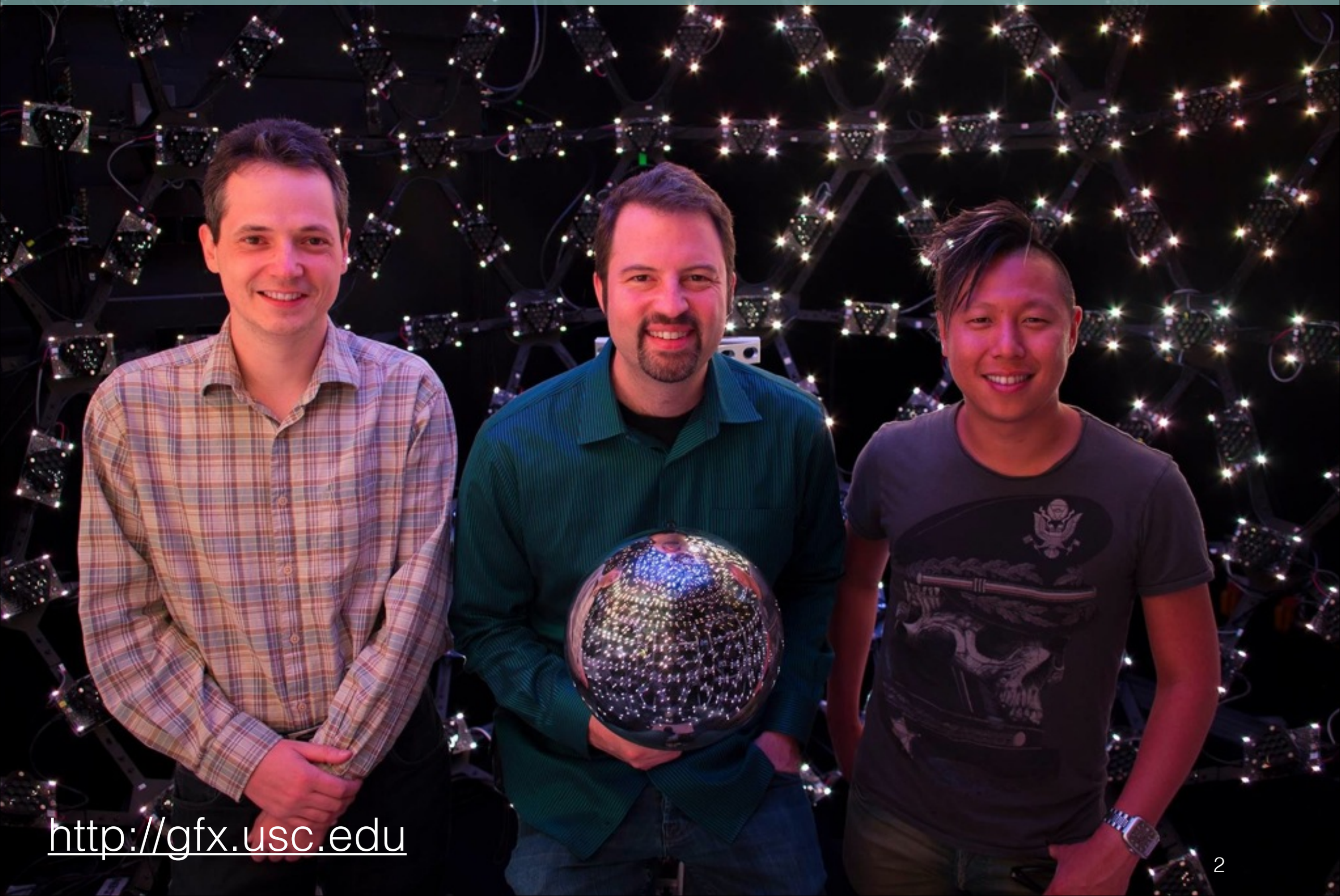
CSCI 599: **Digital Geometry Processing**

Spring 2014

Hao Li

http://cs599.hao-li.com

USC Graphics



http://gfx.usc.edu

Geometric Capture [Lab]

http://www.hao-li.com

The **Team**

Instructor

- Hao Li, hao.li@usc.edu
  - Office: SAL 244
  - Office hours: TBD
- Chongyang Ma, chongyang.ma@usc.edu

Assistants

- Mikhail Smirnov, smirnov@usc.edu
  - Office: TBD
  - Office hours: TBD
- Pei-Lun Hsieh, peilun.hsieh@usc.edu

Industrial Light & Magic

Main Campus in the Presidio (LDAC)

Skywalker Ranch

Big Rock Ranch

Big Rock Ranch

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 480 abd CSCI 520 Recommended

Administrative

When and where?

- Tuesday, Thursday, 11:00 am - 12:20 pm
- VKC 203 (Von KleinSmid Center)

Credits

- 3 Units

Website

- http://cs599.hao-li.com/

Exercises

Programming assignments

- based on OpenMesh (tutorial will be given Thursday next week)
- 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 2 months/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

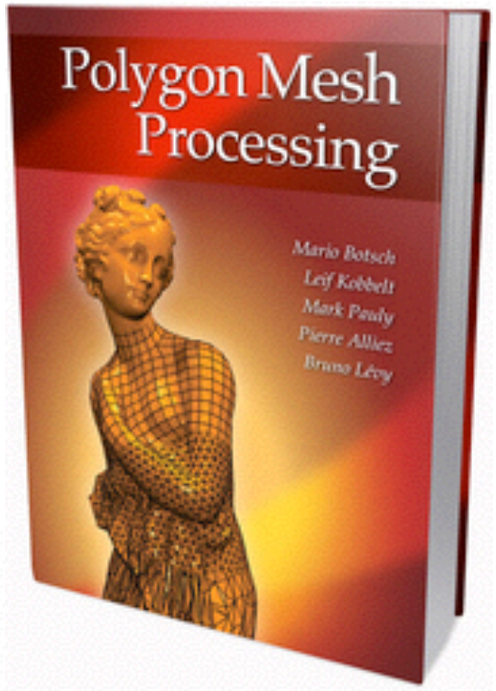
- Do not copy any parts of the assignments from anyone
- Do not look at other student's code
- Collaboration only for the project
- USC Office of Student Judicial Affairs and Community Standards (Hell) will be notified

Course **Objectives**

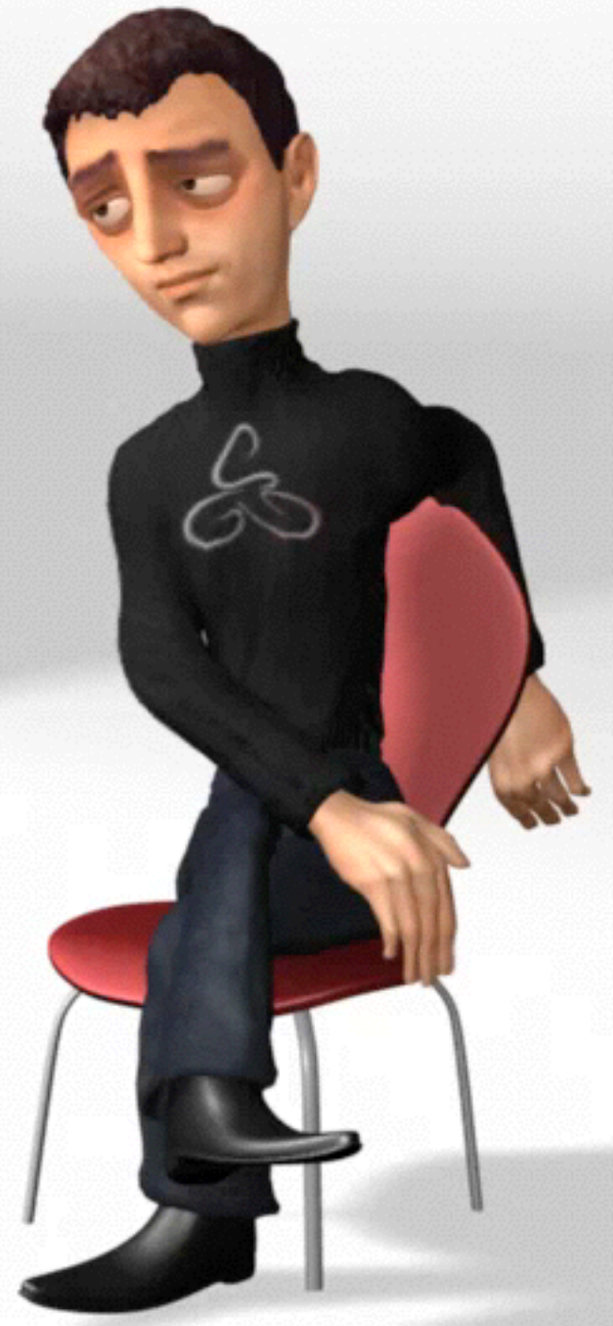
- **Define** and **relate** the basic concept, tools, and algorithms in geometric modeling and digital geometry processing
- Critically **analyze** and **assess** current research on surface representations and geometric modeling and apply the proposed methods in your own work
- **Design** and **implement**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

Recommended **Textbook**

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



Acknowledgement



Course material taught at:

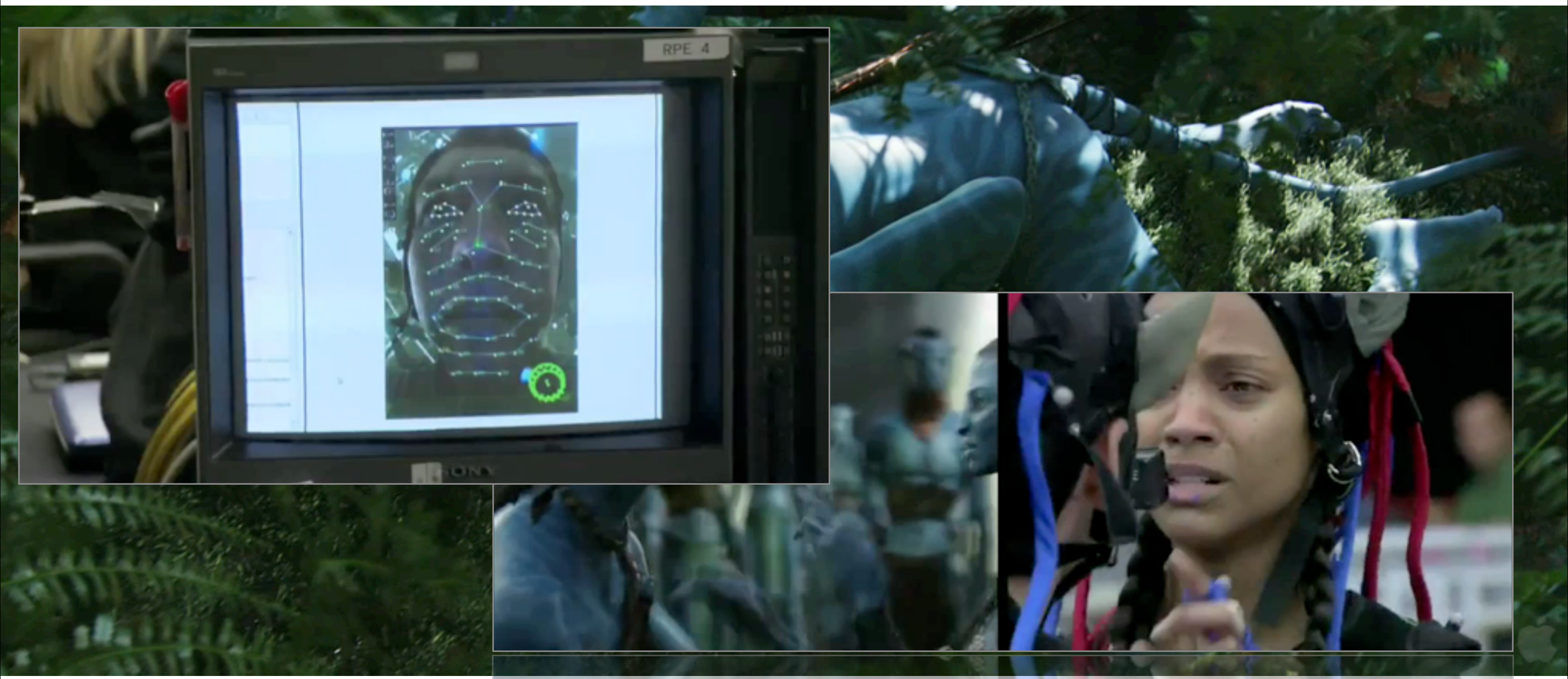
- EPFL, Mark Pauly (My PhD Advisor)
- Bielefeld University, Mario Botsch
- INRIA, Pierre Alliez, Bruno Levy
- RWTH Aarchen, Leif Kobbelt

An **Example**

Computer Graphics

The Vision

Performance Capture



IMocap

IMocap


2008-03-13 16:32
NG210
talmage
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20.92 mm

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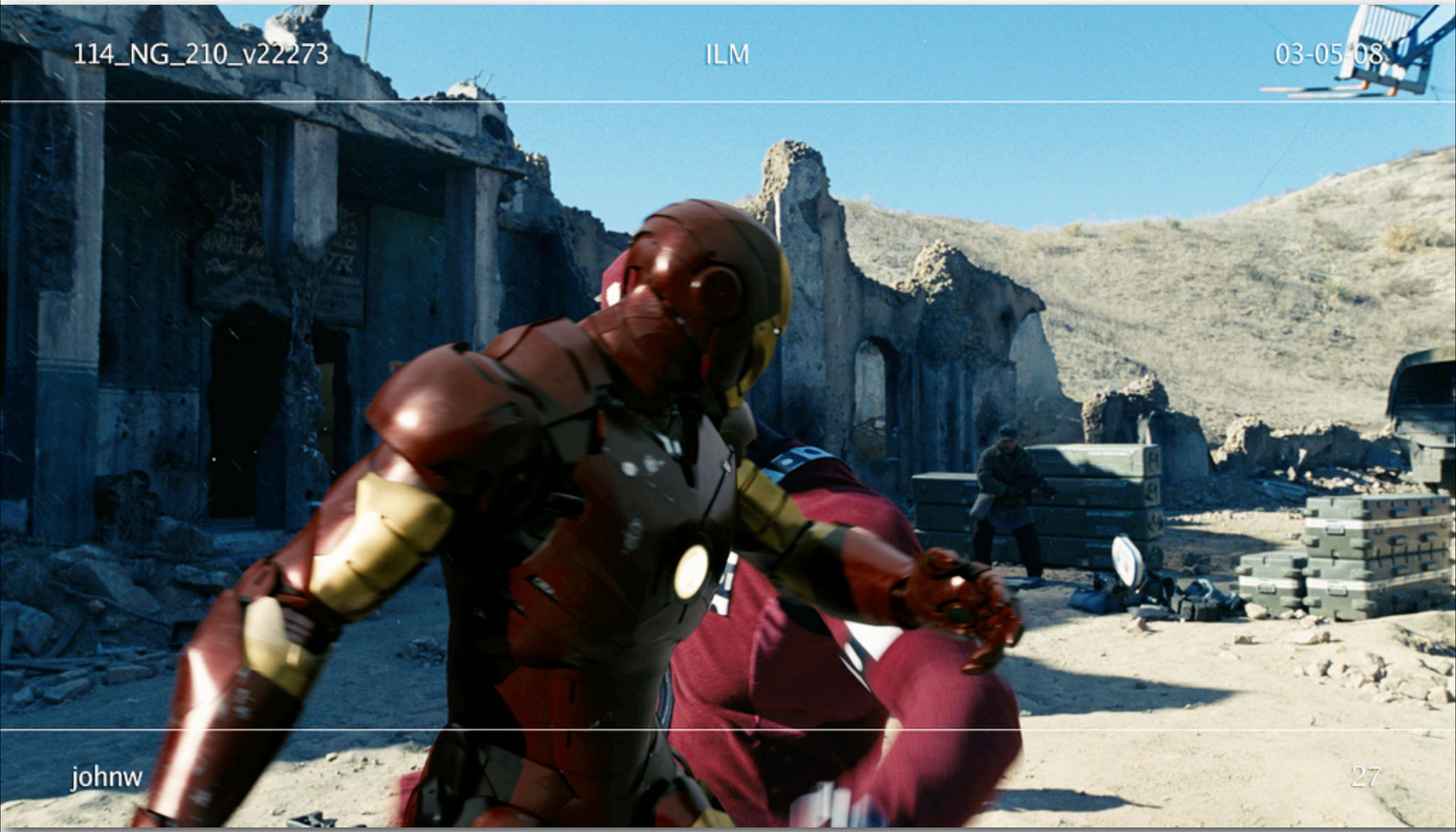
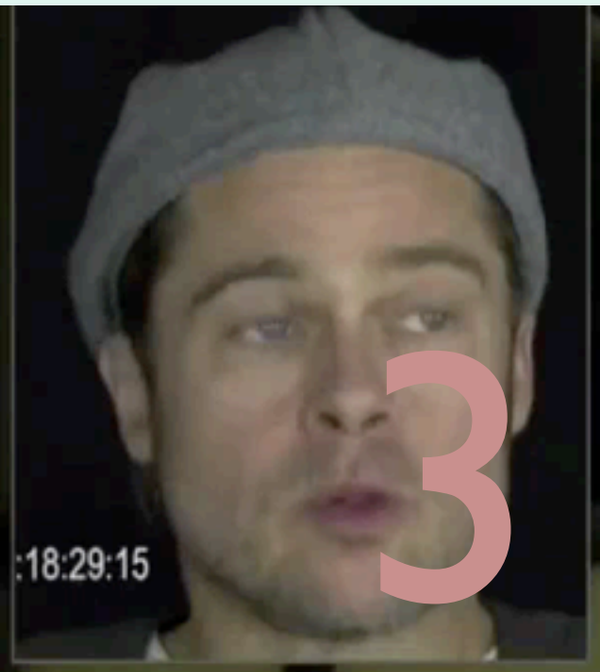


