Adaptive Automation in Assembly
For BLUE collar workers satisfaction in Evolvable context

A4BLUE

This project has received funding from European Union´s Horizon 2020 research and innovation programme under grant agreement n° 723828

Project results

ICAM - Toulouse 20/09/2019

A4BLUE objectives

Put together workers and AUTOMATION mechanisms to take advantage of each others strengths

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Put together workers and context-aware ADAPTATIVE ASSISTANCE TOOLS

TO

Increase worker SATISFACTION and workability

Increase productivity and overall PERFORMANCE

Long term socio-economic sustainability

A4BLUE key outputs

Methods & Tools for Sustainability	• Methodology for the definition of the optimal level of automation • Methodology for usability and satisfaction assessment • Socio Economic assessment framework
New or enhanced automation mechanisms	• New: deburring robot and automated tool trolley • Enhanced: smart torque wrench, dual arm and logistic robot
A4BLUE Reference architecture and implementation	• New interaction mechanisms: verbal and non verbal • A4BLUE adaptive framework • Assistance tools: Context aware on the job training and guidance, decision support system and collaborative knowledge management

A4BLUE involves 4 use case scenarios ...

INDUSTRIAL PILOTS

AIRBUS | TOULOUSE, FRANCE

SCENARIO Complex, manual hydraulic system assembly.

WHAT To optimise hydraulic system assembly through the usage of smart tools and Virtual/Augmented Reality.

WHY To evaluate the impact of an adapted AR HMI in terms of performance and error rate for different skilled groups of people and to enable full quality assurance approach and operators performance thanks to traceability.

CESA | MADRID, SPAIN

SCENARIO Landing gear retraction actuator assembly: Manual deburring operation | Assembly process.

WHAT To incorporate a robot to assist the worker in the deburring operation | To incorporate AR based guidance based on operator's profile as well supporting knowledge sharing.

WHY To increase the quality, efficiency and ergonomics of the deburring process | To reduce operators training time through AR; to reduce time for reviewing documentation; to increase confidence, participation, and internal communication among the personnel.

LAB PILOTS

IK4 TEKNIKER | EIBAR, SPAIN

SCENARIO Collaborative assembly in a fenceless environment.

WHAT To introduce active safety measures supporting Human-Robot collaboration; to support personalized ergonomic adaptation; to provide natural Human-Automation multi-channel interaction; to provide decision support dashboards for quality and maintenance.

WHY To evaluate trust, usability and worker satisfaction (in terms of safety, interaction, ergonomics, assistance).

