www.uis.no/leanacademy

I-TRACE: Immersive TRAining for aerospaCE

Focus: Immersive Learning in knowledge dissemination: Offshore, Construction, Mechanical and Manufacturing Engineering

by, Prof. R.M. Chandima Ratnayake, IMBM, UiS, Norway.

Source: https://www.tu.no/artikler/bygger-juletraer-med-hologrammer/438125

http://www.bygg.no/article/1391081

I-TRACE

Immersive TRAining for aerospace

ID 2018-1-IT01-KA202-006836

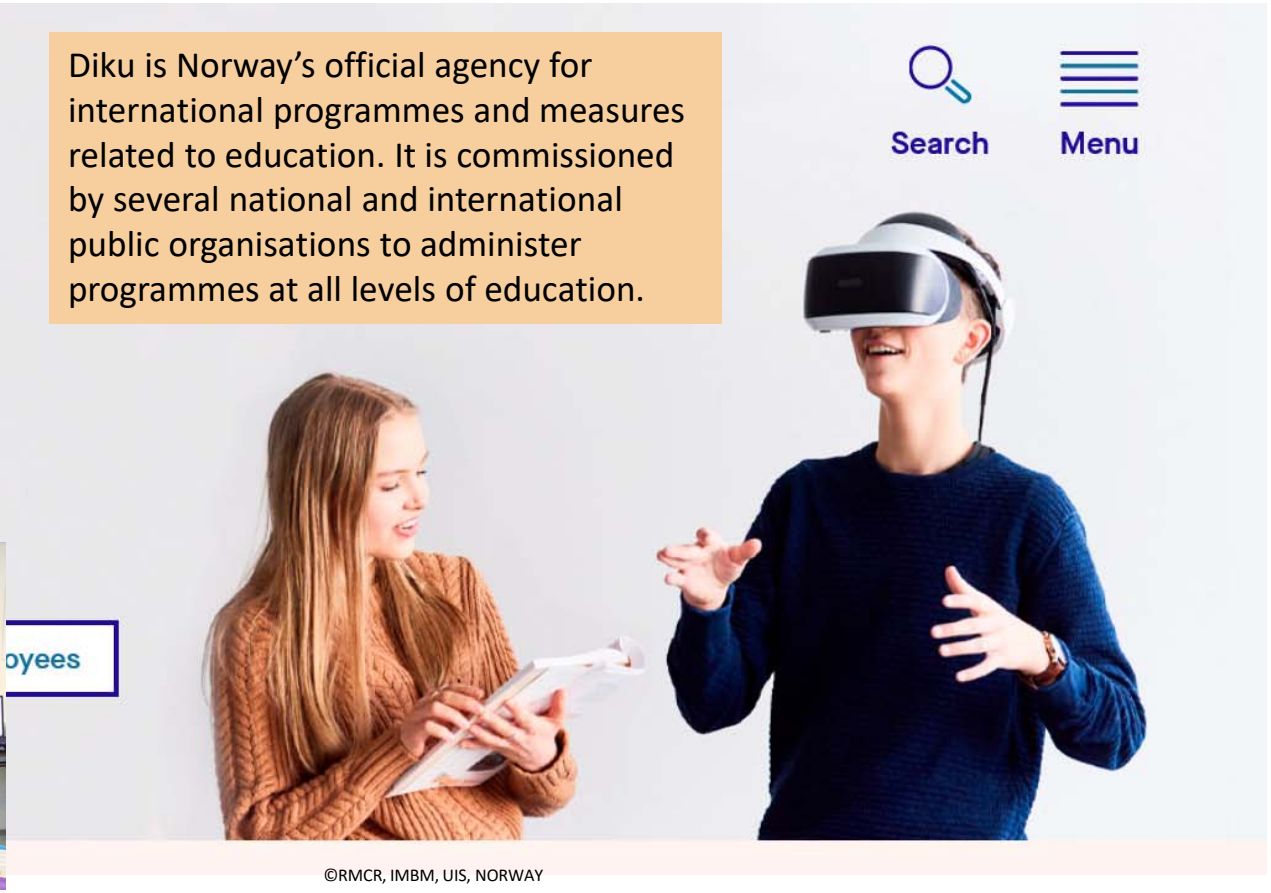
CUP G84D18000120006

National Strategy

https://diku.no/en/

Diku

Diku is Norway's official agency for international programmes and measures related to education. It is commissioned by several national and international public organisations to administer programmes at all levels of education.



UiS and Department of Mechanical and Structural Engineering and Materials Science

University of Stavanger

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Lean 6σ Learning Academy

- LEAN project
- BIM project
- ILA Lean project
- iTRACE project

Lean 6σ Learning Academy

UiS is part of the Lean 6σ Learning Academy, organised by European Networks for Performance Enhancement in Mechanical (Manufacturing) and Construction Industry.

Del artikkel:

Together with the European Networks (in Finland, Poland, Italy, Belgium, Turkey, United Kingdom, Portugal) for Performance enhancement and Department of Mechanical and Structural Engineering and Materials Science,

University of Stavanger (UiS) has a number of strong academic communities linked to the field of performance enhancing in Mechanical and Construction Industry.

The areas of expertise include:

- Mechanical (manufacturing) / Construction
- Engineering
- Lean manufacturing concepts and lean six sigma implementation
- Gamification based knowledge dissemination
- Information Technology
- Digitalization of mechanical/manufacturing and construction operations [Building information modelling (BIM)]
- Implementation of lean philosophies in knowledge work (e.g. Engineering design, Product development, Innovation, Entrepreneurship, Enterprise Resource Planning (ERP), etc., eco-system mapping
- Asset integrity assessment and control

Published 13.03.2018

Contact

University of Stavanger

Front page | Research and PhD studies | Research areas | Manufacturing and construction engineering | Lean 6σ Learning Academy | iTRACE project

Lean 6σ Learning Academy

- LEAN project
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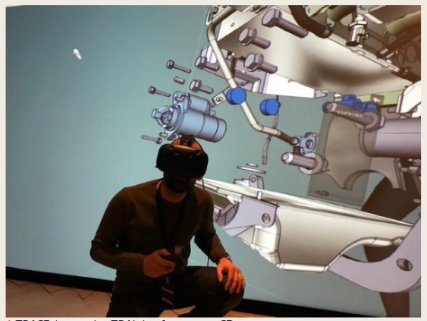
- iTRACE project

I-TRACE, Immersive TRAining for aerospaCE

Department of Mechanical and Structural Engineering and Materials Science at University of Stavanger is a partner of an ERASMUS + Project that is aimed at creating strong partnerships between the world of education and the business world, to develop technical-professional training opportunities strongly anchored to the needs of companies in the European aerospace supply chain.

Del artikkel:



I-TRACE, Immersive TRAining for aerospaCE

Facts

Start Date: 01-11-2018

The project's focus in Norway is on the process industry (e.g. oil and gas), engineering contractors, and manufacturing industry. It

Project Partners

Educational partners:

Politechnika Rzeszowska Im Ignacego Lukasiewicza Prz

Istituto Tecnico Settore Tecnologico "E.FERMI"

University of Stavanger

Institut Illa dels Banyols

Industrial partners:

Consell General De Les Cambres Oficials De Comerc Industria i Navegacio De Catalunya

Cadland SRL

iTrace Project

Project manager at UIS

Professor R.M. Chandima Ratnayake

Project Website

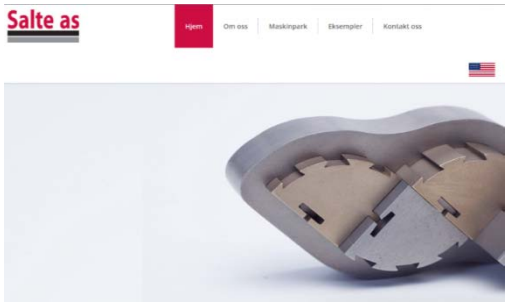
Project Output

https://www.uis.no/research-and-phd-studies/lean-6-learning-academy/

Offshore Petroleum Industry, Engineering Contractors and Manufacturers/Construction Industry

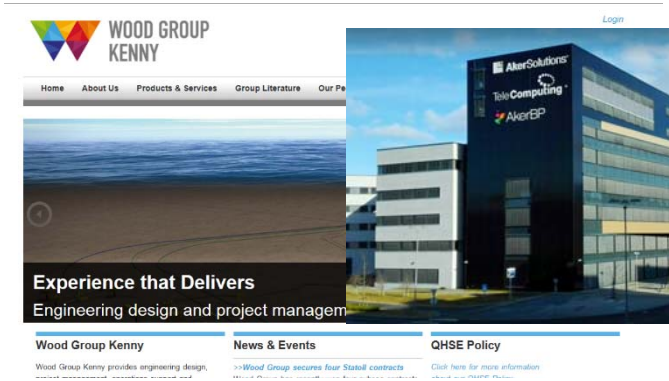
Construction Industry

Offshore Petroleum Industry



Manufacturers (Medium, small and micro-scale)

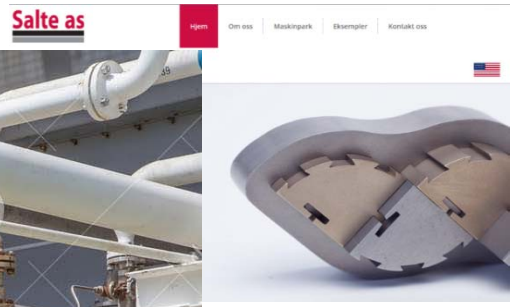
Engineering contractors



Offshore Petroleum Industry vs Aerospace Industry (Risk of potential failures and Hazardous Nature and equipment used are almost the same)

Construction Industry

Offshore Petroleum Industry



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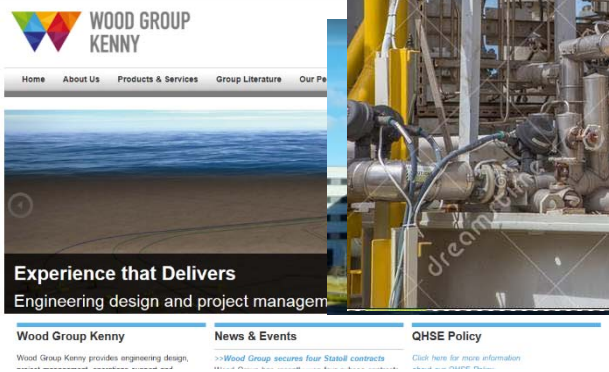
nd micro-scale)

Engineering cont

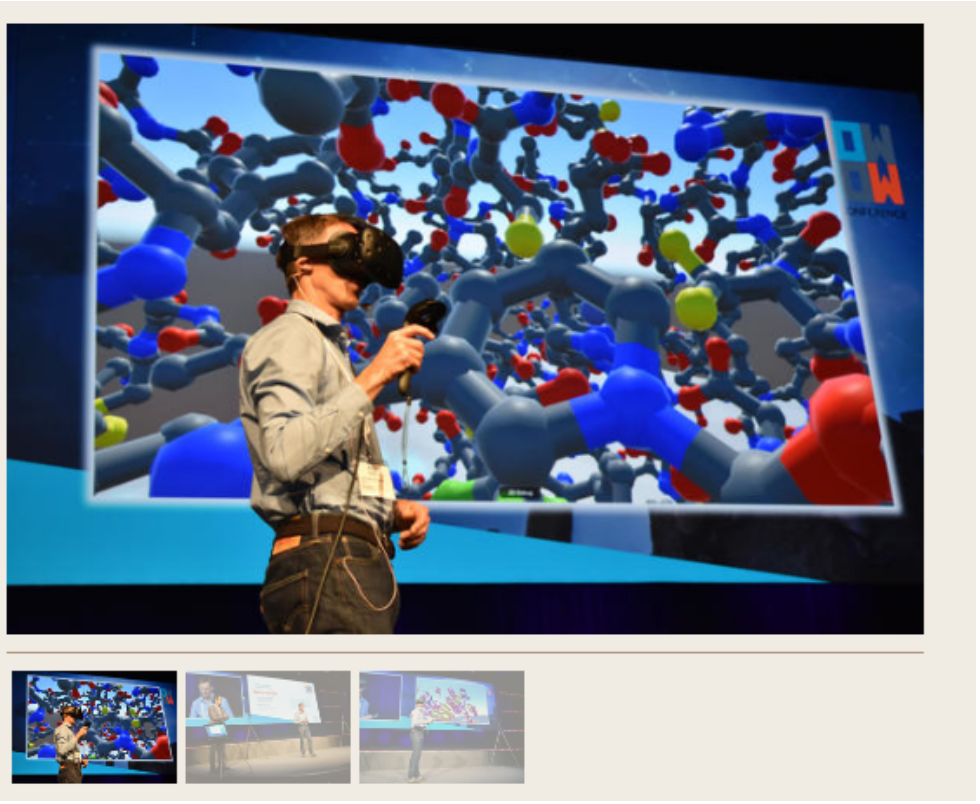


Gas Turbine Compressor Centrifugal Type on Offshore Oil and Gas Production and Processing Plant.

AR/VR Developments within University of Stavanger

Teaching molecular biology in virtual reality

CORE (Centre for organelle research)



https://www.uis.no/faculty-of-science-and-technology/teaching-molecular-biology-in-virtual-reality-article120293-9694.html

AR/VR use in University of Stavanger: Didactical Digital Lab

VR-show and competitions

Curious about VR? Friday the 20th of April there will be competitions on VR in the Didactical Digital Lab.

Tweet Like 0

https://student.uis.no/studiehverdag/undervisning-og-praksis/didaktisk-digitalt-verksted-ddv/

Facts

20.04.2018
12:00 - 15:00

Didactical Digital Lab,
Hagbard Line house

On Friday the 20th of April there will be a VR-show in the Didactical Digital Lab. You will get the opportunity to use new VR-technology, play games and take part in competitions. There will also be presentations of brand new VR-technology. Drop in and learn more about VR-technology and other cool stuff.

NB! Signing up is needed for this class. You sign up by sending an e-mail to ddv1@uis.no.

Didaktisk digitalt verksted (DDV) foundation in IMBM:
https://www.uis.no/research-and-phd-studies/lean-6-learning-academy/itrace-project/?s=25469

Minister's involvement and interest in immersive learning:
http://www.bygg.no/article/1391081

3D Organon VR Anatomy https://www.youtube.com/watch?v=QFiSfEX-Q0M

Minister's involvement and national interest in immersive learning

C2 **Training of Trainers about Immersive Methodology** **Leading Organisation: STAVANGER**	Participants: **2 teachers/trainers from each organization.** Open to local participants (teachers/trainers/employers) **Practical experimentation of pedagogical approaches and methodologies** based on **digital integration in teaching**, through the use of immersive learning, offered by the new 3D virtual learning environments or other innovative forms of experiential learning. The University of Stavanger guides the training informing about immersive methodology both from educational and from technical point of views, and share information about **successful examples in oil and gas sector**, which has many common characteristics with aerospatial sector. The course **will be focused especially on the higher education point of view**, showing how immersive training is used for tertiary education and professional training.

