

Social industrial collaborative environments integrating AI, Big Data and Robotics for smart manufacturing - CONVERGING

7 May 2024

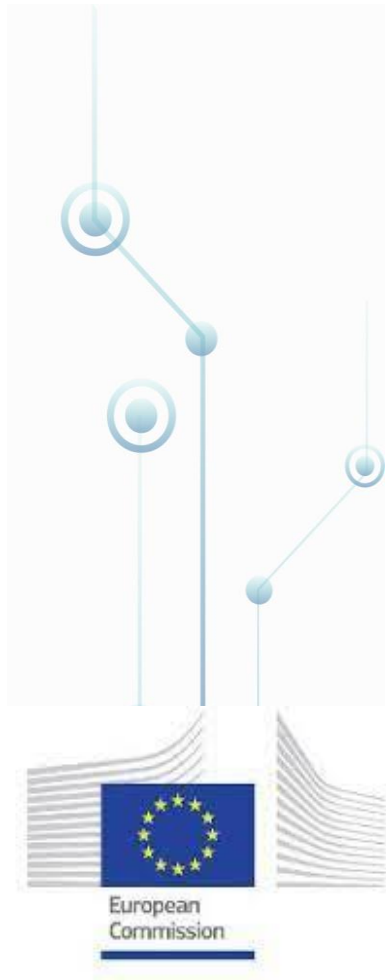
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CONVERGING Participants



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- ❖ 16 partners
- ❖ 9 countries

	Participant organization name	Short Name	Country	Organization type
1	UNIVERSITY OF PATRAS	LMS	GREECE	RTO
2	FUNDACION TECNALIA RESEARCH & INNOVATION	TECNALIA	SPAIN	RTO
3	ELECTROLUX ITALIA SPA	ELUX	ITALY	END USER
4	ISRAEL AEROSPACE INDUSTRIES LTD	IAI	ISRAEL	END USER
5	COMAU SPA	COMAU	ITALY	INDUSTRIAL
6	PILZ INDUSTRIE ELEKTRONIK SL	PILZ	SPAIN	INDUSTRIAL
7	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV	IPK	GERMANY	RTO
8	ASOCIACION DE INVESTIGACION METALURGICA DEL NOROESTE	AIMEN	SPAIN	RTO
9	NETCOMPANY-INTRASOFT SA	INTRA	LUXEMBOURG	INDUSTRIAL
10	PRIMA ADDITIVE SRL	PRIMA	ITALY	END USER
11	VISUAL COMPONENTS OY	VIS	FINLAND	INDUSTRIAL
12	FORD ESPANA SL	FORD	SPAIN	END USER
13	ITERA SOLUCIONES DE INGENIERIA SL	ITERA	SPAIN	INDUSTRIAL
14	TEACHING FACTORY COMPETENCE CENTER	TF-CC	GREECE	INDUSTRIAL
15	KAWADA ROBOTICS CORPORATION	KAWADA	JAPAN	RESEARCH
16	CRANFIELD UNIVERSITY	CU	UK	RESEARCH



CONVERGING Motivation



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- tremendous **challenges** on the manufacturing firms due to **global scale occurrences** including economic crisis and an unprecedented pandemic.
- both **human and automated resources** that can work **together seamlessly** or mutually exchange tasks, allowing the execution of any process plan in more than one, non-predetermined ways
- significant **breakthroughs** that can support flexible production in smart factory setups
 - **Perceive:** *Identify and recognize, process, resources, environment and their actual status*
 - **Reason:** *Analyze the status of production system and autonomously formulate plan of actions*
 - **Adapt:** *Automatically apply modifications to h/w and control systems to execute formulated plan*
 - **Collaborate:** *Seamlessly work with humans or other resources to achieve high quality/ performance*
 - **Innovate:** *Expand capabilities through allowing introduction of new technologies and Openness*

CONVERGING vision is:

“to develop, deploy, validate and promote smart and reconfigurable production systems including multiple autonomous agents (**collaborative robots, AGVs, humans**) that are able to act in diverse production environments. The diversifying factors will be a multi-level **AI based cognition** (line, station, resource levels) which will exploit the **collective perception (Digital Pipeline)** of these resources, allowing them to interact with each other and seamlessly coexist with humans under a «**social industrial environment**» that ensures trustful, safe and inclusive user experience”

