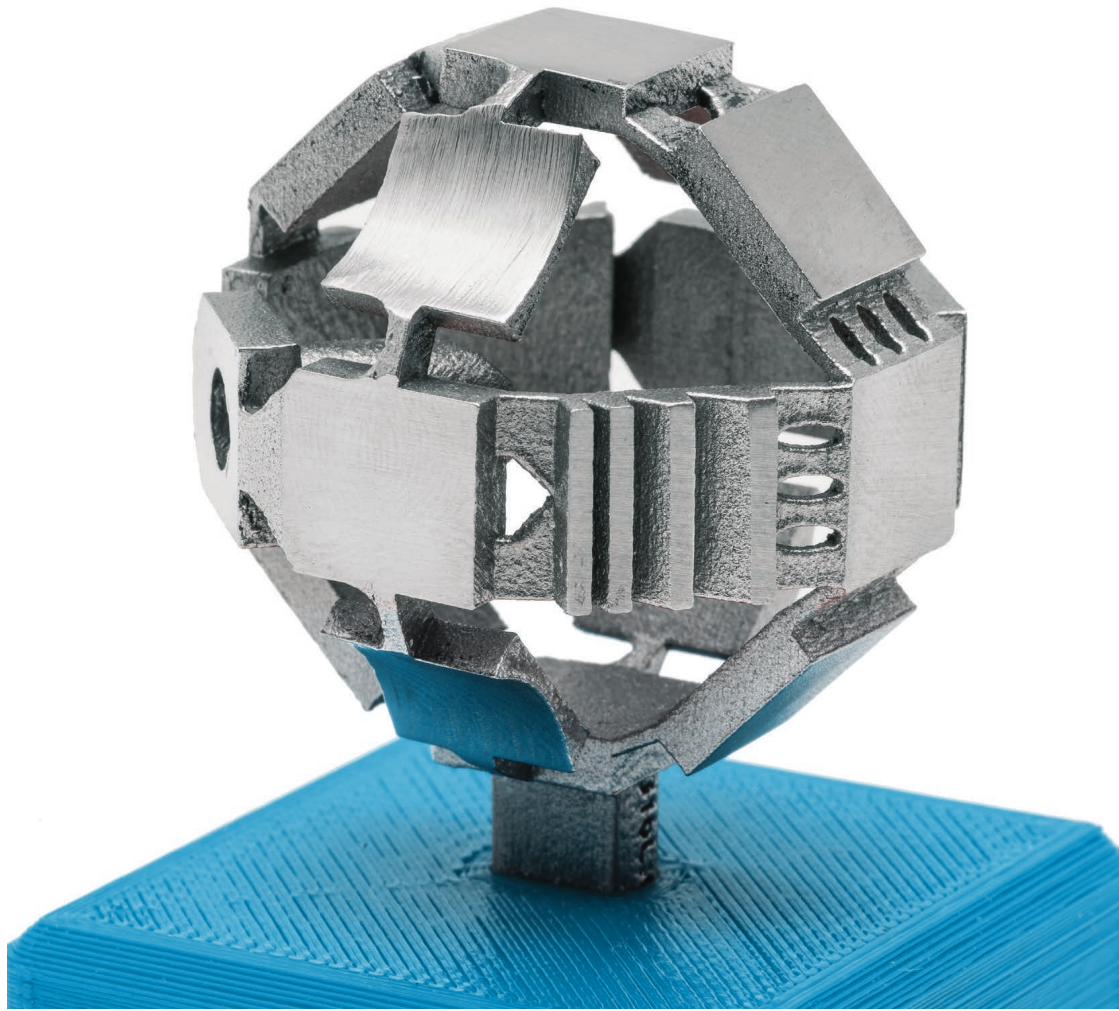
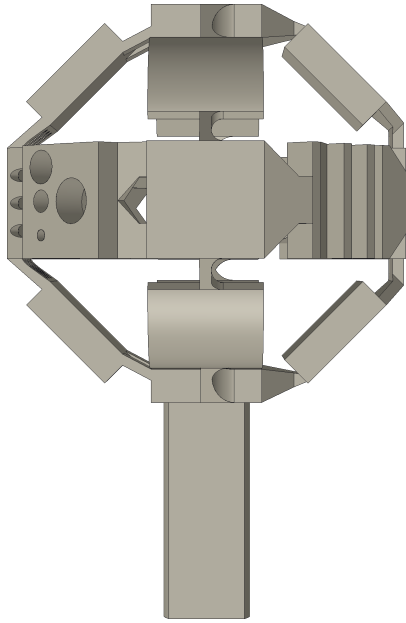


surfineers

morQ

measurement
object for
roughness
Qualification





What is the morQ

The measurement object for roughness Qualification (morQ) is a next generation test sample to verify and quantify your complete AM process chain - from build parameters, material optimisation or post processing - and their respective effects on the surface quality and geometry.