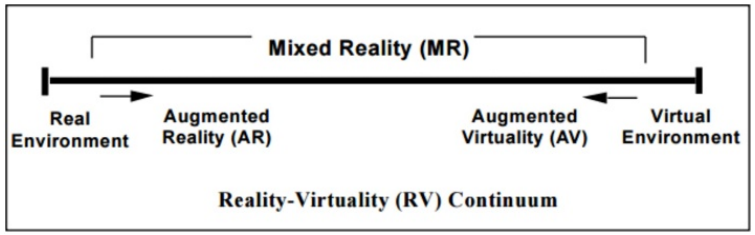
Immersive Learning Training Content

- Keywords / Definitions/XR
- Basic modules of an immersive learning system
- Role of Knowledge Dissemination vs. Why XR?
- Architecture of AR systems
- Augmented and Virtual Reality
- State of the art of VR applications in design and manufacturing processes

Keywords / Definitions

IMMERSIVE

- "generating a three-dimensional image which appears to surround the user" (*Oxford-Dictionary*)
- "providing, involving, or characterized by deep absorption or immersion in something (such as an activity or a real or artificial environment)" (*Merriam-Webster*)
- "seeming to surround the audience, player, etc. so that they feel completely involved in something" (*Cambridge-Dictionary*)
- "providing information or stimulation for a number of senses, not only sight and sound" (*Collins - Dictionary)*



Keywords / Definitions

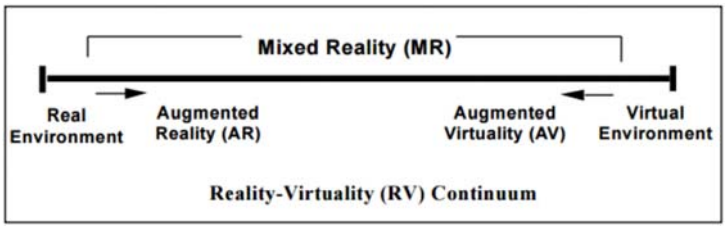
Extended REALITY (VR)

- Extended reality (XR) is a term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables.
    - it includes representative forms such as augmented reality (AR), augmented virtuality (AV) and virtual reality (VR) and the areas interpolated among them.
    - The levels of virtuality range from partially sensory inputs to immersive virtuality, also called VR.

- XR is a superset which includes the entire spectrum from "the complete real" to "the complete virtual" in the concept of reality–virtuality continuum introduced by Paul Milgram.
    - XR's association lies in the extension of human experiences especially relating to the senses of existence (represented by VR) and the acquisition of cognition (understanding) (i.e. represented by AR).
    - With the continuous development in human–computer interactions, this association is still evolving.

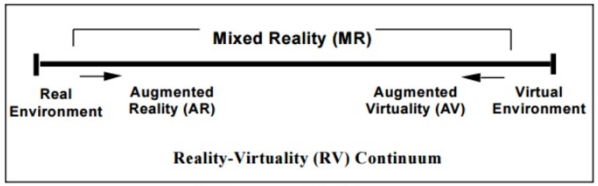
Source: Wikipedia, the free encyclopedia

http://panopics360.com/extended-reality-xr/



Source: Milgram, Paul; H. Takemura; A. Utsumi; F. Kishino (1994). "*Augmented Reality: A class of displays on the reality-virtuality continuum*" (pdf). Proceedings of Telemanipulator and Telepresence Technologies. pp. 2351–34. Retrieved 2007-03-15.

Keywords / Definitions



Reality	Augmented Reality	Virtual Reality	Mixed Reality	Augmented Virtuality	Virtuality
The actual world that we experience with all of our senses.	Information and data overlaid on top of the actual world.	A complete digital representation of the actual world.	The introduction of possible elements into an actual world.	The introduction of actual elements into a possible world.	An imaginary world that mostly follows the rules of the actual world.
An actual house.	A realty app provides details of an actual house.	A 3D image of actual furniture. A virtual tour of an actual house.	Simulation of different furniture, virtual or new, in an actual house.	Staging of actual furniture in a new house.	A 3D model for a new house or of new furniture.
Key concept: Physical co-presence of people and objects.	Key concept: Add utility to physical co-presence.	Key concept: Enable perceived presence and full immersion.	Key concept: Adaptation of actual scenarios.	Key concept: Participation in possible scenarios.	Key concept: Vision of a completely different world.

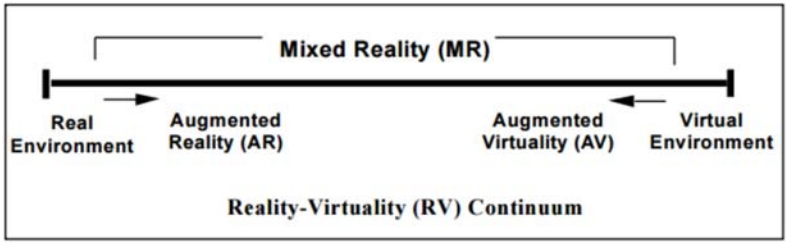
Real

Possible

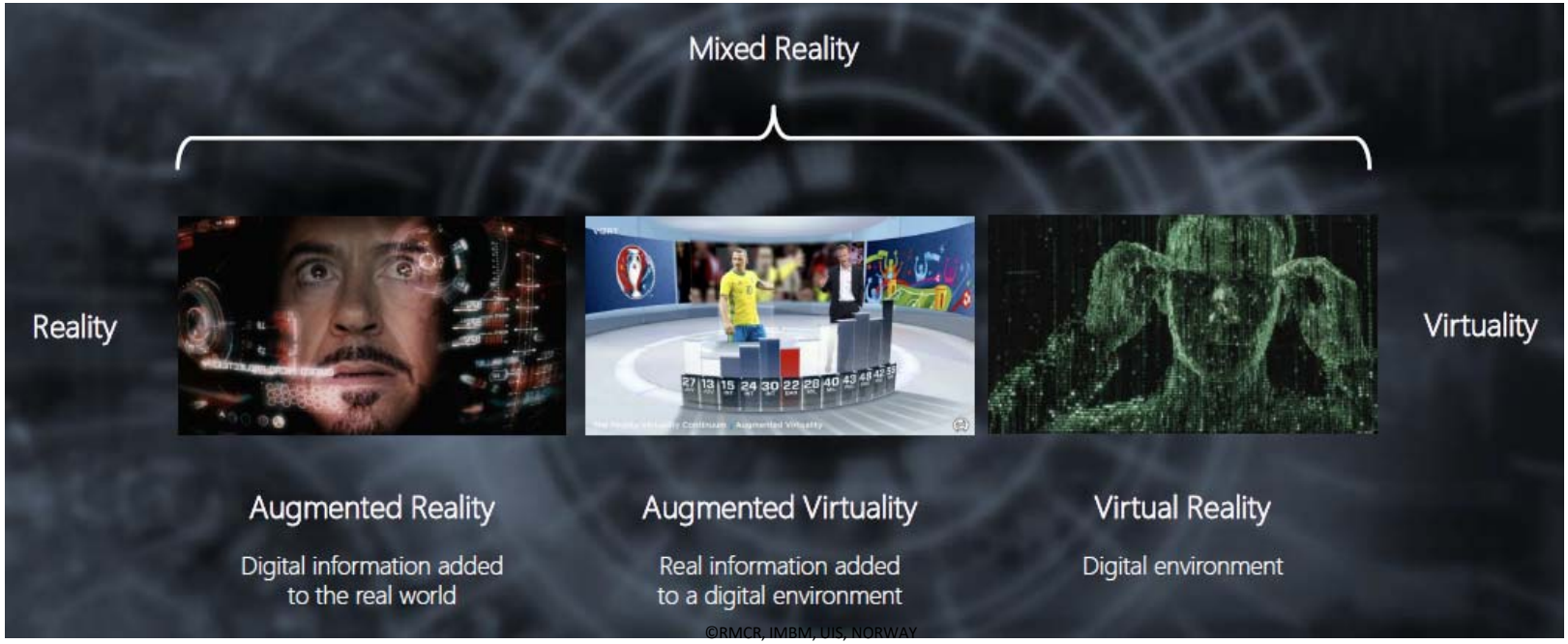
The Virtuality Continuum

[by Paul Milgram, a professor of mechanical and industrial engineering at the University of Toronto].

