REGINNA 4.0

Reverse engineering and inspection in digital factory

Sara Giganto

Manufacturing Process Engineering Area, Universidad de León (Spain)

Supported by eit Manufacturing

Funded by the European Union

EIT HEI Initiative – Innovation Capacity Building for Higher Education – eit-hei.eu

www.reginna4-0.eu

Table of Contents

1. 3D Scanning and its applications
2. Applications: Reverse Engineering and Inspection
3. Reverse Engineering vs Forward Engineering
4. Optical Inspection vs Contact Inspection
5. Capabilities, advantages, constraints and limits of optical systems for Reverse Engineering and Inspection
6. Practical case of Reverse Engineering
7. Practical case of Optical Inspection

3D Scanning or Three-dimensional Digitization

3D scanners are tri-dimensional measurement devices used to capture real-world objects or environments so that they can be **remodeled** or **analyzed in the digital world**

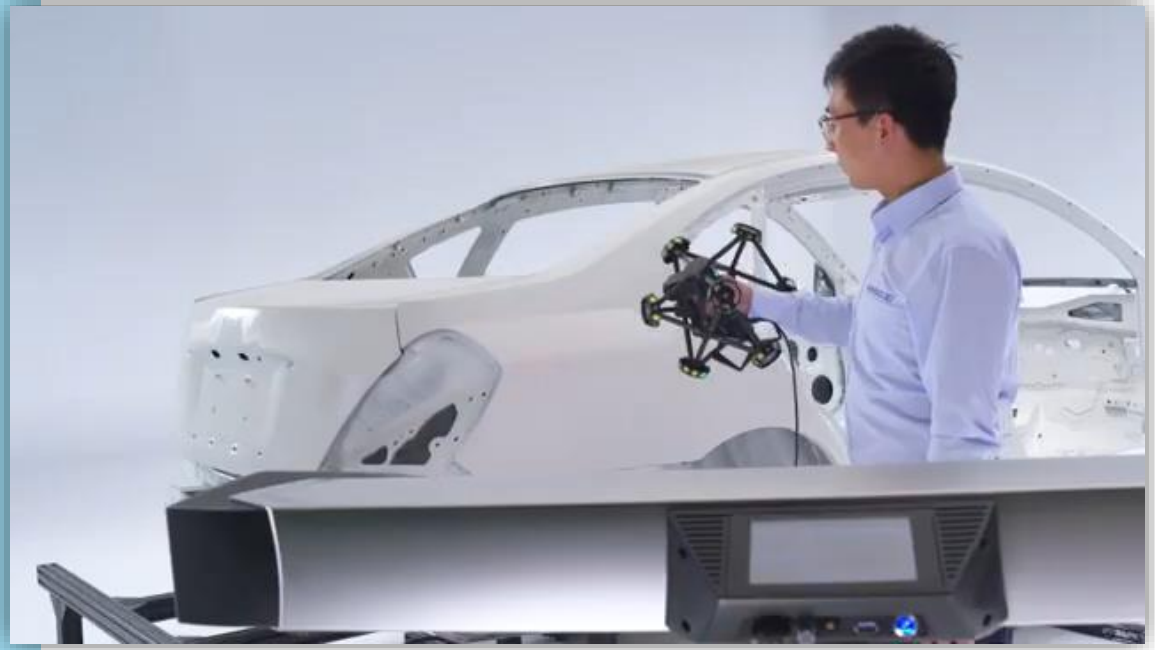
(complete or partial 3D measurements of any physical object)

https://www.youtube.com/watch?v=Fafg3cJ5SfI

3D Scanning Applications

Collected 3D data is useful for a wide variety of applications:

- Entertainment Industry
- Augmented Reality
- Motion Capture
- Gesture Recognition
- Robotic Mapping
- Industrial Design
- Orthotics and Prosthetics
- **Reverse Engineering** and Prototyping
- **Quality Control/Inspection**
- Digitization of Cultural Artifacts



