



PD17920

# Reverse-Engineering Modeling Techniques in Inventor

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## Learning Objectives

- What is Reverse-Engineering and Why?
- 2D -> 3D
- Mesh -> 3D
- 3D -> 3D
- Tips and Tricks

## Description

Reverse engineering is an essential part of product development process. Whether you are a designer doing benchmark or retrofitting an older design, you need to work with incomplete data. Digesting the incomplete data and changing it into useful model geometry is a science and an art. Generally, most CAD tools have provided some capabilities to enable varying levels of reverse engineering. Inventor 2017 software particularly offers quite a few workflows to help the reverse engineering process. It enables the users to obtain high-fidelity results. Regardless of the formats of the source data (2D or 3D), these workflows provide interesting opportunities. This class will introduce various workflows and techniques with real-world examples. The attendees will get a better understanding of these workflows and learn how to tackle future reverse engineering tasks with ease. This session features Inventor Professional. There are commercial tools available helping recognize features, but depending on the model and capability of the tools, you get varying degree of success. More than likely, so manual operations are still needed.

## Your AU Expert(s)

Johnson is a software QA engineer, who has worked on Inventor for more than 15 years since R5.3. He participates in various projects through the years and understands how Inventor functions very well. He has interacted with users around the world to understand the workflows better and find room for improvement in the product.

## What is Reverse Engineering? Why?

Reverse Engineering is a process to make sense of existing partial data and rebuild the model for engineering purposes.

### Vendor supplies

Your vendor provides partial data to conceal design detail. But, you need the complete model to proceed with your design.

### Original designer is gone

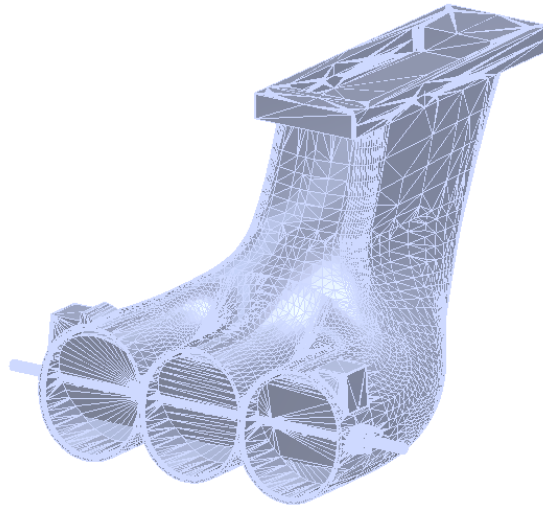
Whoever built the model originally no longer works in the company or cannot remember what was done.

### Competition

You are in a competitive situation and you need to study your competitors' offerings.

### Scanned data

You have pre-existing parts without CAD data. You laser-scan the part and you want to rebuild the CAD data.



*MESH MODEL*



## 2D -> 3D

### 2D Drawing

#### DWG underlay

Link to a DWG file and display the objects in an ipt. Then project the needed geometry to a sketch.

Access: Open a part -> Import -> select a DWG file -> pick one of the origin planes -> pick the origin point or a vertex to snap to)

#### Import points

Import 2D or 3D points from Excel file or text file containing point coordinates. Either keep them as sketch points or create lines from the points.

Access: Open a part -> create a 2D or 3D Sketch -> Points -> pick an Excel file or text file containing point coordinates.

#### Import wires

Import 2D or 3D wires from DWG, STEP, SAT, or other formats. The wires become 2D or 3D sketches.

Access: Open a part -> Import -> a file containing wire data.

#### DWG import

Import the DWG geometry as Inventor sketch geometry.

Access: Open -> find a dwg file -> Options -> select Import -> go through the Import wizard options to get sketch geometry.

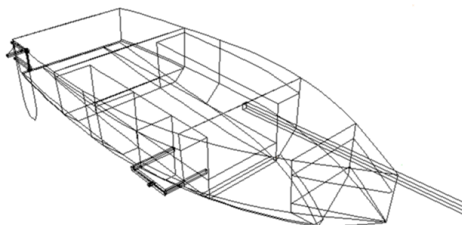
#### 2D -> 3D tool

Import the dwg file as 2D sketches. Select a view plane to project the sketch geometry to. The box helps position the sketches correctly based on orthogonal views.

Access: Load 2D to 3D add-in. Import dwg file as sketches or create sketches -> pick Base or Projected view button in the ribbon and pick a face on the box -> Window-select sketch geometry

#### From 2D print or scanned data

This is the most traditional way of reworking. You will need to understand the drawing views very well. Recreate the geometry accordingly.



2D AND 3D WIRES



## Tips and tricks

1. Identify the datum planes.
2. Understand scale, units, and major dimensions
3. Work on base views and projected views before section views or detail views

\*Verification: Create drawing views based on rebuilt part to compare

## Raster or Mesh -> 3D

Inventor 2017 recognizes mesh edges and vertices; mesh geometry can be used as a reference to create surface or solid geometry

### 2D Raster Data (Image or PDF)

#### Place in 2D Sketch as a reference

Although Inventor does not interact with image directly. An image can be inserted to a sketch and you can create curves by tracing the image. Image size and mode scale need to be in sync.

#### AutoCAD Raster Design tool

It has the ability to convert certain raster data to AutoCAD geometry. This is a little bit like 2D feature recognition. The tool works well with map or the line width is constant.

## Pre-Process

### Mesh Mixer

A standalone tool to separate shells, analyze meshes, smoothen irregularities

## Post-Process

### Mesh Enabler

Convert mesh to Brep (composite)

Access: Load Mesh Enabler add-in -> import a mesh file (stl or obj) -> right-click on the mesh node in the browser -> Convert to Base Feature

### Project Mesh

On Inventor 2017, mesh vertices and edges can be projected to a sketch just like surface body or solid body geometry.

