European Union side events

05/12/2023

Empowering a Human-Centric Industry for the Twin Transitions

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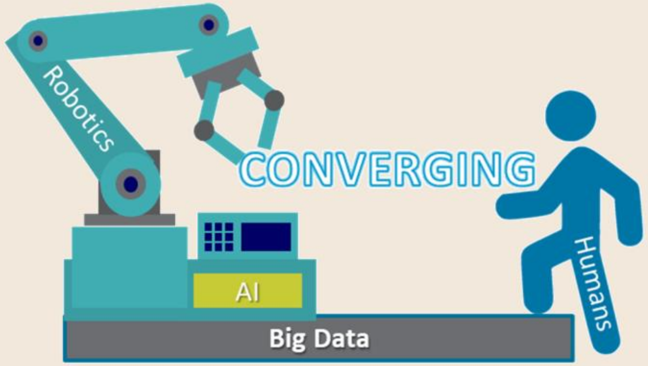
CONVERGING Motivation



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- tremendous **challenge**s 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*
  - ***Innovat****e: 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 Motivation

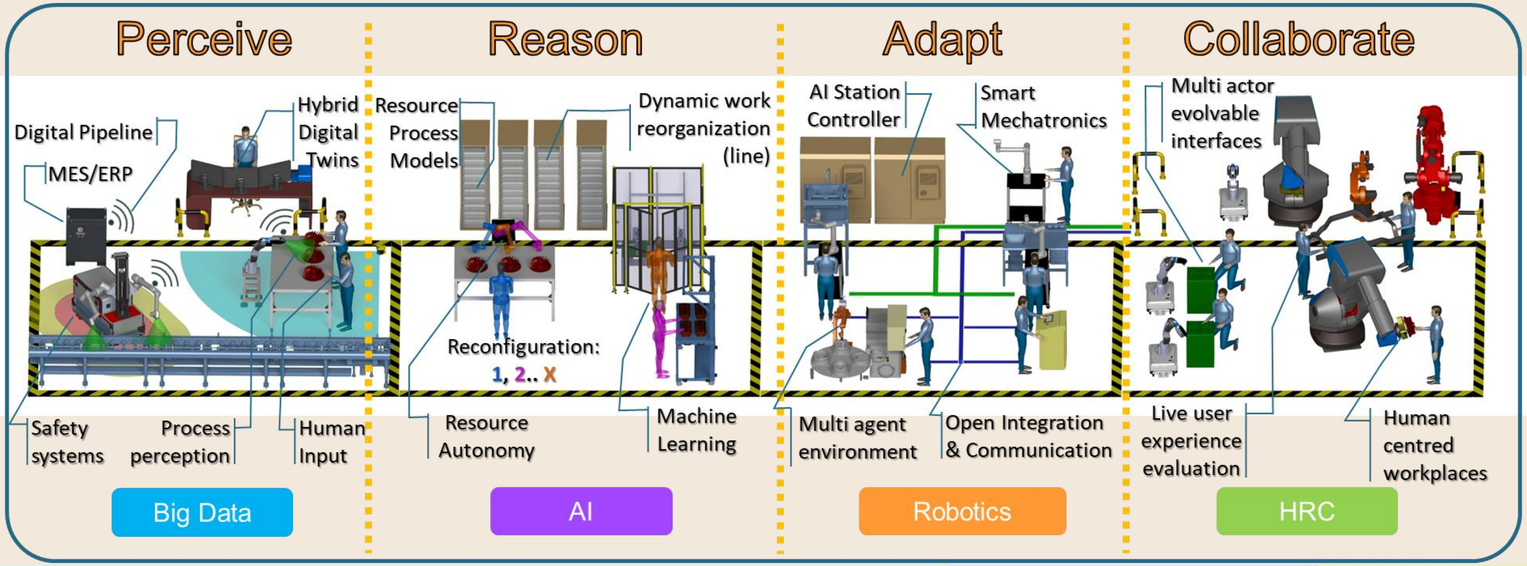
- ***Objective O1:*** Implementing a highly **reconfigurable production system** by deploying **collaborative robotics** and **smart mechatronic devices**, relying on **multi-level AI** to achieve autonomy