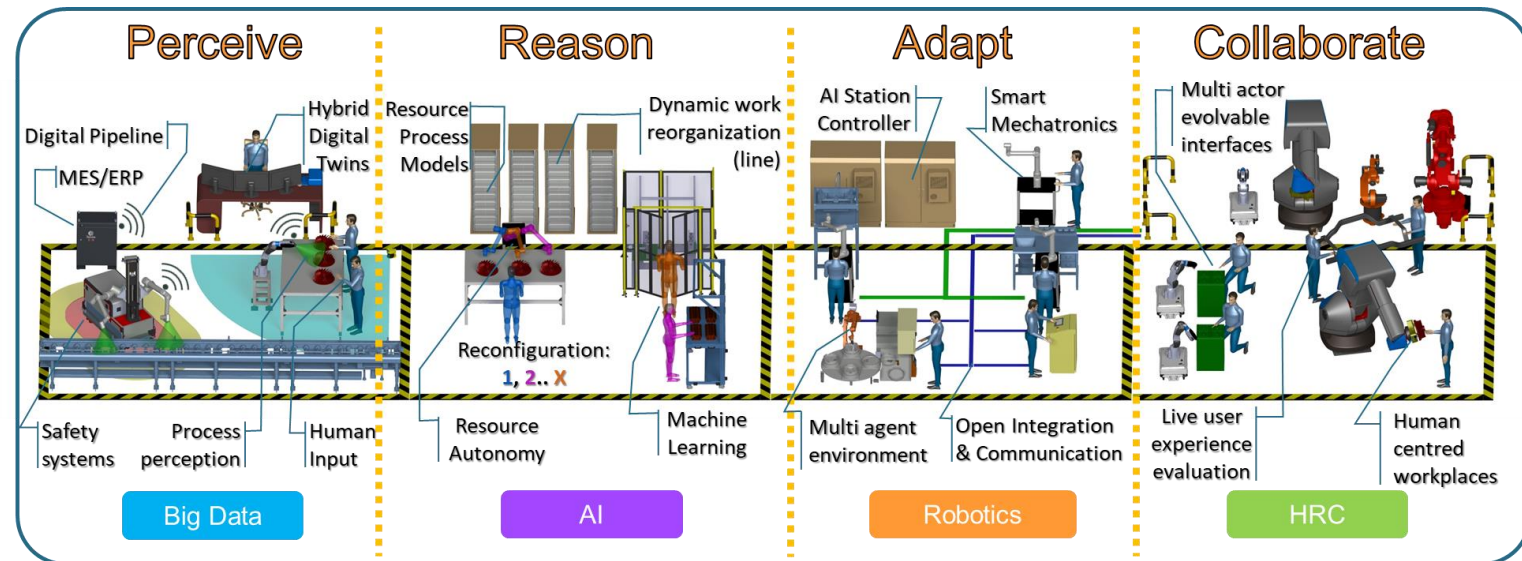
CONVERGING Objectives



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- **Objective O1:** Implementing a highly **reconfigurable production system** by deploying **collaborative robotics** and **smart mechatronic devices**, relying on **multi-level AI** to achieve autonomy
- **Objective O2:** Providing **open and standard means to interconnect** all production entities (**Big Data pipeline**) for real time capturing (**Digital Twin**), storing (**Data at Rest**) and processing (**Data in Motion**) to support autonomous and collaborative behaviour with minimal user intervention
- **Objective O3:** Establishing a **human centered social-industrial environment** where all activities and interactions with humans are dynamically shaped to maximize user experience, trust, skills & safety
- **Objective O4:** Providing the **software and hardware interfaces** to ensure safe and seamless interaction with collaborative robotic solutions, minimizing learning curves and setup times
- **Objective O5:** Create innovation ecosystem through a network of **open Pilot Lines** - involving robotic application stakeholders, SMEs and RTOs to inspire further development and deployment





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CONVERGING Use cases

Automotive use case - FORD



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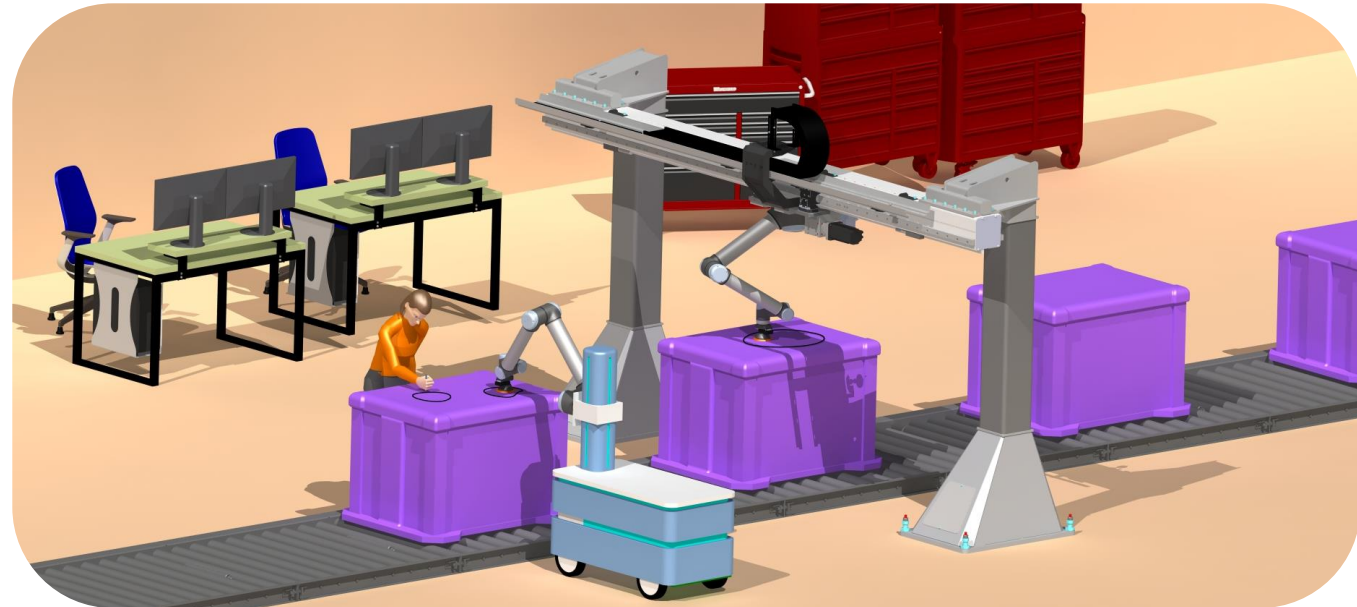
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Current State



