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Augmented Reality to Supplement Work Instructions

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Augmented Reality to Supplement Work Instructions

- Augmented Reality
- AR for assembly
- User study example
- Key feature: object tracking
- AR for design

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Augmented Reality

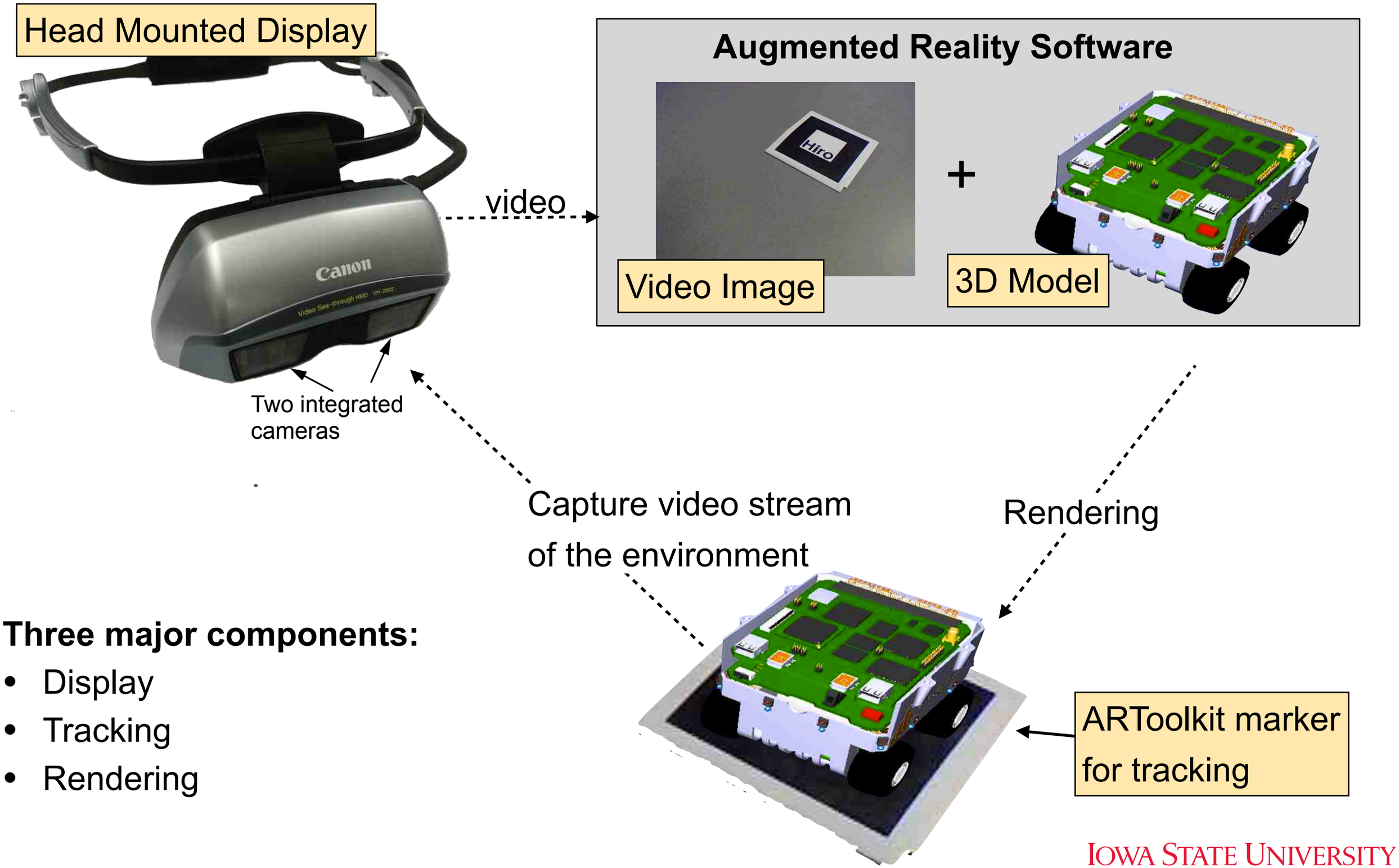
Augmented Reality (AR) technology is a type of human-computer interaction that superimposes the natural visual perception of a human user with computer-generated information (i.e., 3D models, annotation, and text).

According to Azuma, AR

- combines real and virtual,
- is interactive in real time, and
- registered in 3D

Azuma, Ronald: A Survey of Augmented Reality. In: Presence: Teleoperators and Virtual Environment 6, pp 355 - 385. 1997

How does Augmented Reality work?



Three major components:

- Display
- Tracking
- Rendering

Motivation

Challenges:

- Long learning / re-learning process
- Lost assembly time
- Product callback due to assembly mistakes

"Per year, global automotive warranties are estimated as USD 40 billion, 3 -5 % loss in sales. [...] *due to lack of knowledge concerning techniques and processes [...]"*

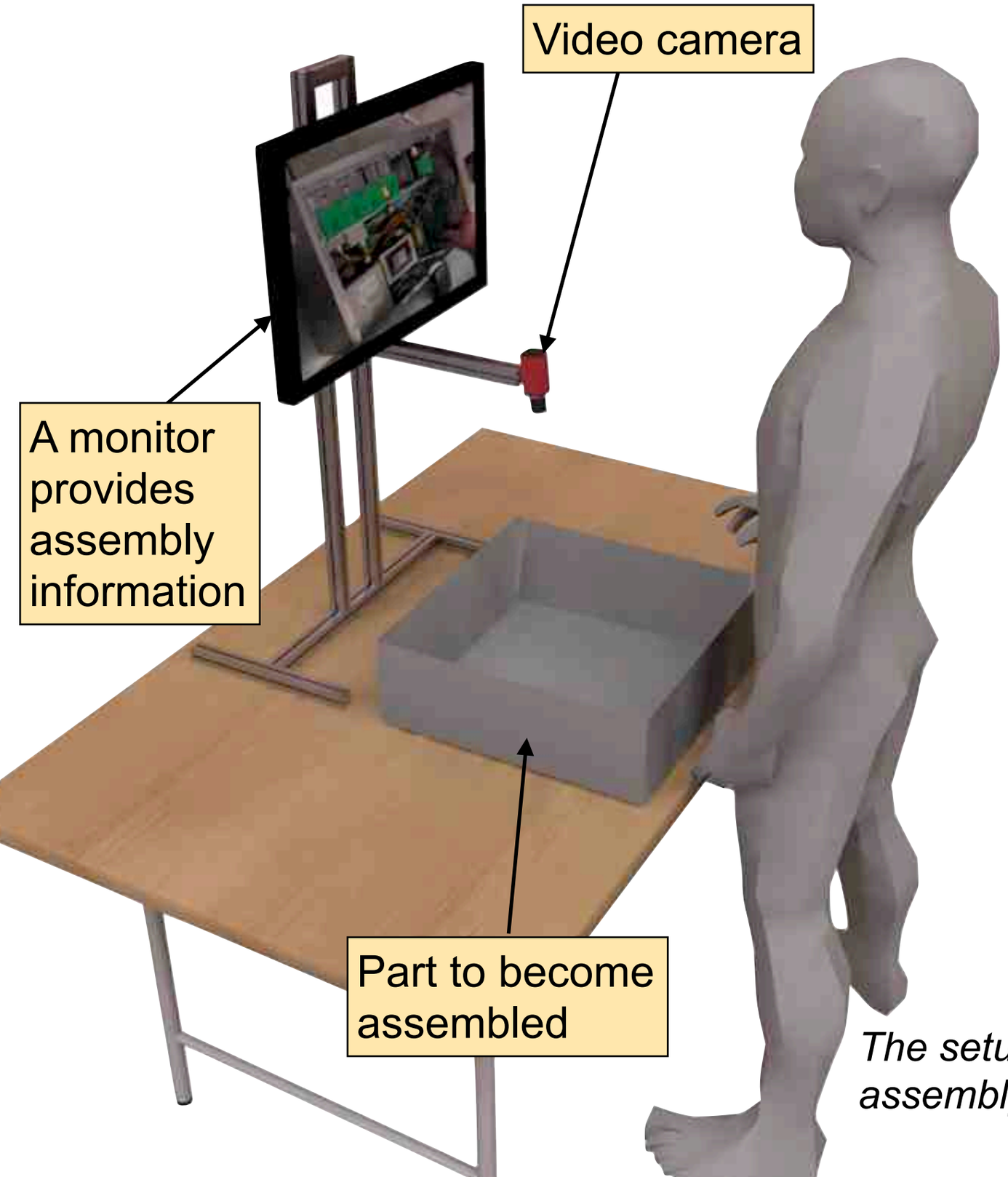
"From Recall to Prevention" SGS Consumer Information Bulletin, 2012

