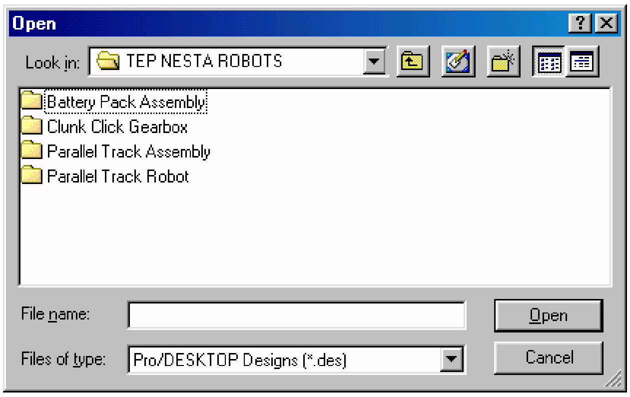
Introduction

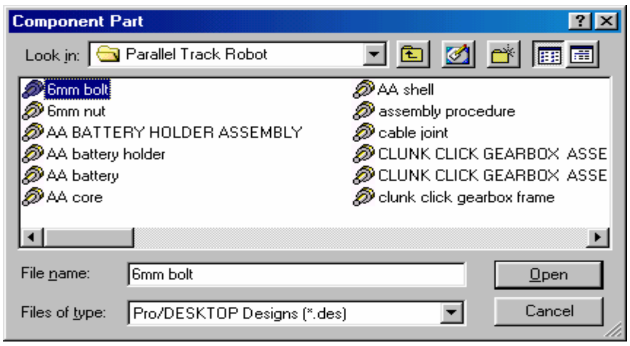
This tutorial uses the alignment tools of Pro/DESKTOP to create an accurate assembly of a robot. The components are created as single items or as sub assemblies. Each Pro/DESKTOP solid model represents an actual component available from the Teaching Resources Centre at the University of Middlesex. The learner can build a robot in the virtual environment of Pro/DESKTOP and then create an actual robot from the TEP resources.

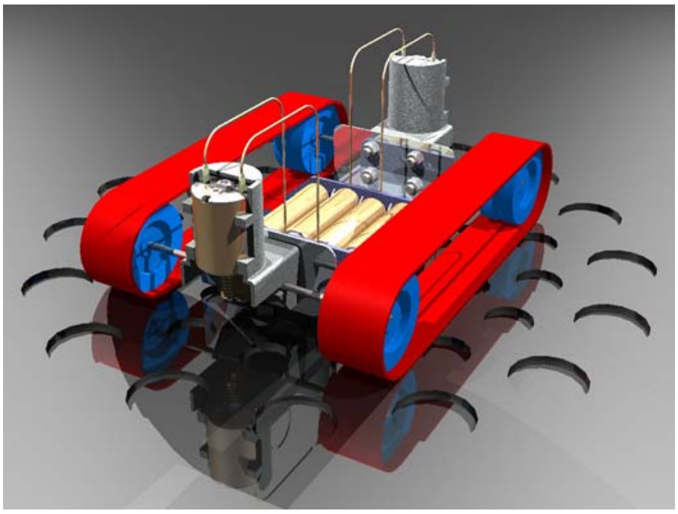
The Pro/DESKTOP components are available as a free download from the TEP website www.tep.org.uk and can be saved onto the learners own computer. This tutorial will invite the learner to access the component from the directories shown below.

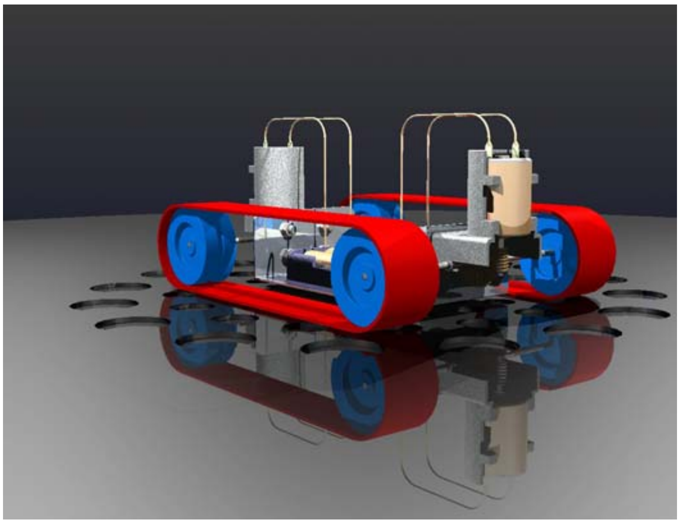


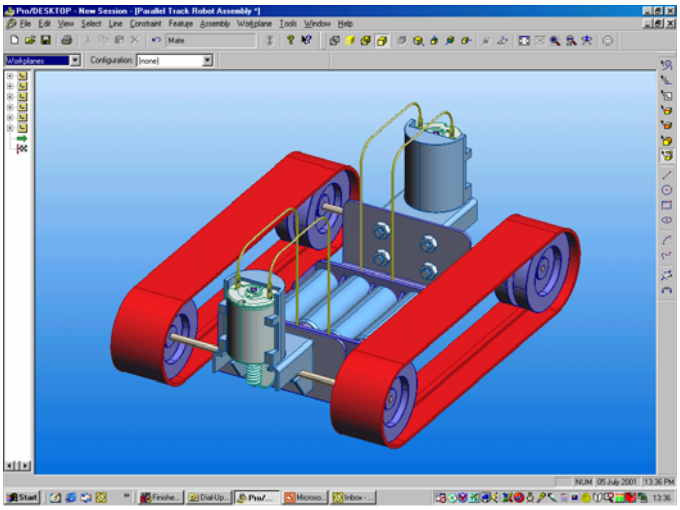
Each file will contain Pro/DESKTOP solid models to enable the learner to add a component or a larger assembly to the robot design.

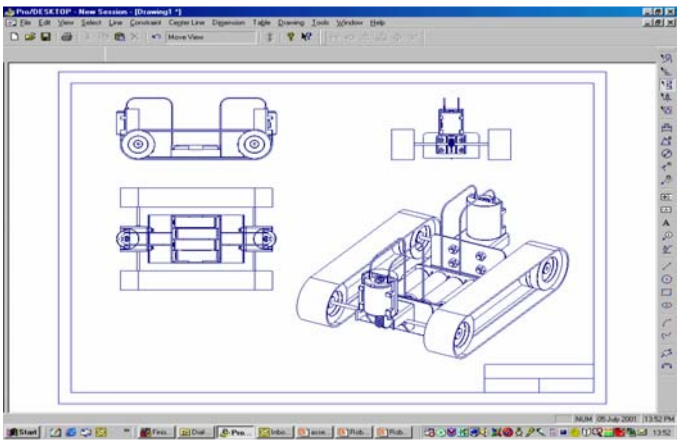
The files may contain smaller components such as the 6mm bolt shown below. The tutorial will describe how to assemble the components and create the robot.







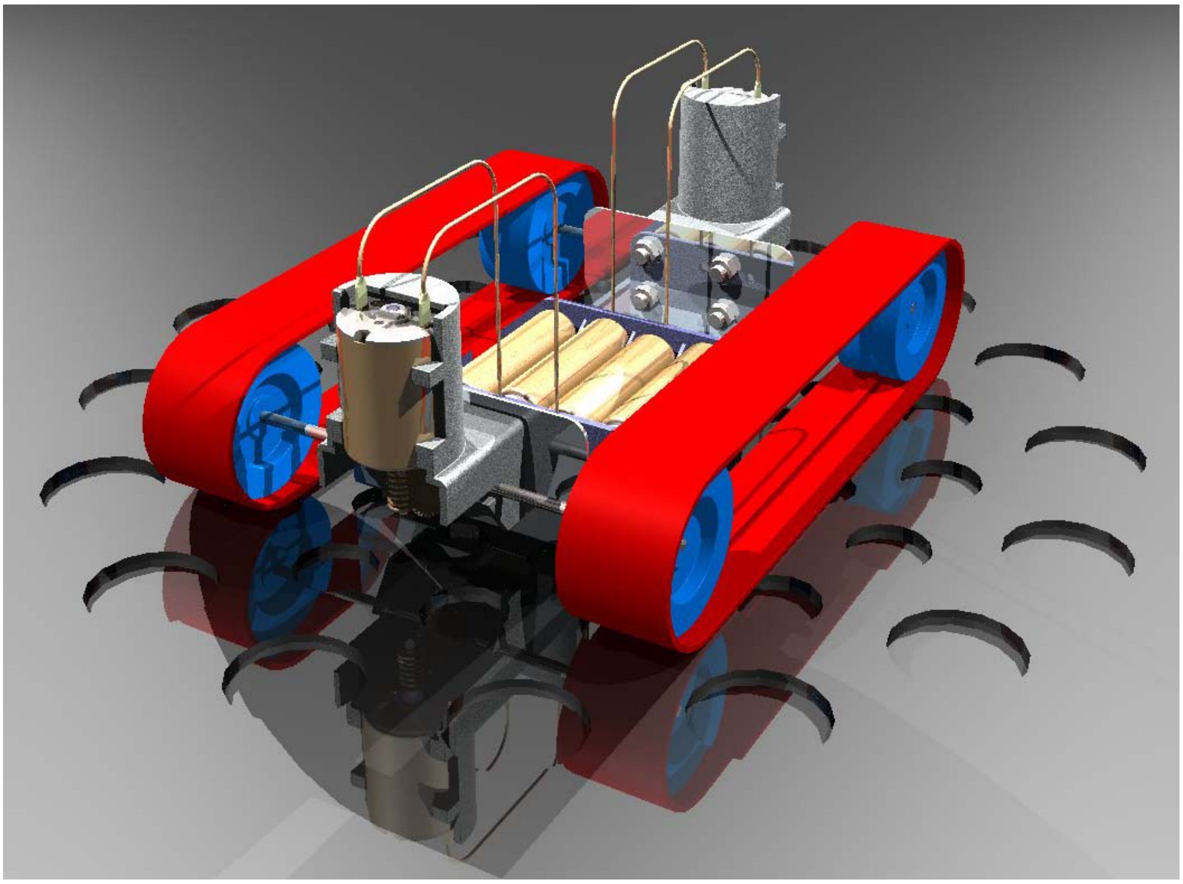




CONTENTS

Section One

Assembling the gearbox to the frame



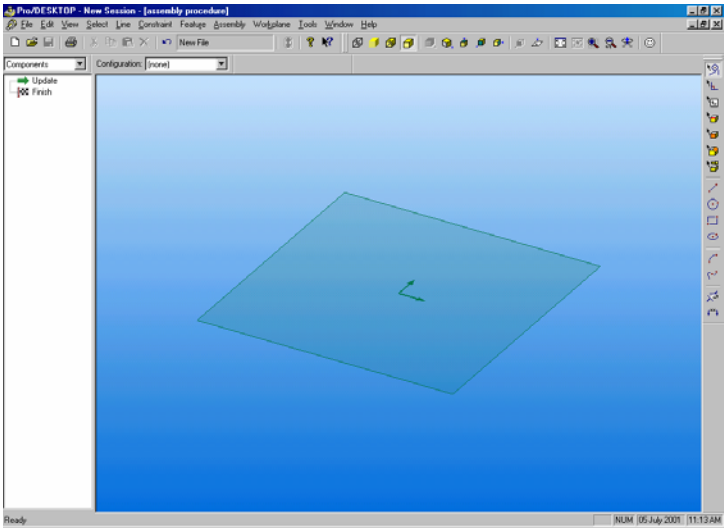
Learner Outcomes:

In this section you will use the following alignment tools in Pro/DESKTOP

- Fix Component
- Mate
- Cente Axes

The gearbox comprises of several individual components but is supplied as a complete sub assembly ready for you to attach to the body framework.