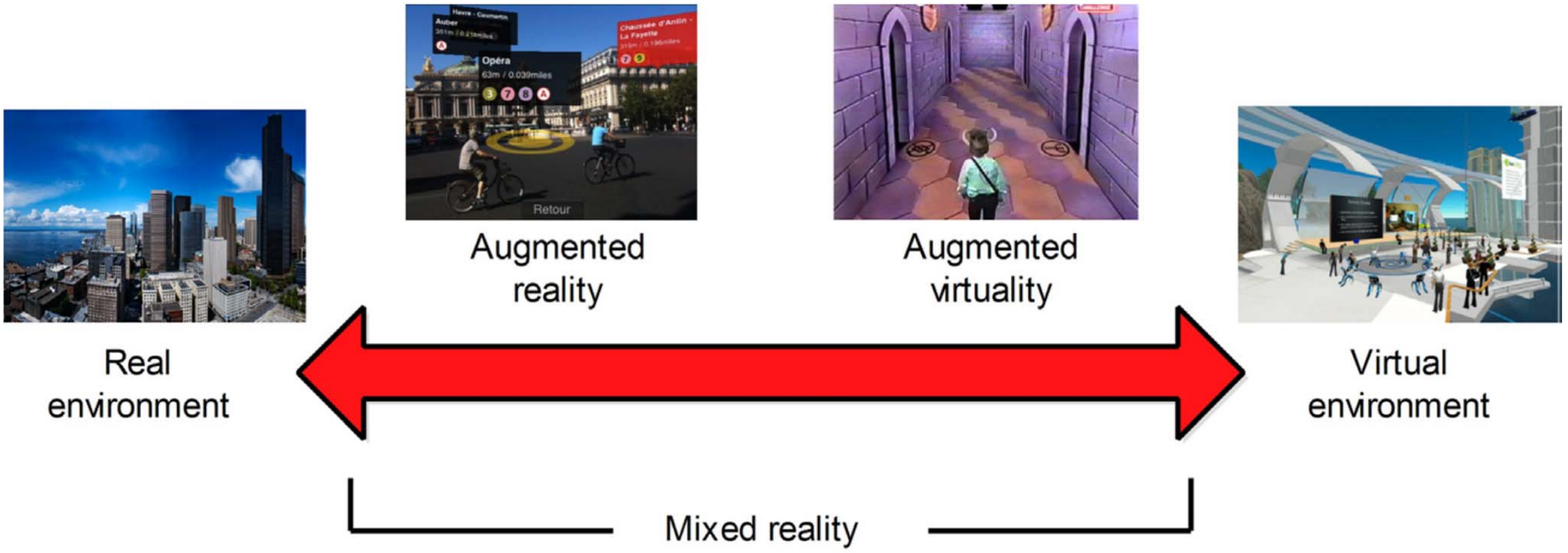
The Virtuality Continuum



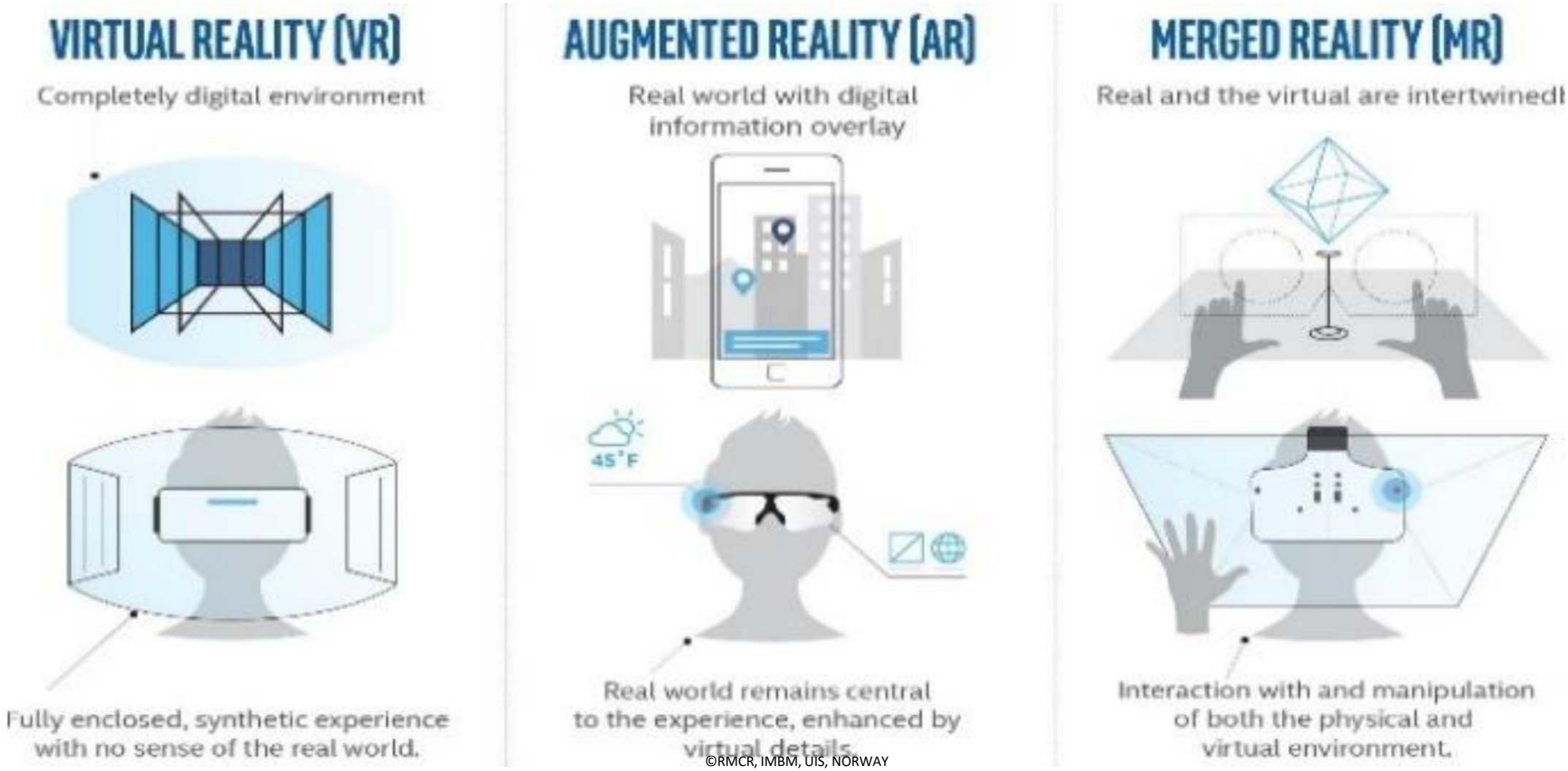
Mixed Reality



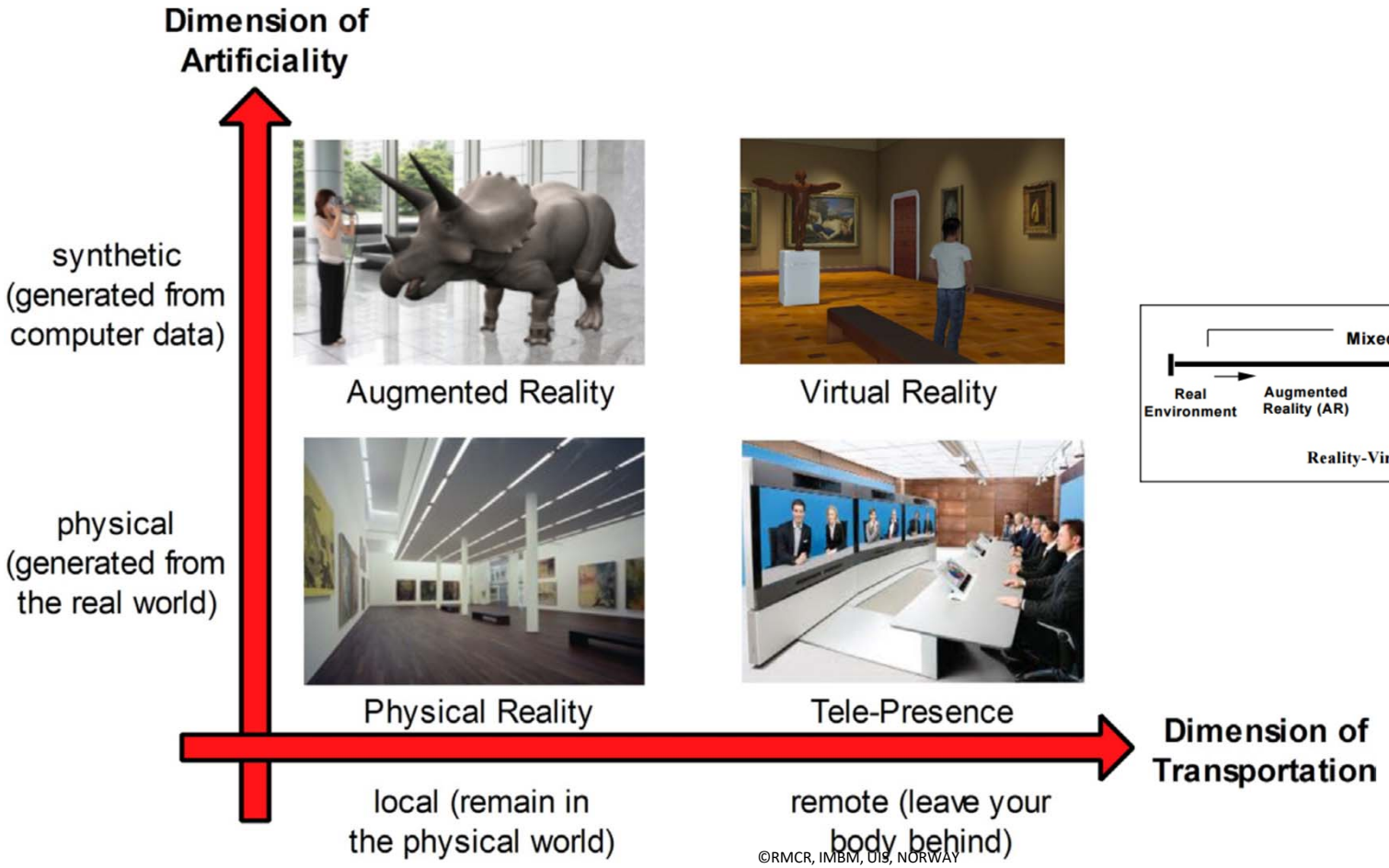
Reality-virtuality continuum

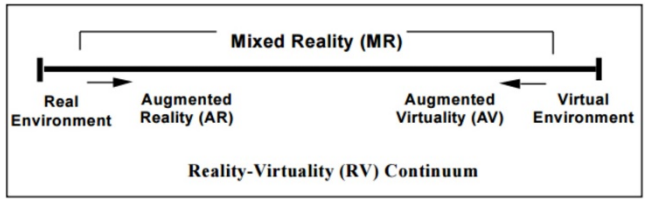


Reality-virtuality continuum



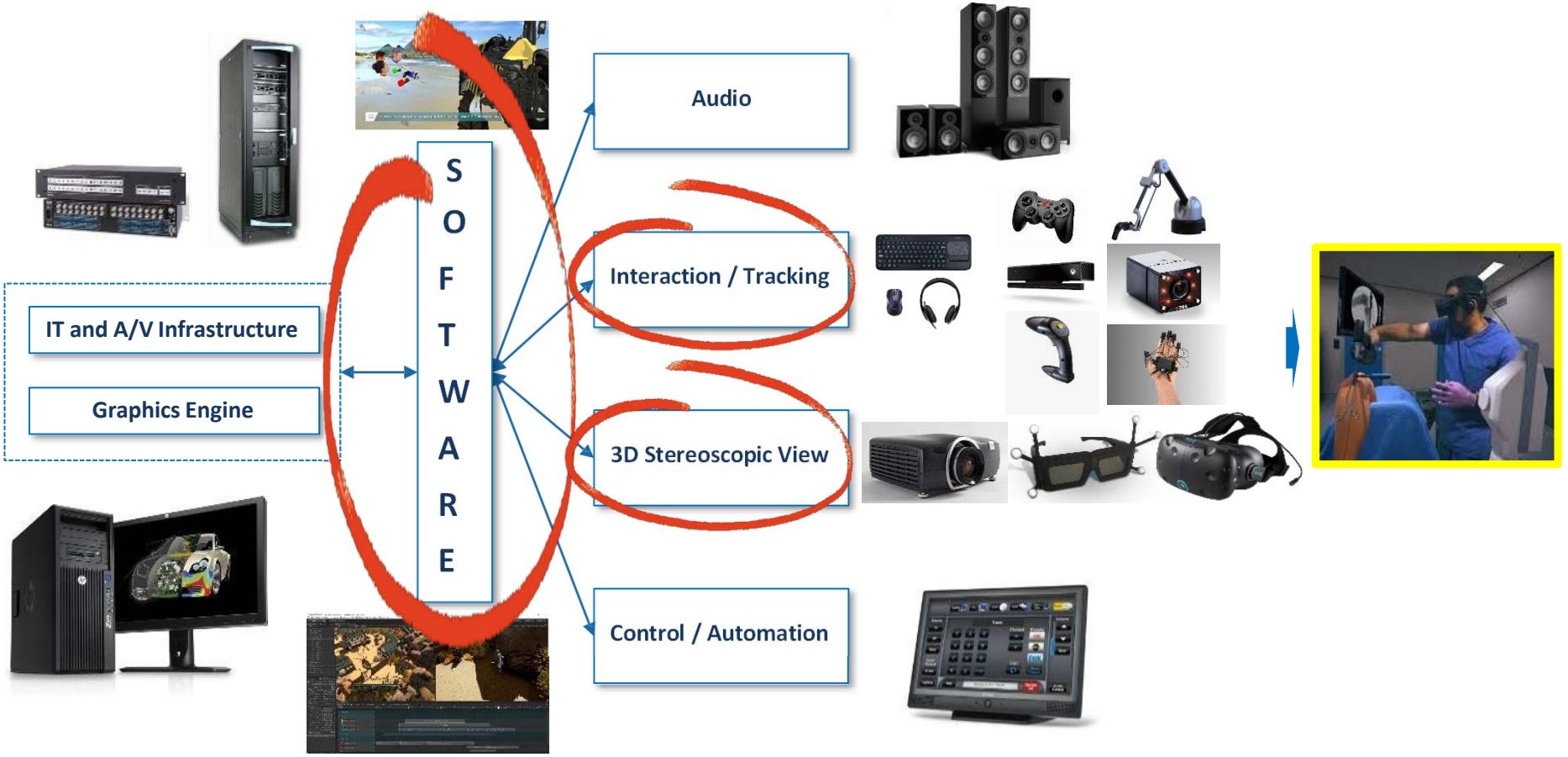
Reality-virtuality continuum





Basic modules of an immersive learning system

Basic modules of an immersive learning system



Interaction / Tracking

Standard

PROS

Low cost

Easy to use

CONS

Limited interaction

Low precision

Gaming

PROS

Low cost

Games compatibility

CONS

Limited interaction

Low precision

Usually interfaces must be developed

Tracking / Haptic

PROS

Advanced interaction

High precision

CONS

Medium cost

Usually must be integrated by developing

Professional training is needed

Tracking / Haptic + VR Driver

PROS

Advanced interaction
High precision
Maximum flexibility
Transparently display of existing 3D applications

CONS

Relatively High cost

Role of Knowledge Dissemination and Why XR?

Why Extended Reality?

- Level of understanding
- Geometric understanding

- Immersive environments can convey information in a more comprehensive manner compared to monitor based or paper based [29].
  - There are at least three ways, an immersive environment can enhance understanding of information:
    - I. by transfer,
    - II. by situated learning, and
    - III. by enabling multiple perspectives

Source: [29]Elliot W Eisner. Eisner, Elliot W., The Enlightened Eye: Qualitative Inquiry and the Enhancement of Educational Practice. Prentice-Hall, 1991.

Why Extended Reality?

Transfer

Transfer is the ability to use knowledge learned in one situation and apply it to another [31].

- Example: Possible transfer in the industry;
  - Experts and/or senior members of a team would be able to identify problems before they occur or
  - knowing how to deal with problems when they occur, (i.e. experienced something similar on a previous project).
  - A way to implement the above in a virtual environment can be a virtual reality case.
- Role of higher education: Even though a person never experiences that exact case in real life, they might be able to draw some parallels and utilize their knowledge.
  - i.e. leaning to stay clam in stressing situations or know what strategy to use when solving a problem in practice [32].
- Note:
  - Term transfer is not to be confused by the term knowledge sharing.
  - Term transfer relies on previous personal experiences/education,
  - knowledge sharing relies on obtaining knowledge from an external source [33].
    - i.e. from (but is not limited to) other people, articles, news and social media.

Why Extended Reality?

Situated learning and multiple perspectives

"a good way to learn may be to try and fail until you do not fail".

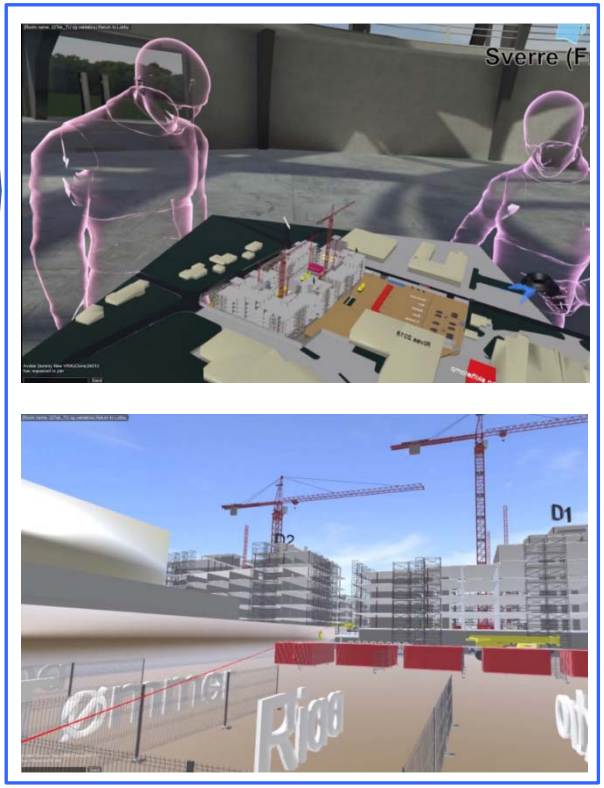
- i.e. a risky way of thinking if you consider industrial applications in the real world and is not a feasible concept.
- A better idea is to perform the try and fail actions in a life-like, virtual environment and possibly fail.
  - using authentic contexts and activities coupled with expert mentoring, a gradual increase of skill level is obtained.
  - This approach is relevant for skilled workers in further training and in improving employees' ability to identify and mitigate HSE risks, amongst others (e.g. welding, design, product development, planning, etc.).

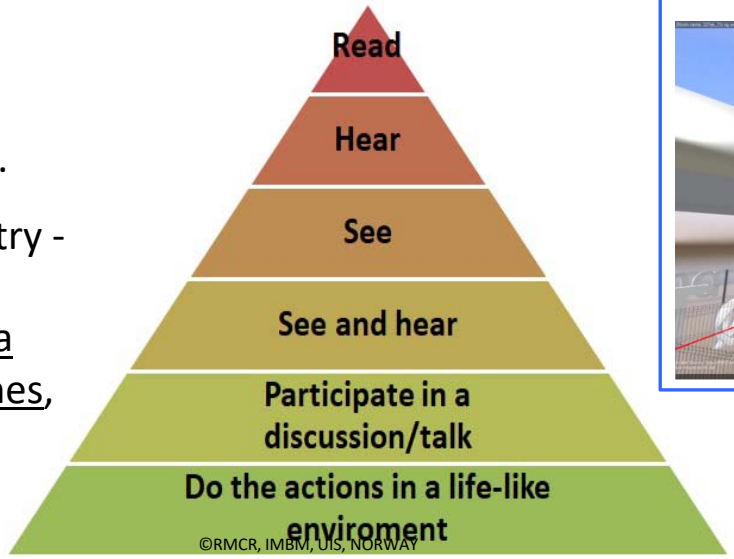
Edgar Dale's cone of experience as shown here illustrates the amount of information obtained through different activities.

Why Extended Reality?

Reading vs. Situated Learning

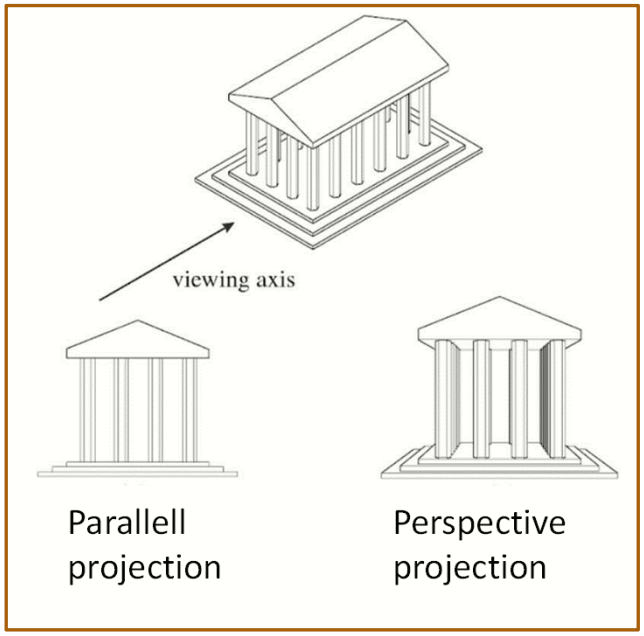
- Reading conveys the least amount of information while situated learning provides the most.
- Note: Industrial applications consist of frequent complex problems within mechanical, manufacturing/ construction, planning, design, product development, etc., disciplines.
- Examples: Construction industry - areas containing multiple disciplines, or the planning of a construction site with load zones, placement of cranes, etc.