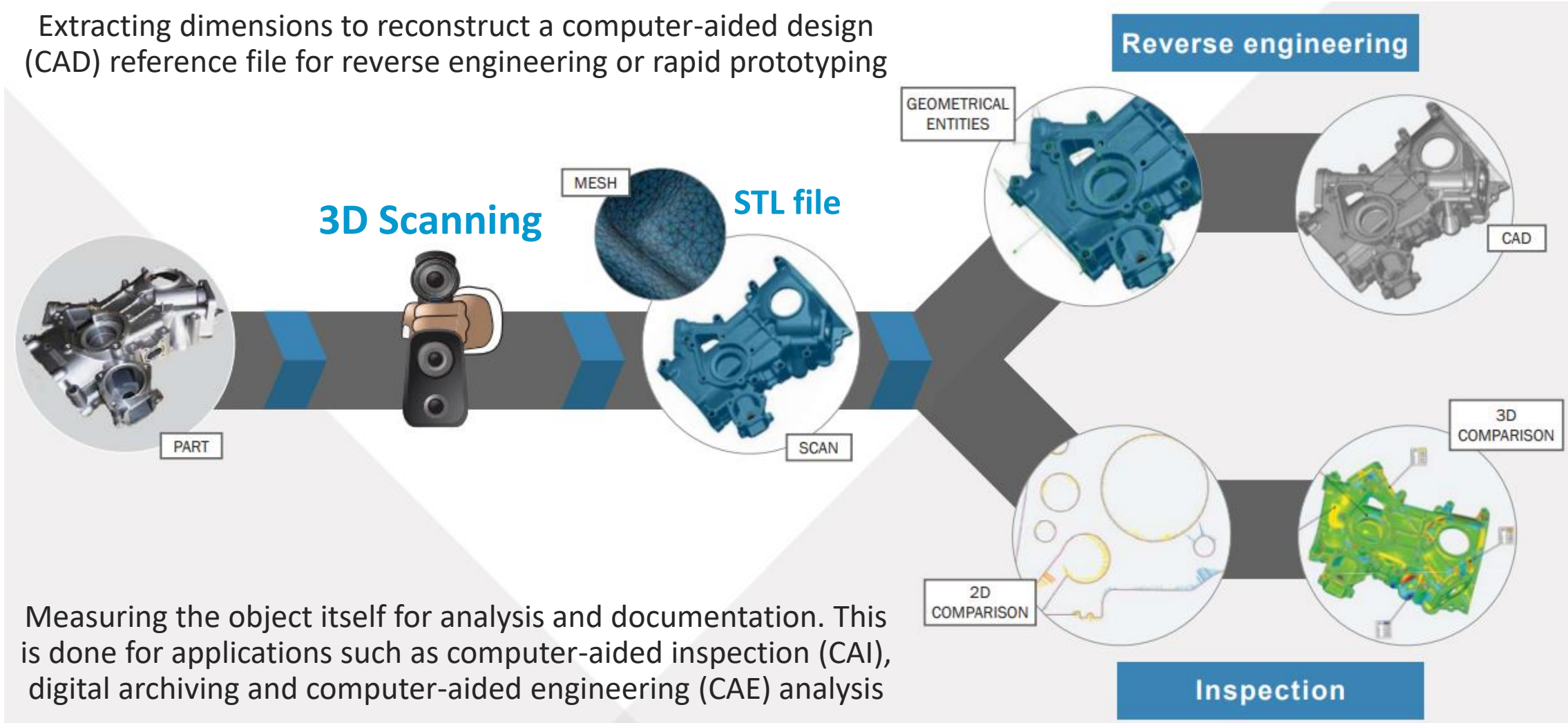
https://www.youtube.com/watch?v=OBqj41o89RM

https://www.youtube.com/watch?v=fuBoHO7hYQ4

REGINNA 4.0

Reverse Engineering and Inspection

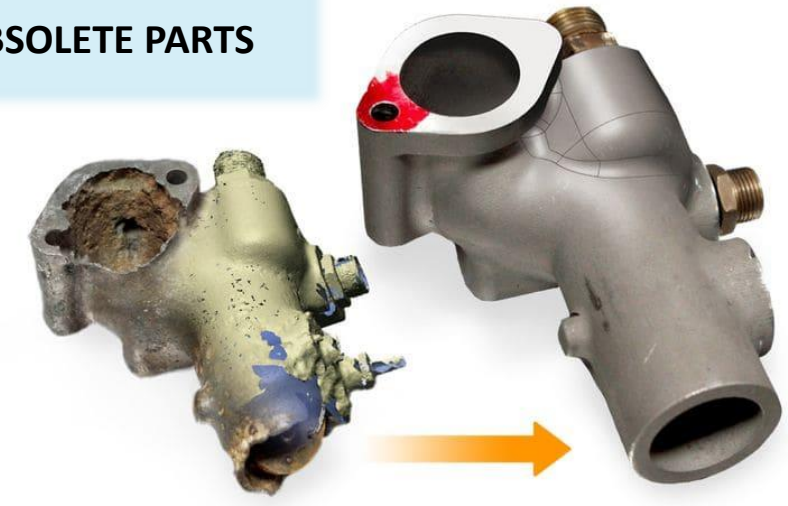
Extracting dimensions to reconstruct a computer-aided design (CAD) reference file for reverse engineering or rapid prototyping

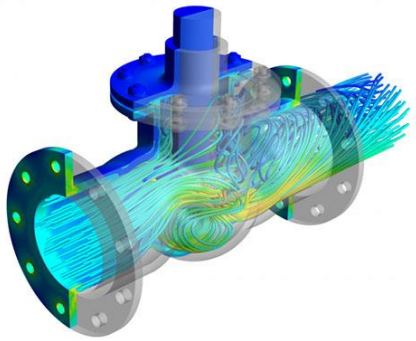


Measuring the object itself for analysis and documentation. This is done for applications such as computer-aided inspection (CAI), digital archiving and computer-aided engineering (CAE) analysis

