Virtual and Augmented Reality in Production

Fraunhofer Institute for Production Technology IPT

28.02.2024 | *Alexander Kreppein, M.Sc.*

2004

George W. Bush speaks in Orlando before his reelection

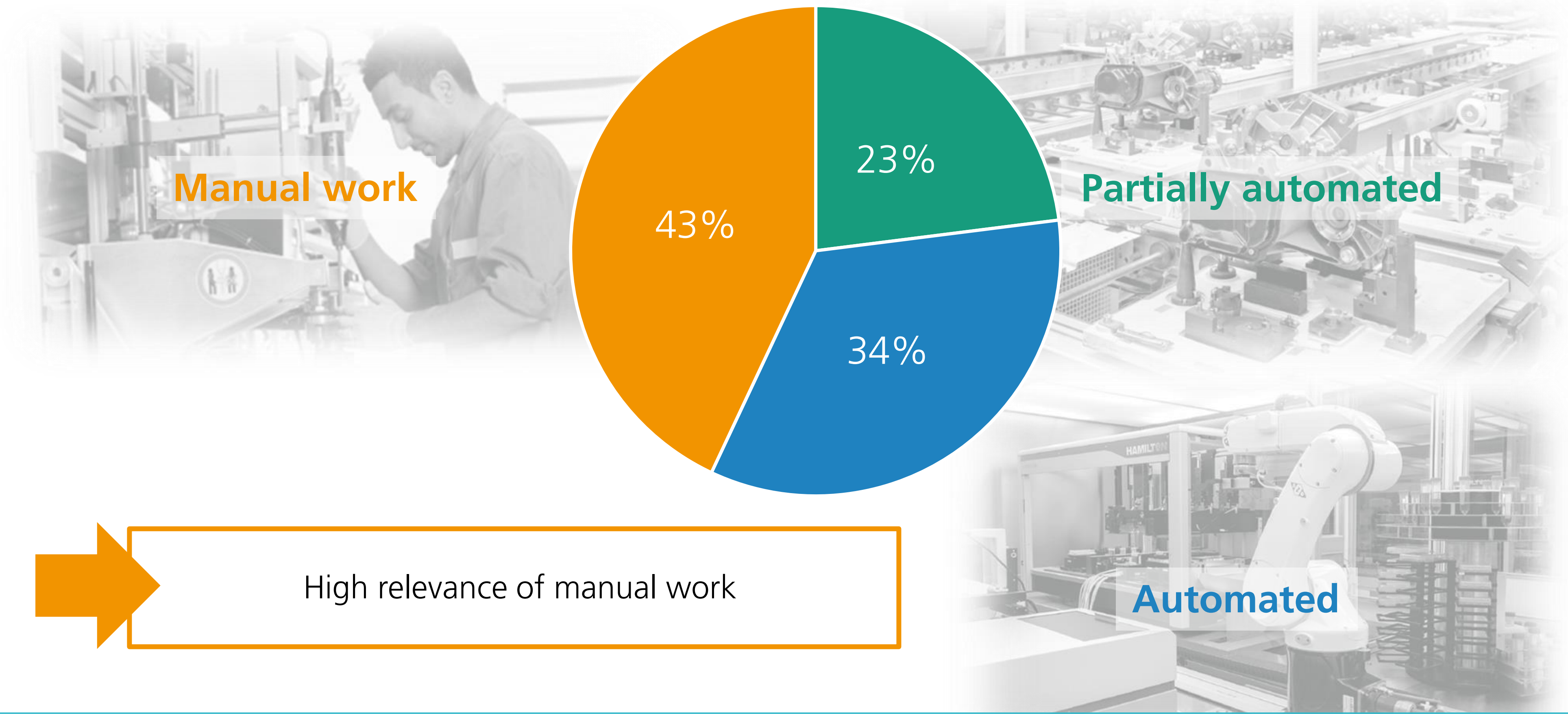
2018

Donald Trump gives a speech in Minnesota

2024

Smart Devices combine a variety of functions

Automation in production and assembly using the example of Germany



High relevance of manual work

How can Smart Devices help in an industrial context?

There are many different forms of smart devices

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From the real to the virtual world

Real world

Augmented reality

- Virtual objects overlay the real world

Mixed reality

- Interaction with the real and virtual world

Virtual reality

- Fully artificial world

The transitions are smooth, and it is not always possible to draw an exact line.

Real world — Virtual world

Augmented Reality

Mixed Reality

Virtual Reality

When is which technology used?

Real world

Augmented reality

- Virtual objects overlay the real world

Is used when real objects are to be supplemented with additional information.

Example: Logistics employee receives visual information on the location of a product.

Mixed reality

- Interaction with the real and virtual world

Is used when you also want to interact with both worlds.

Example: The digital twin of a robot is to be controlled in the real world.

Virtual reality

- Fully artificial world

Is used when interaction with the real world is not necessary or possible.

Example: Production planning of a new factory to be build.

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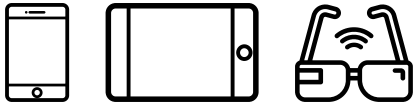
Examples of hardware for the individual technologies

Real world

Augmented reality

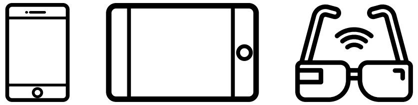
- Virtual objects overlay the real worlld



Example: Google Glass

Mixed reality

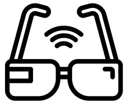
- Interaction with the real and virtual world



Example: Microsoft Hololens

Virtual reality

- Fully artificial world



Example: HTC Vive

With the help of r**emote support** and r**emote maintenance**, specialists guide employees from a distance. They can often “see through the eyes of the employee on-site “ and display information in the employee‘s field of vision. This reduces costs and increases quality.

Many factors need to be taken into account when selecting, imnplementing and using Smart Expert Systems. The focus is on people.

Smart Devices

How to find the right smart device for your application?

Smart Glasses Guide for Industrial Applications | https://smartglasses.guide

Anwendungen

Smart Glasses Guide

Wie oft sollen Mitarbeiter Datenbrillen in Ihrem Anwendungsfall tragen?

5 mal pro Monat

Wie lange sollen Mitarbeiter die Datenbrille in Ihrem Anwendungsfall pro Tag tragen?

0,5 Stunden pro Tag

In welche Anwendungskategorie lässt sich Ihre Anwendung einordnen?

- Werkerassistenz und Training
- Dokumentation
- Videostreaming
- Individuelle Anwendung

Handelt es sich um einen internen Anwendungsfall oder sollen Kunden, Lieferanten etc. einbezogen werden?

- interne Anwendung
- unternehmensübergreifende Anwendung

In welchem Organisationsbereich planen Sie Ihre Anwendung?