- Polishing of stamping dies
- Manual work
- Labor intensive operations – ergonomic issues
- Subjective evaluation of polishing result

CONVERGING Vision



- Robotized polishing of stamping dies
- Human robot collaboration
- Operator to mark the areas to be polished
- Mobile/stationary robot to automatically polish the marked areas
- Quality control

CONVERGING Use cases

White goods use case - ELUX



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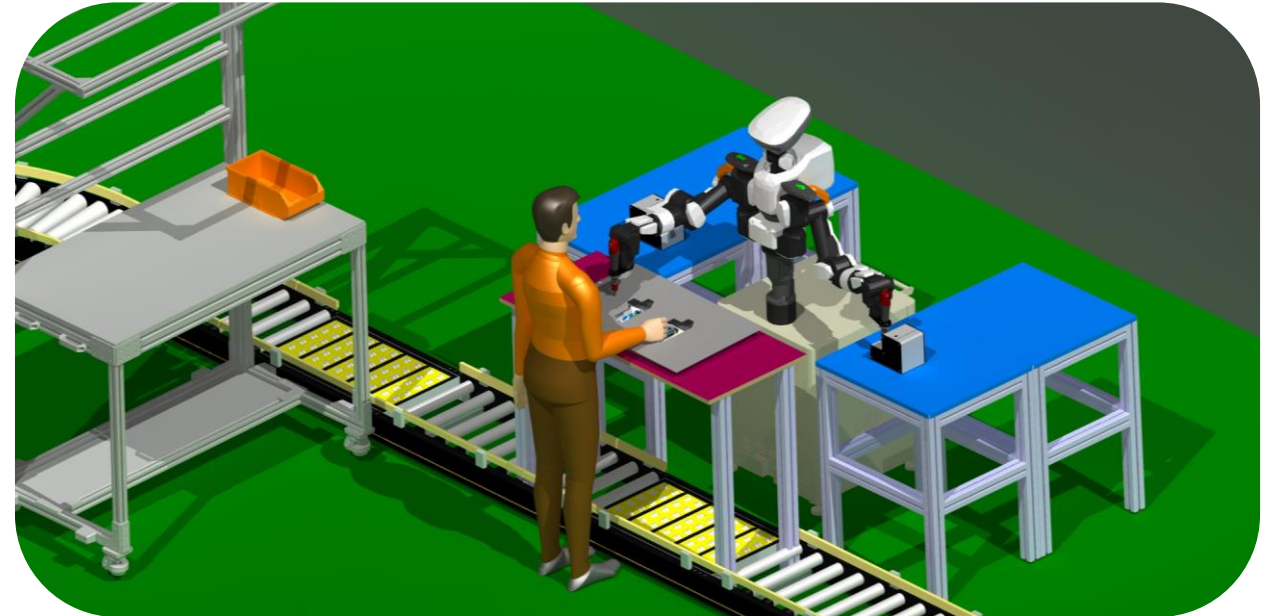
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Current State



- Assembly of kitchen hobs
- Manual work
- Labor intensive operations – ergonomic issues
- Productivity constraints

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- Human robot collaborative assembly
- Humanoid dual arm robot
- Space and part sharing
- Identification of human actions - prediction
- Advanced environment and process perception

CONVERGING Use cases



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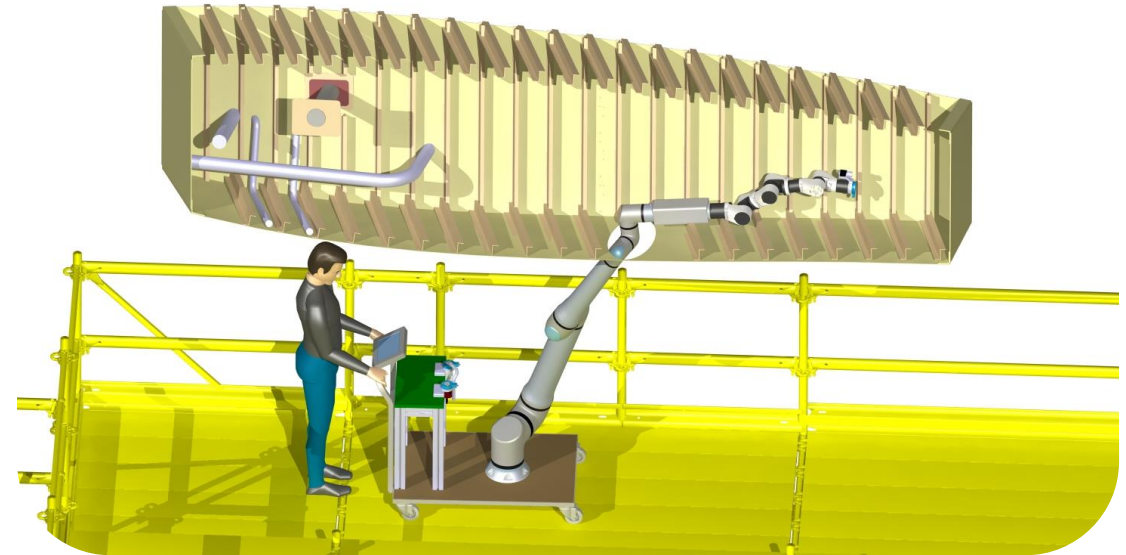
Aeronautics use case - IAI

