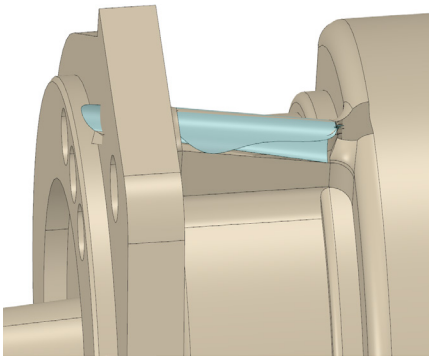
ANSYS

White Paper

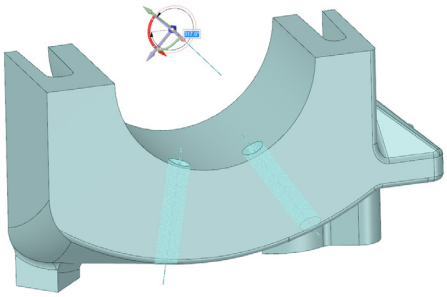
From Concept to Prototype: ANSYS SpaceClaim for 3-D Printing

Saving time and money preparing 3-D CAD models for 3-D printing

If you produce prototypes or small quantity runs of your parts or products, or have them manufactured through a prototyping service – or offering this service yourself: In each case you have to import, modify and prepare models for your prototyping purposes. In this white-paper we'll explore all things related to preparing models for prototyping through 3-D printing. From the importing and direct modeling manipulation of data from all major CAD systems, to the optimizing and output STL file, you will learn how ANSYS SpaceClaim streamlines processes connected to 3-D printing. In 10 short paragraphs we'll focus on ANSYS SpaceClaim as an easy-to-use, low total cost of ownership engineering tool that is faster and easier than using any traditional 3-D CAD-System. Finally, the innovative company FORMRISE reports on their experience in preparing models with ANSYS SpaceClaim for laser sintering.



Time and data losses are the rule when importing CAD data from other programs



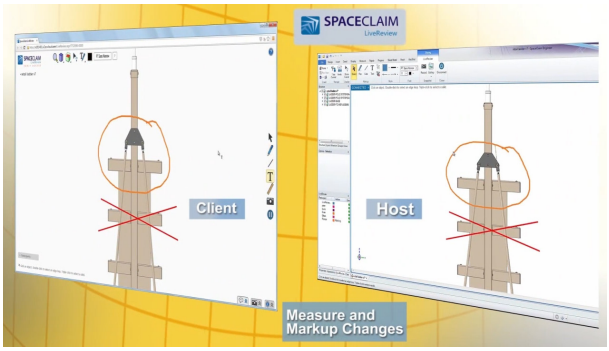
For example, with direct modeling users can easily edit the location of boreholes

1. Complexity of Feature-Based Modeling Technology

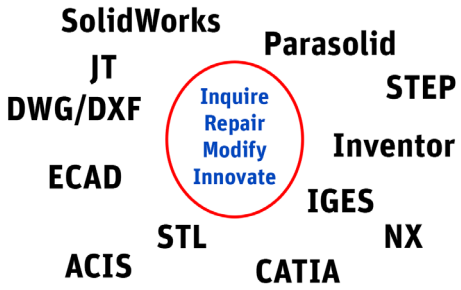
At first glance, a conventional 3-D CAD system with a history tree (or feature manager) is an adequate tool for engineers to design products. Features can be rapidly changed by dimensioning, enabling engineers to explore many design alternatives in a short period of time. Unfortunately, the handling and use of the dependencies of the many design elements with one another in the feature-based modeling technology requires a great deal of knowledge and skill. However, engineers who will be responsible for support and problem solving over the entire life cycle of the products or who have to focus on production, have neither the time nor the interest for this complicated modeling technology. It turns out that feature based modeling is not the best tool to use in all situations for all design or manufacturing engineers, especially when importing 3-D models that require edits simple or complex edits.

2. Simple changes: Direct modeling

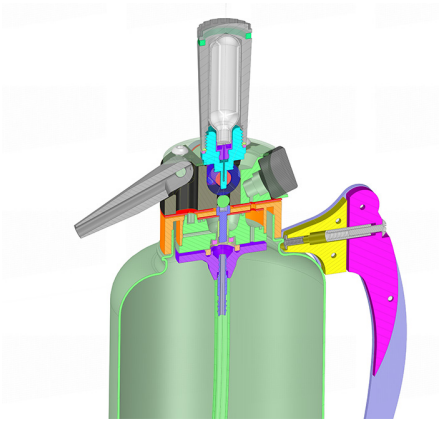
Many software vendors have embraced a newer modeling paradigm called direct modeling. With direct modeling no feature hierarchy or dependency exists. Users easily select geometry elements they want to change and directly edit the geometry. When using direct modeling, users don't have to worry about managing complex feature dependencies. If you at all have to import and modify CAD data from other programs, this technology is suitable for those modeling requirements. This approach saves users the high expenditure in knowledge and training necessitated by feature-based modeling. Although powerful enough for experienced users, direct modeling is often ideal for casual users of CAD.



