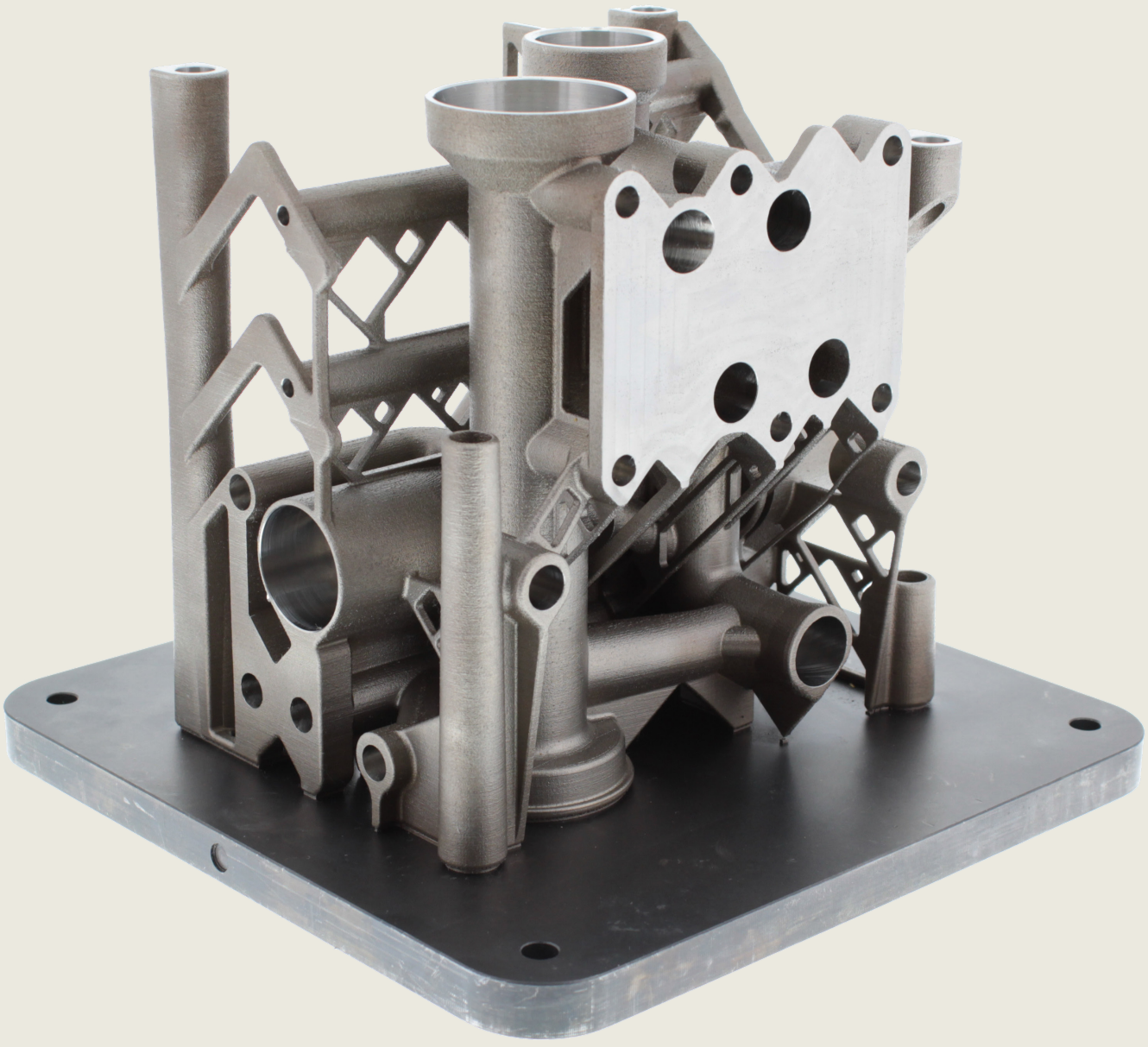
DASSAULT SYSTEMES

SPATIAL

SPATIAL SDKS: STREAMLINING SOLUTIONS FOR METAL AM IN RENISHAW QUANTAM



Renishaw, is a world leading engineering and scientific technology companies supplying industrial automation and process control solutions and services across a wide range of industries including aerospace, automotive, electronics, energy, marine, mining and healthcare solutions. It is also a world leader in the field of additive manufacturing (3D printing) where it designs and manufactures a range of industrial 3D metal printers which ***print*** parts from layered metal powder using laser sintering.