RWTH AACHEN UNIVERSITY | AACHEN, GERMANY

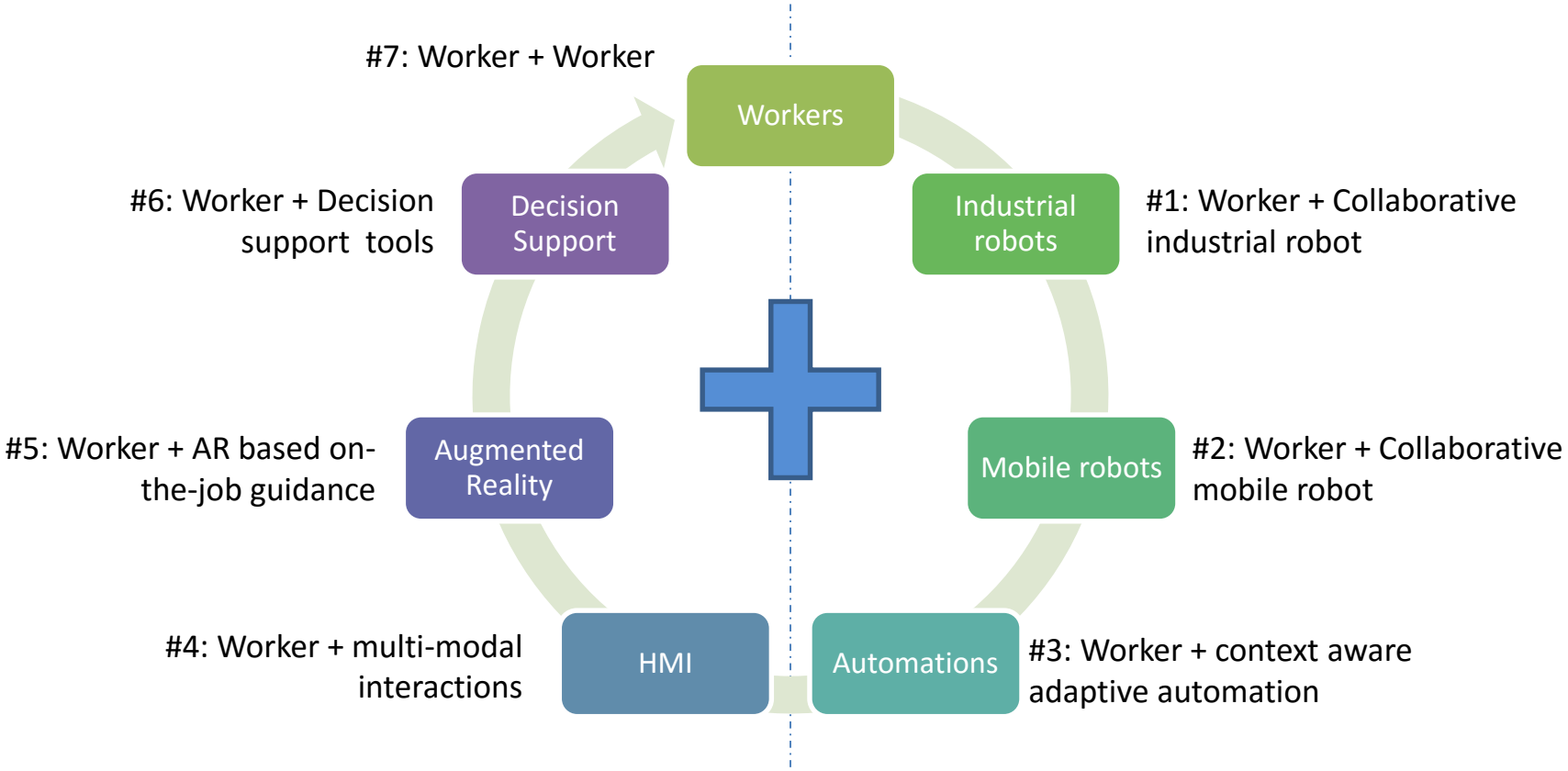
SCENARIO Final assembly of electric vehicles.

WHAT To incorporate AR based guidance based on operator's profile and to provide the tools required for the assembly by means of an automated tool trolley.

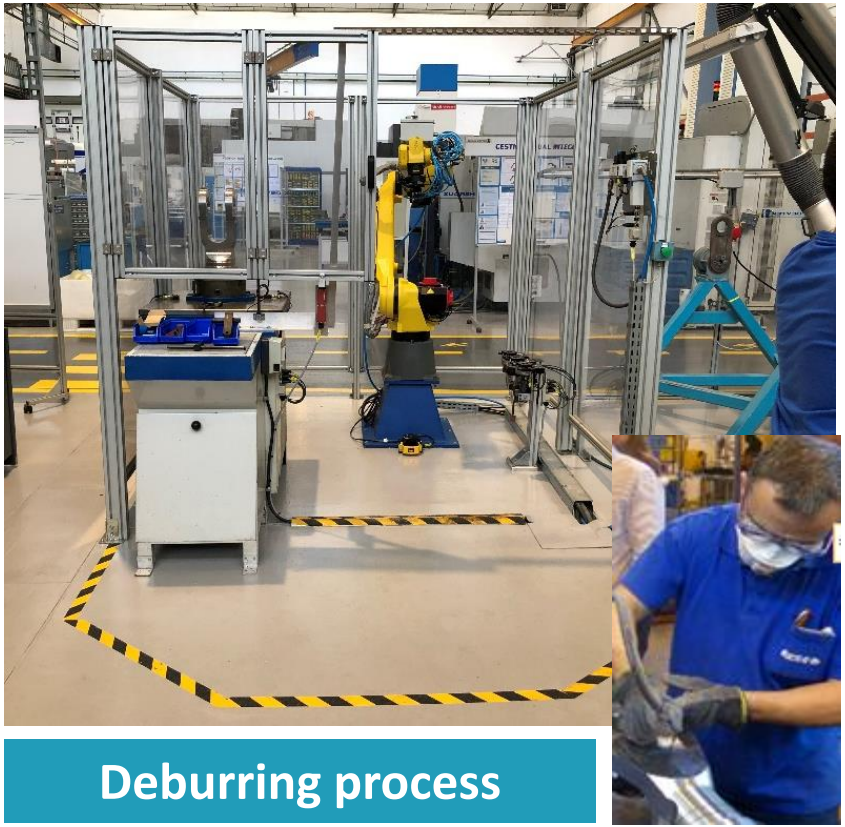
WHY To improve worker satisfaction, to reduce training time, to improve process efficiency; to improve ergonomics; to validate a tool to determine the optimal degree of automation.