Reverse Engineering Applications

OBSOLETE PARTS

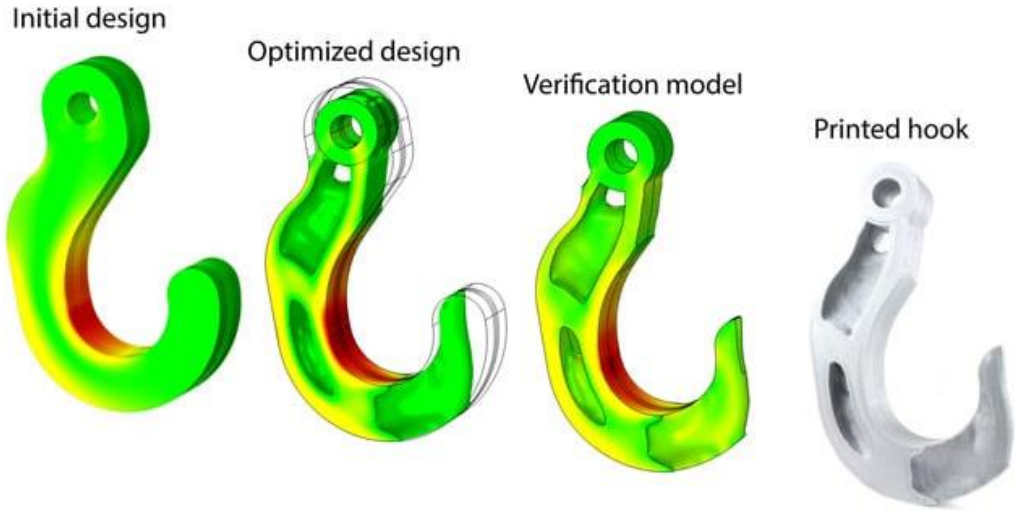




SIMULATIONS

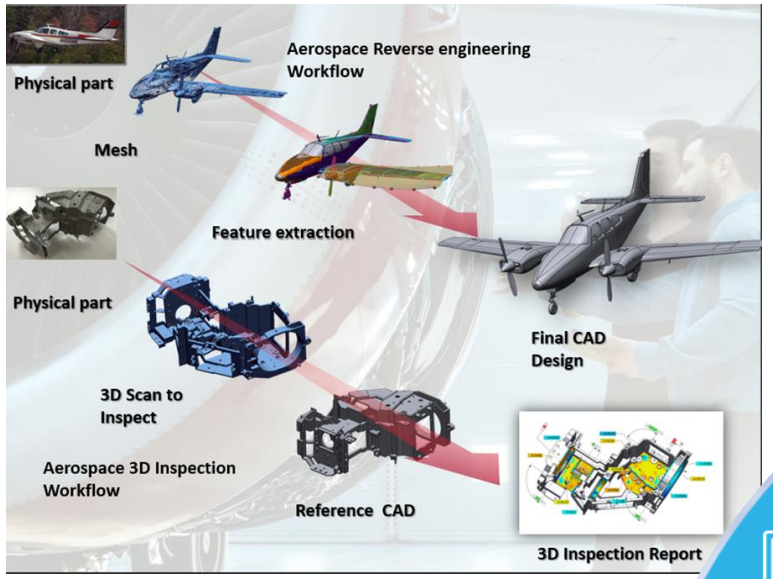
DESIGN OPTIMIZATION

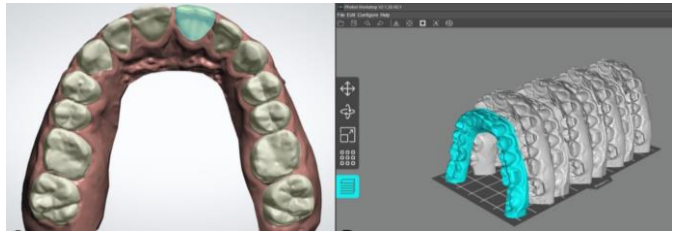
CREATION OF DIGITAL LIBRARIES

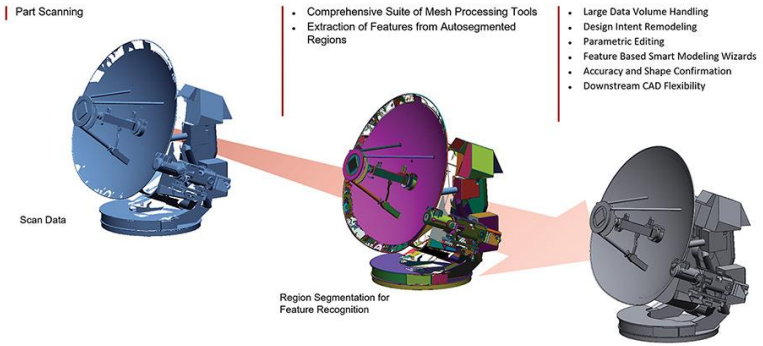


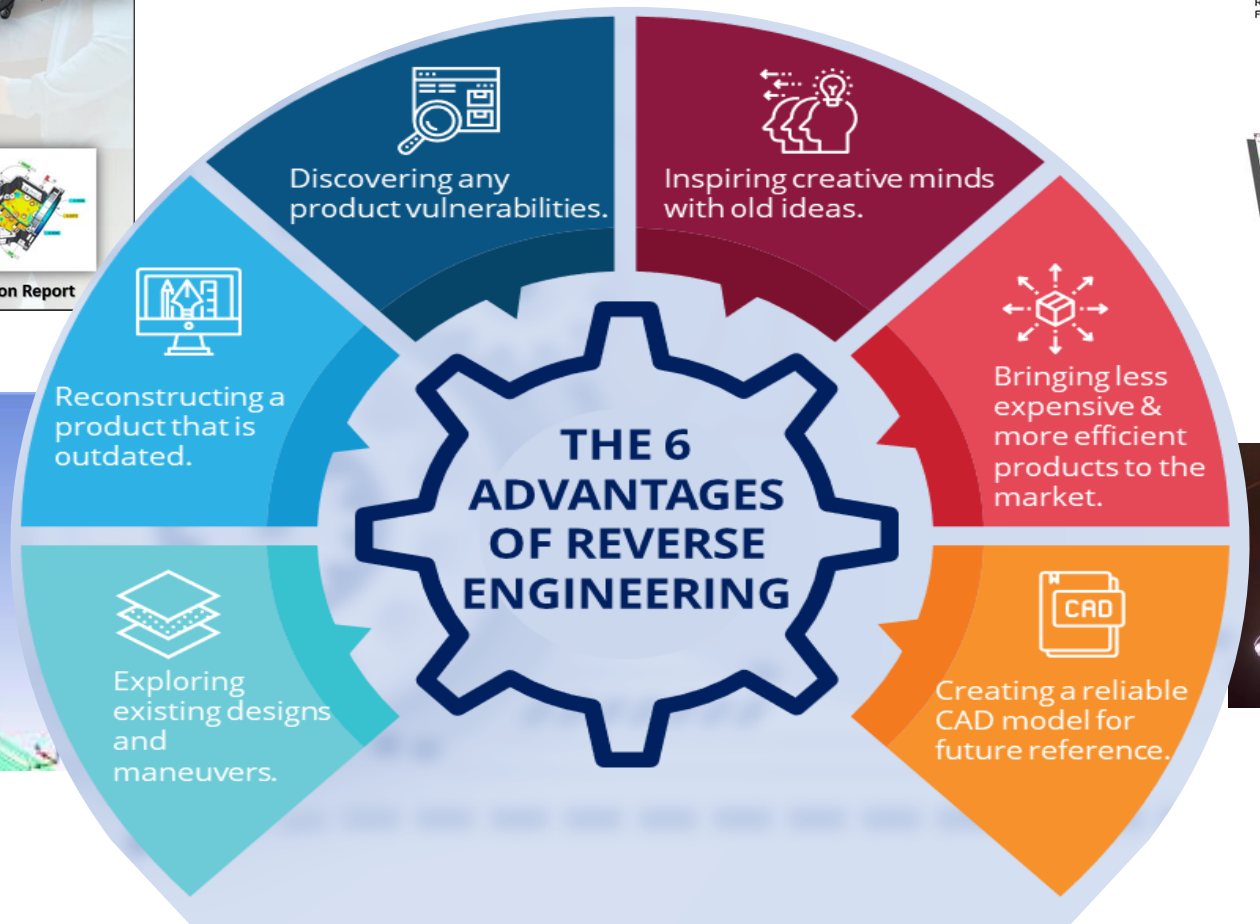
REGINNA 4.0

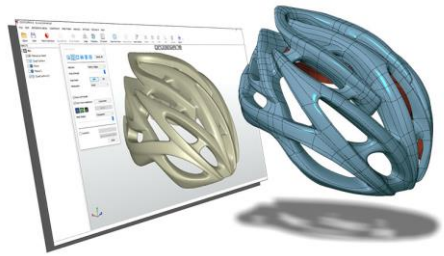
Reverse Engineering Applications

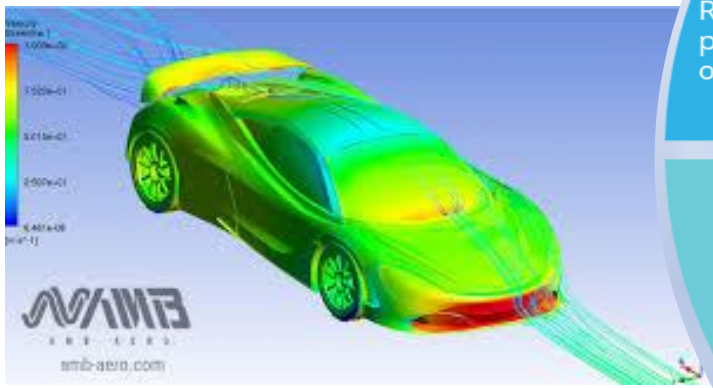












Forward Engineering

Creating new products from scratch