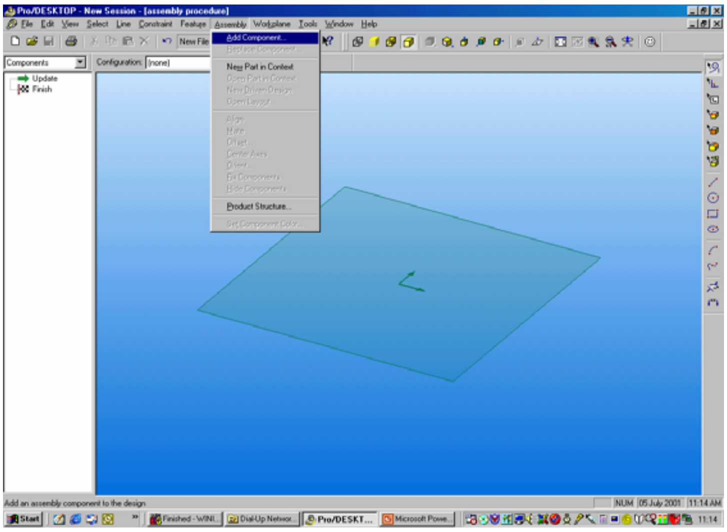
Robot Assembly Tutorial



Command:
From the pull down menu select:

File – New – Design

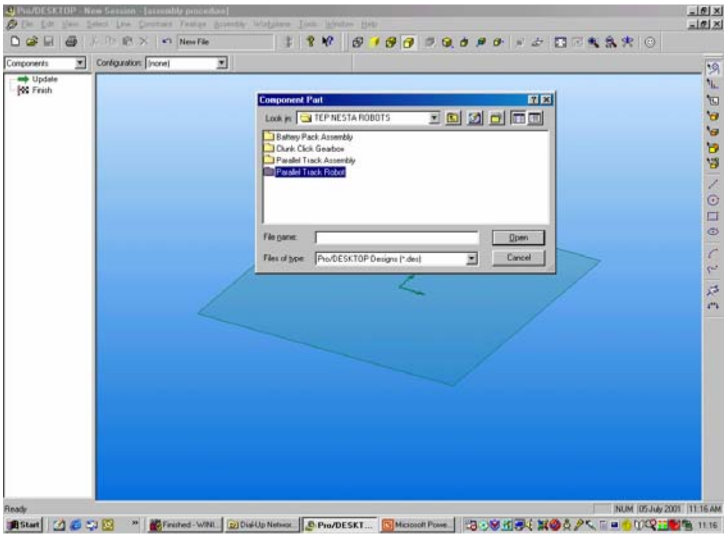
It is important to begin the sequence with a new file. This procedure will ensure that the robot assembly is saved with a unique file name. If we opened a single component and assembled everything else onto it we would loose the original component as a single file.



Command:
From the pull down menu select:

Assembly – Add Component

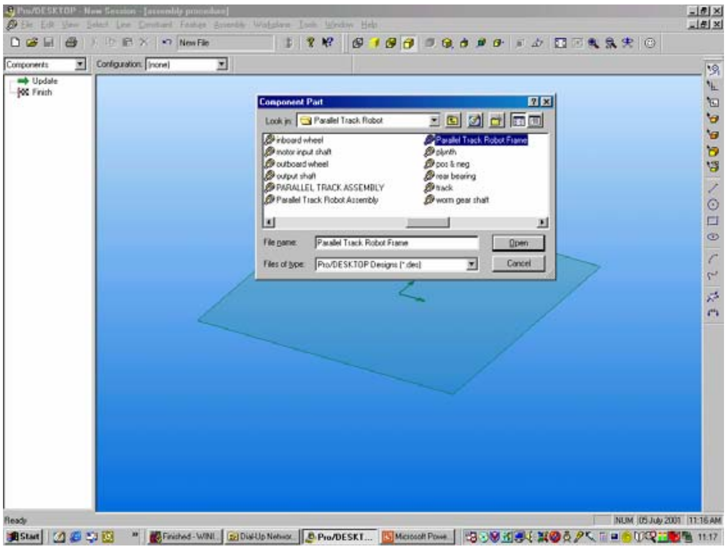
This command will be repeated through the assembly procedure to access the component parts from their discreet files.



Command:
From the sub menu select:

Parallel Track Robot

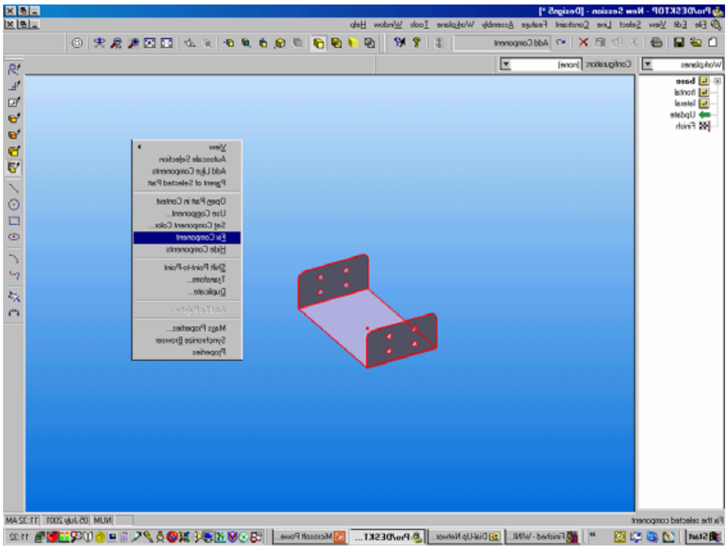
This directory contains the first of the components of the robot assembly.



Locate the file:

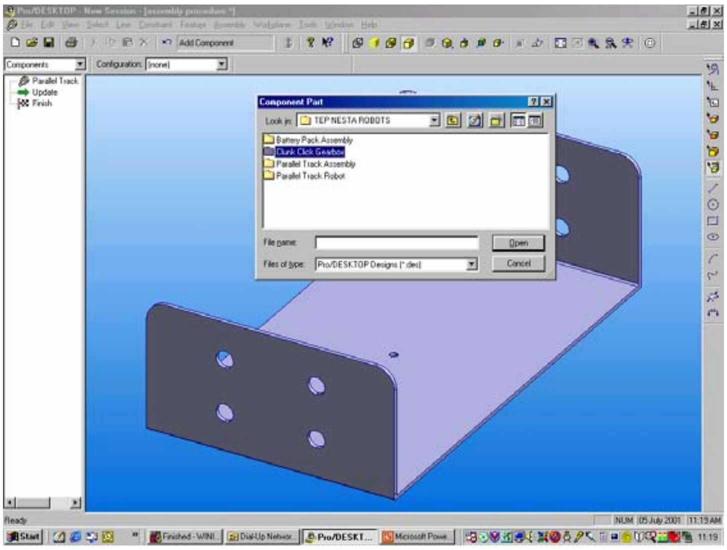
Parallel Track Robot Frame

Select the file and pick **Open** to bring the component onto the screen.



The Robot Frame supports all of the remaining components. The first task is to fix the frame in 3D space so it is static and all the components can be assembled onto it.

Right Click (**RC**) and select **Fix Component** from the sub menu.



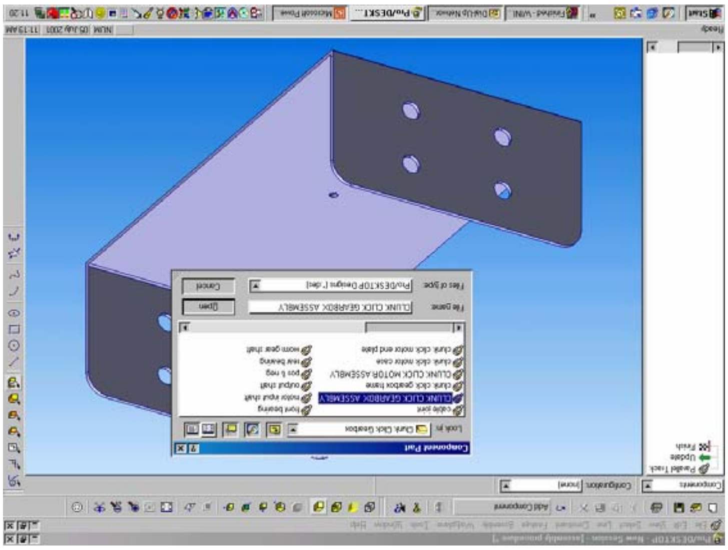
Command:
From the sub menu select:

View – Autoscale (shift A) to centralise the frame in the screen.

From the pull down menu select:

Assembly – Add Component

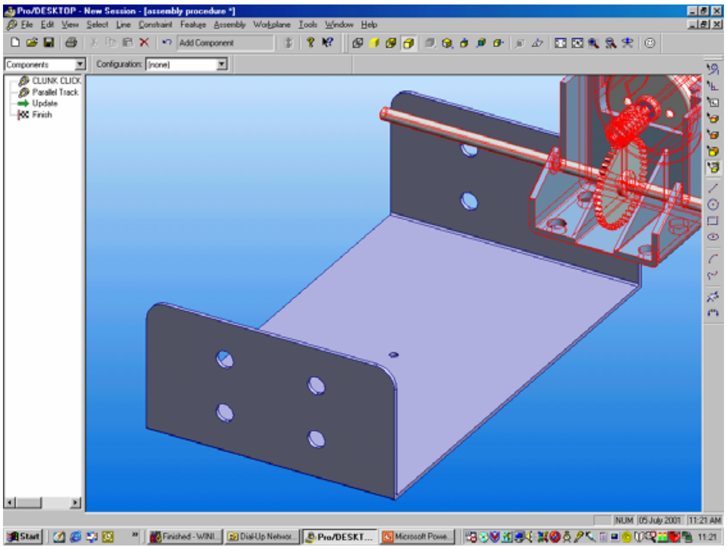
Select the directory called **Clunk Click Gearbox**



Locate the file:

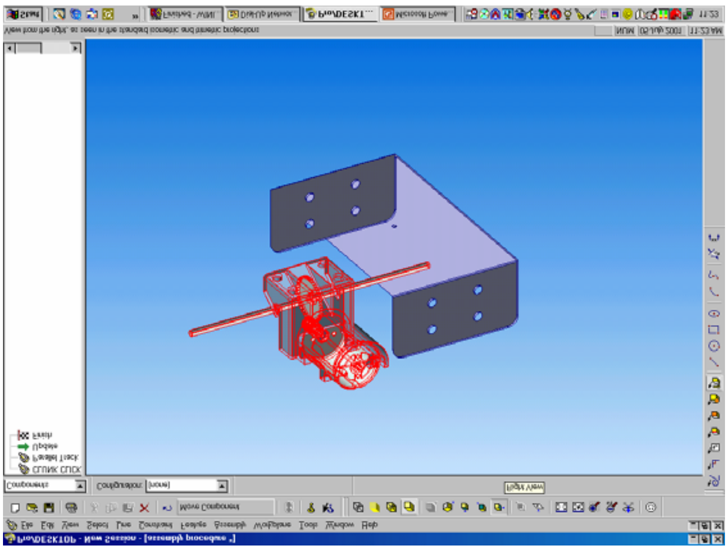
Clunk Click Gearbox Assembly

Select the file and pick **Open** to bring the component onto the screen.



The snapshot shows the gearbox assembly on screen, notice how the gearbox is red to indicate it is selected.

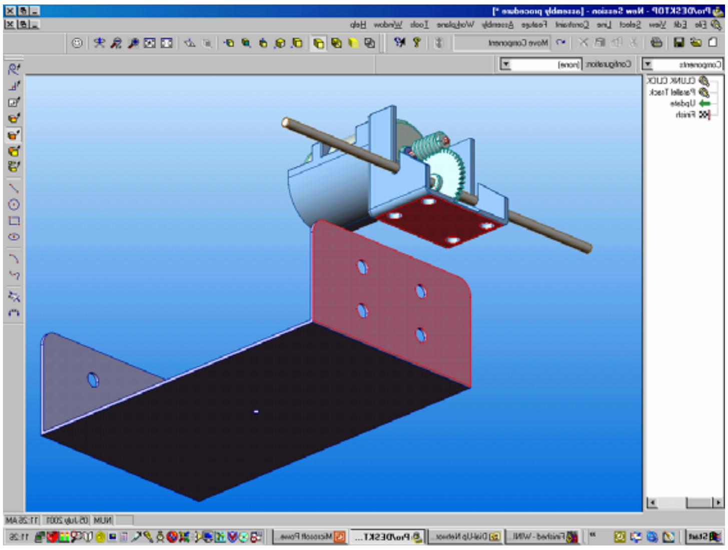
The next sequence will reposition the gearbox into a more convenient position to allow for accurate assembly.



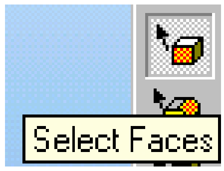
Command:
From the sub menu select:

View – Autoscale (shift A) then (shift H) to centralise the frame in the screen.

