

Title: 3-D printing of Mechanical Fasteners

Objective: To prepare a 3D model of mechanical fasteners and perform drafting to obtain orthographic projections.

Components/Equipments required with specifications: 3D modelling software- INVENTOR, fractory software as a slicer, single nozzle 3D printer, and PLA filament, computer systems (i5 processor, 4GB RAM).

Procedure:

3D Modelling of Nut:

1. Setting up drawing sheet & Plane of work:
 - a. Inventor → New → Metric → Standard mm → Create
 - b. Sketch → 2D → Plane Selection
2. 2D sketch creation:
 - a. Draw Toolbar → Rectangle → Polygon → enter no. of sides
 - b. Constraint toolbar → Dimensions → give dimensions to make sketch fully constrained (GREEN COLOUR figure)
 - c. Draw Toolbar → Circle
 - d. Constraint toolbar → Dimensions → give dimensions to make sketch fully constrained (GREEN COLOUR figure)
 - e. EXIT 2D sketch
3. 3D modelling:
 - a. 3Model → Extrude → Select Profile → enter values for extent (10mm)
4. Thread Creation:
 - a. 3Model → Threads → Face selection (inner) → Specifications → Thread Type (ISO Metric) → Size(10) → Designation (M10X1)
5. Save file:
 - a. File → Save → file type → .ipt
 - b. File → Export → file type → .stl

3D Modelling of Bolt:

A. BOLT HEAD

1. Setting up drawing sheet & Plane of work:
 - a. Inventor → New → Metric → Standard mm → Create
 - b. Sketch → 2D → Plane Selection
2. 2D sketch creation:
 - a. Draw Toolbar → Rectangle → Polygon → enter no. of sides
 - b. Constraint toolbar → Dimensions → give dimensions to make sketch fully constrained (GREEN COLOUR figure)
 - c. Draw Toolbar → Circle
 - d. Constraint toolbar → Dimensions → give dimensions to make sketch fully constrained (GREEN COLOUR figure)
 - e. EXIT 2D sketch
3. 3D modelling:
 - a. 3Model → Extrude → Select Profile → enter values for extent (10mm)

B. BOLT BODY

4. Select face from bolt head → new sketch → create circle → exit sketch → extrude → enter values for extent (50mm)
5. Thread Creation:

3Model → Threads → Face selection (outer) → Specifications →
Thread Type (ISO Metric) → Size(10) → Designation (M10X1)

6. Save file:

7. File → Save → file type → .ipt

8. File → Export → file type → .stl

C. DRAFTING

1. [Front View: Top View: Isometric View]

- Open BOLT ipt file → My Home → New → Metric → Drawing → ISO idw → create
- Place views → Base → view → front view → Right click → create
- Projected views → click on Base view obtained in step (a) → choose the direction upwards for TOP VIEW → click & create
- Repeat step (c) for isometric view.

2. Dimensioning & Annotating Views:

- Annotate → Dimensions
- Annotate → Threads
- Double Click Views → Label views → Edit

3. Title Box

- Model → Drawing Resources → Title Box → ISO → Right Click → Edit → ISO → Right Click → Done

D. 3D Printing

1. Export file into Fracktory workbench:

- Fracktory → Load → Select File → Open

2. Setting up time and material used

- Click on Object → Scale → Rotate → Lay Flat
- Checking Layers
- Checking Parameters like layer height (0.1<layer height<0.3), fill density, support type , support adhesion.

3. Send G codes to SD Card

- Click → save tool path

4. Settings for 3D printing operations

I. Checking Build plate sheet conditions

- If PET sheet is not having smooth and dust free surface then change the sheet → Remove the sheet (PET) → Apply water + soap solution to Aluminium build plate → Stick the new PET sheet over build plate → using wedge shape smaller wiper wipe off the bubbles trapped inside water+soap solution → Dry off the build plate → Place the build plate onto build platform

II. Bed-Levelling

- Main Menu → Prepare → Levelling Wizard → place A4 sheet over build plate → @ Home/ origin check friction between nozzle tip & A4 sheet while continuously shaking the A4 sheet and adjusting Z- axis via rotating the i-ball either clockwise or anticlockwise. Press okay once the friction level is sufficient → Repeat the same for @ front and back positions over build platform.

III. Filament Insertion

- Prepare → Nozzle Preheat → set the nozzle temperature to 210°C → Reinsert the filament via extruder head → Check

that filament reached nozzle tip & stop pushing filament to nozzle
once melted filament start coming out from nozzle.

IV. Copying G codes to 3d printer

a. Prepare → Print from SD Card → Select file name → Print

V. Once print get over remove the print from build plate using spatula.

Results:

Fig: 2D sketch of nut & bolt

Fig: Final 3D modelling of nut & bolt

Fig: Final Drafting of nut & bolt

Fig: Importing .stl file in fracktory workbench and assigning operational parameters to the file. (screenshots for load, toolpath, rotate, lay flat, layers, support type & adhesion)

Fig: Setting up 3D printer to print. (screenshots for filament insertion, nozzle preheating, bed levelling, how to put PTE sheet over build plate, print from SD card)

Fig: Final 3D printed model of nut & bolt

VI. Discussion :

Write about the challenges you faced while learning 3 D modelling & 3D printing, how you overcome your design restrictions.

VII. Learning Outcomes:

- 1) Learnt how to create 3D models from 2D sketch using inventor modelling software with the help of 3D commands like extrude, revolve, pattern etc .
- 2) Learnt mating concept between two objects via thread creation along with types of thread and their nomenclature.
- 3) Learnt to fabricate the prepared design via generating 3D printing G-codes.