IMocap

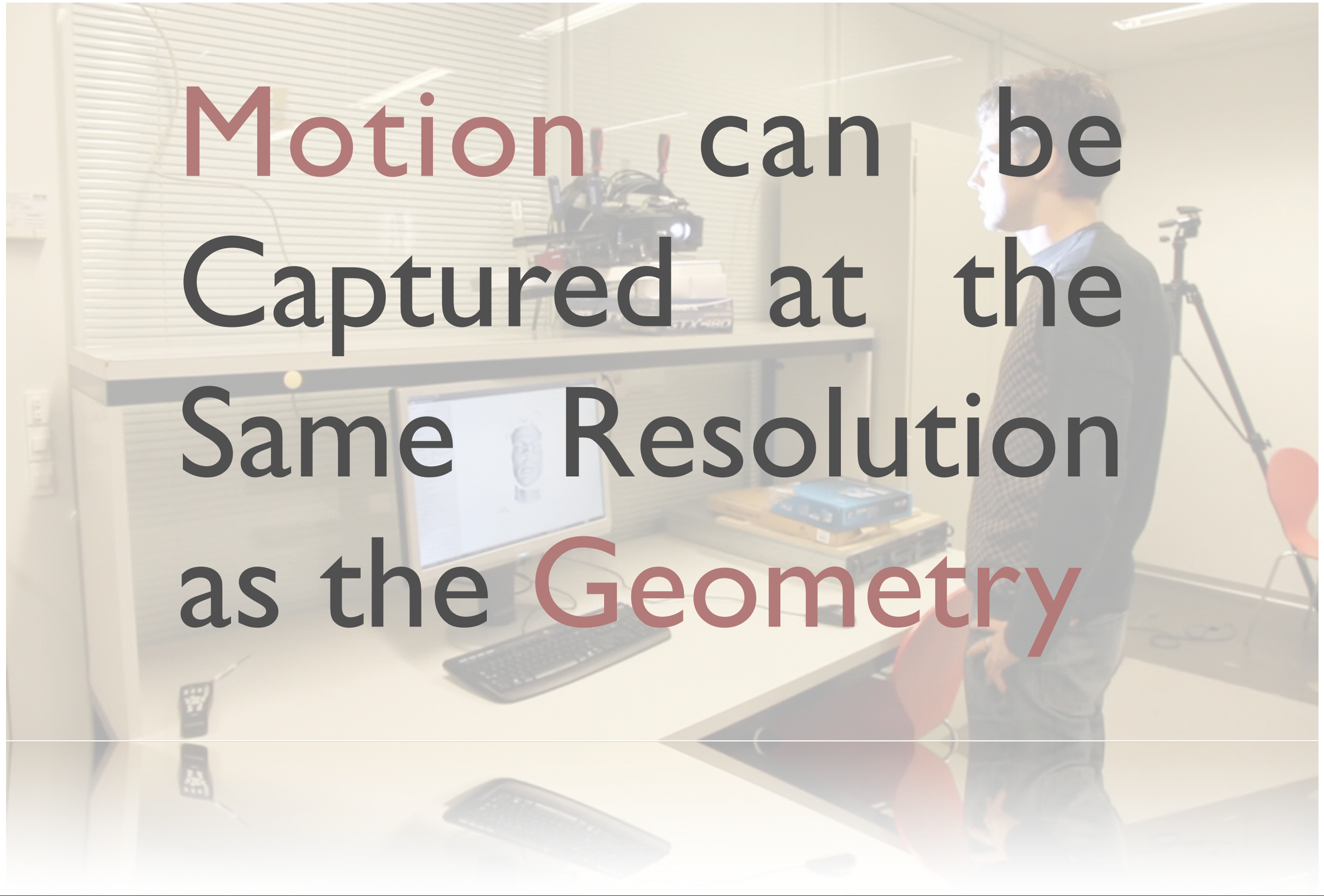
Facial Perfomance Capture



3 weeks for

10 seconds

Geometry Capture

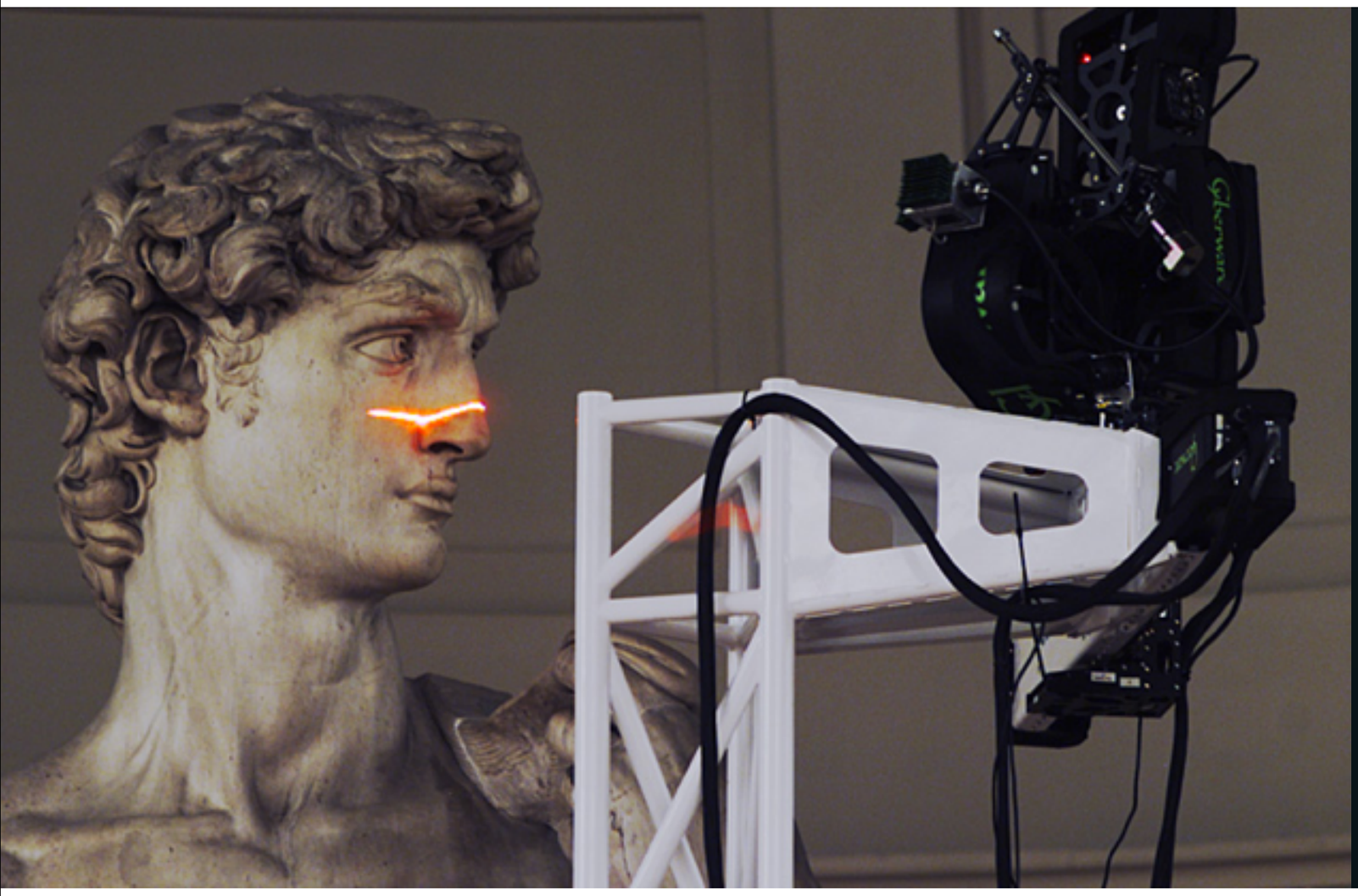


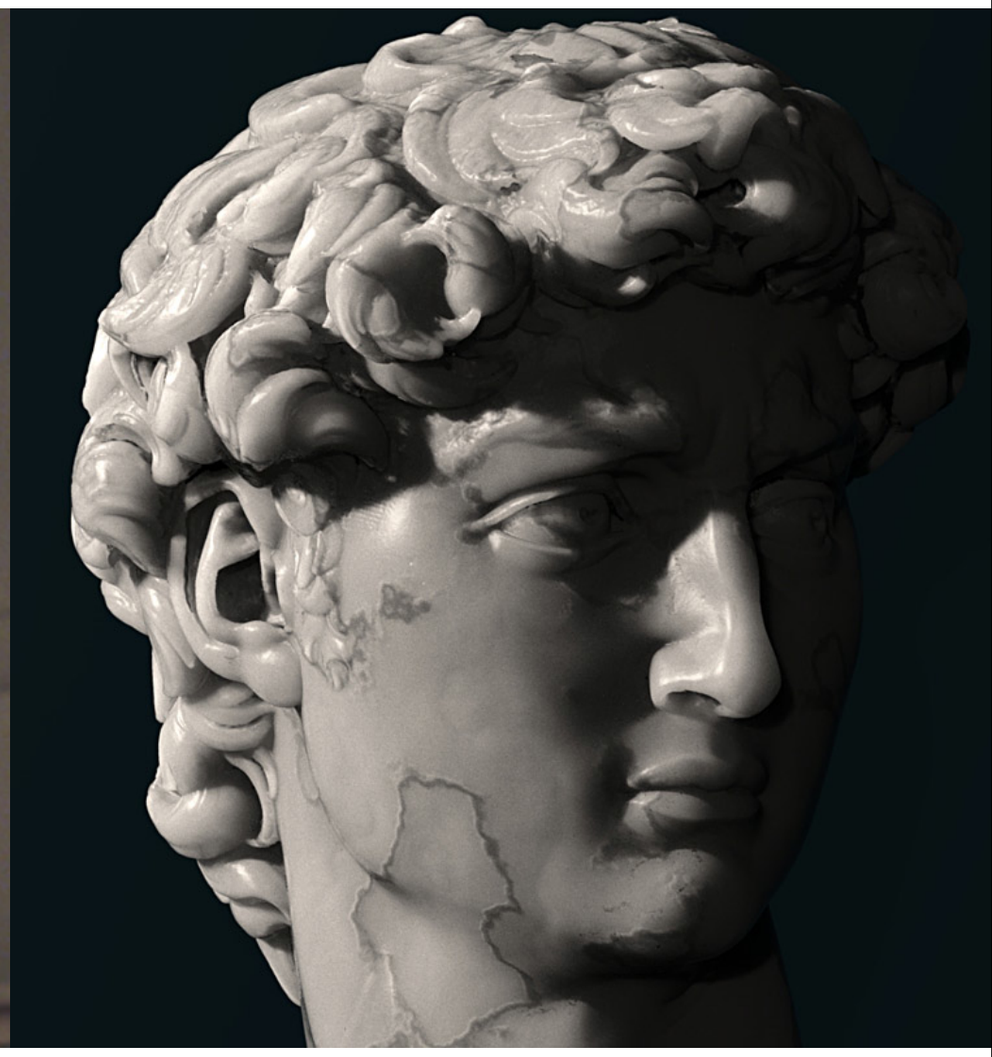
Realtime Facial Performance Capture

Capturing Geometry

Static 3D Capture

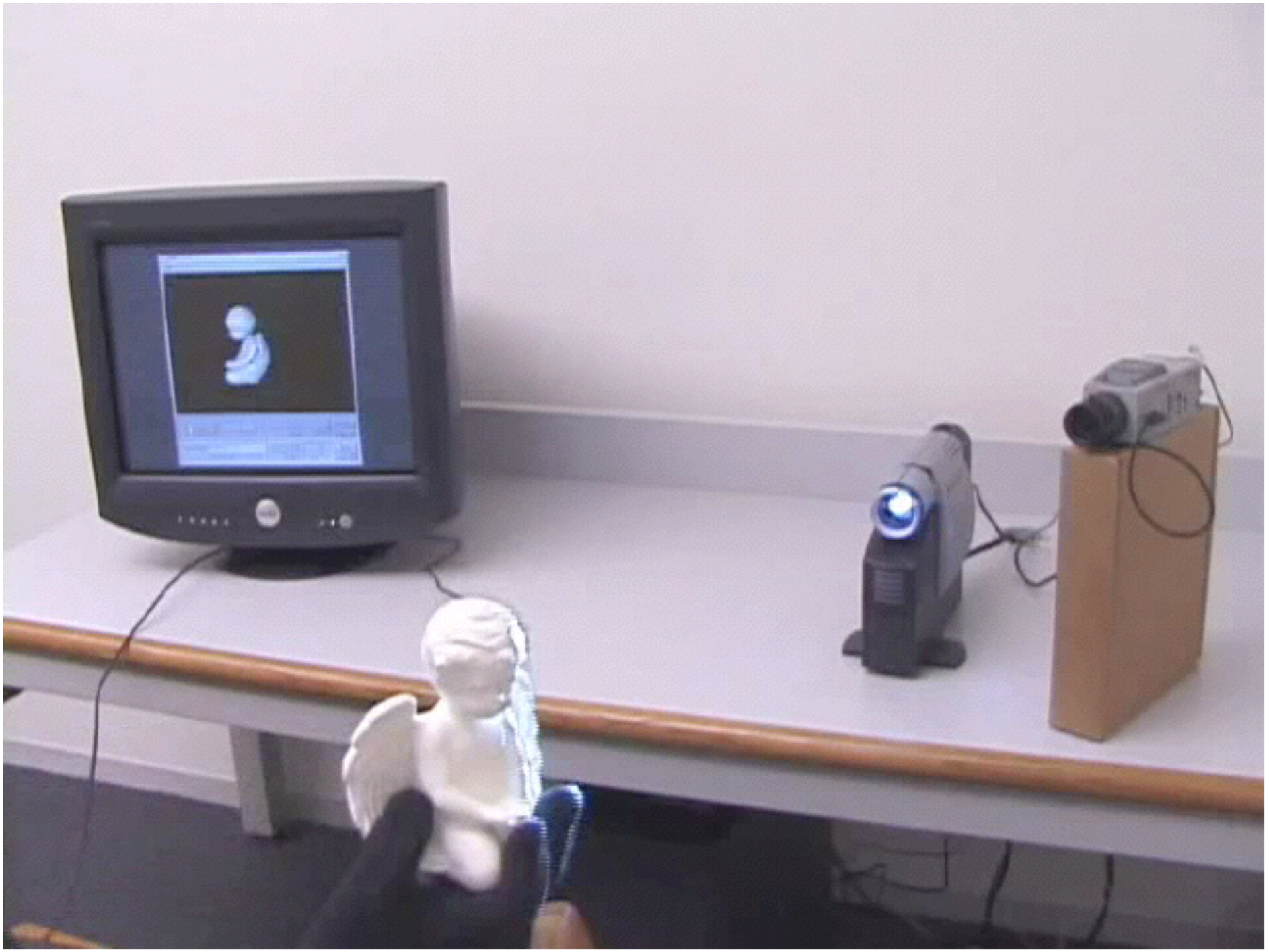
Stanford 2002





Dynamic 3D Capture

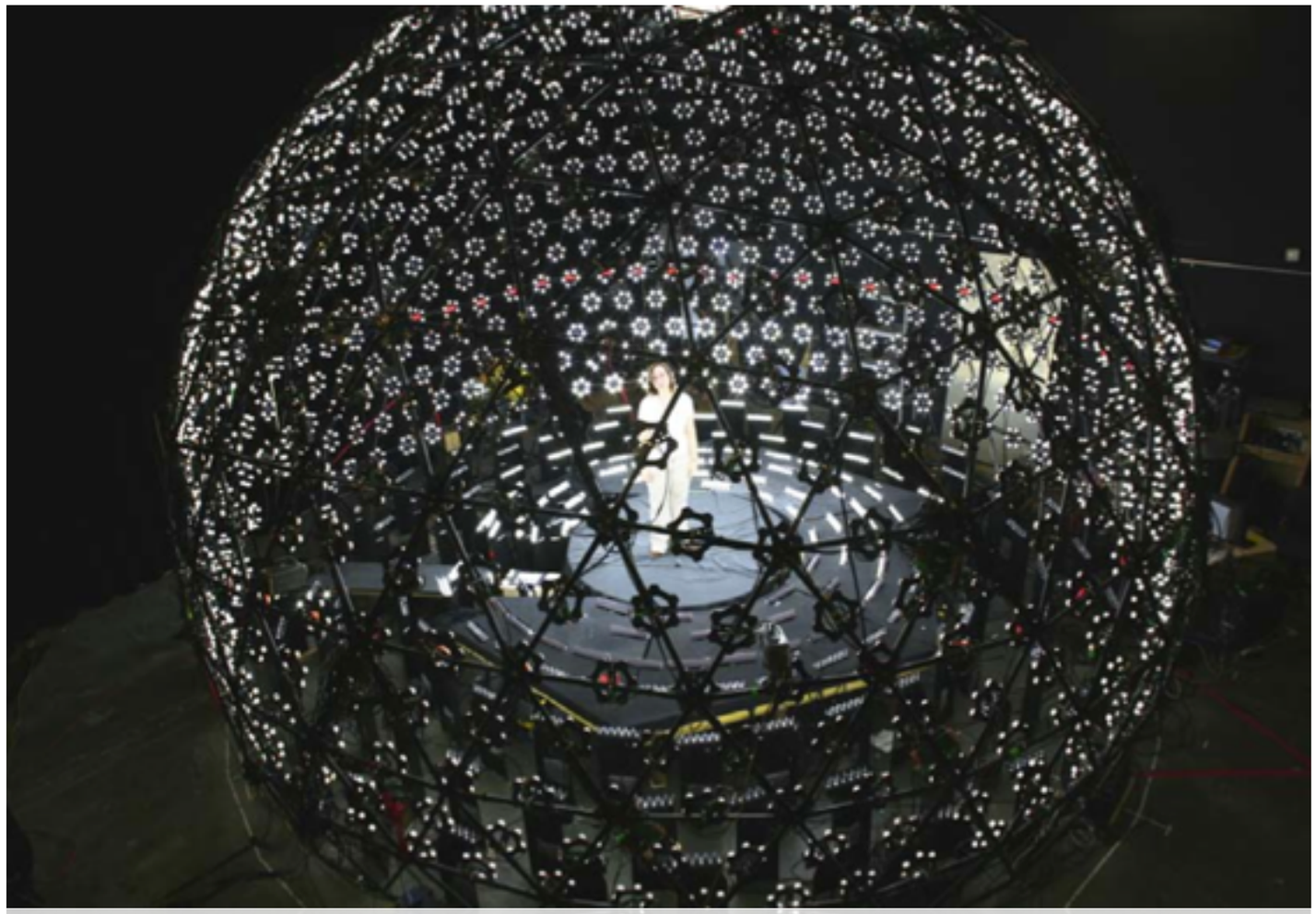
Stanford 2002



Commercial 3D Capture

Artec Group

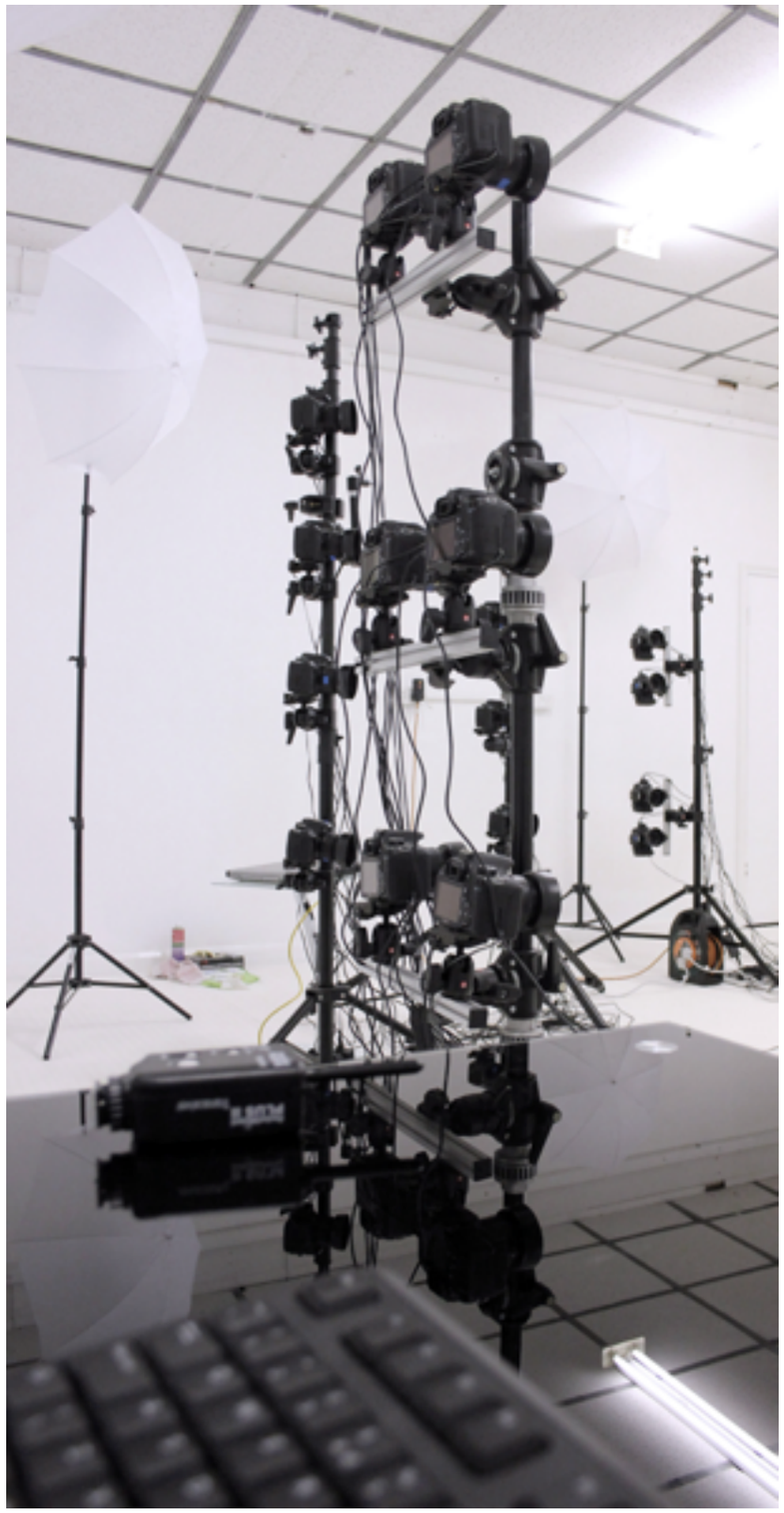
Full Body Capture



3D scanner

3D acquisition

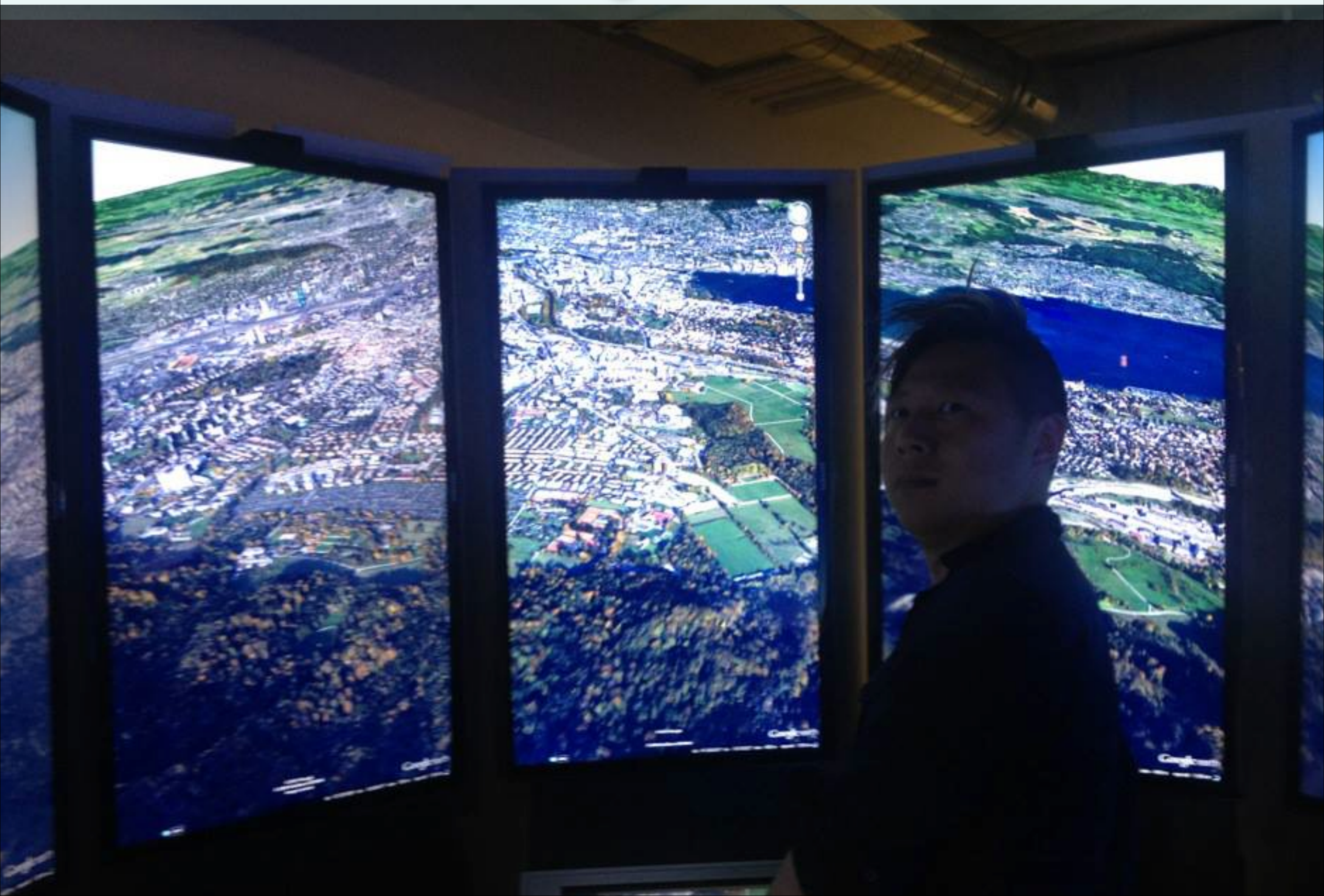
Multi-View Stereo



Lee Perry-Smith, Infinite Realities
+ Agisoft

Capturing Cities

Google Earth