- Produktentwicklung
- Produktion
- Montage
- Qualitätssicherung
- Wartung & Instandhaltung
- Service
- Marketing

Mit welchen existierenden IT-Systemen planen Sie für Ihre Anwendung eine Integration?

- Maschinendaten
- ERP
- CAQ
- CAD
- MES
- CRM

Bitte charakterisieren Sie Umgebungsbedingungen, in der Ihre Anwendung eingesetzt werden soll.

- Indoor Einsatz
- Outdoor Einsatz
- schmutzige Umgebungsbedingungen
- hohe Luftfeuchtigkeit
- Aerosole
- Laute Umgebungsbedingungen
- Explosionsgefahr
- Sicherheitshelm erforderlich
- Sicherheitsbrille erforderlich

Wird für Ihren Anwendungsfall voraussichtlich eine WLAN Verbindung benötigt?

- kein WLAN Zugang nötig
- teilweise WLAN Zugang nötig
- kontinuierlicher WLAN Zugang nötig

Welche Steuerungsmöglichkeiten sind in Ihrem Anwendungsfall gewünscht?

- Touch-Bedienung
- Sprachsteuerung
- Gestensteuerung

Wie sollen Informationen auf der Datenbrille dargestellt werden?

- Statische Bildschirme
- Hologramme

Welche Kontexttechnologien planen Sie einzusetzen?

- 2D Codes
- Bluetooth, BLE
- NFC
- GPS

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Smart Glasses Guide for Industrial Applications | https://smartglasses.guide

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ROLE OF MOBILE ROBOTS IN PRODUCTION INTRALOGISTICS

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Funded by the European Union

28.02.2024

CONTENT

- Introduction to Mobile Robot (MR) as MHE
- Technological Impact in Production Logistics
- Conceptual Model to Implement MR
- Case Study and Results
- Outlook

MHE: Material Handling Equipment

MOBILE ROBOT AS MATERIAL HANDLING

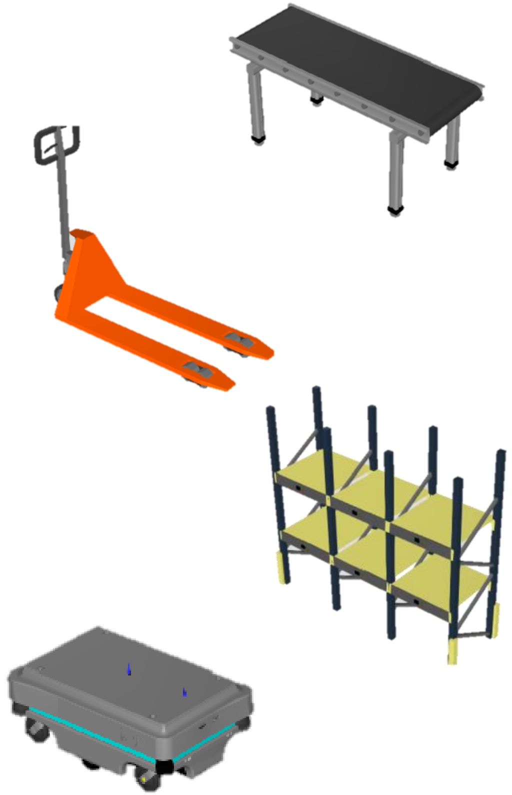
- Material handling is an important pillar of production systems especially when processing or assembling of discrete parts and products.

Functions

- Loading and unloading work units at each station
- Positioning work units at each station
- ***Transporting work units between stations in multi-station systems***
- Temporary storage of work units

Equipment

- Cranes
- Conveyors
- Forklift
- Pallet jack
- Buffer racks
- ***AGV and Mobile Robot***



AGV: Automated Guided Vehicle

TECHNOLOGICAL IMPACT IN PRODUCTION LOGISTICS

Aspects

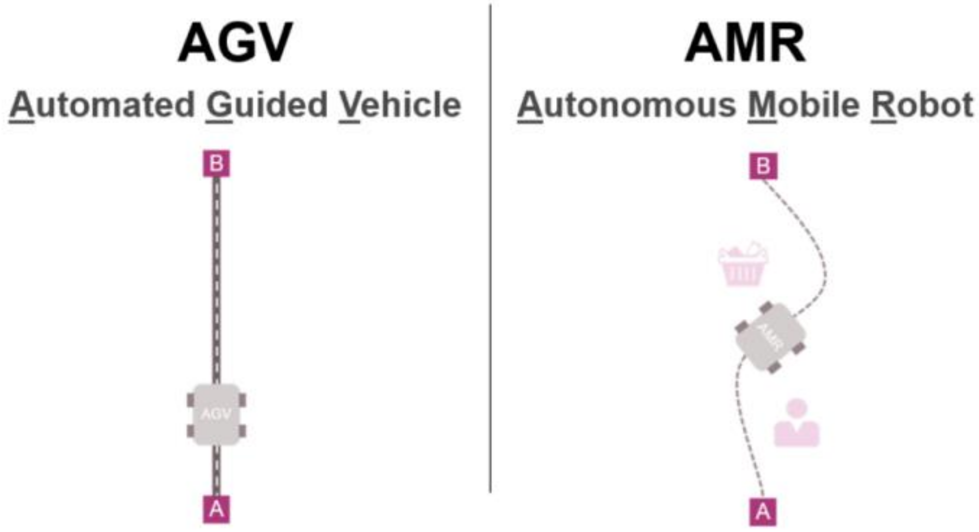
- To automate the repetitive process of transportation of goods on a factory floor
- To use modern technological asset for the transportation and integration of IoT
- To improve the performance of production intralogistics by *on-time delivery*, *reduces labour cost* and *fatigues*

AMR

- Use of AMR as a material handling equipment creates an ergonomic workspace
- AMR for factory floor logistics trigger the smart factory concept with the application of Internet of Things (IoT) and Artificial Intelligence (AI)
- Deployment of AMR may lead to increase of production capacity and flexibility

AMR: Autonomous Mobile Robot

TECHNOLOGICAL IMPACT IN PRODUCTION LOGISTICS



(a)

