Post-Processing for HP Multi Jet Fusion

Tuning your HP MJF technology to the design

Introduction

Post-processing is the final stage in the end-to-end process for HP Multi Jet Fusion technology. It is a crucial stage in the manufacturing cycle. Finding a suitable post-processing workflow can significantly impact the look and feel of the final part, as well as its mechanical properties.

Post-processing encompasses two key stages: primary and secondary post-processing. Primary post-processing refers to cleaning processes that are required for Multi Jet Fusion printed parts. Secondary post-processing, on the other hand, refers to processes that may affect the mechanical properties of the part, provide cosmetic enhancements, or reduce surface roughness, for example.

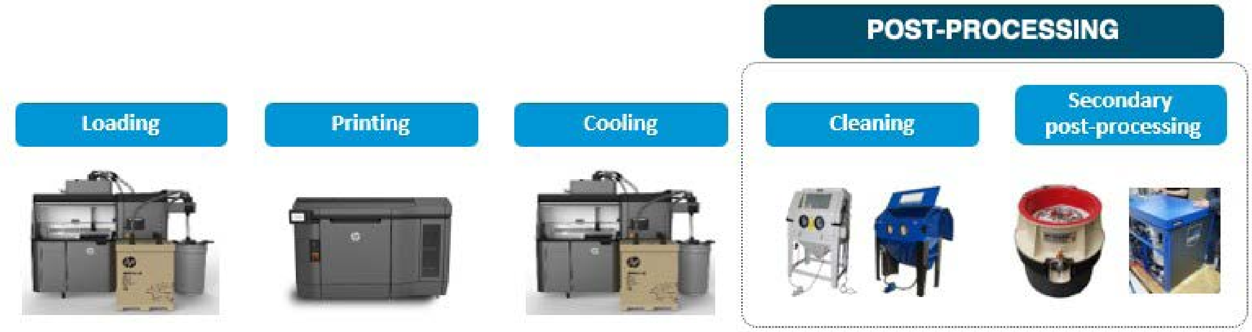

Figure 1. E2E HP Jet Fusion 3D Printing workflow

Given the nature of HP Multi Jet Fusion technology, which injects fusing and detailing agents onto a powder-based material, primary post-processing is a mandatory stage for all parts printed with HP Jet Fusion 3D Printing Solutions. As the part is printed, it is encapsulated in unfused material, which needs to be removed to obtain the desired raw printed part.

It is important to consider this post-processing stage when designing the part. By adding drain holes, lattice structures, or a chain in duct parts, cleaning the printed parts need not be a complex task. For specific tips and recommendations on how to design parts to facilitate cleaning, see **Design for Cleaning.**

Secondary post-processing is an optional step and depends on the specific requirements of the application where the final part will be used. The techniques included in this post-processing stage can be classified as providing **cosmetic attributes** (for example, dyeing and painting), or reducing **surface roughness** (for example, vibratory tumbling or chemical polishing); however, this is not a strict classification, as some techniques such as painting or electroplating can provide both attributes.

Primary Post-processing – Cleaning

This stage involves removing excess unfused material from the surface of the printed part. If this excess is not removed correctly, it will not only affect the part's overall look and feel, but also alter the dimensional accuracy of the part.

After a job is finished, parts are "uncaked" or unpacked, either automatically or manually, in the processing station or in the printer depending on the specific HP Jet Fusion 3D Printing Solution, and unfused material is reclaimed in the system for recycling. When unpacking, printed parts must be left with a significant layer of unfused material, as it has been exposed to varying levels of fusing and detailing agents, as well as high levels of energy, altering its properties. Any unfused material left after material reclaim should not be recycled.

The layer of remaining unfused material can be removed by using different techniques:

- Bead blasting
- Air blasting (in combination with bead blasting)
- Water jet blasting (also known as water jetting)

The basic operating principle for the three techniques is identical, although the media used to expel the excess material changes. They all use pressure to dislodge the unfused material from the surface of the part so that the fused material is visible. Bead blasting and air blasting are dry techniques, whereas water-jet blasting is a wet technique.

Figure 2. Part after unpacking, uncleaned (left); Part after cleaning (right)

Bead Blasting

Bead blasting involves propelling an abrasive or blast media, usually in bead or sphere form, at high pressure against the surface of the part using compressed air. As well as dislodging the unfused material from the surface, the bead dimples the surface without affect its dimensional stability, providing a more uniform, "satin" finish.

The unpacked parts are placed in the blasting chamber. An air compressor pushes air into a pressurized hopper, where it is mixed with the blast media, and the air-blast media mix is projected into the blasting chamber onto the unpacked parts via a blast gun or nozzle.