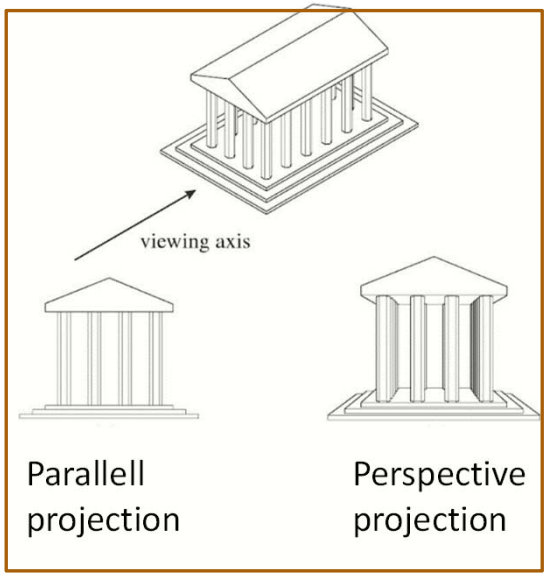
Why Extended Reality? '2D/3D' vs. 'Immerse oneself'

- Interpreting 2D drawings or even a 3D model on a screen may not provide enough clarity of the problem.
  - Being able to immerse oneself "in to" the problem and looking at it from any desirable angle, be it exocentric (from outside, looking in) or egocentric (from within looking out), improves understanding of the problem.
  - An immersive virtual environment has a statistically significant advantage over monitor displays when it comes to understanding complex 3D geometry.
- The main reason XR could be beneficial for the industry:
  - the difference in spatial cognition (3D understanding) between monitor-based consumption of digital environments and immersive ones [29].
  - When evaluating a design using XR, realistic proportions are observed but the same can not necessarily be said about 3D designs on 2D display surfaces [37].
    - The reason for this loss of realism is due to the fact that 3D objects are displayed as 2D objects using projections.
  - A projection is a technique to transform 3D objects to 2D objects.
    - There are essentially two types of projections: **Parallel-** and **perspective projection.**

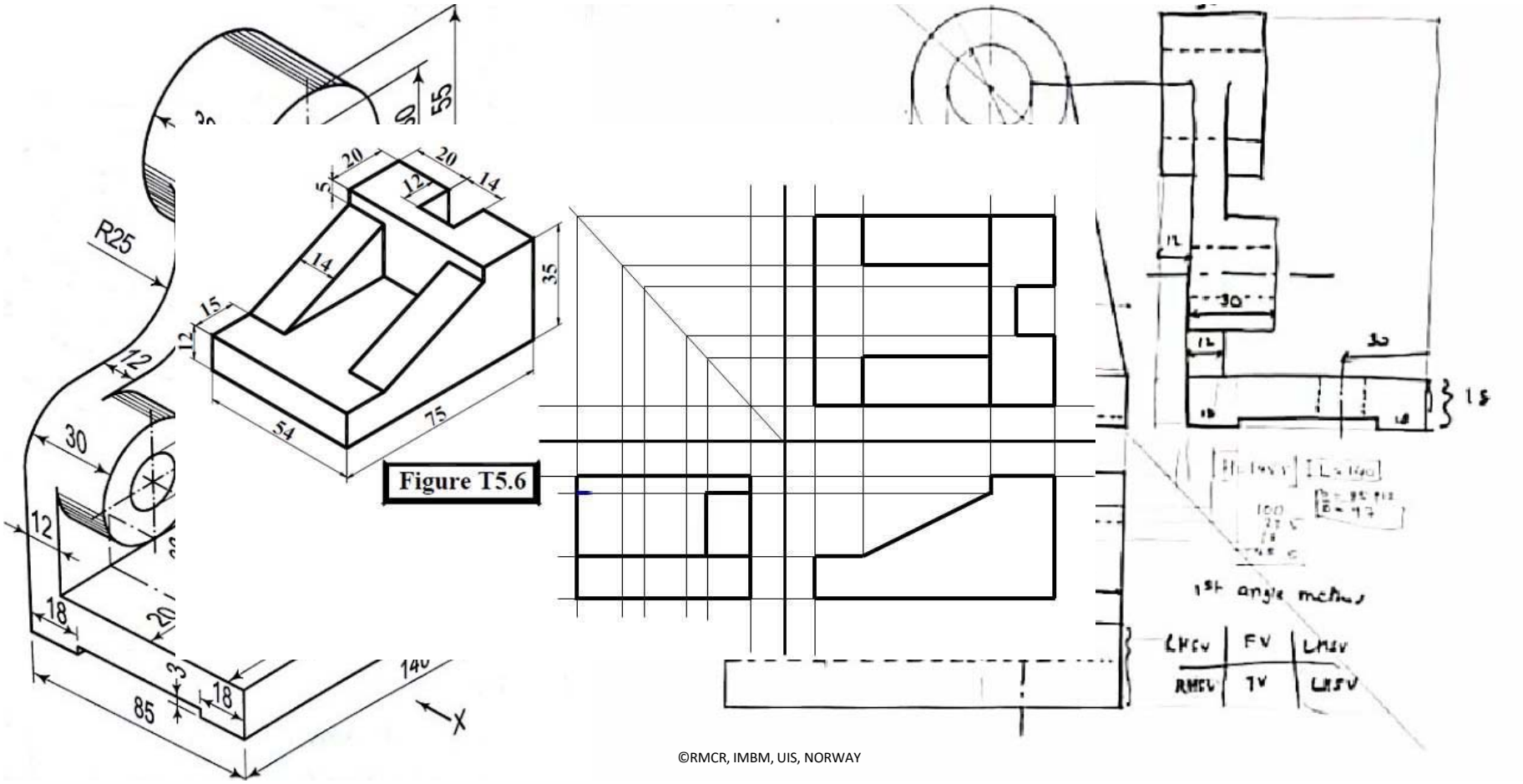


Why use Extended Reality? ‘2D/3D’ vs. ‘Immerse oneself’

- With parallel projection, - the "camera" or center of projection is located at an infinite distance from the object [39].
  - Lines that are parallel in two dimensions remain so in three dimensions.
  - The benefits of using a parallel projection is that dimensions are preserved and parallel lines remain parallel, making such a projection suitable for technical drawings.
  - The drawbacks are that angles are generally not preserved and the fact that it looks unrealistic.
- Perspective projection assume that the "camera" or viewpoint is near the object [39].
  - Lines that are parallel in three dimensions are thus not necessarily parallel in two dimensions.
  - The benefit of using a perspective projection is that the size varies inversely with distance, resulting in a realistic look. The drawback is that distance and angles are, in general, not well preserved [40].
- When using XR to evaluate a design, it is possible to obtain the benefits of both types of projections with no drawbacks.
  - A sense of space and realistic design is achieved while preserving dimensions.
  - A design is usually presented using a perspective projection in XR [39], but design properties such as measurements and angles are usually accessible from the model and easily accessed in an immersive environment.



Why use Extended Reality? ‘2D/3D’ vs. ‘Immerse oneself’

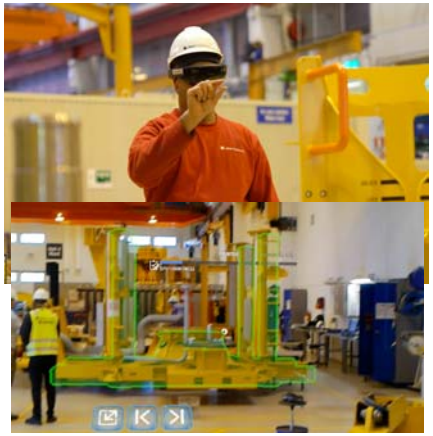


Augmented Reality (AR) and Virtual Reality (VR)

Keywords / Definitions

AUGMENTED REALITY (AR)

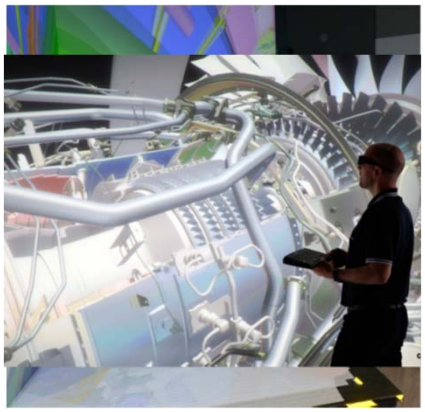
- "an artificial environment created through the combination of real-world and computer-generated data". *(Collins Dictionary)*
- "an enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device (such as a smartphone camera)" (*Merriam-Webster*)
- "an interactive experience of a real-world environment whereby the objects that reside in the real-world are "augmented" by computer-generated perceptual information, sometimes across multiple sensory modalities" (*Wikipedia*)



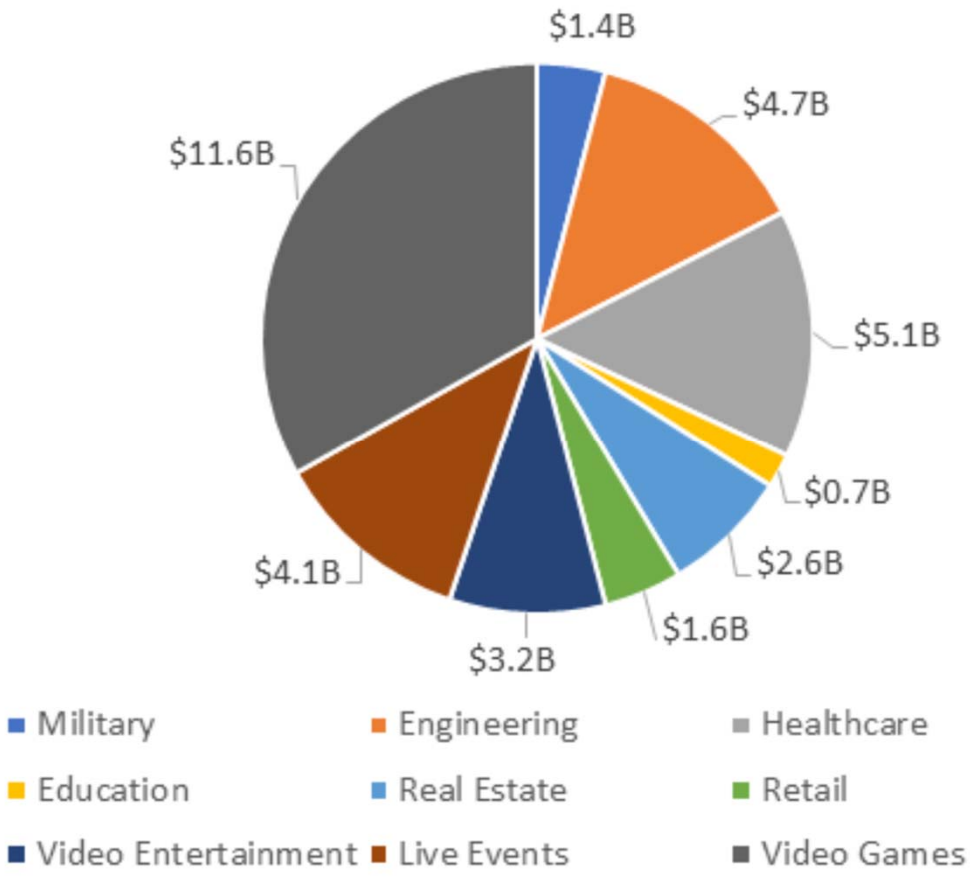
Source: https://www.tu.no/artikler/bygger-juletraer-med-hologrammer/438125

VIRTUAL REALITY (VR)

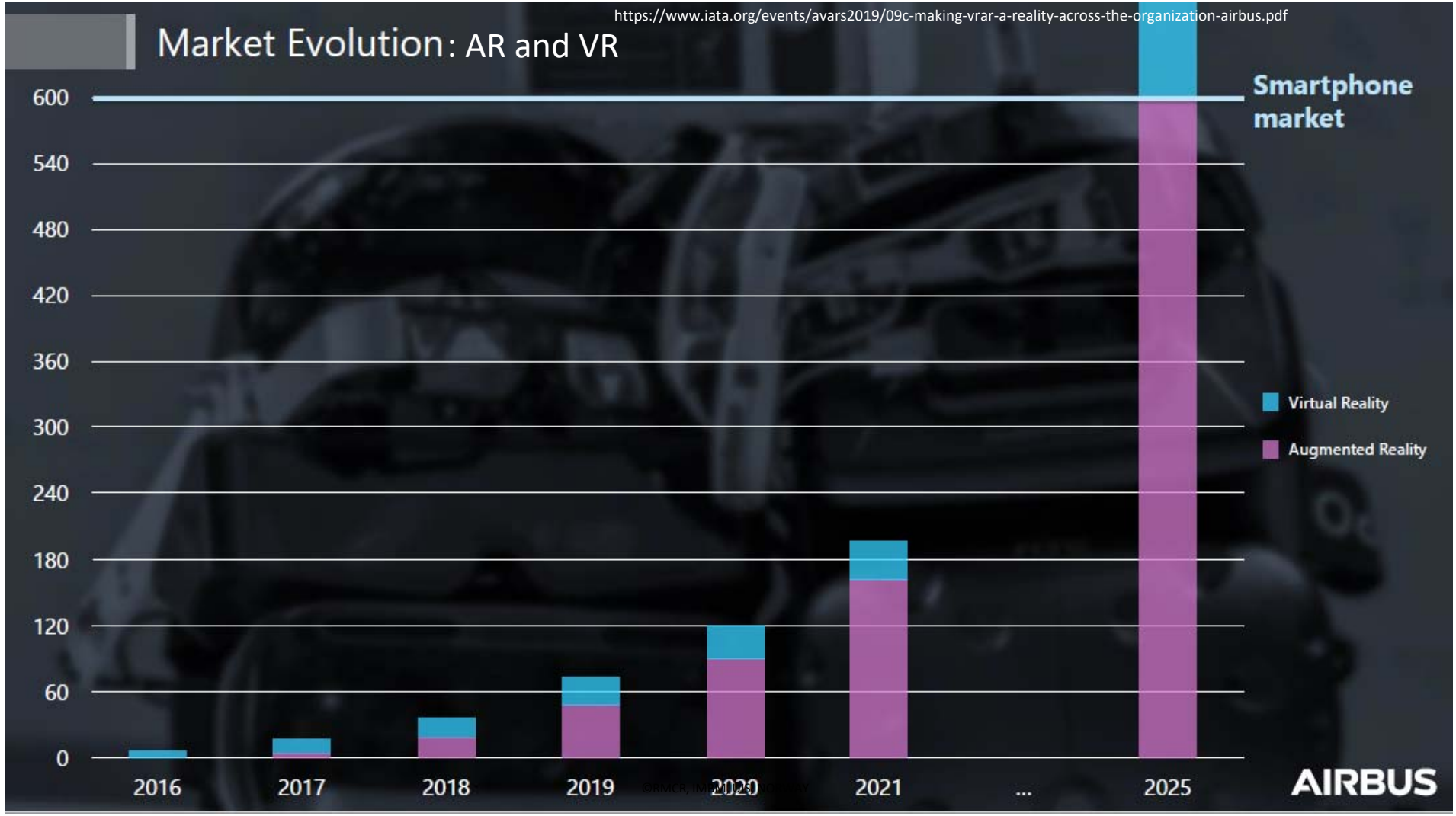
- "is an interactive computer-generated experience taking place within a simulated environment, that incorporates mainly auditory and visual, but also other types of sensory feedback like haptic. This immersive environment can be similar to the real world or it can be fantastical, creating an experience that is not possible in ordinary physical reality". (*Wikipedia*)
- Note: "Augmented reality systems may also be considered a form of VR that layers virtual information over a live camera feed into a headset or through a smartphone or tablet device giving the user the ability to view three-dimensional images ". (*Wikipedia*)
- "an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment". (*Merriam-Webster*)



Projected Revenue for VR & AR Sector

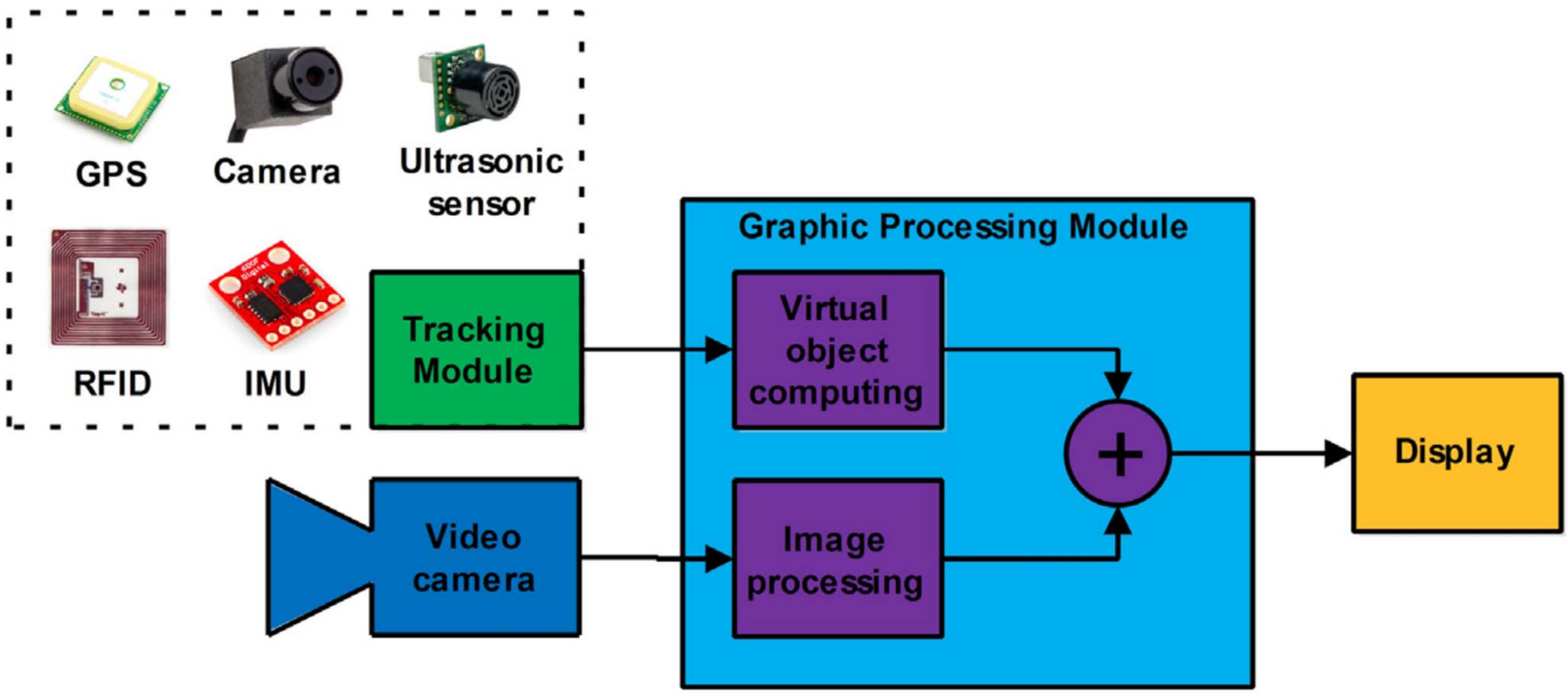


https://www.iata.org/events/avars2019/09c-making-vrar-a-reality-across-the-organization-airbus.pdf



