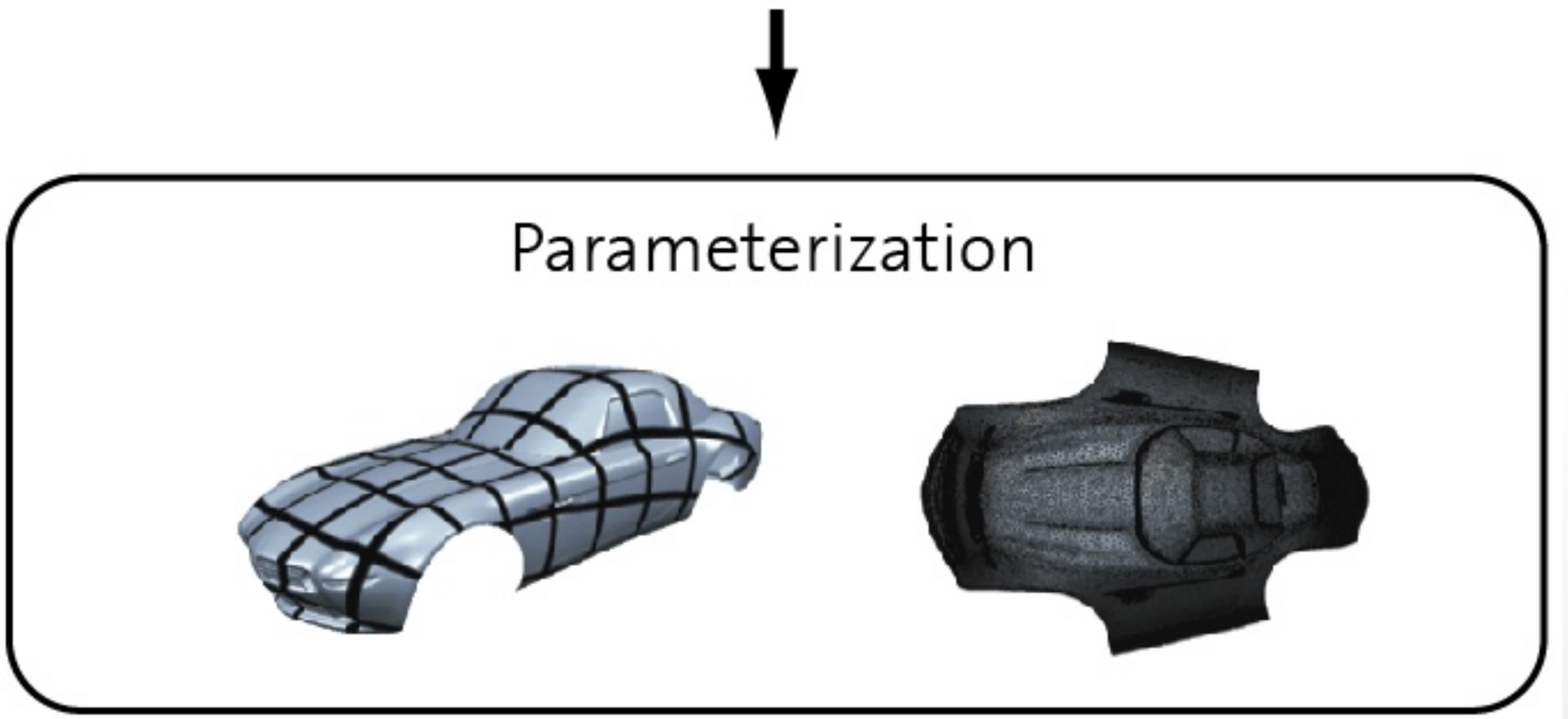
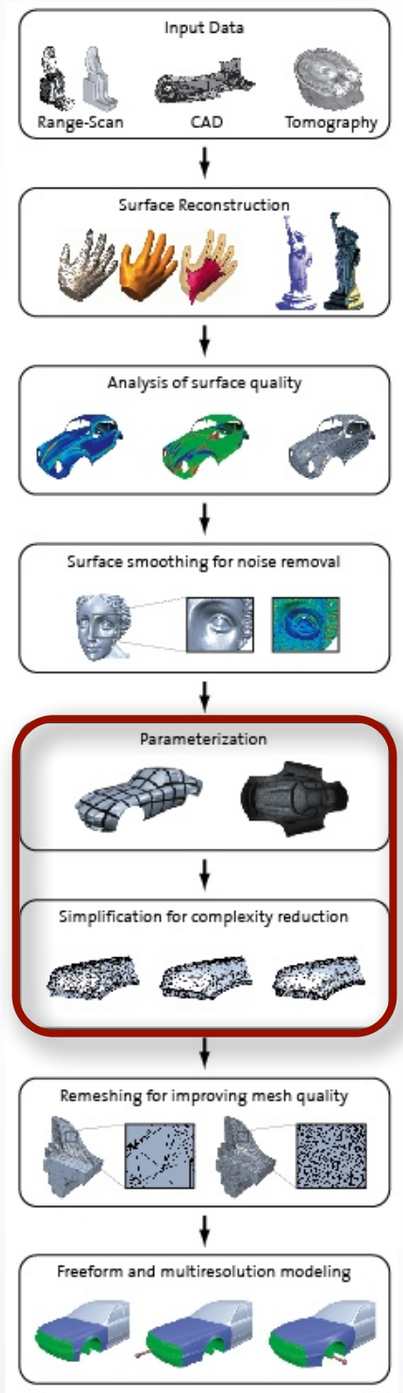
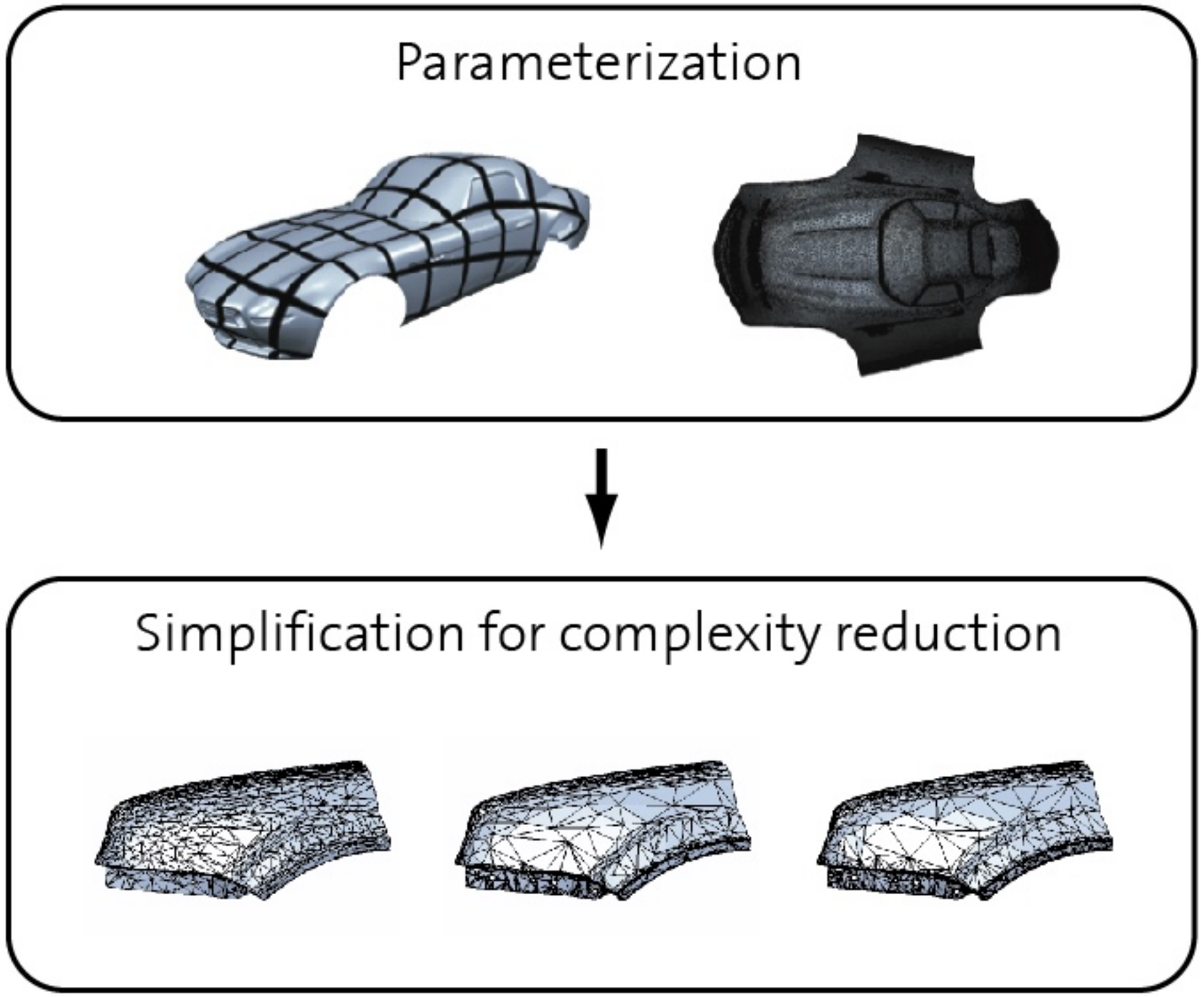