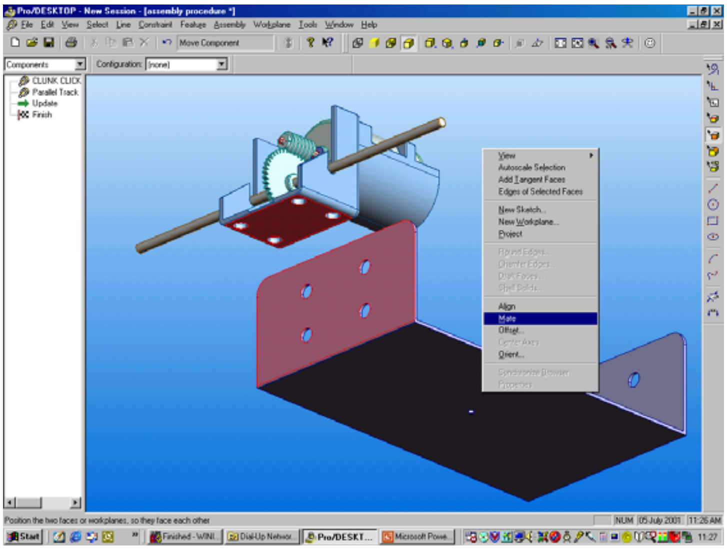
Move the cursor over the gearbox, the **move** icon appears, hold down the Right Mouse Buton (**RMB**) and drag the gearbox into the position shown in the snapshot.



Us the up arrow key on your computer keyboard to rotate the assembly into the position shown in the snapshot.
Pick the **Select Face** icon from the Design Toolbar.



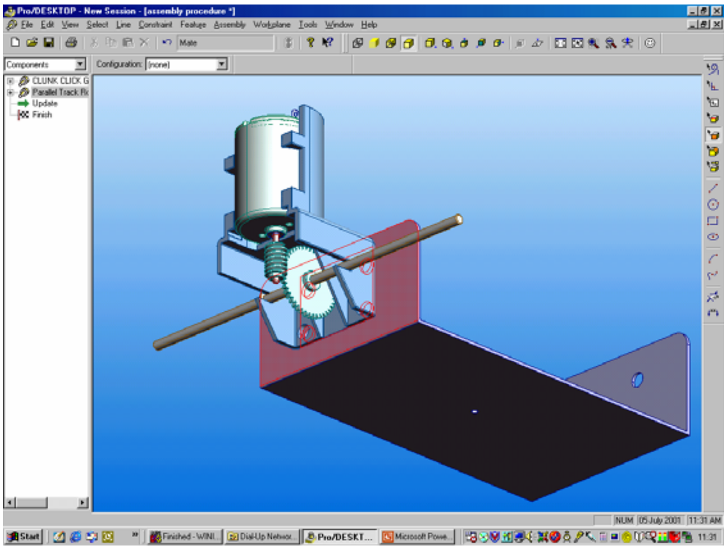
Hold down the shift key on your computer keyboard and select the two faces shown in the snapshot.



RC and select **Mate** from the sub menu.

The Mate command will bring the two selected surfaces into contact with each other.

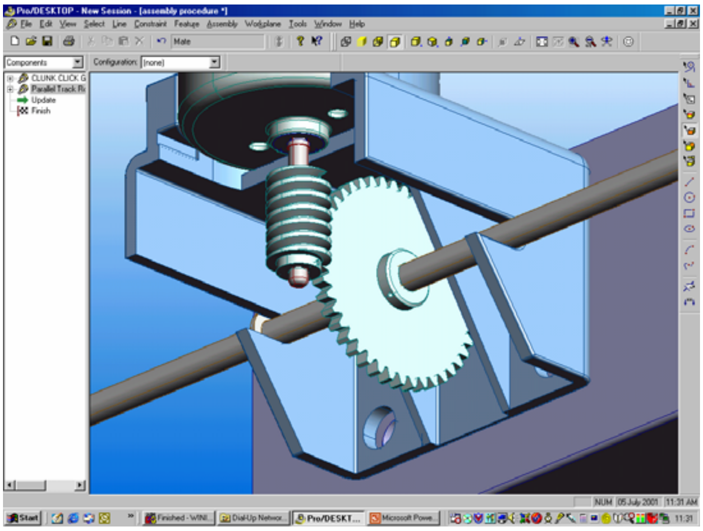
The two surfaces will share the same plane of contact but the plane is infinite in size.



This snapshot shows the two surfaces in contact.

The gearbox is in the correct alignment but the holes on the gearbox need to be aligned to the holes in the frame.

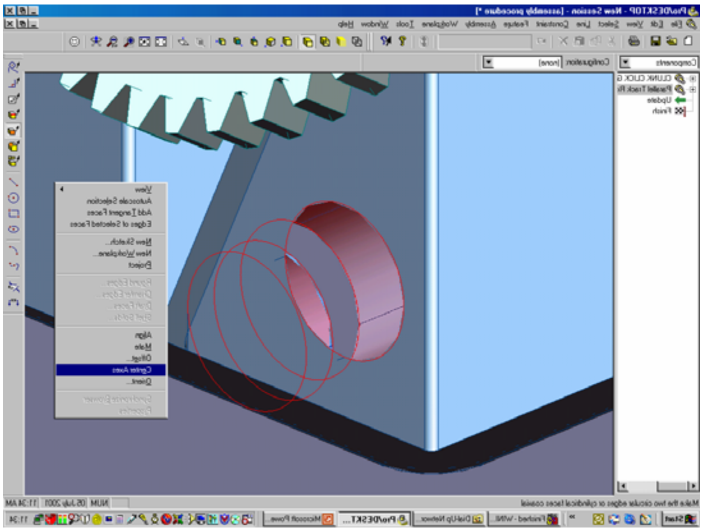
The next sequence describes how to use the **Centre Axis** command to align the holes.



Command:
From the sub menu select:

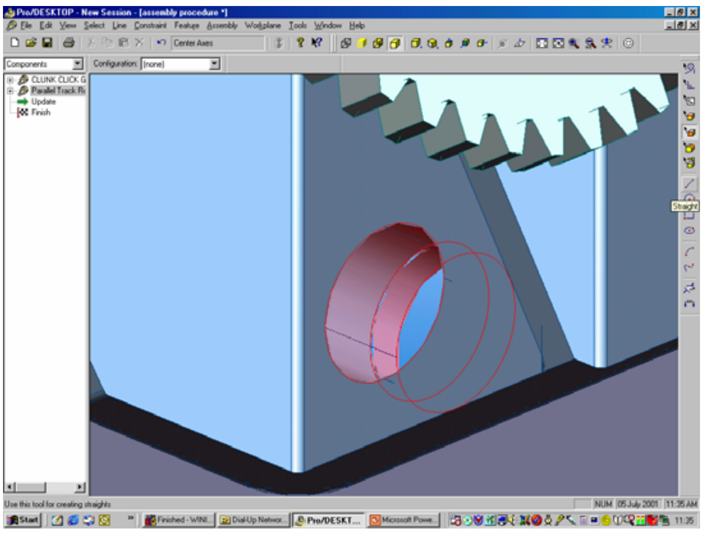
View – Zoom in (shift Z) to capture the detail shown in the snapshot.

Remember that the zoom icon creates a window from the centre of the detail outwards.



Zoom in closer and select the two cylindrical surfaces shown in the snapshot.

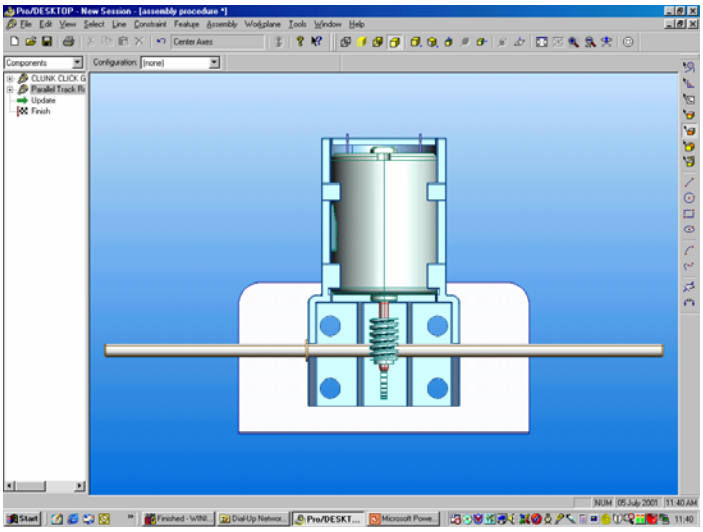
RC and select **Centre Axes** from the sub menu.



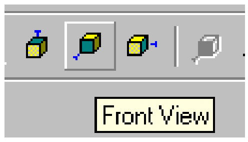
The snapshot shows the two holes in alignment.

Repeat the sequence with the diagonally opposite holes to complete the alignment procedure.

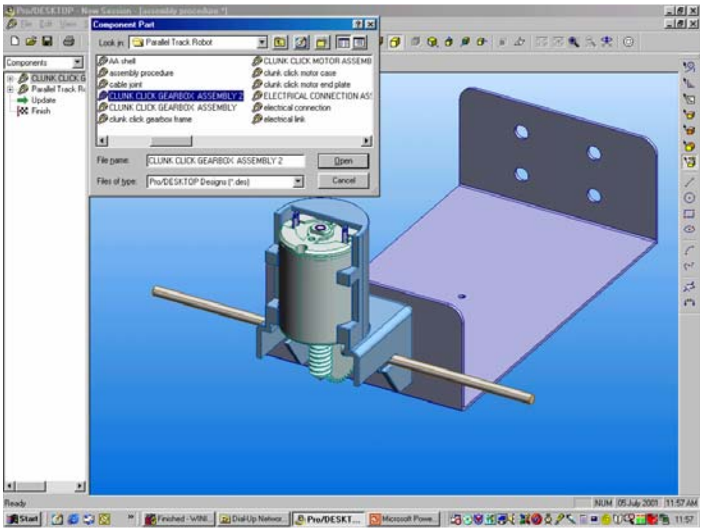
You will need to zoom in and out and manipulate the assembly using the arrow keys on your keyboard to gain access to the holes.



Select the Front View icon from the views toolbar.



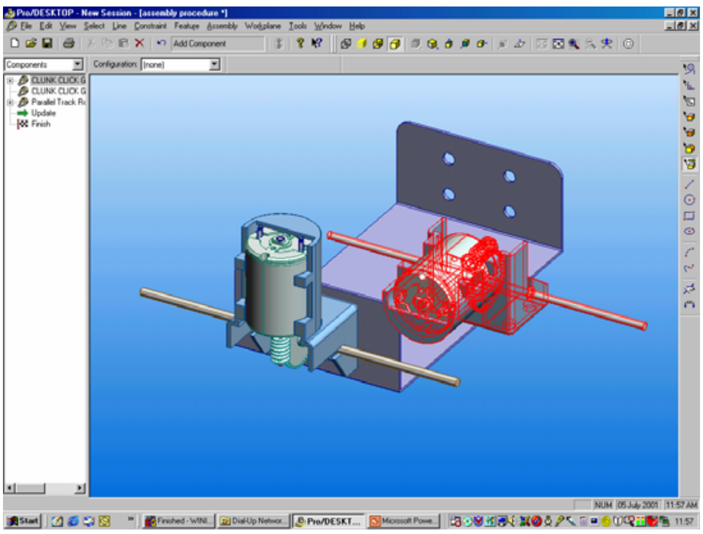
Select shift A to centralise the assembly. The snapshot shows the holes correctly aligned.



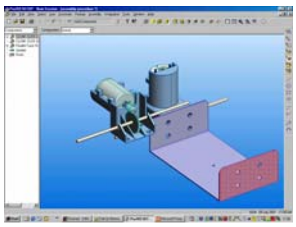
From the pull down menu select:

Assembly – Add Component

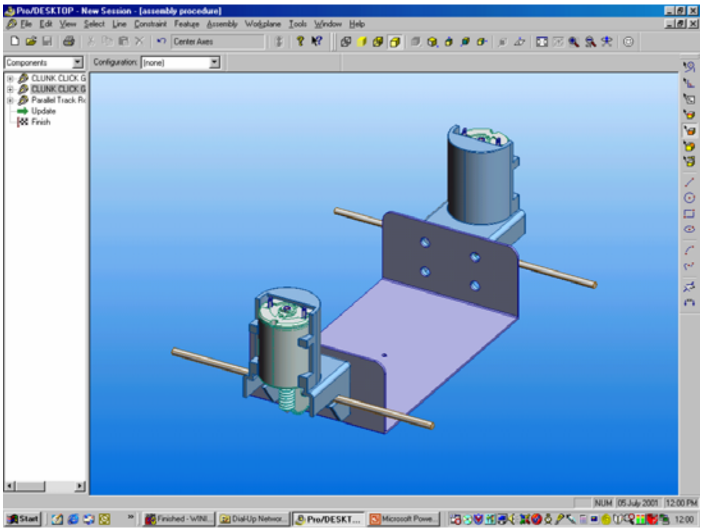
Select the file called **Clunk Click Gearbox Assembly 2**



Rotate the viewpoint with the left and right arrow keys on your keyboard.