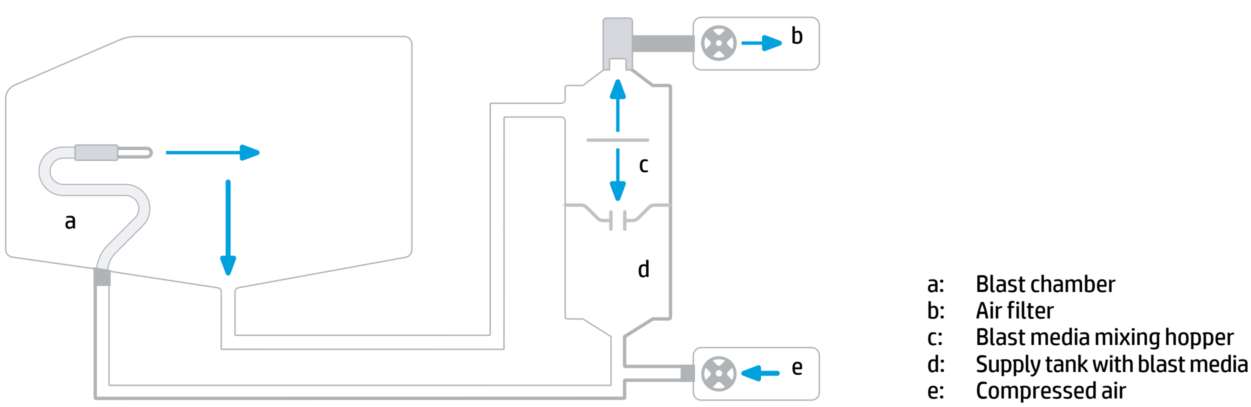

Figure 3. Functional diagram of a bead blaster

Bead blasting can be performed manually or automatically depending on the specific requirements of the part to be cleaned.

In automatic bead blasting, the parts are placed in the blasting chamber and usually moved, using a turntable, tumbler, track or conveyor, so the parts are exposed to the fixed or mobile blast nozzles. In manual blasting, an operator is responsible for controlling both the delivery of the blast media using a foot pedal and the distance from the blast nozzle to the part.

Automatic bead blasting allows multiple parts to be processed simultaneously, achieving a consistent finish on all parts. Often additional parts such as small filler balls are added to the chamber to ensure a uniform finish on all parts.

Manual bead blasting is more suited to fragile parts that require careful processing to avoid damage. However, the process is more time-intensive than automatic blasting for high production volumes, and is also susceptible to greater error as parts can be burnt more easily if they are placed too close to the blast nozzle.

Figure 4. Automatic bead blaster

Both systems require a compressed air installation that offers a minimum air pressure of 3 bars, however more pressure may be required for better results. There are numerous solutions on the market that offer manual and automatic bead blasting, and standard equipment specifications usually satisfy the requirements for cleaning HP Multi Jet Fusion printed parts.

Regardless of whether an automatic or manual system is used, there are five key factors to consider in bead blasting:

- Blast media
- Air pressure
- Nozzle diameter
- Distance to part
- Time required

Figure 5. Made for HP Jet Fusion blasting equipment

Blast media

The size and the type of beads result in different surface finishes. There are several materials that can be used as blast media: glass, stainless steel and other metals, for example. For parts printed with HP Multi Jet Fusion technology, pure glass beads with a diameter of 70–110 µm are recommended, since they do not affect the dimensional accuracy of the part. Stainless steel beads of a similar diameter may also be used, as they provide a darkened, more uniform surface and result in a greater abrasion of the surface. Although their cost is higher, stainless steel beads are suited to high production volumes, as they are hardwearing, and cleaning the filters and the machine afterwards is easier.

The beads may be single-use or reusable depending on the blaster configuration; however, they must be replaced at least 6 to 8 hours in high production lines, for a blast media load of 12 kg, or 3 to 4 hours for a blast media load of 5 kg, to avoid the risk of polyamide contamination.

Figure 6. Printed part cleaned with glass beads (left); part cleaned with metal media (right)

Air pressure

This is a determining factor in bead blasting. If the pressure is too low, the process will be ineffective and more time will be required to clean the surface. If the pressure is too high, the bead may break and cause damage to the part's surface. Nonetheless, generally speaking, increasing the pressure decreases the cleaning time.

For automatic bead blasting, the air pressure should be set at around 4–7 bar. This value should be adjusted according to the time required, the geometry of the part, and the quality of the abrasive media.