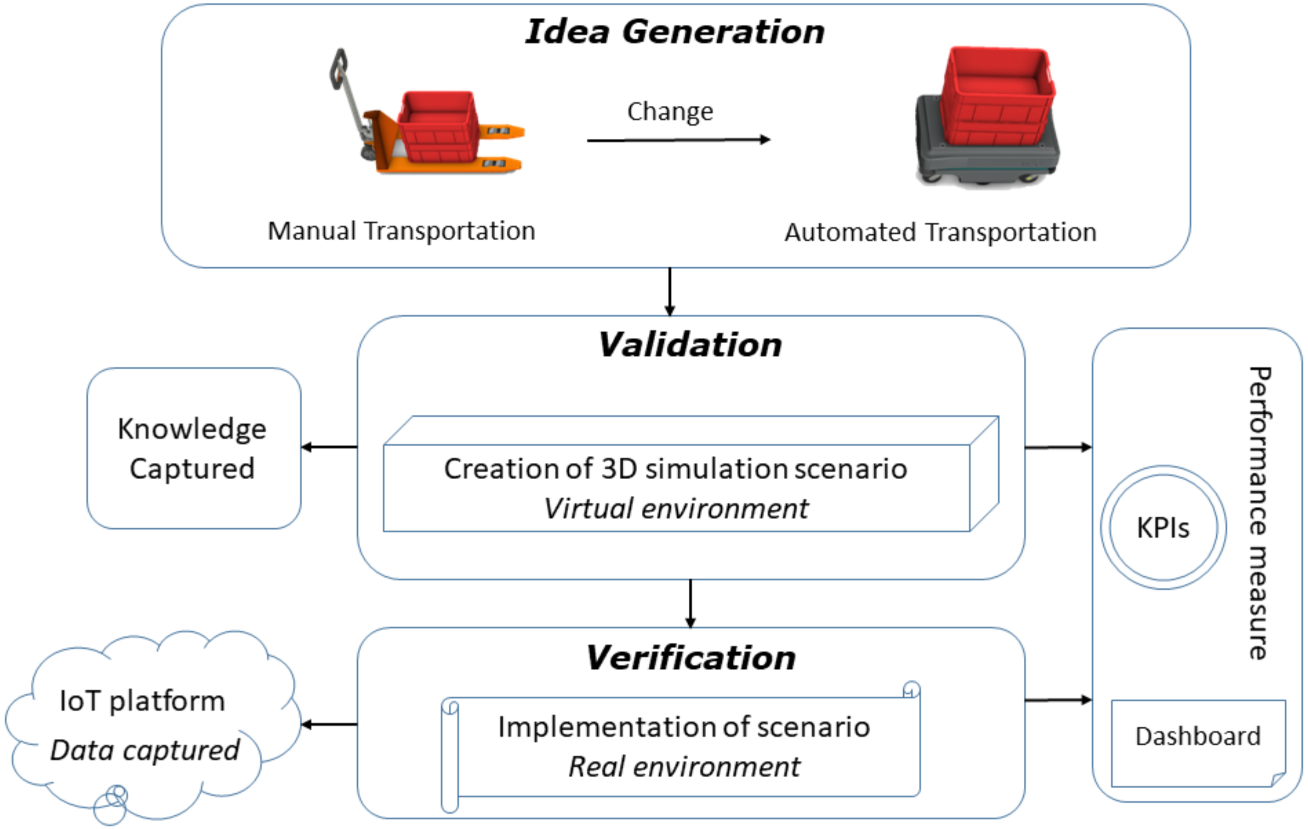
(b)

(c)

(b) Mobile robot transporting boxes
(c) Mobile robot carrying a Cobot

(a) Source: https://www.infineon.com/cms/en/applications/robotics/mobile-robots/

CONCEPTUAL MODEL TO IMPLEMENT MOBILE ROBOT



DESCRIPTION OF CASE STUDY

- Conceptual model applied to a **food manufacturing company** intralogistics process, the company produces and sells prepared foods

- Most of the production activities are ***operated manually***, especially the **production *floor logistics*.**

- The ***transportation and material handling*** of goods are the **key activities** (processes) on the production floor

- They intend to ***explore and adopt the automation possibilities*** in the production logistics

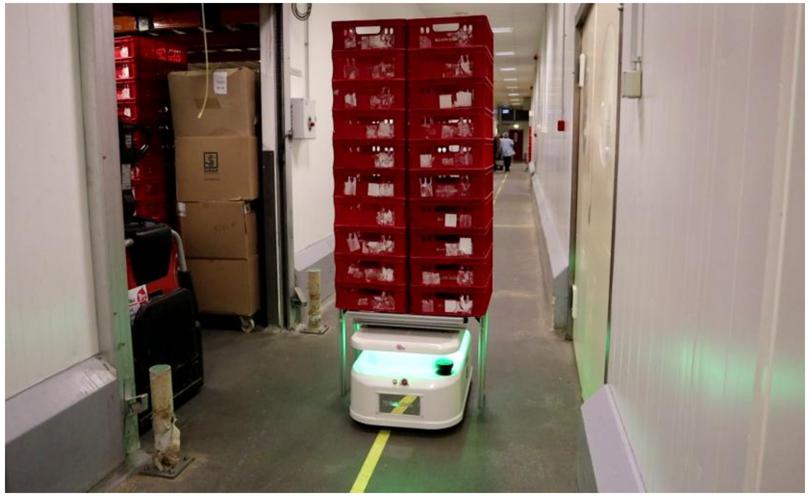
- Keen to ***implement AMRs*** for the material transportation within the production floor and willing for ***experimental study***