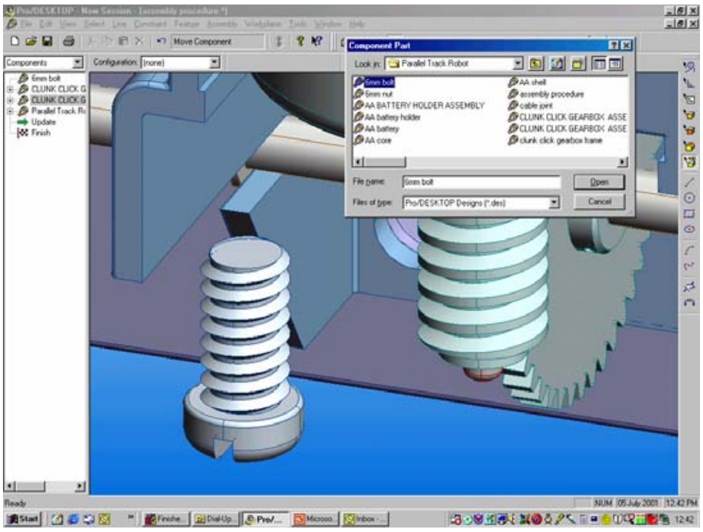


Repeat the alignment procedure described in the previous sequence and align the second gearbox assembly to the frame.



The snapshot shows the robot starting to take shape. The robot currently comprises of the frame and two gearbox assemblies.

The next sequence will add the 6mm nuts and bolts used to secure the gearbox to the frame.

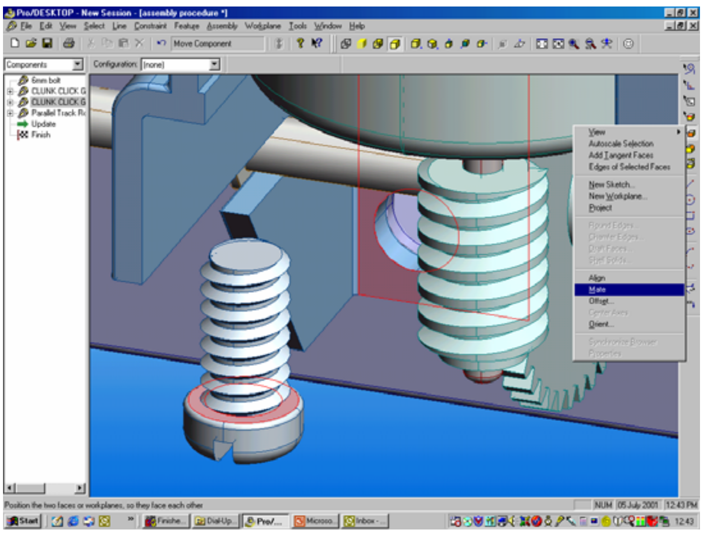


From the pull down menu select:

Assembly – Add Component

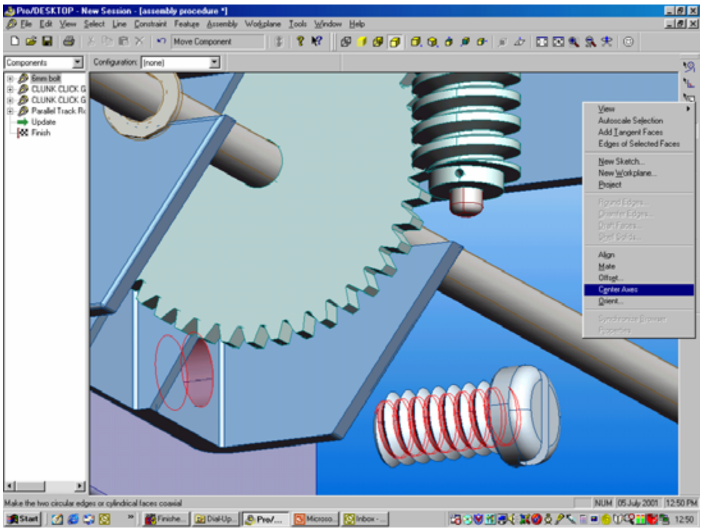
Select the file called **6mm bolt**.

Change the viewpoint to capture the detail shown in the snapshot.



Select the two surfaces shown in the snapshot **RC** and select **Mate** from the sub menu.

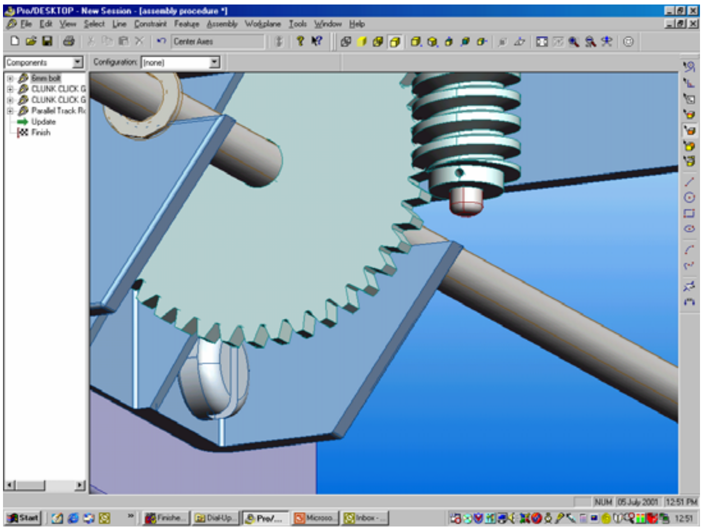
This will bring the flat surface of the 6mm bolt into contact with the surface of the gearbox frame.



The 6m bolt comprises of a thread form wrapped around a cylindrical core. In the next sequence we will align the hole in the frame with the cylindrical core.

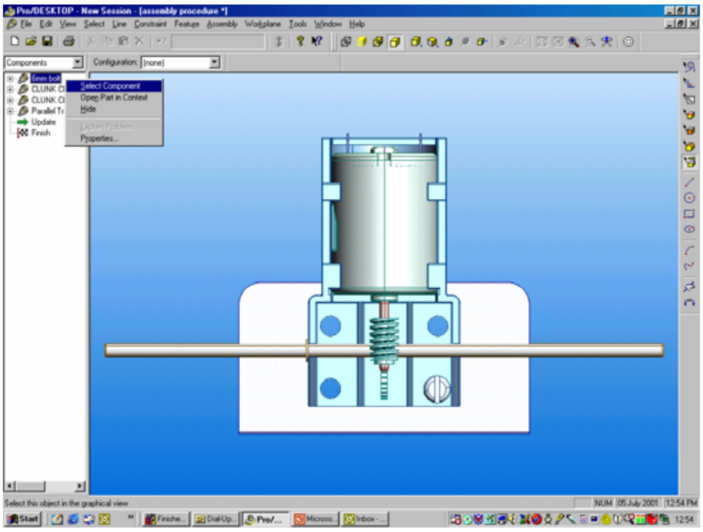
Pick the Select Face icon and select the hole in the frame. Hold down the shift key and carefully select the cylindrical core of the 6mm bolt.

RC and select **Centre Axes** from the sub menu.

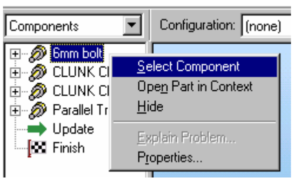


The snapshot shows the result of the alignment procedure.

In the next sequence we will use an **Edit** procedure to copy the original bolt into the remaining 3 holes.



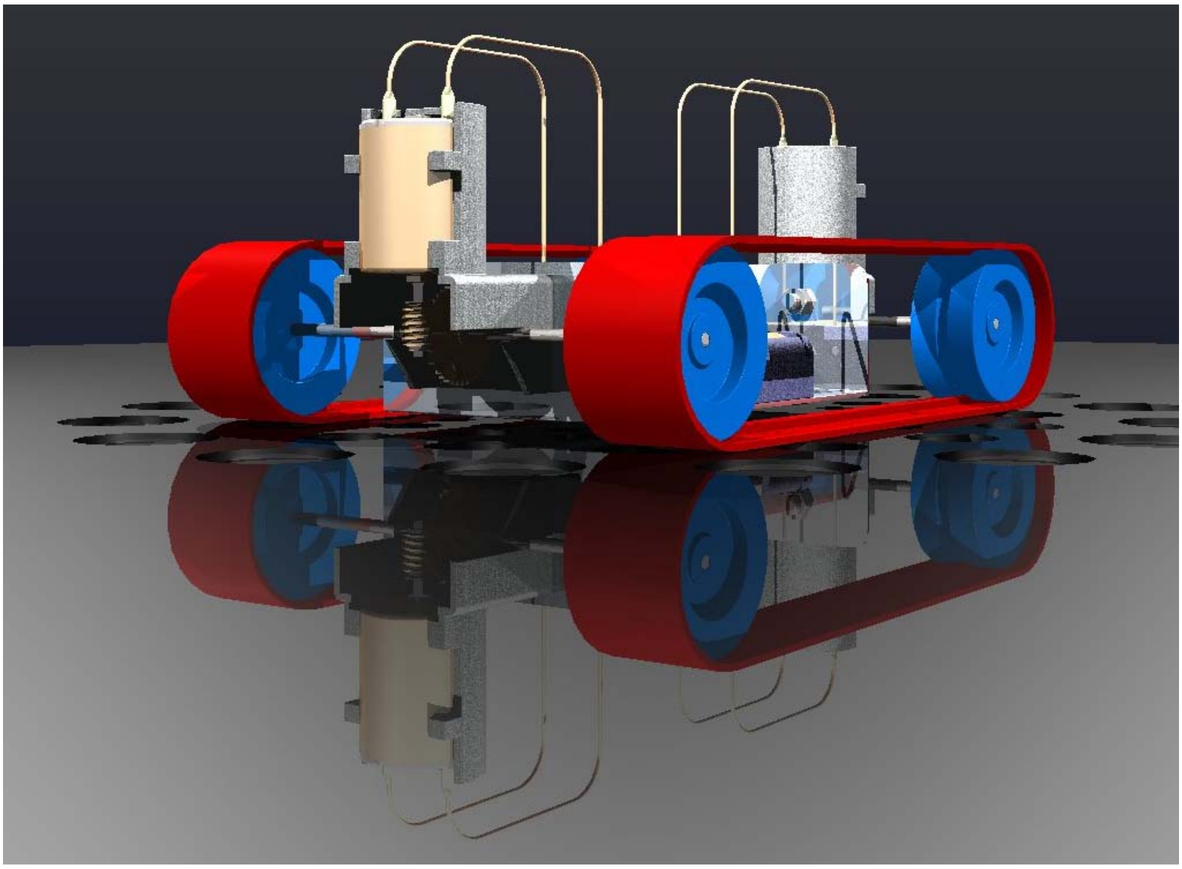
Change the viewpoint to Front view and select Autoscale to centralise the assembly on screen.



Change the browser to Components, move the cursor over the 6mm bolt and **RC**. Pick **Select Component** from the sub menu.

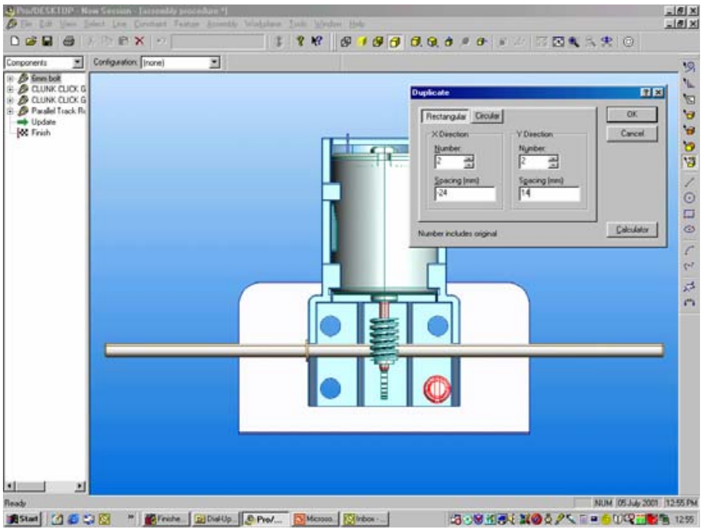
Section 2

Assembling the 6mm bolts to the gearbox



Learner Outcomes:

In this section you will use the Duplicate command within the Edit menu to replicate the 6mm bolt to match the holes in the gearbox and frame.