Geometry Processing Pipeline





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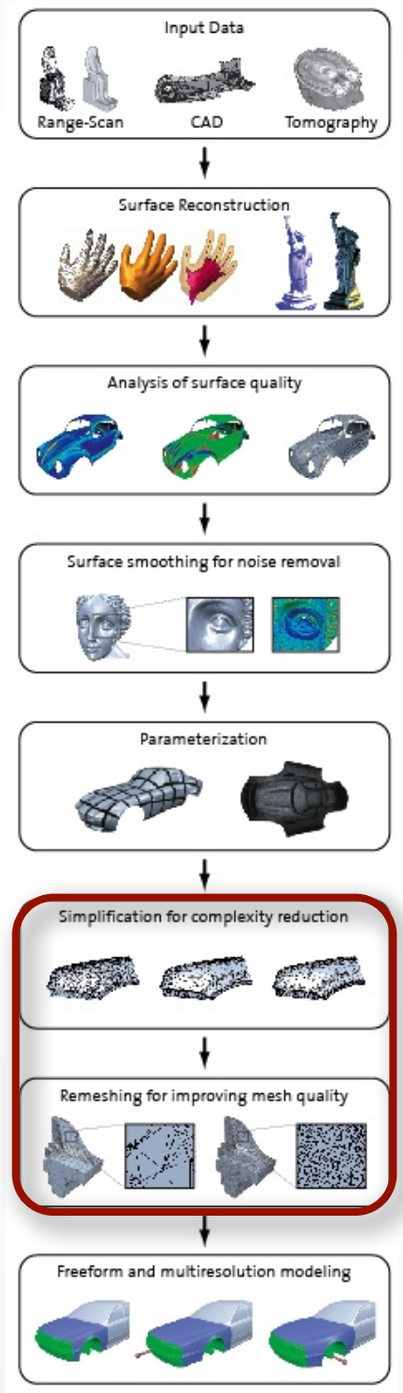