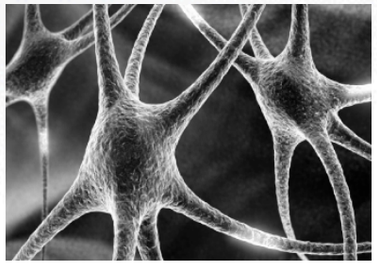


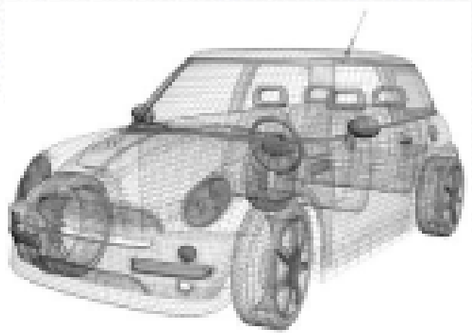
Geometry

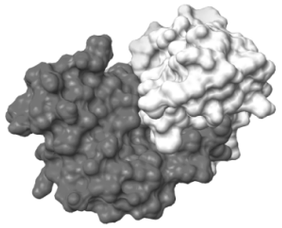
γεωμετρία

geo = earth

metria = measure

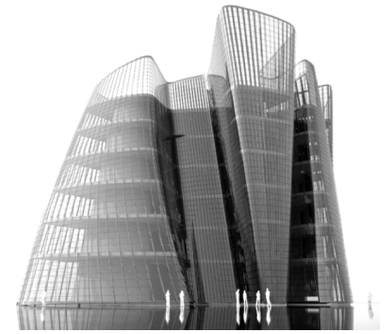


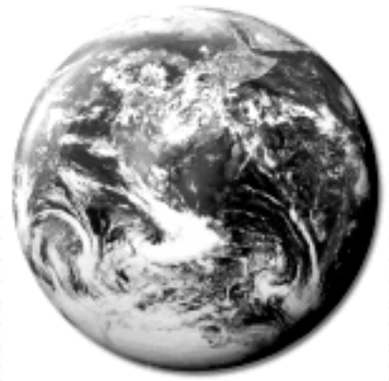




Geometry

γεωμετρία

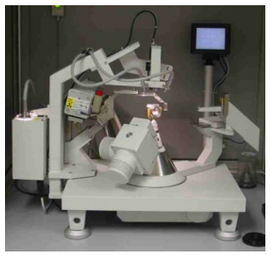




microscope

ultrasound

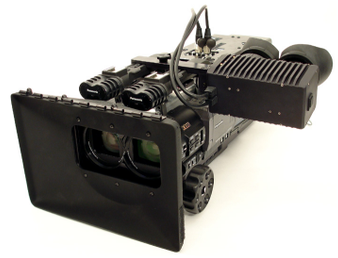
MRI scanner



x-ray diffractometer

Geometry

γεωμετρία



stereo camera

radio telescope

laser scanner

time-of-flight scanner

Overview

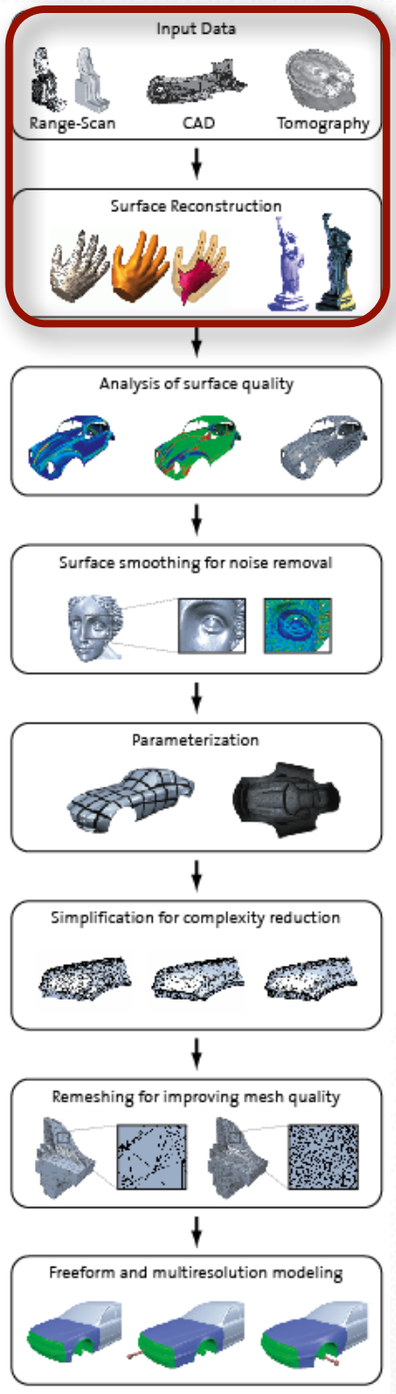
Geometric Modeling

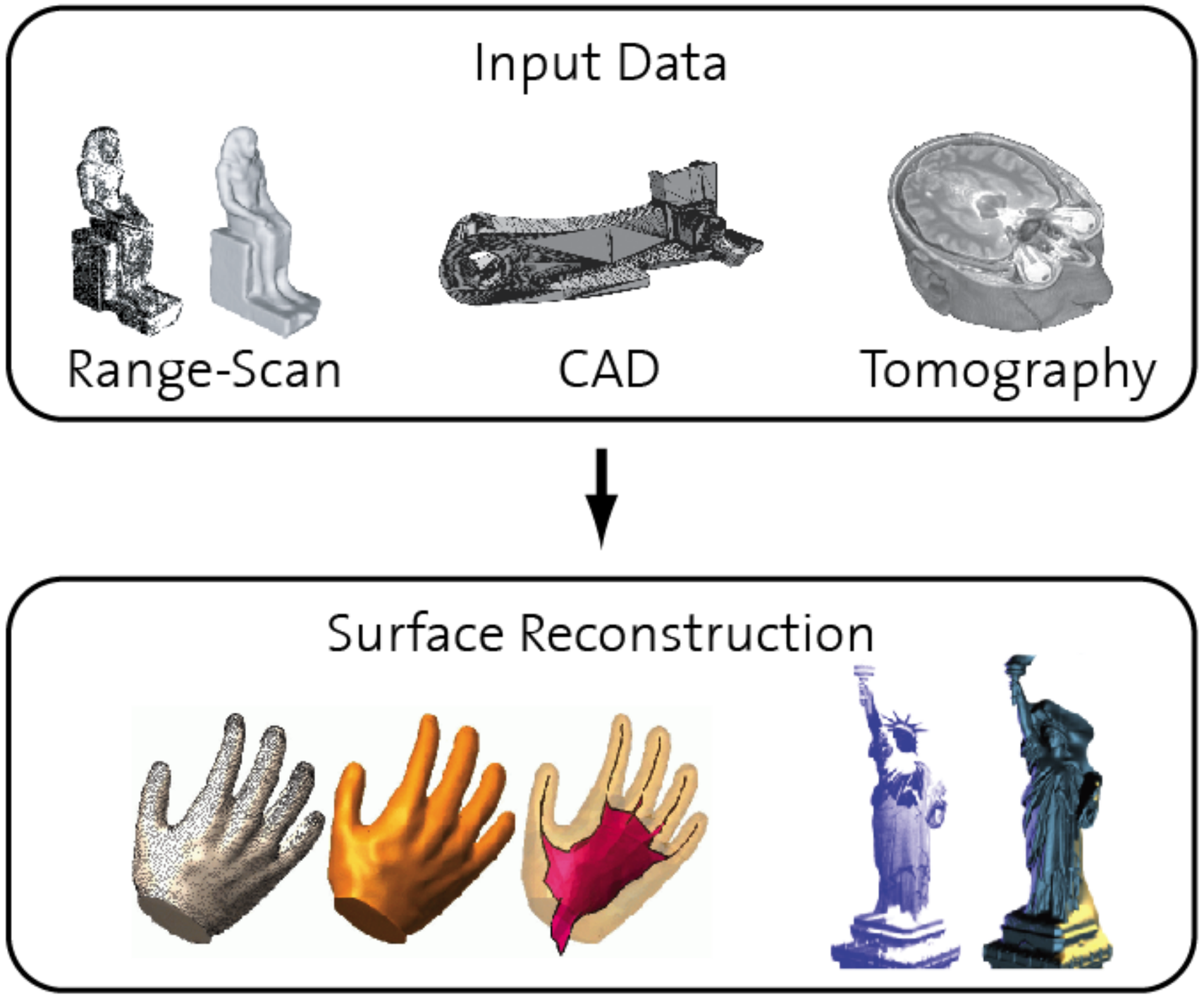
- Techniques and algorithms for representing and processing geometric objects