CASE STUDY – AUTOMATION OF ROUTES

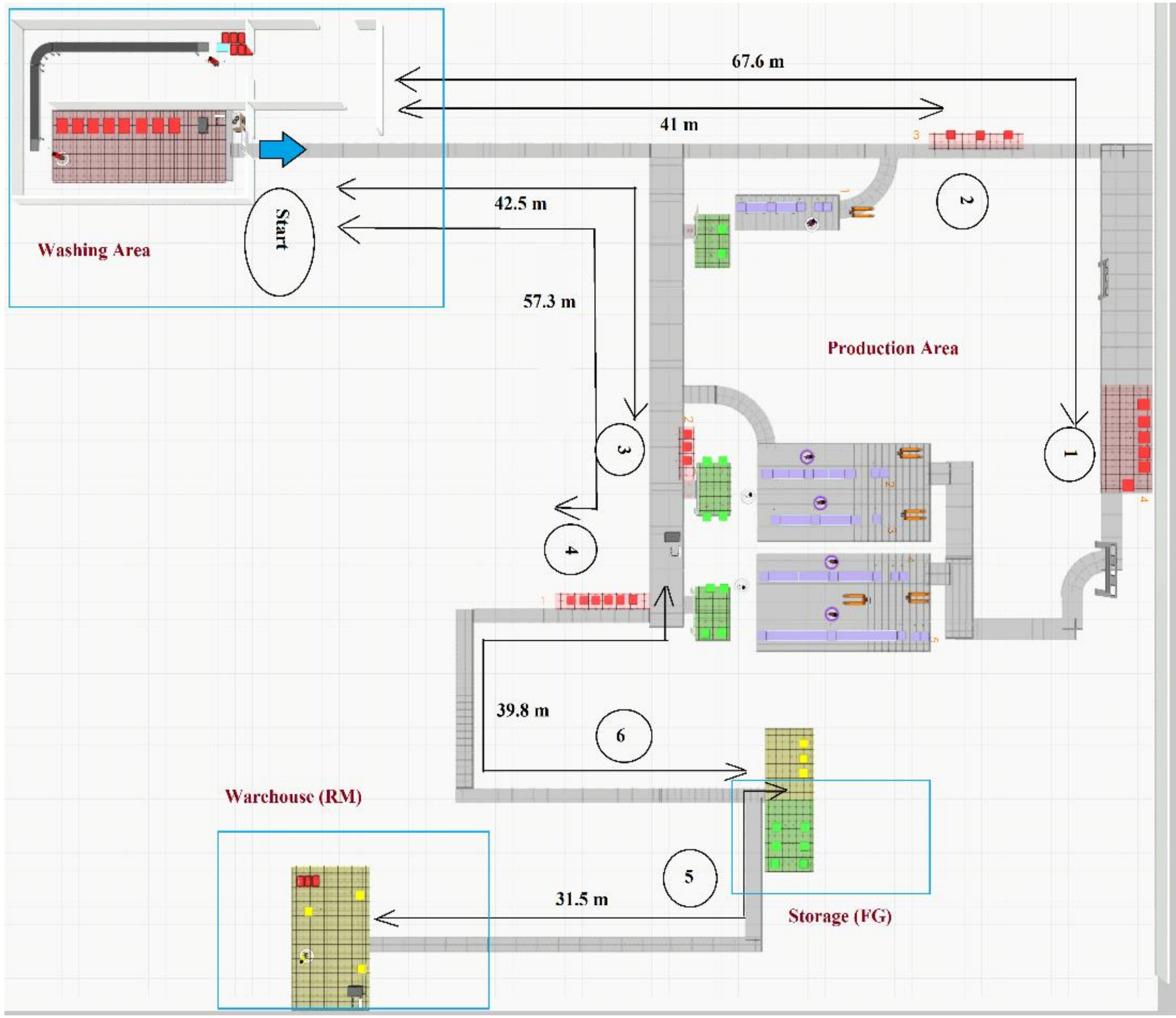
- *The production facility handles the transportation of boxes (containers) by human-worker using hand lifters and special wheels. Approximately 4000-5000 red boxes are moving daily in production.*

Main objective is to automate the following via AMRs:

- Transportation of the empty boxes between the washing facilities and intermediate storage (red marked area)
- Transportation of boxes filled with finished products to the warehouse (green marked area)
- Transportation of raw materials to intermediate storage (yellow marked area)



CASE STUDY – PRODUCTION LAYOUT & SIMULATION ENVIORNMENT



CASE STUDY – KPIs FOR ANALYSIS

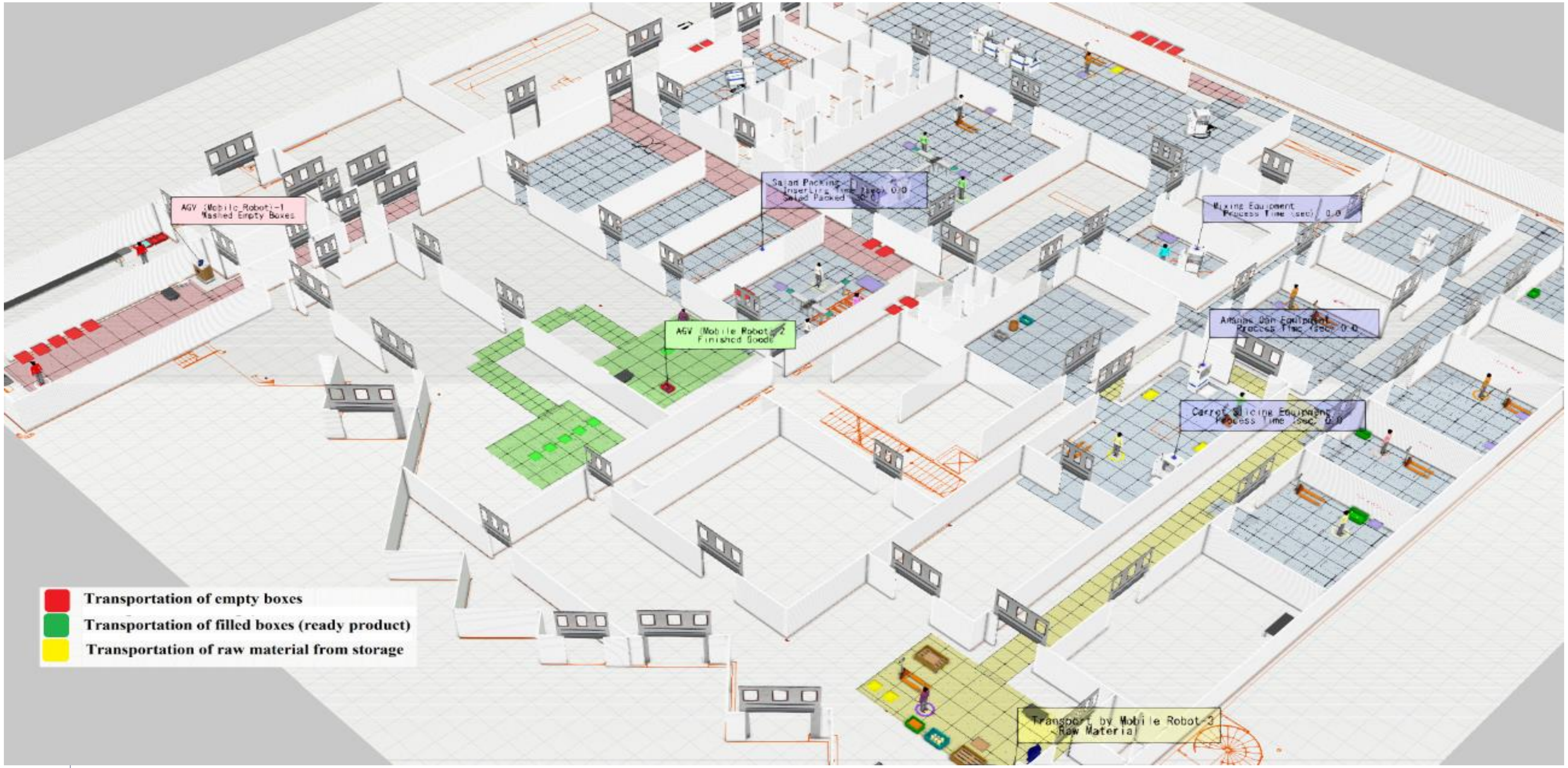
- P_1 – Defects during the transportation
- P_2 – On-time delivery
- P_3 – Inventory turnover
- P_4 – Labour cost for transportation