Combine assembly

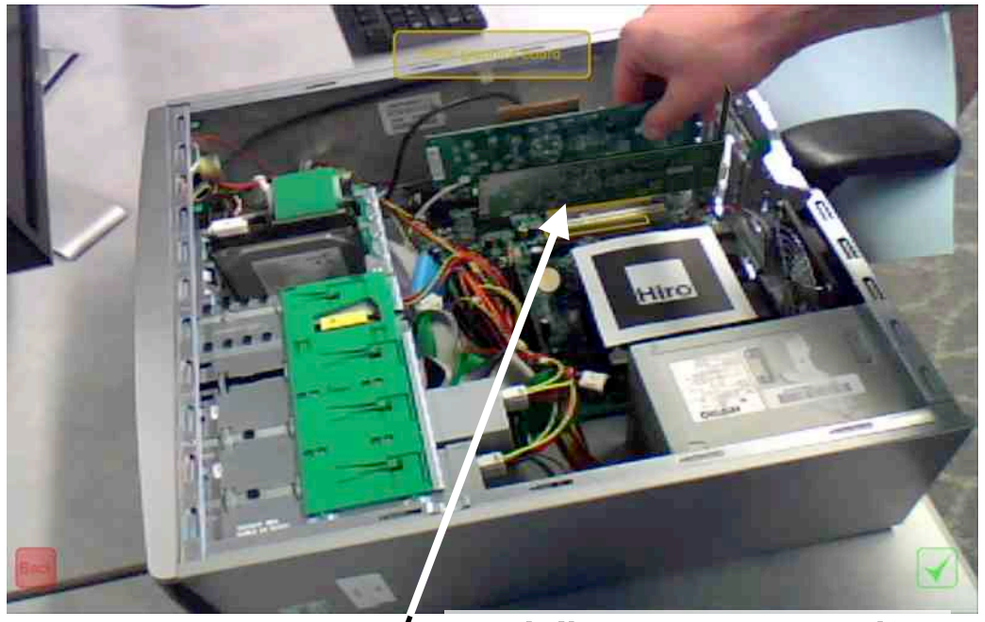
Opportunities:
(reported in previous studies)

- Increased learning performance
- Up to 30% faster assembly
- Reduced number of assembly mistakes

AR Assembly Station - Concept Design



The setup of the AR assembly station



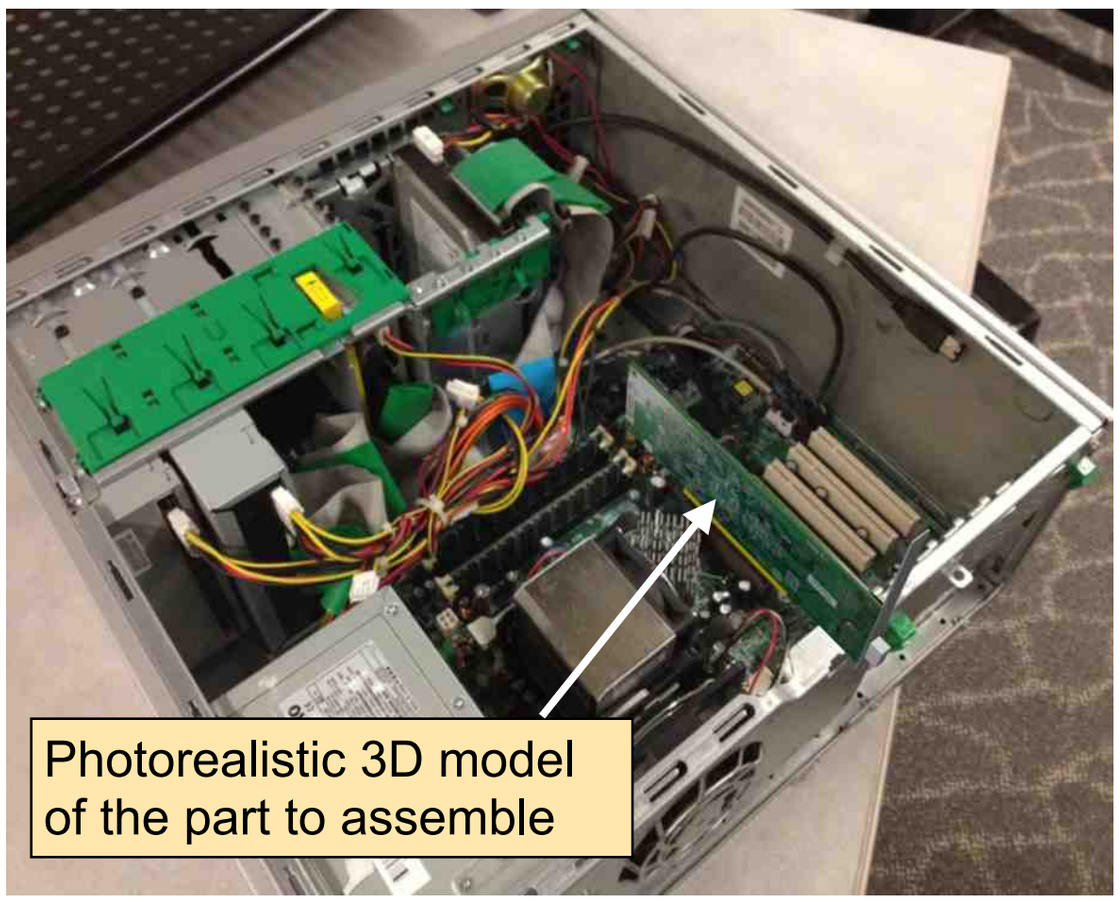
View on monitor

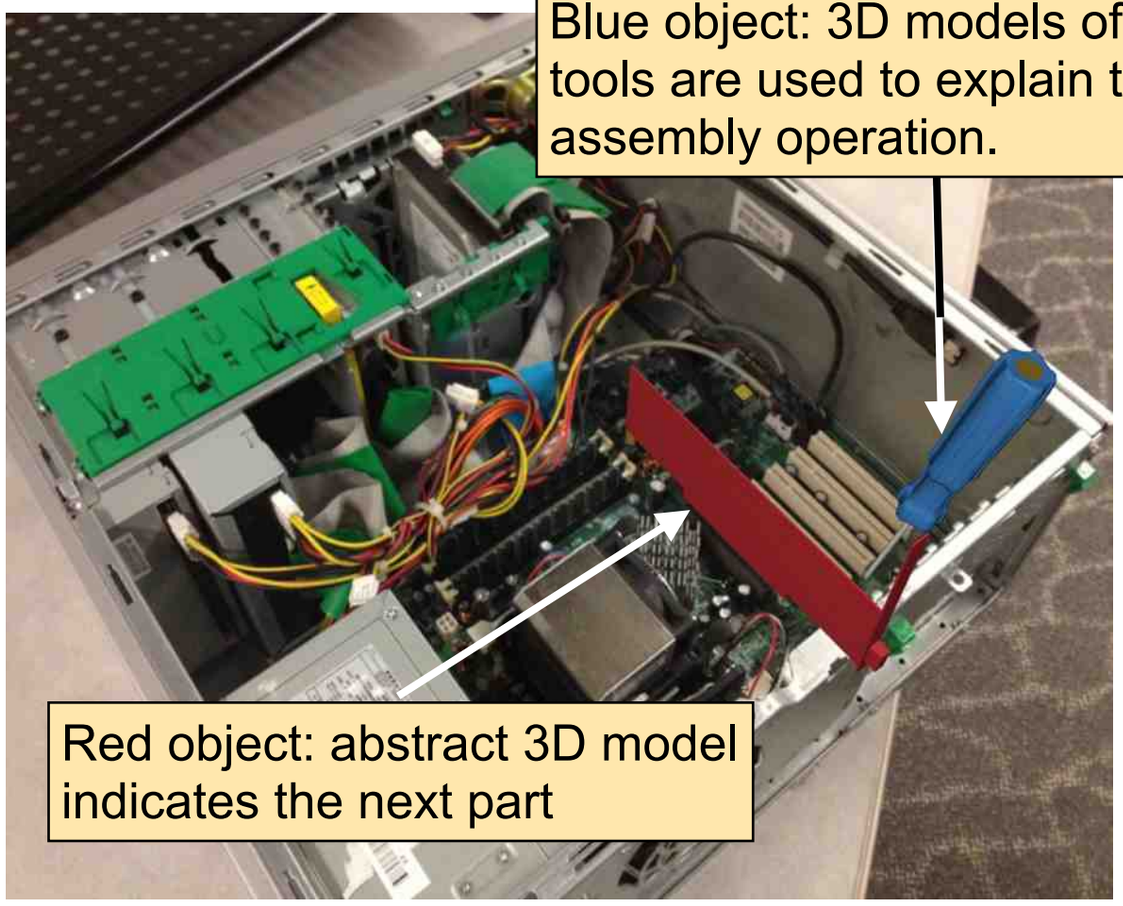
A animated 3D model shows the assembly location and how the part becomes assembled.