Current State



- Inspection and maintenance of aircraft fuel tanks
- Manual work
- Exposure of humans to hazardous environment
- Quality assurance issues – human errors

CONVERGING Vision



- Robotized inspection and maintenance of fuel tanks
- Remote monitoring – teleoperation
- Operator support via advanced AR interfaces
- Operator to intervene in situ when needed

CONVERGING Use cases

Additive manufacturing use case - PRIMA



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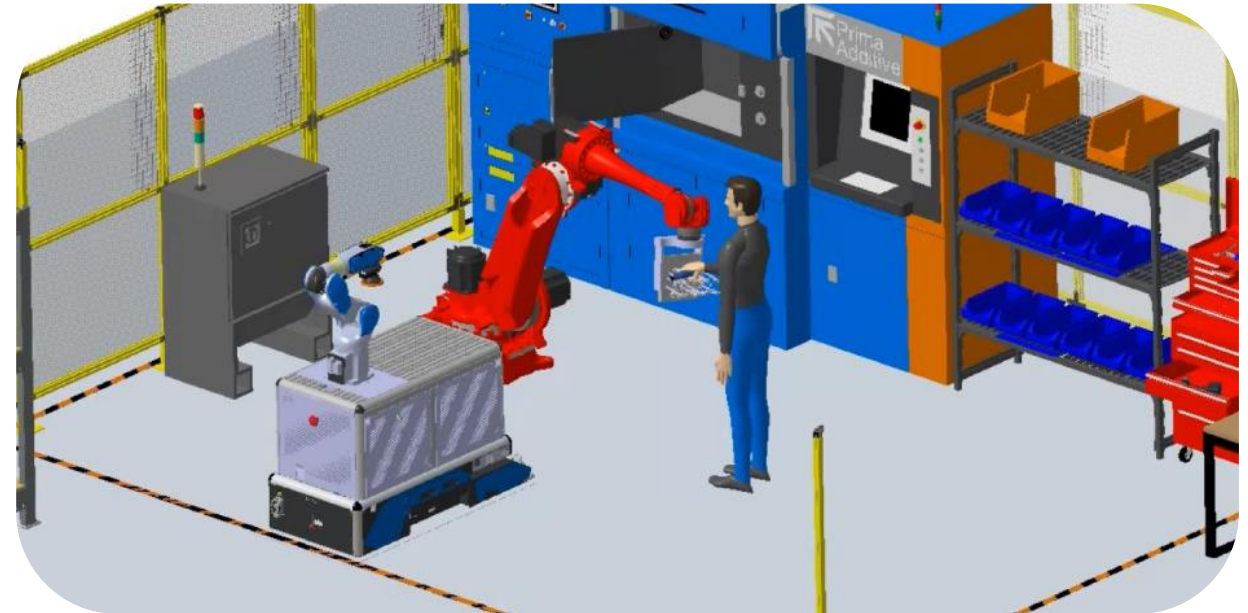
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Current State



- Post processing of additive manufactured parts
- Manual work
- Exposure of humans to hazardous substances
- Quality assurance issues – defects due to human work