### Convert Mesh

Fit Mesh Face command allows users to convert certain group of mesh to a surface

## Tips and Tricks

Estimate tolerance

Ensure unit

Simplify mesh (plane, cylinder, torus..)

Identify features

Work in zones

Round trip validation (mesh -> Brep -> mesh)



## 3D -> 3D

### Imported Surface and Solid

From neutral formats like STEP, or other CAD systems

#### Analytical Geometry (Plane, Cylinder, Sphere, and Torus)

Geometry checking: Use Measure command to find out dimensions; use work feature commands to check if the geometry is analytical.

Tube path: Use Rule surface command to find a path.

Simplification: Use Delete Face command to simplify geometry.

Zoning: Divide the model into different zones

Mass properties: Compare working model mass properties vs imported model.

#### Freeform Geometry

Cross Section Profile: Use Section Analysis.

3D Sketch: Create Intersection Curves.

Simplification: Use Delete Face command to simplify geometry.

Convert a face to Freeform: Use Freeform Convert.

### Tips and Tricks

Geometry creation tools can help detection.

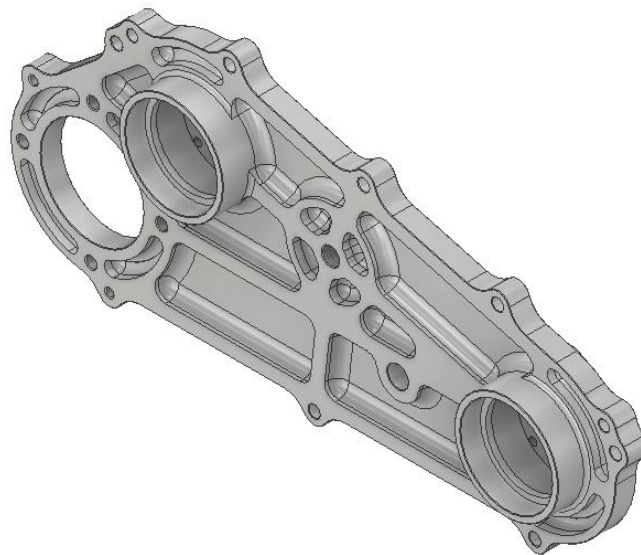
Delete Face and Offset Surface are handy tools.

Ruled Surface is more than surface.

3D Sketch: curve on face.

Feature recognition.

Keep it simple.



IMPORTED GEOMETRY

### Thin-wall and Sheet Metal Parts

Find the thickness: Use Sheet Metal Default or Measure.

Remove unnecessary detail: Use Delete Face or other modeling commands.

Thicken faces: Use Thicken command.

Rip corners: Use Rip or Corner Rip command.

Create bends: Use Sheet Metal Bend command.

Create relieves: Use Corner Seam command or create relieves in Flat Pattern.

### Tips and Tricks

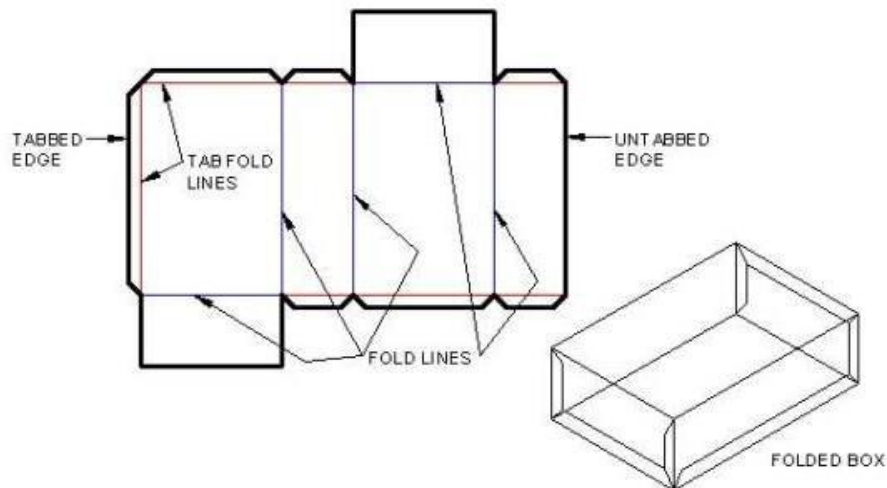
Focus on main shape first.

Postpone creating relieves as much as possible.

Use Thicken feature to ensure perpendicular detail faces.

Create bigger rips.

Create multiple solids.



*IMPORTED THIN-WALL PART*

## Conclusions

### Fidelity depends on source 2D/3D data

If the objective of Reverse Engineering process is to have an identical model to the original one, certainly it will take a lot of effort and resource. There isn't a one-click approach to do that as of today. However, there are ways to recreate the model very close to the original one. Simplifying the geometry is always desirable. It helps you find the design intent much sooner and the rest of the design intent may unravel itself during the process.

### Beware of precision loss due to double-conversion

When one CAD data is converted to another CAD format, certain things will be lost (precision, feature tree, or geometry). This behavior is being leveraged to obscure design intent to protect IP. Certainly one cannot control how the original data was created. But, we need to make sure the process does not contribute to more data loss or misinterpreting design intent.



### **Inventor offers workflows to facilitate recreating models from partial data**

Inventor 2017 is quite versatile in terms of handling various form of data: 2D/3D points, wires, image/mesh, surface, and solid. With help from other Autodesk tools, a designer can make good sense of the partial 2D/3D data and then recreate the Brep.

### **Understanding these techniques helps determine the level of detail to share**

Most CAD systems are able to work on partial 2D/3D data. If leaking intellectual property is a concern, these techniques will help you find the best way to share your design data but keep critical intellectual property intact.