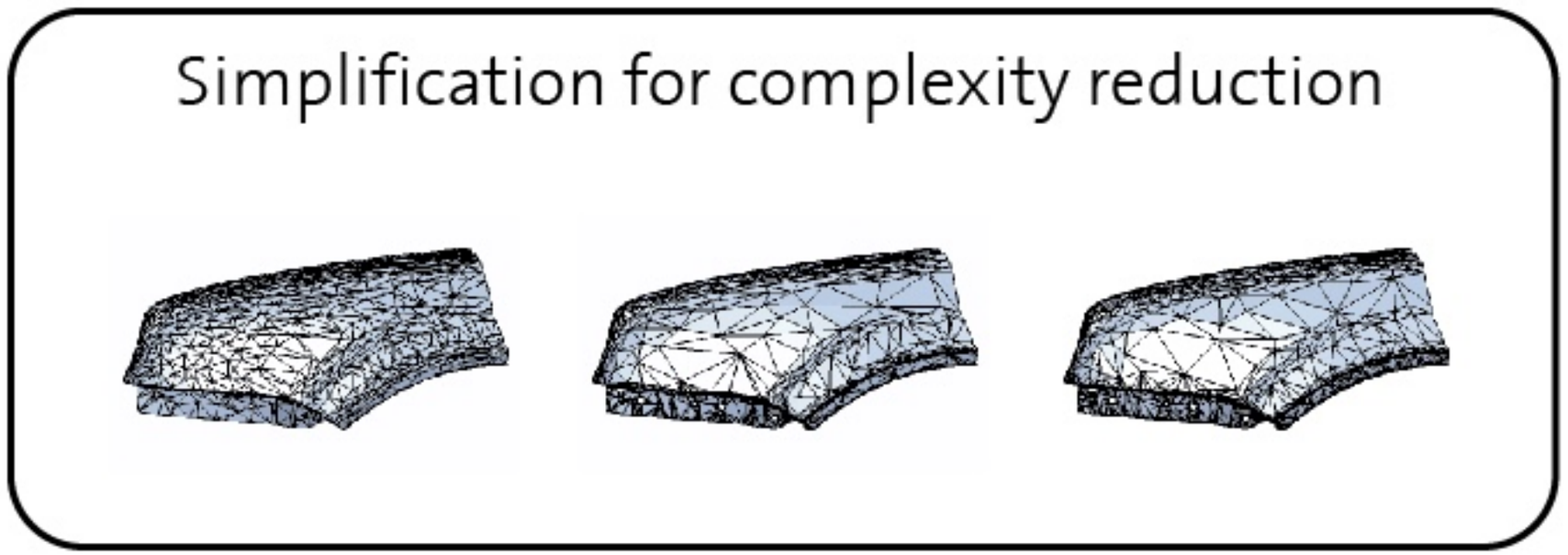

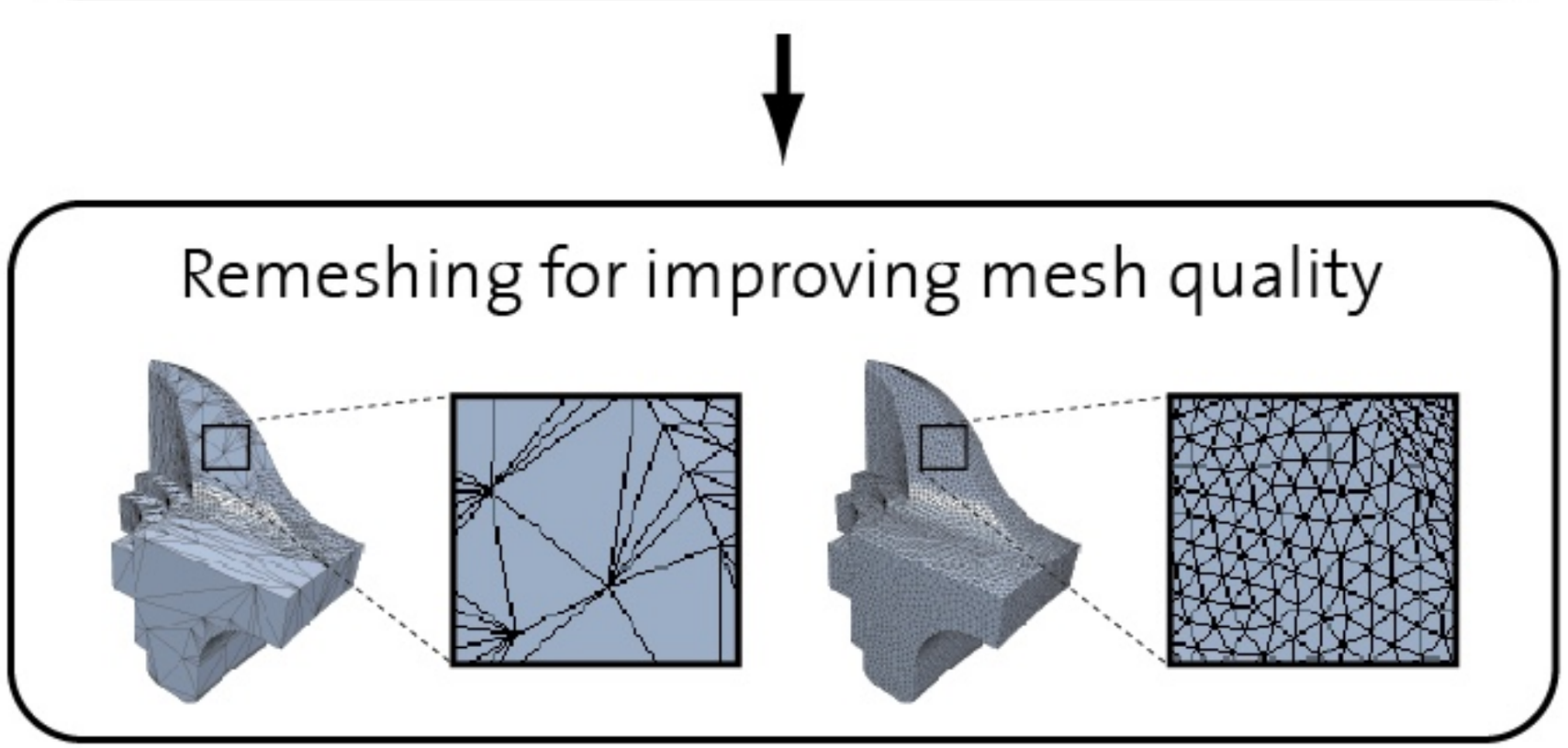

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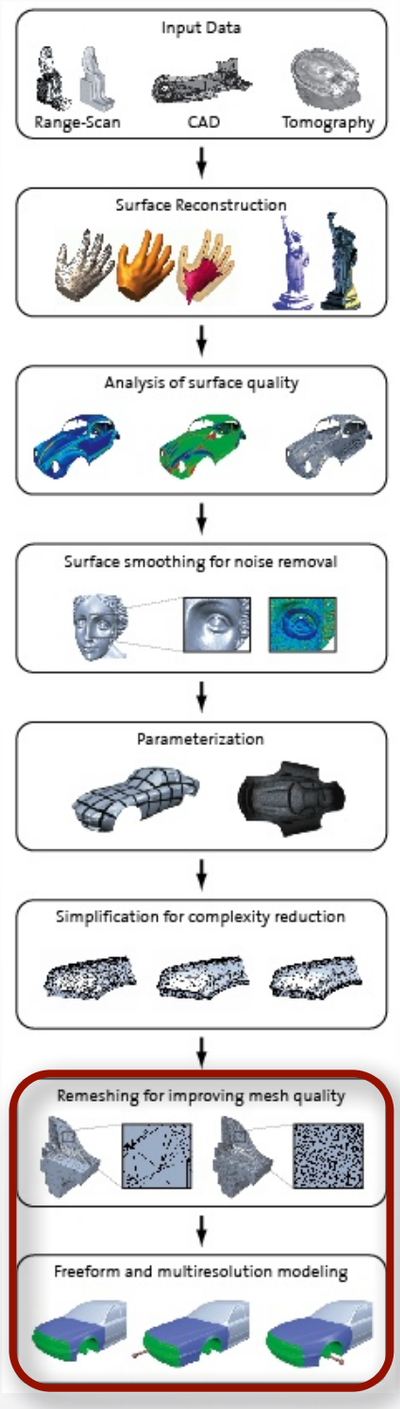
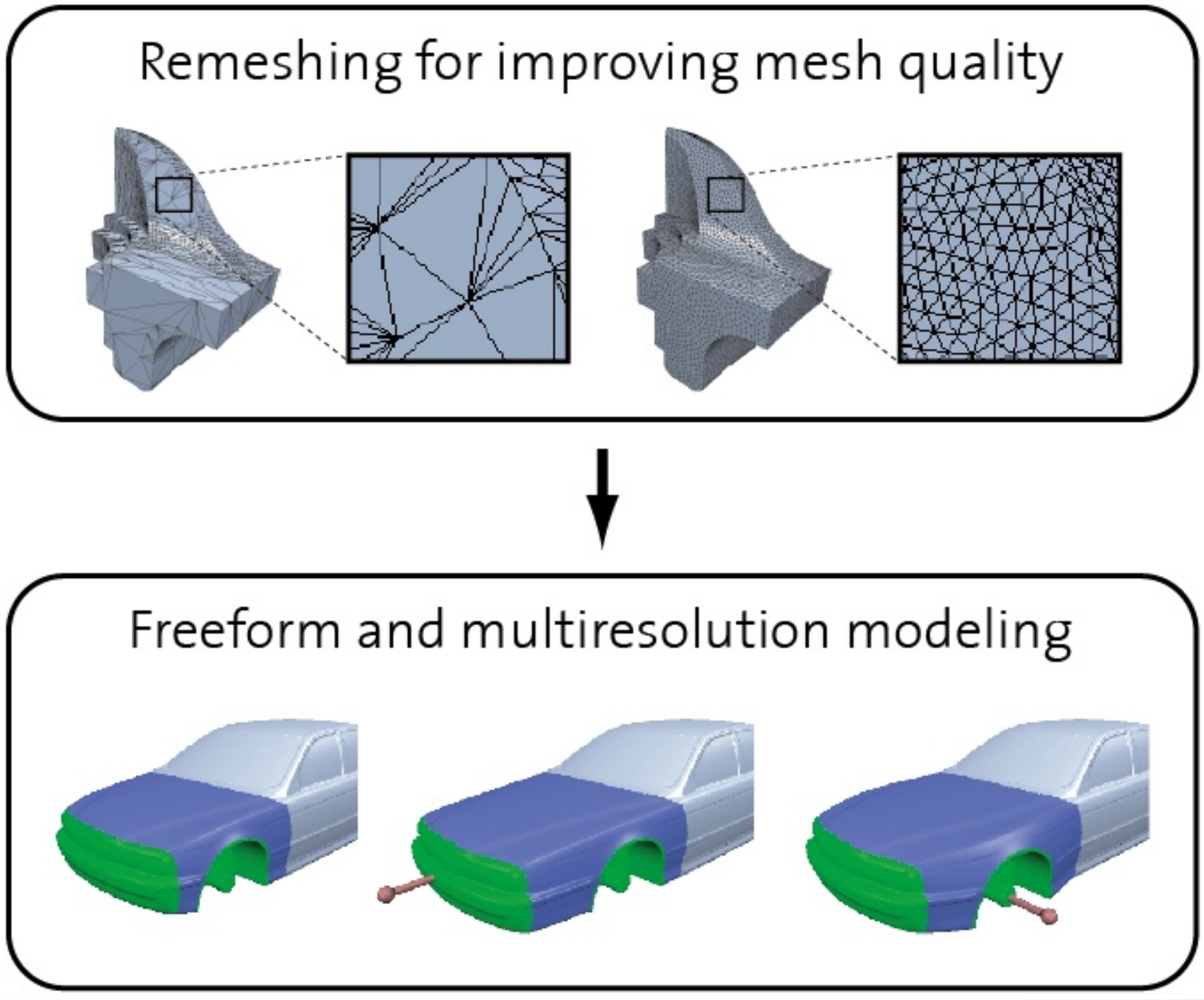
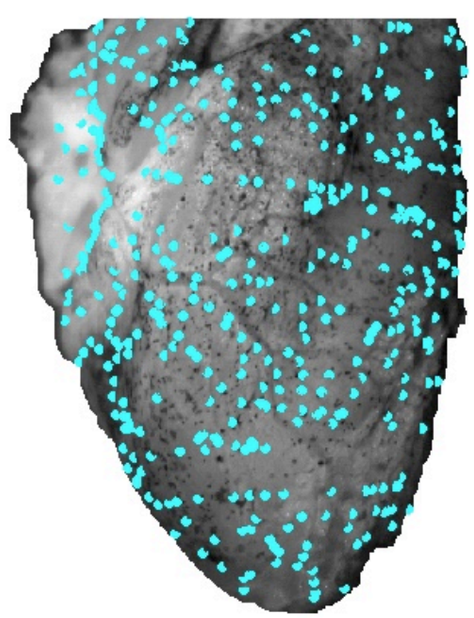