- ***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



CONVERGING Use cases

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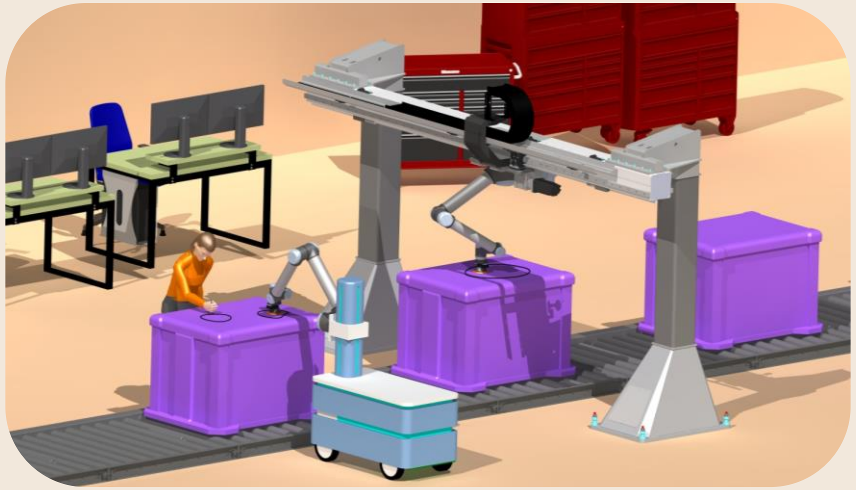
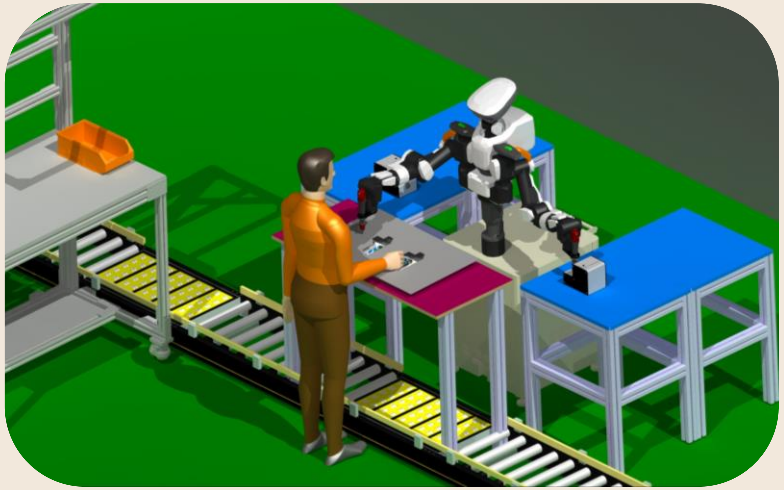
Automotive use case – FORD
Polishing of stamping dies



- **Manual work**
- **Labor intensive** operations – **ergonomic issues**
- **Subjective evaluation** of polishing result

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

White goods use case – ELUX
Kitchen hobs assembly



- **Manual work**
- **Labor intensive** operations – **ergonomic issues**
- Productivity constraints