AUGMENTED WORKPLACE

A4BLUE collaboration dimensions



Worker + Collaborative industrial robot



Deburring process

Deburring robot

- Industrial robot collaborating with process operations to perform the MOST EXHAUSTING phases of the deburring process

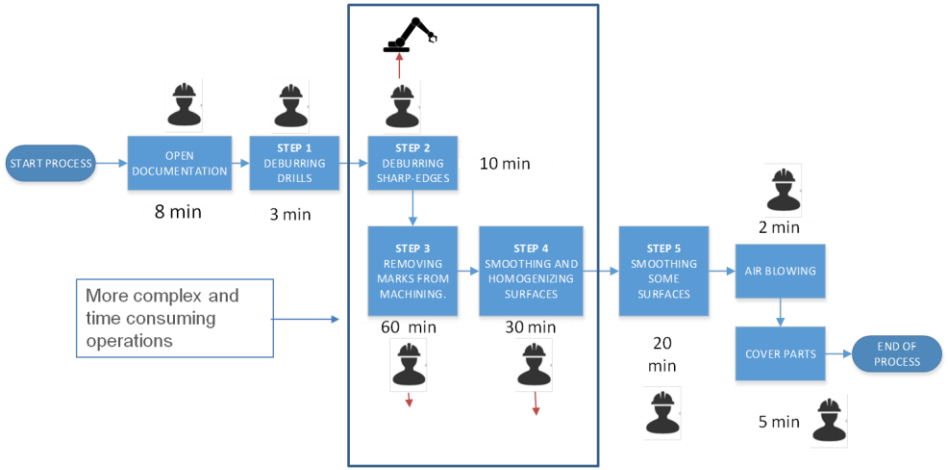
Initial situation

- Long, exhausting, repetitive, non added-value manual task
- High physical demands: risk of breathing metal chips, bad ergonomics conditions (i.e. moving heavy parts)
- Results are highly dependent on the operator's expertise

Worker + Collaborative industrial robot

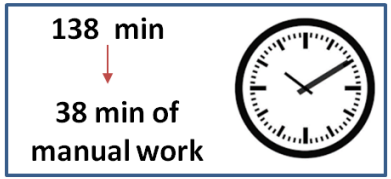
Resulting benefits

- **Improved efficiency:** increases productivity while maintaining quality (i.e. 100 min reduction of manual work)
- Reduced **process variability**
- **Improved working conditions**: increases ergonomic and safety conditions and reduces physical demands
- **Opens up job opportunities:** the level of required expertise is lowered
- **Increased worker satisfaction**



Identified actions

- **New added value competences** required → scheduled training in robot programming for the operators



Worker + Collaborative mobile robot

Automated tool trolley

- Provides on demand tooling

Logistic robot

- Transports parts from/ to the warehouse

Resulting benefits

- **Improved efficiency:** reduction of displacements
- Reduced **physical demands**
- **Opens up job opportunities** to people with some kind or physical or sensorial limitations