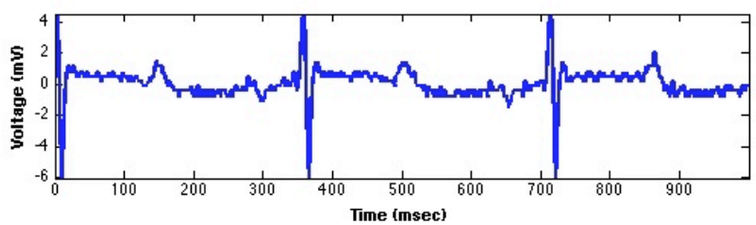


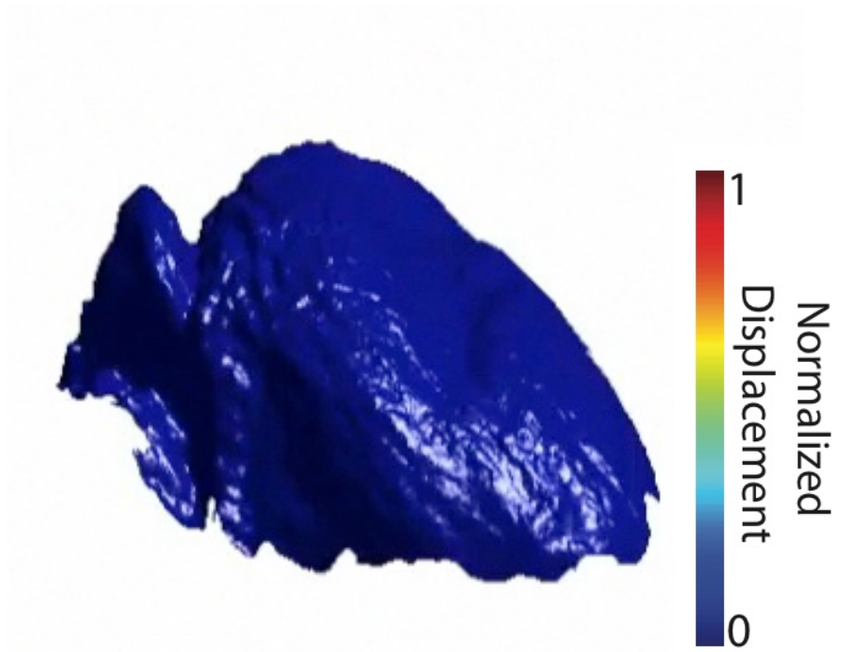


Impacting Science

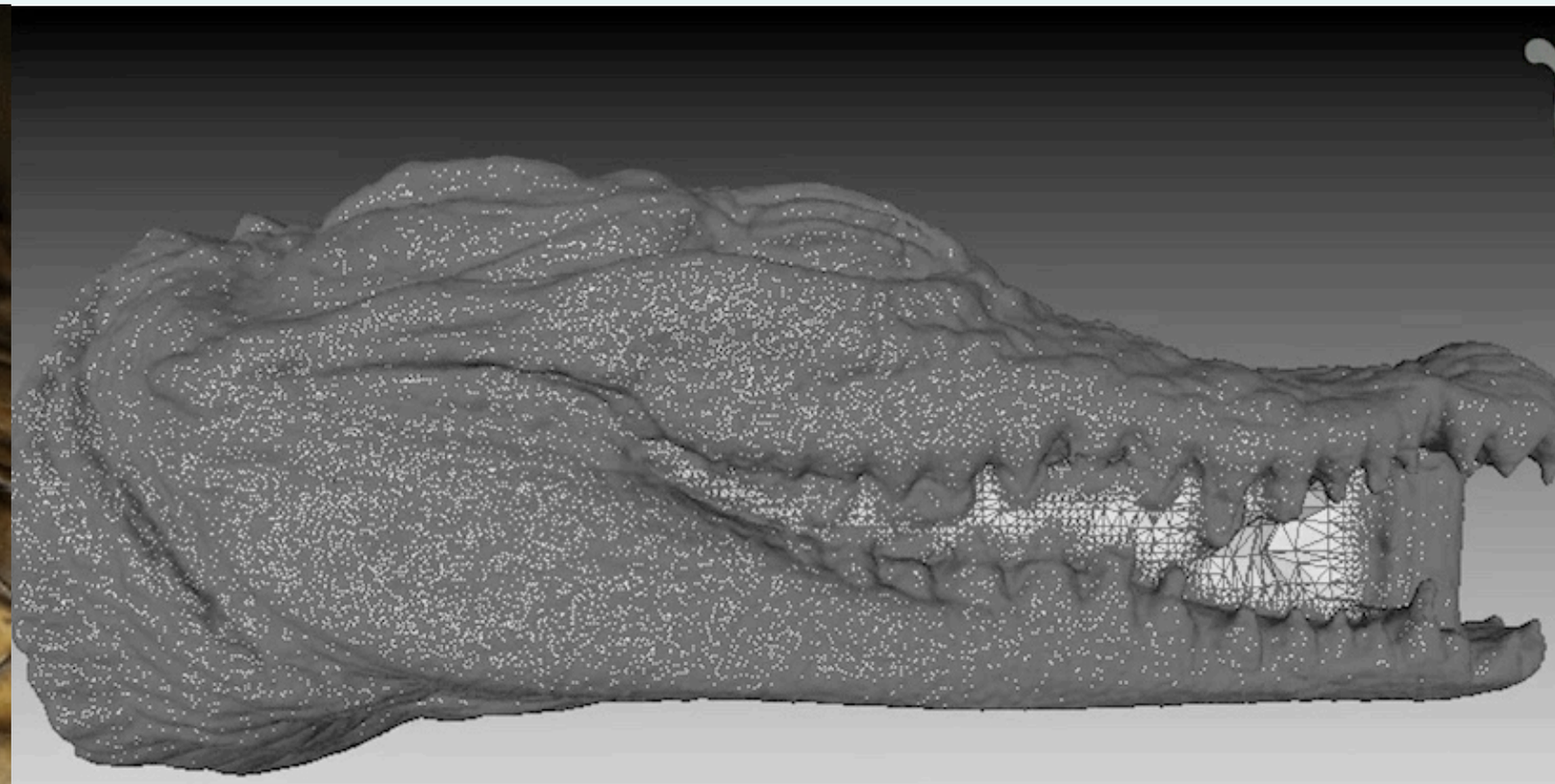
Cardiology




Voltage (mV)
4
2
0
-2
-4
-6
0
100
200
300
400
500
600
700
800
900
Time (msec)


