

Creating Part Draft

IRONCAD TECHNICAL EDUCATION

Creating Part Draft

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Creating Part Draft

IronCAD is an excellent tool for constructing complex, molded parts that require Draft for part ejection from the mold. This tutorial will focus on the methodology, techniques, and tips used to build a typical plastic, injection molded, Toaster Top Case. Using the IronCAD tools that efficiently create part Draft, such as Extrude, Spin, and Loft will be highlighted throughout this tutorial.

The tutorial assumes the IronCAD user has a basic working knowledge of how to manipulate Cross-Section Sketches, combine and move features dropped from the Shapes Catalog, and use the basic features of the Triball. An understanding of plastic part design is also very helpful and it is recommended that the IronCAD user supplement this tutorial with plastic design guides supplied by most major Plastic Producers.

SETUP FOR THIS TUTORIAL:

- A) Change the default Kernel to Parasolids. *Tools>Options>Parts>Default Kernel Type for New Parts>Parasolids*
- B) Make sure to uncheck the Allow Reordering for all newly created parts. This is accomplished by a Left Click to the part in the Scene Browser at the Drilldown: Part/Assembly level, and then Right Click the part and uncheck the Allow Reordering option. When Allow Reordering is on, IronCAD will move features in the Scene Browser based on its own algorithms, which may or may not capture the design intent.
- C) Note: The camera changes in this tutorial between perspective and orthographic to highlight the action being demonstrated. An Orthographic Camera is generally used when editing Cross Sections

Understanding Draft

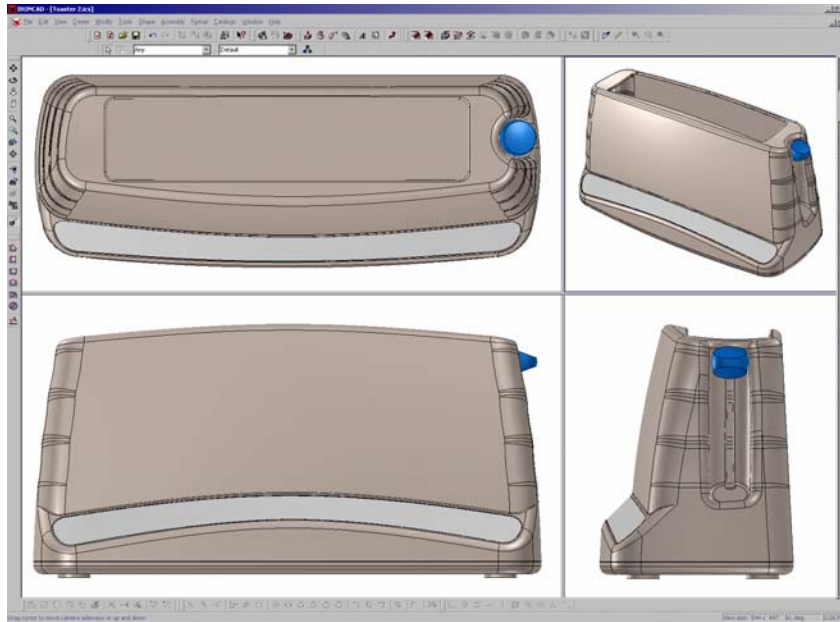


FIGURE 1.0 Final Toaster Assembly Orthographic and Perspective Views

TIP: Determining Draft

A general rule of thumb in determining draft in Injection Molded Plastic Parts is 1 to 2 degree(s) starting draft plus an addition 1 degree for every .001" of texture depth. Always use the largest draft allowed with the design and consult with Molder before starting a complex plastic part design program.

Figure 1.0 shows the final shelled Toaster design consisting of the Toaster Top Case, Knob, Control Panel Overlay, and Bottom Case Parts. This tutorial will focus on the steps and methodology used with creating the Top Case of this Toaster.

Building molded parts in IronCAD requires an understanding of part draft and how to efficiently model it using the Extrude, Spin, and Loft tools. Draft is defined as the tapering required on all sides, bosses, ribs, etc. of the part that are perpendicular to the Parting Line of the Mold. (See Figure 1.1) Draft is always aligned with the Die Draw of the opening and closing of the mold. Draft allows the molded part to be safely ejected from the mold without damage to the part or the mold. Some IronCAD tools, such as Extrude, allow draft to be numerical input, while others, such as Spin, Sweep, and Loft, require that the Cross-Section Sketch contain the draft information. For the sake of this tutorial, Draft is generally used when referring to a Mold and Taper used when building parts specific to IronCAD. The terms will be used interchangeably for this tutorial.