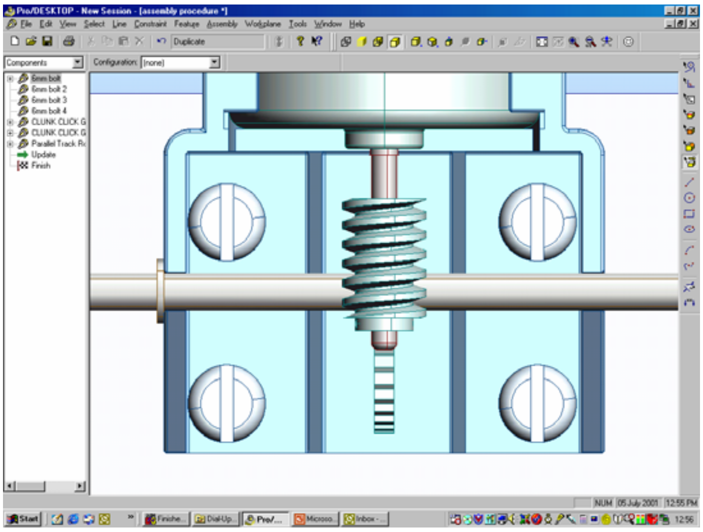


Command:
From the pull down menu select:

Edit – Duplicate

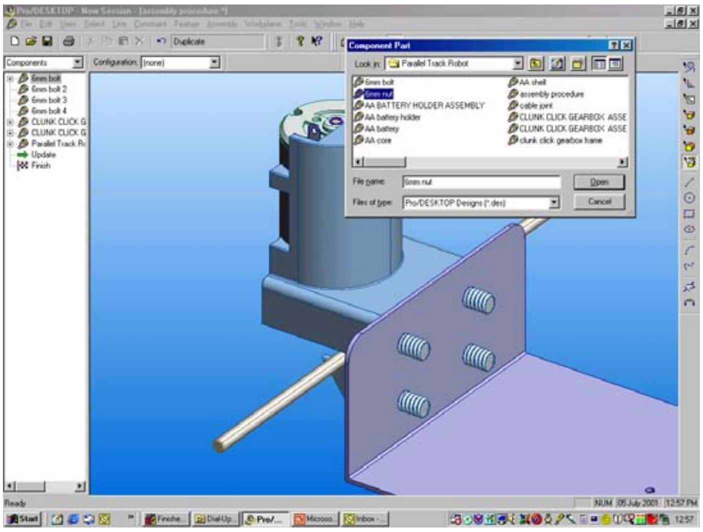
Set the X Direction Number to 2
Set the Spacing to –24mm

Set the Y Direction Number to 2
Set the Spacing to 14mm



The snapshot shows the bolts positioned into the holes in the frame.

We will use this procedure again to duplicate the 6mm nut.

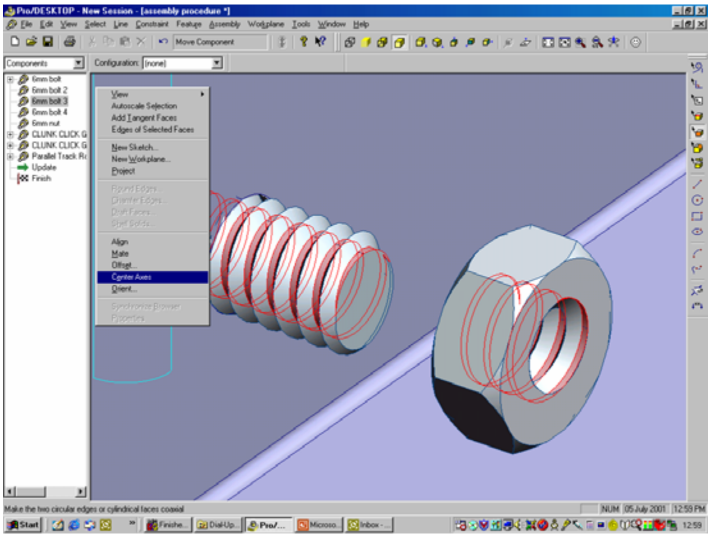


Select **shift T** to change to a 3D viewpoint.

From the pull down menu select:

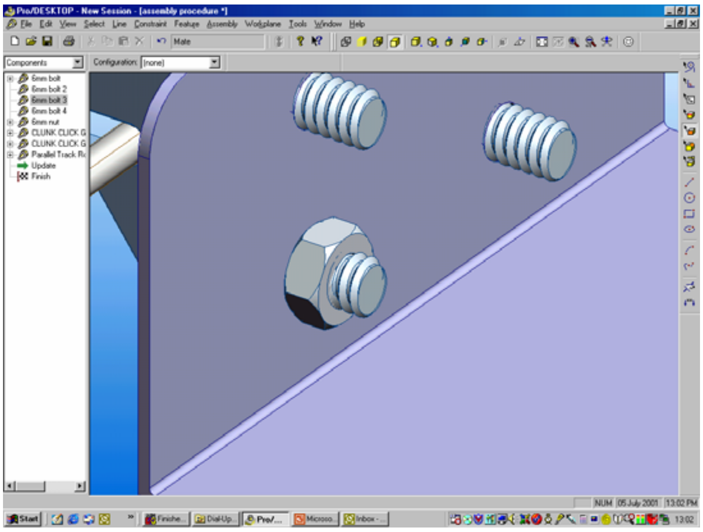
Assembly – Add Component

Select the file called **6mm nut**.



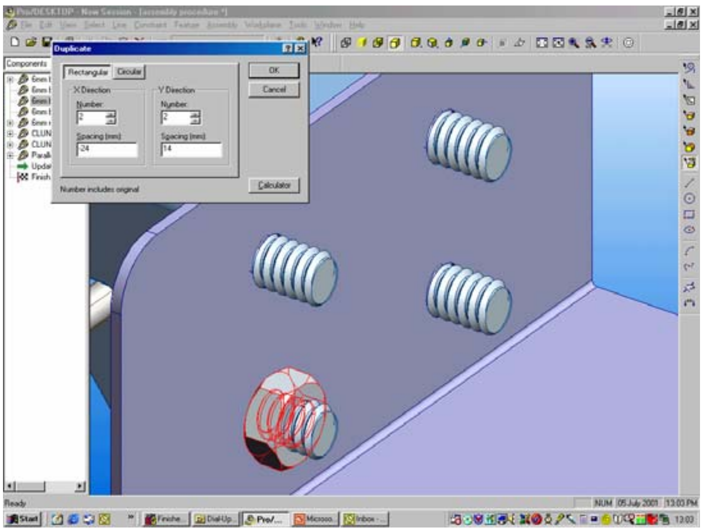
Reposition the 6mm nut to the position shown in the snapshot. Pick the Select Face icon from the design toolbar and select the cylindrical core of the bolt and nut.

RC and select **Centre Axes** from the sub menu. This will ensure the nut and bolt share the same centre line.



Select the inner face of the frame and the corresponding face of the 6mm nut.

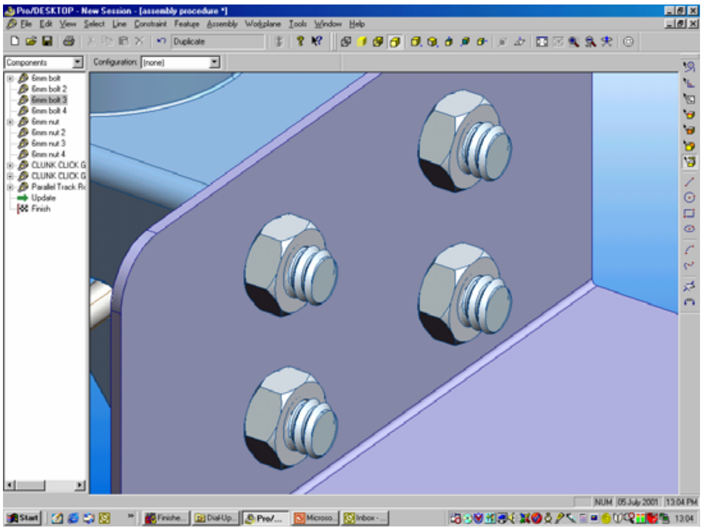
RC and select **Mate** from the sub menu to complete the alignment sequence.



Change the browser to Components, move the cursor over the 6mm nut and **RC**. Pick **Select Component** from the sub menu
From the pull down menu select:
Edit – Duplicate

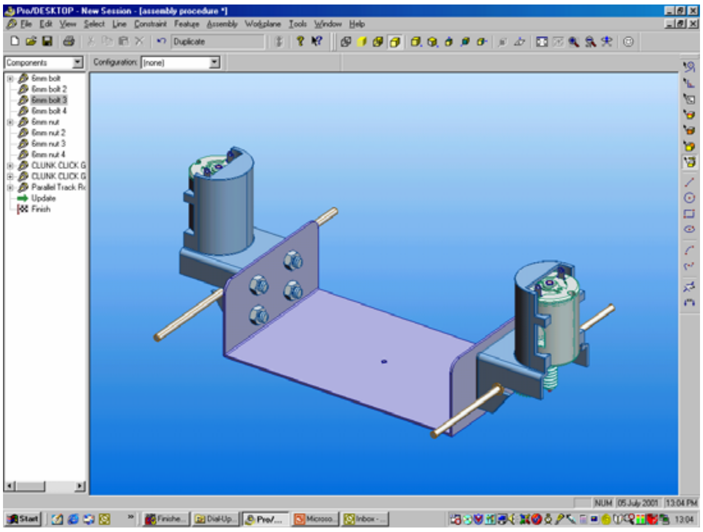
Set the X Direction Number to 2
Set the Spacing to –24mm

Set the Y Direction Number to 2
Set the Spacing to 14mm

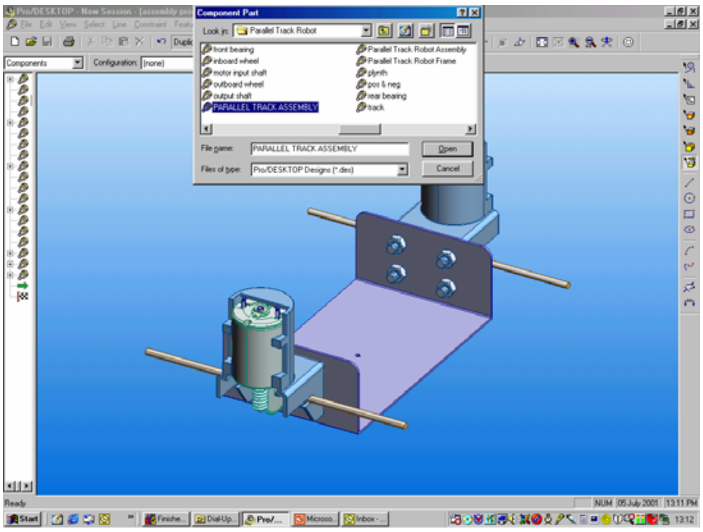


The snapshot shows the bolts positioned into the holes in the frame.

Select shift A to change the viewpoint to include the full design



The snapshot shows the two gearbox sub assemblies connected to the frame. In the next sequence we will add the parallel tracks that drive the robot.



Select shift T to change to a Trimetric viewpoint.

