DfAM Worksheet

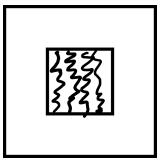
January 27, 2022

This is the proposed content for the evaluation worksheet for AMXR phase-2 experimentation. It is derivative of previous work from Joran Booth and Jennifer Bracken. To read this document, note that the title in bold is the evaluation metric and the enumerated options are the "scored options" to select from.

Higher score = stronger recommendation for AM

1 Material Removal

Support structures ruin the surface finish



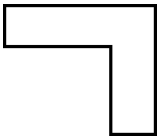
Support structures almost always leave a poor surface texture and can be very hard to remove from tight spaces. Your part will be at risk of breaking or being non-functional if you do not consider how the part will be supported during manufacturing

1. Internal cavities, channels, or holes do not generally have openings for removing material
2. The gaps for support material removal are generally small and difficult to navigate
3. Material can generally be removed from internal cavities, channels, or holes

2 Unsupported Features

2.1 Overhangs

Unsupported features that stick out will droop

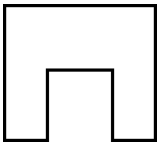


Overhanging features that stick out in mid-air will naturally droop and will require support structures to fabricate. The longer the overhanging feature, the more pronounced will be the droopiness

1. The part generally has **long** overhanging features
2. The part generally has **short** overhanging features
3. There are no overhanging features

2.2 Bridges

Bridges may droop without sufficient support

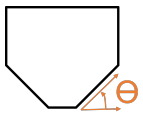


[**?**] Bridged structures are supported on opposite ends and are therefore not overhanging. They may instead droop in the center if the bridges are too long. Hence, these features may also need additional support to successfully print

1. The part generally has **long** bridges
2. The part generally has **short** bridges
3. There are no bridged features

2.3 Self-Supporting Angles

Self-supporting structures do not require additional support



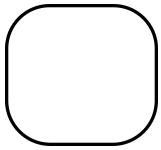
Self-supported features are any features that stick out with less than a 45-degree slope measured from the horizontal build plate. Such features reduce the further need for support material and often improve surface finish

1. Features are generally inclined **less than 45 degrees** from the build plate
2. Features are generally inclined **greater than 45 degrees** from the build plate
3. There are no inclined features

3 Cross Sections

3.1 Rounded Corners

Sharp corners on flat areas increase the chance of warping

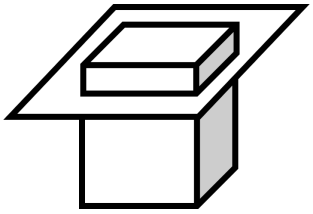


Warping of flat surfaces is affected by the corners of the surface area. The sharper the corners, the more likely ths surface may warp. Rounding corners helps distribute stresses to reduce the chances of warping

1. Corners on surfaces parallel to the build plate **have no** chamfer or fillet features
2. Corners on surfaces parallel to the build plate **have some** chamfer or fillet features
3. Corners on surfaces parallel to the build plate **have generous** chamfer or fillet features

3.2 Size/Area

Large, flat areas tend to warp

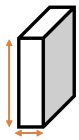


Additive manufacturing often struggles to make perfectly flat parts. For most surfaces, flatness doesn't matter. It does matter where two parts meet, though. The larger the flat surface, the more warping you will see

1. The part generally has **large** flat surfaces
2. The part generally has **medium-sized** flat surfaces
3. The part has **small or no** flat surfaces

4 Thin Features

Thin features will almost always break



Thin features refer to the thickness of one outside wall to another outside wall. Thin features are difficult to manufacture and are just as difficult to remove from the build plate. The orientation of the features does not significantly reduce the difficulty to manufacture them

1. Feature height to width ratio is generally **above 30:1**
2. Feature height to width ratio is generally **between 30:1 and 20:1**
3. Feature height to width ratio is generally **below 20:1**

5 Surface Accuracy

Surface accuracy may be affected by stair-stepping effects

Curved surfaces oriented perpendicular to the build plate will exhibit stair-stepping hence affecting the surface accuracy and finish. For features or surfaces that require close to design finish, the surface should be oriented parallel to the build plate

1. **All** curved surfaces are oriented perpendicular to the build plate
2. **Some** curved surfaces are oriented perpendicular to the build plate
3. **No** curved surfaces are oriented perpendicular to the build plate