

Part III

Assemblies - Worked Examples

The general interface for producing assemblies is very similar to that seen for producing parts. As with physical assemblies it is often advantageous to assemble limited numbers of components into sub-assemblies and then assemble the sub-assemblies. ProEngineer represents all assemblies the same so there is no disadvantage in working with sub-assemblies.

The assembly of individual parts can be achieved with both static and dynamic constraints and these can be redefined. In this part the static constraints are used. There are 7+ assembly techniques however for most assemblies only 3/4 are used, see Figure 20.

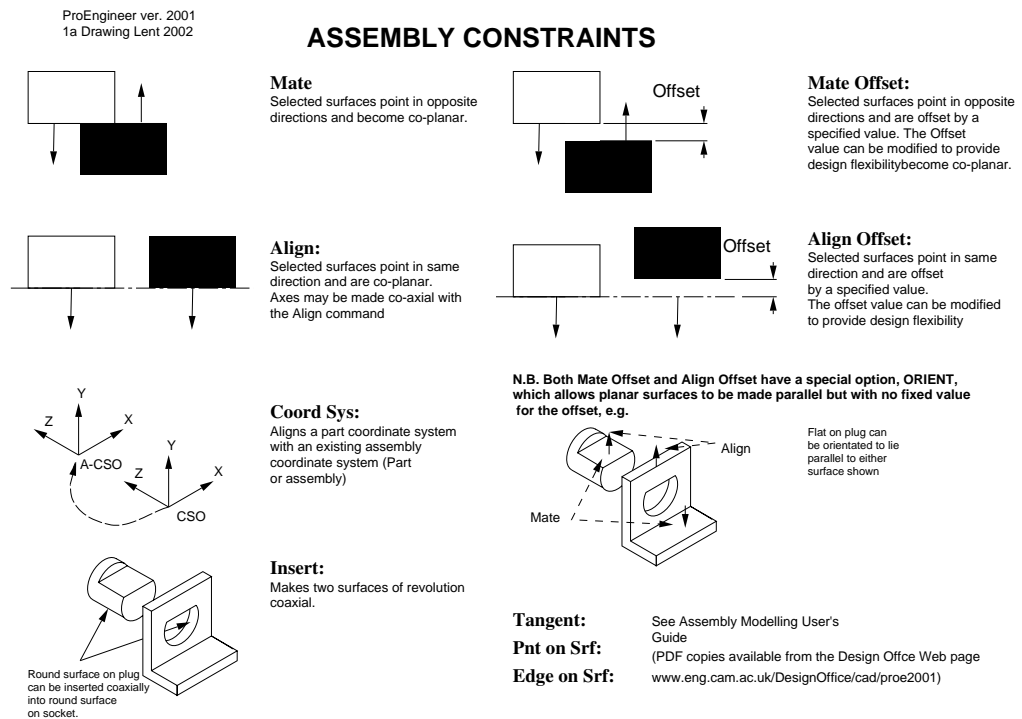


Figure 20: Static Assembly Constraints

12 Motor Sub-Assembly


12.1 Start Assembly

using the (New Assy) function icon or FILE→new→Assembly start an initial sub-assembly, motorsubassy



Placement Dashboard

12.2 Initial Component

Insert the motor as the initial component by using INSERT → Component → Assemble or () (from the right icon bar) then

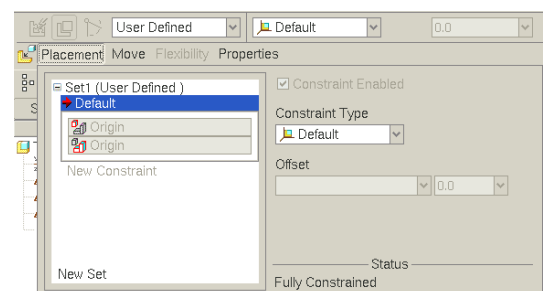
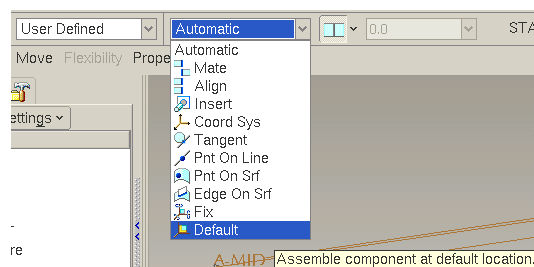
- **Component Selection** Select the predefined motor280.asm from the list of files.
N.B. You can limit the list of files to just parts by selecting TYPE part at the bottom of the window.
- **Placement** By default the system will try and automatically place the motor in the main drawing window. To specifically place the motor restraining constraints in three planes need to be added.