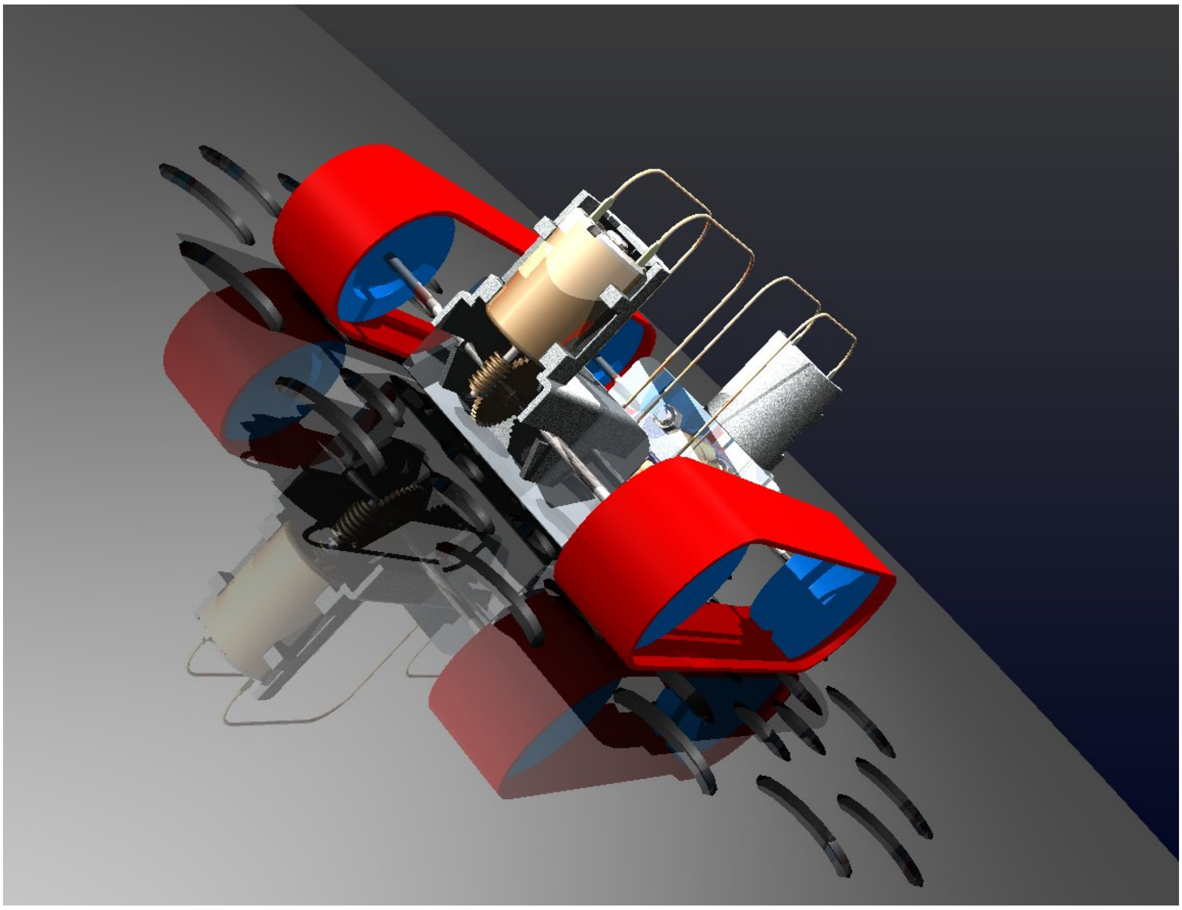
From the pull down menu select:

Assembly – Add Component

Select the file called **PARALLEL TRACK ASSEMBLY**

Section 3

Adding the parallel tracks

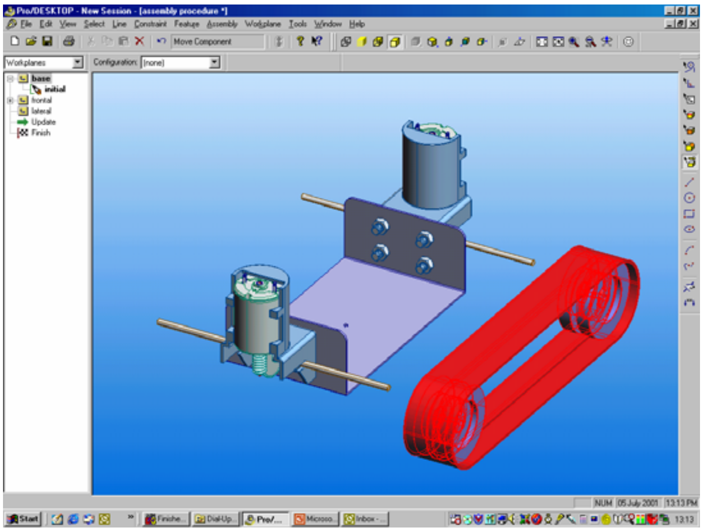


Learner Outcomes:

In this section you will use the following alignment tools within Pro/DESKTOP.

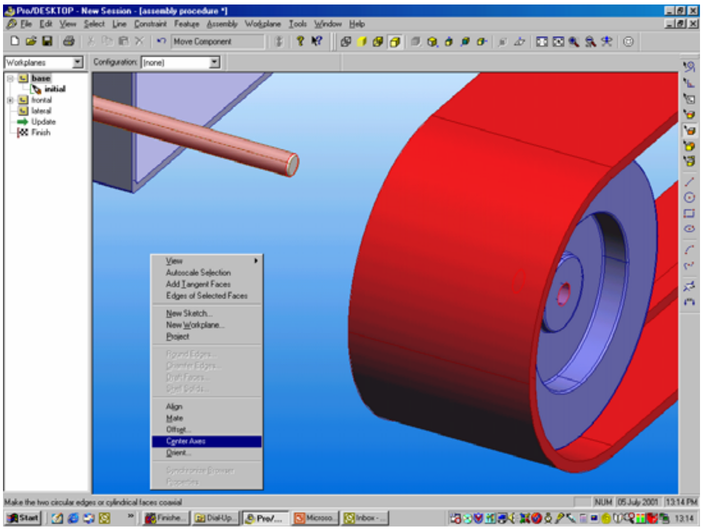
- Centre Axes
- Align

The Parallel tracks are supplied as a complete sub assembly ready for you to connect to the output shaft of the gearbox.



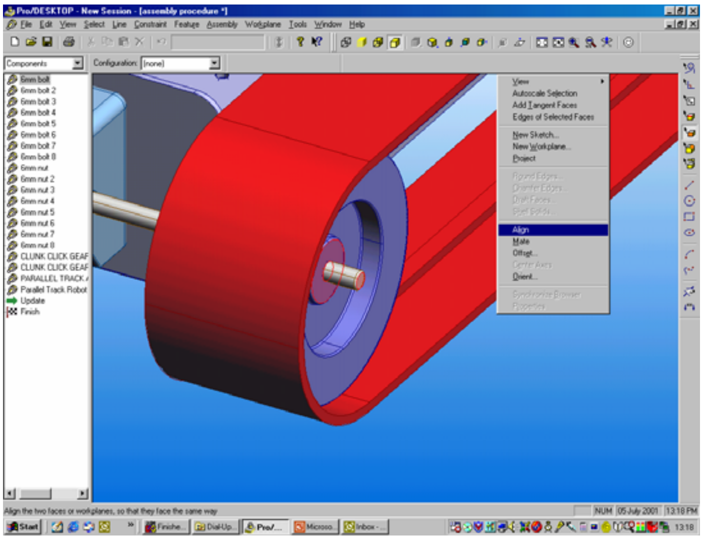
The snapshot shows the Parallel Track Assembly positioned close to the gearbox drive shaft.

Zoom in to capture the detail of the front wheel and the front drive shaft.

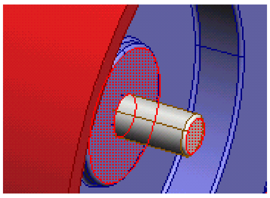


Select the hole in the wheel and the drive shaft (shown as red in the snapshot).

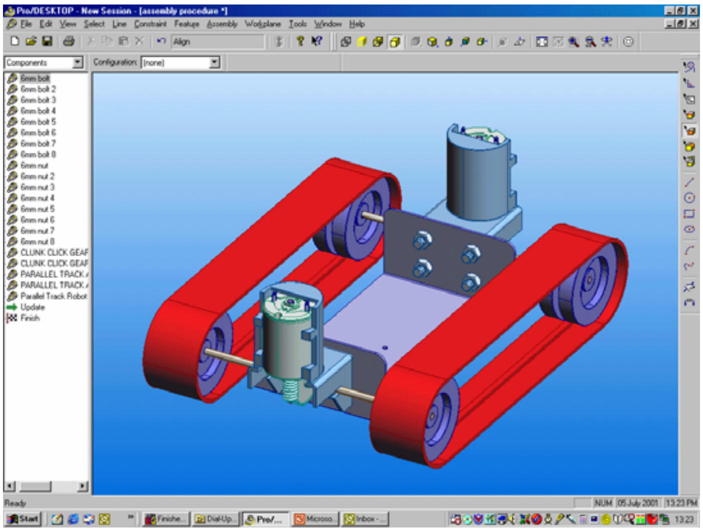
RC and select **Centre Axes** from the sub menu. This will ensure the wheel and drive shaft share the same centre line.



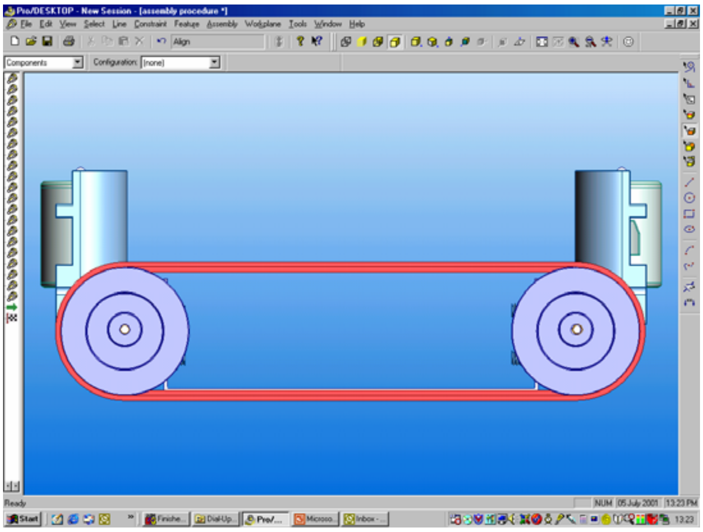
Select the end of the drive shaft and the end face of the wheel hub as shown below.



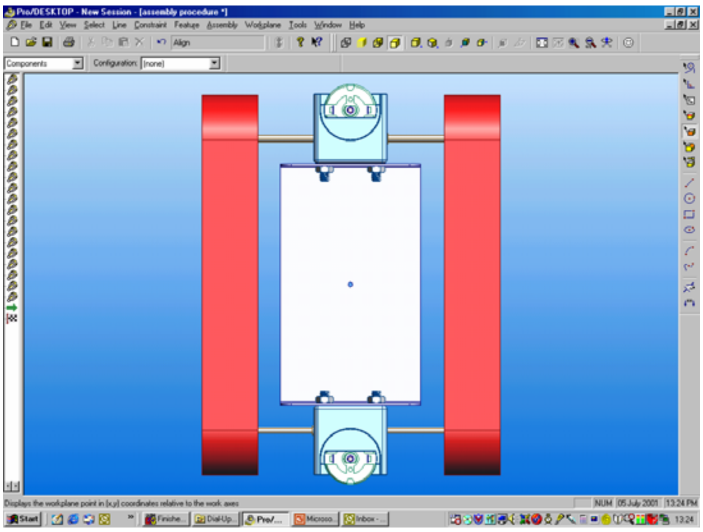
RC and select **Align** from the sub menu to bring the two surfaces into alignment.



Repeat the sequence for the remaining Parallel Track Assembly as shown in the snapshot.



