Rules for Additive Manufacturing Cheat Sheet

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Introduction

In principle, any component can be made by either subtractive or additive manufacturing techniques. However, various design features pose completely different challenges to both methods. As the number of parts being made directly by additive manufacturing grows, it's important to lay down design principles suitable for such processes and to ensure parts are designed for additive manufacturing.
Several factors should be considered at the design stage to effectively produce parts using these technologies.

Credit: http://www.assemblymag.com/articles/93741-design-for-additive-manufacturing?

Maximum Part Size

The maximum size of additively manufactured parts is constrained by the size of the available machinery. If the part is bigger than the maximum capacity of the machine, the following methods can be adopted to solve the problem.
If the end use is only to create a prototype, then the part can be scaled such that the maximum dimensions fit the machine. Of course, due to scaling, some finer details could be lost depending on the scaling factor and the feature dimensions. This could require some editing or clean up in the scaled 3D model.

Faces Requiring Support

Because additive manufacturing methods build the part layer by layer, some designs might require additional support during production. Features such as negative drafts, overhangs and undercuts require support in FDM, SLA and 3DP.
As a consequence, such features should be avoided wherever possible. Creating part supports increases manufacturing time and that, in turn, increases cost. Parts requiring supports also might need secondary processes. The support might have to be cut away, and the joint lines might have to be sanded and cleaned.

Minimum Wall Thickness

The minimum wall thickness of a part depends on the additive manufacturing method and the resolution of the machine. Very thin walls could make the part fragile. As a result, engineers should maintain a minimum wall thickness to lend sufficient strength and rigidity to the part.

Boss Design

Part designs may have bosses, which serve as points for attachment and assembly. The most common boss designs consist of cylindrical projections with or without holes. Holes in bosses are designed to receive screws, threaded inserts or other fastening hardware. Under service conditions, bosses are often subjected to stresses not encountered in other sections of a component. So, bosses are generally designed with a draft to increase the strength at the bottom

Minimum Feature Size

The minimum feature size of various part features such as holes (blind or through), pockets (depression text, symbols or cutouts), islands (protruding text, symbols, bosses or pins) is constrained by the additive manufacturing method, machine resolution, wall thickness, and whether the feature is on a vertical or horizontal wall. The minimum feature size is constrained by the bead width in FDM and the laser spot diameter in SLS. Machine manufacturers recommend that the minimum feature size along the X-Y plane should be greater than or equal to four times the resolution of the machine, while the minimum feature size along the Z axis should be greater than or equal to the machine's resolution. To get more accurate parts from additive manufacturing, feature dimensions should be greater than these minimum sizes.

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When analyzing a design for additive manufacturing, software should check the following:

- **Maximum part size.** Compares part size with maximum allowable part size and shows a failure if the part is larger.
- **Minimum wall thickness.** Compares wall thickness of the part and highlights regions where thickness is less than the minimum allowable thickness. This rule also helps to check for minimum distance between holes, cutouts or pockets and minimum distance from edges to pockets.
- **Faces requiring support.** Recognizes negative drafts, overhangs, undercuts and other features requiring support and highlights those faces.
- **Minimum thickness of faces requiring support.** Compares the thickness of faces requiring support against the minimum allowable thickness and highlights the faces that fail.
- **Minimum feature size.** Compares the sizes of pockets, islands, text and other features against minimum allowable feature size and highlights the features that fail.
- **Recommended rib parameters.** Recognizes ribs and compares the ratios of rib-base thickness to nominal wall thickness and rib height to nominal wall thickness against maximum allowable ratios.
- **Rib reinforcement check.** Compares the ratios of rib area to nominal wall thickness and rib width to nominal wall thickness against maximum allowable ratio and highlights the features that fail.
- **Boss ID to OD ratio.** Recognizes bosses and compares the ratio of their inner diameters to outer diameters against the minimum allowable ratio and highlights the features that fail.
- **Boss height to OD ratio.** Compares the ratio of boss height to outer diameter against the maximum allowable ratio and highlights the features that fail.
- **Minimum hole diameter to thickness or depth ratio.** Recognizes holes and compares their diameter-to-thickness (depth) ratio against the minimum allowable ratio and highlights the features that fail.
- **Knife edge.** Recognizes knife edges and highlights them.
- **Recommended corner radius.** Recognizes fillets and compares their diameters against the minimum allowable radius and highlights the features that fail.** Also recognizes sharp edges and highlights them.
- **XYZ slice dimensions.** Checks whether all X-Y dimensions are multiples of four times the machine resolution and whether Z dimensions are multiples of the resolution and highlights the regions that fail.

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