It is normal with the first component in an assembly to constrain it via it's base coordinate system, this can be done by either

placing the shaft using the 'Assemble component at default location' tool ()

OR

1. CONSTRAINT TYPE → **Coord Sys**
2. Select the Component Reference **CSO**, (picked from the window)
3. Assembly reference **A-CSO**, (picked from the window or MODEL TREE)



N.B. To aid the selection of constraint references it is often useful to toggle the display of datum planes/axis/points/coordinate systems to simplify the view. These can be switched on/off via the icon bar or hotkey sequences (ed - Datum planes, ec - Coordinate systems, ea - Axis, ep - datum Points).

- **Exit** If the references have been selected correctly the placement status should show 'Fully Constrained', references can be re-picked by selecting the associated arrow in the menu and reselecting in the window. Accept the placement with 'OK' ().

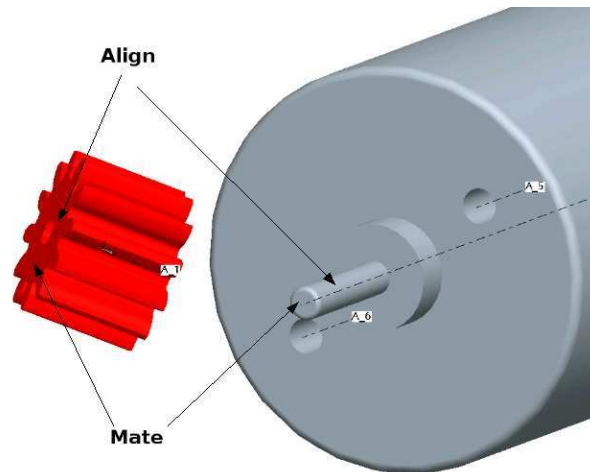


Figure 21: Pinion Gear Placement Constraints

12.3 Pinion gear

To assemble the Pinion gear use the same basic command structure as with the motor, i.e. () or INSERT → **Component** → **Assemble**, but then select the pinion gear gear.prt.

N.B. To manipulate the component being assembled use <CTRL><ALT> + mouse buttons

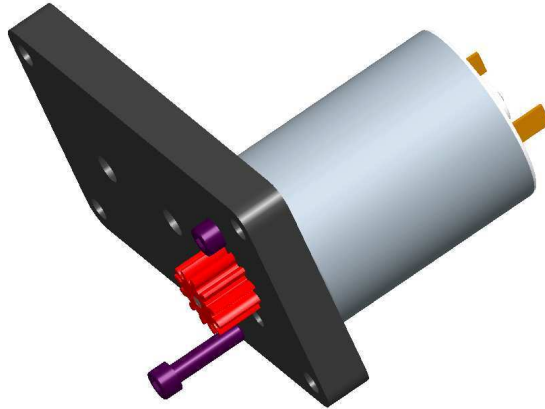
- **Align** constraint using the axis of the motor shaft and the gear as references. This constrains the gear in the two dimensions perpendicular to the axis of the shaft.

N.B. It is often useful to use the RMB select option in conjunction with the SMART selection tool to 'drill' to the selection of references

- **Mate** To restrict motion along the shaft add a second constraint, TYPE **Mate** and choose the end of the gear and the end of the shaft as the references.
- **Offset** Select the offset option and enter 1.5 mm.

The gear should now snap to the correct position and the Placement Status indicate 'Fully Constrained'. (Leave the Allow Assumptions box ticked)

- Review () If you are not satisfied with the placement re-edit the constraints/references, then click **OK** () to accept the placement.



Backplate sub-assembly

13 Back plate Sub-assembly

Create another sub-assembly, *back_plate.asm* in a similar manner to the motor assembly

- Insert the *inner_plate.prt* component as the initial component using the default constraints.
- Assemble the motor sub-assembly, using three constraints
 1. Front face of the motor mated against the plate
 2. Axis of the motor and the axis of the main hole
 3. Axis of the bolt holes and the holes on the front plate of the motor.