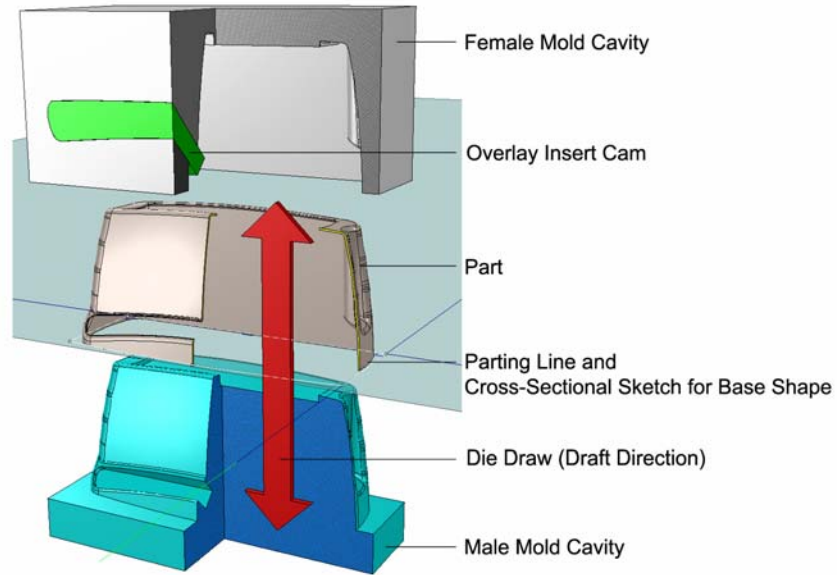


FIGURE 1.1 Cut-a-way Perspective of an Injection Mold and Part. Note how the part tapers or drafts as it extends into the Female Mold Cavity.

Anatomy of a Part Build

The Toaster Top Part is constructed in IronCAD of an Extruded Base Feature with Spin and Loft Features that remove or cut the Sides, Front, Control Panel Overlay, and Top areas. (See Figure 1.2) The term Cut and Remove will be used interchangeably throughout this tutorial. This construction methodology has the following benefits:

- Allows for the greatest surface modification with the least number of features.
- The features are independent of each other, which allows for rapid and radical modifications.
- Fewer features allow for faster part regeneration.
- The part shells without complications.
- Blends work without complications.
- Fewer features equal less modeling time.

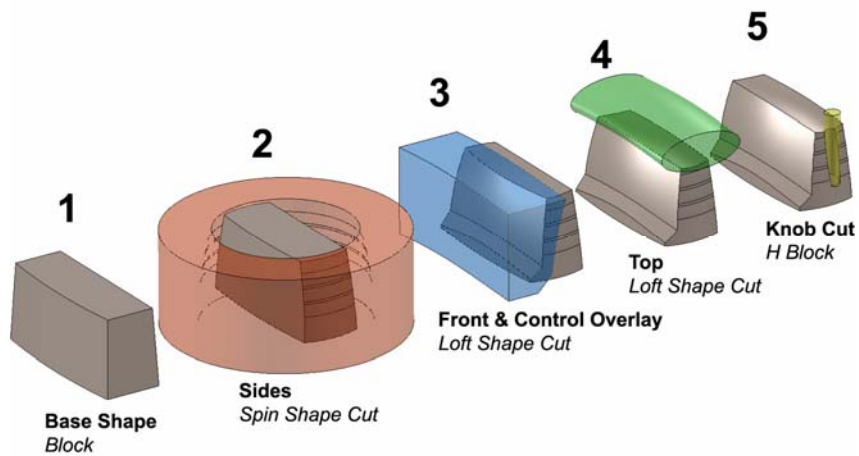


FIGURE 1.2 Anatomy of the Toaster Top Part construction, Note: Blends and some Cuts have been suppressed for clarity

- Allows for rapid Draft changes.

TIP:
When to use
Rounds

Adding fillets to the Base Shape Cross-Section Sketch usually creates problems with other sequential Part Blends. Add blends after all major Cuts have been applied to the Base Shape. Fillet(s) added at the Cross-Sectional Level also makes it more difficult for other IC users to edit your model because the Cross-Sectionally produced fillets are not displayed in the Scene Browser.

Additionally, a fillet added at the Cross-Sectional Sketch Level is drafted and changes its value along the draft. A Blend applied along the same drafted edge remains constant. Try it yourself and see.