- **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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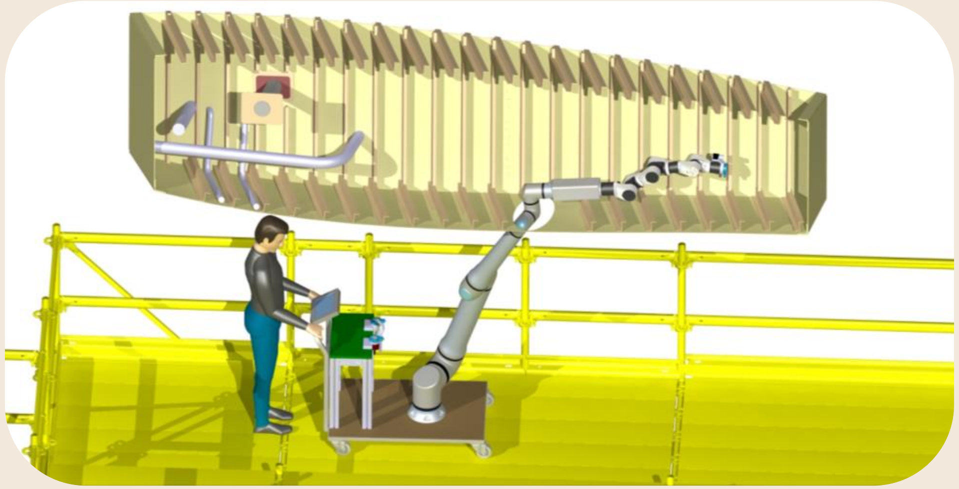
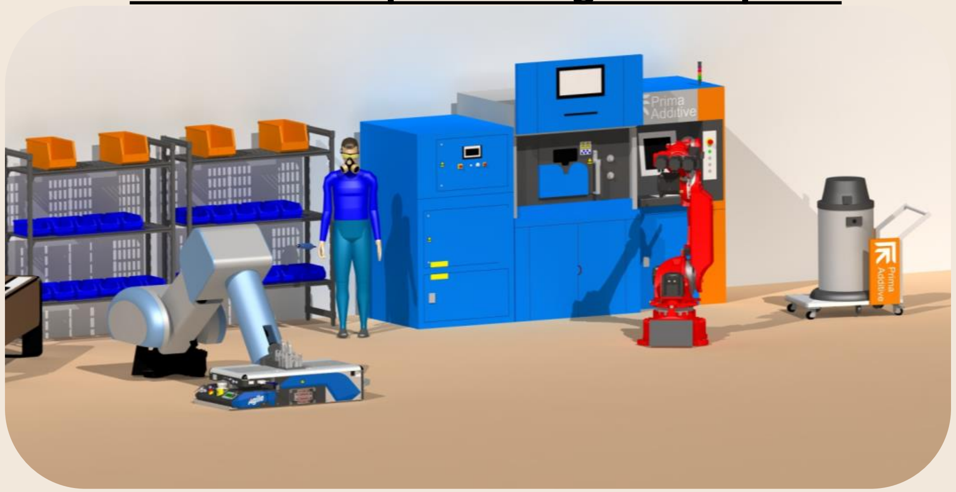
Aeronautics use case – IAI
Fuel tank inspection



- **Manual work**
- Exposure of humans to **hazardous environment**
- **Quality assurance** issues **– human errors**

- **Robotized** inspection and maintenance of fuel tanks
- Remote monitoring – **teleoperation**
- **Operator support** via advanced AR interfaces

Additive manufacturing use case
PRIMA Post processing of AM parts



- **Manual work**
- Exposure of humans to **hazardous substances**
- **Quality issues** – defects due to human work