N.B. If it becomes difficult to manipulate the view predefined constraints can be toggled off/on by selecting the tick-box at the end of the individual constraints. If a component is incorrectly aligned/mated the itm can be flipped using the arrow icon ()

- Assemble two M2.5x6 Capheads screws (*shcs_m25.prt*), aligning the axes and mating faces.
- Assemble one m3 bolt (*shcs_m3.prt*) into the mounting holes on the plate, n.b. heads are on the motor side of the plate.
- Assemble one spacer (*spacer_plate.prt*) onto the M3 bolt with one end mated against the plate.

13.1 Analysis

The system has numerous checking and analysis routine, one that is useful on the completion of a (sub-)assembly is **Global Interference** to check that the parts are correctly defined/assembled.

- **Model Analysis** From the ANALYSIS pull down menu select **Model Analysis**. In the new menu select analysis TYPE → **Global Interference**. Accept the default setting by selecting **Compute**. After a few seconds the system will return with information about any interferences in the lower scrollable window.
- **Correction** Depending on the construction/errors made in the assembly there should be a number of interferences shown, notably
 - the interference fit of the pinion to the shaft, with an associated volume of interference in mm^3 .
 - Small interferences between the bolts and the plate due to the rounds under the heads of the bolts.

If there are any other other interferences it is necessary to understand the error and modify the parts or assembly settings.

N.B. Modification of parts can be carried out by reloading the individual part file or from the assembly itself. (Select SETTINGS (above model tree) → Tree Filters → Display Features ('tick') → OK will allow individual features to be accessed from the assembly MODEL TREE.) The box by the component's name allows the feature information to be expanded/contracted.

- **Re-check** Return to the assembly window, (reactivate if required) and re-run the analysis to confirm the interference has been eliminated.

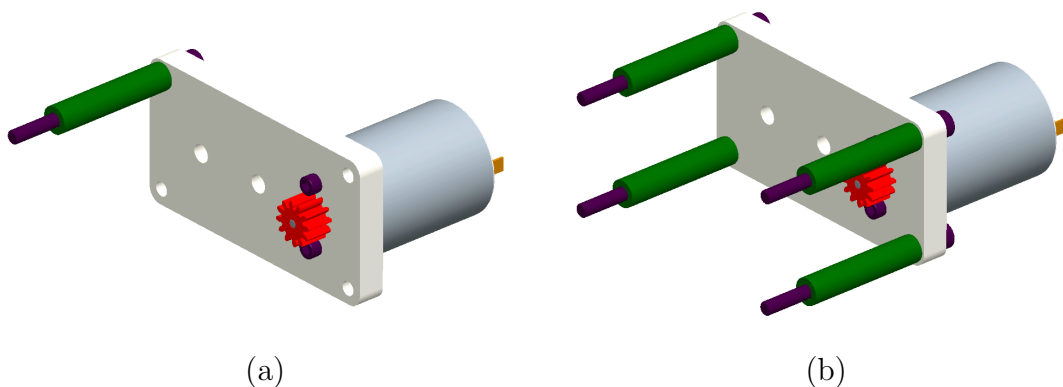


Figure 22: Patterned Assembly, (a) Initial bolt and spacer placement (b) Assembly after 'reference' patterning

14 Patterned Assembly

As the mounting holes were defined as a pattern it is now possible to use the link assembly to this pattern. Select the M3 bolt from the model tree and RMB→ Pattern. Accept the default settings, **Reference**, and exit the dashboard, see Figure 22.

15 Main Assembly

Start the main assembly of the gearbox by creating an assembly called *gearbox* and insert the whole backplate assembly as the initial component with default references.

15.1 Gear Cluster

The gear cluster, comprising of the output shaft associated gears, spacers etc and the corresponding lay shaft sub-assembly is given in as a predefined part. (Details on how to assemble this using the components generated in part II of this hadnout are given in the appendix)

Assemble the cluster using

- Align the Lay-shaft axis and the corresponding hole in the back plate assembly
- Align the end of the shaft with the back of the plate
- Align two assembly datum planes, one from the overall assembly and one from the gear cluster.