LiveReview enables several users to review and edit a model or an assembly in real time



Formats from other CAD programs can be edited as though they were created in ANSYS SpaceClaim



Even complex components and assemblies can be edited in cutaway view

3. Collaborative 3-D innovation, earlier product maturity

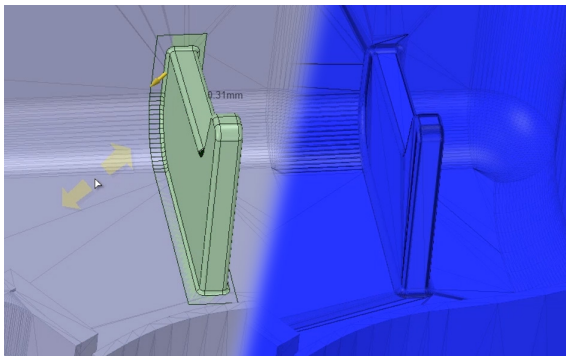
Engineers can easily create alternative designs and collaborate in a cloud environment. Teams all over the world can check models, perform calculations using CAE methods or test them with the help of prototypes. Developers don't have to be power users of a highly specialized, traditional CAD system to prepare the necessary 3-D product data. Thanks to the simplicity of ANSYS SpaceClaim it is possible to test many variations in less time. Engineers are able to make decisions more quickly in the design/conceptual phase and establish a high product maturity. As a result, it is easier to meet tight project schedules. Employees at all levels of the product development and prototype or manufacturing processes can run the system without CAD experience. While parametric, history-based CAD professional systems offer great advantages for many tasks, their use in the prototype phase often presents obstacles. CAD direct modeling is significantly easier to learn and apply, makes users productive more rapidly, and greatly shortens the lead time.

4. Import and Process of any desired Geometry Data

In ANSYS SpaceClaim all native CAD data, neutral formats, and STL files can be imported and edited without difficulty. This helps when a product developer has the task of preparing CAD data for the preliminary production or prototype construction. Poor, defective geometry from the source can be automatically or semi-automatically reconstructed with repair tools and converted to a "watertight" boundary representation (BREP) model. When various elements are too small or walls too thin to be produced in a rapid prototyping method, intuitive direct modeling tools such as "Pull", "Move", "Fill", and "Combine" modify the geometry with ease.

5. Goal-oriented: create and adapt geometry quickly

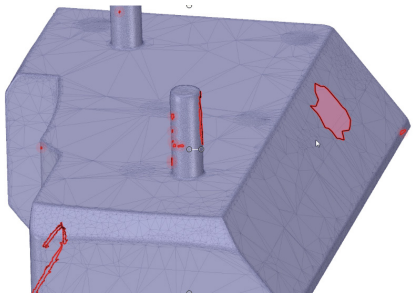
At this point in the process it is important to relieve the developer of the time-consuming operation of feature-based CAD systems: defining new design features, deciphering the logic of the feature tree, and organizing the construction history. Not to mention that a given model was possibly created by a third party, and possibly in another CAD system. All these factors impede rapid development and design innovation. Options are needed for rapidly creating geometry or working directly on geometry in an appealing and visually enhanced technique, such as cutaway or cross section views. Engineers often need to easily create support geometry for the layering models or to remove geometry elements. The desired result is the adaptation of models within a short period of time in order to lower construction time, material consumption and costs. Engineers find that ANSYS SpaceClaim's unique approach to modeling makes this possible.



A solid is placed and merged into the blue STL file - a unique function of ANSYS SpaceClaim

6. "Hybrid modeling" of STL data

As a special feature ANSYS SpaceClaim allows the "hybrid modeling" of STL files: this means that users can influence STL files with solid models. Solid or surface geometry can be used for simple or complex Boolean operations – merge with the STL file or removed material from it. Thus, for example it is easy to add dimensionally stable connections to a complex STL free form surface geometry. Other typical tasks can also be accomplished faster with ANSYS SpaceClaim. Among these are the covering and thickening of geometry or the filling of gaps; scaling of models to an ideal size; the splitting of large parts into several pieces, which can then be processed in parallel and in time saving manner; the rapid creation and verification of connection elements such as lips or mortises and tenons for the subsequent assembly of the parts. It is just as easy to tessellate STL network data with ANSYS SpaceClaim for the correct resolution of the used prototyping or 3-D printer hardware.