Average Inventory (I) = Throughput (R) x Average Flow Time (T)

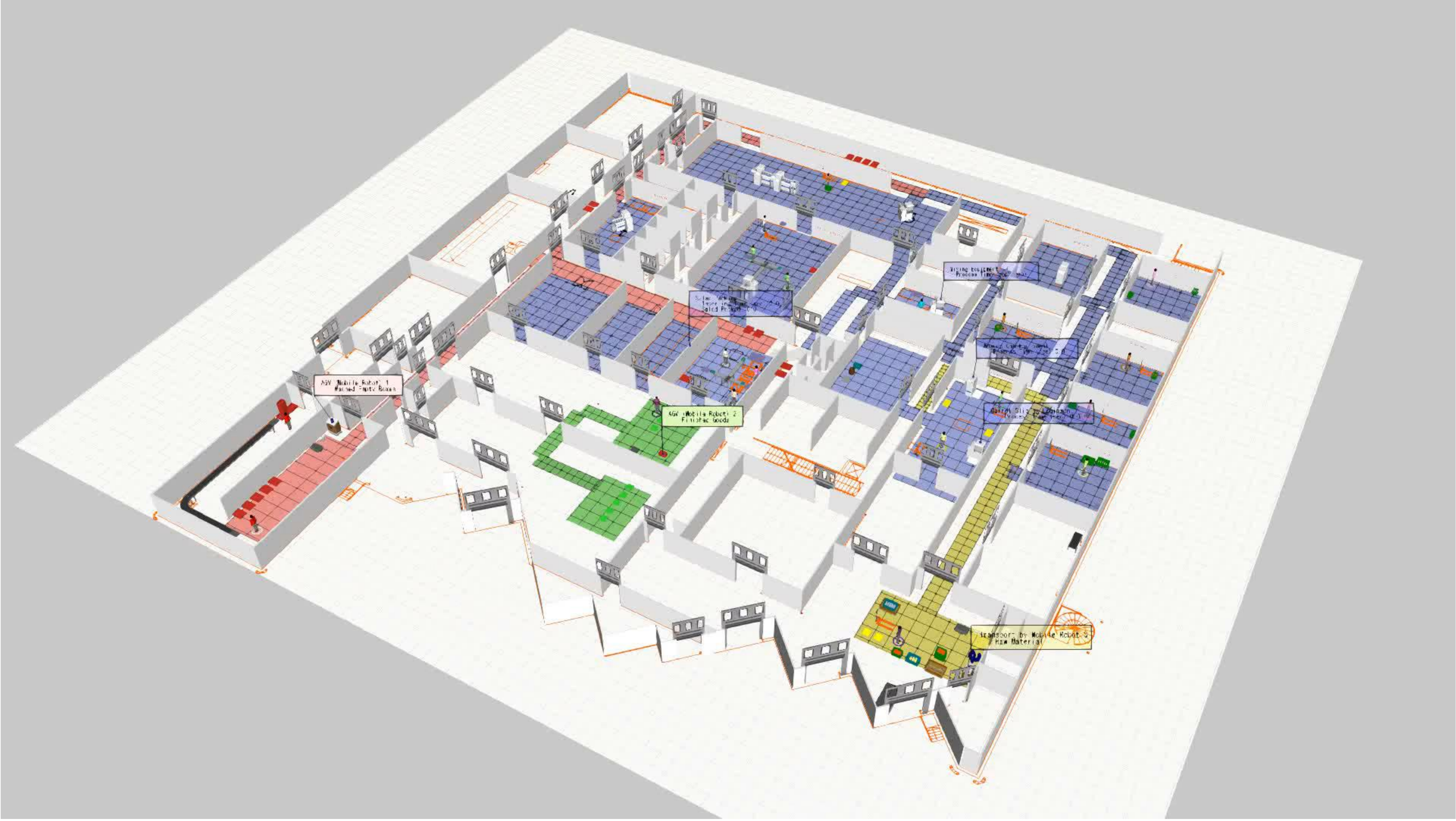
Inventory turnover = R / I

Cost = Investment + Operating cost (fixed and variable)

CASE STUDY – 3D SIMULATION MODEL OF PRODUCTION FACILITY



CASE STUDY – SIMULATION MODEL VIDEO



IMPLEMENTATION OF SCENARIO IN REAL ENVIRONMENT

RESULTS (KPIS COMPARISON)

KPI	Current Scenario (manual)	Virtual Scenario (automated)	Real Scenario (automated)	Estimated improvement
P1: Defects	**Irregularities existed due** to the messy corridors (routes) with random boxes (crates)	**Irregularities did not exist** as in the simulation the designated routes were clearly defined for robots	**Irregularities were mitigated** as the implementation of robots in a real environment leads to neat and clean routes.	10% reduction in existing transportation defects
P2: On-time delivery	**Insufficient amount of boxes** at the right time and at the right place. High waiting time at production lines	Simulation enables to **plan the number of boxes** at right time and place. For 12 hours simulation run with 3 robots, minor waiting time was overserved.	**On-time deliveries of** empty red **boxes were improved** as robots connected to the IoT platform, communication between them facilitate the availability of empty boxes at the right time and at the right place.	5% increase in on-time delivery
P3: Inventory turnover	**Inadequate inventory turnover** due to the lack of boxes. The **throughput was 321 boxes per hour**.	For an hour simulation run in the virtual setup of the same scale, **throughput was 336 boxes**.	Sensors data and **controlled planning of robots** enabled to **improve inventory** turnover.	5% increase in inventory turnover
P4: Labour Cost	Manual transportation incurs cost, when human labour realized fatigue due to repetitive activities.	Enables effective planning to allocate the workers and robots for the right and productive job.	The proper planned implementation of robots leads to a reduction in operating transportation costs. As the number of logistic workers decreased.	15% reduction in the labour cost

OUTLOOK

- Mobile robots can be used for the automation of the intralogistics processes. However, there are limitations in terms of size and weight

- KPIs analysis and experimental study revealed, it is technically feasible to use AMRs for intralogistics and it can enhance the proactive decision making

- The implementation of mobile robots needs a support of other technologies like IoT and Machine Vision

Case study video link:
https://www.youtube.com/watch?v=tsc0JmgqPIw&list=TLGG76swkvTxDeEwMjA5MjAyMg&t=4s

Reference:
Mahmood, K.; Karjust, K.; Raamets, T. (2021). Production Intralogistics Automation Based on 3D Simulation Analysis. Journal of Machine Engineering, 21 (2), 102−115. https://doi.org/10.36897/jme/137081

THANK YOU FOR ATTENTION!

