RIS Industry 4.0 Hubs

Virtual Reality/ Augmented Reality (VR/ AR)

LMS
Laboratory for Manufacturing Systems & Automation

eit Manufacturing

Introduction to Immersive Technologies

Virtual Reality (VR)
A computer-simulated experience based on the perception of reality entirely through virtual information. The user is immersed into a virtual world and interacts using head-mounted display devices.

Augmented Reality (AR)
Additional virtual information is provided by adding layer of graphical objects to the real world. Digital elements are being added to a live view commonly using the camera of a smartphone, tablet or other device.
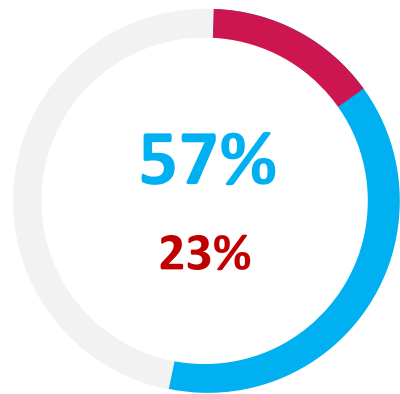

Mixed Reality (MR)
Includes both VR and AR for merging the virtual and the physical environment. The user can interact with the digital content through a head-mounted device.
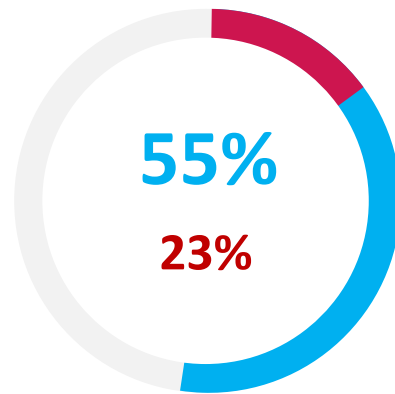
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Manufacturing Systems
& Automation

Industrial Benefits

[Capgemini Research Institute, 2018, Digi-Capital]

■ **The rest**   ■ **Early achievers**

57%
23%

Efficiency Increase

55%
23%

Safety Increase

52%
21%
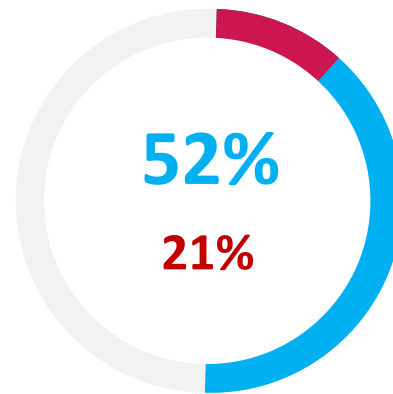
Productivity Increase

47%
19%
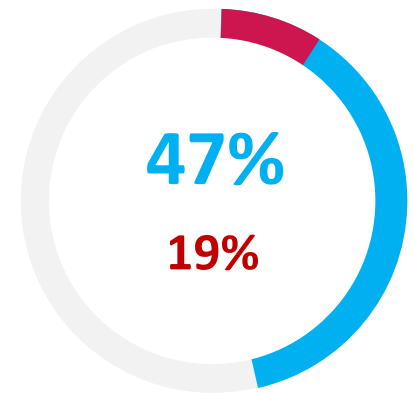
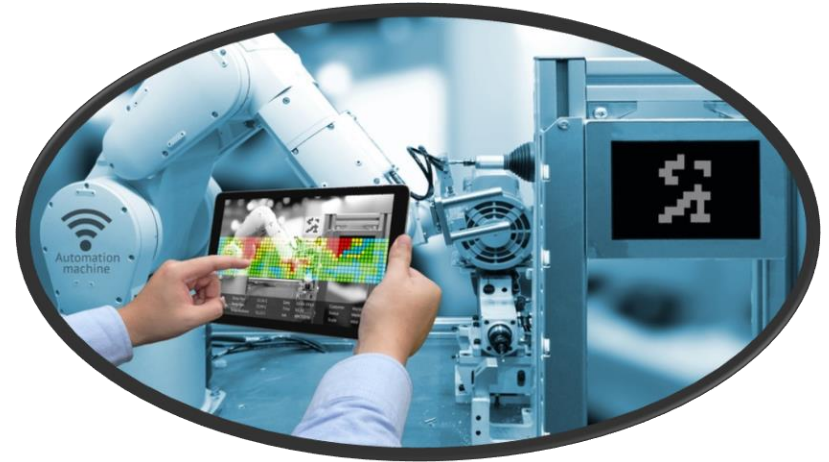**Complexity Reduction**