Information Presentation

Three major functions:

- Indicate the next part to assemble
- Show the assembly location
- Explain the assembly operation





Possible solutions for the presentation of assembly related information

Assembly User Study

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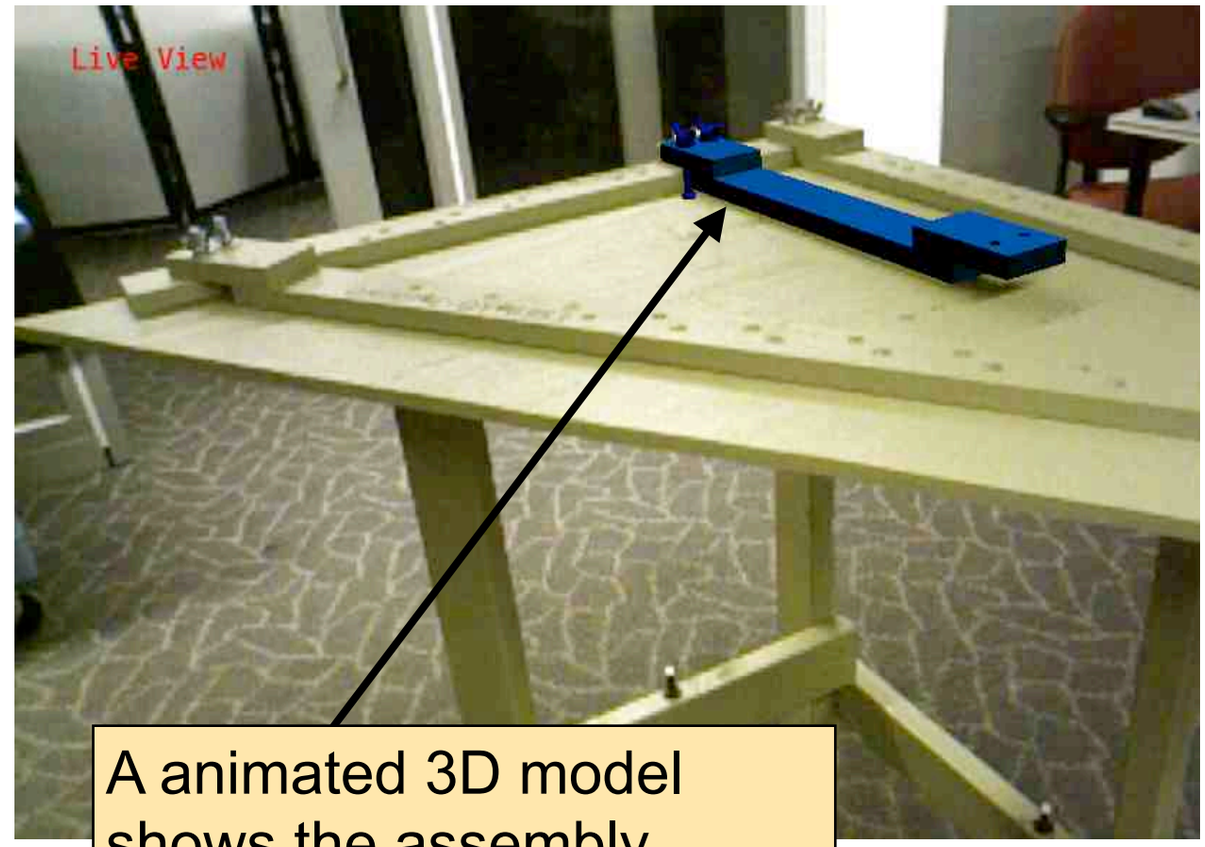
Goal: assessment of the efficiency of AR-based assembly instructions.

Tablet computer: instructions are shown on the display

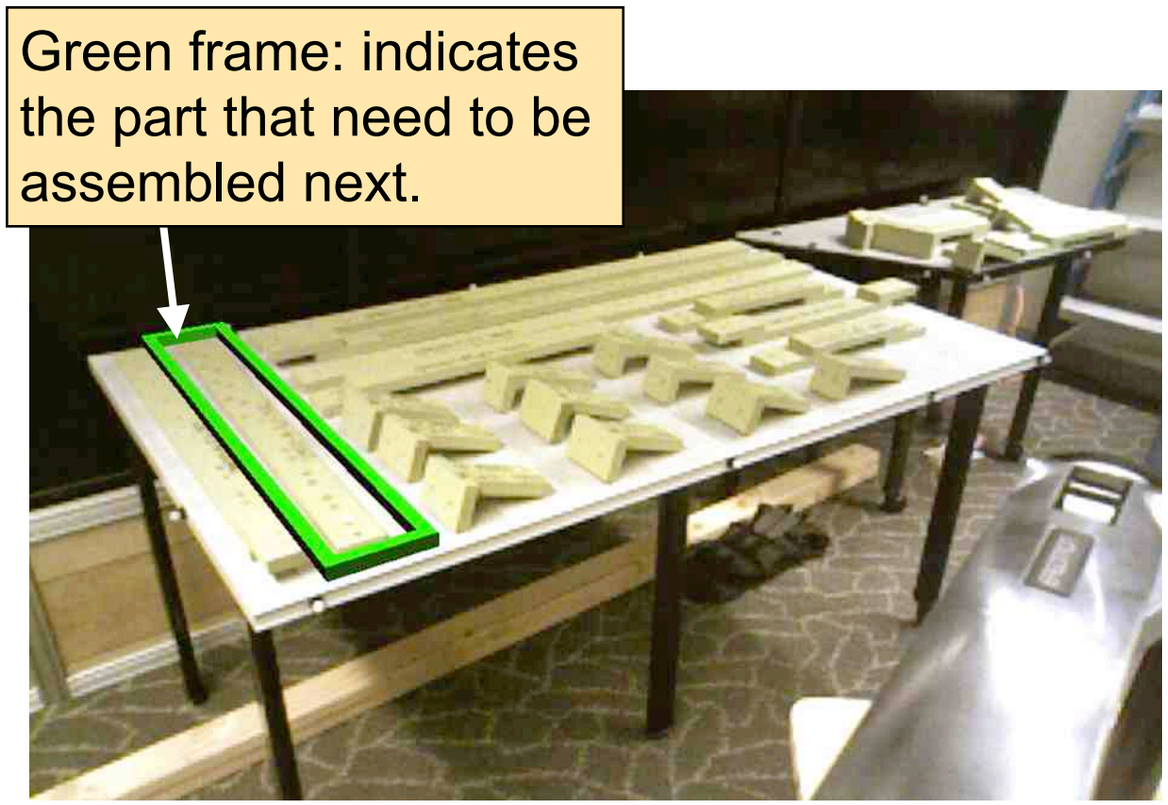


A animated 3D model shows the assembly location and how the part becomes assembled.

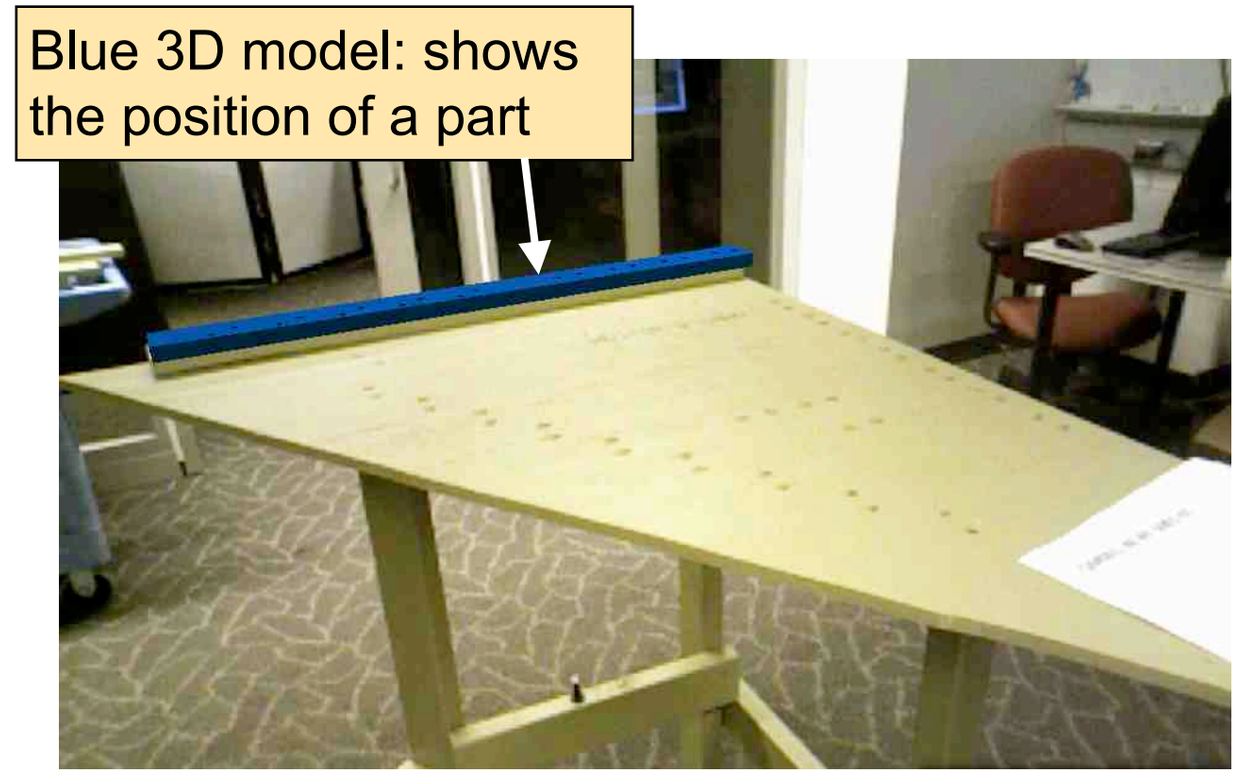
Three setups are compared:

- Desktop instructions
- Mobile instructions
- Augmented Reality instructions

Assembly User Study



Parts table



Mechanical structure

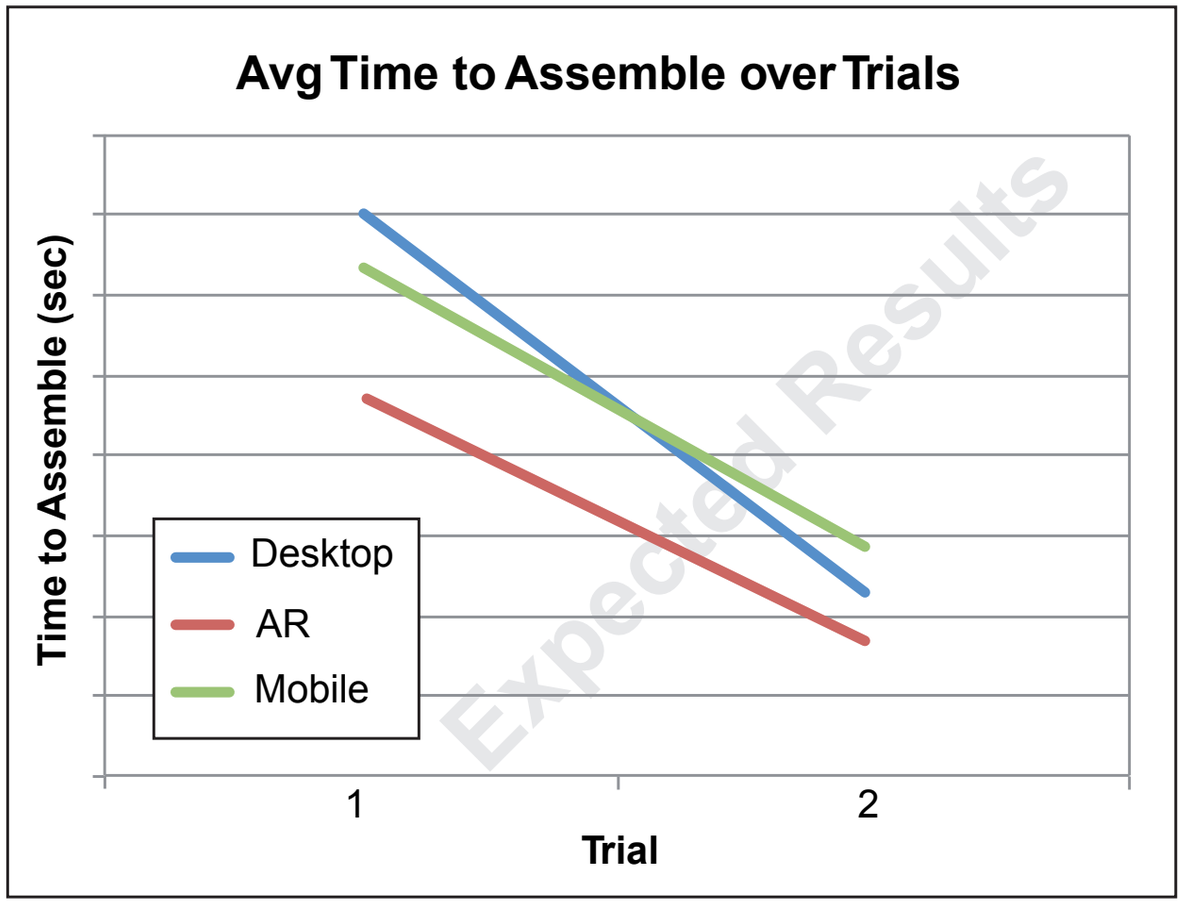
Part bins

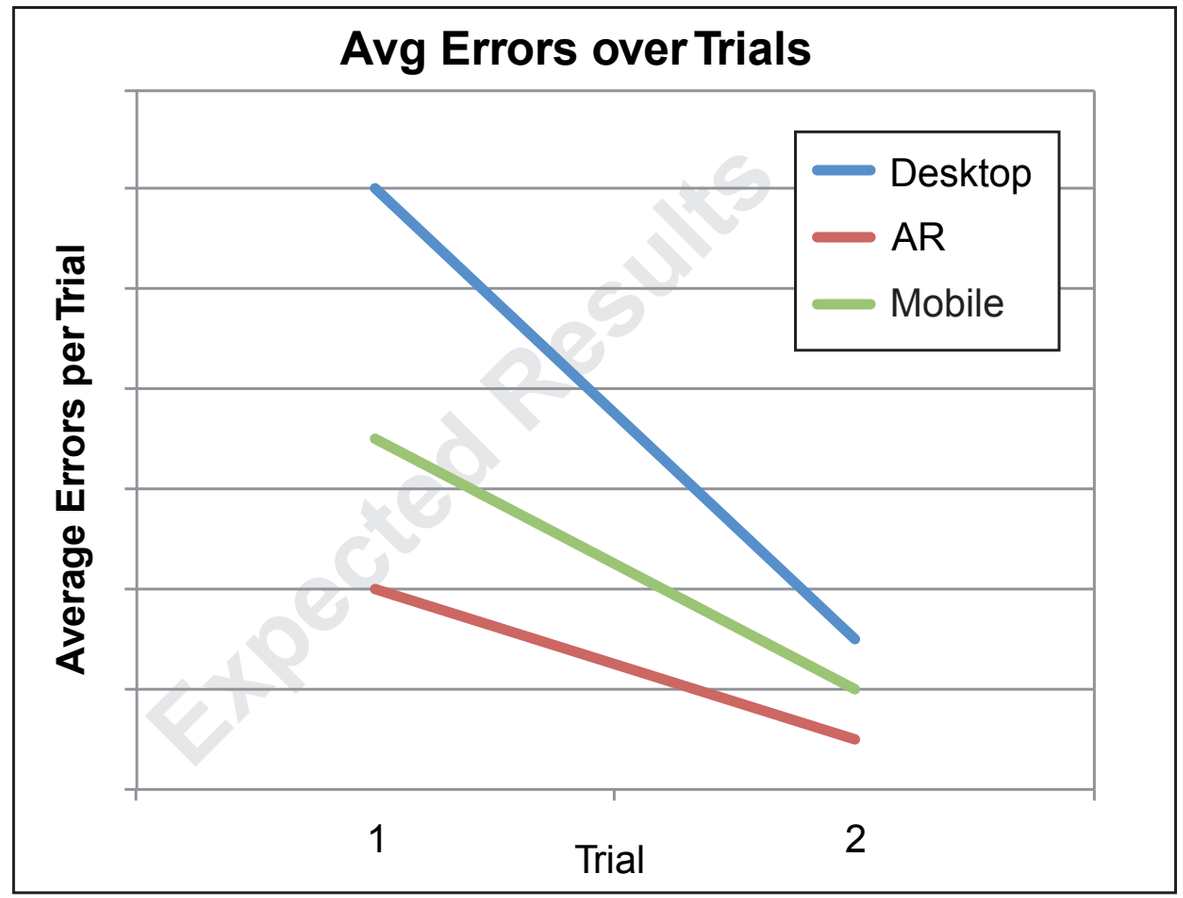
AR supports at three locations:

- Parts table
- Part bins
- Mechanical structure

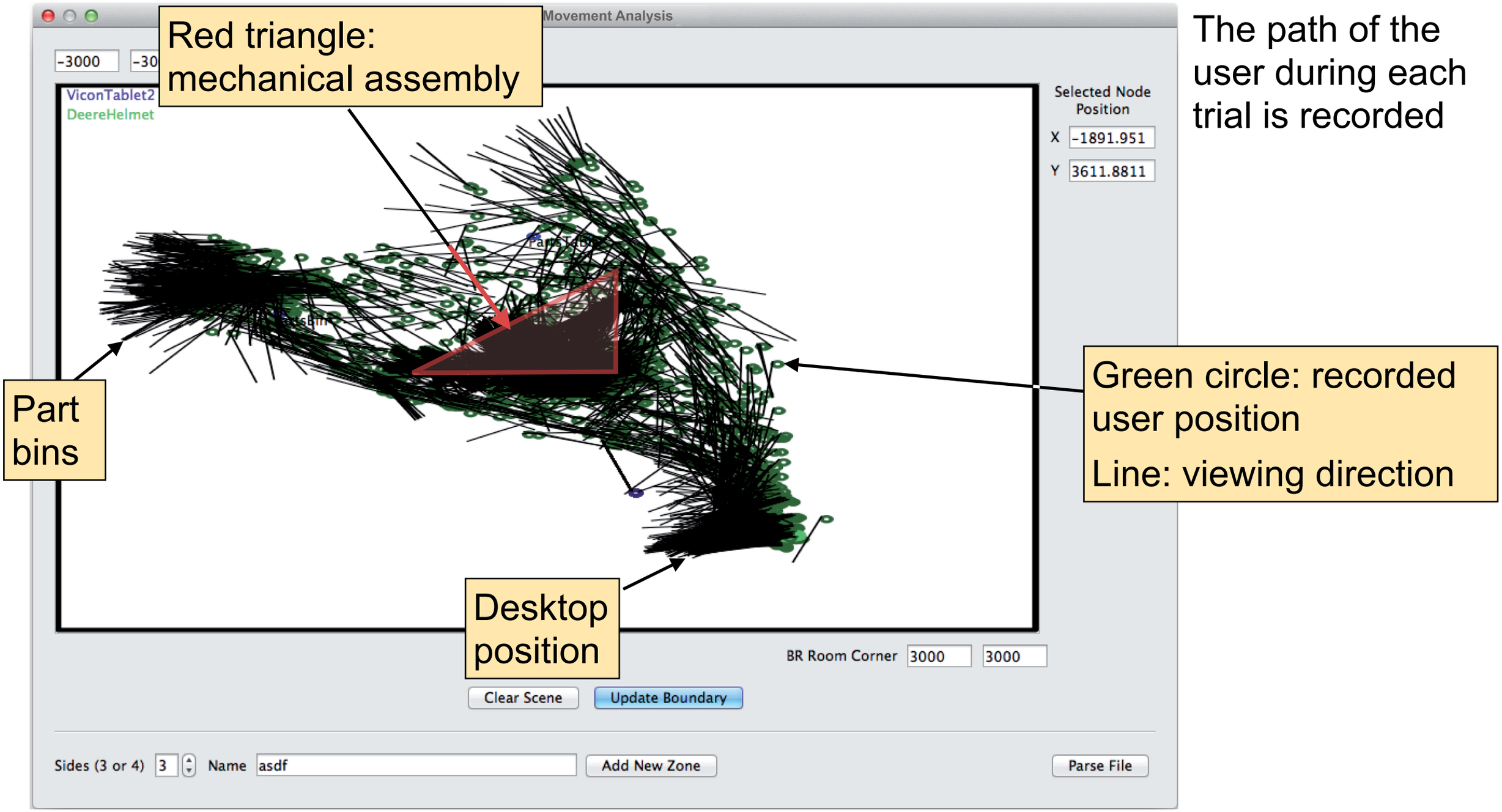
Expected Data - Time and Errors

Errors and assembly time are recorded and analyzed





Expected Data - Path



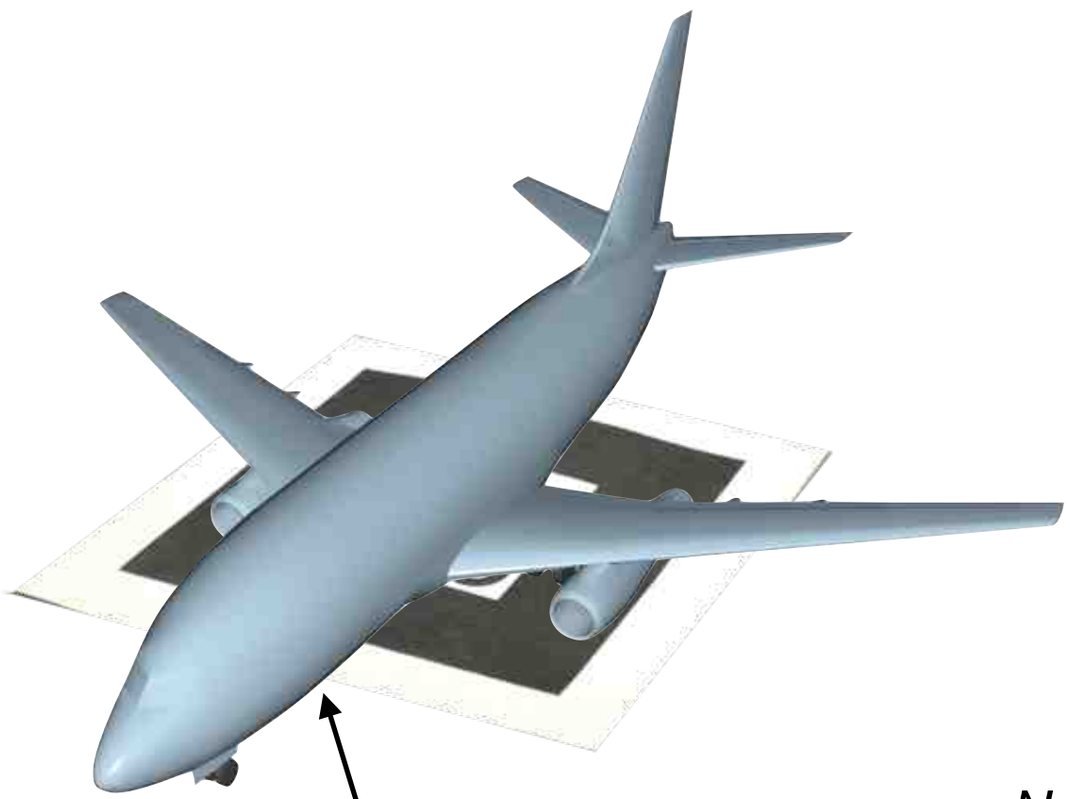
The path of the user during each trial is recorded

Data recorded during a desktop instruction trial

Tracking

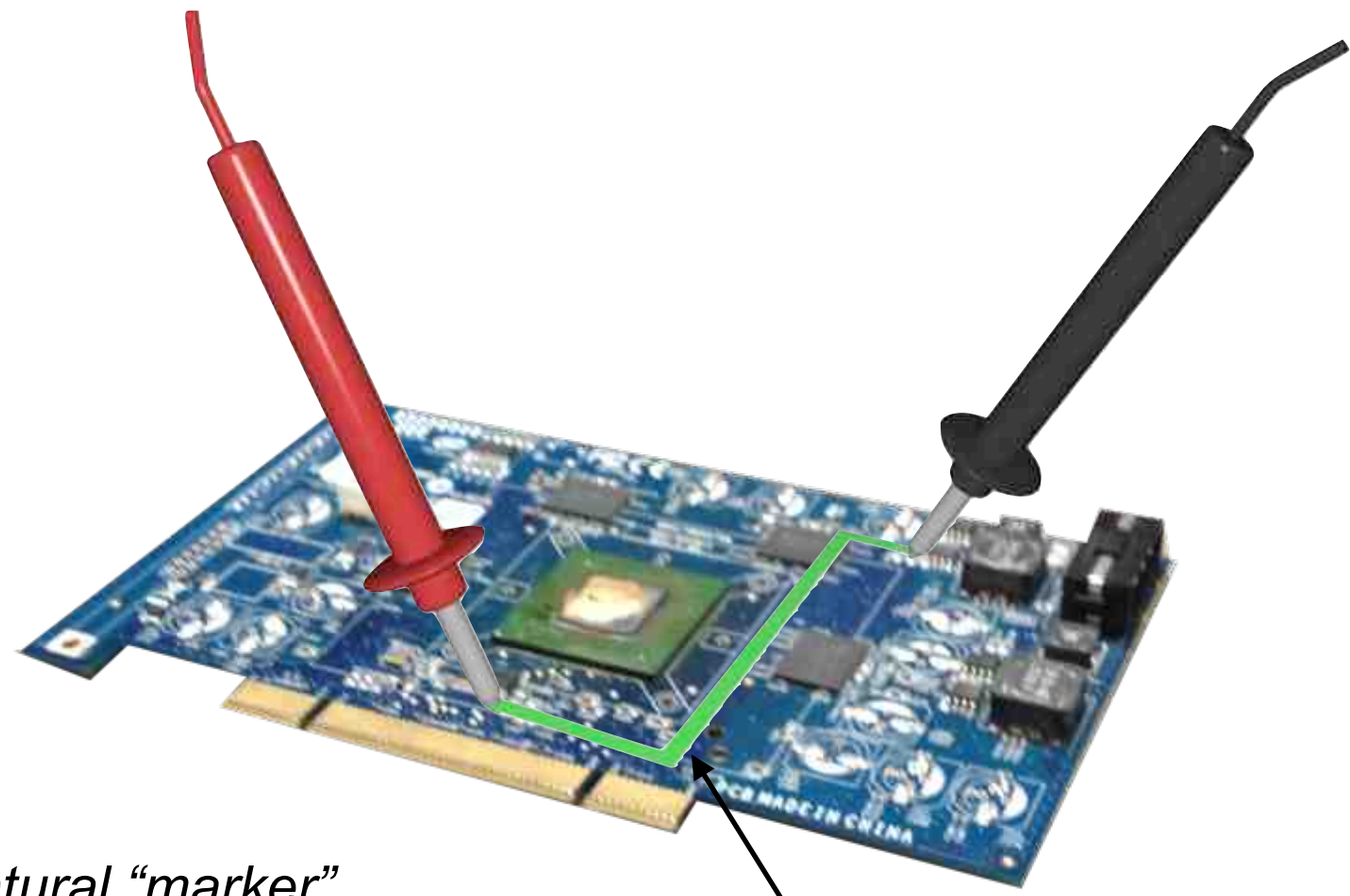
Augmented Reality relies on object tracking:

- Marker-based tracking
- Natural feature tracking
- 3D model tracking



Artificial marker

3D model superimposes the artificial marker



Natural "marker"

3D models superimpose the circuit board

Natural Feature Tracking Technology

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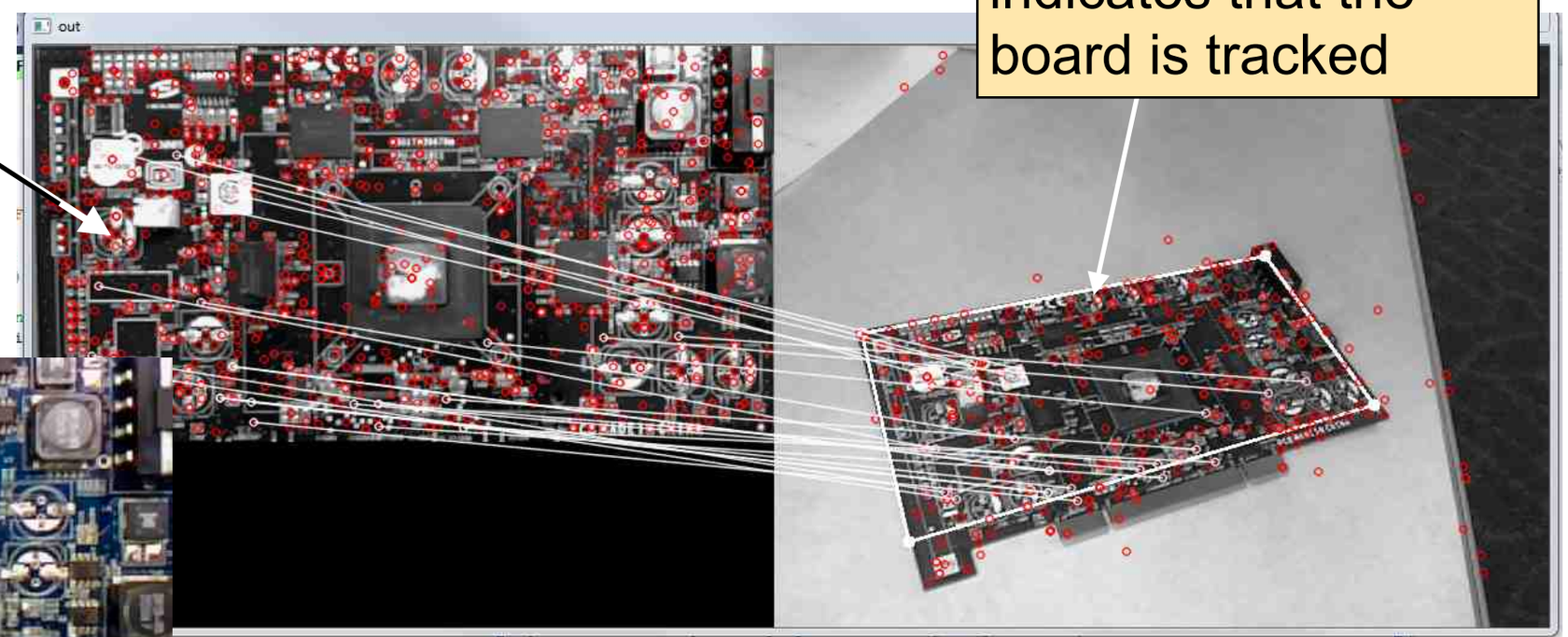
- Input: photo of the object to track
- Find and store unambiguous points (feature)
- Identify these points in a video stream

Red dot: feature, stored to identify the circuit board.

White frame: indicates that the board is tracked



Unambiguous points (left) are identified in a video stream (right)

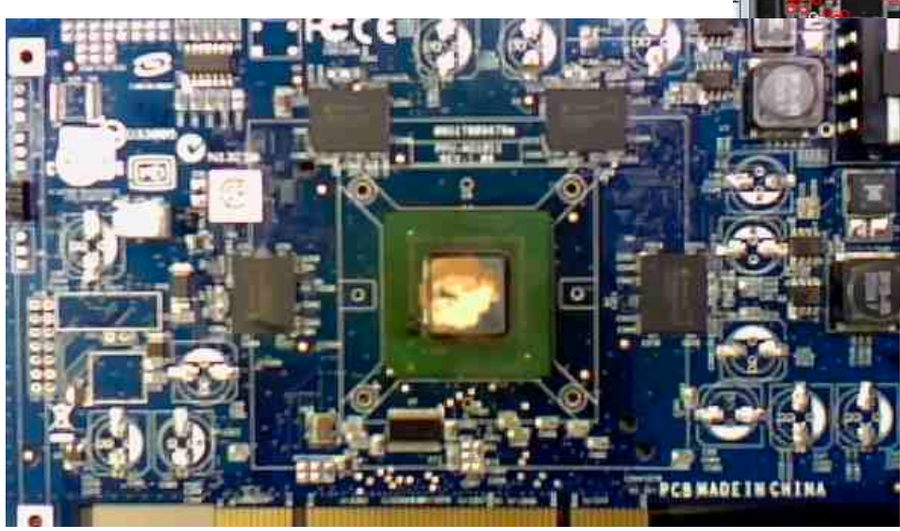


Photo of the object to track

- Everything can be a marker
- Multiple objects
- Real time

Partner:

Rockwell Collins

3D Model Tracking Technology (1/2)

Combine gear switch

Tracking of rigid objects

- No planar surface
- No distinguishable features

Partner:

3D Model Tracking Technology (2/2)

