

How to reduce cost by increasing yield

Enhancing Manufacturing Efficiency with the HP Jet Fusion (JF) 5600 Series 3D Printing Solution and HP 3D Process Development

Overview

CEA, a French government-funded technological research organization, and HP Additive Manufacturing (AM) Solutions aim to unite manufacturers in advancing the digital transformation of production processes with cutting-edge 3D printing technologies. Their primary objective was to evaluate how to improve part quality and repeatability across three different application domains: automotive, industrial, and railway. To take advantage of the latest available technologies, HP AM Solutions recommended utilizing the HP JF 5600 Series 3D Printing Solution combined with the HP 3D Process Development package.

Challenge

Scaling production to achieve consistent, high-quality parts requires excellent repeatability and stringent process control. The primary challenge was to enhance part quality yield and reduce variability to minimize costs associated with reprints.



Results Summary

The findings highlighted significant improvements in part quality and cost efficiency when utilizing the HP Jet Fusion 5600 Series 3D Printing Solution, particularly with the addition of the HP 3D Process Development package:

- Up to 40% total cost savings due to improved yield
- 70% improvement in Density Variability (standard deviation)
- Up to 83% improvement in Mechanical Property Variability (standard deviation)
- Up to 43% increase in Average Dimensional Yield

Approach

CEA and HP AM Solutions applied HP 3D HR PA 12, enabled by Evonik on the HP Jet Fusion 5600 Series 3D Printing Solution across three specific applications:

Automotive

Interior parts, courtesy of Renault Group



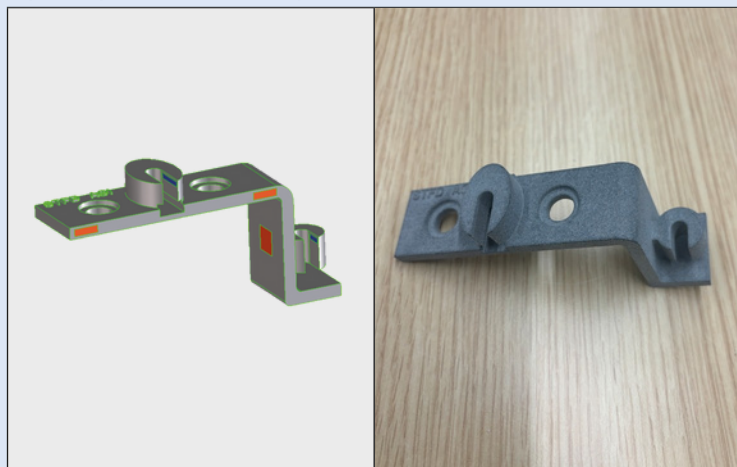
Industrial

Fluid management parts, courtesy of Markem-Imaje



Railway

Spare parts, courtesy of SNCF Réseau



The study evaluated these applications in two stages:

1. Comparing the **HP Jet Fusion 5200 Series 3D Printing Solution** with the **HP Jet Fusion 5600 Series 3D Printing Solution**.
 - a. The Balanced print mode was selected for both printers.
 - b. Standard tensile specimen was included in the builds for evaluation.
2. Comparing the **HP Jet Fusion 5200 Series 3D Printing Solution** with the **HP Jet Fusion 5600 Series 3D Printing Solution** plus the **HP 3D Process Development**.
 - a. The HP 3D Process Development package is an optional addition to the HP Jet Fusion 5600 Series 3D Printing Solution and includes the following elements:
 - i. HP 3D Process Development software, used for tuning HP Multi Jet Fusion technology process parameters.
 - ii. “Hardware Specific Calibration” performed by HP AM Solutions to remove any dimensional bias from each printer in a fleet.
 - iii. Ability to perform a dimensional “Job Adjustment” to tune the scaling and offset factors specific to a print file.
 - iv. Support, Training, and Documentation provided by HP 3D Professional Services.
 - b. Build files:
 - i. Functionally equivalent build files were used in all tests—same packing density, placement of tensile bars, part orientations.