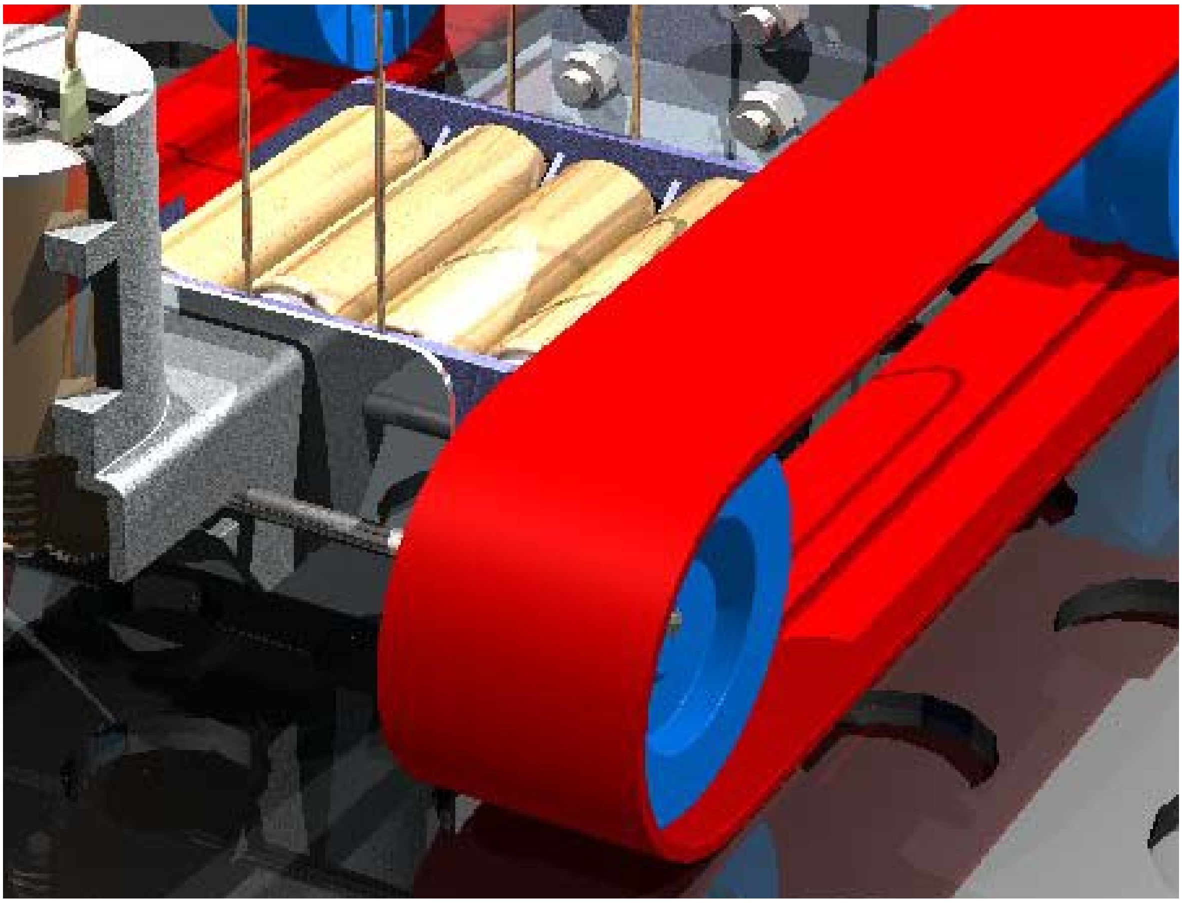
Side View



Top View

Section 4

Adding the battery holder assembly

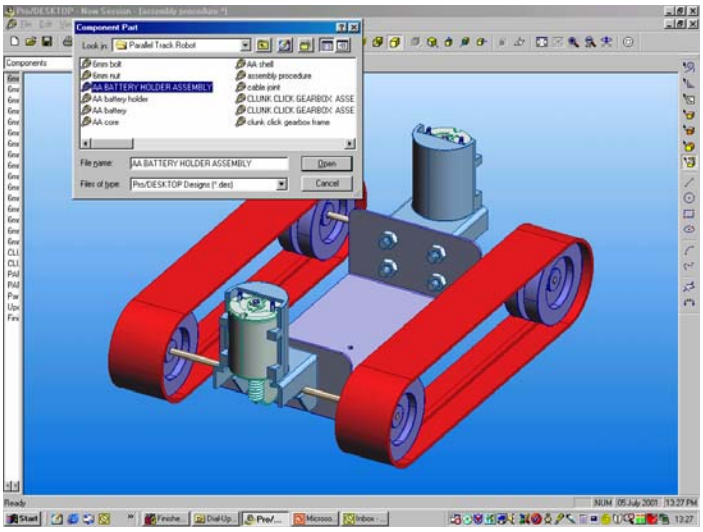


Learner Outcomes:

In this section you will use the following alignment tools within Pro/DESKTOP.

- Centre Axs
- Mate

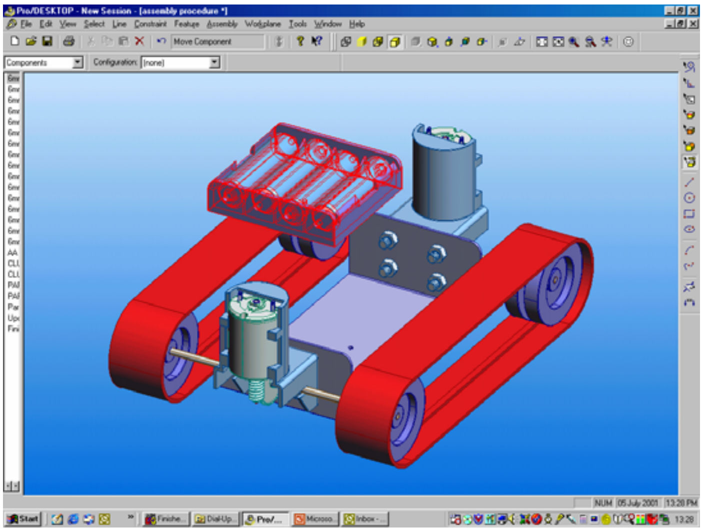
The Battery Holder Assembly is supplied as a complete sub assembly ready for you to connect to the robot frame.



From the pull down menu select:

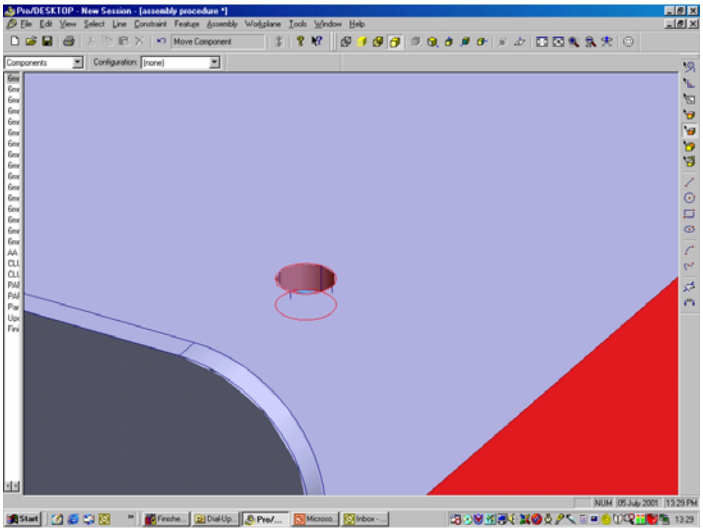
Assembly – Add Component

Select the file called **AA BATTERY HOLDER ASSEMBLY**

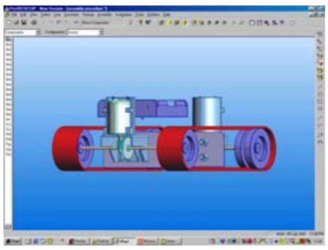


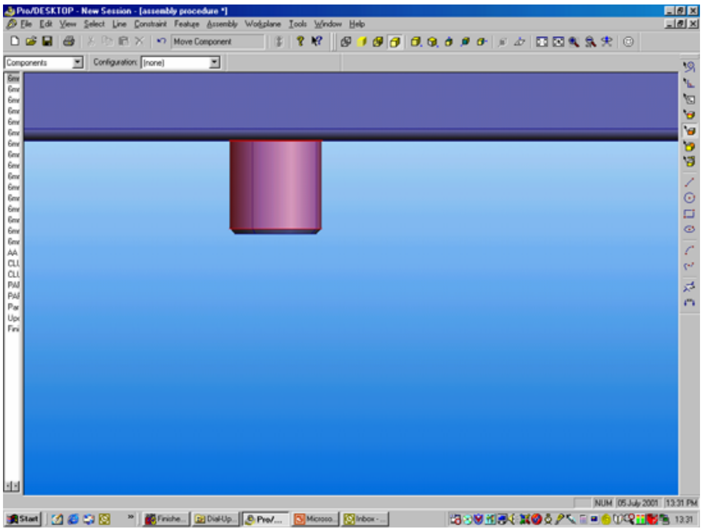
The battery holder appears on screen. Move it to the position shown in the snapshot.

(note) components appear on screen in the same plane as the active workplane. If any component in this tutorial appears in the wrong orientation make sure the correct workplane is active. In this case **Base** is the correct workplane.

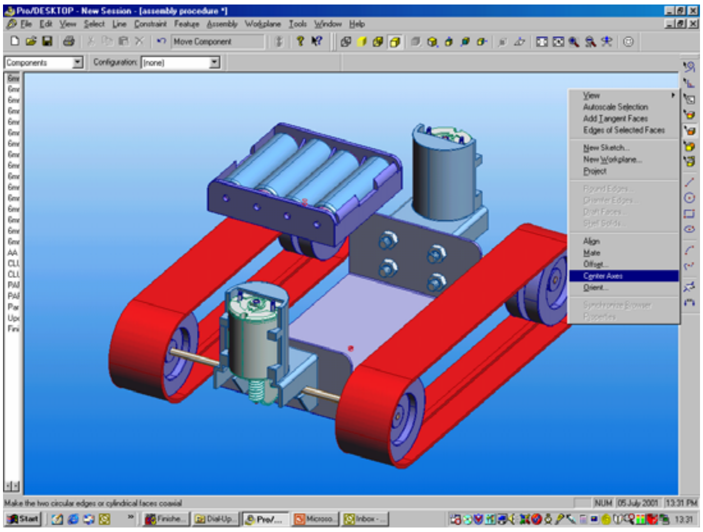


Zoom in to select the hole in the centre of the robot frame as shown in the snapshot. Remember to hold down the shift key and zoom out to the previous viewpoint.

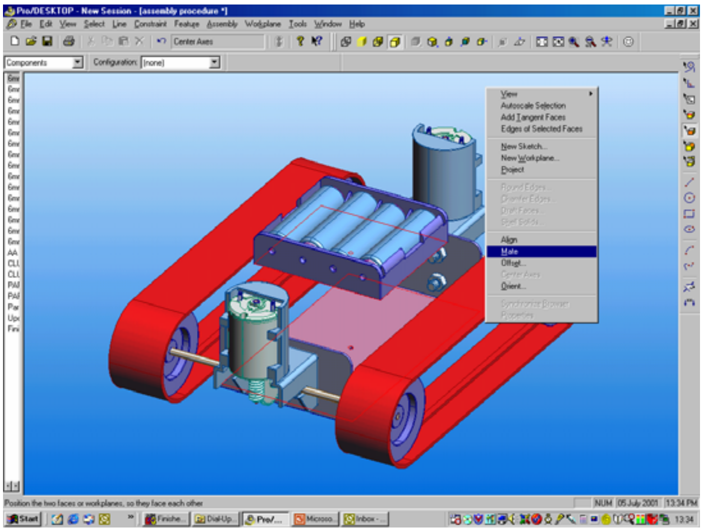




Zoom in to select the abutment shown in the snapshot.

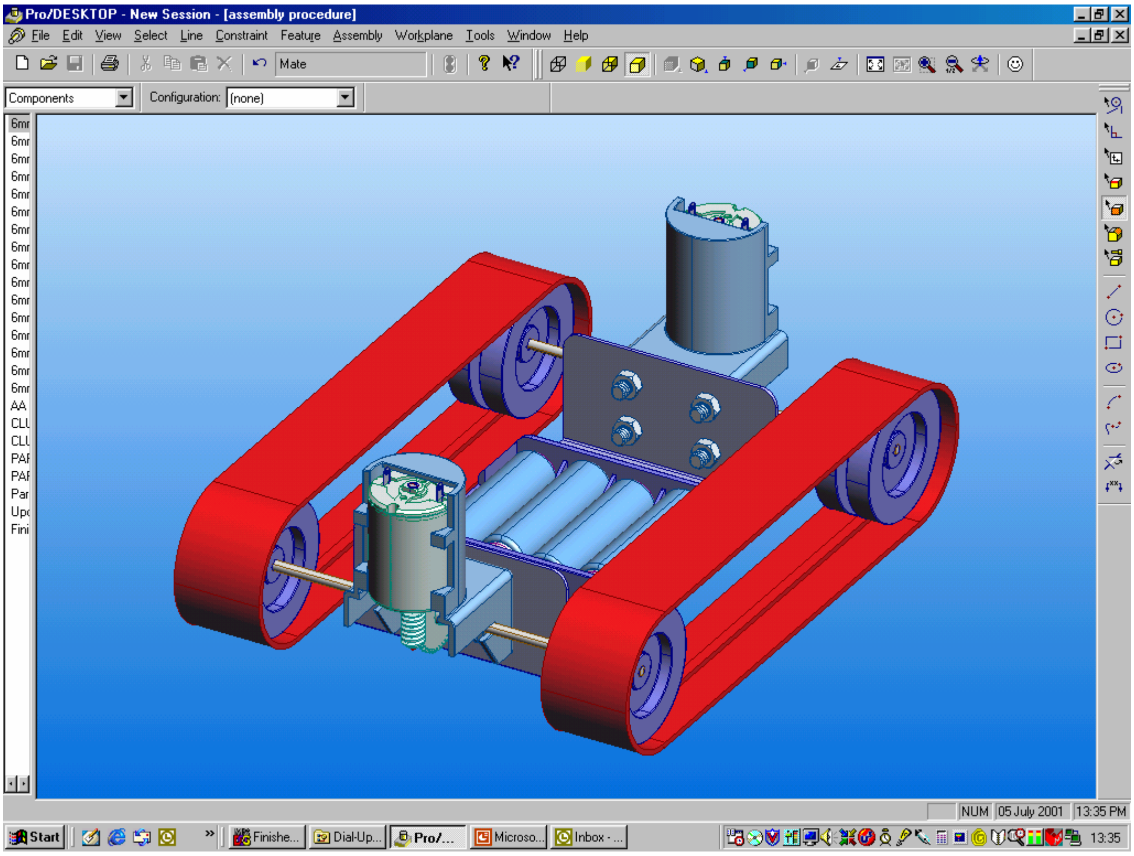


Zoom out, **RC** and select **Centre Axes** to ensure the shaft and hole share the same centre line.