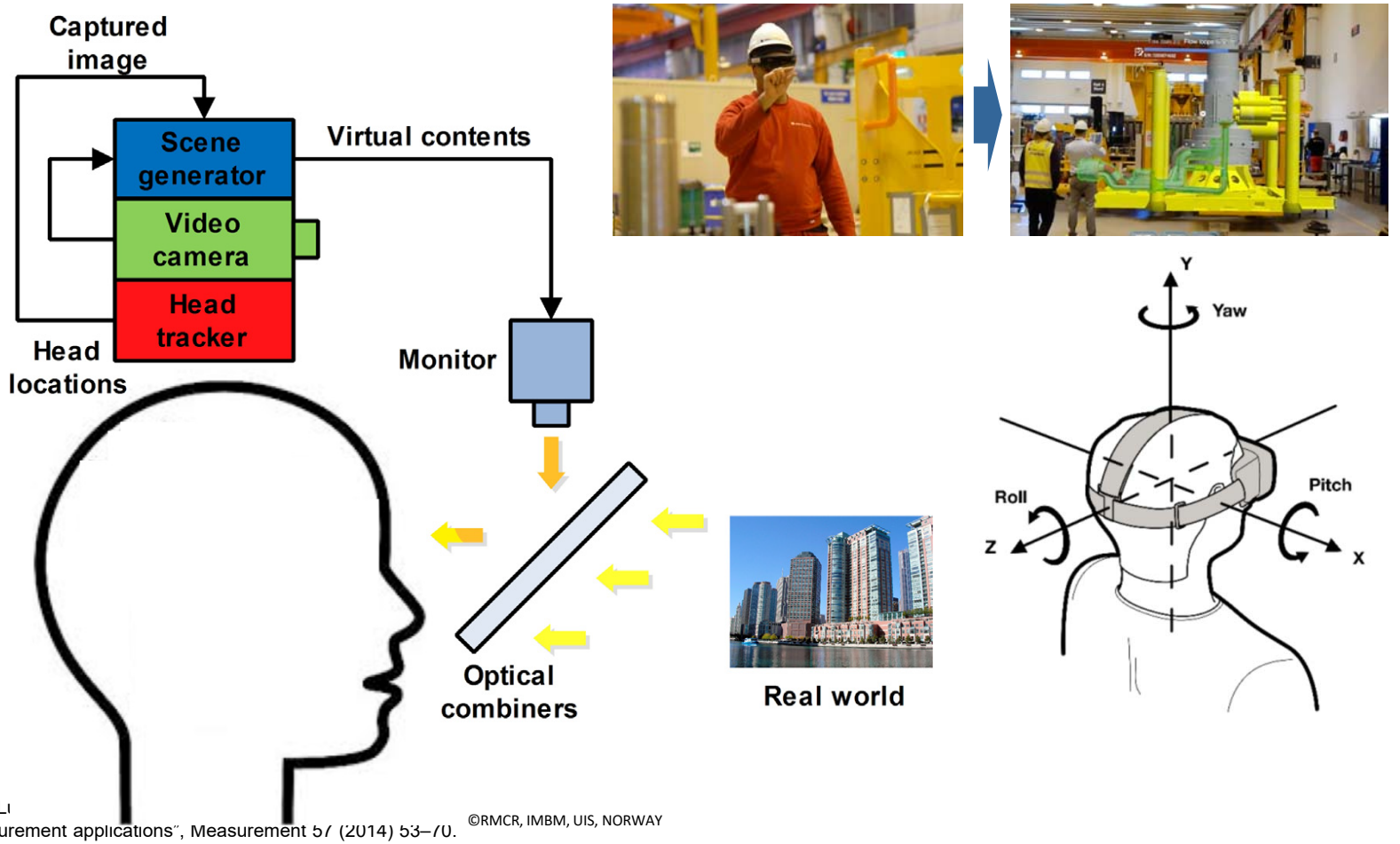
Architecture of AR systems

General architecture of an AR system



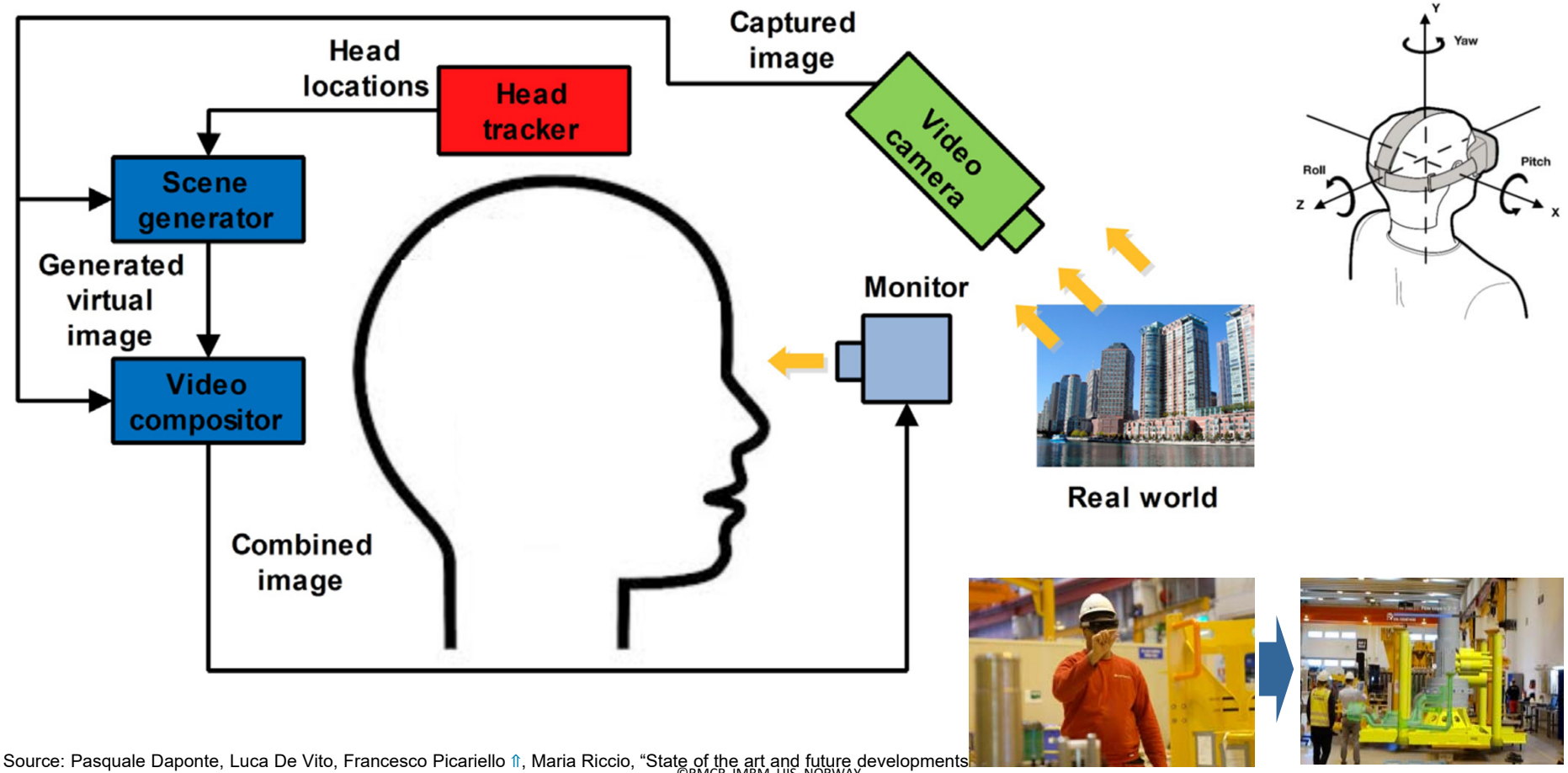
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of an optical see-through Head Mounted Display (HMD)



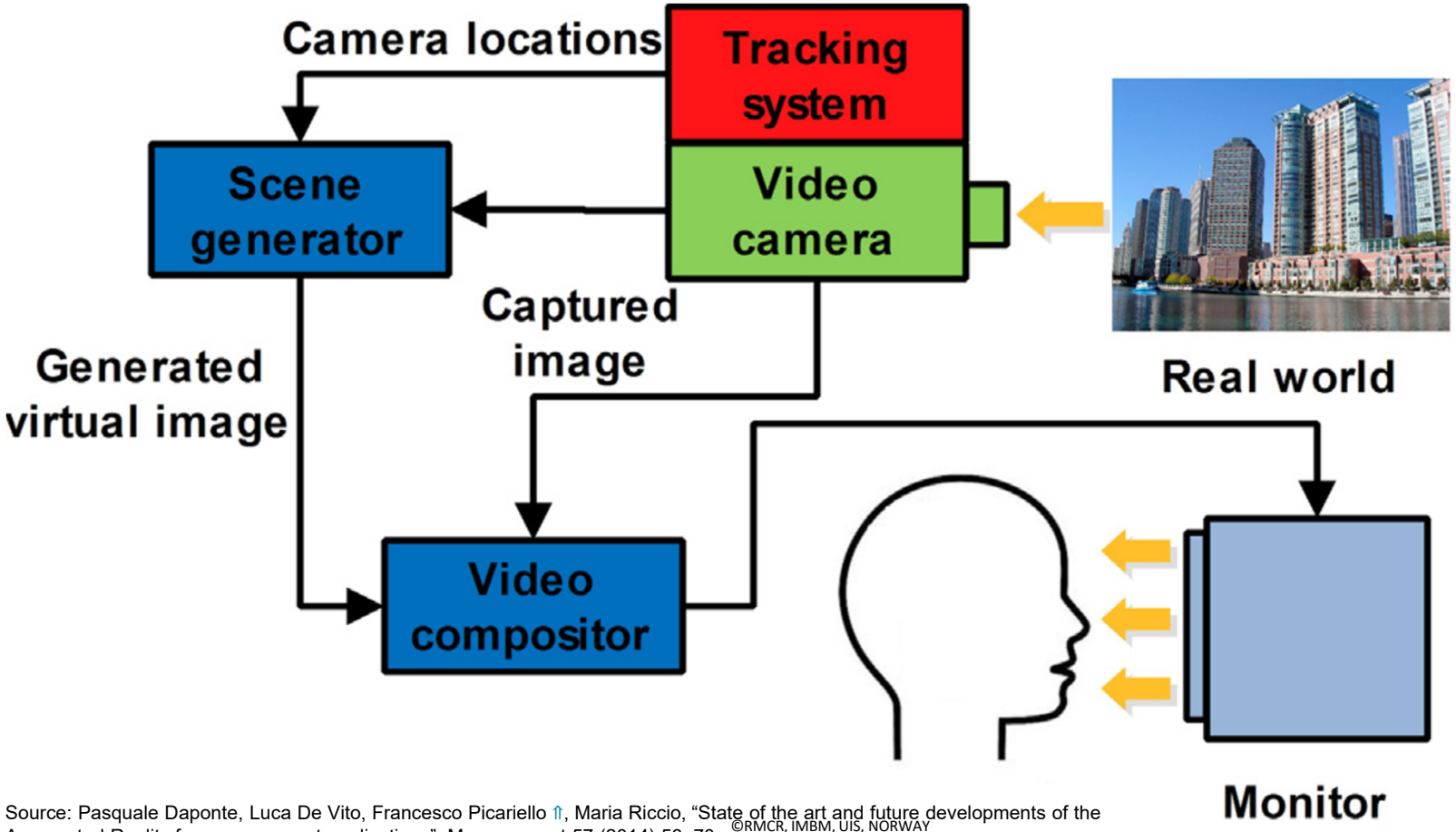
Source: Pasquale Daponte, Li
Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of a video see-through Head Mounted Display (HMD)



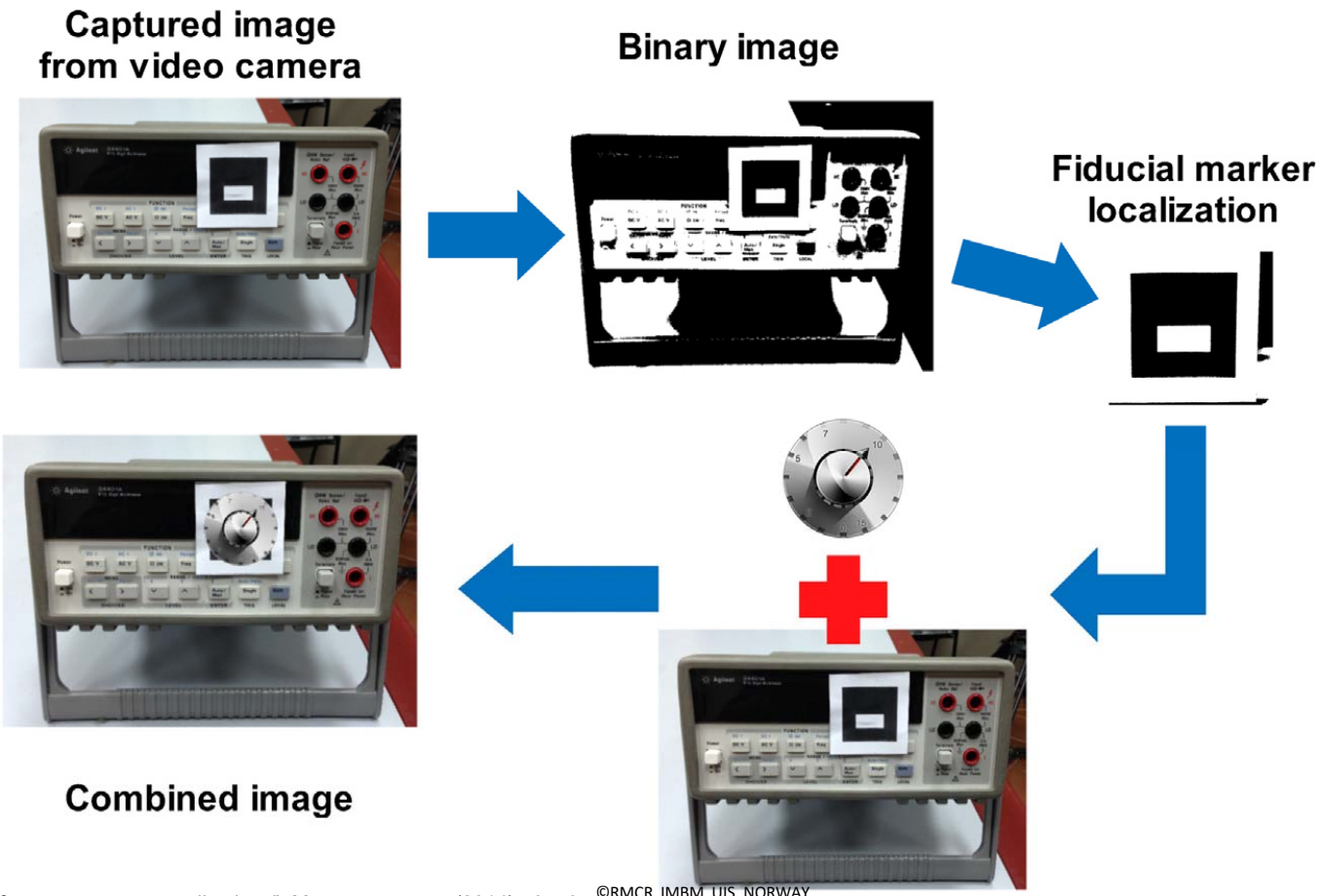
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of a monitor-based AR system