Logistic robot

Tool trolley

Worker + context aware adaptive automation

Adaptation to process variability

- Automatic configuration of the process parameter

Resulting benefits

- Increased quality

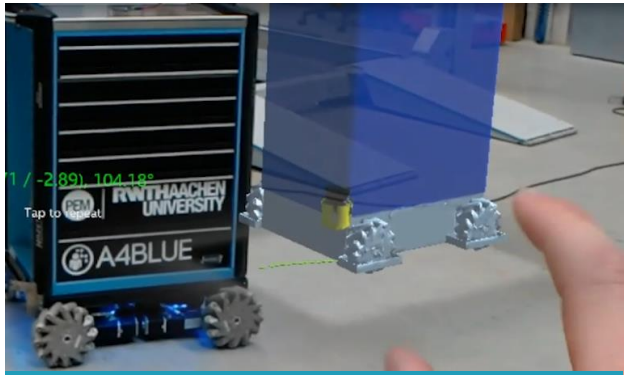
Adaptation to human variability

- Ergonomic positioning based on workers ‘characteristics

Resulting benefits

- Reduced **physical demands**
- **Increases safety**
- **Opens up job opportunities**

Worker + multimodal interaction



Tool Trolley HMI

Dual Arm HMI

Multimodal interaction with Tool Trolley

- Voice commands for long range steering
- Gesture commands for short range navigation
- Follow-me function for ergonomic improvements
- AR-supported navigation and trajectory visibility

Multimodal interaction with robots and MES

- Voice commands: natural speaking
- Gesture commands

Resulting benefits

- **Improved efficiency:** reduction of displacements
- Reduced **physical demands**
- **Opens up job opportunities** to people with some kind or physical or sensorial limitations

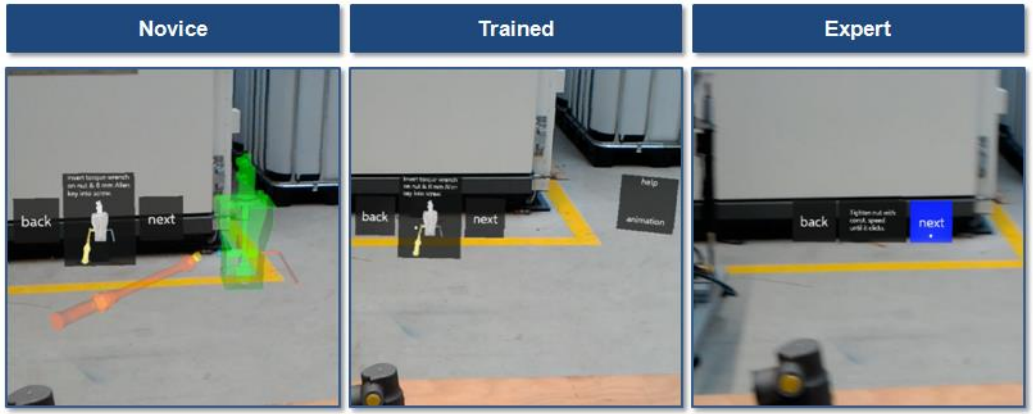
Worker + AR based on-the-job guidance

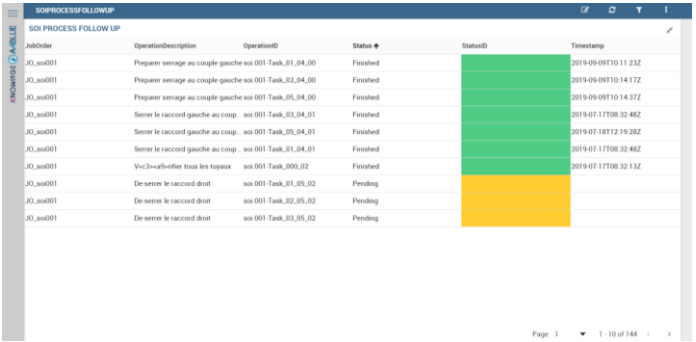
On the job guidance

- Context aware information: based on the operation being performed and the profile of the worker

Resulting benefits

- **Improved traceability:** completion of all the steps is registered.
- Reduces **training duration**
- **Opens up job opportunities** to less experienced workers,