The sample is designed to contain flat surfaces in all build directions at set angles and a wide range of exemplary geometries that altogether form a challenging part to print and post-process. It functions to showcase the boundaries of AM and any post-processing technologies applied after manufacture.

You can employ this sample to optimise the whole process chain even before having to manufacture your real application parts.

How to use the morQ



Download the files from surfneers.com/downloads

Follow these simple rules to get the most out of the morQ:

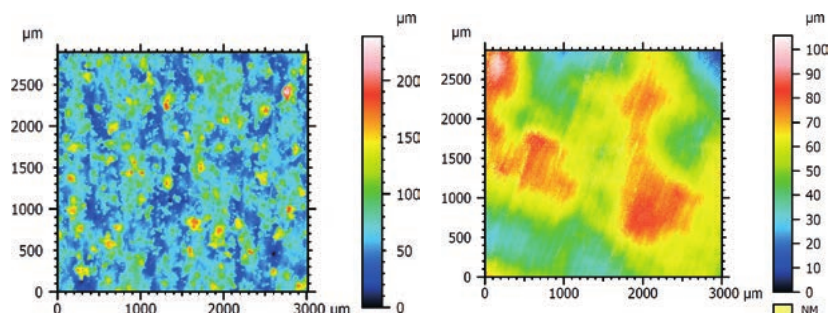
1. download the files
2. define what aspect you want to investigate
2. prepare the build, nesting, supports, etc.
3. define the build parameters
4. build the morQs
5. Post process the morQs
(powder removal, support removal, waviness reduction, polishing, etc.)

Use the morQ for:

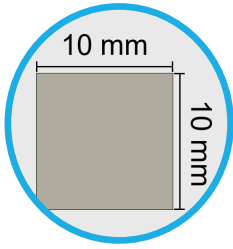
- evaluate build parameters
- verify machine performance
- check uniformity on the buildplate
- ensure stability of production between multiple machines
- test your support attachment strategy
- evaluate new post processing steps/technologies
- verify your existing AM process chains
- print the morQ with every build to ensure process stability of a series production

Perform a full Analysis

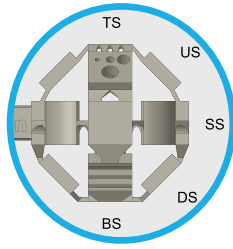
- quantify surface waviness and surface roughness in all build directions
- evaluate geometry features
- feed back your learnings into the optimisation process
- contact the Surfneers for support on optimising your processes



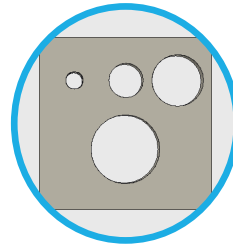
morQ's Features



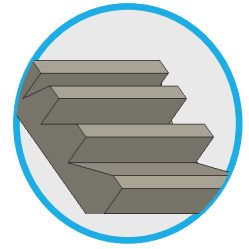
Surfaces are of sufficient size to measure areal roughness according to ISO25178.



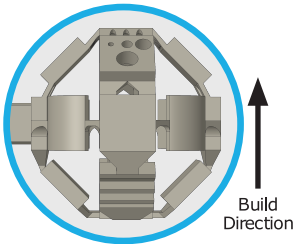
Surfaces are built in all build directions: Top Skin (TS), Up Skin (US), Side Skin (SS), Down Skin (DS), Bottom Skin (BS).



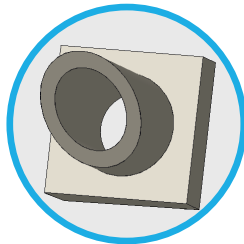
A series of hole geometries serves to highlight the limitation of surface finishing of small features. The hole diameters are 1, 2, 3 and 4 mm.