For manual bead blasting, the air pressure should be lower, around 3–5 bar, with the recommended value for non-fragile parts being 5 bar, and 4 or 3 bar for fragile parts. A lower pressure is recommended for manual bead blasting compared to automatic bead blasting, as other factors such as operator experience and blasting angle can affect the outcome.

Nozzle diameter

The diameter of the nozzle should be taken into consideration when determining the air pressure. The abovementioned values for air pressure are based on the use of a 10 cm-diameter nozzle. If the diameter of the nozzle is less than that, the pressure value should be adjusted proportionally.

Distance to part

The distance from the blast nozzle to the part determines the effect that the blast media have on the part's surface. It is also one of the factors that can give rise to incidents during the cleaning process. For automatic bead blasting, the distance is controlled by the equipment configuration (around 15–20 cm), while for manual bead blasting this can be manually controlled, and a closer distance of 10–15 cm is recommended. To avoid damaging parts by insufficient distance, a printed cage can be used to group small parts or parts with fragile features.

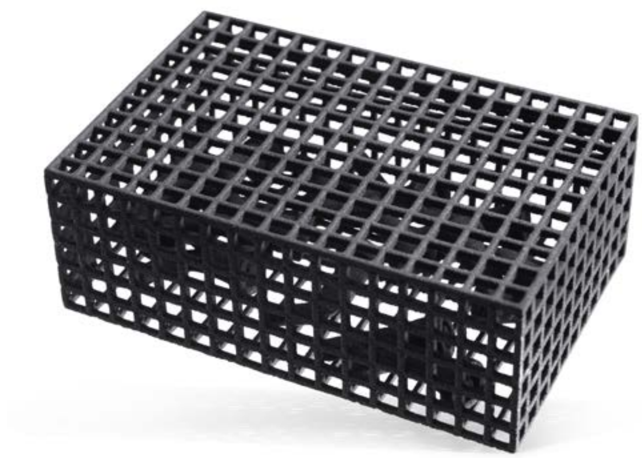

Figure 7. Cage printed with small parts inside

Time required

As mentioned before, manual bead blasting is more time-intensive, and depends on the operator's experience and judgment on whether the part is clean enough or not. The time required also depends on the geometry, size and complexity of the part. On average, 20 to 40 seconds is required to clean a part of medium size and complexity with no thin surfaces or fine detail. For fragile parts where less pressure is used, the value might be greater.

For automatic bead blasting, the time required is calculated based on the condition of the media. If the media is new, less time will be required compared to bead blasting done with reused media. On average, the process takes around 10 to 20 minutes.

It should be noted, however, that the overall look and feel of the part can be improved with less pressure and longer blasting time.

Air Blasting

Air blasting involves propelling a stream of compressed air onto the part's surface. It is usually used in conjunction with bead blasting to remove any remaining powder material and blast media dust that may have been left on the surface without affecting the dimensional or mechanical properties of the part.

The operating principle of air blasting is similar to bead blasting: an air compressor feeds air into a pressure vessel, and a trigger mechanism releases the jet of compressed air from the pressure vessel onto the surface of the part via a blast nozzle.

Air blasting requires a compressed air installation that provides a minimum air pressure of 3 bar, although greater pressure may be required for better results.

Since compressed air has a lower impact force on the surface compared to blast media, air blasting does not provide uniformity on the powder removal process and is not recommended as the sole solution for cleaning parts. It should be used only after the part has been bead-blasted.

Nonetheless, air blasting may not be necessary if the part has been blasted using a blaster that contains a deionizer. The deionizer electrically discharges the parts, meaning that any dust falls from the surface.

Some bead-blasting solutions also offer air blasting functions, in which case the same machine may be used for both processes, however ensure that the machine does not contain any abrasive media before proceeding to air-blast the parts.

Similar to bead blasting, the key factors that influence the outcome of the process are air pressure, nozzle diameter, distance to part, and time required. The values for these factors are similar to manual bead blasting. To summarize, the air pressure range should be between 3 to 5 bar, adapted according to the nozzle diameter; an optimal distance of 15 cm should be left between the part and the blast nozzle; and an average time of 10 seconds per part will be required, depending on the complexity and size of the part, as well as the operator's experience.

Water Jet Blasting

Water jet blasting or water blasting involves jetting a fluid mixture of compressed air and water via blast nozzles onto the part surface to remove powder. It can also be used for initial surface finishing by including a suspended solid (or blast media) in the fluid mixture.

The technique has usually a higher cost than bead blasting, but it provides several key advantages. It is ideal for cleaning complex geometries or ducts automatically, since the blast nozzles have different orientations, allowing the fluid to penetrate hard-to-reach areas. It also can reduce slightly the surface roughness with minimal additional processing time, much faster than using traditional vibratory system for the same initial roughness reduction.