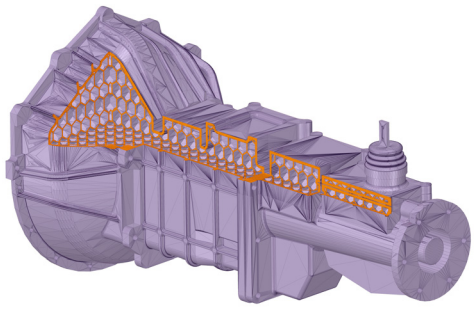


Shrink wrapping of a noisy, dirty STL model

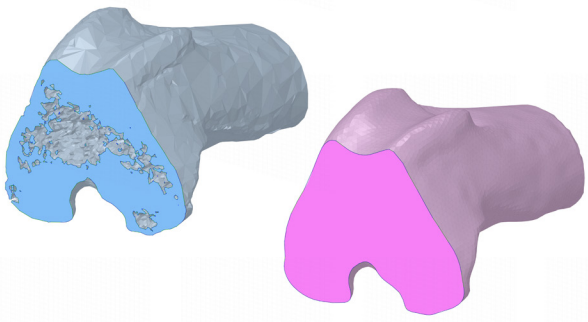
7. Preparation for 3-D printing

However, we've barely scratched the surface when it comes to options for preparing STL data for 3-D printing. Users without any training in CAD can check an STL file's integrity for water tightness, and subsequently clean up all types of imperfections. Holes, incorrectly aligned perpendiculars or positionally identical triangles are detected and automatically remedied. With a few commands components can be shelled or hollowed out to save weight. Inversely, shelled bodies can be filled with custom 3-D grid structures to achieve stability and strength.

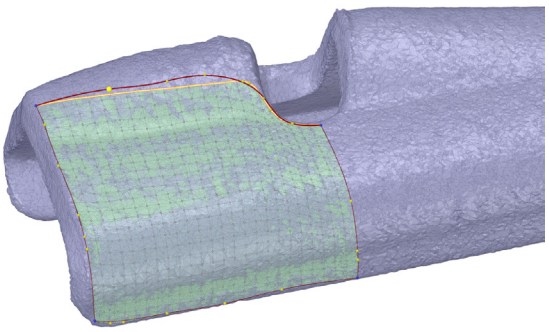
With the new shrink wrap function selected bodies get a water-proof, uniformly faceted outer boundary. Even bodies with interior irregularities and "noise" are instantly cleaned with this tool. In this way even poorest scan data or 3-D models can be prepared for 3-D printing in minimum time.



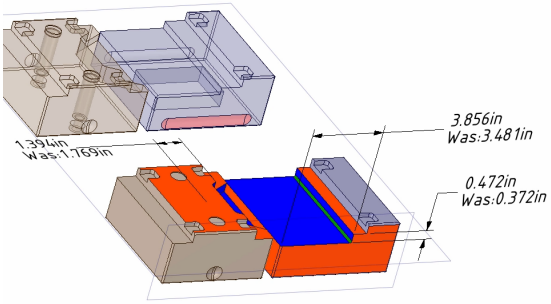
Surface patches can be placed via an automated tool



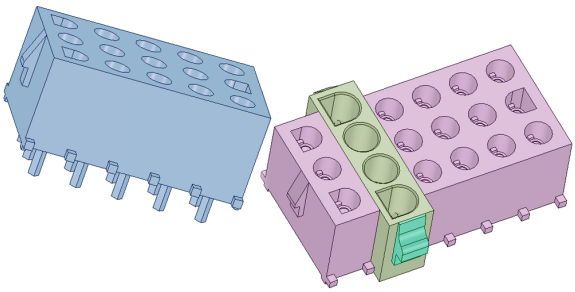
Interior support structures, or infill, can be inserted at any time



The solid resulting from the scanned component is compared to the original



Changes to components are documented in color and dimensionally



Existing models can be easily combined with new objects for new drafts

8. Reverse Engineering

Another requirement involves creating an exact geometry for sequential processes in development and production on the basis of the STL file. This can be accelerated with practical tools, such as a relatively new function called skin surface. Once highly organic bodies are scanned, rapidly repaired and optimized (decimated or normalized), the skin surface tool extracts surface geometry from any connected collection of facets. This highly automated tool closely fits complex surfaces to a user's selection, or it will join together other surfaces, all while accurately following the topology of an STL file. For parts that are cylindrical in nature, the tool will generate recurring loops with a couple of mouse clicks and create surfaces. At any point a deviation tool can compare the STL to the created solid or surface model. Different colors highlight where the solid model is outside or within the STL network. The tolerances can be specified individually.