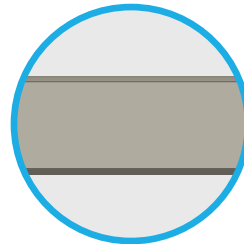
Trench-like geometries present sharp corners in various aspect ratios. This is challenging to build accurately.



the morQ's build orientation is designed so that the part is mostly self supporting whilst containing the highest amount of variety of surfaces.

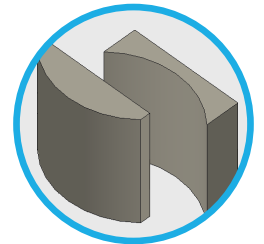


A 5 mm hole, with a pipe feature attached is located at the bottom of the morQ. Here, deep hole finishing and coating processes will struggle.



The shaft serves multiple functions:

- Hold the morQ in finishing and coating processes.
- Space to imprint a logo and check overhanging features.
- Marking of unique ID's for traceability.



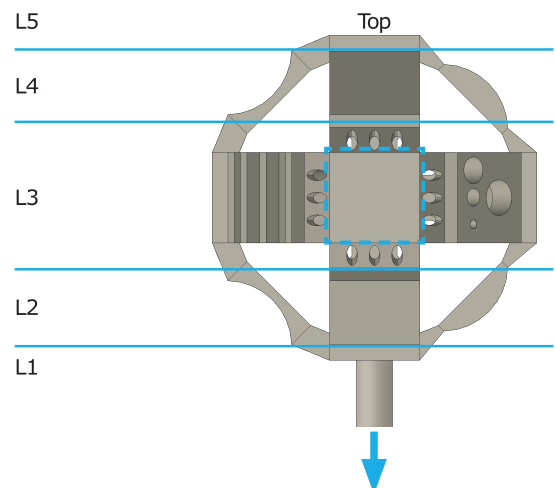
Convex and Concave surfaces simulate complex skins, where the AM process can really shine. Controlled roughness on these is very important.

Naming Strategy

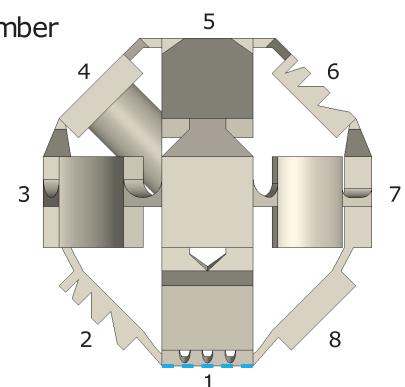
Build the morQ on your favourite AM system

- Each morQ has a space to contain a unique identifier: The shaft has a flat section to engrave ID numbers prior to the AM process or after manufacture.
- Here is how we've done it: **sPAT042ID12**
(**sPAT** - Project Name / **042** - Batch Identifier / **12** - ID Number)
- Each surface also has a unique identifier and is named with the following convention:
 - The 'layer' number that the surface is located at.
 - the rotational position number of the surface, counting clockwise.
 - Every empty space on Level 2 and Level 4 counts as a position also.
 - the front of the morQ is also the Top Skin.
- The highlighted example: **L3-1**
The Top Skin is located on Level **3**, Position **1**, so this surface is called an **L3-1**.

Layer number



Rotation number



Measure and Verify

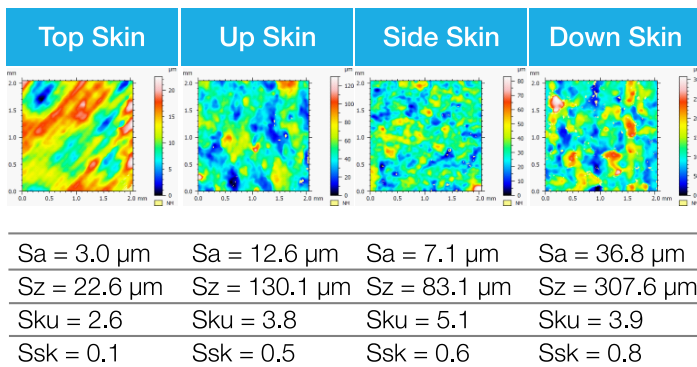
Surface Texture: Waviness and Roughness

- Measure each surface with areal surface texture measurement technologies according to ISO 25178.
- Try to avoid profile measurements, as the results may be ambiguous due to the complex surface morphologies on AM Parts. Still, a profile measurement is better than no measurement.
- The surfaces will exhibit many structures: melt tracks, embedded powder particles, layer effects, etc. and need to be quantified.

