



# Wanted!

## Nice snug little holes for fasteners

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# This fastener needs a home!

The screenshot displays the STEP-NC Machine software interface for a file named 'as1-ug-242\_fmt'. The main window shows a 3D model of a bolt with various annotations and dimensions. The left sidebar contains a tree view with the following structure:

- DRF A
  - Part Datums
  - Part Callouts
- nba
  - bolt
    - 0.0010 in M "Straightness.1"
    - 0.0050 in A "Position.1"
    - 0.0030 in A "Position.2"
    - 0.0010 in A "Perpendicularity.1"
    - 1.1811 in +0.0100 -0.0100
    - 1.3386 in +0.0200 -0.0100
    - 0.1181 in +0.0050 -0.0050
    - 0.5906 in +0.0020 -0.0020
    - 0.3937 in +0.0187 -0.0197 "ID for SH"
  - DRF A
    - Part Datums
    - Part Callouts
  - nut
  - nba
  - nba
  - lb\_assem
  - rod\_assem

The main 3D view shows the bolt model with several annotations and dimensions:

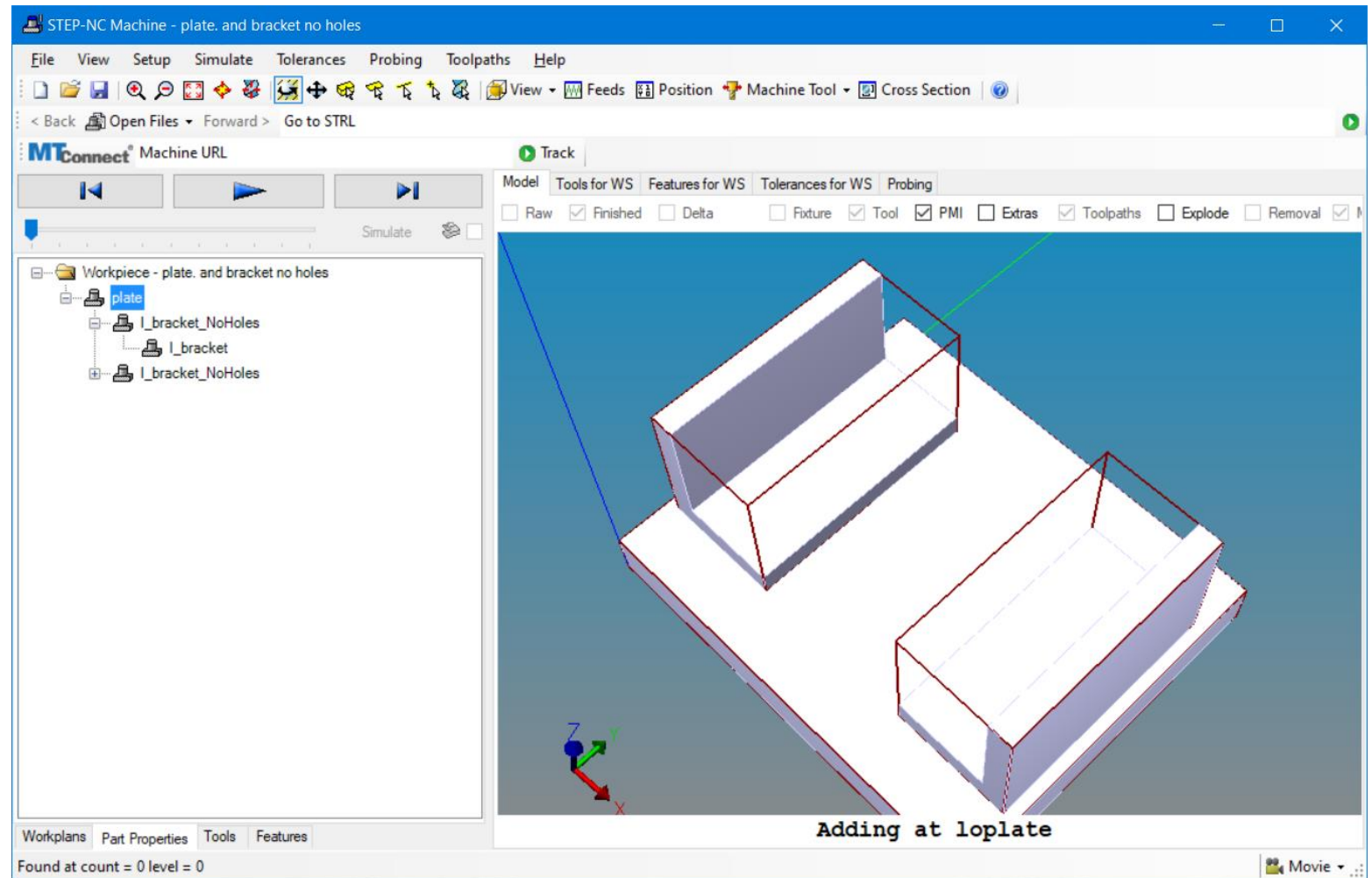
- 1.339 ± .010
- 1.181 ± .010
- .118 ± .005
- .001 A

The bottom of the window displays the text "Showing all annotations".