9. 3-D Direct modeling for approval

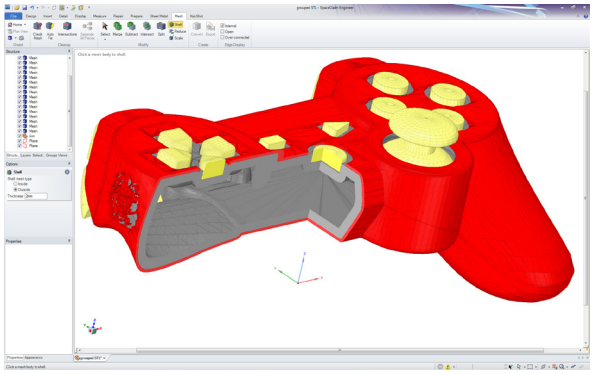
When production specialists want to make various changes to the original models in order to enable production or 3-D printing, they have to communicate the intended changes to the client or their own development department. This happens fast with ANSYS SpaceClaim: you can always output your results in the standard STEP, IGES, STL or native Parasolid or CATIA formats. A collaboration, cloud based approach called Live Review lets other that have only a browser instantly see a model on your screen. Both parties have markup capabilities so communication between changes is simple. And speaking of communicating changes, the 3D markup capability within ANSYS SpaceClaim is a comparative tool that automatically detects and highlights changes between versions of model. With this functionality engineers get all the advantages of continuous development processes without unnecessary time losses.

10. Direct modeling accelerates the conceptual phase

Engineers make design decisions based on their understanding of the problem and their experience. This is followed by a secure and detailed definition of the product. It is very important that the engineers have built on sufficient knowledge via their draft, so that only a few changes are necessary in later development phases. Developers have to deliver a complete definition of the product concept. The use of 3-D direct modeling in this phase accelerates the development process and finally leads to a more rapid introduction to market.

With direct modeling the prototype phase can be organized in such a way that CAD changes are implemented by a design team and not pushed through the "bottleneck" of chronically overworked CAD departments. Thus more change loops in a shorter time and a more rapid establishment of high product maturity are possible. Once this has been achieved and the conceptual phase is completed, the detailed design for serial production can follow in parametric CAD systems.

Peter Spitzwieser, principal at FORMRISE, at his workstation



A housing can be easily divided in several meshes

A Case Study: Data hub for 3-D printing

With its comprehensive know-how about the new technology of laser sintering, FORMRISE GmbH in Töging am Inn is one of the few suppliers already producing small-scale series of technical parts for numerous branches of the industry. ANSYS SpaceClaim has proven itself to be the perfect tool for transfer, processing, design and modification of 3-D models for production.

In the additive production technology of laser sintering, a workpiece is built by depositing material on the basis of digital design data in layers. “This type of ‘3-D printing’ furnishes very precise, mechanically resilient components suitable for serial production”, says Peter Spitzwieser. For fourteen years he counseled industrial clients who sought economical solutions for special production tasks with systems for laser sintering. In his opinion there is a great market potential apart from the deal with fast prototyping. “However, only for one in every ten potential users did I find sufficient substance for utilizing their own production facilities”, reports the skilled tool and die maker. Today he handles the remaining 9 out of 10 cases. The company he founded in 2014 with business partner Robert Razavi, FORMRISE GmbH supports companies in all areas of industry with services having to do with the new technology of 3-D printing: Specific component development, technical consulting and design workshops for the various procedures – but the serial production of plastic parts in laser sintering is the main focus. In the production hall a FORMIGA P 110 is running, a flexible and highly productive system for effective small series production of individualized products with complex geometries. Another, larger EOS P 396 permits the highly efficient production of serial components in an installation space of 300 x 300 x 600 millimeters. Replacement parts, function prototypes or models can also be manufactured. During production process a thin layer of the powder material is applied to the build platform. A high performance laser melts the powder exactly onto the places that specify the computer generated component design data. After that the production platform lowers itself by a layer thickness of between 40 and 150 µm. The next powder application follows. The material is melted on again and combines with the underlying layer at the defined places. As a result, internal structures and undercuts as well as nested components can be produced in one operation.