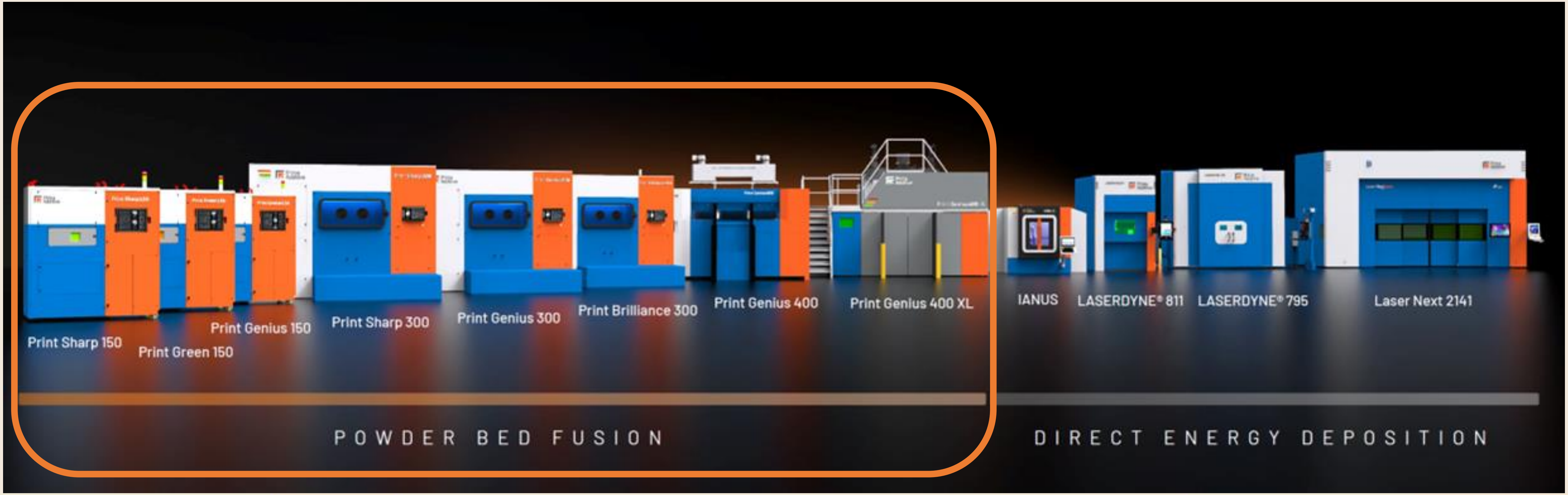
- Human robot **collaborative post processing**
- Robotized blowing of powder
- Medium payload **robot** to act as work **holding device** – operator to perform support removal tasks
- Automatic **robot pose adaptation** to improve **ergonomics**

PRIMA case - Technologies

Two laser technologies

Twelve models

With Prima Additve **Powder Bed Fusion** solutions, is possible to create complex components with quality and repeatability, while **Direct Energy Deposition** systems are capables to build, but also repair and coat metal parts.



PRIMA case - Technologies

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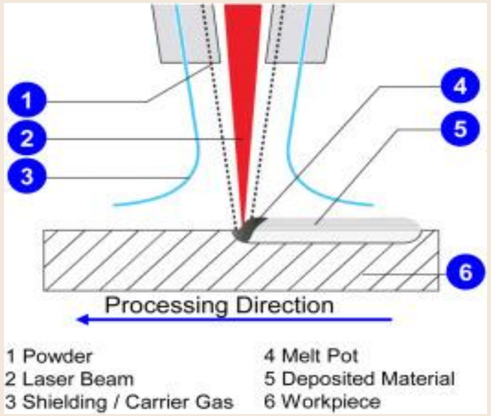
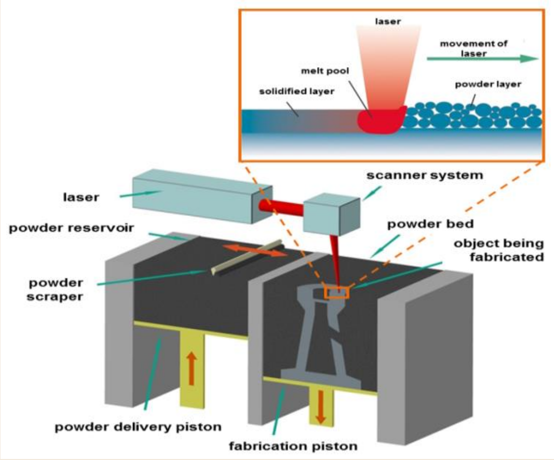
Direct Energy Deposition