1
0
Normalized
Displacement

Evolutionary Biology



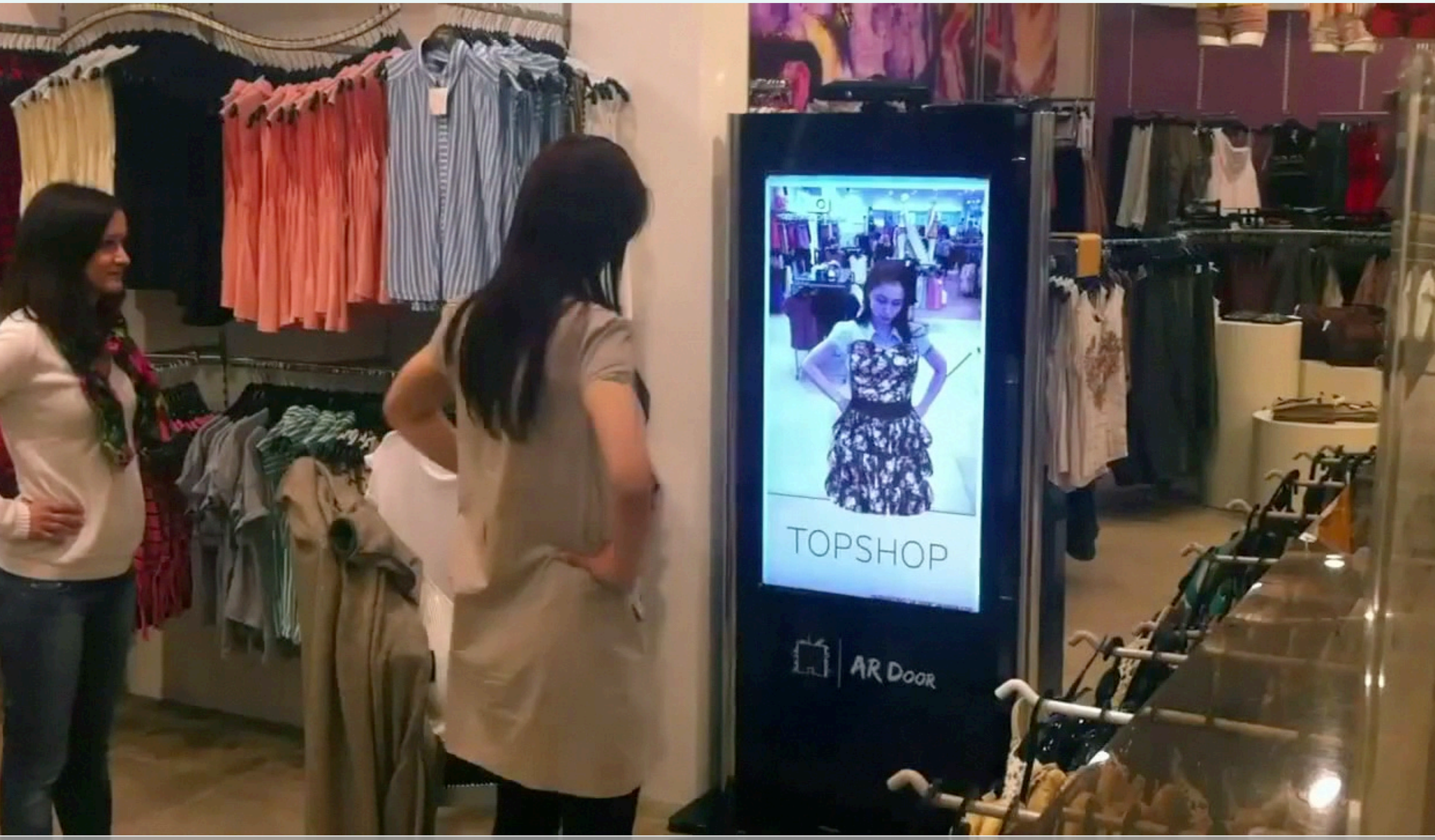
Cancer Treatment

Digitized **Future**

For Everyone

For Everyone

For Everyone

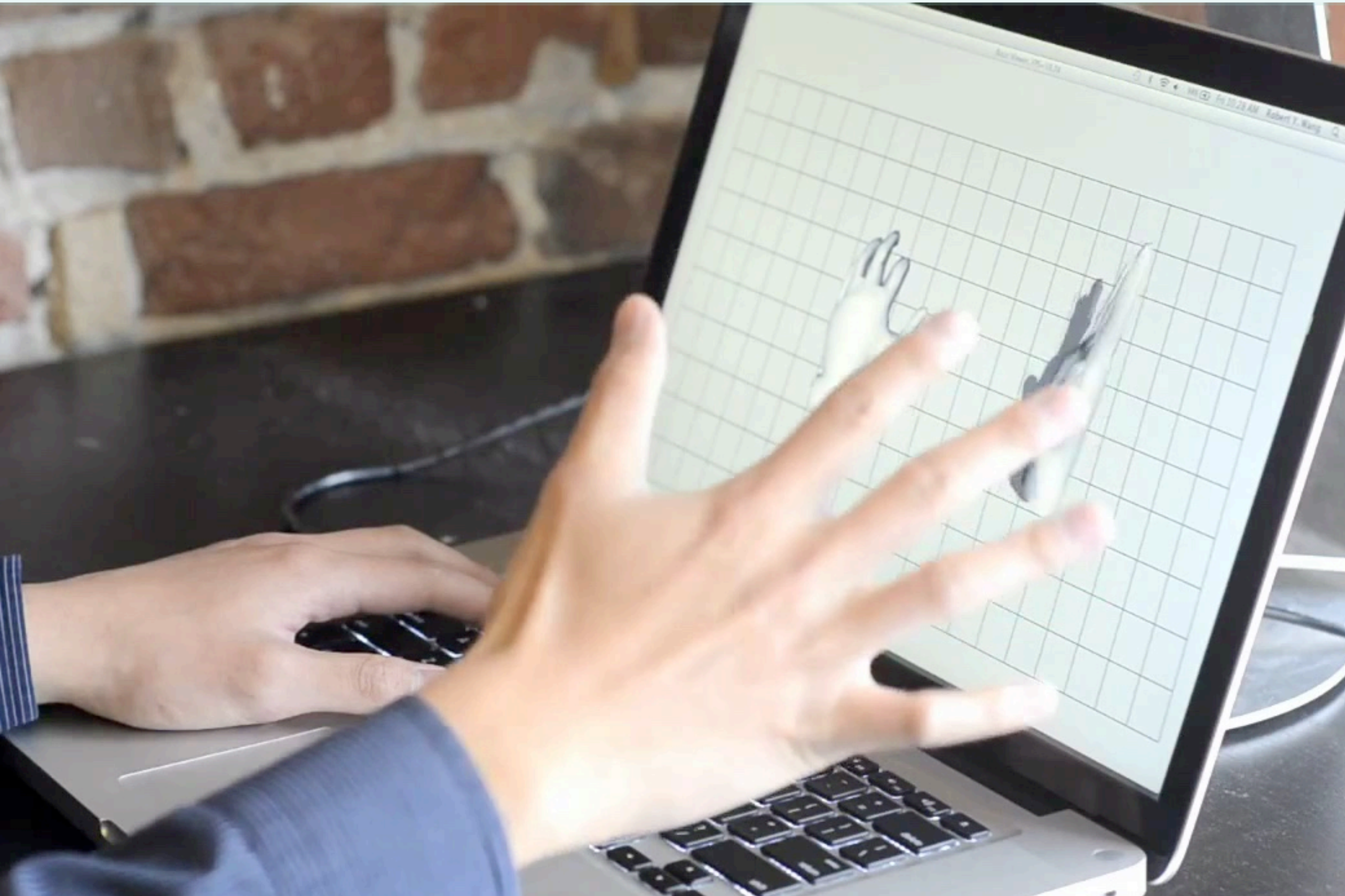


Scanning@Home

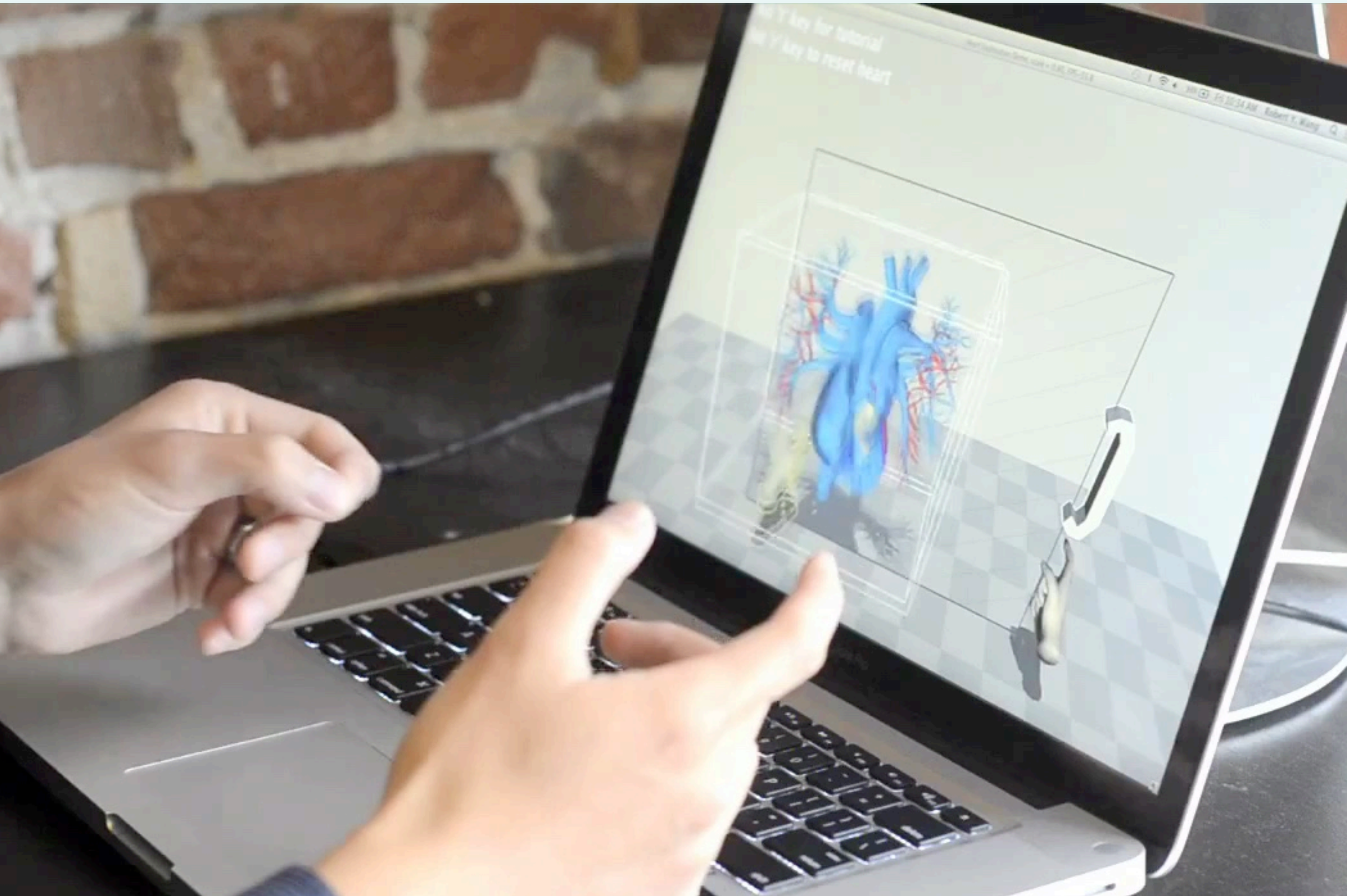
Living Room Entertainment

In Tablet

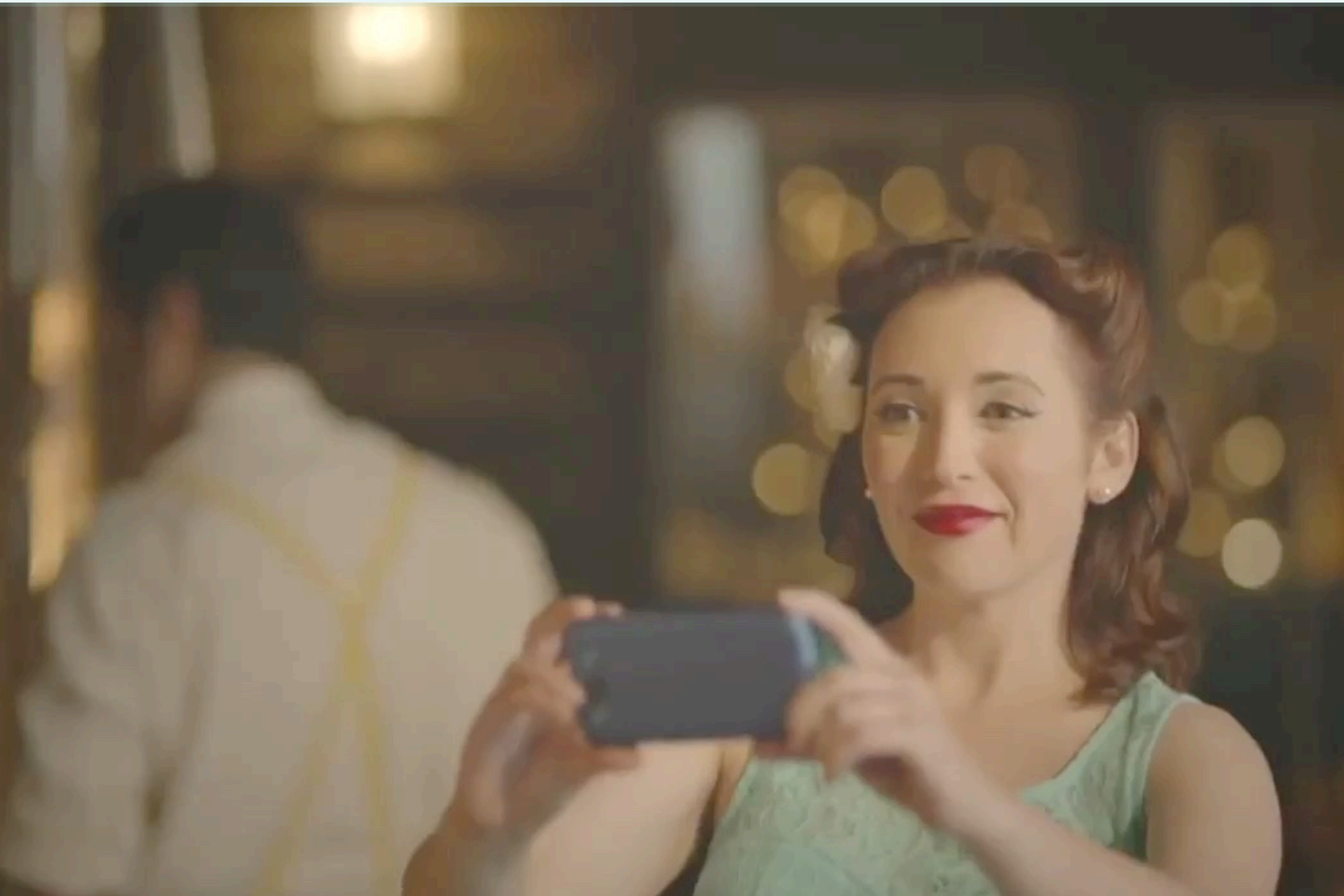
In Laptops



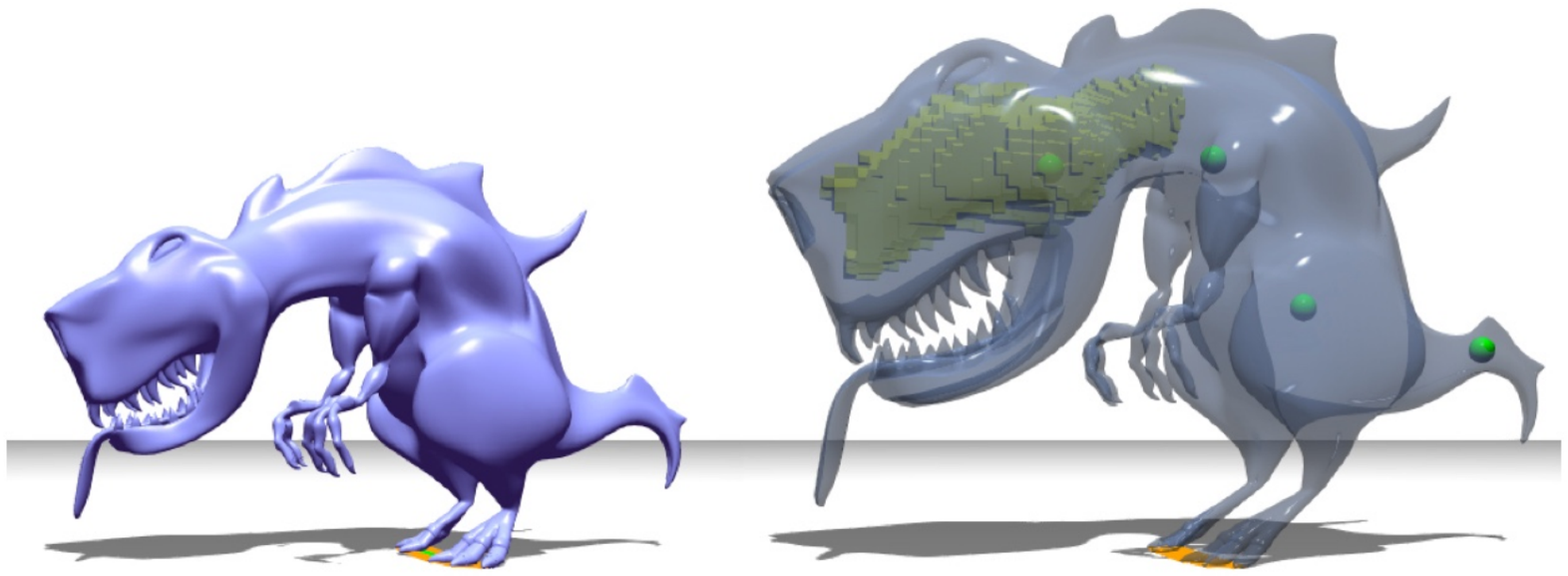
In Laptops

