MORF NX: METAL ADDITIVE MANUFACTURING

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Sponsored by Siemens & Morf3D

Overview

The key advantage that additive manufacturing (AM) has over traditional manufacturing is the ability to produce complex parts more efficiently. However, the **presence of support structures** is vital when adopting AM technique as not all geometries can be manufactured instantly.

Purpose

In this project, we will be focusing on designing the most efficient support structures for three unique parts using the NX software by Siemens, which will enable us to reduce material waste and thus save cost and time for the manufacturing process.

Existing Solution

Figure 1. Lattice Structures (Diamond and gyroid)

Advantages

- Reduce build time
- Reduce material waste
- Providing structural rigidity
- De-powder much easily

Disadvantages

- Inconsistent at high resolution.
- High thermal gradients may cause *distortion.*

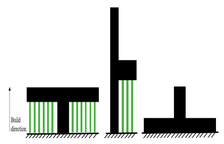

Figure 2. Different part orientations with support for a "T" structure

Part Orientation Optimization Using NX

User has the ability to choose their design goals:

- Surface Area
- Support Volume
- Print Time
- Overheating

Technology and Materials

Figure 3. EOS M 290 3D Printer

EOS M 290 3D Printer utilizes DMLS technology to flash a powerful laser which traces the geometry of the object on the powder bed.

AlSi10Mg is the printing material which is tough, strong, and has low specific weight.

Design Concepts

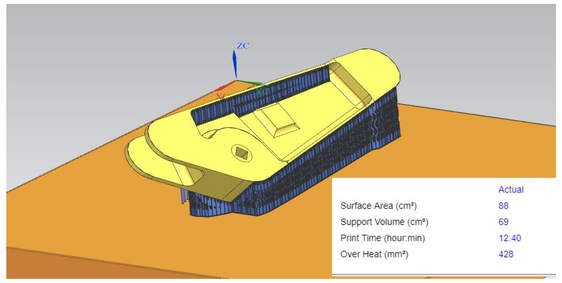

Figure 4. Part 1 with Its Current Design of Support Structures

Boundary Condition:

- Maximum overhang angle at 45°.
- Maximum overheating angle at 60°.

Types of Support:

- Hatch support (with depowdering holes)
- Tree support

Overview:

- Minimized the overheating issue during the manufacturing process.
- Filled in the through holes to reduce support structure volume, which in terms reducing the time it takes to de-powder
- Changed the main hole face from circular to diamond to reduce the time it takes to de-powder.

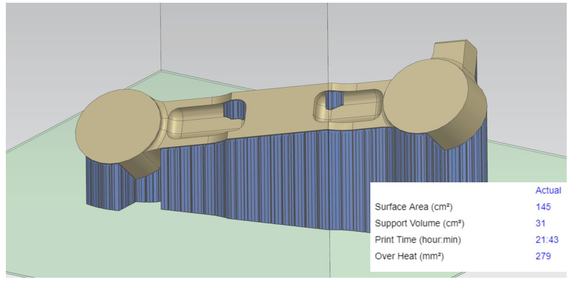

Figure 5. Part 2 with Its Current Design of Support Structures

Boundary Condition:

- Maximum overhang angle at 45°
- Prioritized minimizing support volume & overheating

Types of Support:

- Hatch support (with depowdering holes)

Overview:

- Minimized support volume and overheating at the cost of surface area and print time
- Added machine stock to eliminate need for support structures within holes

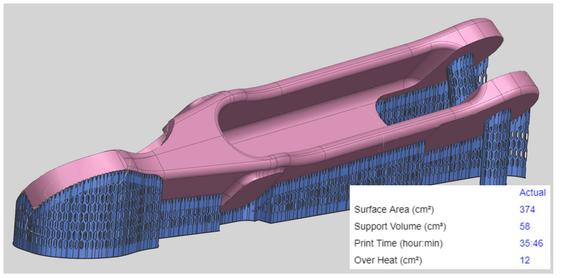

Figure 6. Part 3 with Its Current Design of Support Structures

Boundary Condition:

- Maximum overhang angle at 45°
- Least overheating area

Types of Support:

- Hatch support (with depowdering holes)

Overview:

- Minimized the overheating issue with this orientation and had the other end, where overheating took place the most, higher to dissipate the heat.
- Added stock to circular holes which would be machined later to reduce overhang area.
- Deleted countersinks for less overhang area

Design Requirements

Table 1. Design Requirements

Post Processing Guidelines	Powder must escape from model during de-powdering (3mm min hole diameter)	De-plating should be time efficient (~30min)	Support removal should be time efficient (30~60 min)	Quality surface finishing (smooth and undamaged)	
Support Guidelines	Minimum support structures (measured by volumetric %, TBD)	Orient part to prevent major cross-section change (max 45 degrees)	Holes and tubes larger than 10mm in diameter require supports	Avoid long support structures (40-60mm max)	Use chamfers/fillets to eliminate sharp edges
Build Restrictions	Design must fit in EOS M 290 printer (250x250mm)	Prevent fusing by maintaining a 1.5~5mm gap	Avoid features under 0.4mm (powder-bed process)	Max build height 320mm	Less or no screw holes in part

Benefits

- Excess powder collected can be reused for future prints
- Makes post-processing easier for technicians
- Geometrically complex parts can be manufactured with ease

Future Improvements

- **Trying to implement lattice support structures** to the part instead of relying on hatch supports.
- **Studying bottom-up section views** of part builds to make sure no heat distortion can happen due to large changes in layer cross-sections
- **Varying types of support structures** - use each type to its fullest potential

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