3rd Party 3-D-Models as Starting Point

The economic advantages usually result from the fact that the components are developed directly from 3-D CAD models without intermediate steps and tools. “To do this, you have to know how such a component has to be built”, says Peter Spitzwieser. “There still aren’t any design or production principles for this young technology.” On the one hand, FORMRISE communicates this knowledge to potential clients in consultations and workshops. On the other hand, said clients can also have access to the services of the company. “We contract out larger design projects to free-lance employees”, says Peter Spitzwieser. “and carry out smaller drawing modifications or developments ourselves.” Peter Spitzwieser discovered the ideal 3-D CAD system for these tasks at a trade show by coincidence. Wolfgang Geist, managing director of

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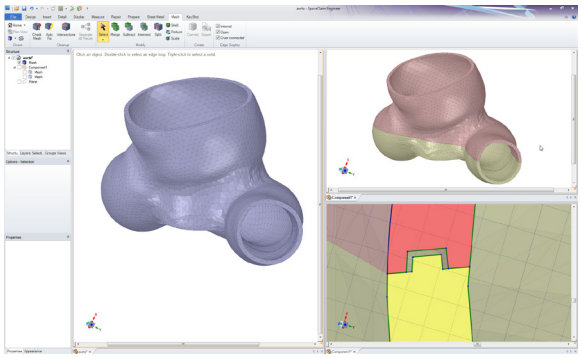
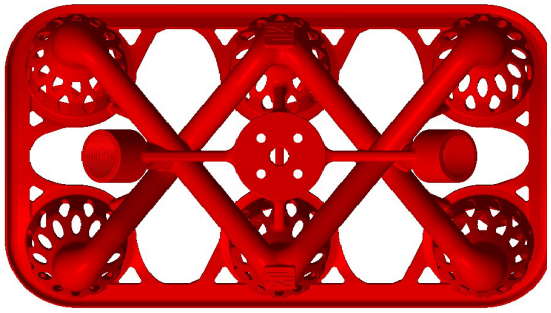


Objects can be split and connected with lap joints

Fast 3-D printing opportunity: Laser sintering with EOS P110 from EOS for high rigidity and quality



Users transition from concept model to finished parts faster with ANSYS SpaceClaim

the distribution partner Conweb, gave him a presentation at the show about the possibilities of ANSYS SpaceClaim. The comprehensive system makes it possible to influence the geometry directly, without regard for structure tree or design history. “By simply modeling I can immediately implement my technical concepts”, says Peter Spitzwieser. “Compared to classic CAD this represents a huge advantage.” The investment costs were only about a third of the estimated price for a CAD workstation – with a double license: “The home license of SpaceClaim lets me also work at home on my projects without having to remove the software dongle each time.” Without prior knowledge of CAD, the skilled tool and die maker was able to familiarize himself with the system using online tutorials.

Simple Functioning – High Productivity

As a rule, clients provide their data in IGES or STEP formats; Parasolid files can also be completely imported without problems. Then comes the detailed work: The components are optimally placed, tolerances and surfaces are verified, radii adapted, offsets attached. The models have to be prepared for laser sintering, so that the output is as wanted. Small changes can result in significant improvements with regard to strength, shape accuracy and function. “I find the right tools in SpaceClaim for all of these changes, which I can immediately apply to the geometry”, says Peter Spitzwieser. Only in exceptional cases, for example if replacement parts have to be produced, for which there is no 3-D model yet, does he create the design file. For that purpose, there are numerous different possibilities that quickly result in the desired effect. “The program is perfect if you only want to make changes to something. However, creating new models without a structure tree is just as easy.” When the preparatory changes are completed, the models are converted to STL data and saved. With this, the layers are defined that the systems have to apply. Also, there are further options for influencing SLT files like scaling, modeling or cutting.

Solid Business Model

Although the conventional drawing functions are not often required, there are advantages to having a comprehensive and full-blown 2-D/3-D system like SpaceClaim on hand. For example, you can quickly derive drilling templates from a model or document production-related changes while the machines are busy producing the model. The machines work the night shift and on weekends – it doesn’t really matter when the parts are removed and freed from the remaining material. Peter Spitzwieser explains, “This makes laser sintering an economical production process. It offers constructive freedoms that are not possible with other production methods. SpaceClaim is the right system to exploit these freedoms.”

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