"Is the traditional approach to product development, in which designers and engineers start with a concept or idea and work through a series of steps to create a final product"

Stages:

Ideation

Prototyping

Testing

Refinement

Reverse Engineering

Analyzing and replicating existing products

"Is often used when there is a need to reproduce a product that is no longer available or to modify an existing product to improve its performance"

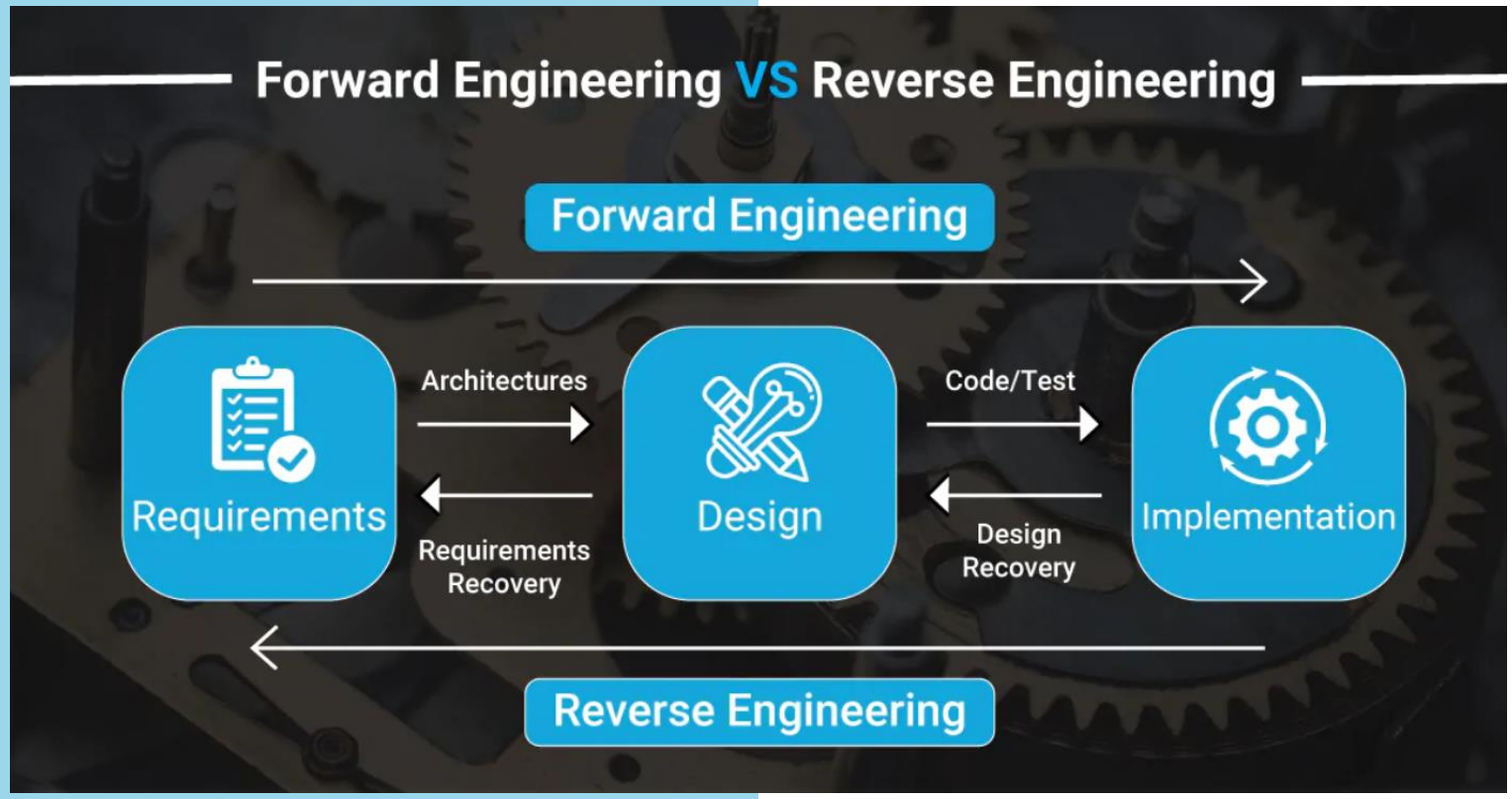
Stages:

Disassembly

Measurement

Analysis

Replication

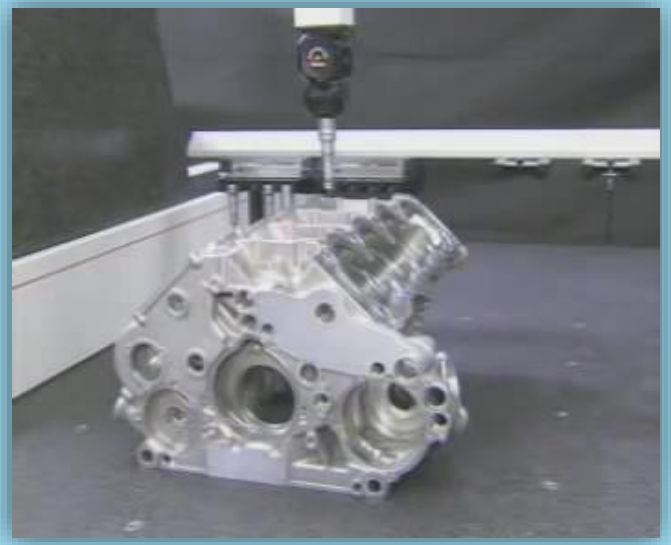


https://www.monarch-innovation.com/forward-engineering-vs-reverse-engineering

Contact Inspection

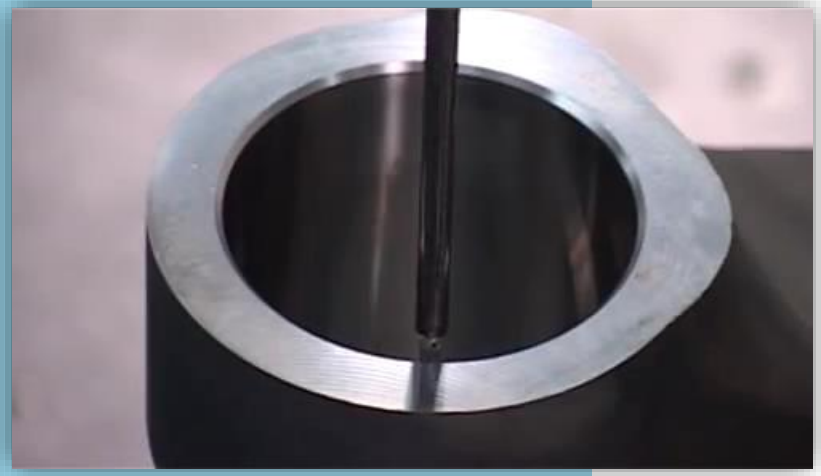
Coordinate Measuring Machine (CMM)

Discretely (point-to-point)



https://www.youtube.com/watch?app=desktop&v=Es7wd44BKc4

Continuously



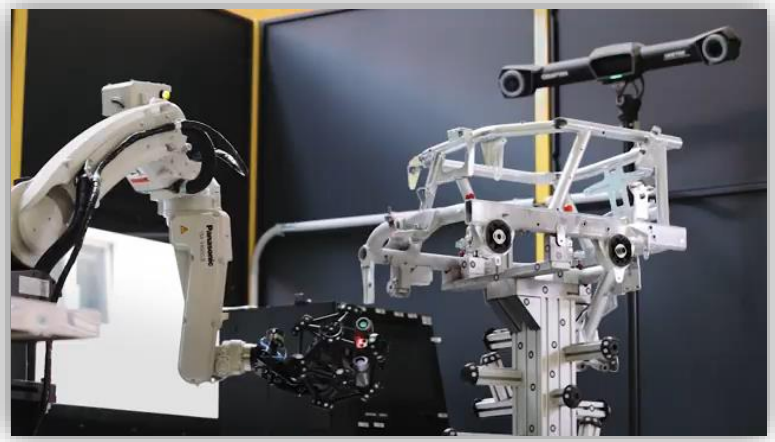
https://www.youtube.com/watch?app=desktop&v=xsdnZDt20tM