CONVERGING Vision



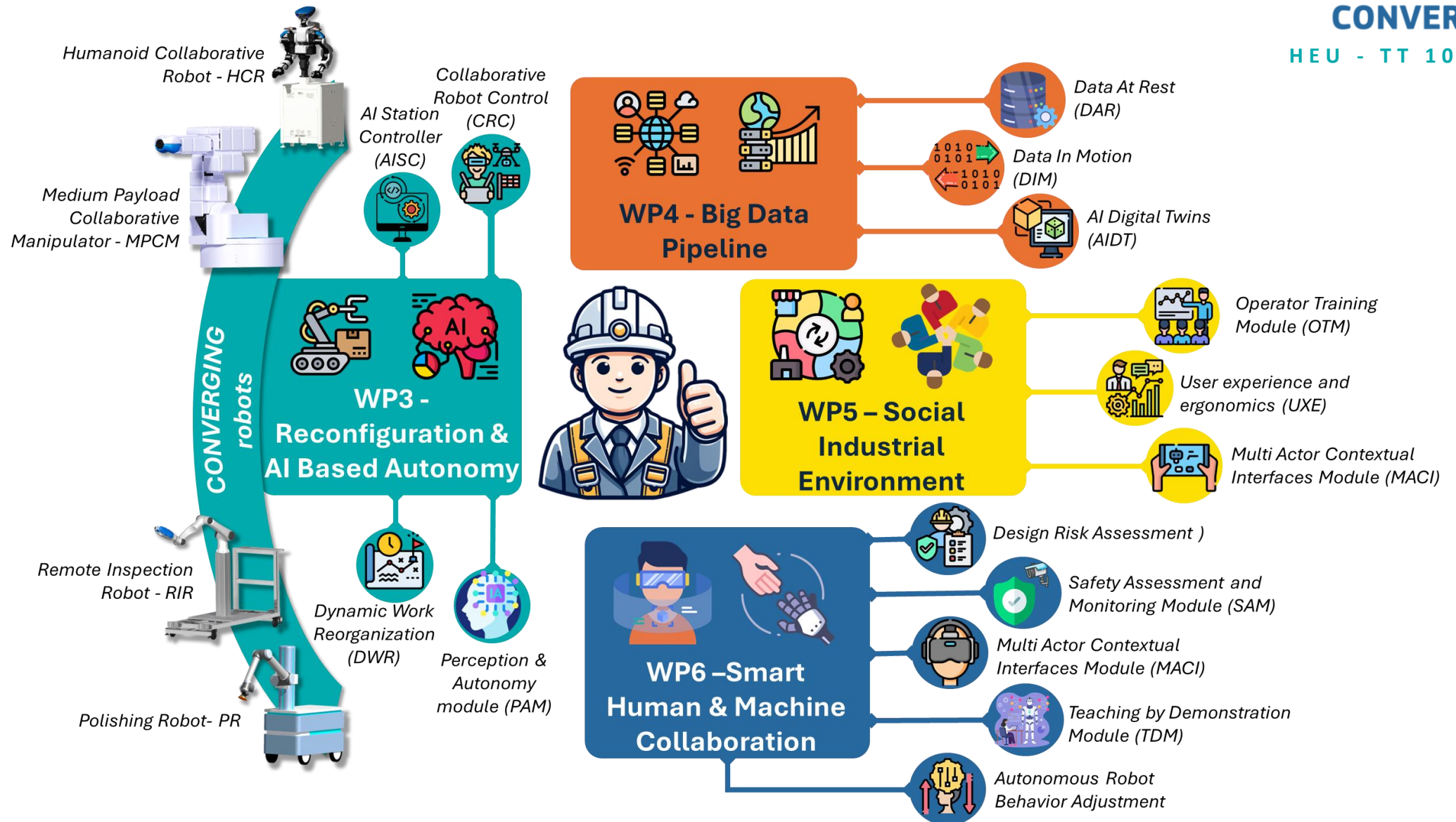
- Human robot collaborative post processing
- Robotized blowing of powder – teleoperation possible
- AGV for logistics tasks
- Medium payload robot to act as work holding device – operator to perform support removal tasks
- Human action perception - automatic robot pose adaptation

CONVERGING Modules



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CONVERGING Reconfiguration & AI Based Autonomy



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WP3

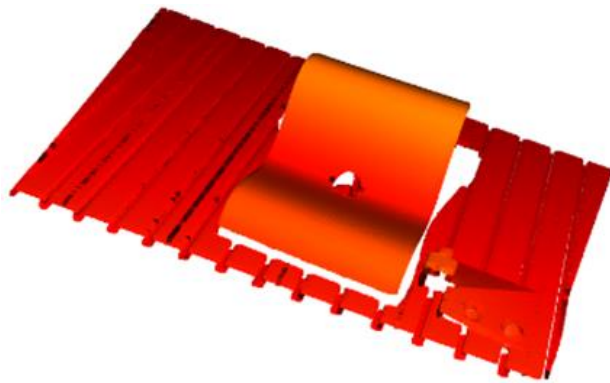
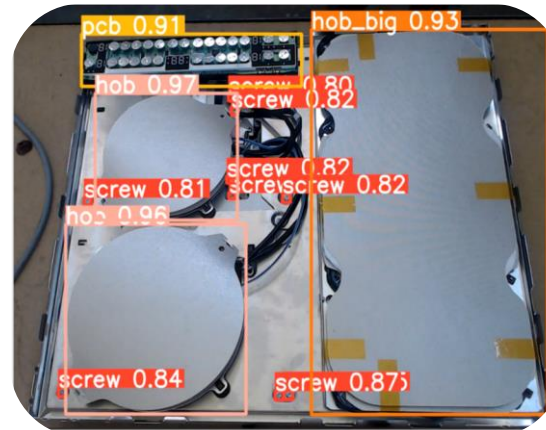
Reconfiguration & AI Based Autonomy