RENISHAW
apply innovation™

Challenge:
Move away from an STL-centric file import process and its limitations while minimizing engineering effort

Solution:
Integration of 3D InterOp™ and the 3D ACIS® Modeler with CGM Polyhedra

Results:
- Eliminates transcription errors
- Enables model healing capability
- Paves the way to future CAD functionality
- Enables support for model-based engineering

RENISHAW'S QUANTAM

Renishaw is an established world leader in engineering technologies, with a strong history of innovation in product development and manufacturing. Today, this history of innovation extends to the design, development and production of advanced metal additive manufacturing systems for direct manufacturing of 3D-printed metallic components.

Prior to 3D printing, it is necessary to generate the printer's laser scan paths that fuse the powder layers to each other to additively form a part. Build preparation software is thus key to generating the high-quality part builds. To maximize build quality on its own printers and to provide its industrial customers with a simple UI in which to orient, support and set build parameters, Renishaw has developed its own build preparation tool – QuantAM.

QuantAM accepts CAD exports in the form of .STL data, allowing the user to prepare the model for the AM process, for example:

- Setting part orientation
- Duplicating, orientating and positioning multiple parts
- Adding support structures
- Reviewing geometry and laser tool path slice by slice
- Reviewing discrete laser exposures within each slice
- Editing the imported model to improve manufacturablity and correct errors

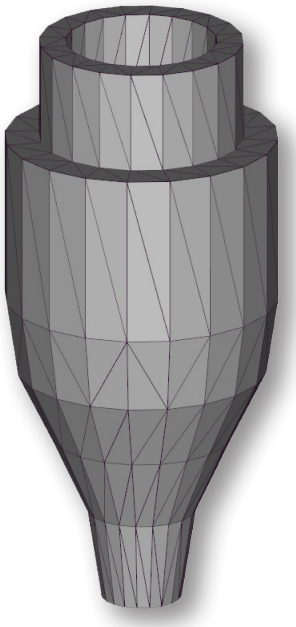
QuantAM is designed specifically for Renishaw AM platforms, providing tight integration to the machine control software and the ability to accurately and rapidly review all build files prior to production.

ISSUES WITH STL IMPORT

Digitally driven additive manufacturing systems require a file preparation stage to take the original CAD geometry and format it into a machine-readable build file. The most common CAD export format is stereolithography (STL). The STL format describes a surface as a collection of connected triangles — the more complex a surface is, the larger number of triangles that are needed to define that surface.

While STL import has served the industry well, there are several limitations with this format:

- Regardless of the number of triangles used to describe a surface, it is still an approximation, for example, a sphere described as a collection of triangles can only approach the accuracy of a parameterized model of a sphere (and never achieve the simplicity of the description).
- If the wrong triangle density is chosen at the time of export, it can have an impact on the resulting print quality. An end user has to have a good understanding of what the print resolution of the equipment is.
- Because an STL representation is an approximation, it both limits and complicates the ability to edit the model.
  - Errors in translating the intent of the model, with any fixes being manual and less than perfect.
  - A fixed/repaired model diverges from the original, complicating keeping specifications in sync.
  - No support for product and manufacturing information (PMI).



Example of the issues with STL import: too low a triangle density combined with lack of canonic surfaces

TAKING ADVANTAGE OF SPATIAL SDKS

New for QuantAM 2017, Renishaw's software engineering group architected a major overhaul to their current platform. With the help of Spatial's technical team, Renishaw have integrated two key components into QuantAM: the 3D ACIS Modeler with CGM Polyhedra and 3D InterOp.

Moving to the ACIS Modeling Kernel

A major change to the QuantAM solution was to move to the ACIS modeling kernel and away from the reliance solely on an STL representation of the model. This move to a native modeling kernel delivers significant advantages to both Renishaw and their customers.

World-Class Healing

High-quality geometry output is essential in preserving a model's robustness and quality for use in 3D printing. Without this, 3D models for components may have gaps between the edges or other irregularities due to differences in how modeling programs define edges, faces, and shapes. These irregularities can lead to an unusable model. The 3D ACIS Modeler provides access to a powerful set of functions and routines that can

handle these tough modeling problems of stitching, geometry simplification and gap tightening.

The 3D ACIS Modeler add-on, CGM Polyhedra, provides QuantAM access to robust and powerful polygonal healing capabilities on tessellated data — an important capability because STL imported data is often imperfect, obscuring the intent of the model.