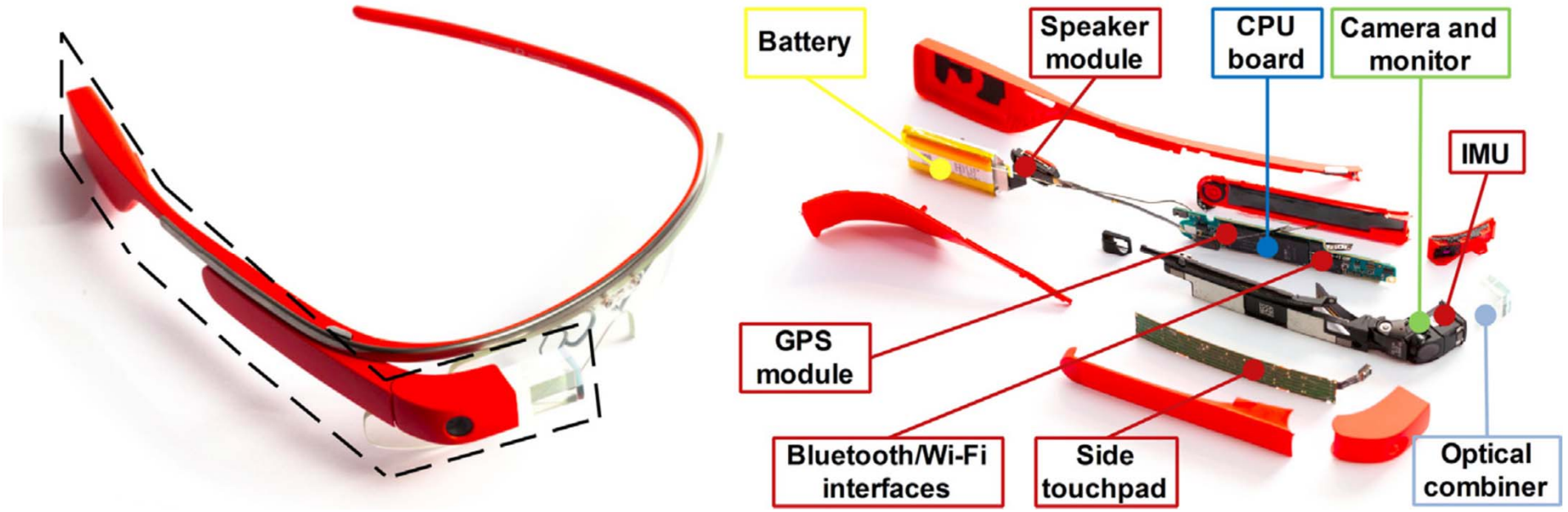
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Main operations for a marker-based AR system



Source: Pasquale D
Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

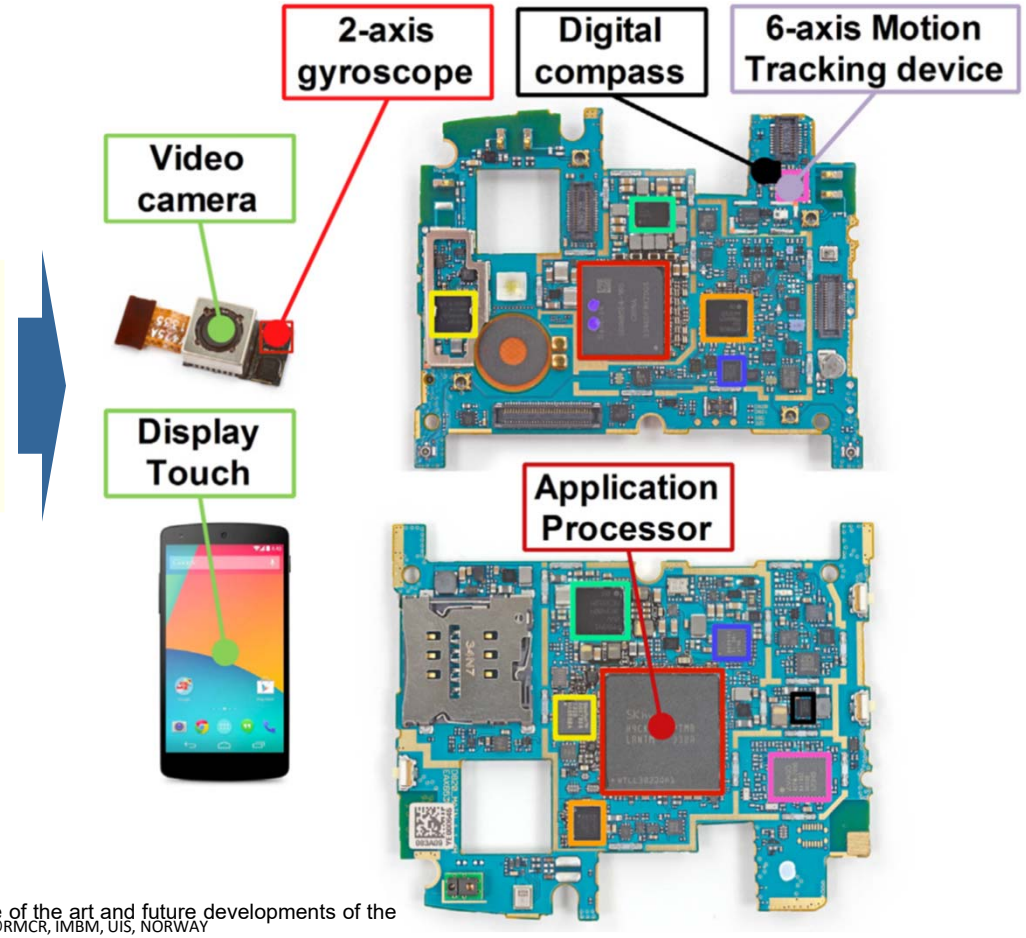
Hardware description of Google Glass



Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

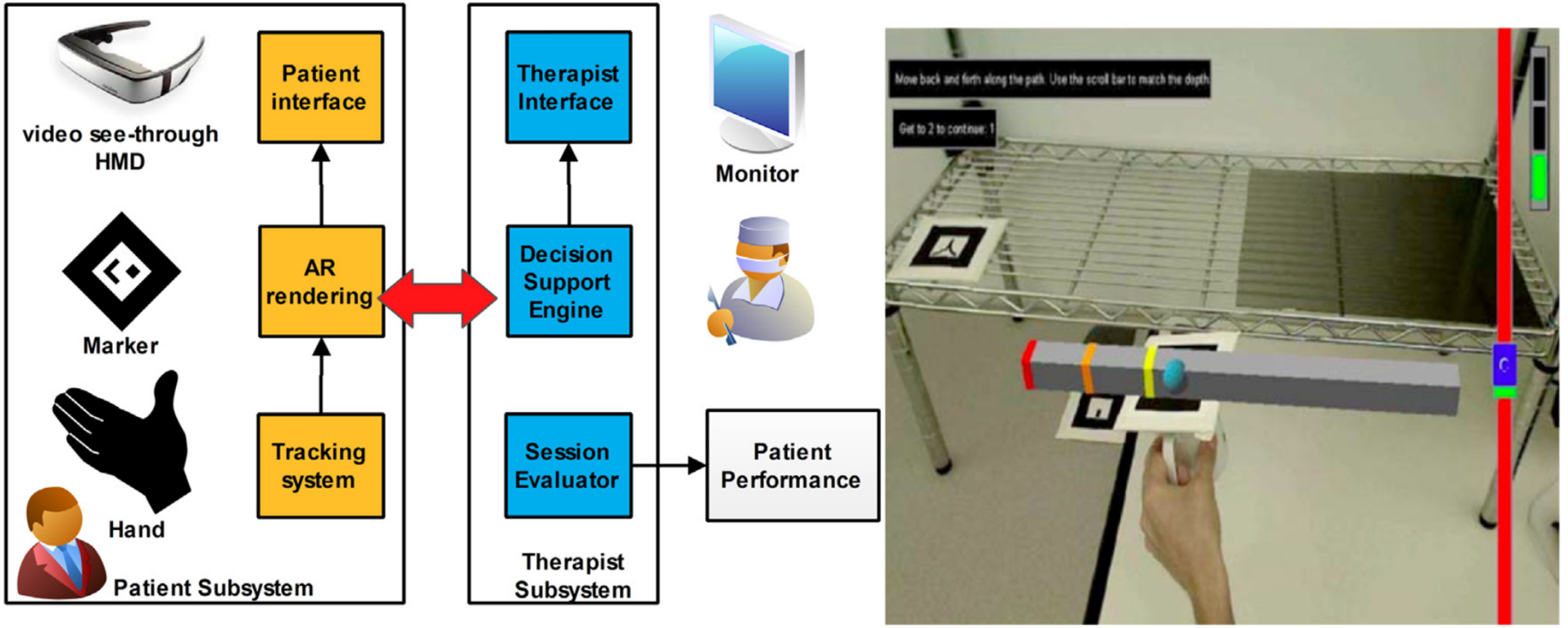
Hardware overview of Nexus 5

Modern handheld platforms, such as tablets and smartphones, contain the following devices that can be used for implementing AR systems.



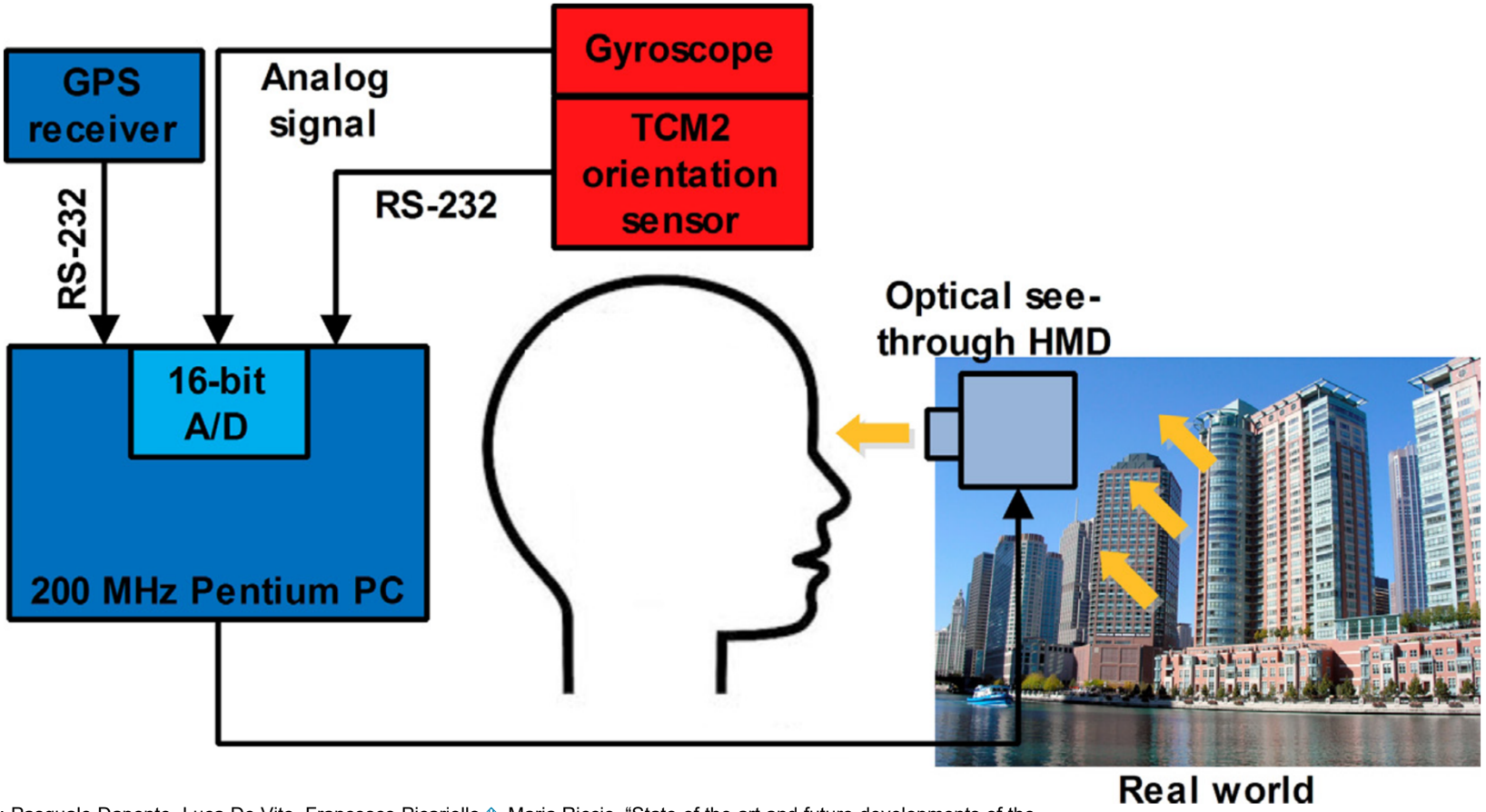
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of an AR system for poststroke-patient rehabilitation



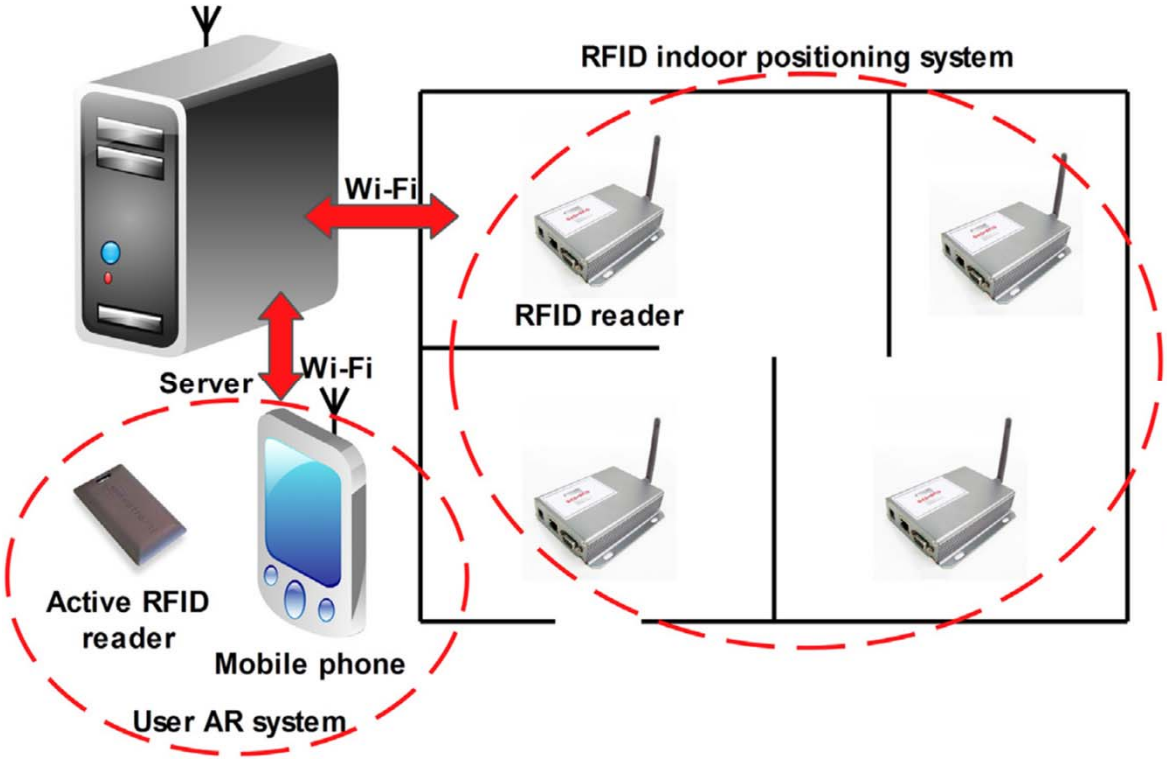
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of a hybrid tracking system for an outdoor AR navigation system