Mechanical Properties

HP JF 5200 Series 3D Printing Solution vs. HP JF 5600 Series 3D Printing Solution and HP 3D HR PA 12, enabled by Evonik

The HP Jet Fusion 5600 Series 3D Printing Solution enhances achievable repeatability of part quality for HP Multi Jet Fusion technology, above the capabilities of the HP Jet Fusion 5200 Series 3D Printing Solution. High repeatability and yield are critical for additive manufacturers looking to scale cost effectively. These improvements can be seen in the reduction in mechanical property standard deviation below:



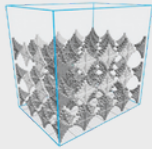
| Printer Series/ Print Mode Metrics | 5200 Balanced | | 5600 Balanced | | Improvement in Standard deviation |
|------------------------------------|---------------|--------------------|---------------|--------------------|-----------------------------------|
| | Mean | Standard deviation | Mean | Standard deviation | |
| Tensile Strength [MPa] | 44 | 3 | 53.5 | 0.5 | 83% |
| Modulus [MPa] | 1777 | 56 | 1918 | 26 | 54% |
| Elongation at Break (EaB) [%] | 5.6% | 1.60% | 14.20% | 1.40% | 13% |
| Density [g/cm³] | 1.001 | 0.010 | 1.023 | 0.003 | 70% |

Table 1. Mechanical Properties results (Z)
Results above will vary from published datasheets due to differences in build designs

Dimensional Accuracy

HP JF 5200 Series 3D Printing Solution vs. HP JF 5600 Series 3D Printing Solution and HP 3D Process Development

HP 3D Process Development provides additional dimensional accuracy tuning and calibration options. When applied correctly, these lead to the highest dimensional repeatability possible with HP Multi Jet Fusion technology. As such, for any production or high-volume applications, the HP 3D Process Development is highly recommended.

| HP JF 5600 Series 3D Printing Solution | HP 3D Process Development | |
|---|---|---|
| | Hardware Specific Calibration | Job Adjustment |
|  |  |  |
| Default profile for all 5600's | Removes Printer to Printer Variation | Removes Printer to Printer Variation in a specific Job |
| | Included with HP 3D Process Development | Feature within HP 3D Process Development |

Best HP Multi Jet Fusion Dimensional Accuracy with the HP JF 5600 Series 3D Printing Solution and the HP 3D Process Development software

Table 2. Dimensional Profiles and Calibrations for the HP JF 5600 Series 3D Printing Solution and the HP 3D Process Development software

| Printer Series | HP JF 5200 Series 3D Printing Solution | HP JF 5600 Series 3D Printing Solution | |
|---------------------------------|--|--|---------------------------------------|
| Print Mode | Balanced | Balanced | Balanced |
| Dimensional Profile/Calibration | General Profile | Hardware Specific Calibration* | Hardware Specific and Job Adjustment* |
| Fluid Part (Markem Imaje) | 64% | 71% | 92% |
| Interior Part (Renault) | 92% | 96% | 99% |
| Spare Part (SNCF) | 50% | 85% | 93% |

Table 3. Average Dimensional Yield results
*Included in the HP 3D Process Development Package

Overall, the integration of the HP JF 5600 Series 3D Printing Solution with the HP 3D Process Development resulted in up to a 40% cost reduction, attributed to enhanced repeatability and yield improvements.

Assumptions on TCO:

- Maximum savings based on SNCF part, comparing HP JF 5200 Series 3D Printing Solution with the HP JF 5600 Series 3D Printing Solution with HP 3D Process Development
- Part Quality Yield is improved up to 43%, based on standard HP Multi Jet Fusion technology tolerances
- Calculation done in February 2025, HP AM Total Cost of Ownership (TCO) Tool V4.3.34
- Basic tier of HP 3D Process Development Package
- Printers are HP Jet Fusion HP Jet Fusion 5620 Pro 3D Printer 3D Printer and 5620 Pro versions
- Standard 5 years amortization
- Includes one Printer, one Processing station, two Build units, and two Natural cooling units.

Conclusion

The CEA study underscores the transformative impact of the HP JF 5600 Series 3D Printing Solution and the HP 3D Process Development package in achieving higher yield rates, reducing costs, and maintaining exceptional part quality. By addressing common sources of variation and enhancing process control, HP AM advanced 3D Printing Solutions are proven to be essential for scalable, efficient additive manufacturing.