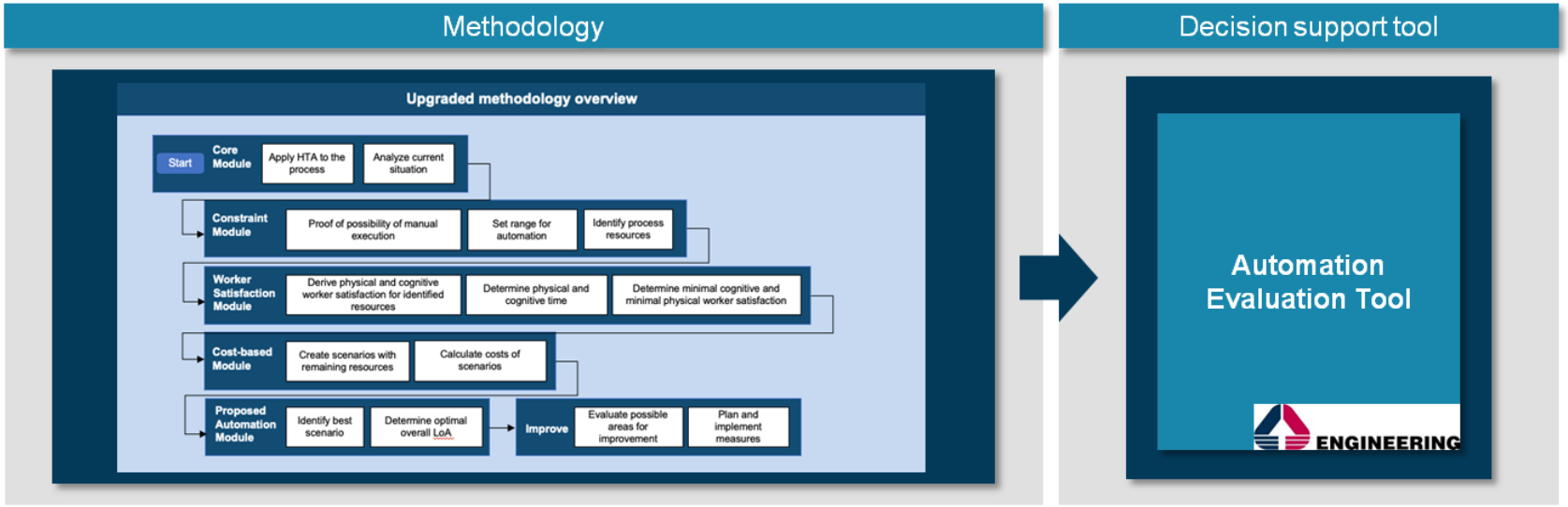
Worker + Decision support tools

Definition of the optimal level of automation

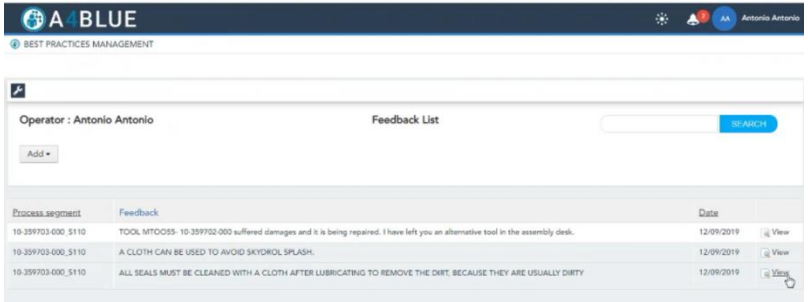
- Based on the optimization of process costs and worker satisfaction