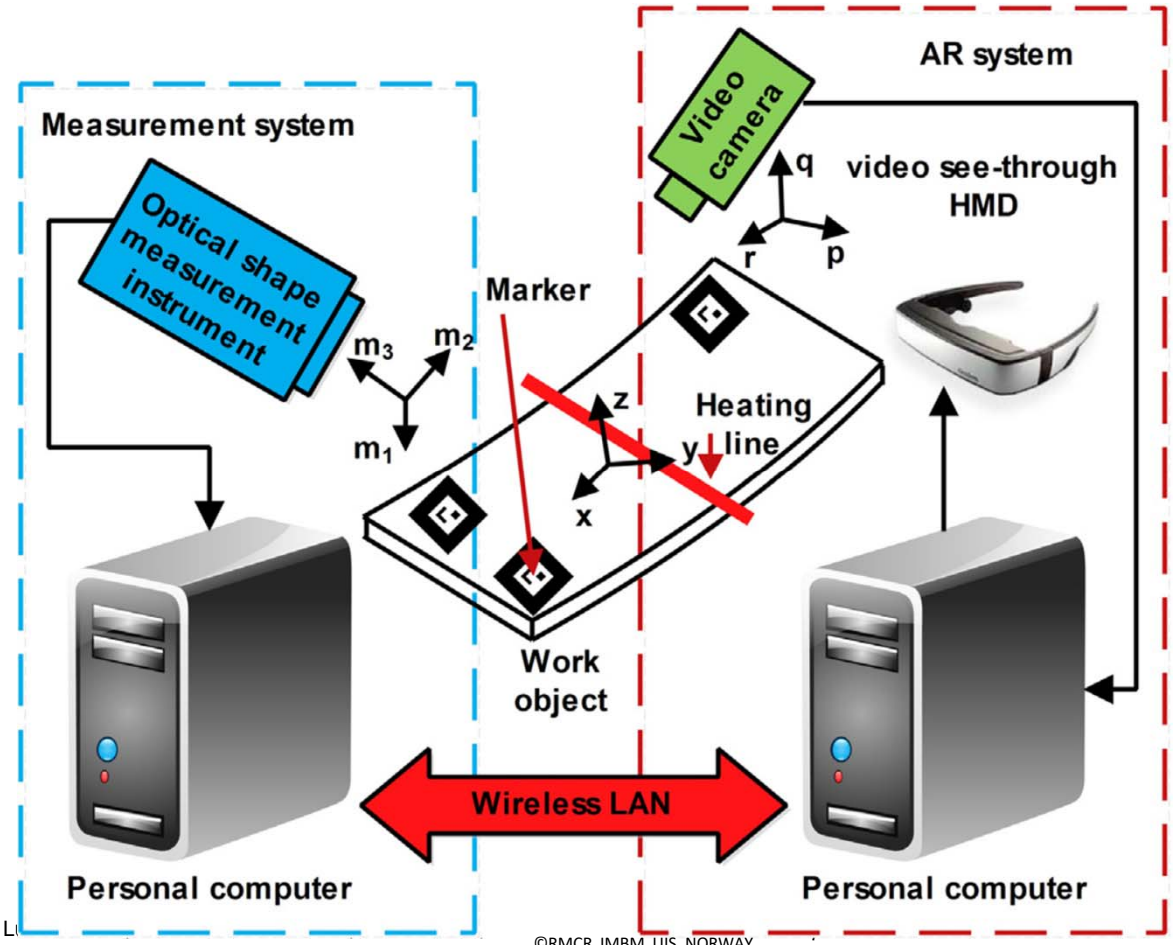
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of a 3D AR mobile system for indoor navigation



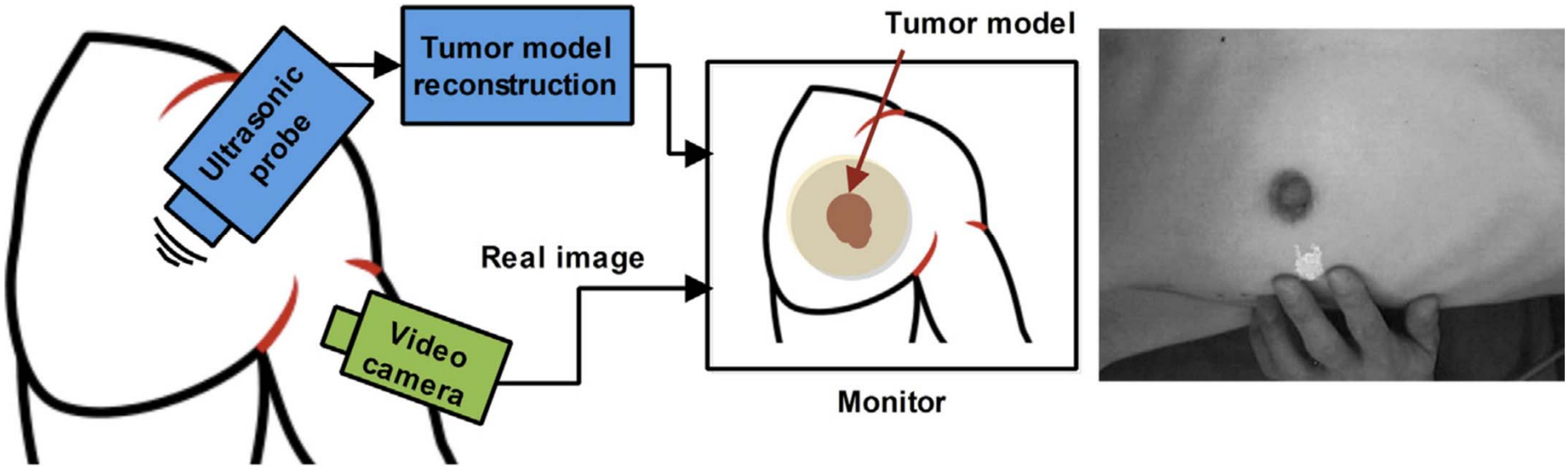
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of an AR measurement system for interactive worker



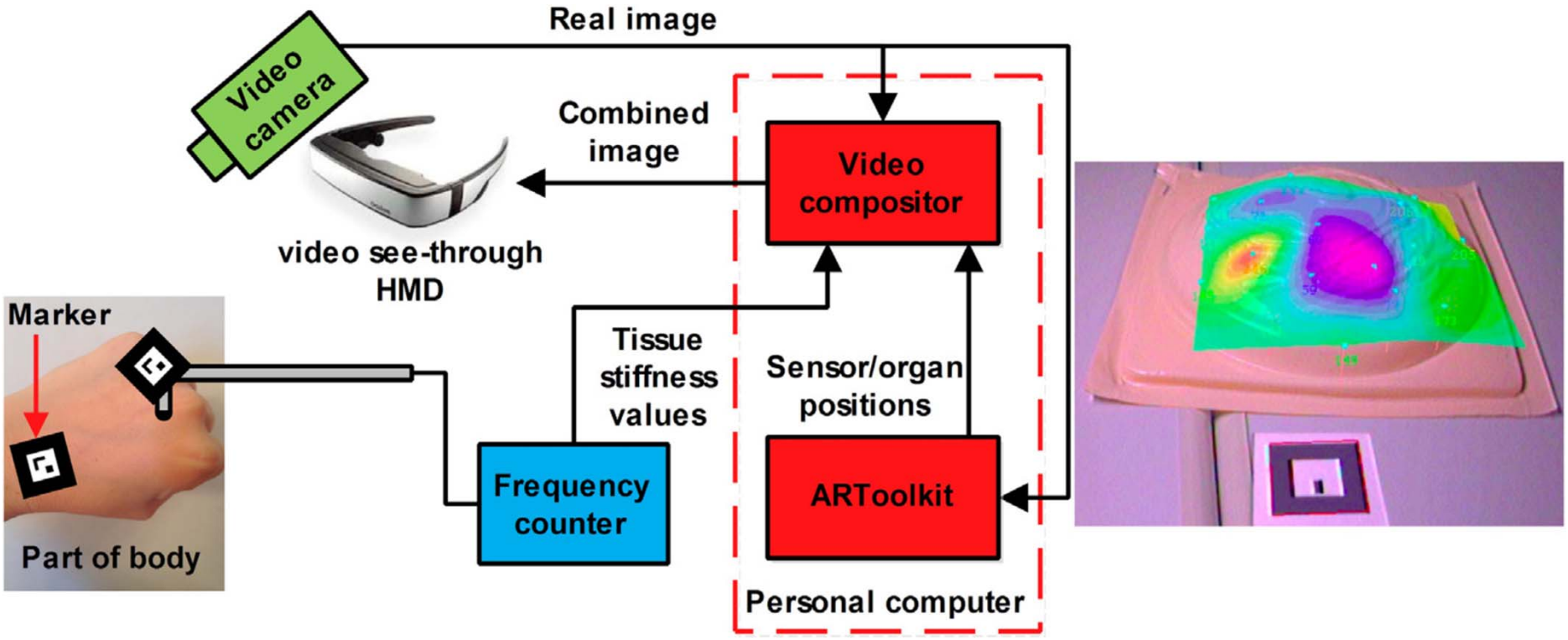
Source: Pasquale Daponte, L
Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of an AR system for the guidance of breast cancer surgery



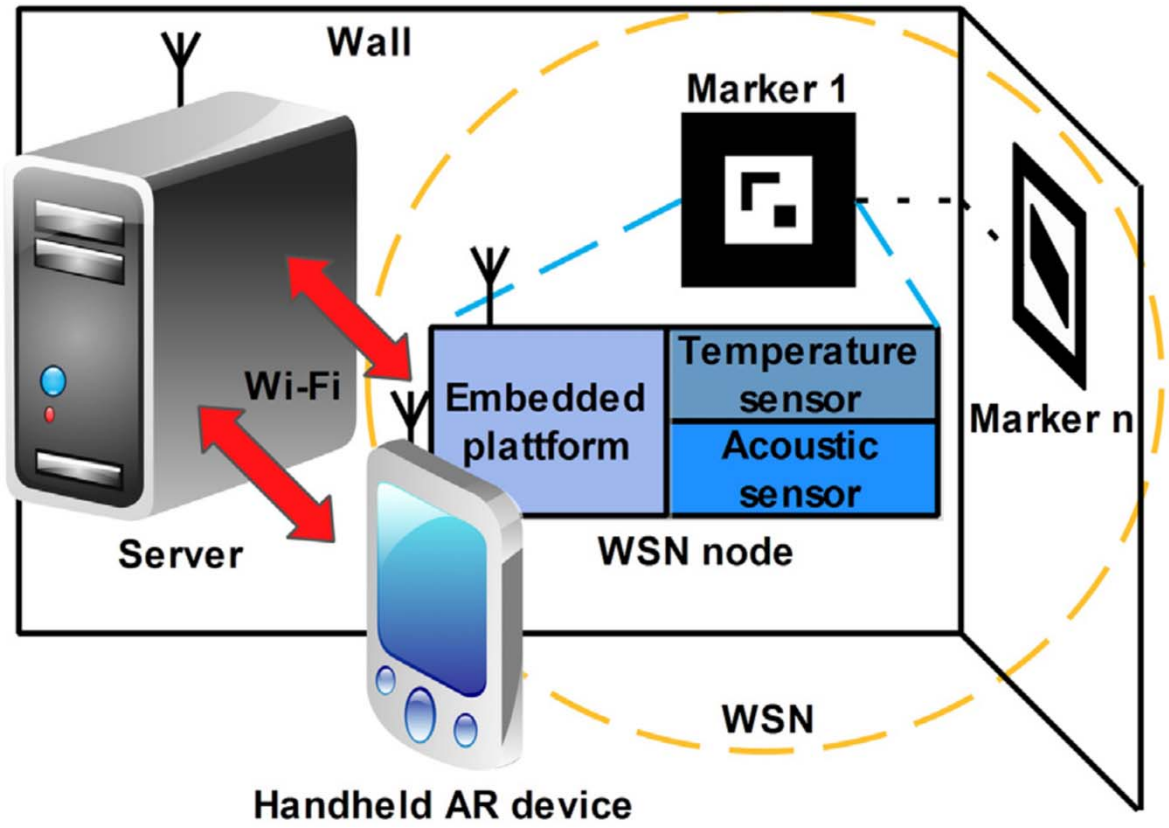
Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of AR system for displaying human tissue stiffness data



Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

Architectural overview of SensAR, a handheld AR system for monitoring environmental information



Source: Pasquale Daponte, Luca De Vito, Francesco Picariello ⇑, Maria Riccio, "State of the art and future developments of the Augmented Reality for measurement applications", Measurement 57 (2014) 53–70.

State of the art of VR applications in design and manufacturing processes

State of the art of VR applications in design and manufacturing processes

VR hardware for CAD

- "Virtual reality (VR) is generally characterized as a three-dimensional, interactive, computer-generated, multisensory synthetic environment" (SPRINGER and GADH, 1996).
- "To facilitate more rapid product development, a VR interface for conceptual design and creation of a CAD model has been proposed" (Dani and Gadh, 1995a).
- "The National Research Council has concluded that design, manufacturing and marketing represents one of the most promising application areas for VR, and this area is recommended for VR technology development and testing" (Durlach et al., 1995) .

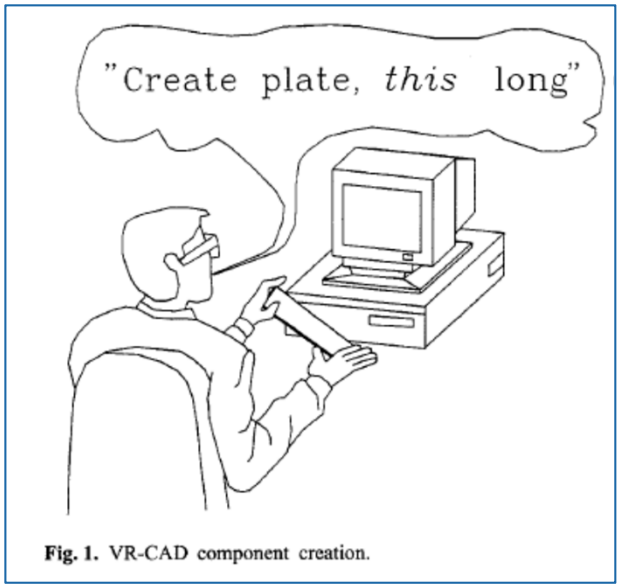


Fig. 1. VR-CAD component creation.

"the goal of a VR-CAD interface is to increase the efficiency of currently available CAD functions such as product documentation, documentation updates for engineering change orders, and design analysis functions" (SPRINGER and GADH, 1996).