Dynamic work reorganization

AI enabled station controller

Resource level autonomy – perception, learning, adaptation

Reconfigurable production – smart interconnected production entities



CONVERGING Big Data Pipeline



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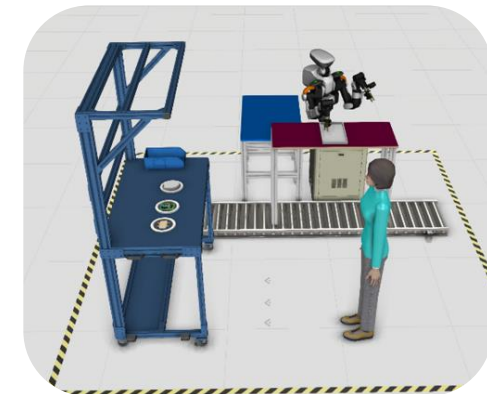
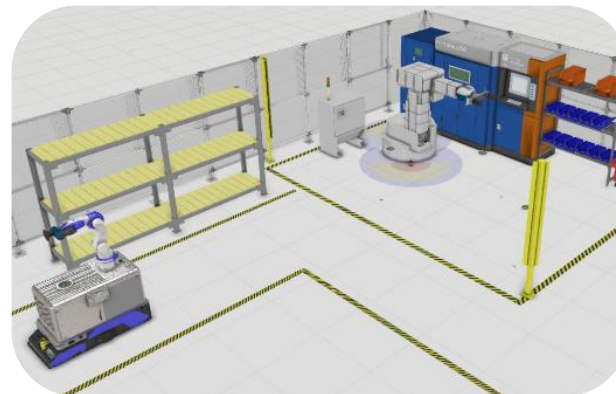
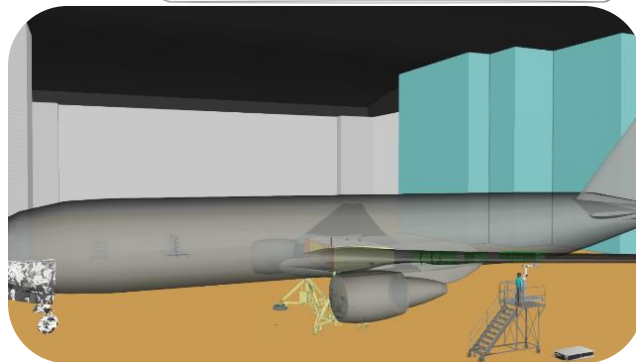
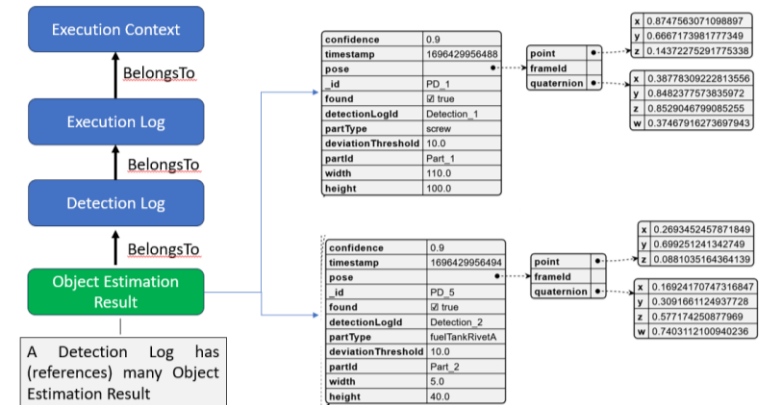
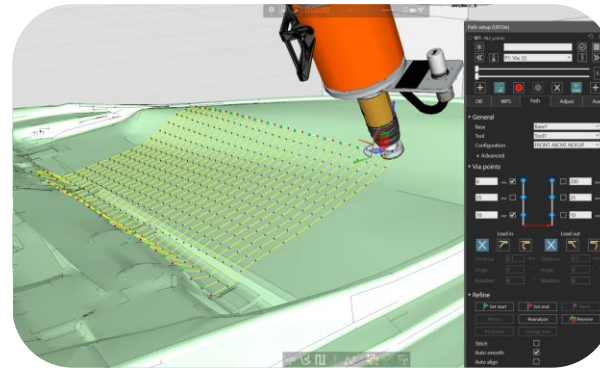
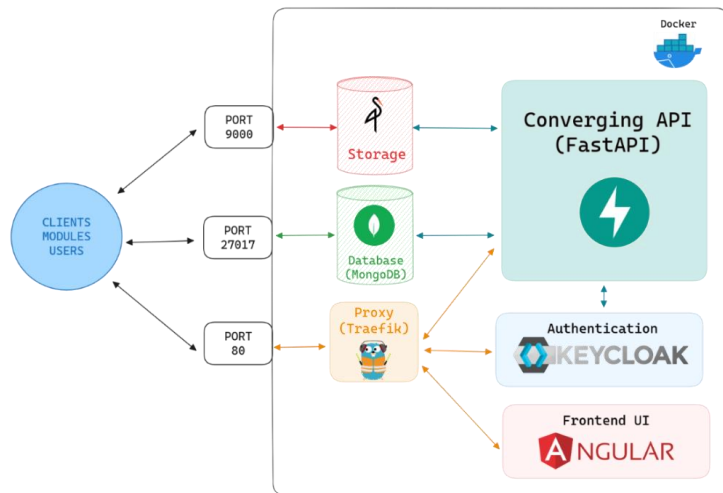
WP4