AR/ VR applications in Manufacturing

- **Training and operator support**
- **Inspection and monitoring**
- **Maintenance and troubleshooting**
- **Product development**
- Manufacturing layout
- Warehouse management
- **Robotics**
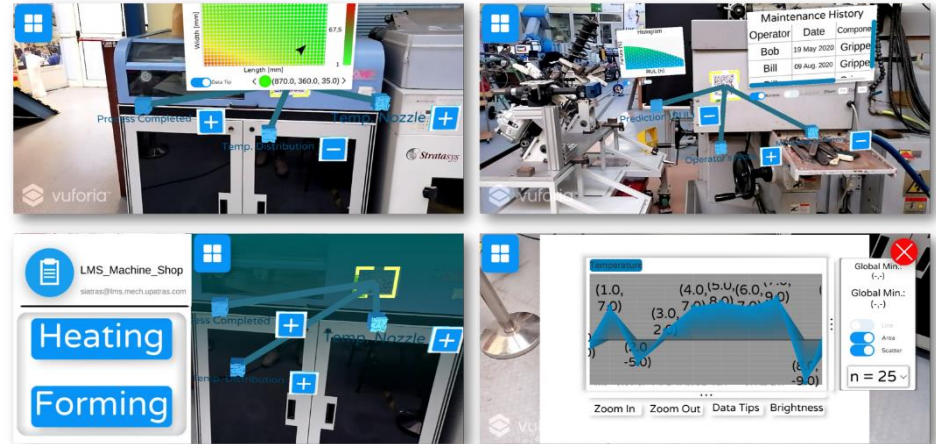- Numerical Control (NC) machining

AR for Supervising manufacturing processes

AR can provide comfortable **online** process **monitoring**, while also **increase mobility** of the shopfloor **control** operator. It thus creates **transparency** within the shopfloor environment, and higher **reactiveness** to disturbances.
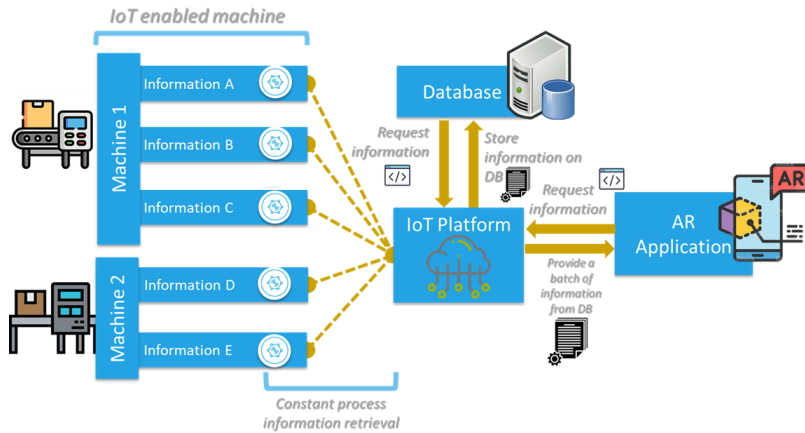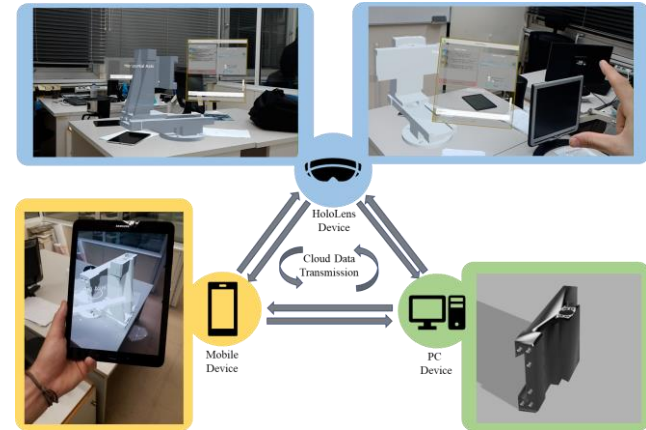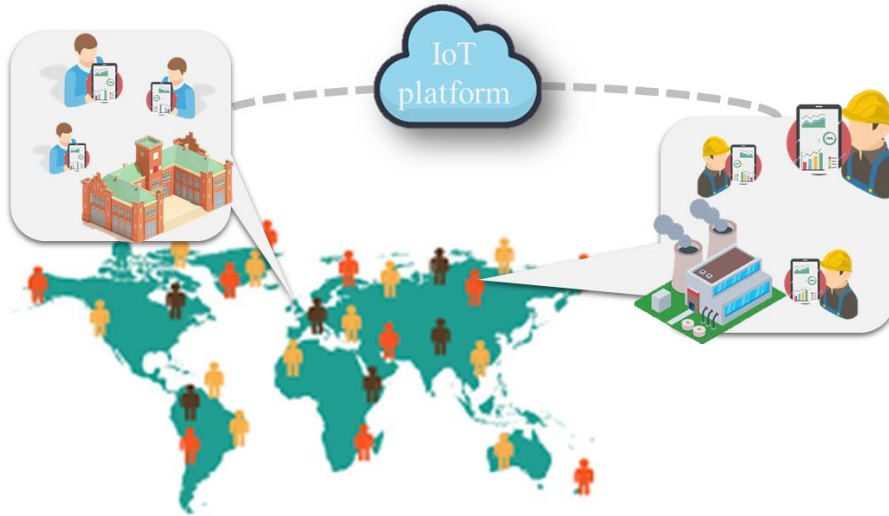