Resulting benefits

- Considers **socio economical** aspects



Worker + Worker

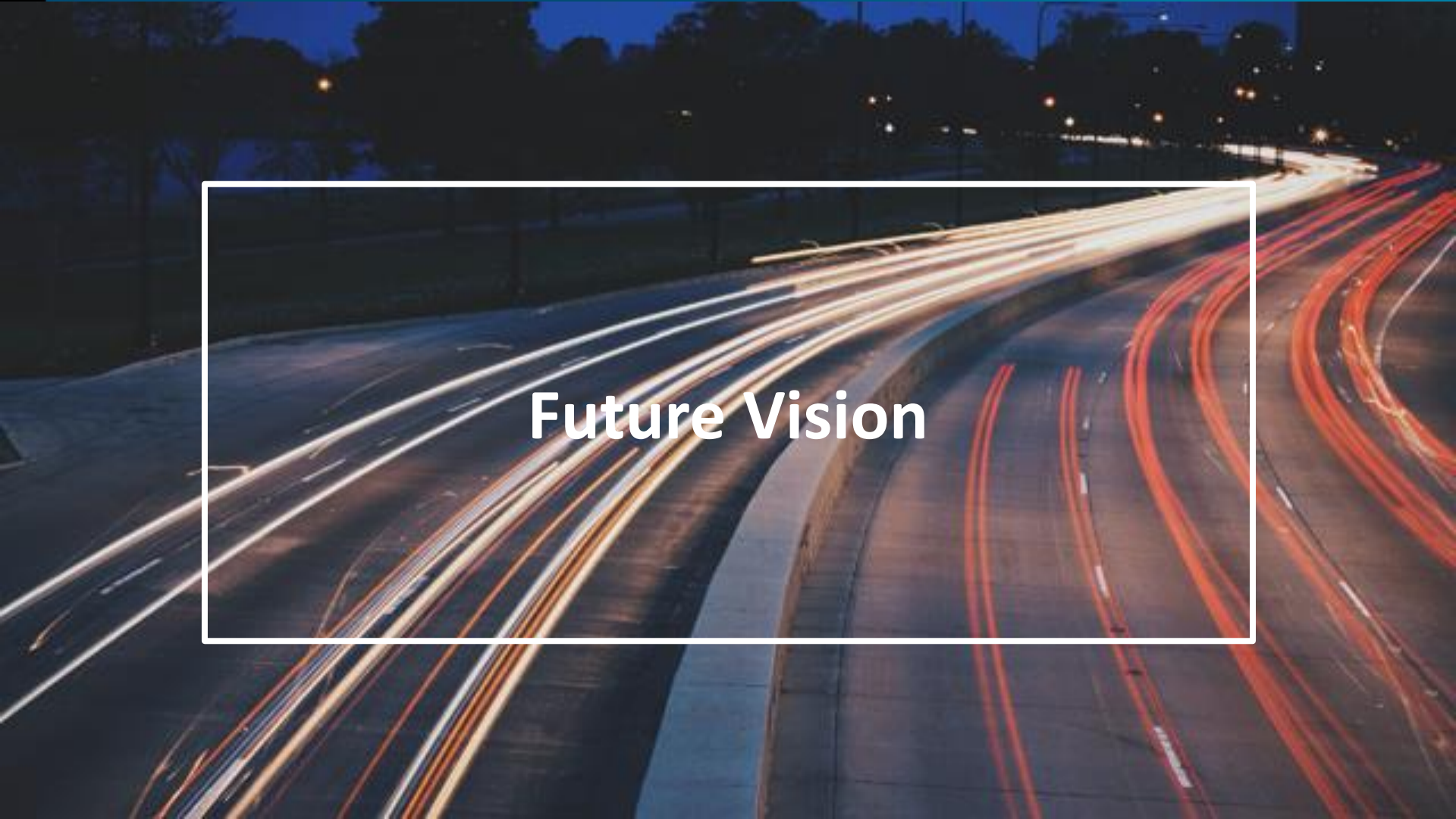


Best practices management

- Knowledge sharing between workers
- Takes advantage of expert workers knowledge
- Different GUIs supported: web based and AR based
- Context aware information: based on the operation being performed