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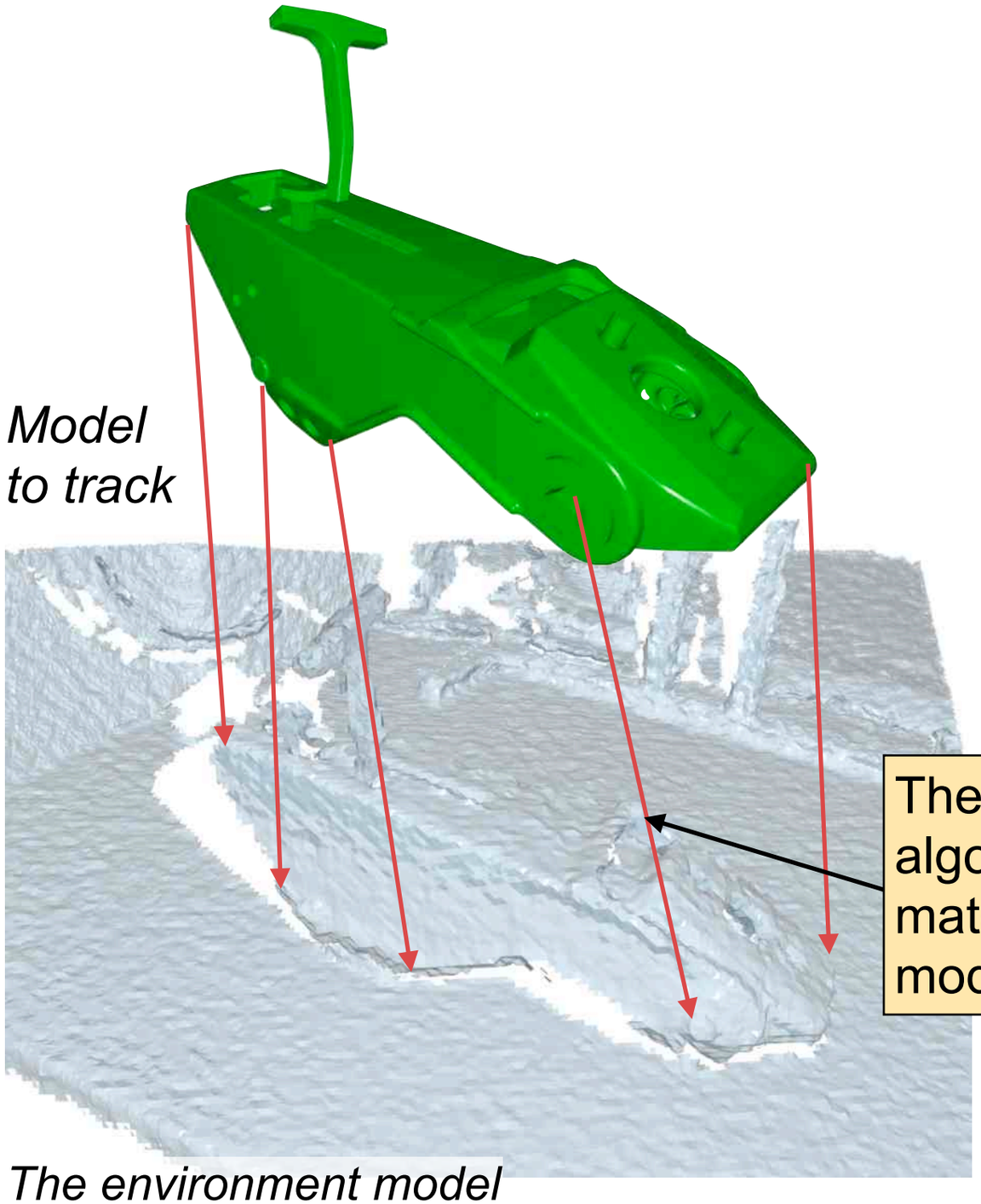
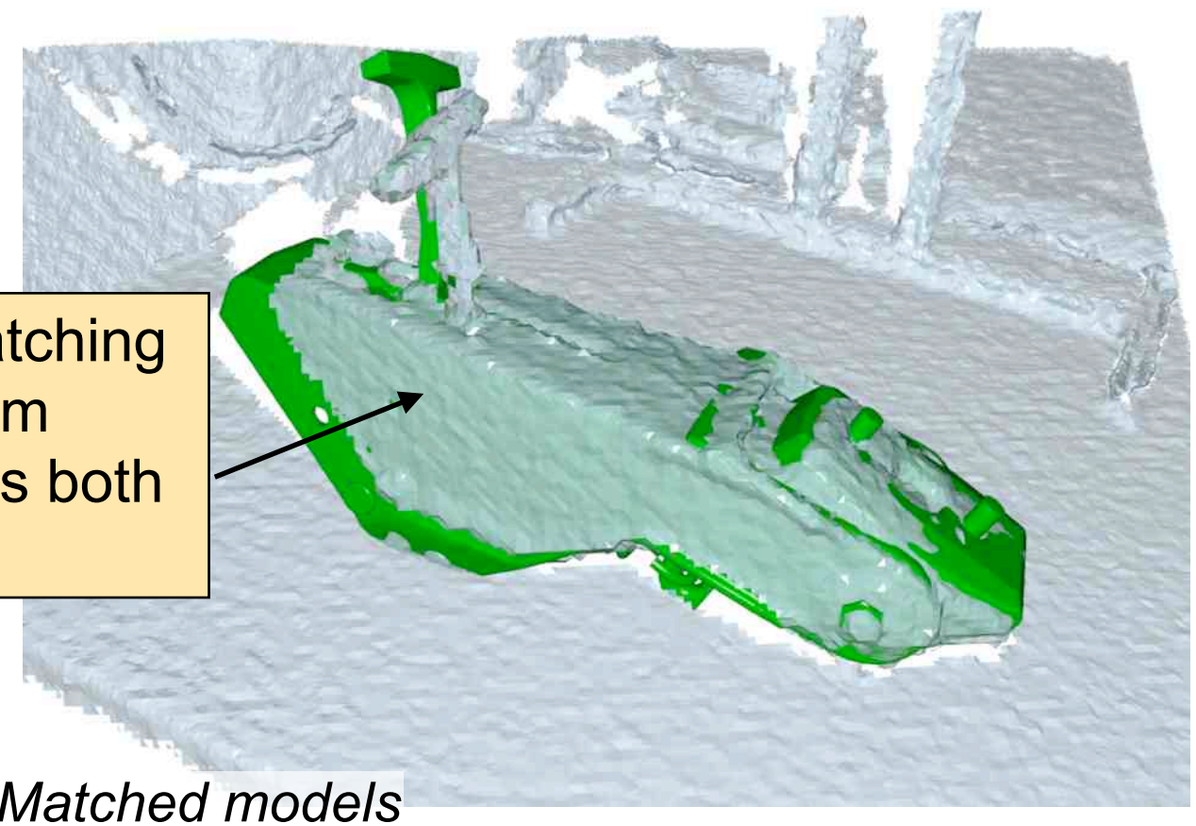
- Depth video camera
- Matches 3D model with environment model
- Input: depth image of the environment and 3D model of the objects to track



The environment model



Matched models

Partner: JOHN DEERE

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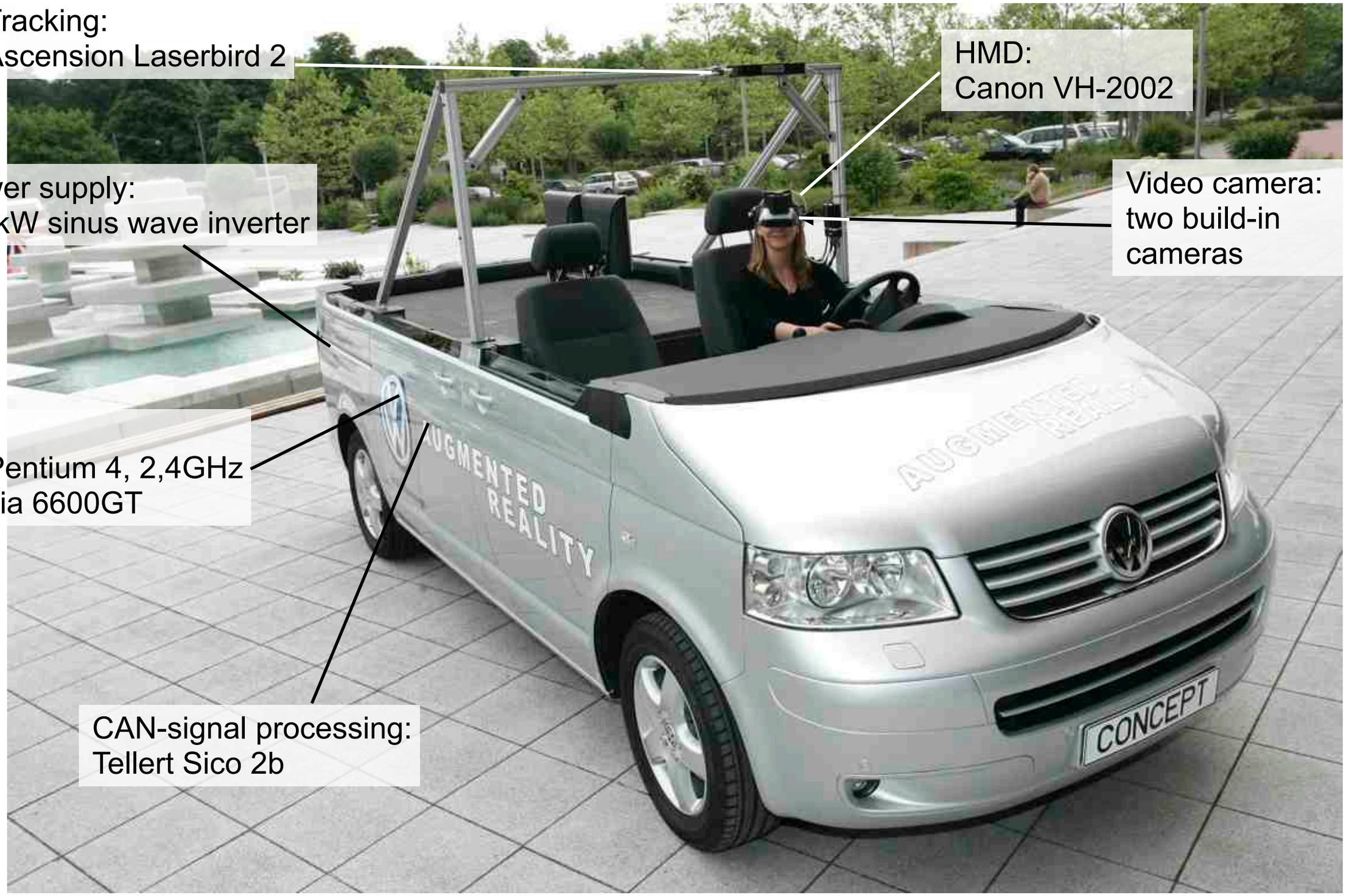
AR Testing Platform