[AMPLI EIT M. Innovation Project]

AR in Product Design

AR creates a collaborative experience between **industry**, **academia** and **research institutes**. Stakeholders can collaborate, solve problems, and test new ideas.

Mourtzis, D., Siatras, V., Angelopoulos, J. and Panopoulos, N., 2020. An augmented reality collaborative product design cloud-based platform in the context of learning factory. *Procedia Manufacturing*, *45*, pp.546-551.

AR in Education

1. Configure the IoT server on the AR application

2. Follow assembly steps-by-step instructions to setup the turbine blade

3. Start the system and monitor functional performance of the blade

4. Remote monitoring collaborative session

5. Inspect the overall model of the system

6. Find the optimal design via KPIs comparison from different experiments

AR can create real-time **information interaction** based on IoT technologies, and **support laboratory** experiments & young engineering **training**.

[PERFORM, EIT M. Educational Project]

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AR in Equipment Maintenance
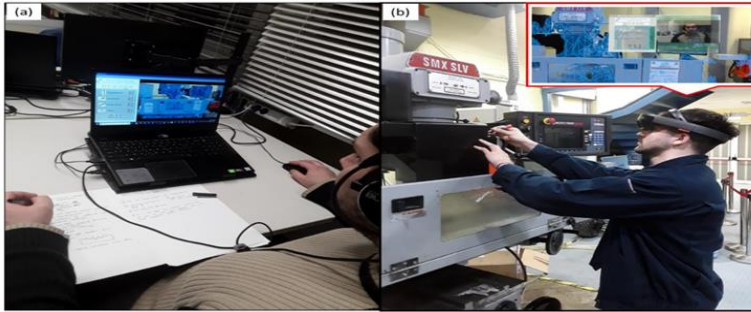
✓ Repair cost decrease

✓ Remote expert assistance

✓ Lower training requirements

✓ Fast troubleshooting

Mourtzis, D., Siatras, V. and Angelopoulos, J., 2020. Real-time remote maintenance support based on Augmented Reality (AR). *Applied Sciences*, *10*(5), p.1855.


[AR mold maintenance tool]