We will focus on *triangle meshes*

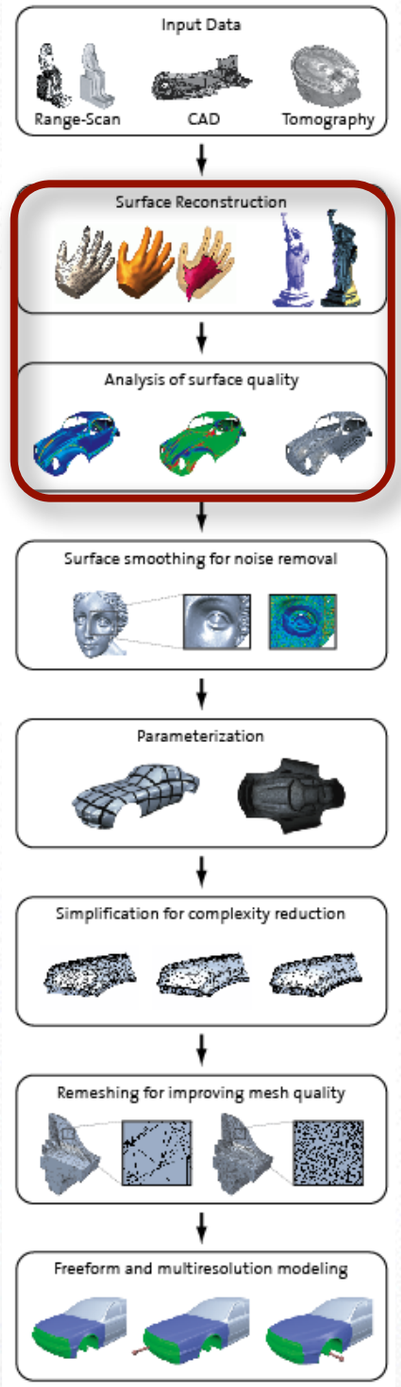
- main questions:
  - **why** are triangles suitable representations for geometry processing?
  - **what** are the central processing algorithms?
  - **how** can they implemented efficiently?