It ensures a dust-free environment, as no subsequent processing is required to remove blast media dust. In general, the fluid can process several kg of powder before becoming saturated, moment in which the supplies would need to be replaced.

The key factors for achieving the best results with water jet blasting are similar to bead blasting:

- fluid composition
- air pressure
- nozzle diameter / distance to part
- time required

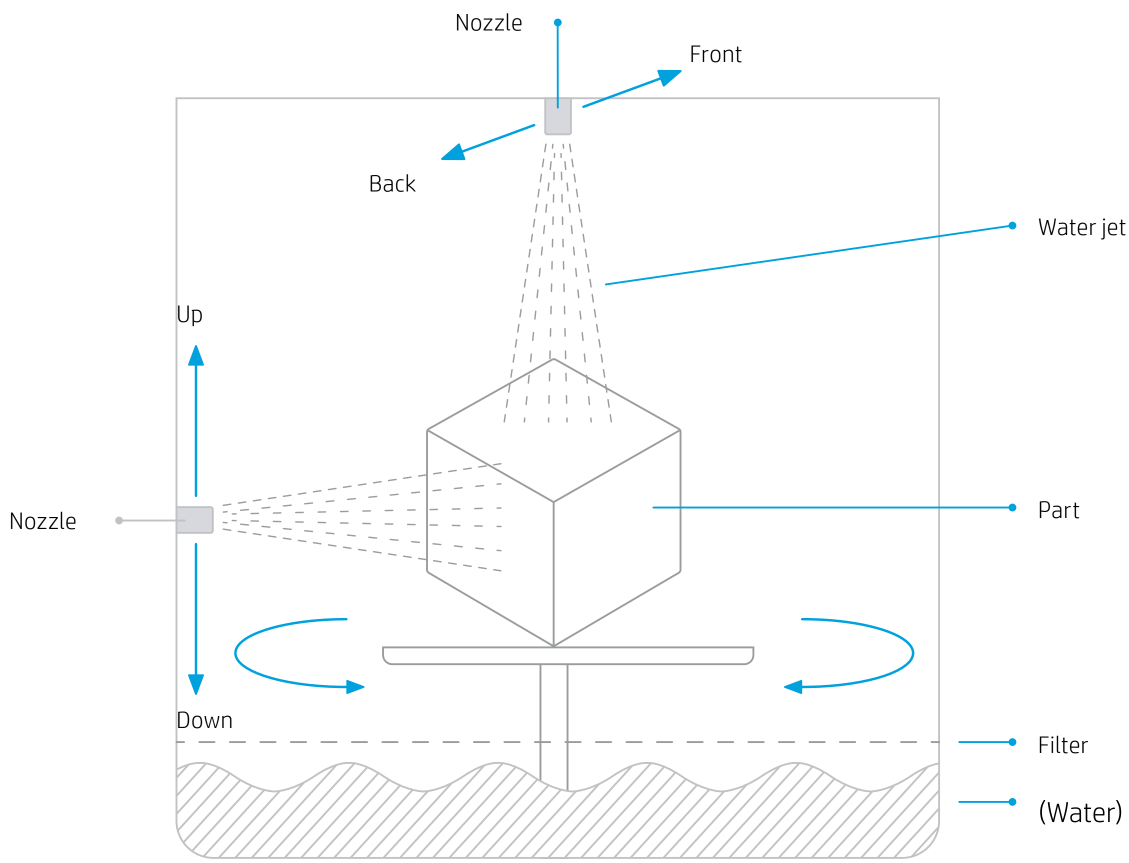

Figure 8. Water jet blasting equipment

Fluid composition

One of the key factors in water jet blasting is the fluid used as the medium. Different fluid compositions can be used according to the solution; for example, pre-treated water without any blast media, or a water-soluble detergent in which an abrasive ceramic or an abrasive ferrous metal is suspended, providing an initial surface finish.

Air pressure

The pressure value is dependent on the part geometry and the presence of fine detail, but it is usually lower than the one used in bead blasting.

Nozzle diameter / distance to part

Since water jet blasting is usually an automated solution that is performed in a sealed chamber with several nozzles pointing different directions, both the nozzle diameter and the distance to part is controlled by the equipment’s configuration.

Time required

As with bead and air blasting processes, the time depends on the complexity and geometry of the part. For parts of medium size and complexity with no thin surfaces or fine detail, an average of 30 minutes or less is required for a full cleaning job.

4AA7-5263ENW, July 2019