Big Data Pipeline

Data at rest – modelling/digital representation

Data in motion – data fusion

Open integration and communication architecture



CONVERGING Big Data Pipeline



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WP5

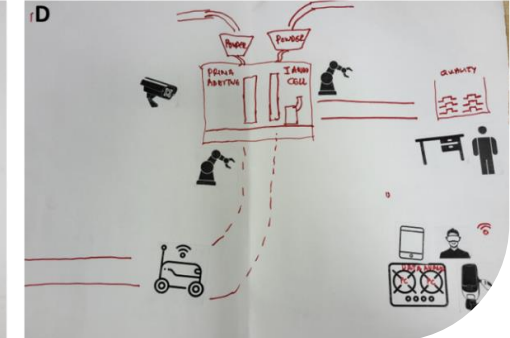
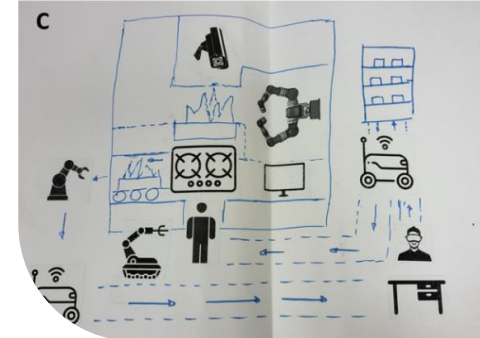
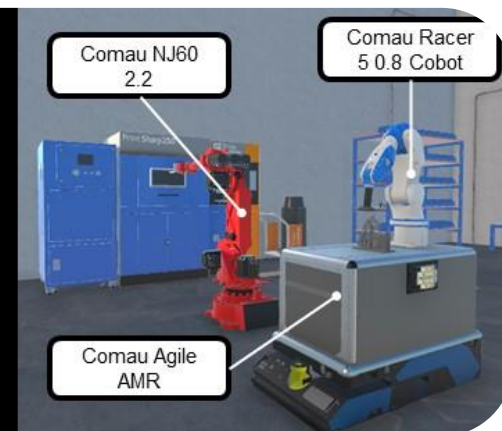
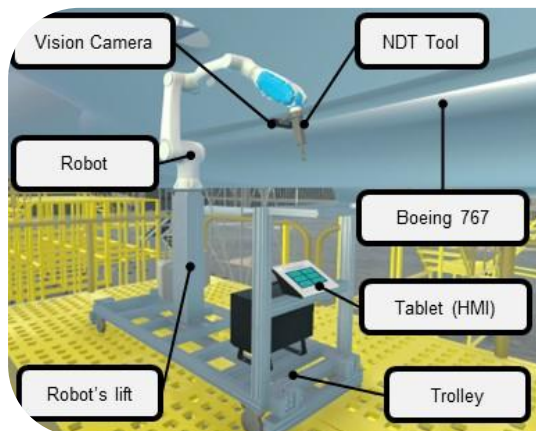
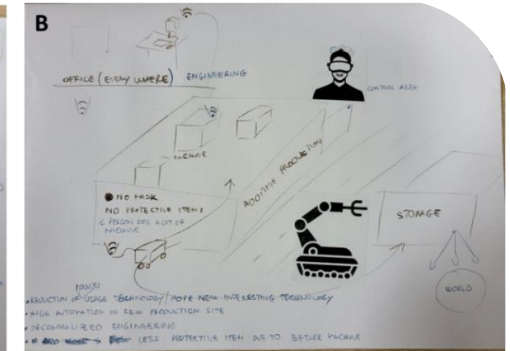
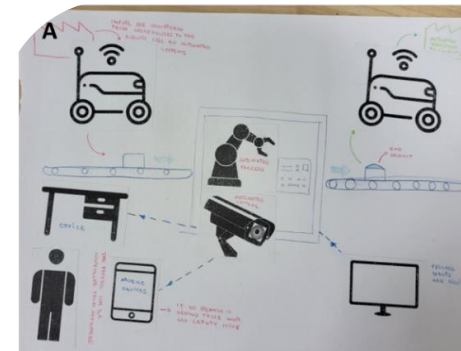
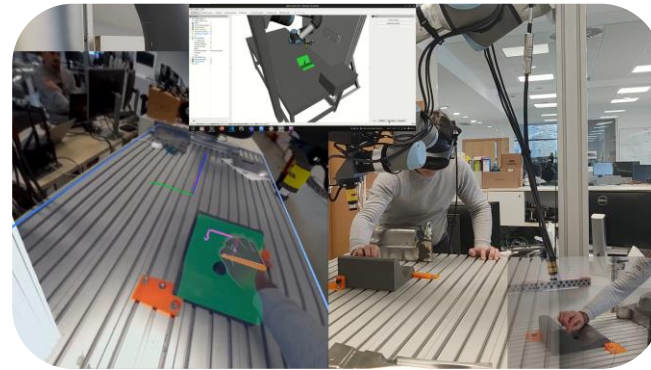
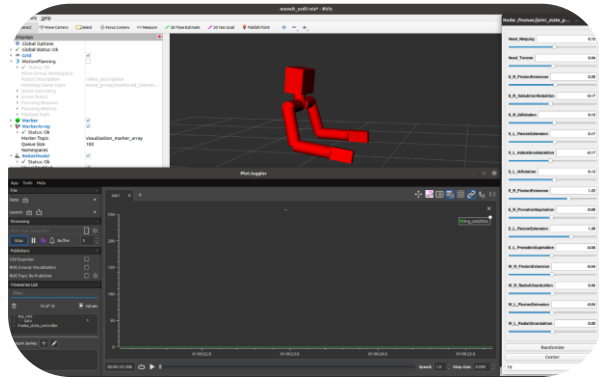
CONVERGING Social- Industrial Environment