# Drill holes where?

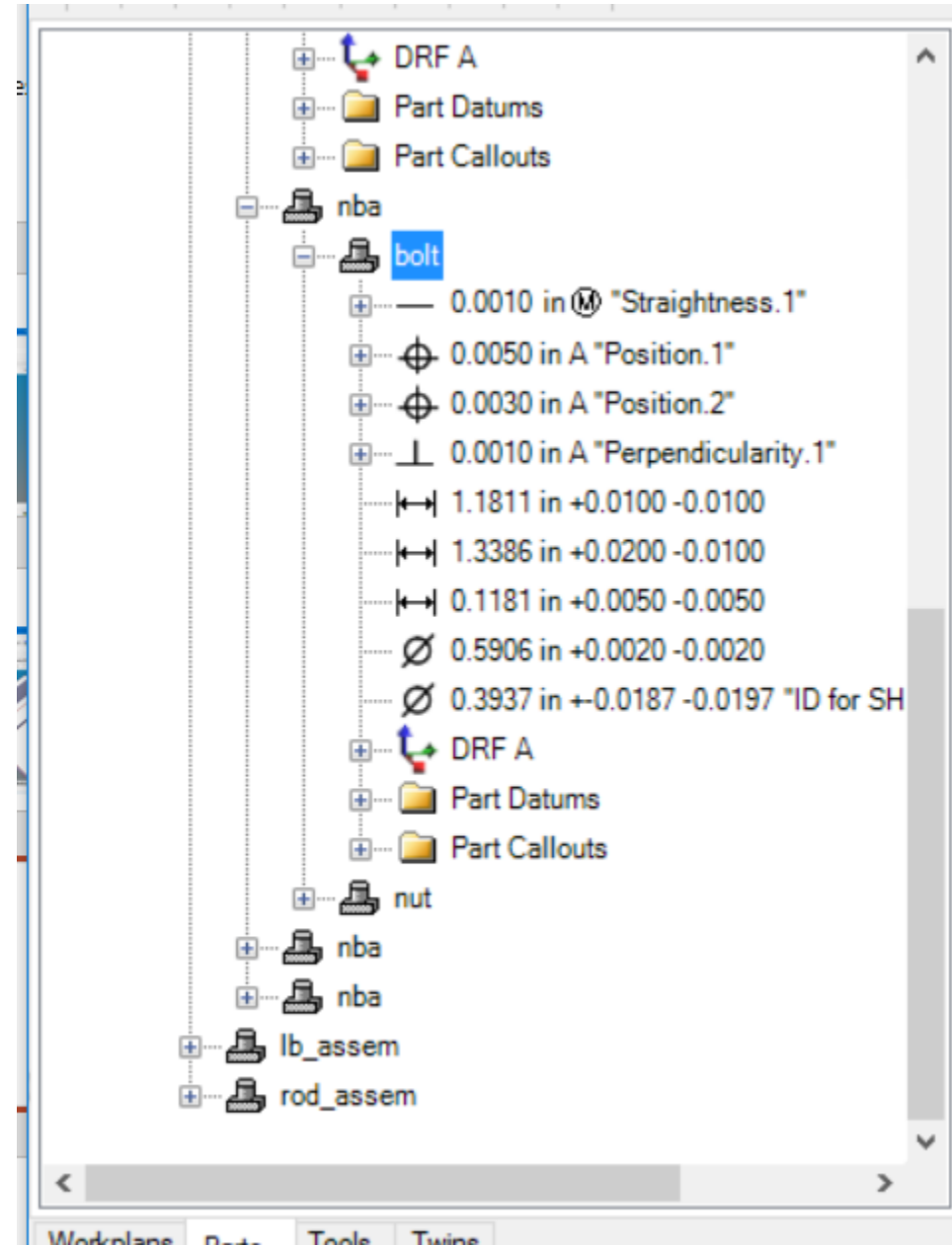
- Nominal location on plate?
- Nominal location on bracket?
- Nominal location of fasteners?





