Empowering a Human-Centric Industry for the Twin Transitions

Gaetano Patrimia, Intellectual Property and Innovation Manager at Prima Additive
- Project CONVERGING
CONVERGING Motivation

➢ 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 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

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
- Subjective evaluation of polishing result
- Human robot collaborative assembly
- Humanoid dual arm robot
- Space and part sharing
- Identification of human actions - prediction
- Advanced environment and process perception
- Productivity constraints
CONVERGING Use cases

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

European Union events
COP28 | 30.11 > 12.12.23 /// DUBAI, UAE

ACT NOW
With Prima Additive Powder Bed Fusion solutions, it is possible to create complex components with quality and repeatability, while Direct Energy Deposition systems are capable of building, but also repair and coat metal parts.
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

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.
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

<table>
<thead>
<tr>
<th>KPIs</th>
<th>Baseline</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum load of (part and tools) to be handled by operator in a cycle</td>
<td>20-30kg</td>
<td>5kg</td>
</tr>
<tr>
<td>Cycle time for the complete process of a part</td>
<td>3 days</td>
<td>1 day</td>
</tr>
<tr>
<td>Postprocessing cost</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>Number of induced defects due to the process</td>
<td>2-5</td>
<td>0</td>
</tr>
</tbody>
</table>
THANK YOU FOR YOUR ATTENTION

gaetano.patrimia@primaadditive.com

www.primaadditive.com