AR in Training & Assistance

✓ Realistic operator training

✓ Online process support

✓ Lower risk for accidents

✓ Higher productivity

✓ Waste reduction due to operator error

Rentzos, L., Papanastasiou, S., Papakostas, N. and Chryssolouris, G., 2013. Augmented reality for human-based assembly: using product and process semantics. *IFAC Proceedings Volumes*, *46*(15), pp.98-101.
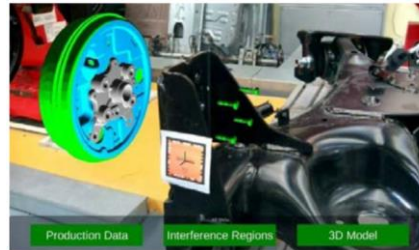
Michalos, G., Karagiannis, P., Makris, S., Tokçalar, Ö. and Chryssolouris, G., 2016. Augmented reality (AR) applications for supporting human-robot interactive cooperation. *Procedia CIRP*, *41*, pp.370-375.
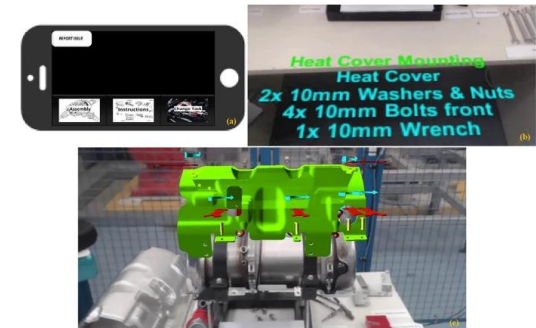
Mourtzis, D., Zogopoulos, V. and Xanthi, F., 2019. Augmented reality application to support the assembly of highly customized products and to adapt to production re-scheduling. *The International Journal of Advanced Manufacturing Technology*, *105*(9), pp.3899-3910.
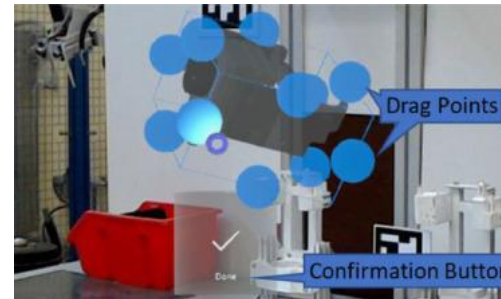
AR in Robotics

✓ AR-based robot control

✓ Increases human robot collaboration

✓ Higher productivity

✓ Safety increase

Lotsaris, K., Fousekis, N., Koukas, S., Aivaliotis, S., Kousi, N., Michalos, G. and Makris, S., 2021. Augmented Reality (AR) based framework for supporting human workers in flexible manufacturing. *Procedia CIRP*, *96*, pp.301-306.

Lotsaris, K., Gkournelos, C., Fousekis, N., Kousi, N. and Makris, S., 2021. AR based robot programming using teaching by demonstration techniques. *Procedia CIRP*, *97*, pp.459-463.
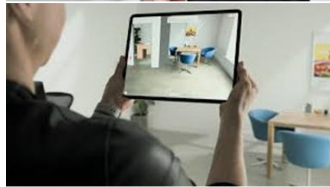
Implementation Options

Choose the AR-enabled device that best fits the industrial requirements

AR devices

- Mobile devices
- Head Mounted Devices

Adapt the AR application to the specific industrial environment using marker or/ and spatial recognition

Environment setup

1. AR devices
2. AR software
3. Edge server
4. Environment setup

AR software

- Unity 3D
- Android Studio
- XCode
- Microsoft Visual Studio

Use one or more of the AR development platforms to develop the AR application. Extend its functionalities using external AR plugin libraries

- Publish-Subscribe pattern
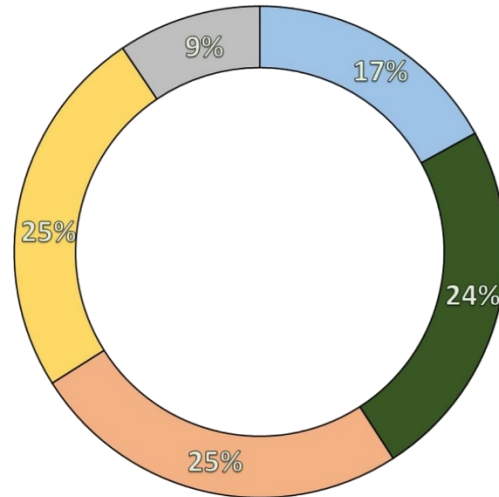- Web service API
- Cloud Database

Edge service

Use an edge service in order to provide online features to the application and further process analysis

Barriers for applying AR/ VR in practice

- Users' health and acceptance
- Tracking methods
- Projection quality, accuracy and interaction
- Hardware
- Development complexity

9%
17%
24%
25%
25%

- **Hardware limitations** concerning the production layout and user mobility

- The **quality** and **accuracy** of the virtual elements

- Possible **discomfort** caused by the prolonged use and the psychological aspect in terms of **acceptance**

- **Deep knowledge** required for the development of complex AR software applications and **lack of knowledge** on new developments

de Souza Cardoso, L.F., Mariano, F.C.M.Q. and Zorzal, E.R., 2020. A survey of industrial augmented reality. *Computers & Industrial Engineering*, *139*, p.106159.

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Thank you!