Advanced Modeling

By using CGM Polyhedra and the 3D ACIS Modeler, QuantAM now benefits from precise B-rep and polyhedral hybrid modeling capabilities. For example, CGM Polyhedra can recognize canonic surfaces, such as planes, cylinders, cones, toroids, and spheres in an STL model, converting these structures to precise representations, and thus preserving the intent of the original model.

Quantum Leap in Editing Capabilities

Because the imported data now exists as a true 3D hybrid model, geometric modifications, edits and corrections can be made to the hybrid model. This updated model can be fed back upstream to the original design team, enabling them to review any changes made to make the part manufacturable.

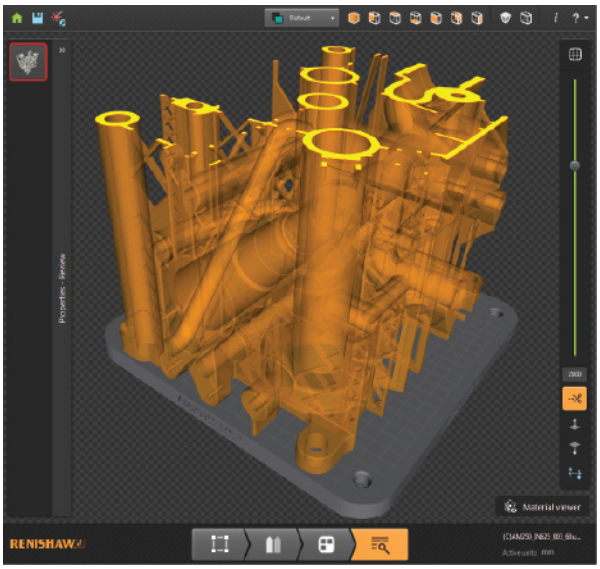
This new flow made possible by the 3D ACIS Modeler enables model-based engineering, where the model ***is*** the specification, allowing for any changes made in manufacturing to be fed back to the entire system.

> **"Our collaboration with Spatial now allows us to not only perform high-quality healing on STL files but, more importantly, to import various CAD formats directly."**
>
> Stephen Anderson
> Director of Group Software at Renishaw

Integrating 3D InterOp

With 3D InterOp, QuantAM can now import many new modelling formats, enabling Renishaw to support additional customers and workflows, including all major CAD providers and associated formats. By adding support for the native formats of other CAD systems, QuantAM can import the original design intent, bringing in not only the geometry data, but also the product structure and assembly, graphical representation, and PMI.

3D InterOp brings automatic healing on import to QuantAM. The goal is to create a model with high enough quality to be correctly interpreted by the modeling kernel while remaining



Slice layer of a complex manifold within QuantAM

true to the intent of the original model. This automatic healing occurs in three areas:

- Modification of the topology of a body by removing duplicate and overlapping vertices, and splitting edges having large discontinuities in their pcurves so that their continuities follow the rules of the modeling kernel.
- Refinement of the geometry which involves reconstruction of self-intersecting and irregular curve geometry of edges, co-edges, and surface geometry of faces, as well as the trimming and sub-setting of underlying surfaces of faces to conform to the rules of the target modeling kernel. 3D InterOp healing does not modify the geometry, ensuring that output conforms to the shape of the original.
- Repair of other invalid data in the body such as loop errors.

Benefits of a Third-Party Solution

From a business perspective, collaborating with Spatial provides Renishaw with .a complimentary set of capabilities and highlights the benefits of this long standing, productive working relationship.

From an engineering perspective, Renishaw gains a robust solution tested on thousands of datasets from hundreds of customers. The team benefits from the Spatial engineering team's years of experience in dealing with 3D modeling as well as translating CAD databases from various vendors while preserving design intent.

As a result, the team does not have to deal with the usual issues when rolling out new code to customers. Moreover, due to the maturity and robustness of the solution set, the number of support issues is greatly reduced. Renishaw's customers benefit from any code fixes and improvements needed by the Spatial community.

CONCLUSION

While .STL files have historically been the standard used by the industry, it is well known that this format can causes issues, typically with broken STLs that need healing, or with low triangle density impacting print quality. A far better approach is to work on the original native geometry, preserving the original design intent of the model. By integrating Spatial SDKs into QuantAM 2017, Renisahw will continue to enable users to build part right the first time.

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