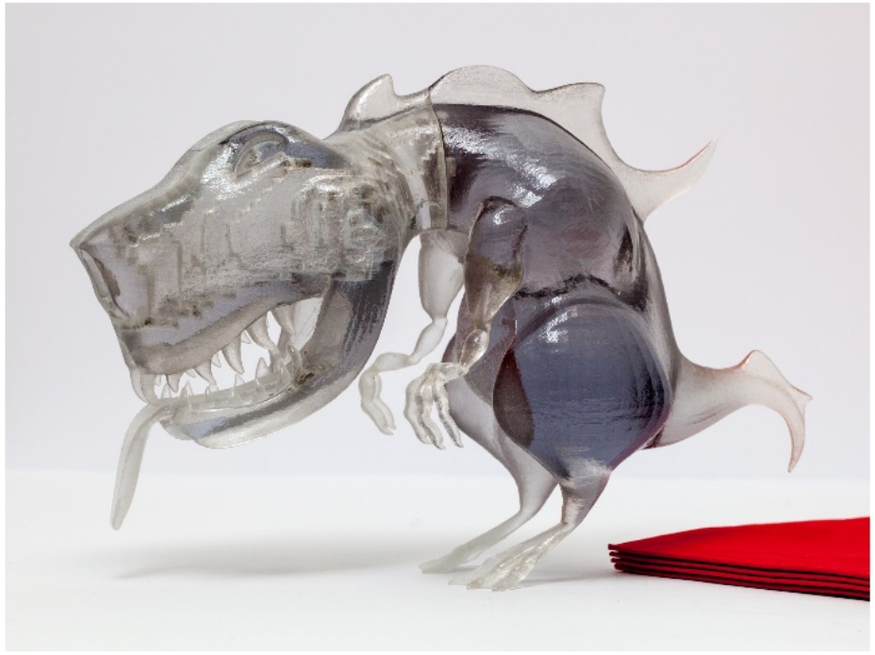


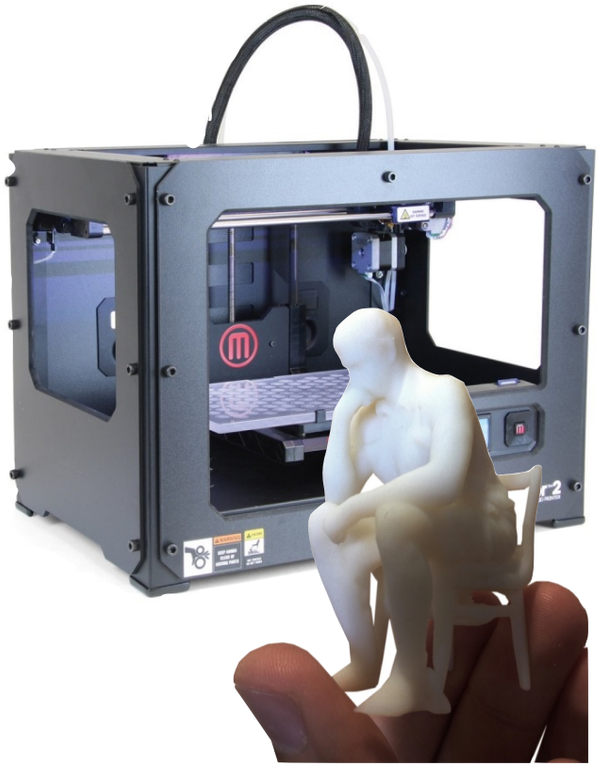
In Smartphones



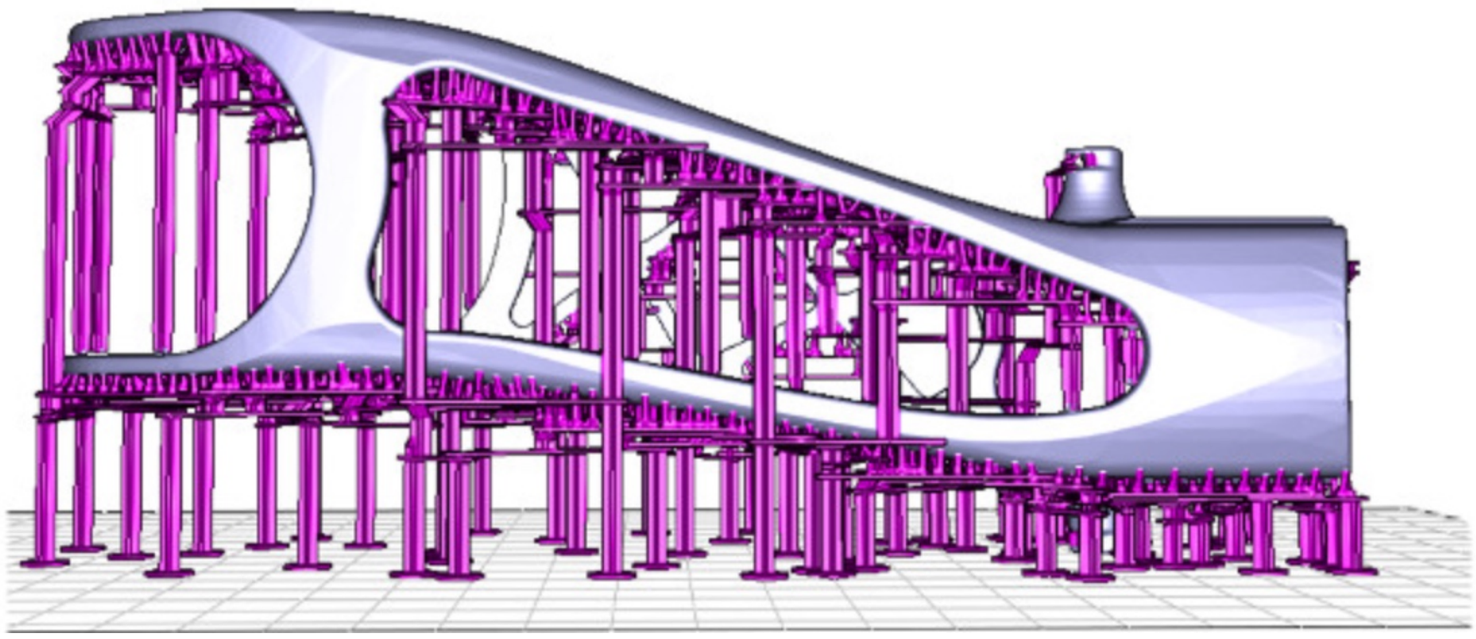
From Capture to Fabrication







3D printing



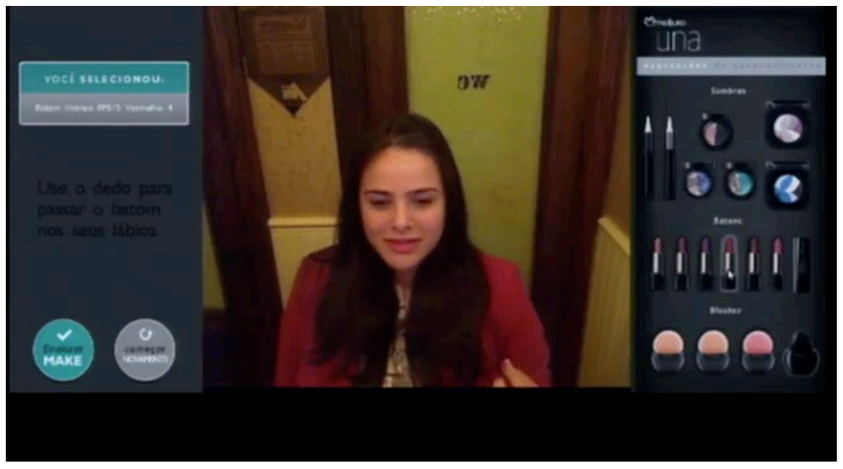
Realtime **Future**

Why Realtime?

VFX/Game Production

Virtual Avatars

Robotics



AR/Virtual Mirror

Realtime Game Engines

Realtime Facial Animation

Virtual Reality **Reloaded**

Oculus VR 2012 / Crytek 2014

Damocles ...