State-of-the-art virtual reality hardware for computer-aided design
SCOTT L. SPRINGER and RAJIT GADH*
Mechanical Engineering Department, University of Wisconsin - Madison, Madison, WI, 53706, USA
Received April 1996 and accepted June 1996

State of the art of VR applications in design and manufacturing processes

- Because the costs for the various devices are changing rapidly, costs have been classified as follows (i.e. in 1996):

  (1) low, <$500;
  (2) moderate–low, $500–$1000;
  (3) moderate, $1000–$5000;
  (4) moderate–high, $5000–$20 000;
  (5) high, $20 000–$100 000;
  (6) very high, >$100 000.

- For the application of VR to a CAD domain to realize a significant presence, overall system cost must be less than $50000 including computer and software.

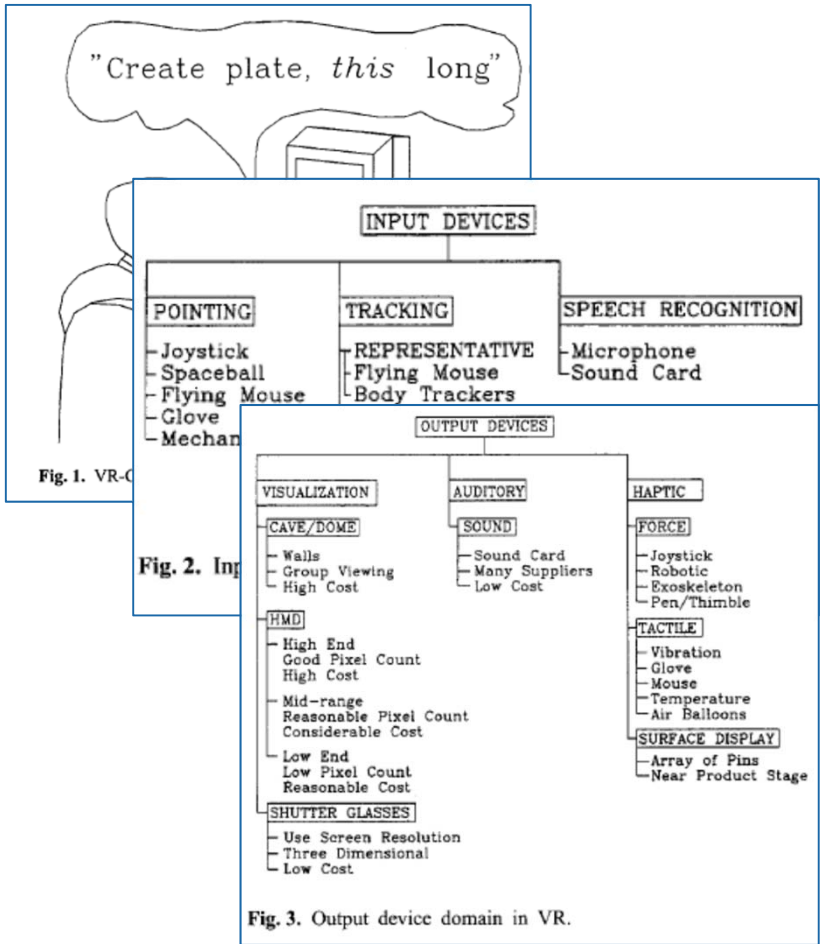


Fig. 1. VR-C
Fig. 2. Inp
Fig. 3. Output device domain in VR.

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Haptic Devices

- Haptic devices include hardware designed to provide a physical sensation of touch to the hand(s) of the operator.
  - The implementation of even simple haptic feedback can greatly improve the level of immersion, and the lack of this type of feedback may seriously handicap human interaction capabilities (Durlach *et al.,* 1995).
- This class of device may be subdivided by the approach used to provide the touch sensation.
- First class of systems provide a force feedback, to a finger, the hand or hand and arm,
- Second class of system provides a tactile feedback as a sensory substitution for the force normally perceived when an object is touched.
- Third class of systems provides the operator with a three-dimensional display of a surface belonging to the virtual environment.

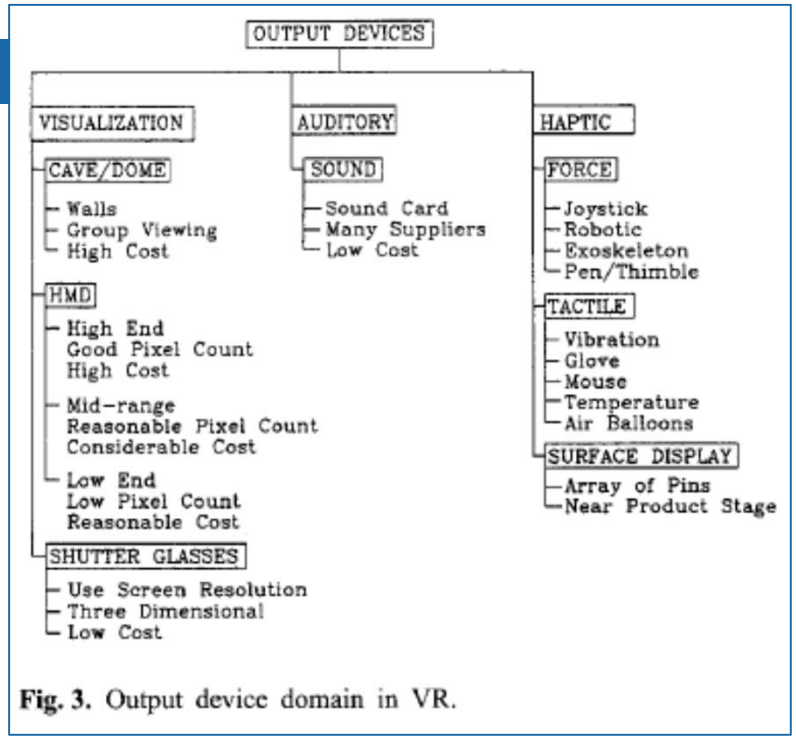
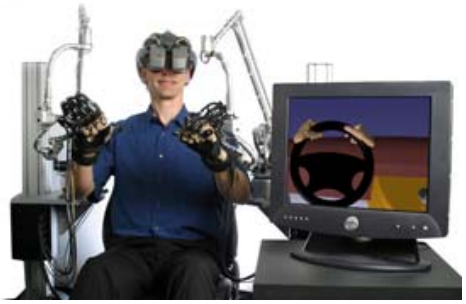


Fig. 3. Output device domain in VR.



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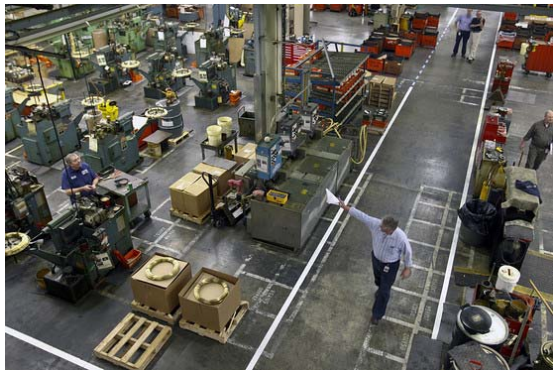
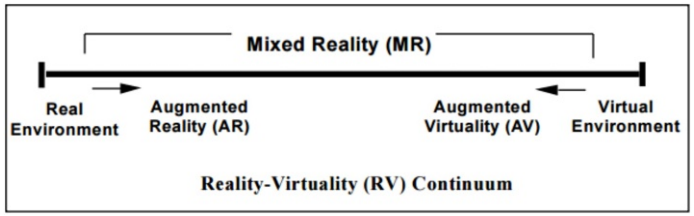
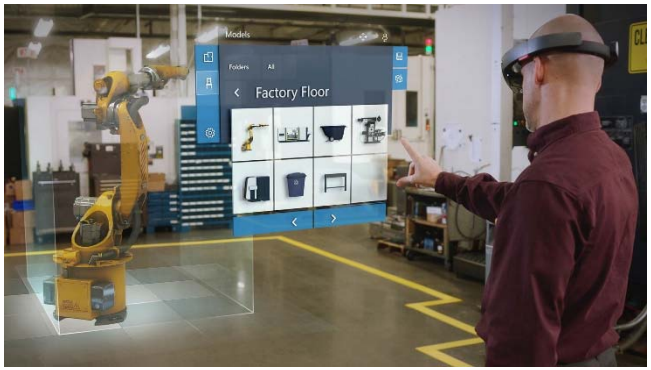


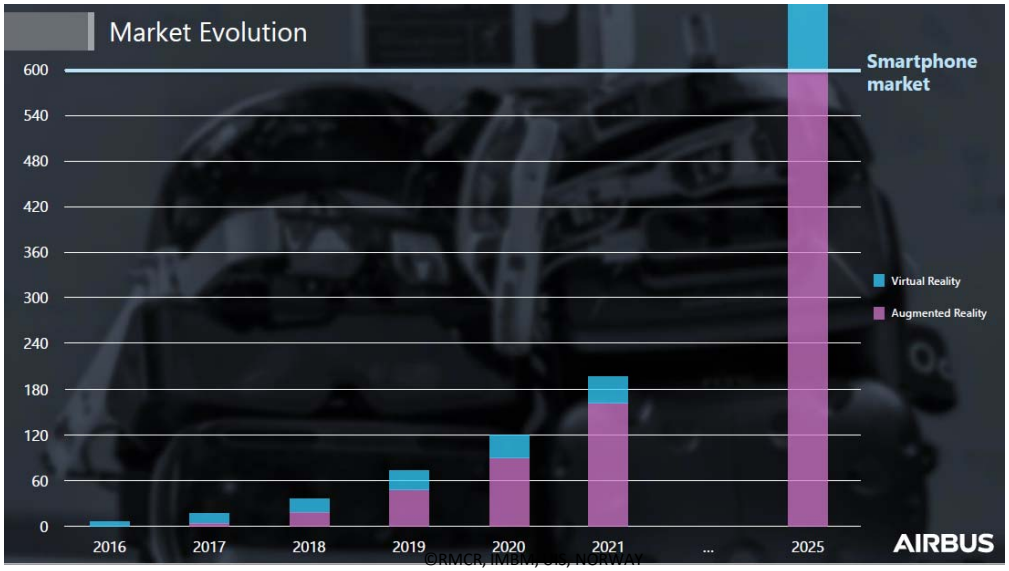
Traditional factory floor





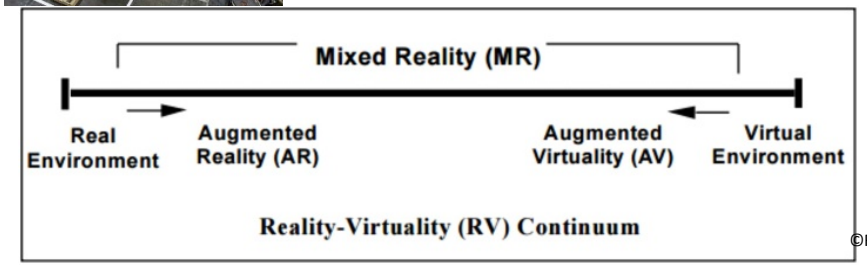
Virtual reality in factory floor

What Can Augmented Reality (AR) do for Manufacturing



What Can Augmented Reality Do for Manufacturing

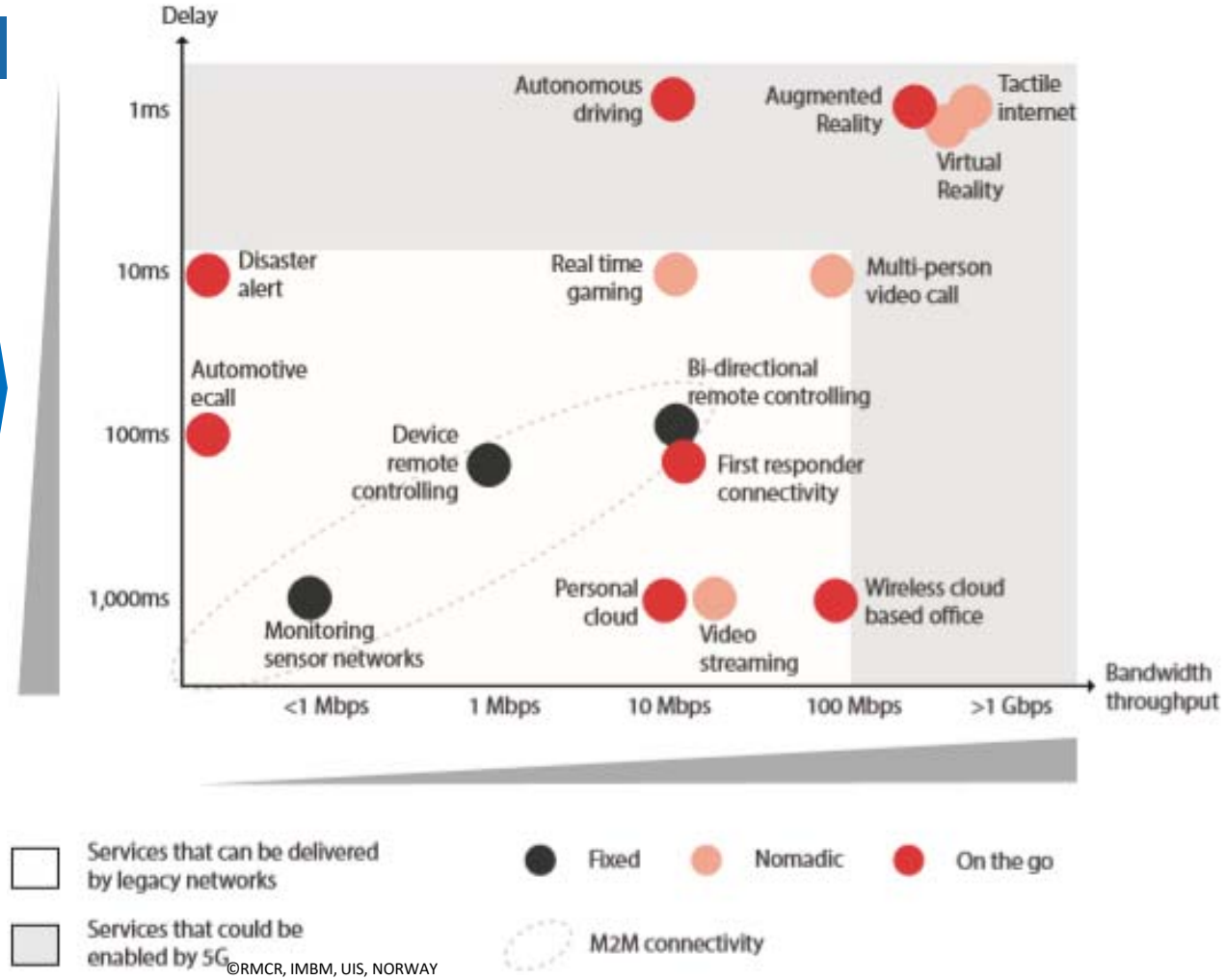
- The notion of a **reality-virtuality continuum** was first introduced more than **two decades ago** [by Paul Milgram, a professor of mechanical and industrial engineering at the University of Toronto].
- To put the **continuum in a manufacturing** context,
  - think of the **far left** (Real Environment) as the **traditional factory** floor: workers operating machines based on information displayed on **dials, gauges or screens**.



First impression about AR: "this is just a marketing gimmick. Manufacturers aren't seriously considering using AR on the factory floor already, are they?"

- The **far right** (Virtual Environment) is exemplified by the use of virtual reality in factory floor planning.

Understanding 5G



Source:
https://www.gsmaintelligence.com/research/?file=141208-5g.pdf&download

What Can Augmented Reality Do for Manufacturing

Examples: **Augmented virtuality** in manufacturing,

- Use of handheld peripherals to input commands,
- Testing ergonomics in VR factory-floor planning
- Augmented visualization of manufactured items.

Source: https://www.tu.no/artikler/bygger-juletraer-med-hologrammer/438125

AUGMENTED REALITY in offshore subsea Christmas Tree Manufacturing.

Thank you for the attention and patience !!!