**Handling tools design**

Note: The following steps illustrate general key steps in CAD software that are required to create the handling tools. The dimensions and design of handling tools depend on the dimensions of soft gripper.

1.1) Sketch the manual control handling tool (Figure 4a)

1.1.1) Right-click on the front plane and click on “Normal to” button to normalize to the front plane.

1.1.2) Click on “Sketch” on the top left corner to open the “Sketch” window. Then, click on the “Sketch” button on the top left corner of the toolbar to draw a L-shape contour to form the handling tool.

1.1.3) Click on the “Smart Dimension” feature beside the “Sketch” button to define sketch dimensions. Ensure that the sketch is fully defined (all drawing lines become black) and exit the sketch when done.

1.1.4) Click on the “Features” window. Then, click on “Extruded Boss/Base” feature to extrude selected contours in the Z-direction.

1.1.5) Click on the back surface of the handle to preselect the sketch plane. Sketch a rectangle and define the dimensions (repeat steps 1.1.2 and 1.1.3).

1.1.6) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a cavity for insertion of soft gripper and piston.

1.1.7) Right-click on the front surface of the handle. Then, click on “Normal to” to normalize to that surface.

1.1.8) Next, click on the “Sketch” window to draw a rectangle (repeat steps 1.1.2 and 1.1.3).

1.1.9) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a cavity for the gripper arms.

1.1.10) Click on the top surface of the model to preselect the sketch plane for creating spaces for the movable cap. Create a rectangle in the “Sketch” window (repeat steps 1.1.2 and 1.1.3).

1.1.11) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a rectangular piece downward.

1.1.12) Click on the back surface of the handle to preselect the sketch plane. Sketch an isosceles right triangle and define the dimensions (repeat steps 1.1.2 and 1.1.3).

1.1.13) Click on the “Features” window. Then, click on “Extruded Boss/Base” to extrude the triangle contour to create two slots for the rectangular cap.

1.1.14) Click on the “Fillet” button on the toolbar in the same window. Create a fillet of 5 mm for the three corner edges at the handle side and a fillet of 2.5 mm for the four corner edges at the head side of handling tool.

1.2) Sketch the rectangular cap (Figure 4b).

1.2.1) Right-click on the front plane and click on “Normal to” button to normalize to the front plane.

1.2.2) Create a contour as shown in Figure 4b (right) in the “Sketch” window (repeat steps 1.1.2 and 1.1.3).

1.2.3) Click on the “Features” window. Then, click on “Extruded Boss/Base” feature to extrude the contour to create a solid feature.

1.3) Sketch the movable piston (Figure 4c).

1.3.1) Right-click on the top plane and click on “Normal to” button to normalize to the top plane.

1.3.2) Create a contour as shown in Figure 4c (left) in the “Sketch” window (repeat steps 1.1.2 and 1.1.3).

1.3.3) Click on the “Features” window. Then, click on “Extruded Boss/Base” feature to extrude the contour to create a solid feature.

2.1) Sketch the robotic control handling tool (Figure 5a)

2.1.1) Right-click on the front plane and click on “Normal to” button to normalize to the front plane.

2.1.2) Click on “Sketch” on the top left corner to open the “Sketch” window. Then, click on the “Sketch” button on the top left corner of the toolbar to draw a rectangular contour to form the handling tool.

2.1.3) Click on the “Smart Dimension” feature beside the “Sketch” button to define sketch dimensions. Ensure that the sketch is fully defined (all drawing lines become black) and exit the sketch when done.

2.1.4) Click on the “Features” window. Then, click on “Extruded Boss/Base” feature to extrude selected contours in the Z-direction.

2.1.5) Click on the back surface of the model to preselect the sketch plane. Sketch a rectangle and define the dimensions (repeat steps 1.1.2 and 1.1.3).

2.1.6) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a cavity for insertion of soft gripper and linear actuator. Note: Ensure that the depth of the extrusion matches with the dimensions of linear actuator’s base.

2.1.7) Right-click on the front surface of the handling tool. Then, click on “Normal to” to normalize to that surface.

2.1.8) Next, click on the “Sketch” window to draw a rectangle (repeat steps 1.1.2 and 1.1.3).

2.1.9) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a cavity for the gripper arms.

2.1.10) Next, click on the top surface of the model to preselect the sketch plane for creating spaces for the movable cap. Create a rectangle in the “Sketch” window (repeat steps 1.1.2 and 1.1.3).

2.1.11) Click on the “Features” window. Then, click on “Extruded Cut” feature to extrude cut a rectangular piece downward.

2.1.12) Click on the back surface of the handling tool to preselect the sketch plane. Sketch an isosceles right triangle and define the dimensions (repeat steps 1.1.2 and 1.1.3).

2.1.13) Click on the “Features” window. Then, click on “Extruded Boss/Base” to extrude the triangle contour to create two slots for the rectangular cap.

2.1.14) Next, click on the inner surface of the handling tool to preselect the sketch plane for drawing the holder for securing linear actuator. In the “Sketch” window, create a rectangle with a circle at the center (repeat steps 1.1.2 and 1.1.3).

2.1.15) Click on the “Features” window. Then, click on “Extruded Boss/Base” to extrude the rectangle with a hole at the middle to create a block with a hole for securing the linear actuator with screws.

2.1.16) Then, click on another inner surface of the handling tool and repeat steps 2.1.14 and 2.1.15.

2.1.17) Click on the “Fillet” button on the toolbar in the “Features” window. Create a fillet of 2.5 mm for the four corner edges at the head side.

2.2) Sketch the rectangular cap (Figure 5b).

2.2.1) Right-click on the front plane and click on “Normal to” button to normalize to the front plane.

2.2.2) Create a contour as shown in Figure 4b (right) in the “Sketch” window (repeat steps 1.1.2 and 1.1.3).

2.2.3) Click on the “Features” window. Then, click on “Extruded Boss/Base” feature to extrude the contour to create a solid feature.