Personalized **Future**

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

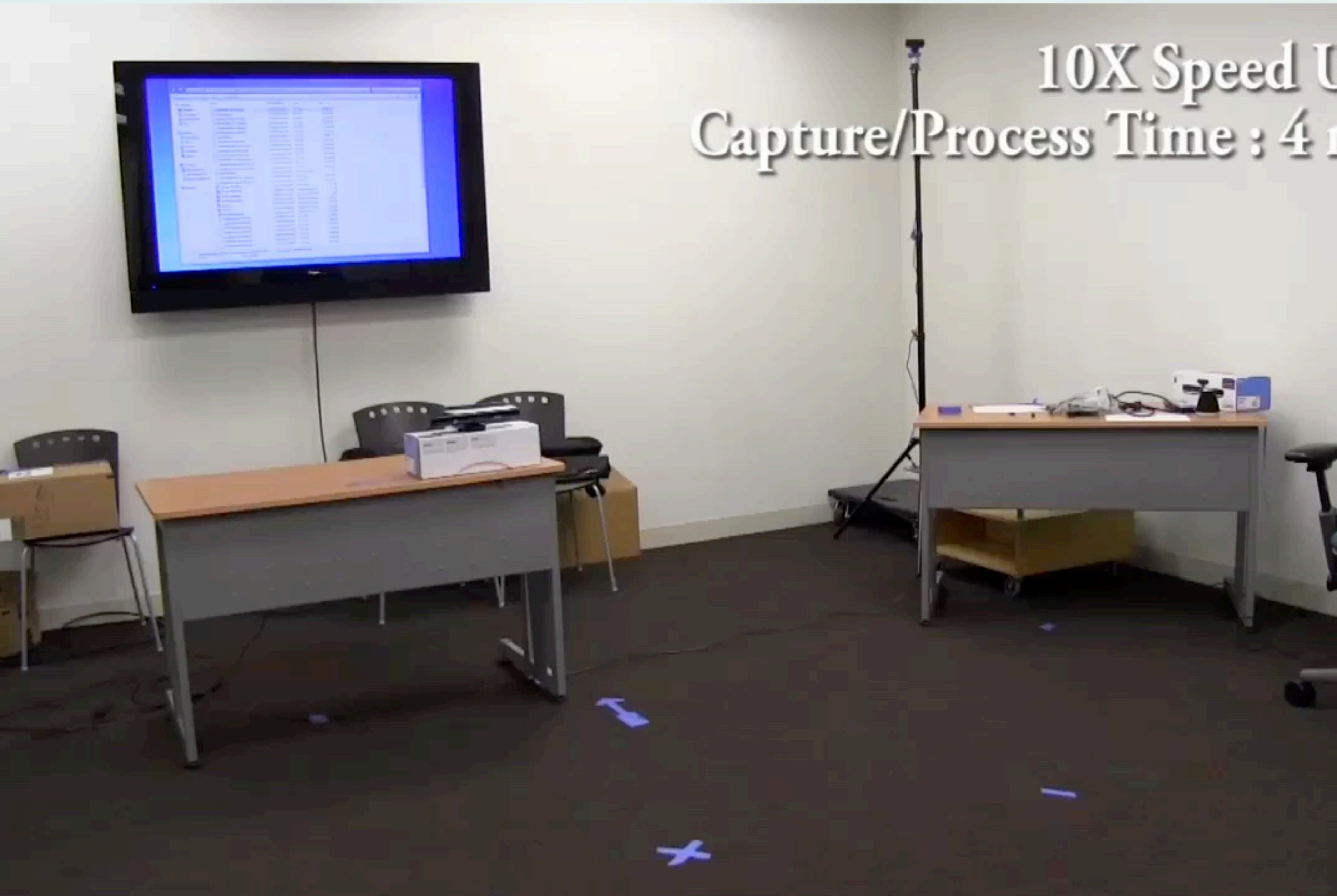
Omote3D Shashin Kan

3D Selfies

3D Selfies

Personalized Games

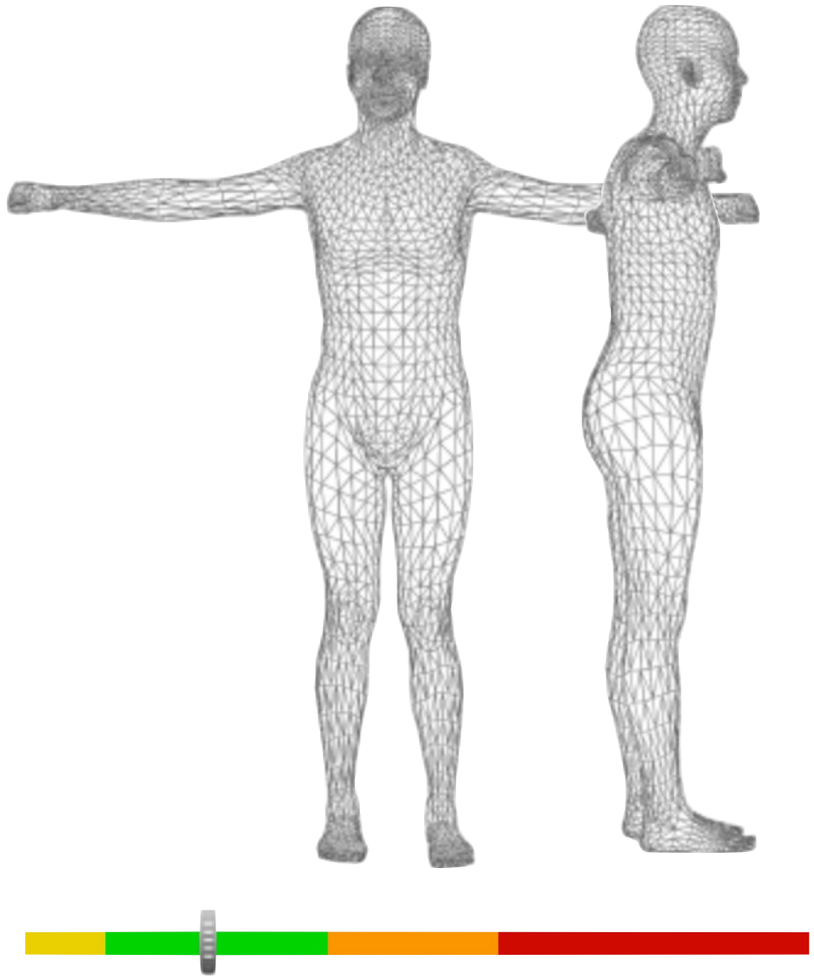
USC/ICT



Personalized **Applications**

MPI IS, Embodee

entertainment



fitness

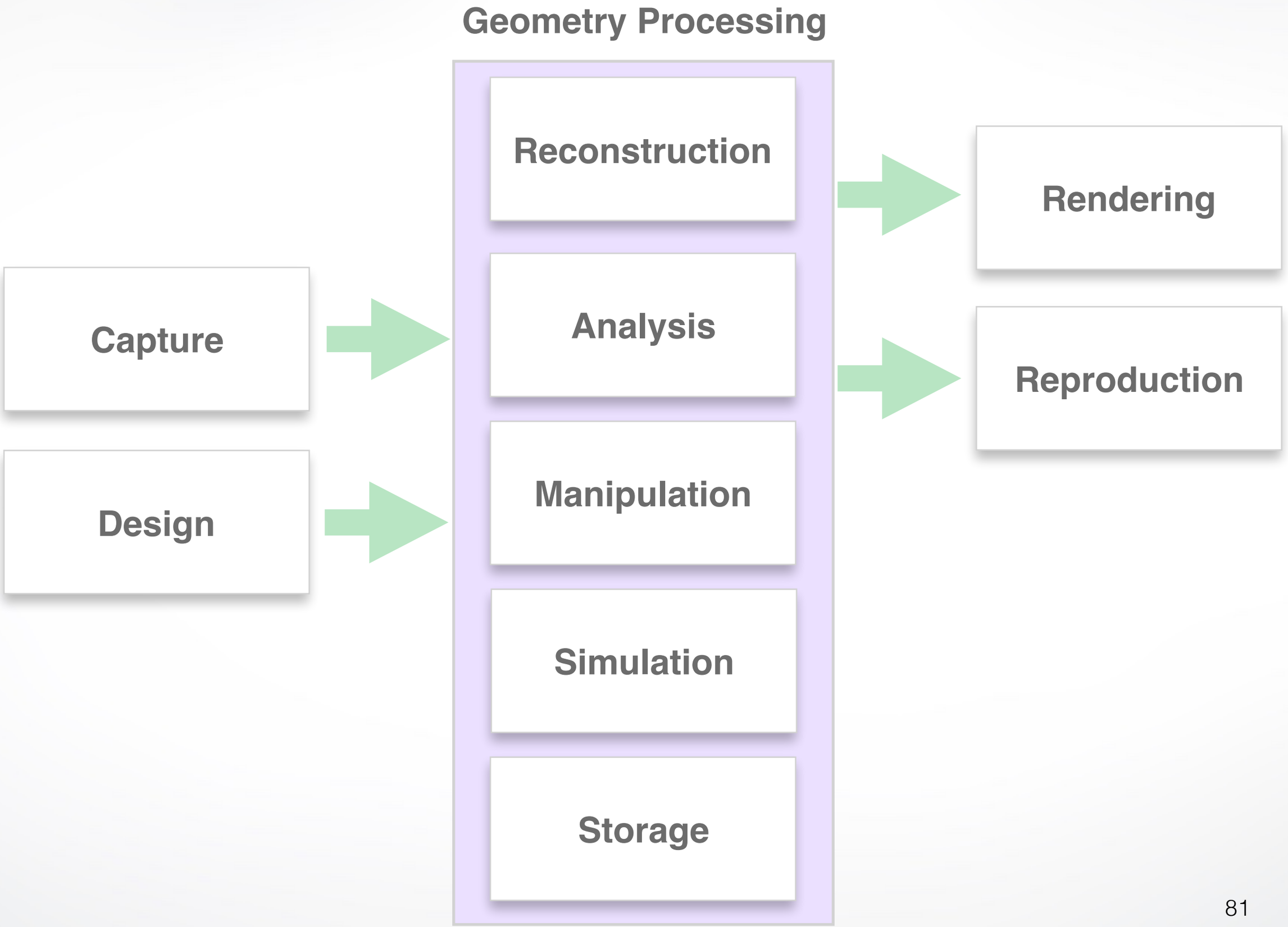
digital garment

Fashion Industry

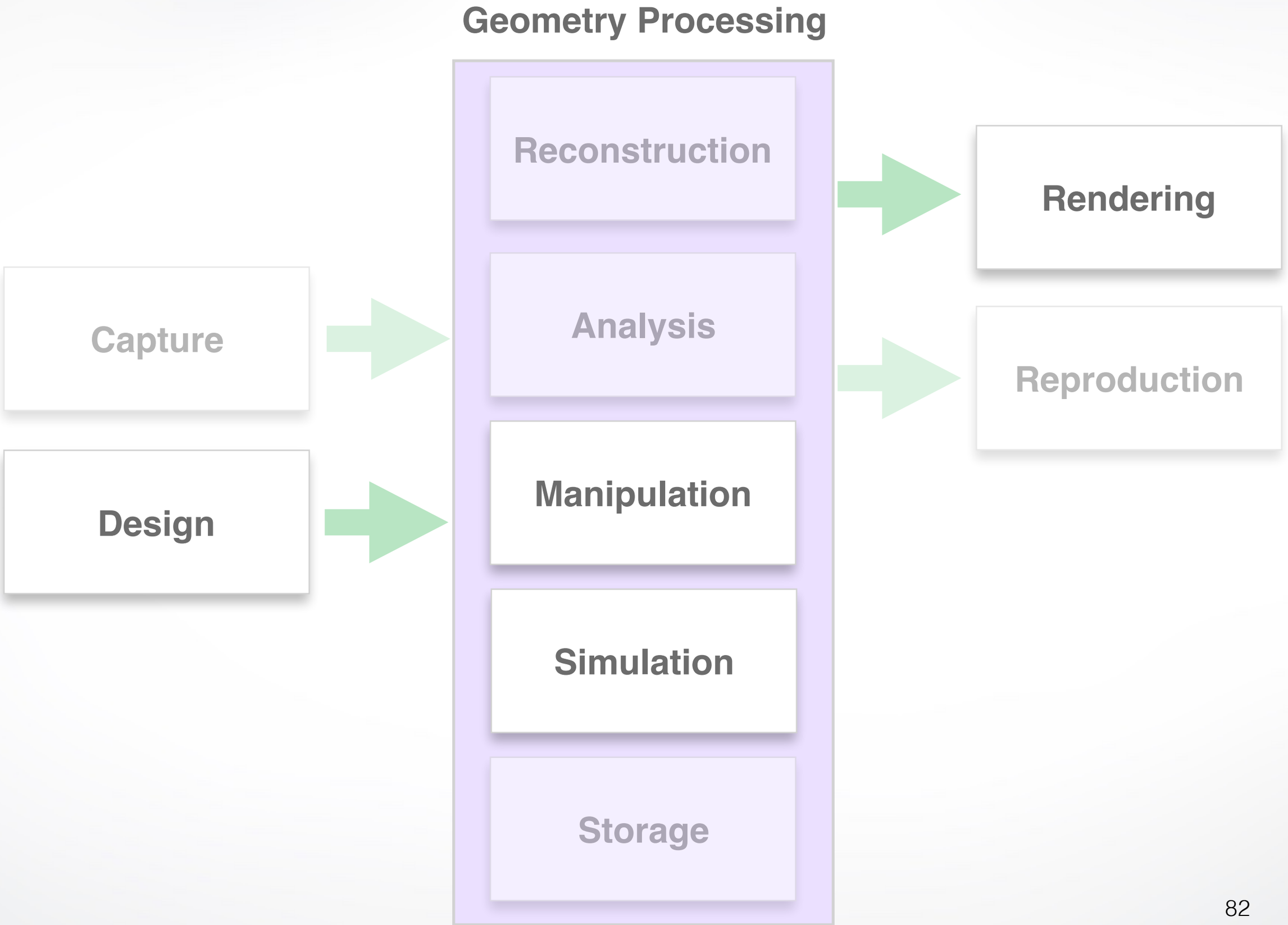