15.2 Front plate and fixings

- Assemble the front plate modelled earlier aligning the axis of two holes and mating the back of the plate with the end of the plate spacers.
- Assemble the washers onto the bolts and mated to the front of the plates, use the reference pattern to fit to all bolts
- Assemble the nuts in a similar manner

15.3 Analysis II

Rerun the model analysis to check the **Global Interferences** This should show some additional interferences between the shafts/spacers and front plate. This is a result of the plate spacers being incorrectly designed, use the measure feature to define the change of length required.

- **Correction** Select the plate spacer from the window or MODEL TREE and then RMB → **Edit**. accept the placement.
- **Check** Rerun the global interference analysis and confirm that the interferences has been removed.

N.B. The assembly can be slow to orient in shaded mode, to speed up placement zoom out reorient as a small item on the screen and then zoom in to the required magnification. The amount of information transfer required to update the screen is significantly reduced thus increasing the update speed especially on slow graphics cards or on remote displays.

16 Assembly Drawing

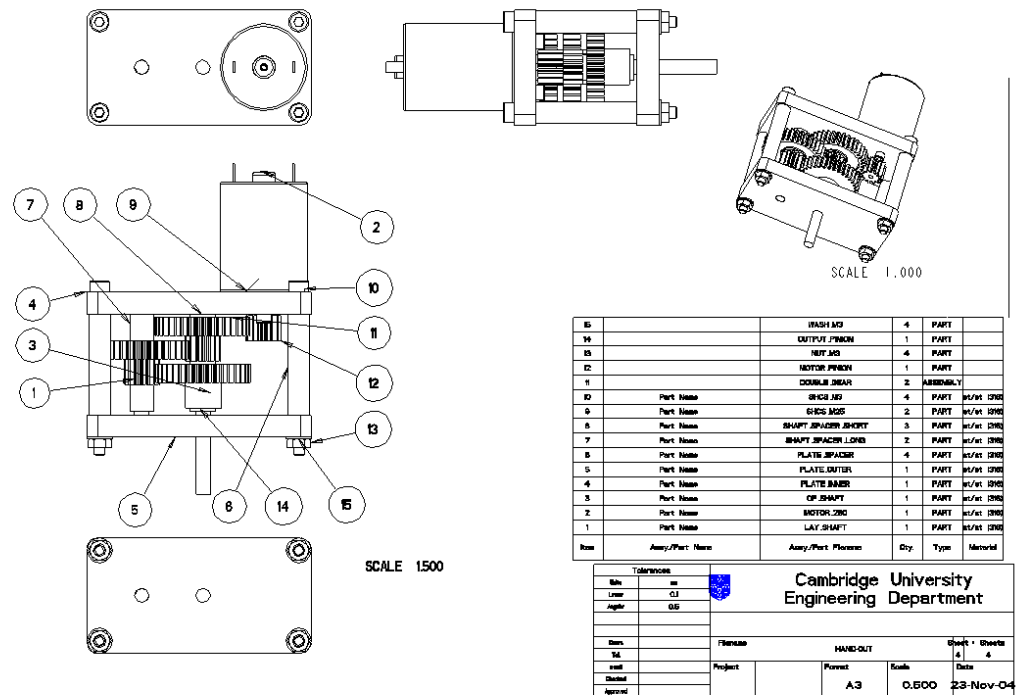


Figure 23: GA of Gearbox

Assembly drawings differ from part drawings in that they tend to have limited dimensions and parts lists. The parts list can be added to any drawing but there are predefined assembly drawing formats available which take information from parameters defined when components are defined using the CUED/MDP start part. See Figure 23

16.1 Start an Assembly Drawing

Use the FILE→**Drawing** command to start a new drawing but choose/browse for an A3_assy format.

16.2 Additional Views

Use the commands used in the part drawings to add additional projected and general/isometric views.

16.3 BOM Ballons

Display the **Bill Of Material** ballons by selecting from the TABLE pull down menu

- Select **BOM Balloon** → **Set Region** → **Simple** from the menus and then select the table of parts just above the title block, i.e. the **Region** to be used to define the balloons. Finish with **Done**.
- Select **Create Balloon** from the BOM BALLOON menu and then the cross section view to place the balloons.