Operators training

Real-time UX and ergonomics evaluation

Multi-actor contextual interfaces

Human centric design



CONVERGING Big Data Pipeline



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WP6

Smart Human-Machine Collaboration (HMC)

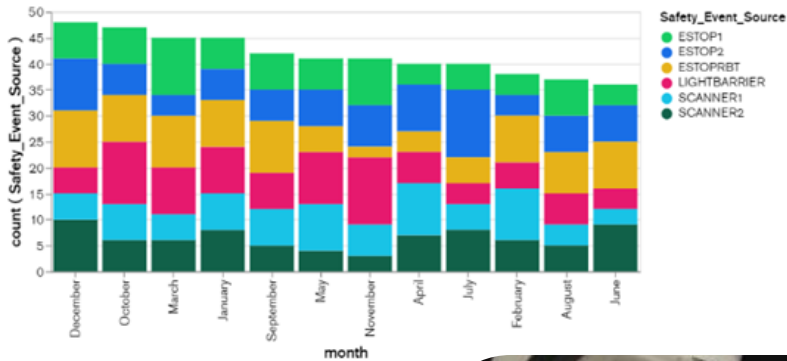
Design Risk Assessment

Adaptive human-machine interaction

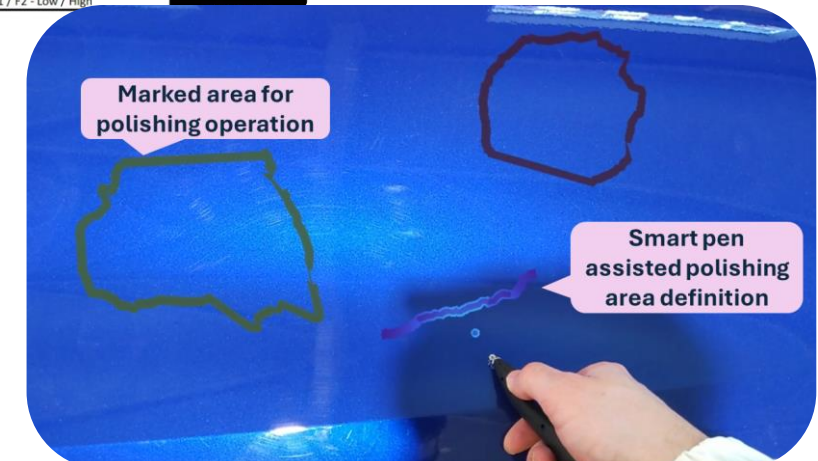
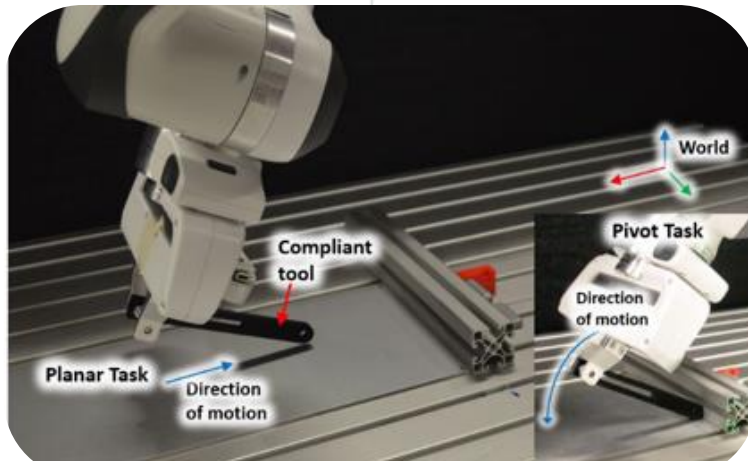
Teaching by demonstration

Autonomous learning strategies for robot behaviour adjustment

Safety Events by Month



Probability of Occurrence (P)	Severity of Injury (S)	Avoidance of the Hazard (A)	Exposure to the Hazard (F)	Risk Level
P0 - Prevented	S1 - Minor			NEGLIGIBLE
	S2 / S3 - Moderate / Serious			LOW
P1 - Can occur	S1 - Minor	A1/A2 - Likely/Not Likely	F1 / F2 - Low / High	MEDIUM
		A3 - Not possible	F1 / F2 - Low / High	
		A1 - Likely	F1 / F2 - Low / High	
	S2 - Moderate	A2 - Not Likely	F1 - Low	
			F2 - High	
		A3 - Not possible	F1 / F2 - Low / High	HIGH
	S3 - Serious	A1/A2 - Likely/Not Likely	F1 / F2 - Low / High	
		A3 - Not possible	F1 / F2 - Low / High	



Thank you for your attention!



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