LE TOTE

phisix

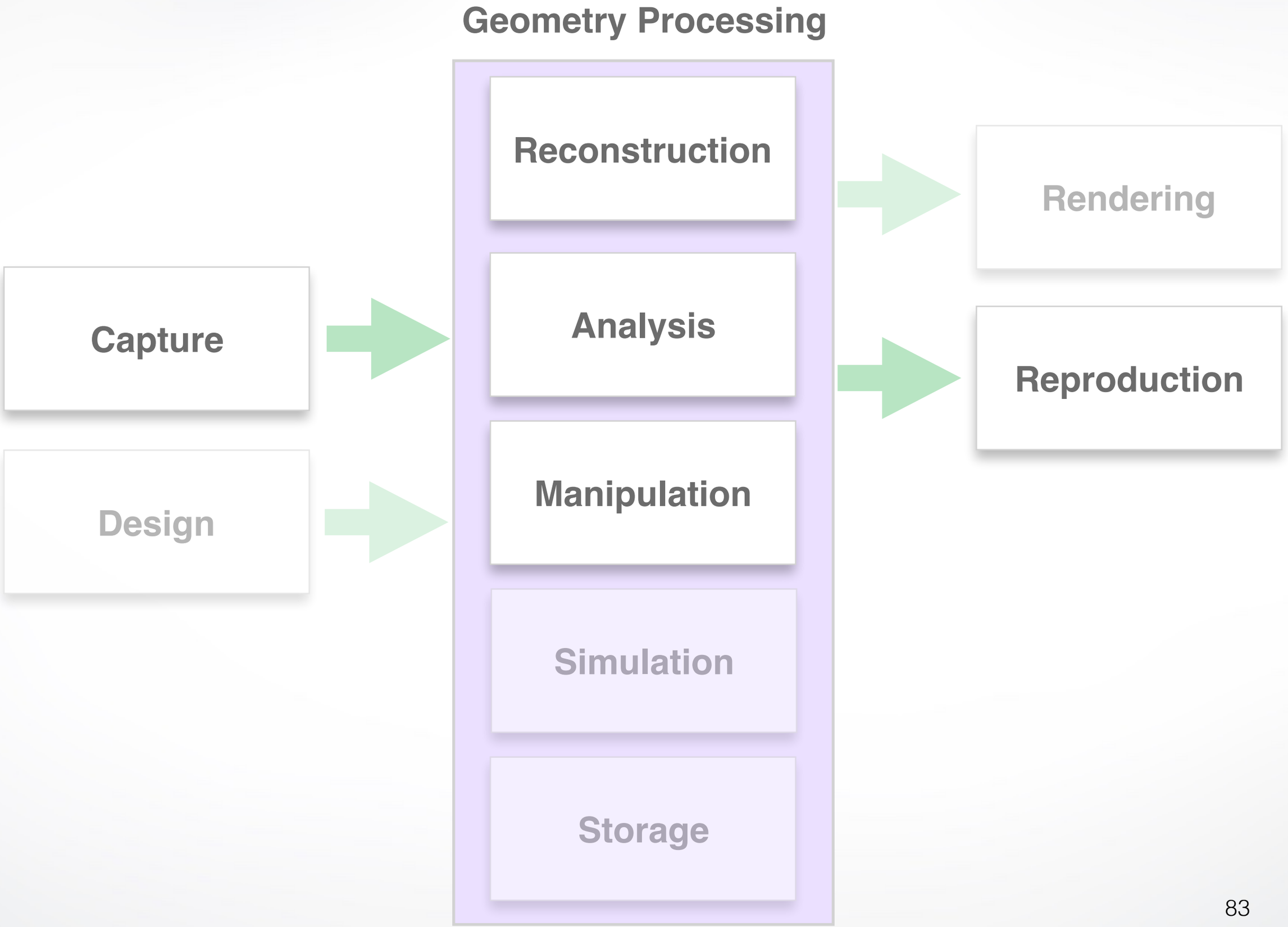
Summary


Geometry Processing
Capture
Design
Reconstruction
Analysis
Manipulation
Simulation
Storage
Rendering
Reproduction

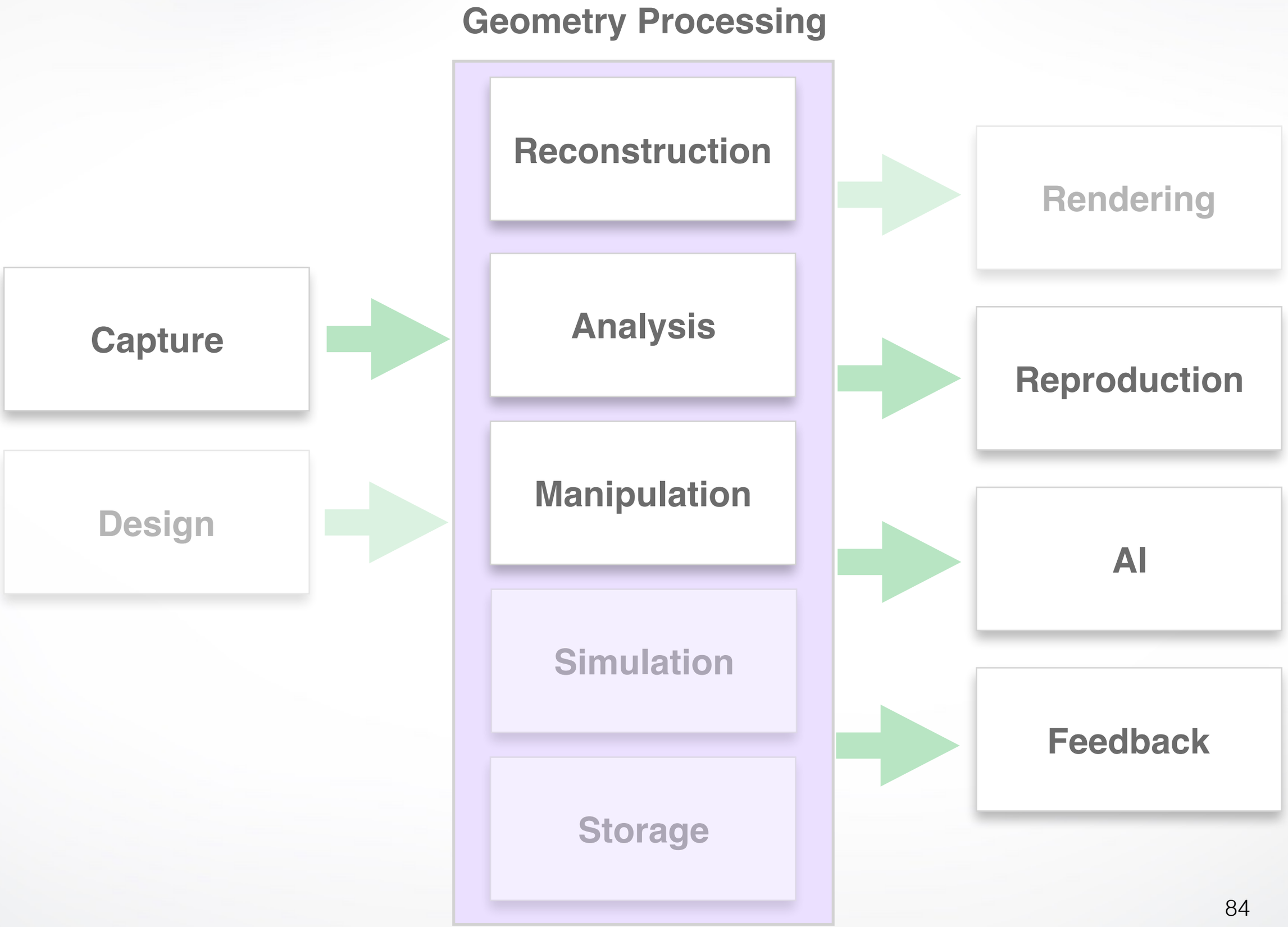
Classic Graphics



Modern Graphics/Vision



The Future: **Big Data / Robotics**



Next Time

- Parametric Approximations
- Polygon Meshes
- Data Structures

http://cs621.hao-li.com

Demos!