Coordinate Measuring Arm (CMA)

https://www.youtube.com/watch?app=desktop&v=VIxSehFAsKk

Optical Inspection

Automatic



https://www.youtube.com/watch?app=desktop&v=ZwY6oci5yqE

Manual

https://www.youtube.com/watch?v=75ku3Ho32Ms

REGINA 4.0

3D Scanning Technologies

Laser scanners

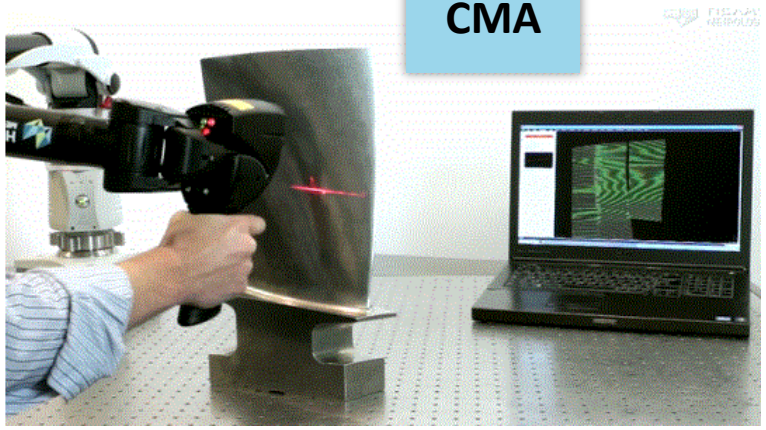
https://www.youtube.com/watch?v=XfvmePlBvPo

Structured light scanners

https://www.youtube.com/watch?v=E7S8XdtAtbk

3D Scanning Technologies

CMA



- Mesh density (number of points)
- Inspection time
- Parts dimensions
- Resolution
- Precision

Manual sensor

CMM

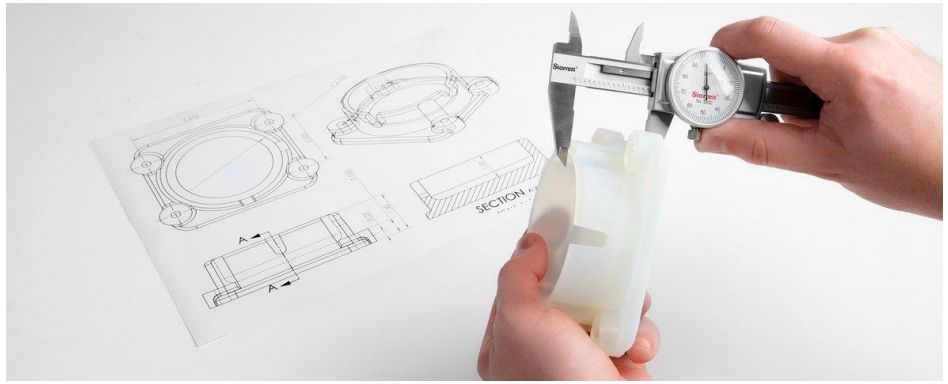
Automatic sensor

REGINNA 4.0

Capabilities, advantages, constraints and limits of optical systems for Reverse Engineering and Inspection

- × Surface finish of parts (color, metallic shine, etc.)
- × Occlusion problems
- × Measurement noise (spurious points)
- × Tolerances are not too tight
- × Non-standardized accuracy

- ✓ No contact (does not damage the parts)
- ✓ Acquisition of large amounts of data
- ✓ Short inspection times
- ✓ Measurement of complex surfaces
- ✓ No precise positioning of parts required



Software for Reverse Engineering

AUTODESK® RECAP

3D SYSTEMS®
Geomagic® Design X™

PolyWorks Modeler™

Geomagic for SOLIDWORKS

mesh2surface
for SOLIDWORKS®

AUTODESK Fusion 360

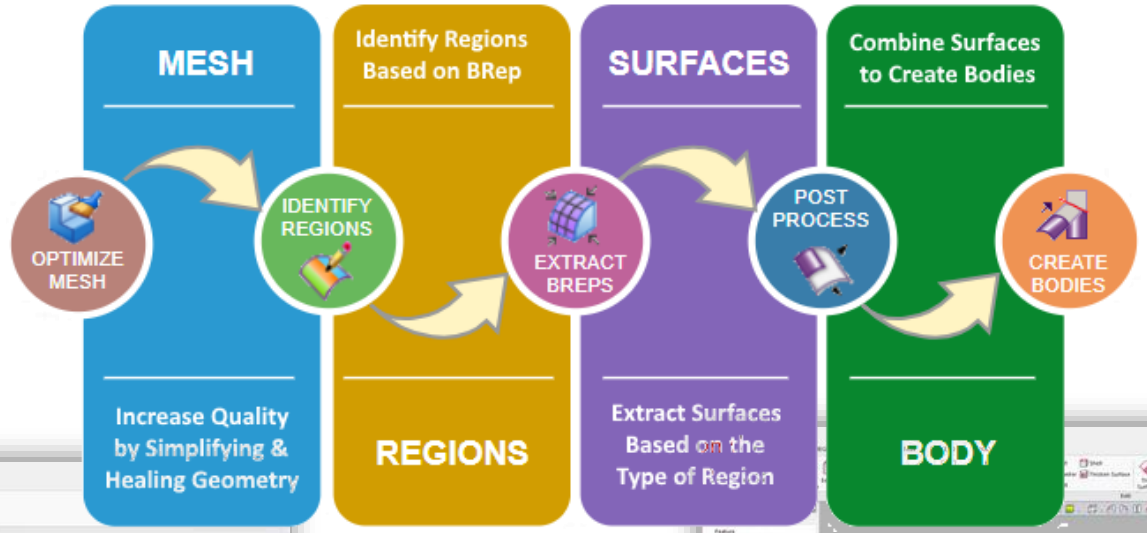
FreeCAD
Open Source parametric 3D CAD modeler