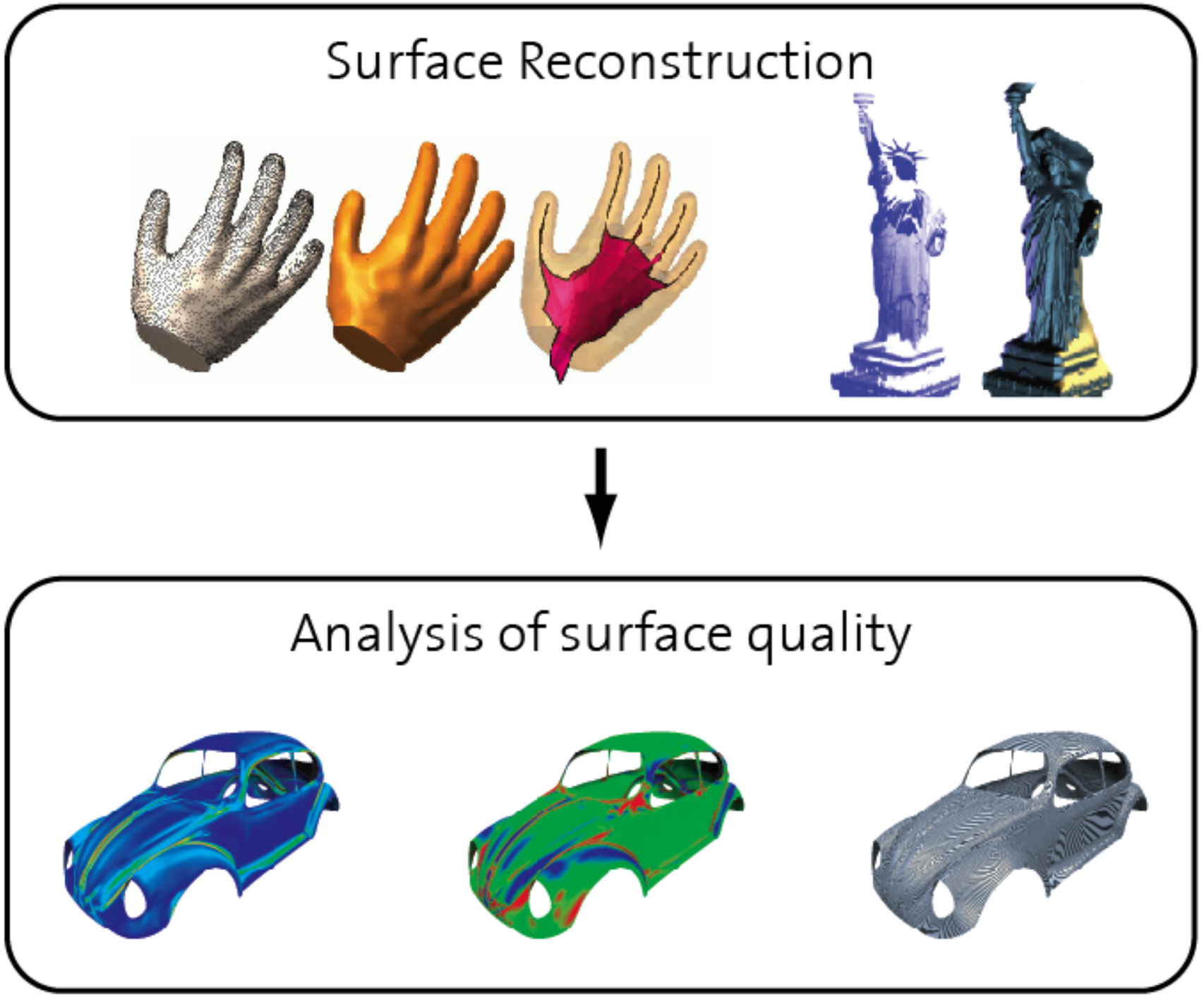
Geometry Processing Pipeline



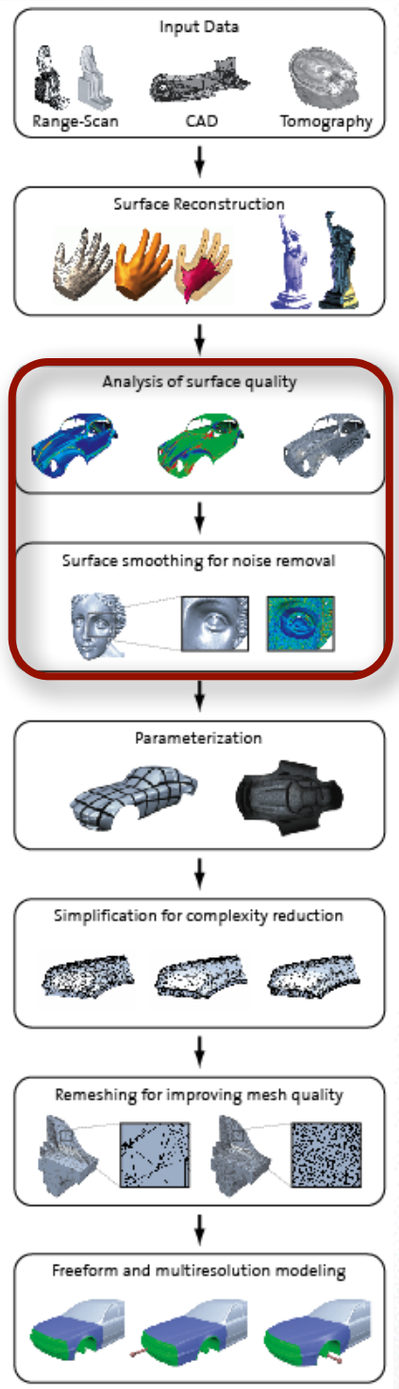


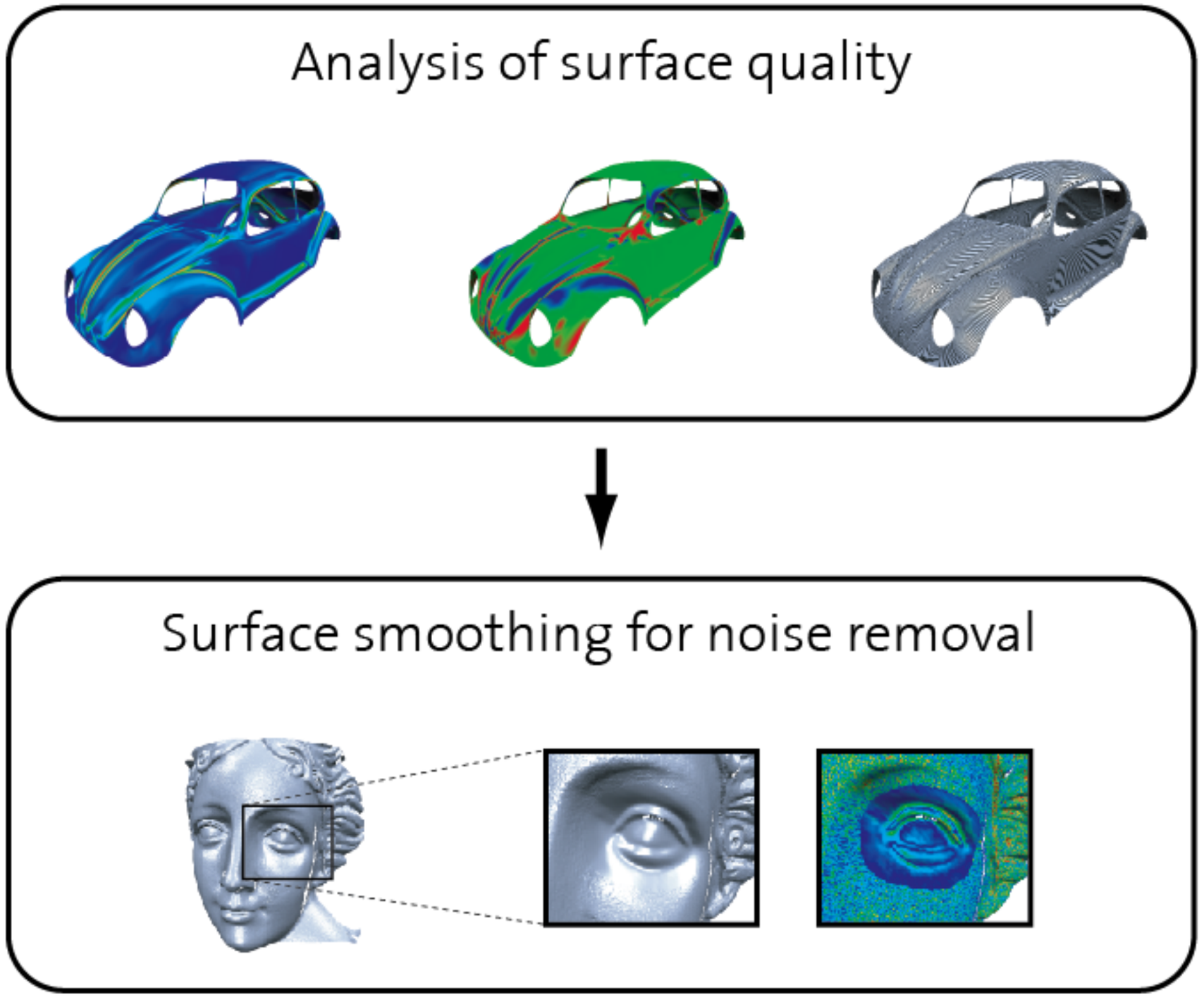
Geometry Processing Pipeline





Geometry Processing Pipeline





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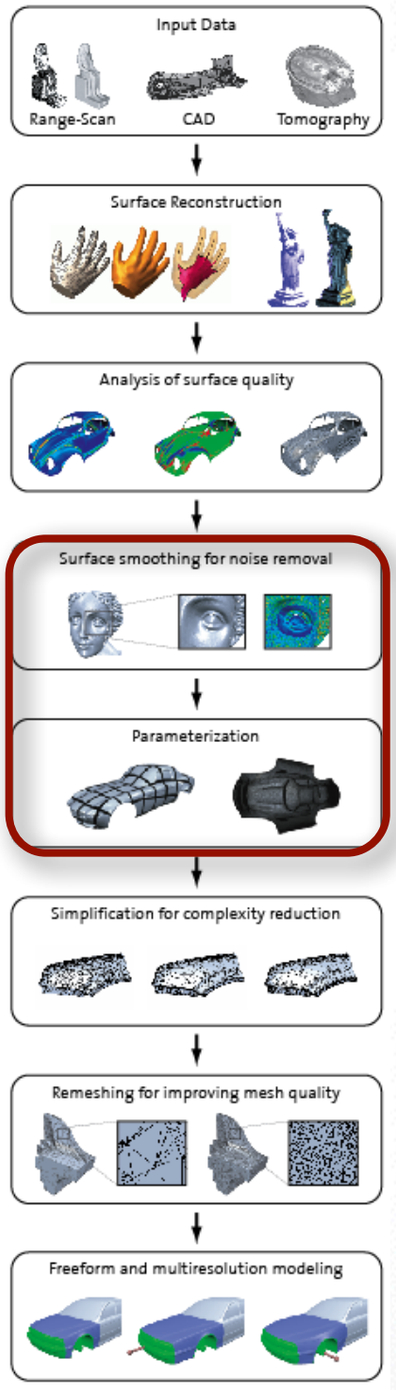
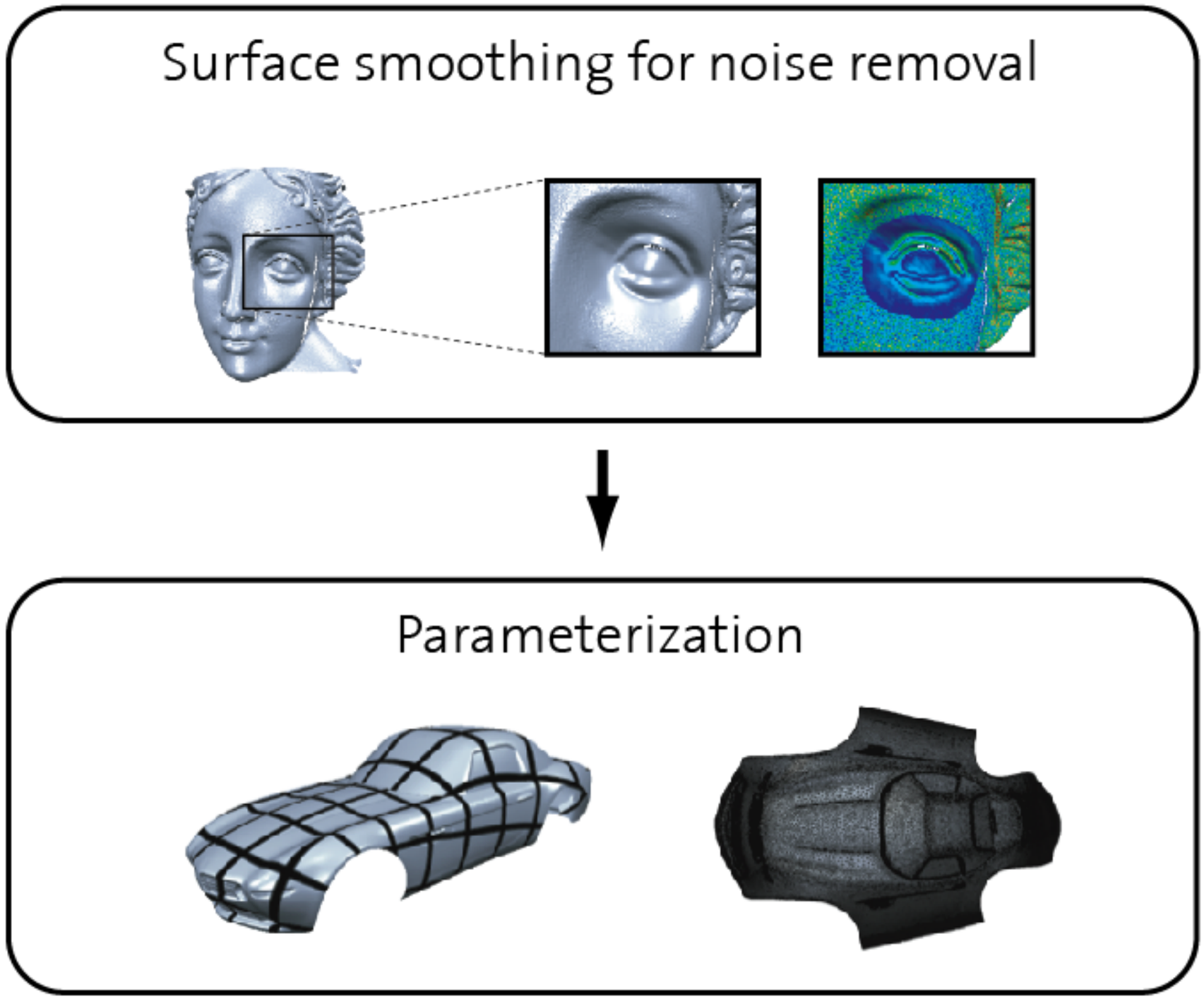
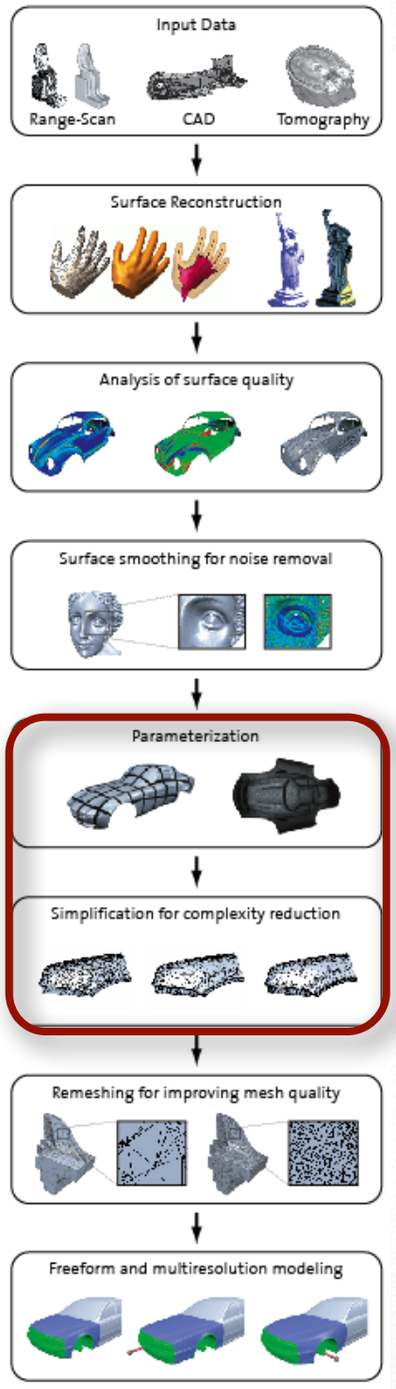
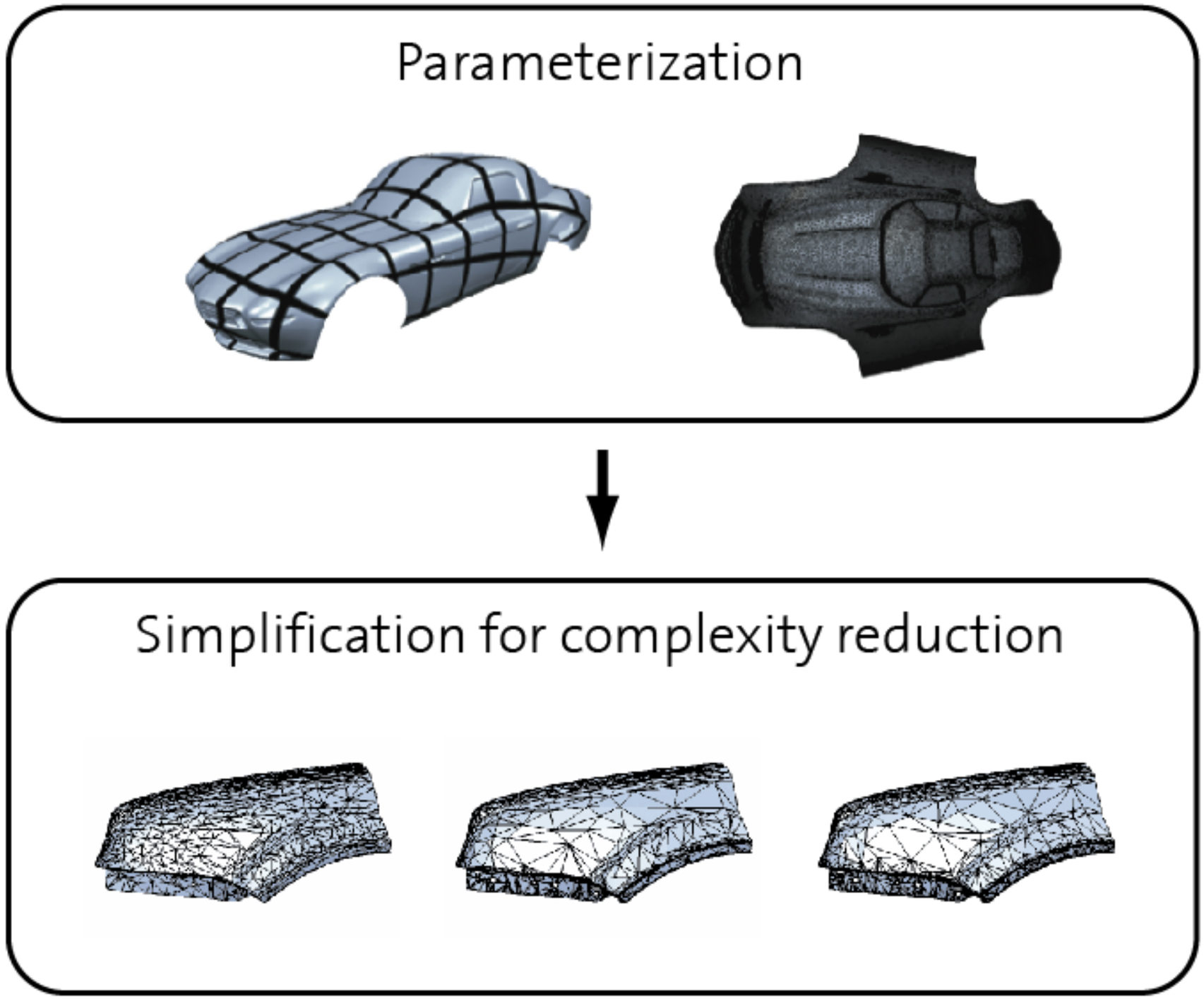


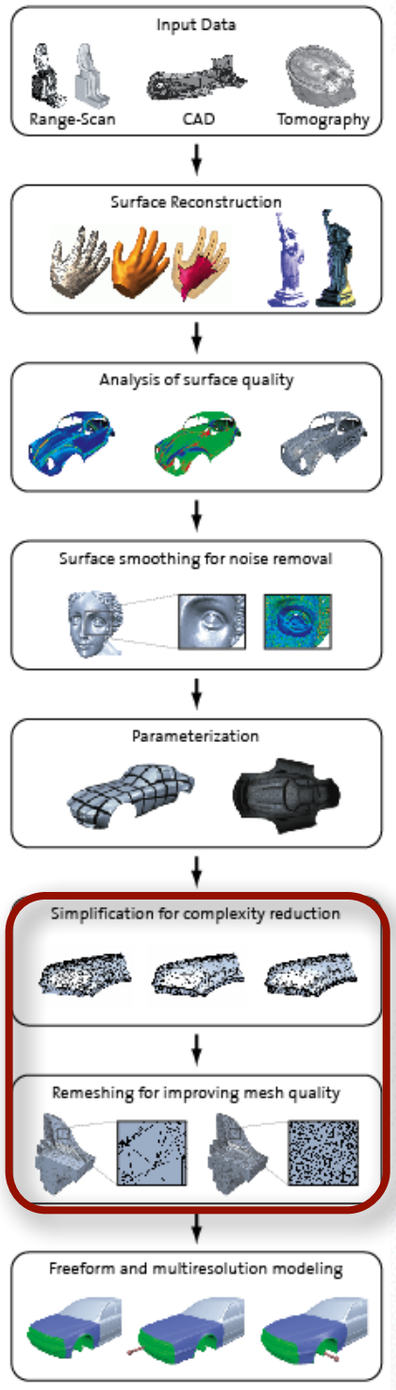


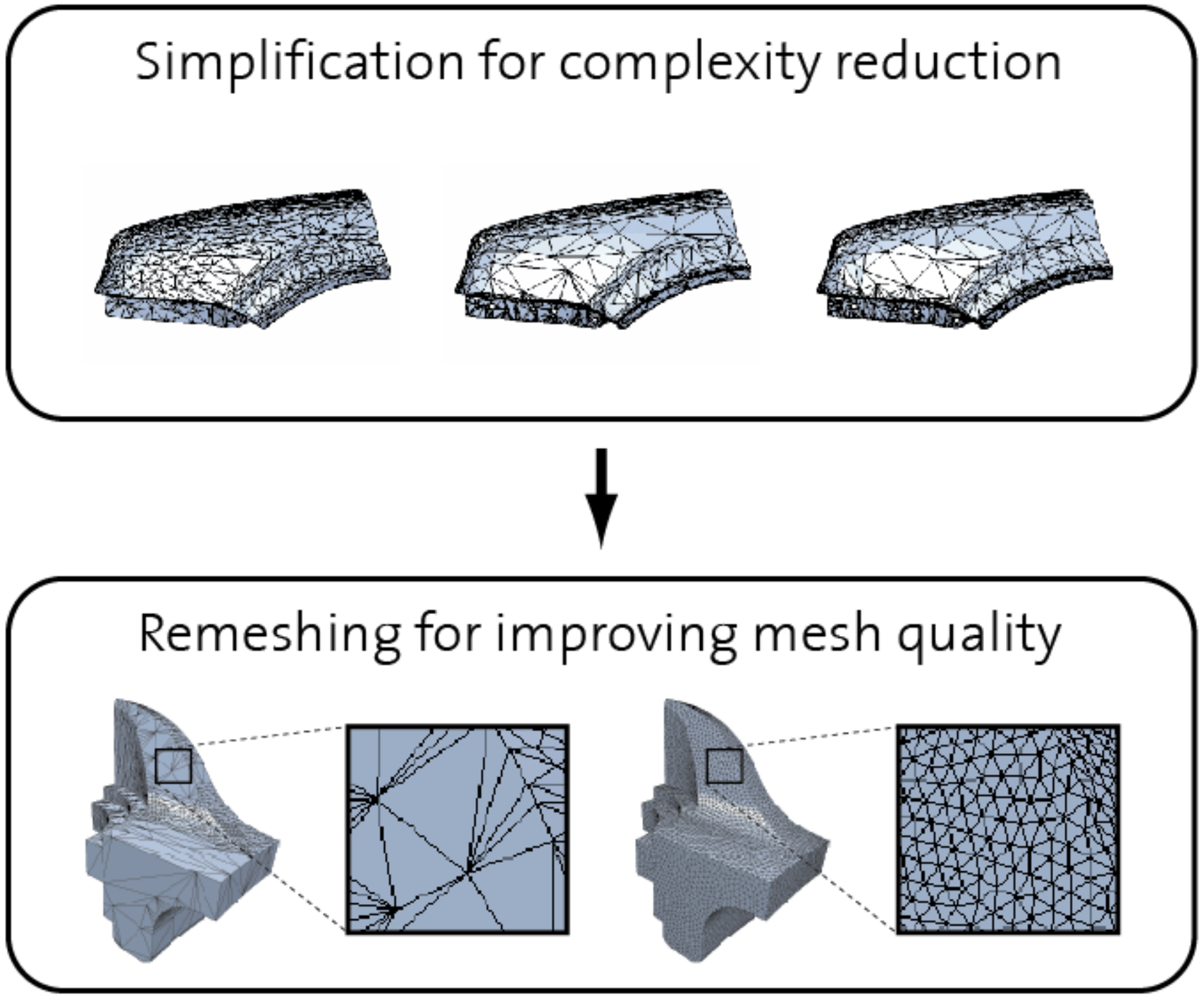
Geometry Processing Pipeline





Geometry Processing Pipeline





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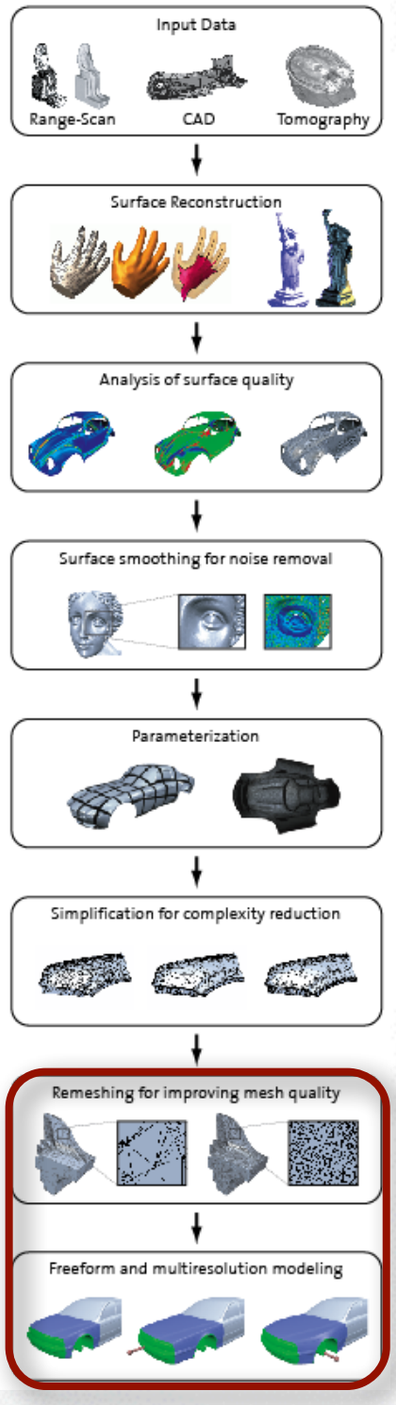
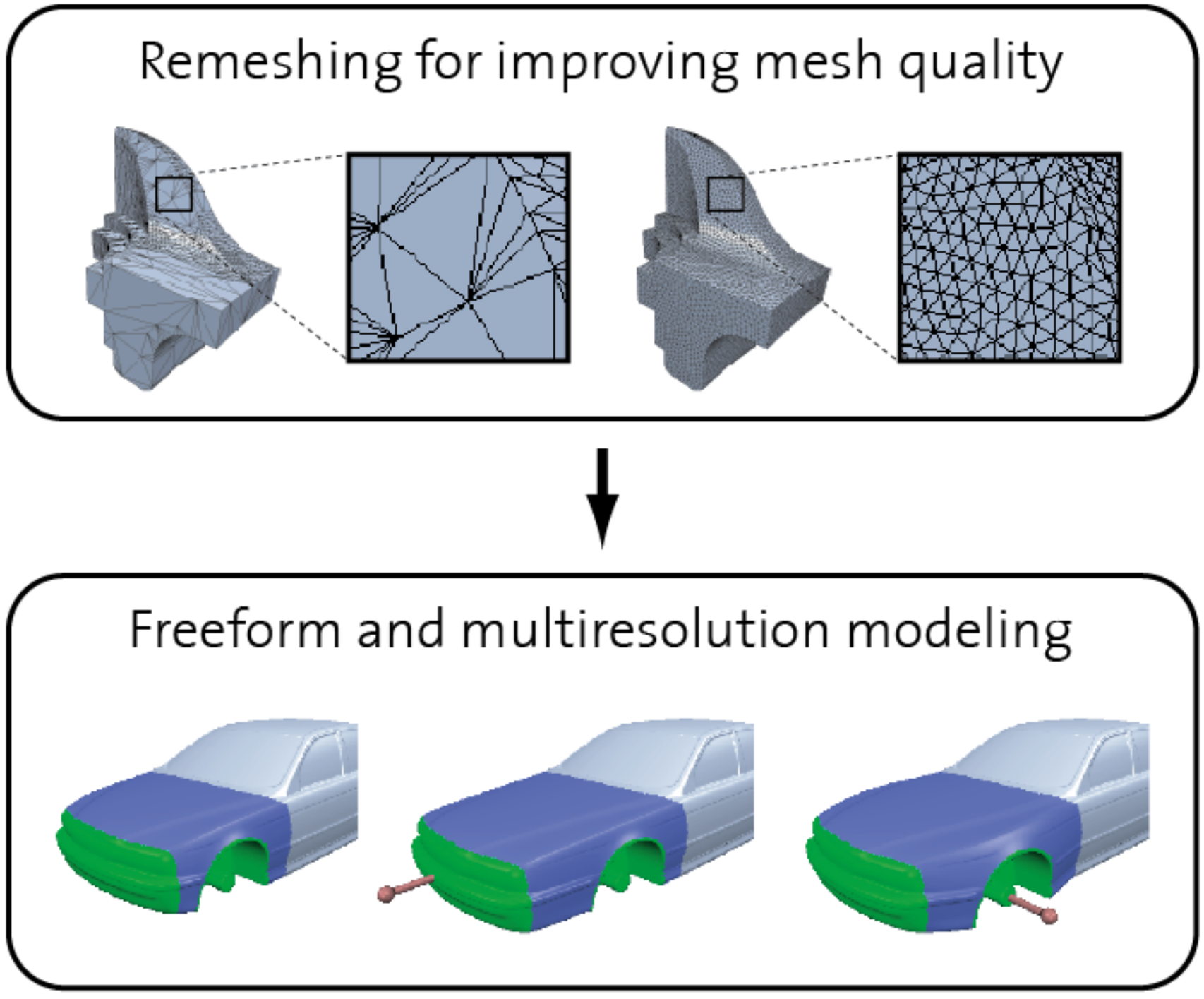
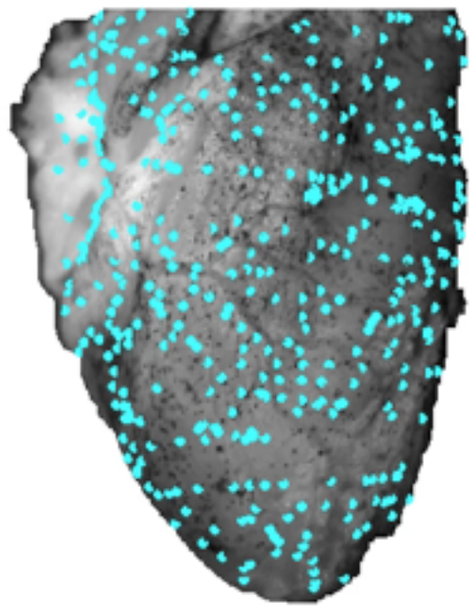
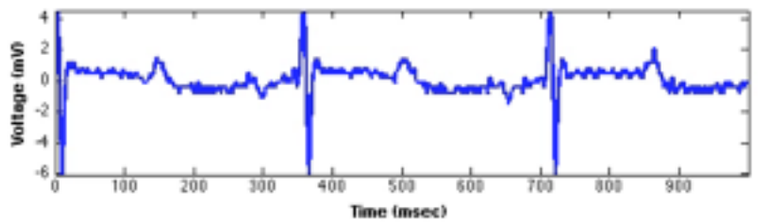




