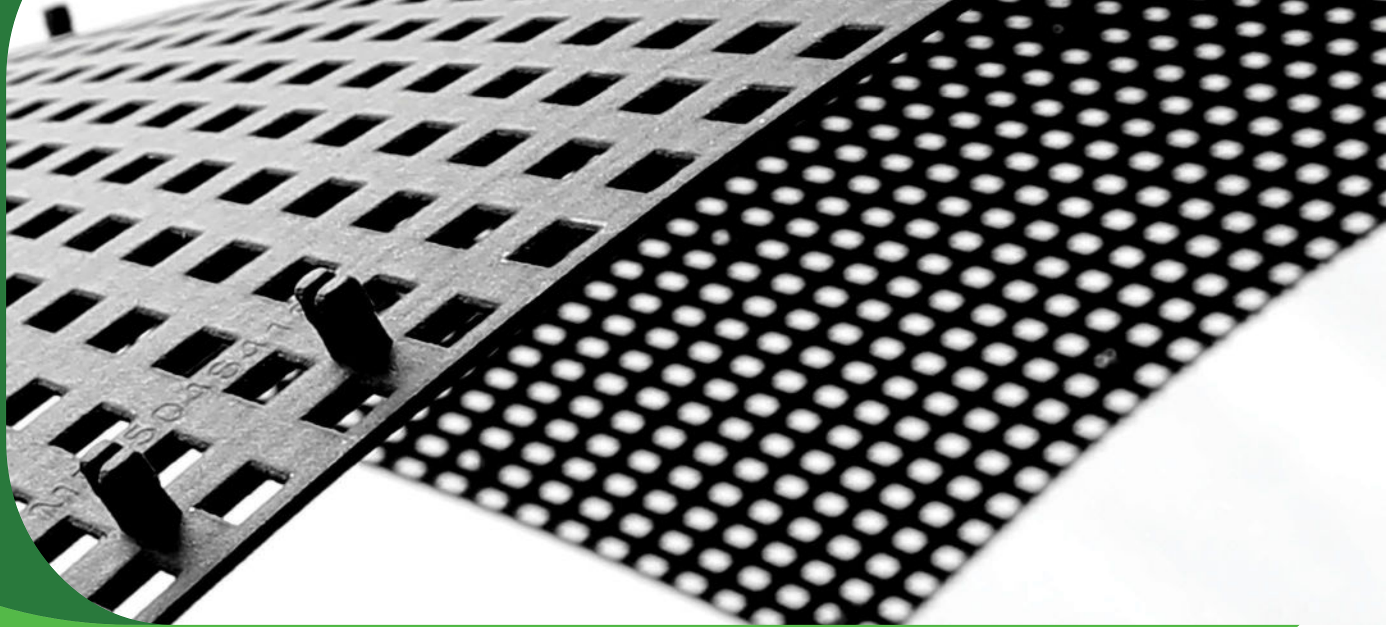

DESIGN FOR STEP TECHNOLOGY WITH ABS MATERIAL

This document provides best practices and considerations for optimizing designs for the Selective Thermoplastic Electrophotographic Process (STEP™). The STEP 3D printing process can produce a wide range of part sizes with best-in-class surface finish, feature detail, dimensional accuracy, near injection molding material properties and with optimized topologies for your application. STEP can often be a direct process replacement for parts that are injection molded today, but with greater design freedom and agility.

These guidelines provide a starting point in understanding the basics of part design, part construction, file preparation and post-processing considerations for Evolve's STEP technology. Please contact Evolve's Applications Team to discuss design and build strategies for your specific designs.

STEP technology has precise control of the material deposition process because the digital image is preformed before it sees any heat, and the heating and cooling processes are exactly the same no matter what shape you are printing. This gives STEP the ability to create fine features with good accuracy and precision.

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GUIDELINES

STANDARD LAYER THICKNESS
• 13.0 microns (0.013mm, 0.0005").

ACCURACY
STEP system characterization was performed using a specific part geometry defined to have features and dimensions representative of actual customer part requests, and with a long dimension of 75mm.

Tolerances for +/- 2 σ
• Capability using default STEP system performance parameters, part nesting and scale factors: ±150 microns up to 30mm, ±0.5%[1] for dimensions > 30 mm.

• Capability using part-specific build optimization strategies[2]: ±45 microns.

HOLE DIAMETER
• Minimum hole diameter: 0.4mm vertical from build platform, 0.6mm at angle.

• Blind hole washout requirement: 3.0mm diameter, 8mm depth.

• The extreme detail capability of STEP technology allows for holes to be edited on the voxel level, which, in some cases, can be used to create holes smaller that 0.4mm.

CLEARANCE FOR MULTI-POINT ASSEMBLIES
· As with any 3D printing process, interlocking and moving parts are possible with enough space between bodies to allow for support removal.

· Use a minimum 0.5mm clearance between parts, as long as this area is vented to allow support material to wash out.

ESCAPE VENTS (FOR REMOVAL BATH FLUID ACCESS
• Minimum 1mm diameter "escape holes" are needed to enable full washout of support material from enclosed areas. These escape holes are useful for venting blind/enclosed holes and large volumes.