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SURE5.0

Industry 5.0 webinar

Extended Reality for Learning: The XR2Learn Approach

Alessio Gugliotta, Senior Program Manager, EIT Manufacturing CLC South

Funded by the European Union

Please, turn off your camera and mute your microphone

XR2Learn EU Project

Mission: Establish platform – based, cross-border innovation community for XR in education and training.

Started in: Jan 2023
Duration: 42 months

Universities

cnit consorzio nazionale interuniversitario per le telecomunicazioni

Maastricht University

HELLENIC OPEN UNIVERSITY

Scuola universitaria professionale della Svizzera italiana SUPSI

Companies

GRUPPO Maggioli

LS GROUP

SYNELIXIS

F6S

Multipliers

eit Manufacturing CLC SOUTH
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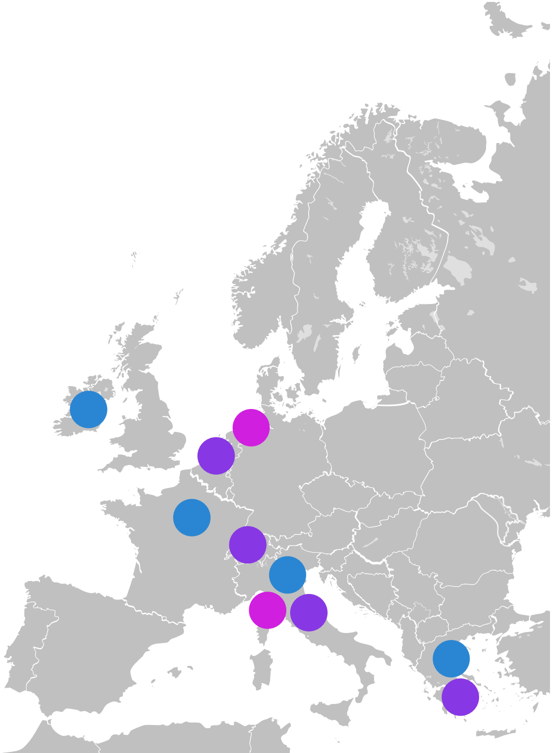
EADTU



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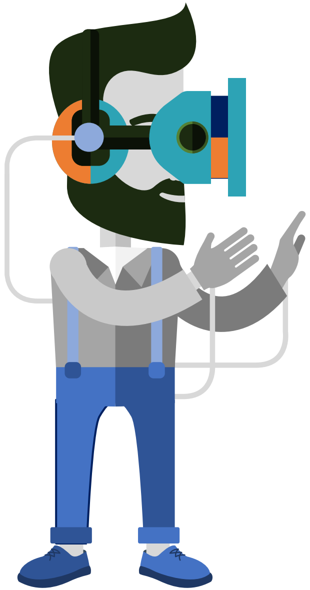
XR Market Context



- XR hardware more powerful + mobile
- XR not only for research labs
- XR development does not require large-scale investment

- XR mainly applied for games + entertainment
- US dominates market
- **Need to Increase European competitiveness**

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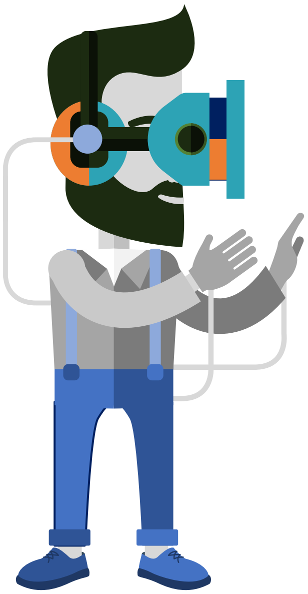
XR & Education/Training



- Huge challenge in educating young engineers and reskilling/upskilling today's worker
- Rich literature documenting the benefits of the use of XR technologies in Education/Training

- Accelerate XR application design and development for education/training
- XR developers need to work closely with education experts
- The cost of XR application development for educational should be reduced

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XR2Learn Vision & Solution

SURE5.0

XR Tech Provider

Edu/Train Tech Provider

Edu/Train Material Creator

Edu/Train Organization

Student/ Worker

Enthusiast

Policy maker

XR2LEARN Digital Platform

Community

Catalogue

IPR management through NFTs

Enablers to accelerate dev

Demonstration Beacon Apps

On demand Dev/Trade Support

Business & Tech Support

Target scenarios

Training applications for the manufacturing domain

Distance learning scenarios

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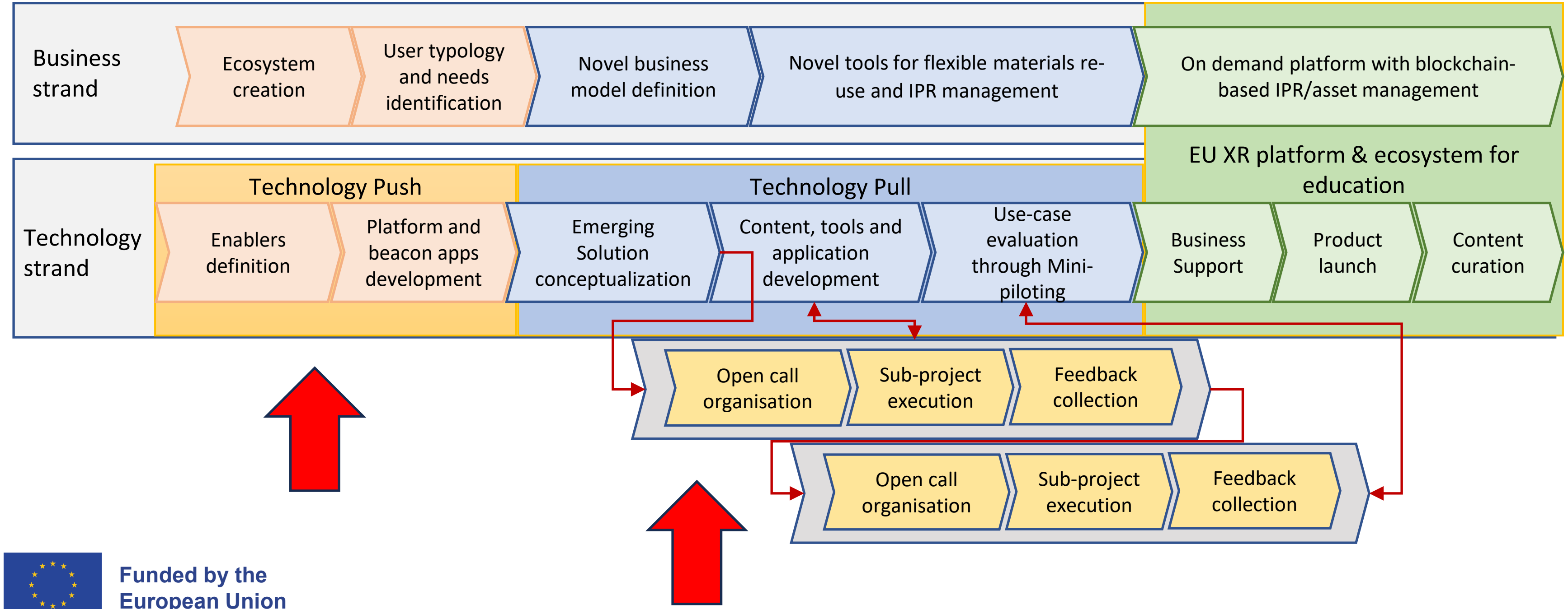
XR2Learn Process