Impacting Science

Cardiology




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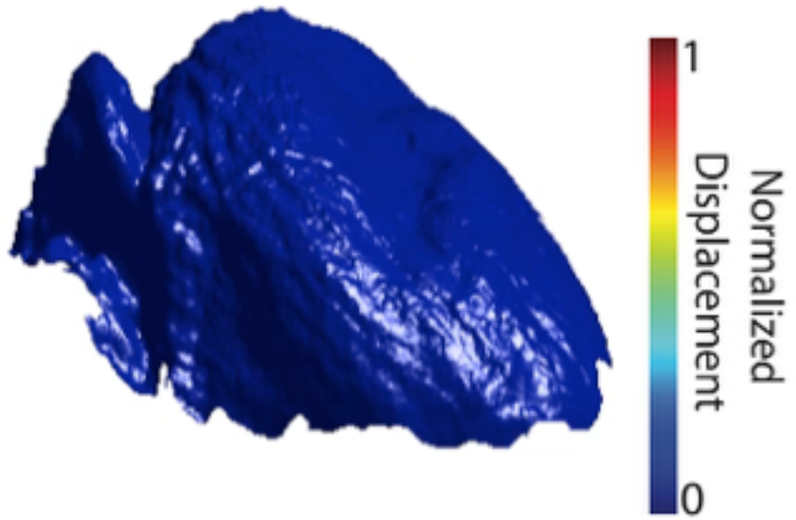
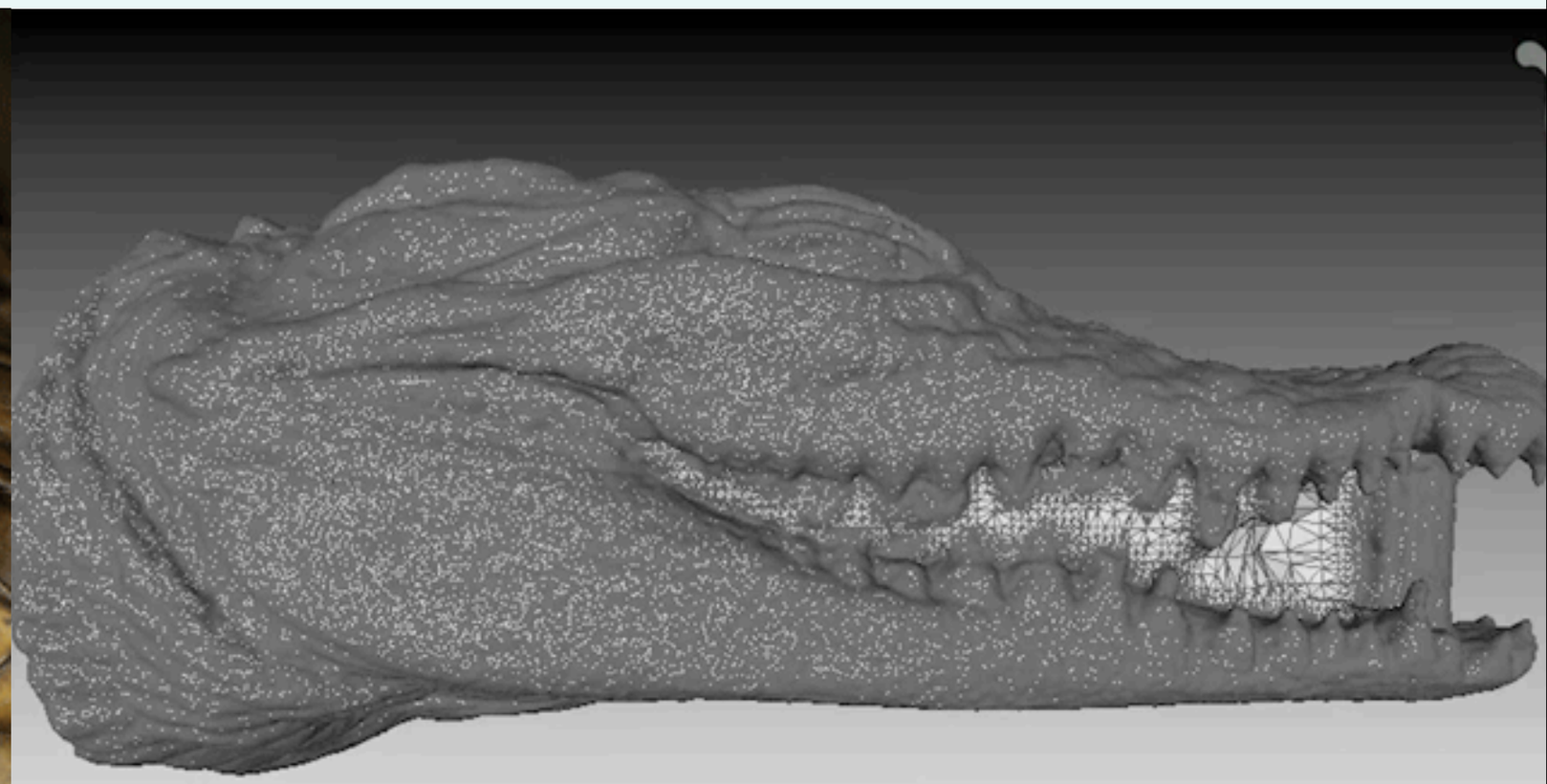
2
0
-2
-4
-6
0
100
200
300
400
500
600
700
800
900
Time (msec)