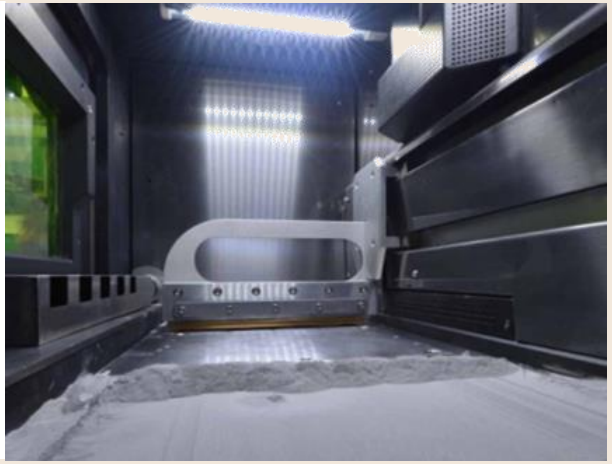
The Direct Energy Deposition process uses focused thermal energy generated from a laser source to fuse powder metal sprayed at the focal point of the laser beam. This laser beam melts the deposited powder to the component. The laser is coaxial to the deposition head which moves in 3 to 5 simultaneous axes. A rotary tilt table can also be installed in order to keep the melt pool created in a horizontal plane. This capability makes the process suitable for adding features to existing parts as well as for repairs and coatings.



Powder Bed Fusion

Powder bed fusion process uses thermal energy to melt specific points on a layer of metallic powder. The thermal energy – produced from a laser source – melts the powder material, which then solidifies as it cools and this way, each area of the part is manufactured. The part is built up into layers and so this process is repeated for each layer to create the part. After the melting of one layer, the platform lowers, and the powder recoater deposits a new layer.





PRIMA case - Current state of the art

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Additive manufacturing (AM) has attracted much attention due to its capability in building parts with complex geometries. Unfortunately, AM metals suffer from three major drawbacks:

1. porosity
2. poor surface finish
3. tensile residual stresses

compromising the fatigue performance.

One of the phases that sometimes is still done manually is the supports removal, that the operator can perform with simple instruments, but it's quite difficult process because the operator can damage the part near the support, compromising its functionalities.

In addition, the support removal job will leave some marks or residual on the part that are always different if done manually, and so the machining for surface finishing is always cost consuming even for small batches, because the geometries could be very different from one part to another.

If we also consider the fact that the pieces produced in additives have complex geometries, we can well understand how sometimes could be complicated to grasp the piece in surface finishing machines and maintain the geometric tolerances required by the customer.

PRIMA case - Solutions within CONVERGING

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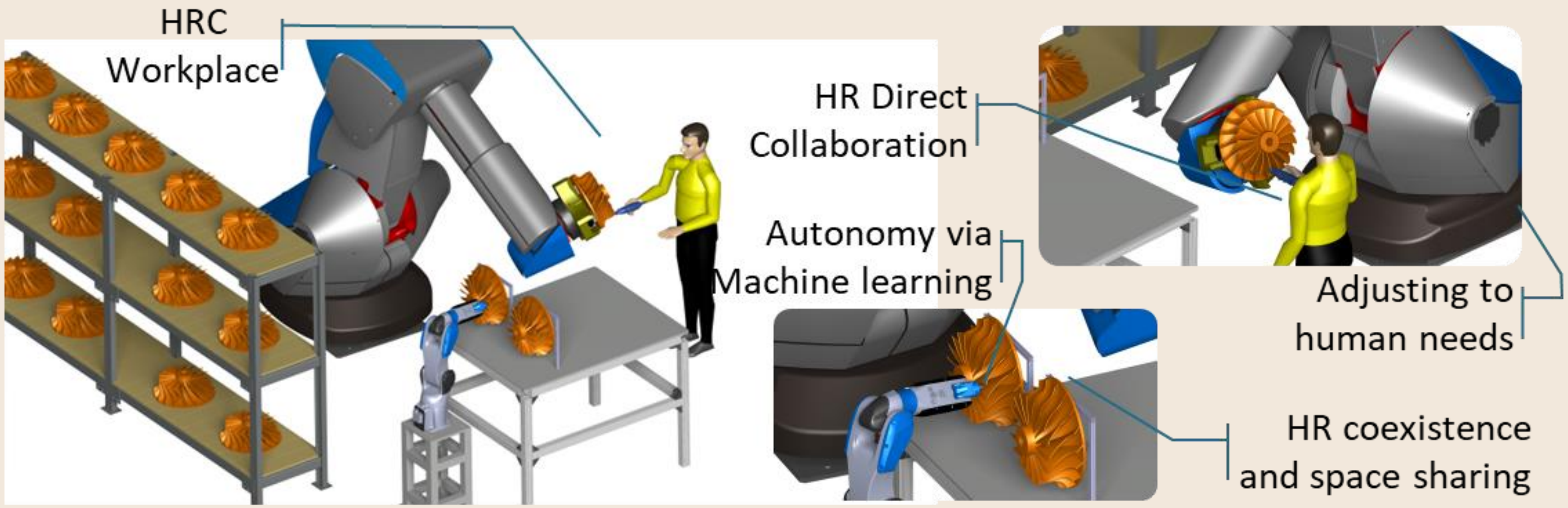