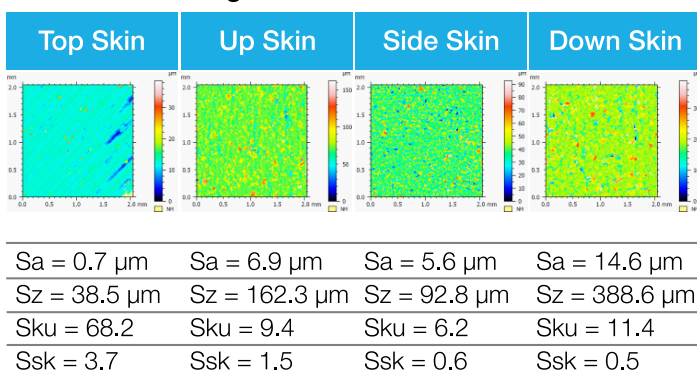
The measurements below were taken with the following parameters:

- Measurement size: 2.04×2.04 mm
- Low-Pass Filter with nesting index $S1 = 100 \mu\text{m}$
- Form Removal with polynomial = 2
- S and L Filter with nesting index $S2 = 10 \mu\text{m}$

S-F Surface: Waviness

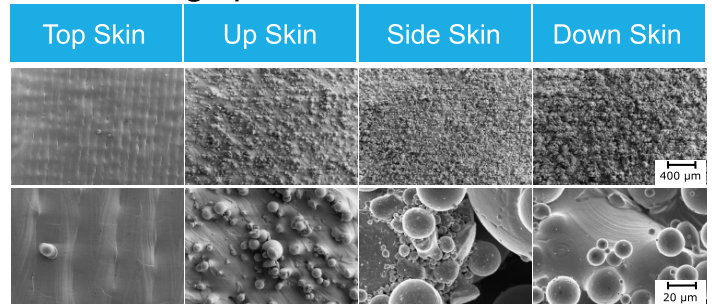


S-L Surface: Roughness



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SEM Micrographs



Geometry

For the verification of surface quality, it is important for the morQ to contain complex geometrical shapes that present difficult to reach positions, undercuts, inside and outside surfaces. This presents a challenge for the AM process, any finishing process that may be required and any subsequent performance adding processes, such as coatings. Below you can find dimensional information of all surface geometries, labelled according to the Naming Strategy shown on page 3.

Unique identifier	Type of surface	Feature	Dimensions (mm)
L1-1	SS (90°)	Flat Surf	10 x 10
L2-1	US (135°)	Flat Surf	10 x 10
L2-2			EMPTY
L2-3	SS (90°)	Concave Surf	10 x 10, R: 7.25, C: 2
L2-4			EMPTY
L2-5	DS (45°)	Flat Surf	10 x 10
L2-6			EMPTY
L2-7	SS (90°)	Convex Surf	10 x 10, R: 7.25, C: 2
L2-8			EMPTY
L3-1(X) TOP	TS (180°)	Flat Surf	10 x 10
L3-2	US (135°)	Trench Surf	Depth: 2; 1.5:1, 1:1, 0.5:1
L3-3	SS (90°)	Flat Surf	10x10
L3-4	DS (40°)	Tube	ID: 5, OD: 7; C:11
L3-5	BS (0°)	Flat Surf	10 x 10
L3-6	DS (45°)	Trench Surf	Depth: 2; 0.5:1, 1:1, 1.5:1
L3-7	SS (90°)	Flat Surf	10x10
L3-8	US (135°)	Multiple Holes (locations given from centre)	ø1 (-3, 2.5), 2 (0, 2.5), 3 (3, 2.5), 4 (0, -1.5); Depth: 3
L4-1	US (135°)	Flat Surf	10 x 10
L4-2			EMPTY
L4-3	SS (90°)	Concave Surf	10 x 10, R: 7.25, C: 2
L4-4			EMPTY
L4-5	DS (45°)	Flat Surf	10 x 10
L4-6			EMPTY
L4-7	SS (90°)	Convex Surf	10 x 10, R: 7.25, C: 2
L4-8			EMPTY
L5-1	SS (90°)	Flat Surf	10 x 10