1
Normalized
Displacement
0

Evolutionary Biology



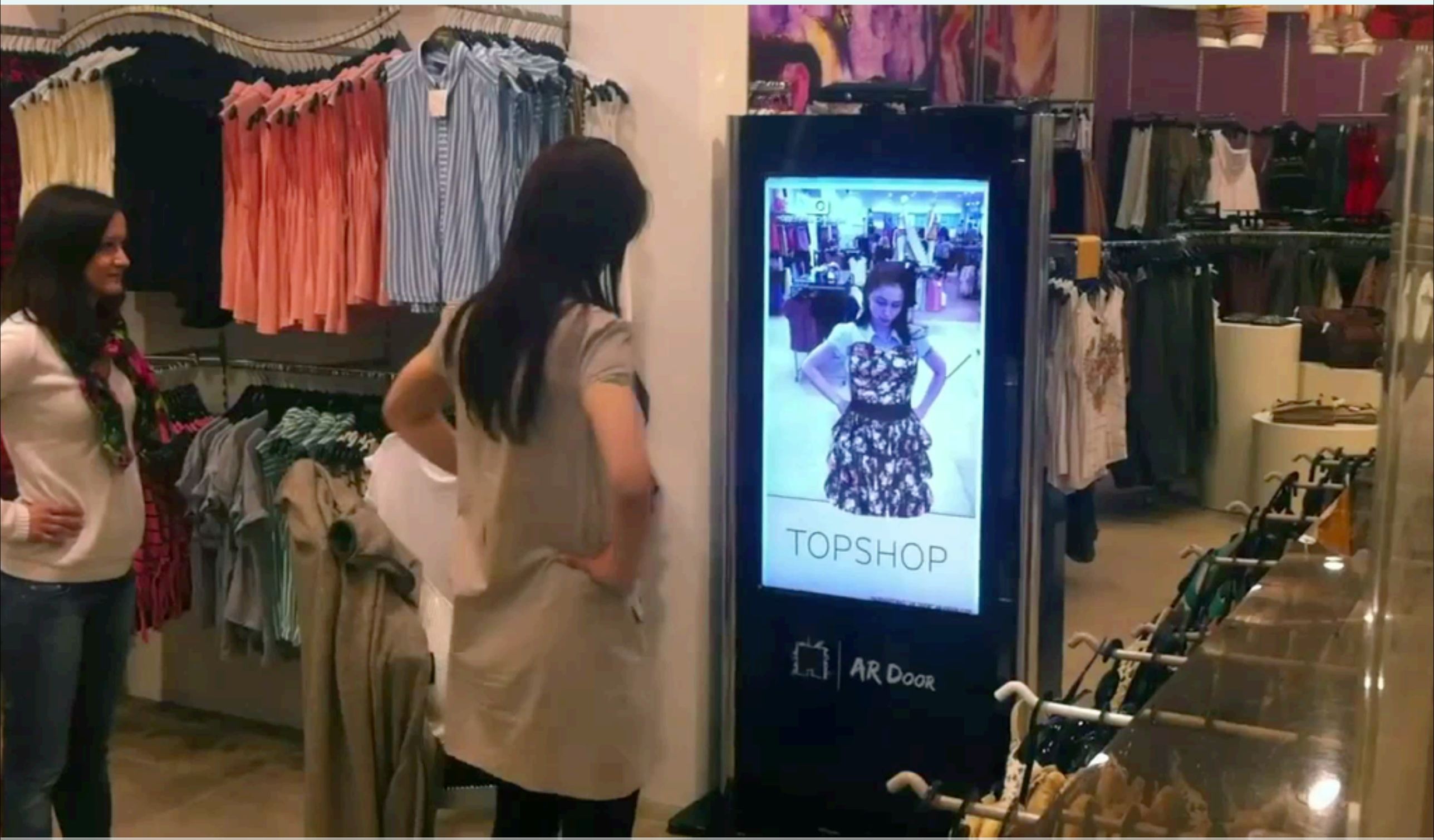
Cancer Treatment

Digitized **Future**

For Everyone

For Everyone

For Everyone

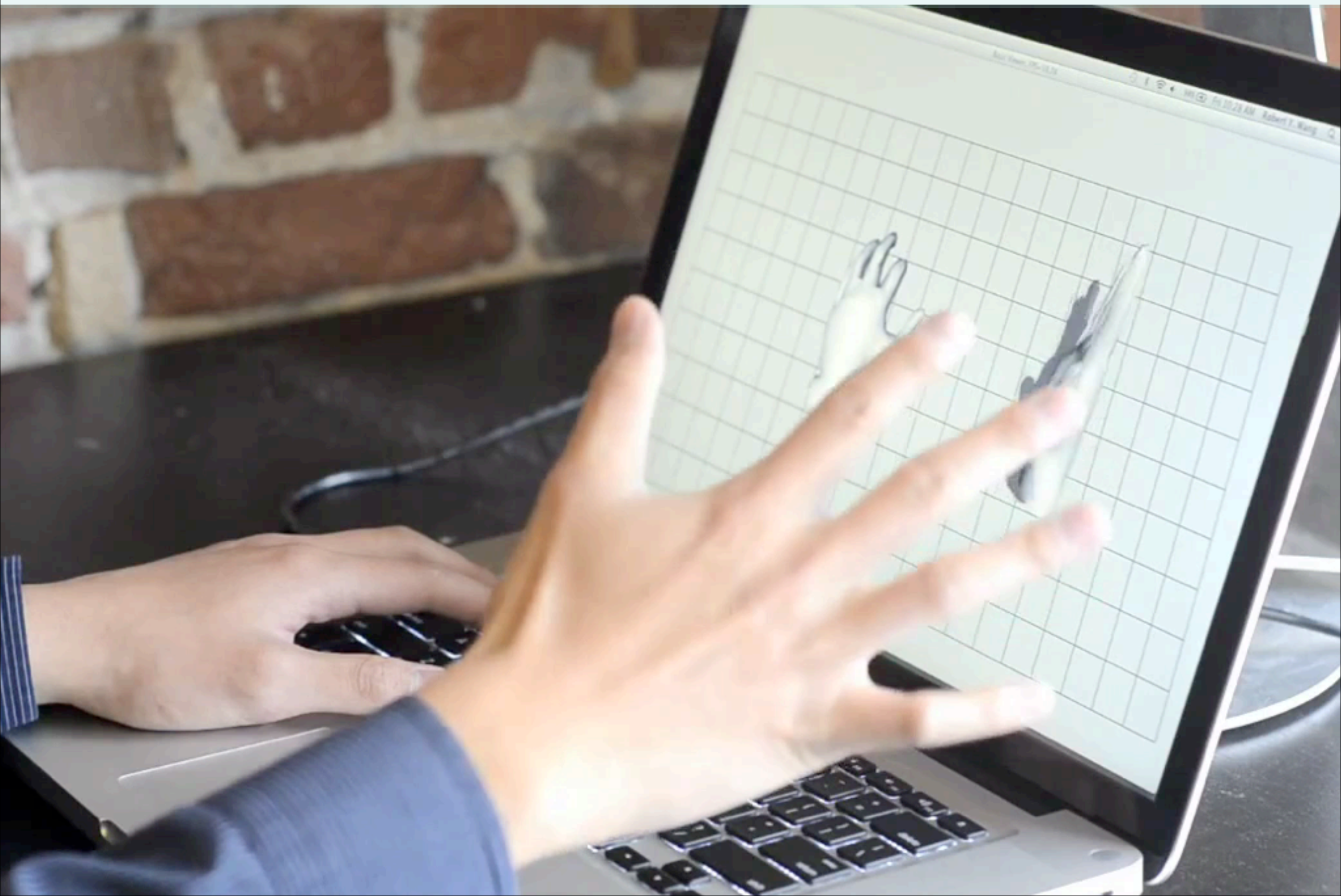


Scanning@Home

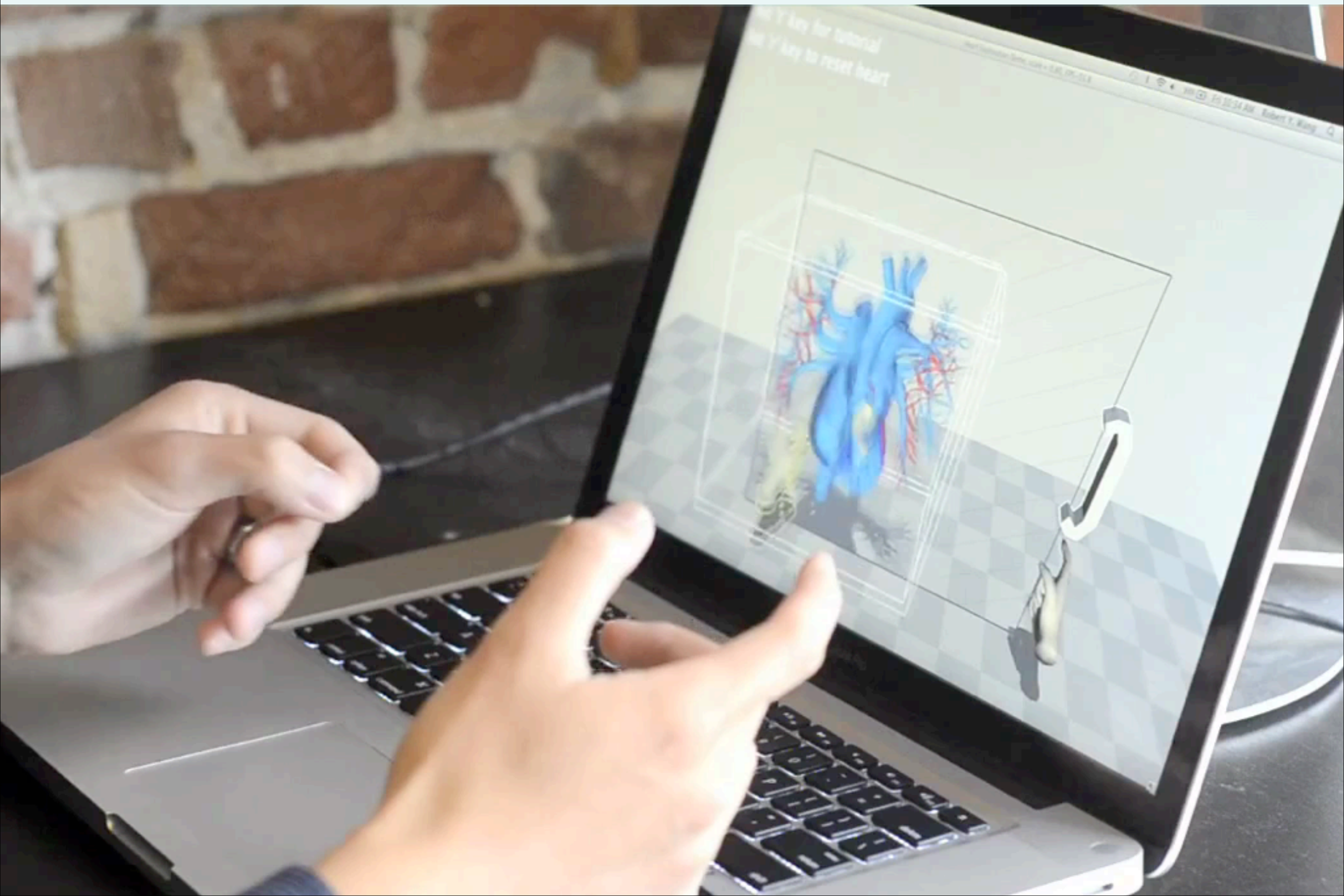
Living Room Entertainment

In Tablet

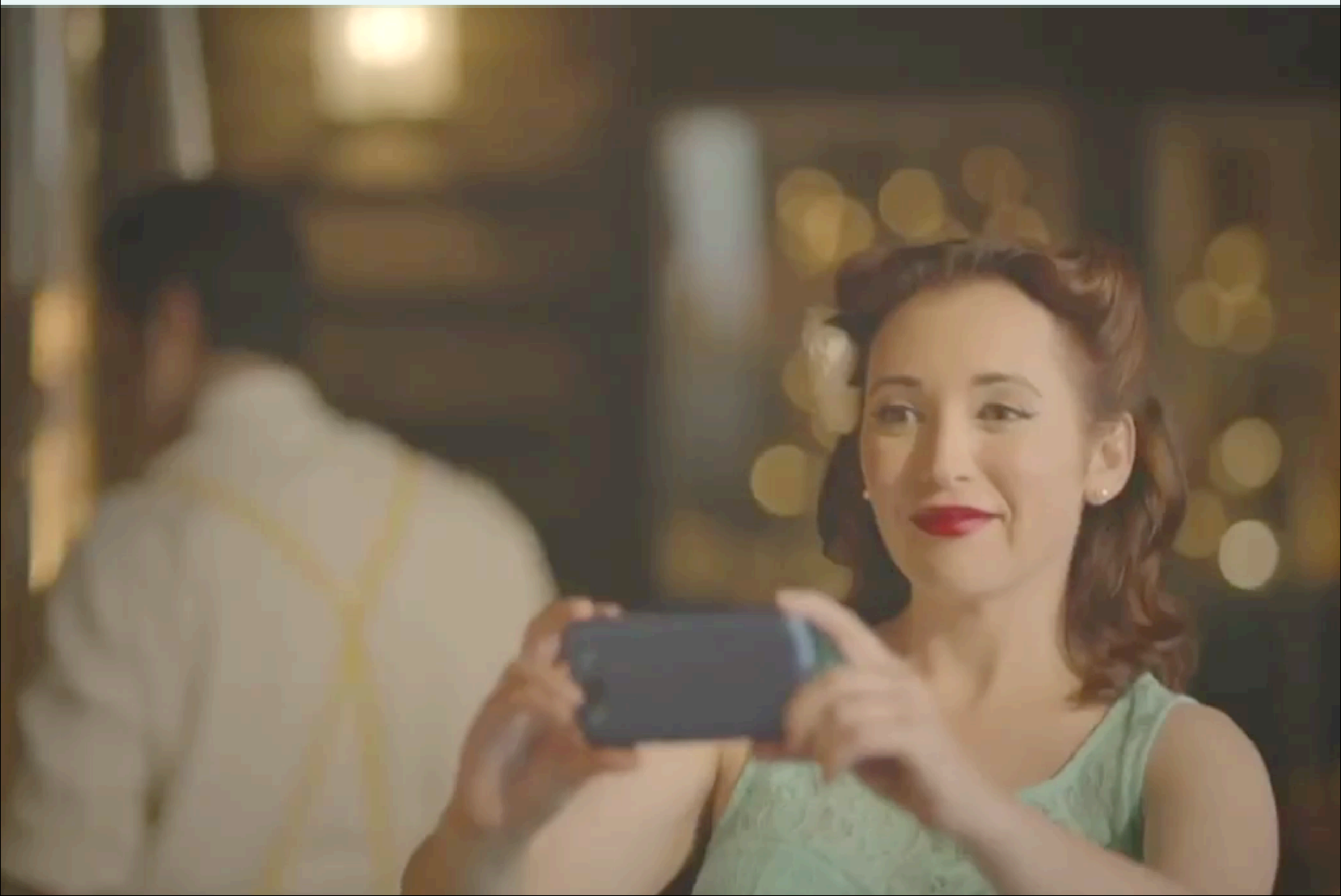
In Laptops



In Laptops



In Smartphones

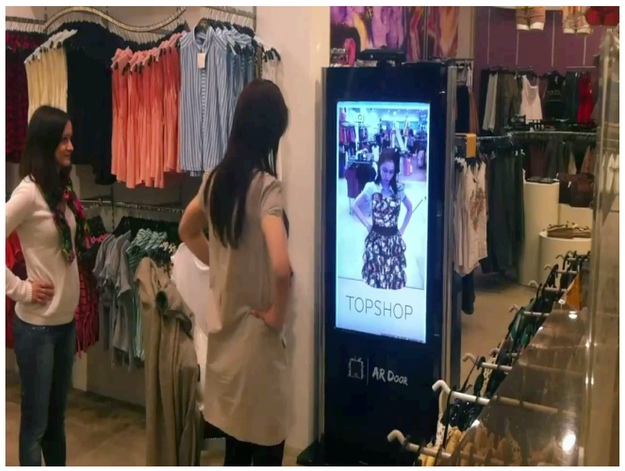


Realtime **Future**

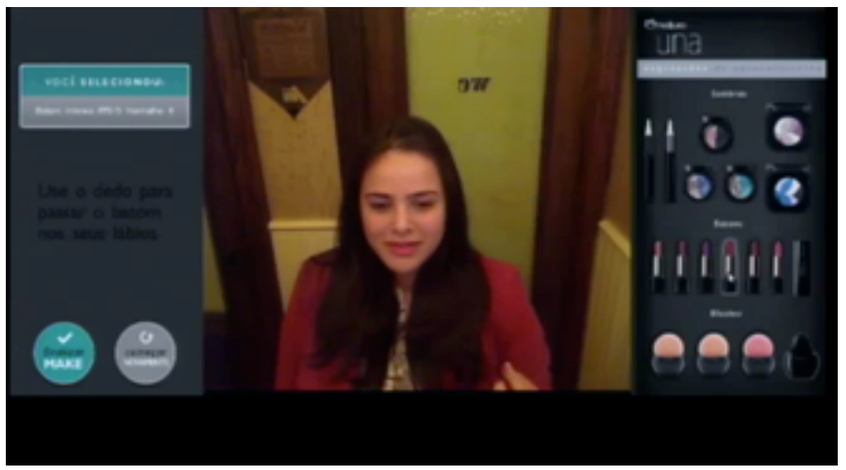
Why Realtime?

VFX/Game Production

Virtual Avatars



Robotics



AR/Virtual Mirror

Realtime Game Engines

Realtime Facial Animation

Post-to Preproduction

Lucasfilm will combine video games and movies to axe post-production process

Customise movies while watching

By **Lee Bell**

Fri Sep 20 2013, 14:59

OVER THE NEXT DECADE video game engines will be used in film-making, with the two disciplines combining to eliminate the movie post-production process.

That rather ambitious claim comes from Lucasfilm, the California production company responsible for the *Star Wars* franchise. Speaking at the Technology Strategy Board event at BAFTA in London this week, the company's chief technology strategy officer Kim Libreri announced that the developments in computer graphics have meant Lucasfilm has been able to transfer its techniques to film-making, shifting video game assets into movie production.