• Increasing exposed surface area of support can decrease washout time dramatically. If a single 1mm hole does not provide sufficient wash out, consider larger or more holes to help direct flow of support removal solutions.

MINIMUM FEATURE DETAIL
• STEP technology excels at pronounced and easily visible small features such as text.

• Text size down to 1.5mm, engraving depth easily visible down to 0.3mm, boss height of 0.3mm minimum.

PIN DIAMETER
• Minimum diameter 0.5mm up to 5mm in length.

• "Caging" (building a lattice structure around the part) can prevent impact damage to fine or fragile features during the wash out process.

WALL THICKNESS
• Minimum thickness: 0.2mm horizontal, 0.2mm vertical.

• Consistent wall thickness is not needed with STEP technology. Wall thickness thinner than, and wider than, what can generally be achieved in injection molding, is possible

SURFACE FINISHES
Standard
• The top and bottom flat surfaces are smooth (Ra = 4 microns).

• Layer lines can be visible on vertical and/or contoured surfaces.

• Bead blasting is sometimes helpful to make surface roughness more uniform over all part surfaces.

• Ra of surface = 4-11 microns.

Textured
• A light texture design on surfaces will mask layer lines.

• Textured parts generally do not need additional processing after support removal.

• NOTE, a significant amount of texturing will increase the file size and packing and slicing times.

THREADS
• Male and female threads down to M4 minimum size can be directly printed.

• Chasing or tapping threaded features is generally not needed.

GET A QUOTE

1. [measured value - nominal value]/[nominal value]

2. May include strategies such as avoiding large height differentials across the build, packing parts closely, and encapsulating fine features with support material. Contact Evolve's AE team for details at applications@evolveadditive.com.

LEARN MORE

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GUIDELINES

PART STRENGTH

- Because STEP builds parts out of true thermoplastics, and uses both heat and pressure during material deposition, part strength and durability are close to Injection Molding (IM) properties of the same geometry.
- Using thicker walls in some areas, instead of adding bosses or ribs, normally required for IM parts, can increase strength in key areas and aid in support material removal for STEP parts.

BUILD NESTING

Build Envelope Size (XYZ)

- Max packable area 589x, 282y, 50z millimeters.
- Z height can be extended to 75mm with a smaller XY area (300x, 200y, 75z).

Nesting Parts

- Parts should be oriented for lowest Z height first. There are situations where running a part in a taller Z height orientation may be better but will increase build time.
- Parts should be duplicated and packed with a 1mm boundary between part geometry. Achieving a high pack density is critical for running efficiently as possible.
- The print engines work best with a consistent amount of material being deposited. Printing a single layer of short parts and some tall parts on the same build will sometimes cause a visible defect, a “witness line”, during the transition. To avoid this, pack parts to reduce dramatic changes in the amount of support material from layer to layer.
- Stacking parts in Z is almost never more efficient than running multiple lower height builds. In a build with tall and short parts, stacking lower height parts to reach the height of the tallest parts is most efficient.
- It is usually best to layout parts in the same direction (no rotation around Z) for consistency. Rotating 180 degrees is acceptable if it helps with nesting, but random angles can sometimes cause defects that are hard to trace to a particular part.

GET A QUOTE

COST EFFICIENCY

- STEP prints 13.0 micron layers every 6.2 seconds, the overall z height of a build directly relates to part cost.
- When possible, nest parts as tightly as possible. Empty areas below the highest point in the build can lead to unnecessary support use, which means longer support removal times and higher part costs.

AQUEOUS SUPPORT MATERIAL REMOVAL BATH

- Support is removed in a high pH hot water solution. This is a hands-off process that require ultrasonics and good fluid flow across support material volumes to be effective.
- Because fluid flow is desirable for support removal, small blind pockets and holes can lead to long wash times for complete removal of support material.
- Large internal radii allow for easier support removal over sharp corners.

PRINT ORIENTATION

- A flat top surface will have a slightly better surface finish than the rest of the part. If a particular surface needs to be as smooth as possible, try to orient it face up if it does not cause issues with support material usage or long run time.
- STEP is a layer driven process, any high stress features on parts (snap, pressure fits) should be oriented to avoid perpendicular layer lines at high stress areas.
- Round holes printed in the Z direction will generally be more circular than ones printed along the XY plane due to layering.

POST PROCESSING

Many types of finishing operations can be performed on ABS parts produced with STEP technology. Evolve has experience with several part finishing processes.

Bead Blasting

This is the best practice for evening out surface roughness. Recommendation is 200 mesh size glass beads at 20-60 psi pressure.

Chemical Vapor Smoothing

Commercially available chemical vapor smoothing composition designed for ABS equipment can be used to improve the surface finish. Some feature details may be lost or warped with over exposure.

Tumbling or Vibratory Finishing

Tumbling is a great way to reduce the visibility of layer lines and improve the surface finish. This process will likely need to be optimized for the part geometry to make consistent parts, especially with fine feature detail geometry and rounding of sharp edges and corners.

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