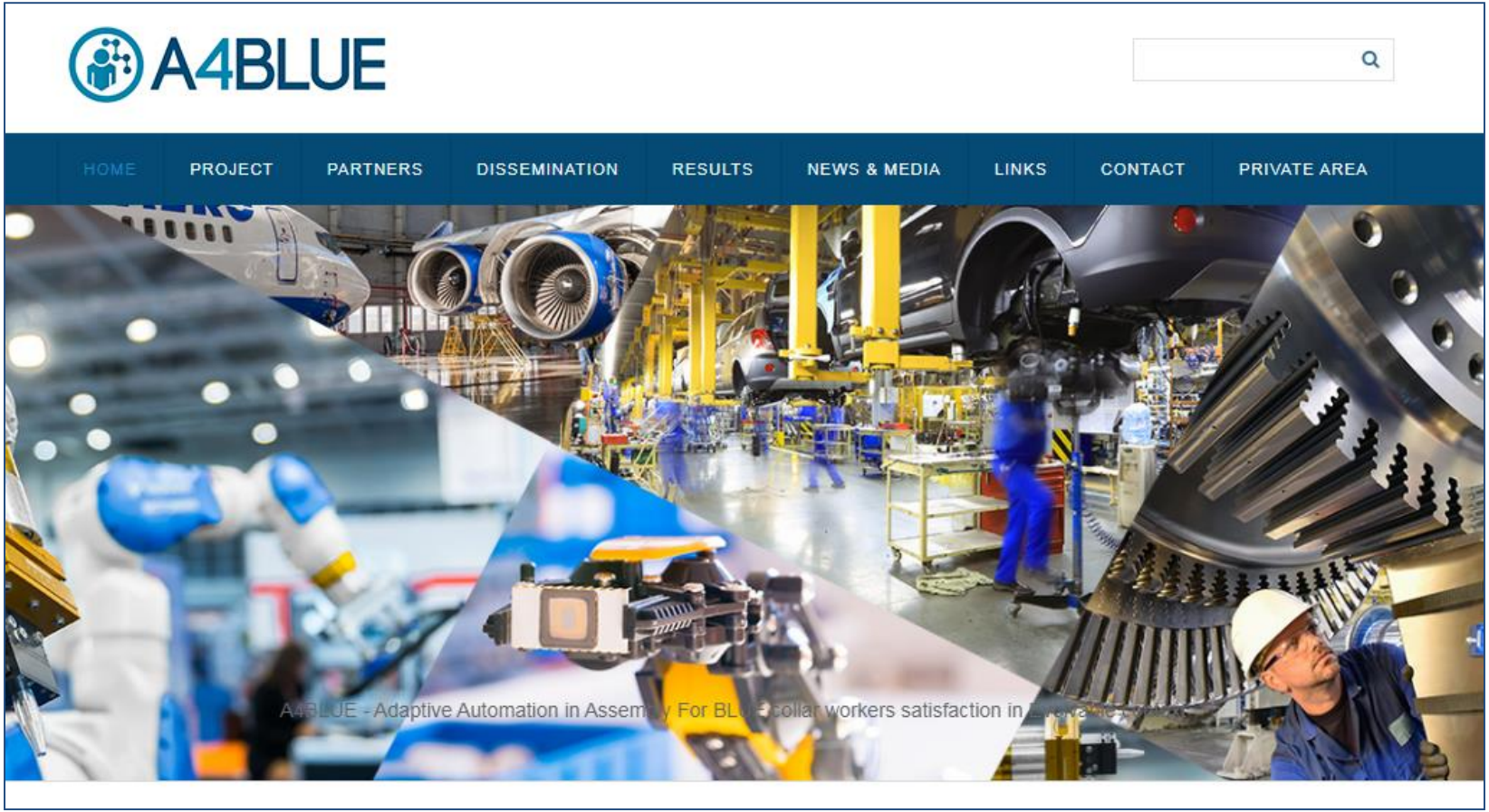
Resulting benefits

- **Improved efficiency:** increased productivity due to reduced time to solve issues during the process
- **Supports** less experiences workers, reduces **training time**


Future Vision

A4BLUE main breakthroughs

- Digital Technologies will bring us toward the Autonomous and Hyper-connected Factories
- Human Factors will remain crucial for the next generation factories
- Humans and Digital Technologies experts need to join forces
- Clear Skill pathways and Assistance technologies will help us on becoming augmented worker (operator 4.0)
- Exploit proactive and open collaboration among all the involved stakeholders (Multi-Actor approach is needed!!)



http://a4blue.eu/

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THANK YOU