Tracking:
Ascension Laserbird 2

HMD:
Canon VH-2002

Power supply:
2,5 kW sinus wave inverter

Video camera:
two build-in cameras

PC:
2x Pentium 4, 2,4GHz
nvidia 6600GT

CAN-signal processing:
Tellert Sico 2b

AR Testing Platform

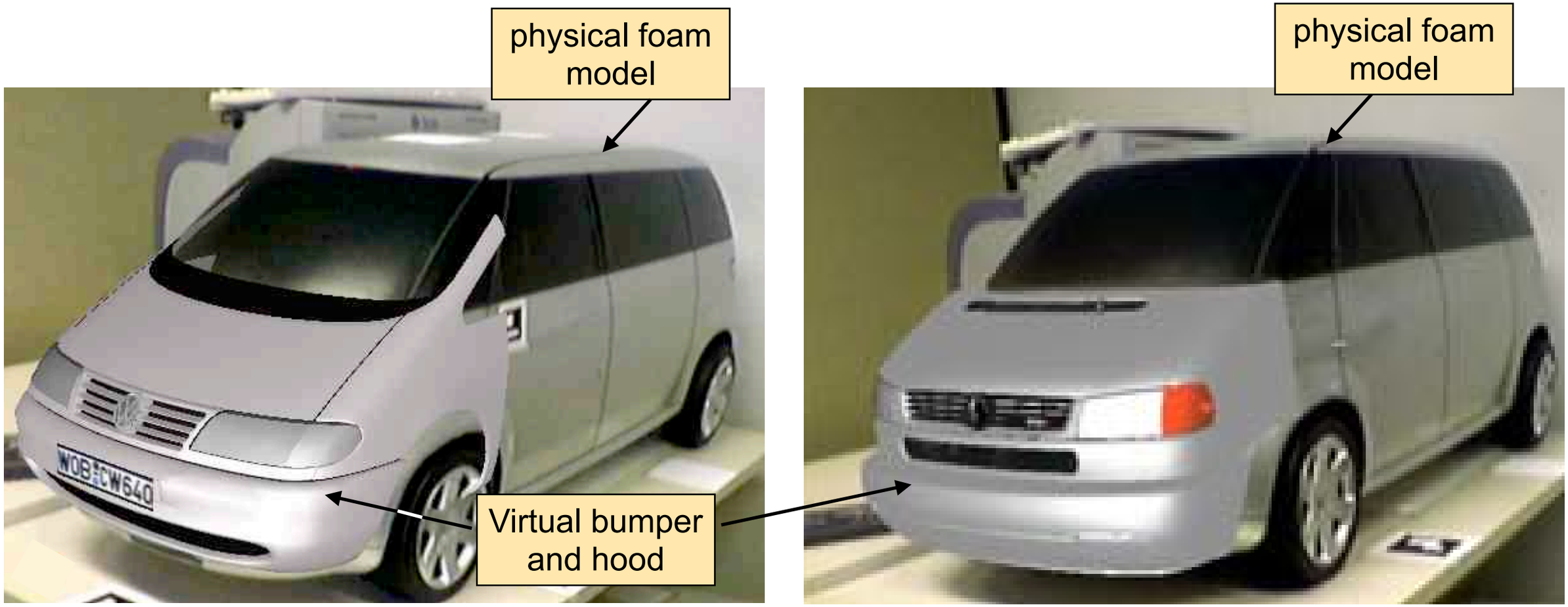
Principle of the AR testing platform

Assessment of viewing conditions:

- Driver asses the car design when driving.
- Virtual parts cover the same part of the physical world than virtual parts

Design Reviews

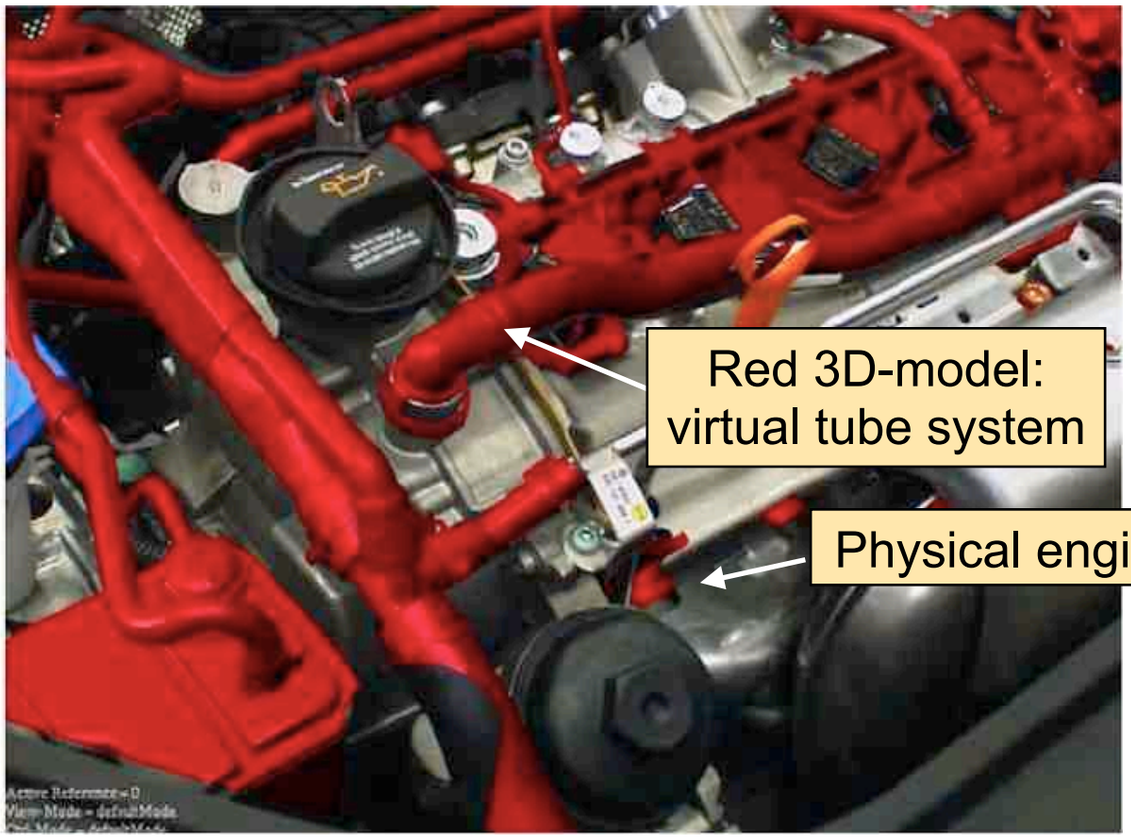
Design review of a car design in an early development stage.



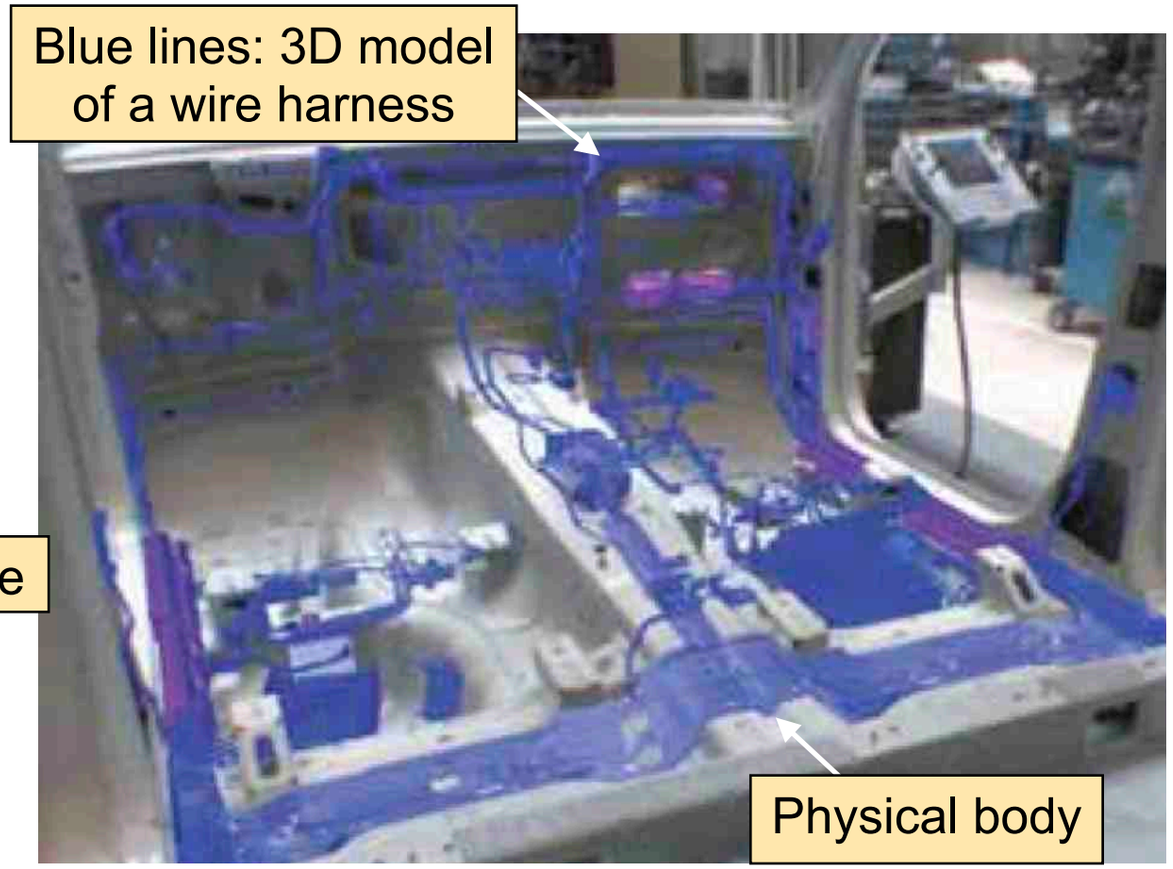
A virtual car front superimposes a physical car body made of foam.

Detailed Design

Several companies already employ AR application on their factory floor.



Design Review application (Volkswagen, Germany)



Virtual Design Review (Daimler, Germany)

Thank you!

Questions?

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