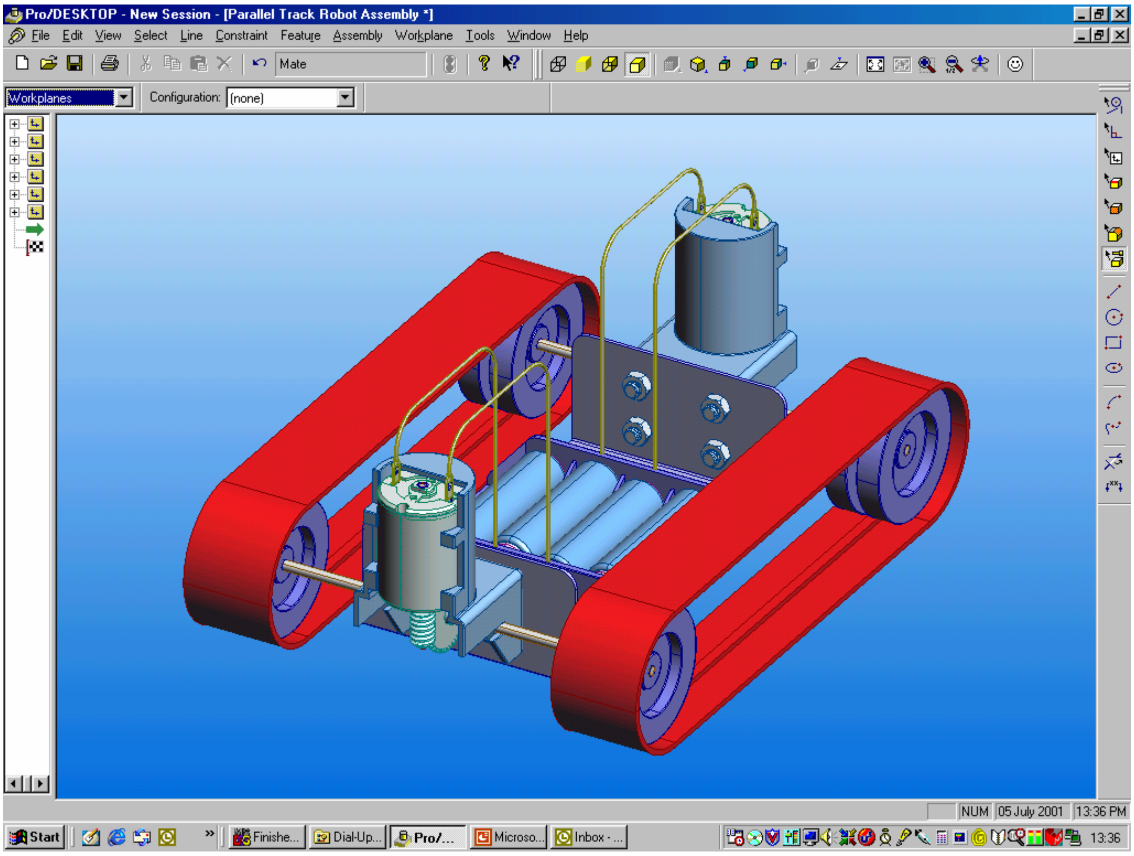


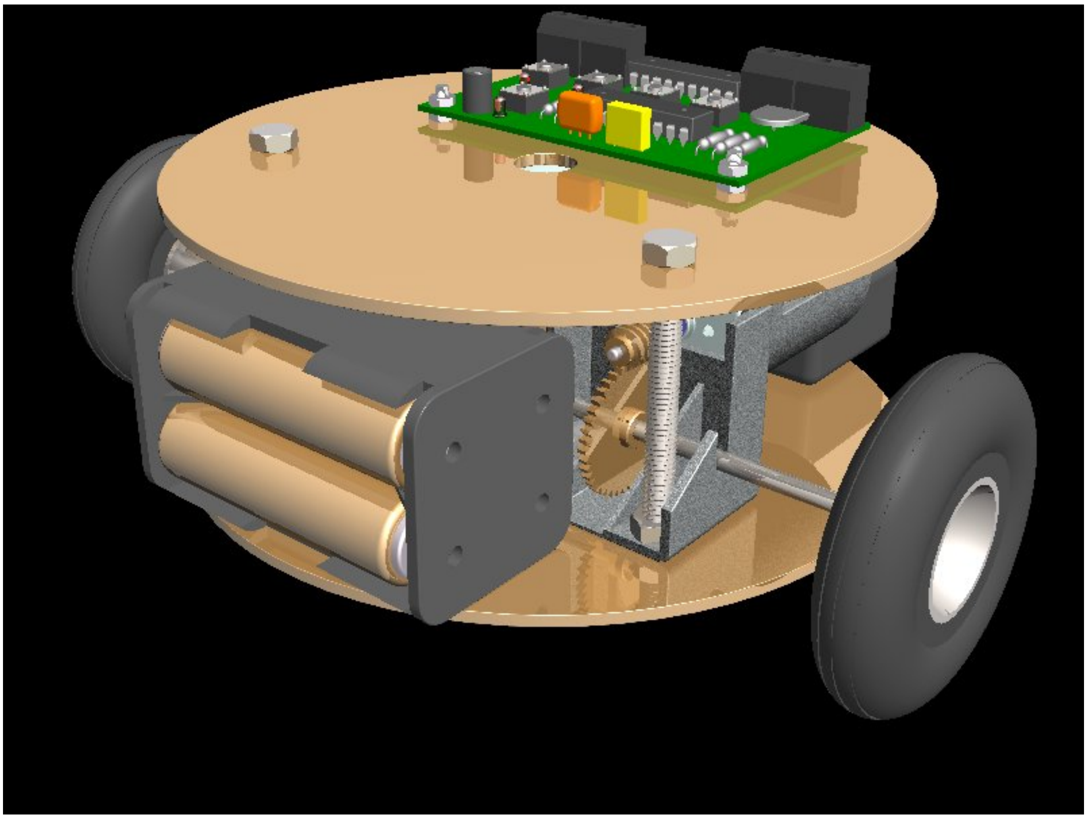
Select the top surface of the robot frame and the bottom surface of the battery holder (shown as red in the snapshot).

RC and select **Mate** from the sub menu.

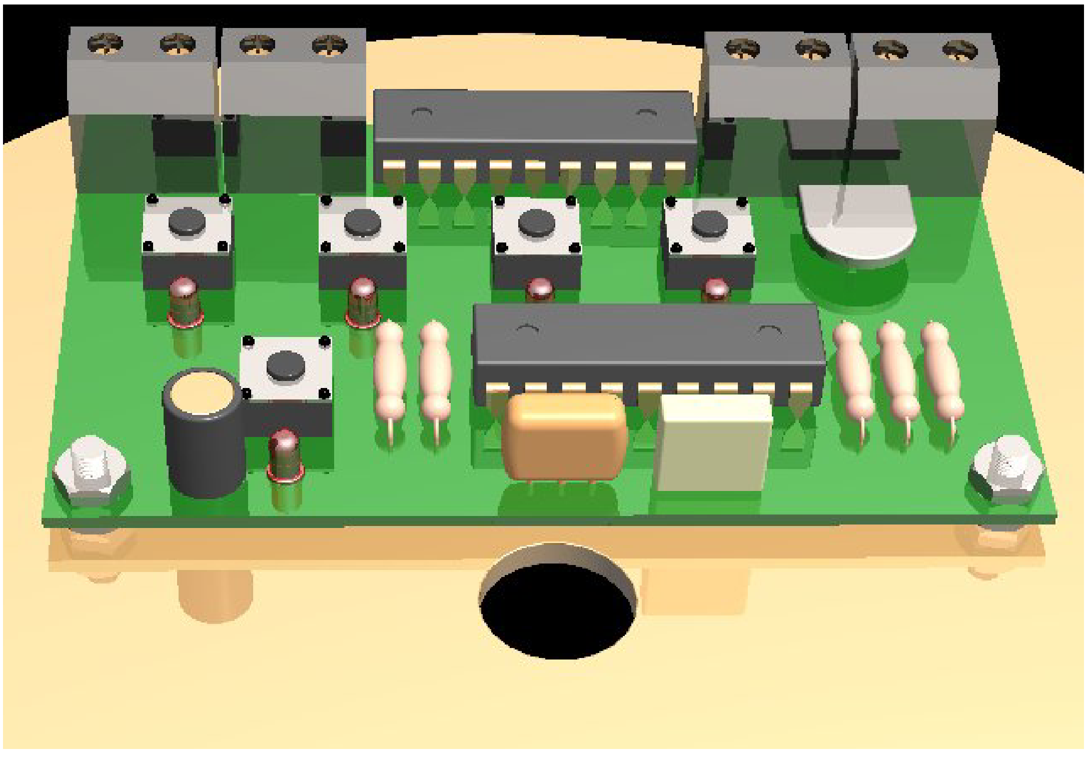


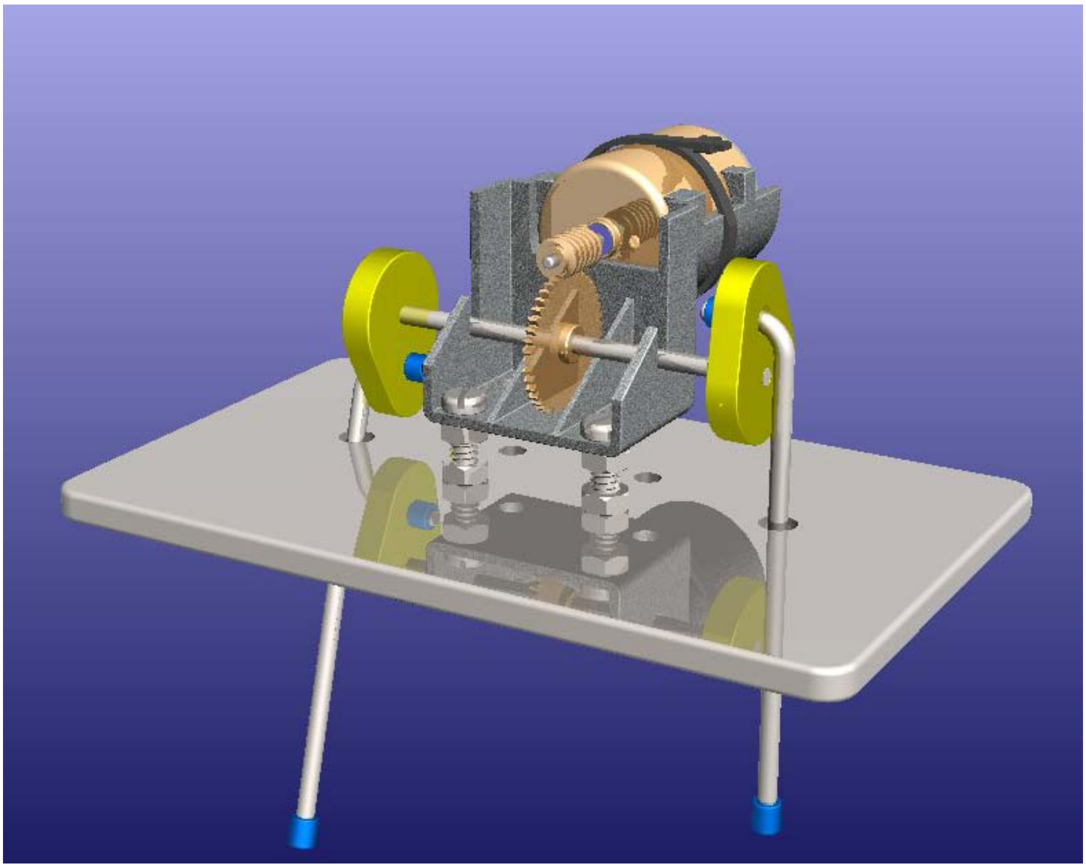
The snapshots on this page show the completed robot assembly. Use the skills gained in this tutorial to add the Electrical Connection Assembly shown below





These snapshots show a variation on the previous design and include a PCB to control speed and direction.





Try experimenting with robot designs to achieve different types of motion like the walker robot shown above. By manufacturing different frame designs you can use the same components to produce a range of outcomes.