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Enabler 1: INTERACT (PUSH)

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Unity plugin **for industrials** who want to create human-centric **simulations** in **virtual reality**

How?

- Recreate accurate physical behaviors in the virtual world
- No-code and tools helpers to quickly setup physics simulation

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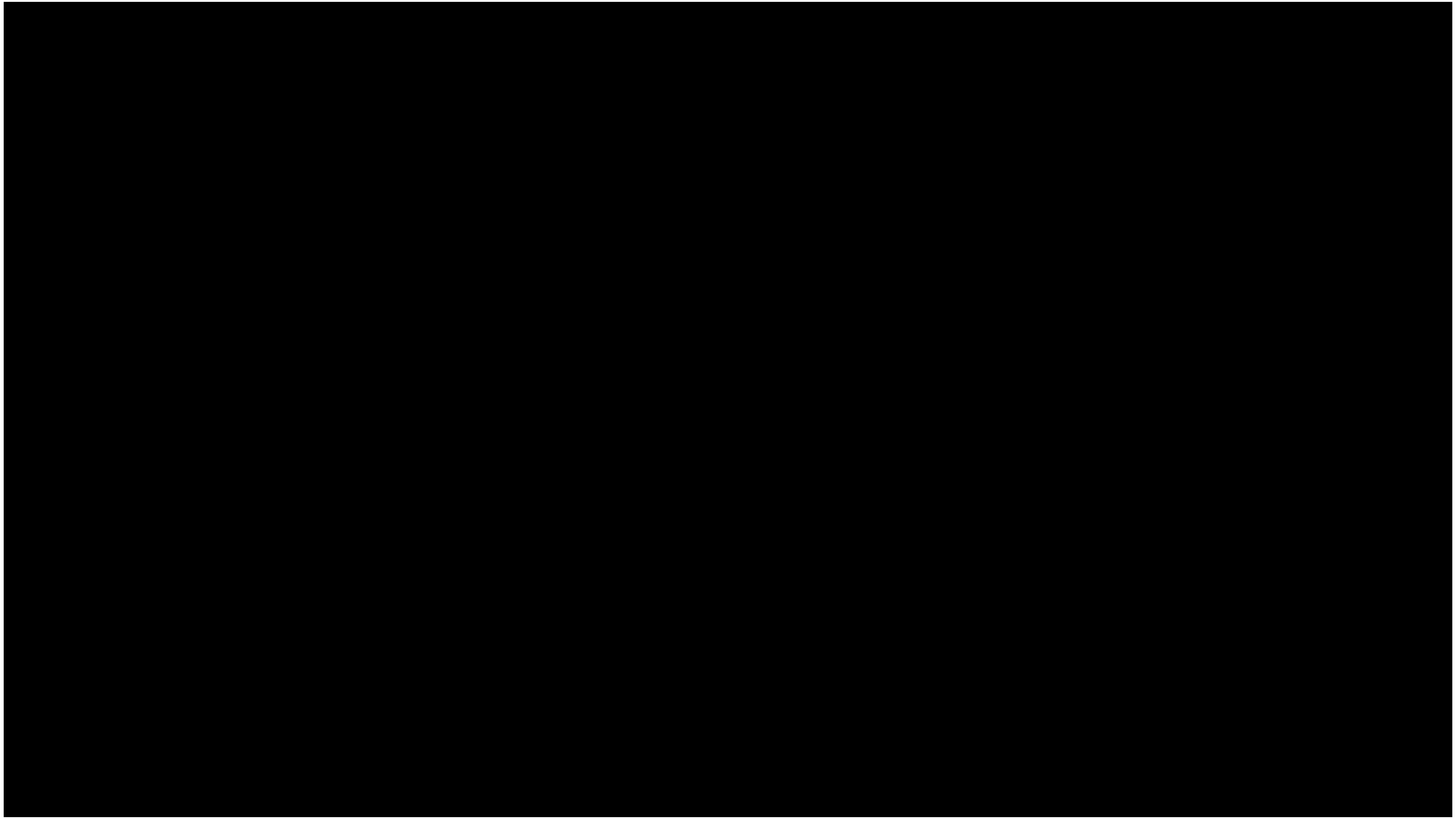
Enabler 1: INTERACT (PUSH)



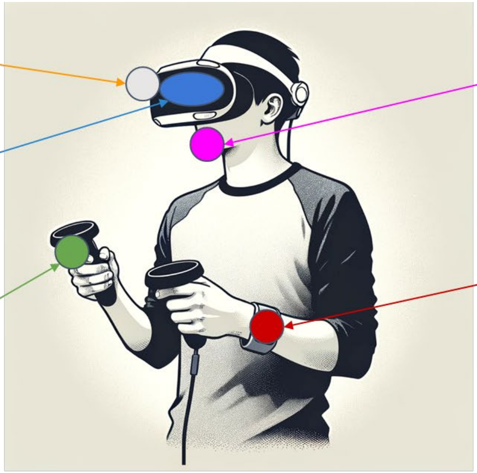
Enabler 2: Magic Xroom (PUSH)

Sensors

VR headset data
- Location
- Rotation

Eye tracking data
- Pupils location
- Focus target
- Eye features

VR controllers data
- Location
- Rotation



Face tracking data
- Face features

Shimmer 3 GSR+ data
- Location
- Rotation
- Acceleration
- Galvanic Skin Response (GSR)
- Photoplethysmography (PPG)
- Heart rate