Personalized **Future**

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

Omote3D Shashin Kan

3D Self-Portraits

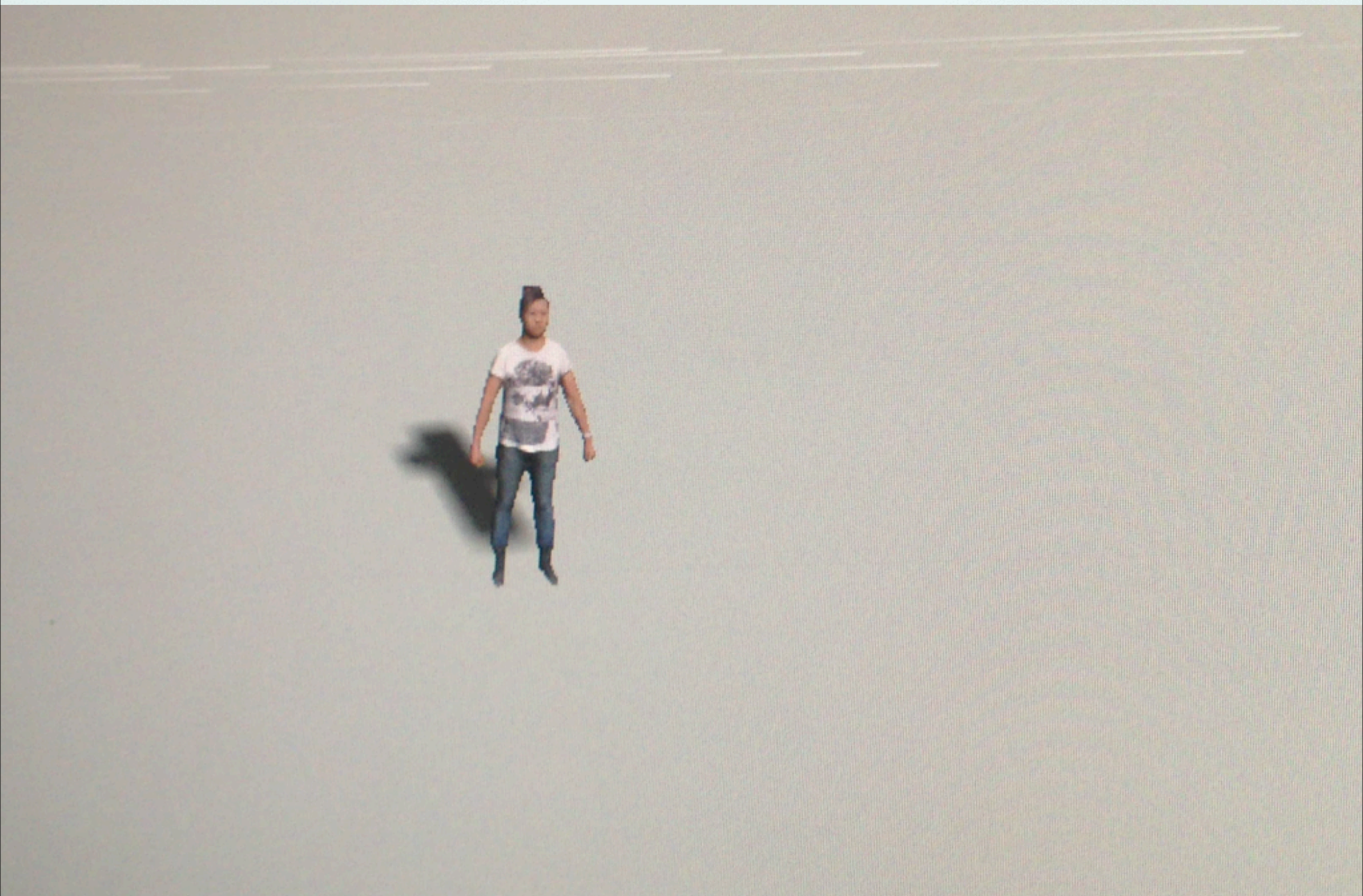
Omote3D Shashin Kan

3D Selfies

3D Selfies

Personalized Games

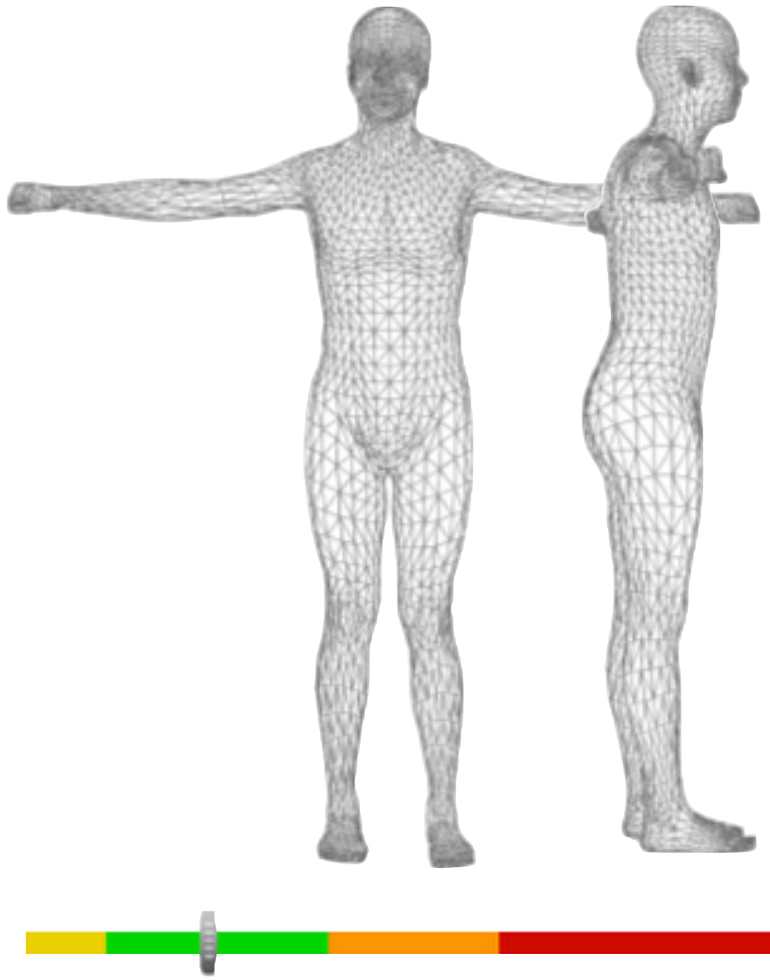
USC/ICT



Personalized **Applications**

MPI IS, Embodee

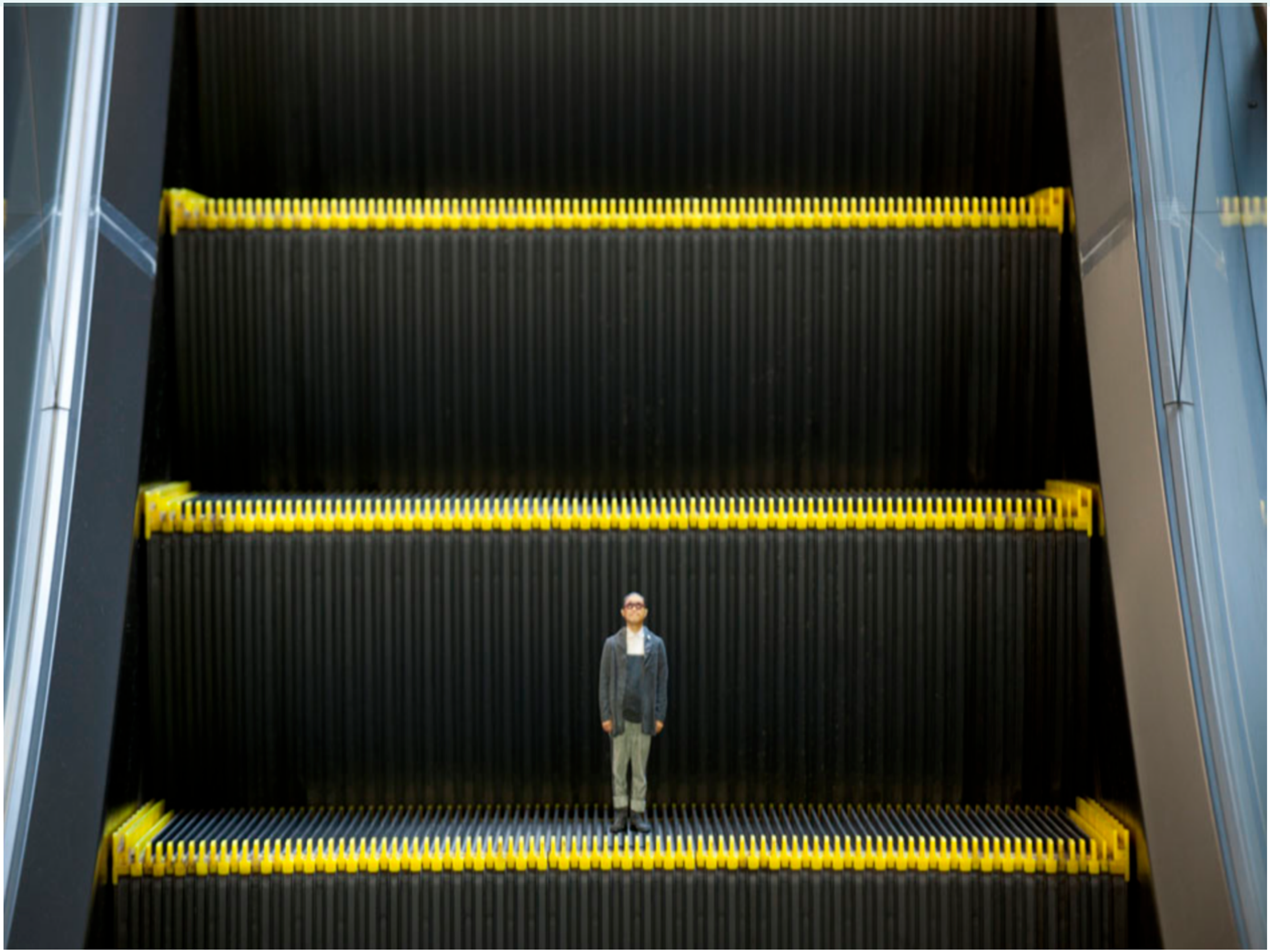
entertainment



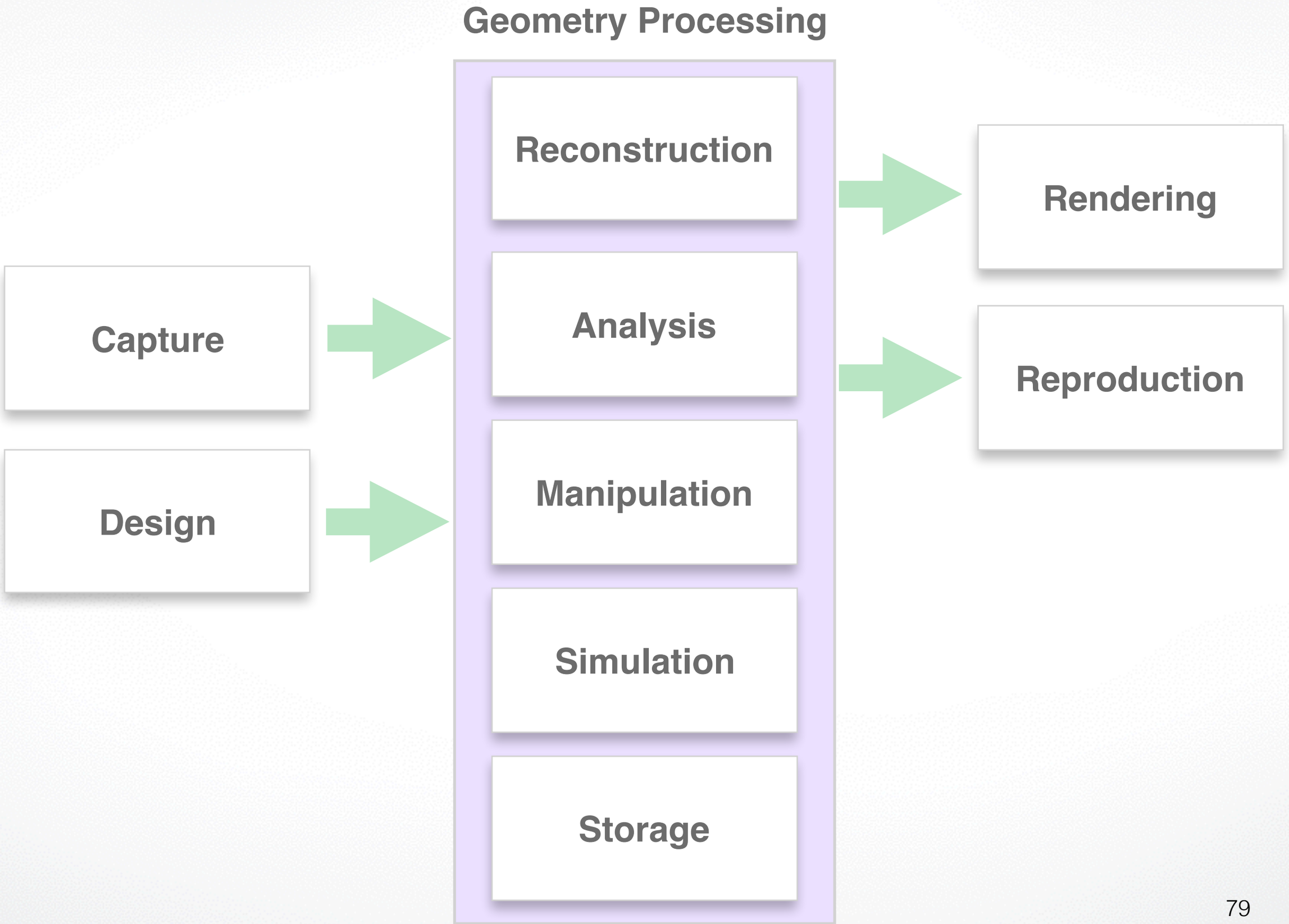
fitness

digital garment

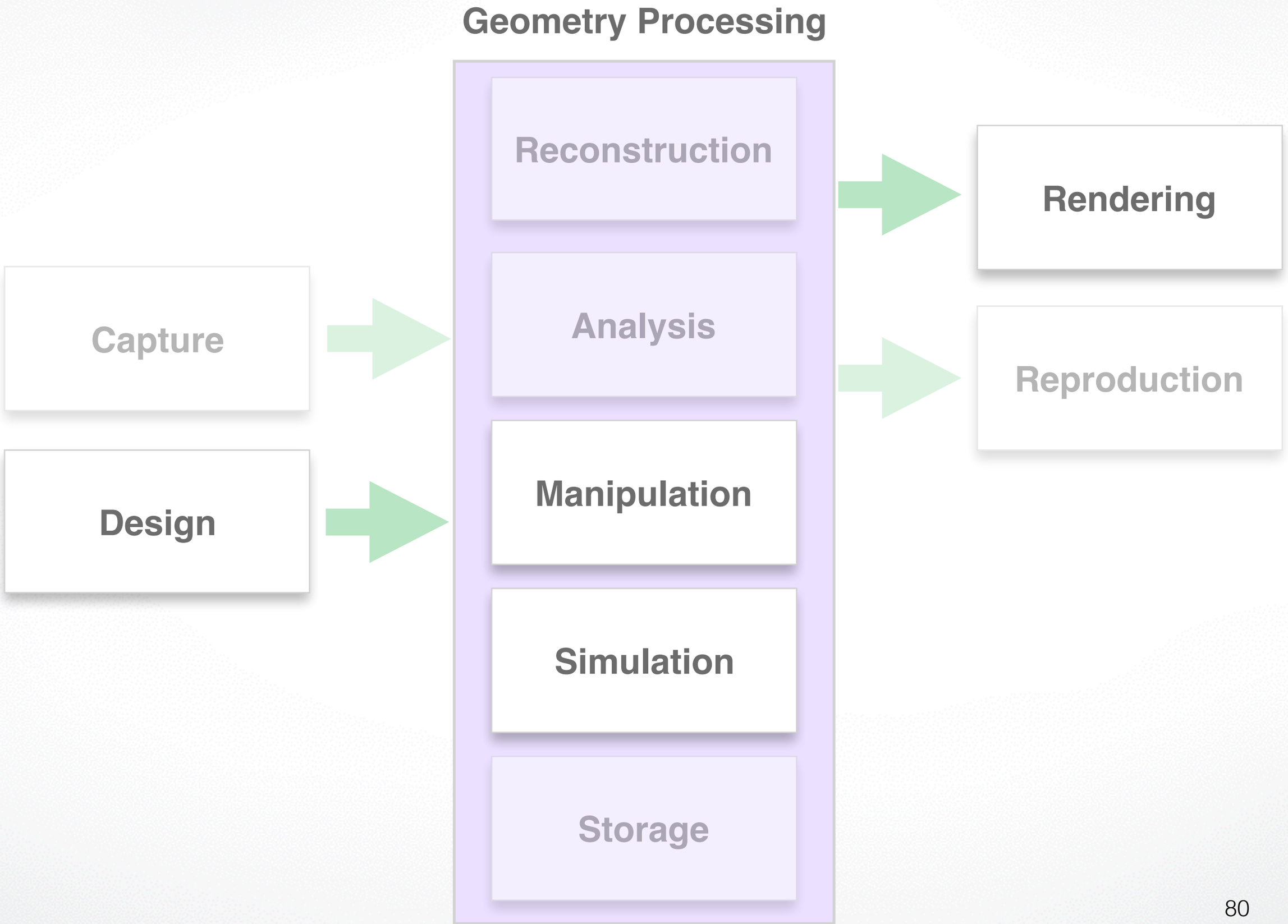
Fashion Industry



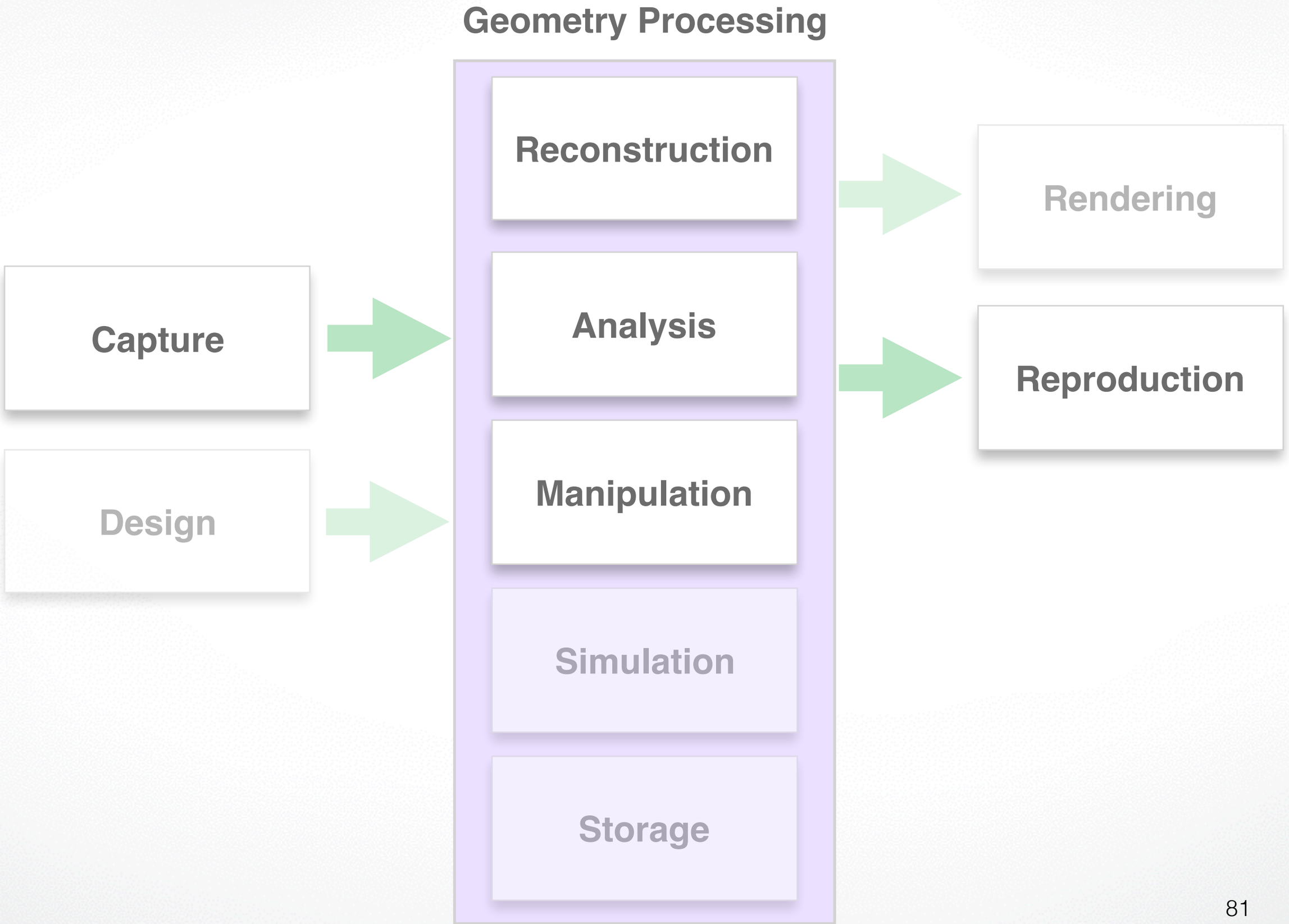
Summary


Geometry Processing
Capture
Design
Reconstruction
Analysis
Manipulation
Simulation
Storage
Rendering
Reproduction

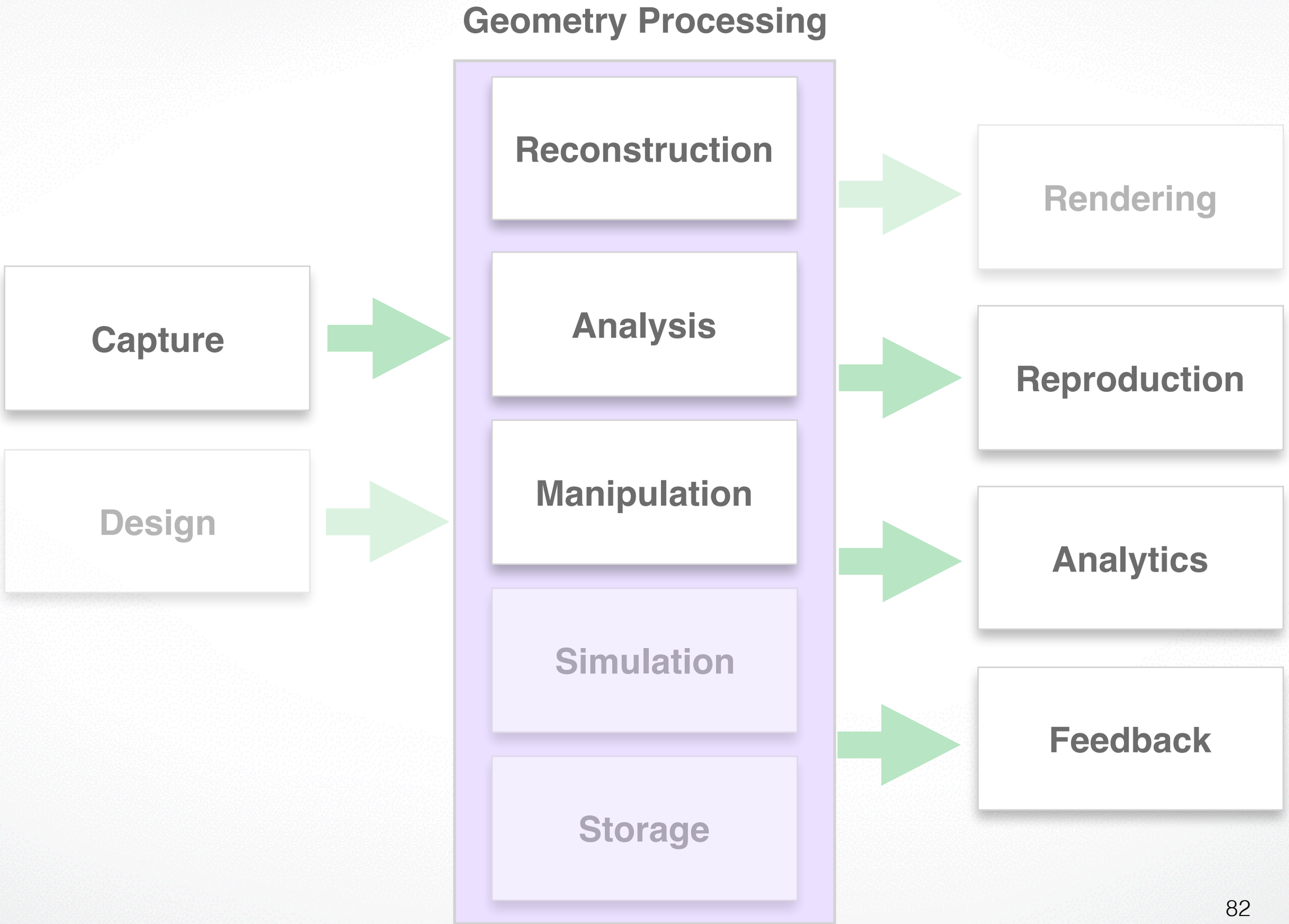
Classic Graphics



Modern Graphics/Vision



The Future: **Big Data / Robotics**



Next Time

- Parametric Approximations
- Polygon Meshes
- Data Structures

http://cs599.hao-li.com

Demos!