The possibility of having an anthropomorphic robot that performs this type of **support removal** and **surface finishing** operations could be the best solution to simulate the human arm as much as possible, reach difficult points and speed up operations of surface finishing because there will be no need to re-orient a lot of times the part in a dedicated machine. The idea will be that the operator will **guide and teach** the robot arm in the support removal job and surface finishing operations. Everything of course with the integration of a **vision system** for a better machine learning but also for compliance with the required tolerances.

PRIMA case - Future vision

The HRC tasks can be divided in 3 main phases:

1. Part removal from AM machine

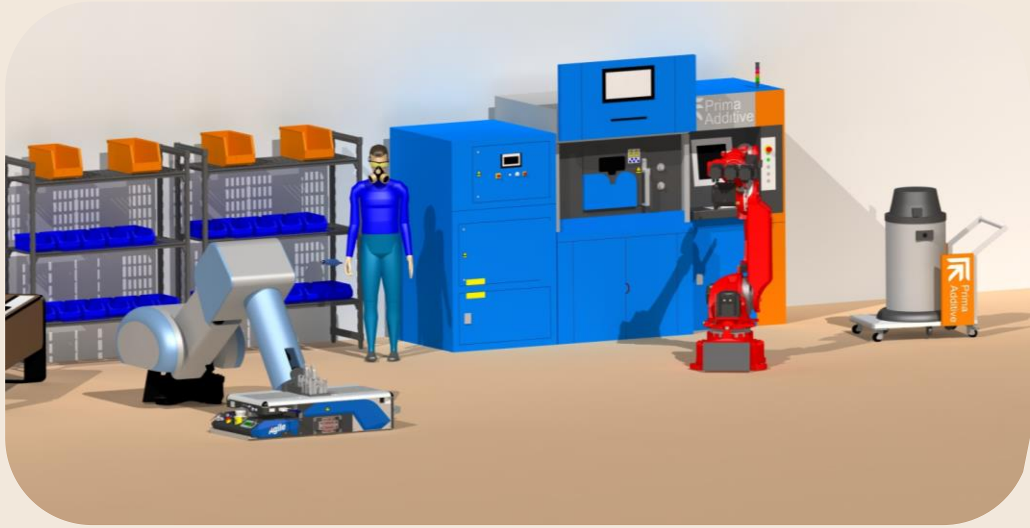
- The robot identify the part inside the AM machine chamber
- The robot blow the powder

2. Part post processing

- NJ40 – presents the part for an ergonomic position
- Mobot provide some tolling to the operator
- Support removal

3. Transportation to storage location

- The AGV moves the part to storage location



PRIMA case - KPIs

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KPIs	Baseline	Target
Maximum load of (part and tools) to be handled by operator in a cycle	20-30kg	5kg
Cycle time for the complete process of a part	3 days	1 day
Postprocessing cost	100%	85%
Number of induced defects due to the process	2-5	0

THANK YOU FOR YOUR ATTENTION

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