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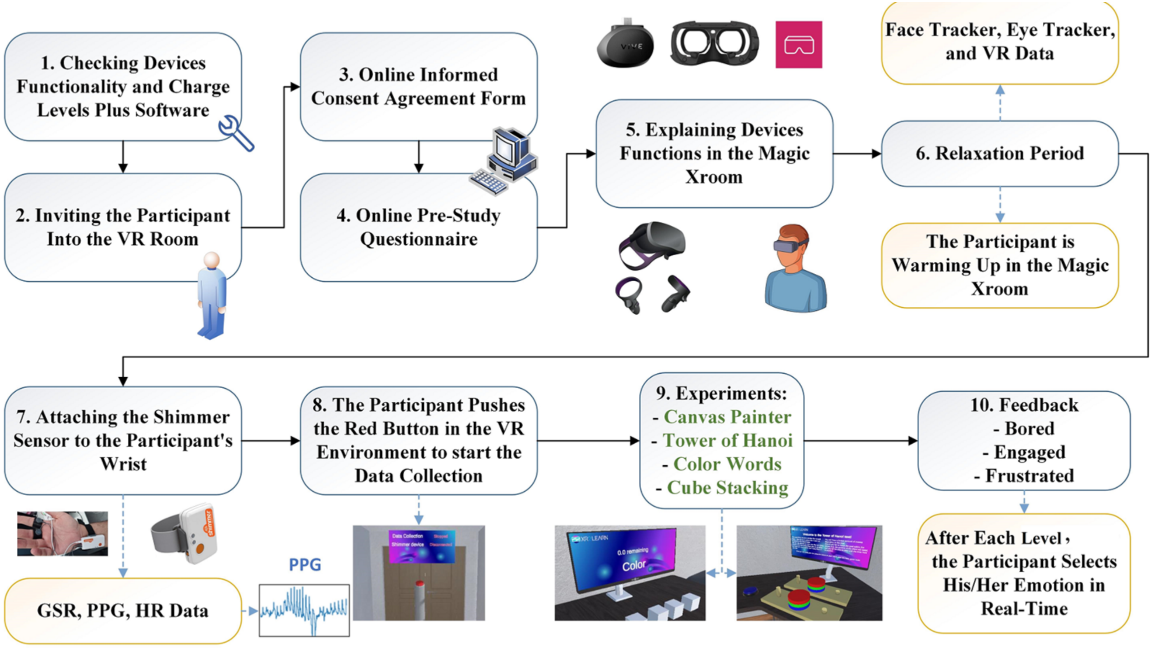
Enabler 2: Magic Xroom (PUSH)

Flow

Experiment protocol
Data Analysis to understand person situations (e.g. stress, boring, etc.)



Scenarios

Stacking Cubes
Colour Words
Canvas Painting
Tower of Hanoi

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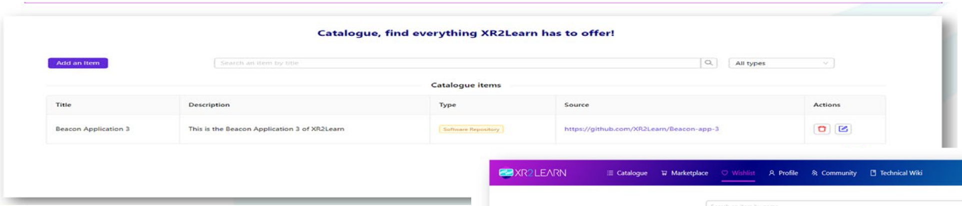
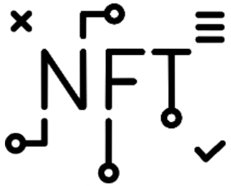
The digital platform (PUSH)

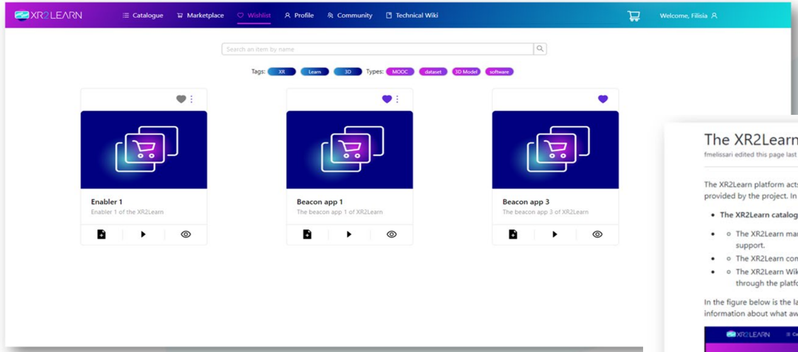
Catalogue
Technologies, Librieries,
Applications

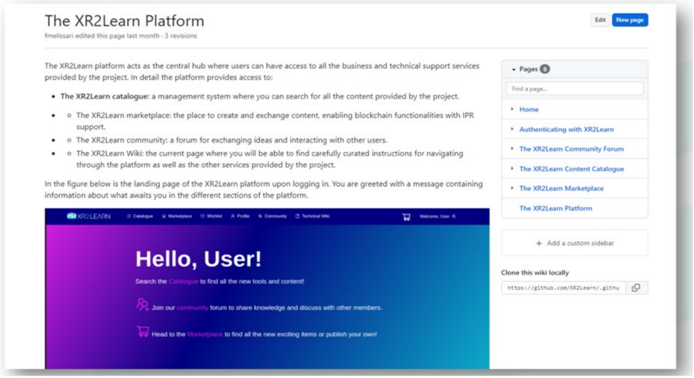
Marketplace
Buy, NFT
Skills.move

Community
Forum
Wiki









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Beacon app: Laser Cutting Machine Maintenance

Funded by the European Union

Other videos: https://www.youtube.com/@XR2Learn

Open calls (PULL)

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Funding
150-300k, tot. 4,2 Mln
Support services

OC1 App. Development
7 projects selected
Jan.-Dec. 2024

OC2 Piloting
Call will open:
End 2024

OC1 Projects

EVR-OSH-5 (Zengo, HU)
Job security, emergencies, multi-user

CARATE (WEKIT ECS, IE)
Space, wearable, blended training

XR4HRC (LTG, TR)
Industrial robotics in immersive environments

PaperXR (NEXUSIT, BG)
Press sector
Cost reduction

XR2IND (INNOV-ACTS, CY)
AI chat training in XR environment

X-Alfy (VenakaTreleaf, DE)
Forest Management 5.0
Sustainable Practices

PROXIMA (BSD, IT)
Macchine CNC Low Resource Scenarios

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Project Summary

SURE5.0

2000+ Online Community Members from more than 20 countries

EUR 4.2M Equity-free FSTP for XR innovators via **2 Open Calls**

>20 complete educational applications/tools provided through the platform

>5 new business models defined(enabled by NFTs)

6 XR enablers provided on the platform by project partners + contributions from Community members

3 beacon applications developed and demonstrated

150+ XR content for educational applications, training materials, learning scenarios & technological guidelines provided via platform.

the
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Thanks for your attention

www.sureproject.eu

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