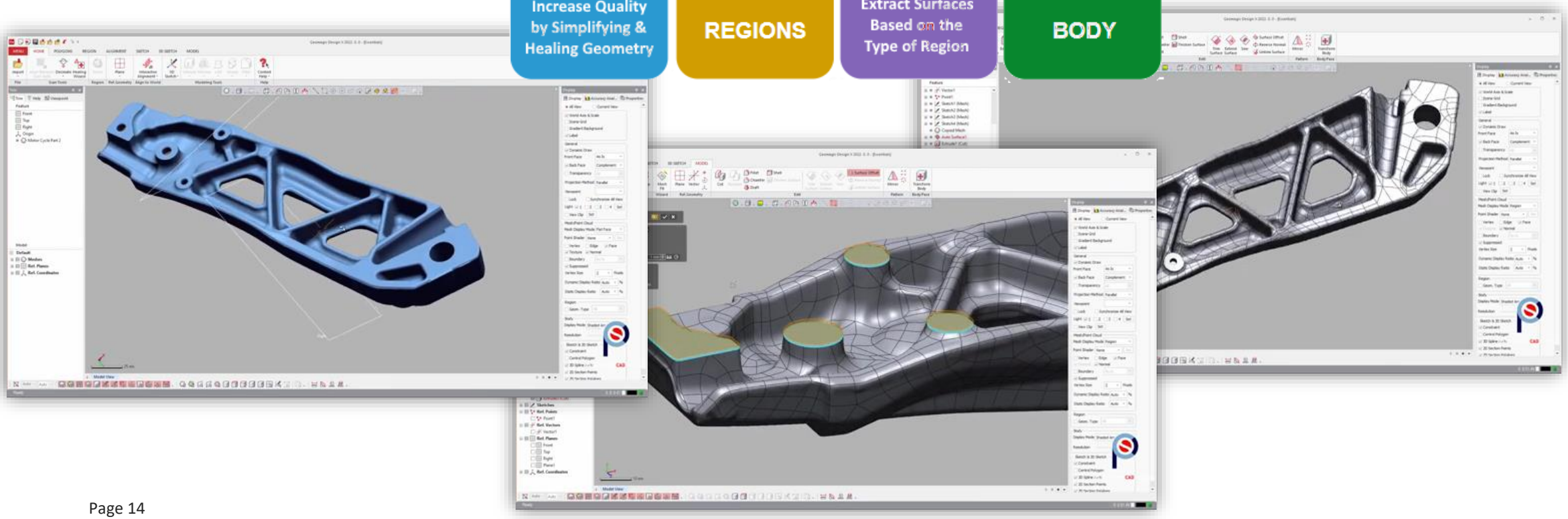
Ansys
SPACECLAIM

iebms
CAD/CAM MES
Software y servicios

REGINNA 4.0

Practical case of Reverse Engineering





https://www.youtube.com/watch?v=8m6IqMdzDxE&t=1338s

Software for Optical Inspection

Geomagic Control X

PolyWorks Inspector™

3D RESHAPER® The 3D scanner software

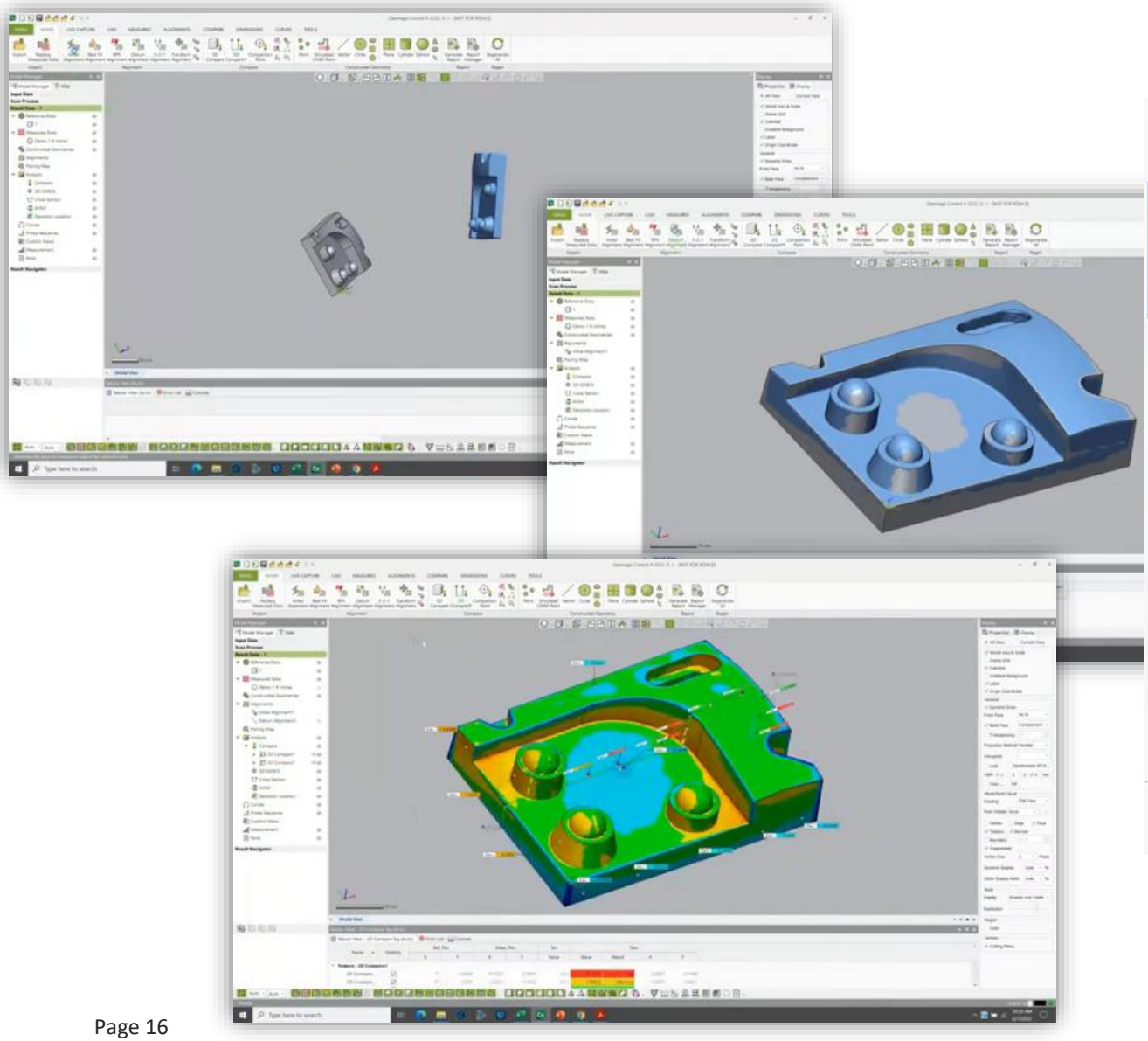
GOM Inspect

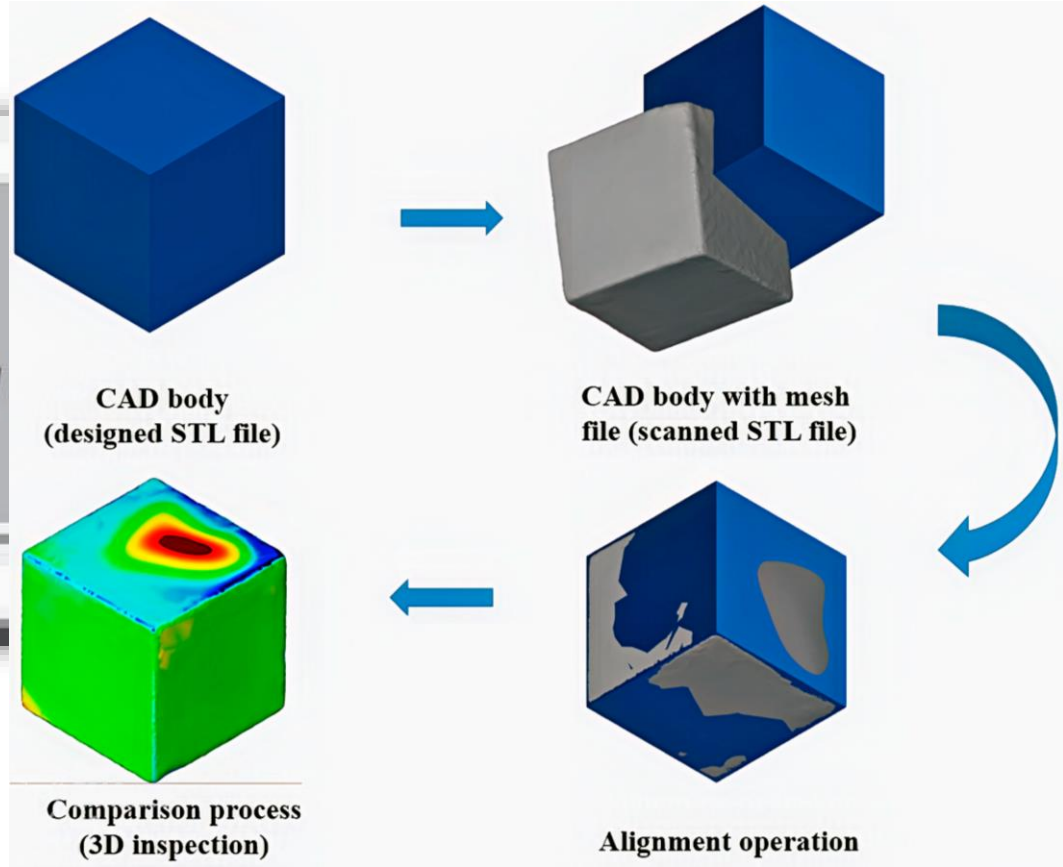
MESH INSPECTOR

CREAFORM

VXinspect™

Practical case of Optical Inspection





https://www.youtube.com/watch?v=kWRyyVDbbo4

REGINNA 4.0

Thank you!

Sara Giganto

Manufacturing Process Engineering Area, Universidad de León (Spain)

Supported by eit Manufacturing

Funded by the European Union

EIT HEI Initiative – Innovation Capacity Building for Higher Education – eit-hei.eu

www.reginna4-0.eu