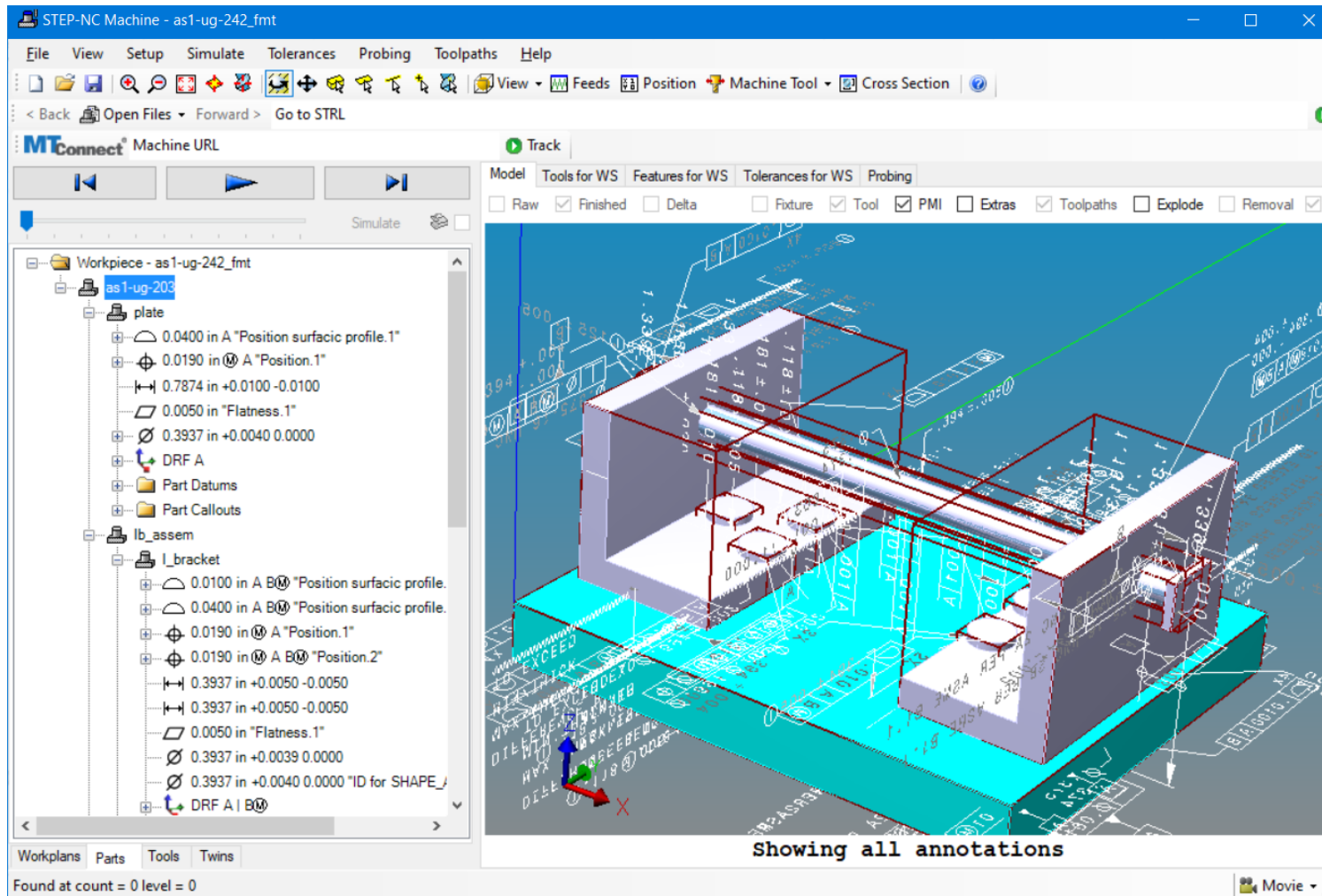
# Drill holes how?

- Fastener prototype has
  - Straightness
  - Perpendicularity
  - Diameters
  - Distances
  - Positions
- Therefore
  - Hole diameter is?
  - Hole depth is?
  - Drilling speed is?
  - Drilling strategy is?





# AS1 Digital Twin Prototype





# Using the Digital Twin Prototype

- Place base and position as plate.1
- Place bracket and position as L-bracket.1
- Place bracket and position as L-bracket.2
- Drill hole.1 using fastener.1 (position.1, diameter.1, depth.1)
- Drill hole.2 using fastener.2 (position.2, diameter.2, depth.2)
- Drill hole.3 using fastener.3 (position.3, diameter.3, depth.3)
- Place tack and position as bolt.1
- Place collar and position as nut.1 (depth.4)



# Summary

- Digital Twin Prototypes are becoming widely available.
- Information for manufacturing is in these prototypes.
- The information is encoded as GD&T.
- The robots must get this information
  - Just in time for available robot and cutter
  - Using robust methods that allow for updates
  - With full checking for exceptions and special cases
  - At minimal cost and maximum profit for the enterprise