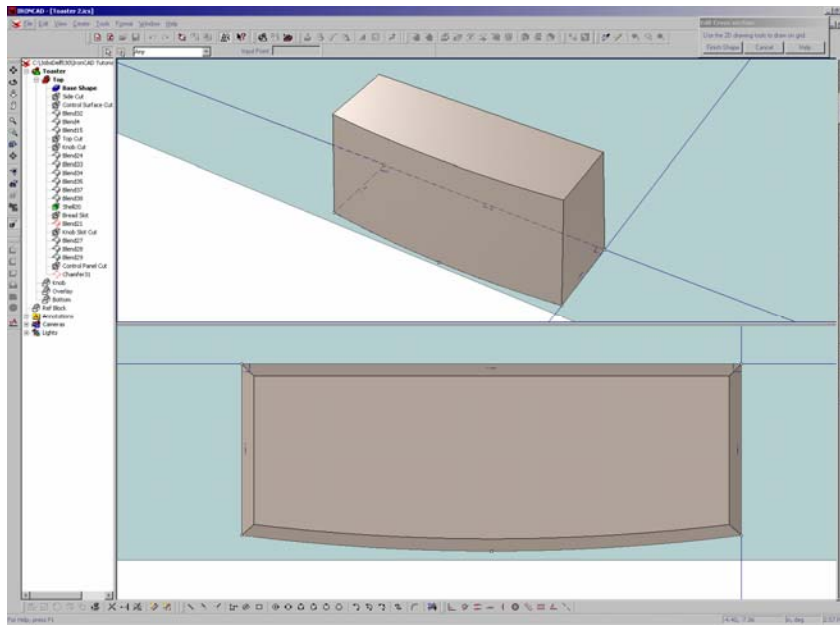


FIGURE 1.4 Base Shape Section with Draft shown in Perspective and Top Views. Note how the top of the Base Shape is smaller than the bottom of the Base Shape.

Cutting the Sides with a Spin Shape

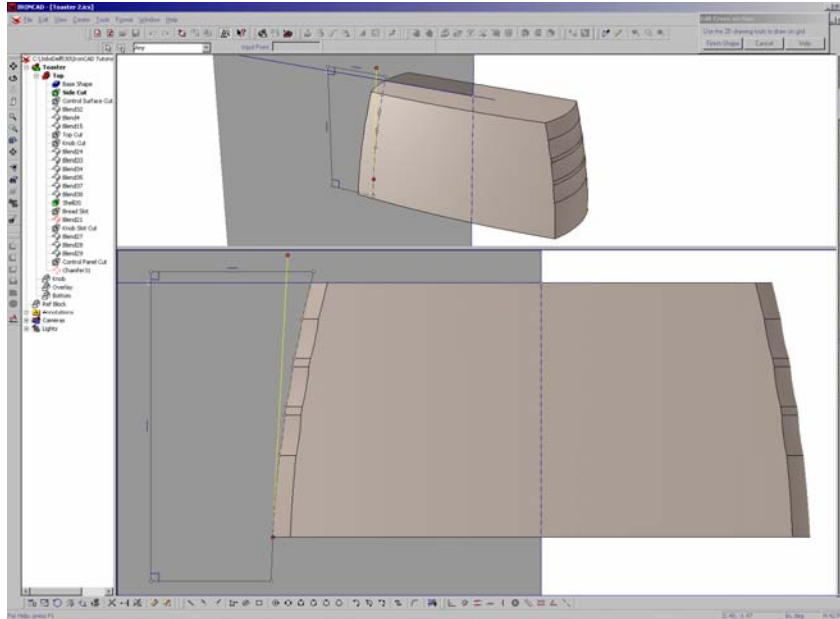


FIGURE 1.5 Spin Cut Cross Section shown in Perspective and Front Views

TIP: Spin Shape Rotation

The Spin Shape cuts through both sides of the part. To only cut one side of the part, select the Spin Shape Intellshape Properties>Spin and change the Angle to less than 180 degrees.

The Sides were cut using a Spin Shape dropped in the center of the top surface and set to Remove Material. (See Figure 1.5) The advantages of using the Spin Shape Cut in this application is:

- The design called for rippled surfaces to make the Toaster easier to grip and move.
- A Spin Shape makes visually appealing, conical (using straight Lines in the Cross-Section) or spherical surfaces (using Arcs in the Cross-Section).

The disadvantages using a Spin Shape Cut include:

- No Intellshape dial-in draft properties
- Care must be taken to make sure the Cross-Sectional line work falls within the allowed Draft.

- Can easily create overly complex surfaces that will not shell.

The Cross Section Sketch contains a 39.4 unit Radius that was drawn to intersect with the projected lower edge (Project 3D Edge Tool) of the Base Shape. This radius will cut most of the side wall along with the added Finger Grip Arcs. Note the Highlighted Yellow Reference Line in the Cross Section Sketch. This Reference Line is tipped at a 3 degree angle representing a 3 degree draft. All of the Arcs fall within the acute side of the 3 degree line ensuring a 3 degree or greater draft for the Side Walls. The 3 degree Draft Line was visually compared to the Finger Grip Arcs, which can become undercuts if they are too deep. Some of the Finger Grip Arcs are less than the allowed 3 degree Draft. These areas will be polished to aid in part remove from the mold.

Cutting the Front Faces

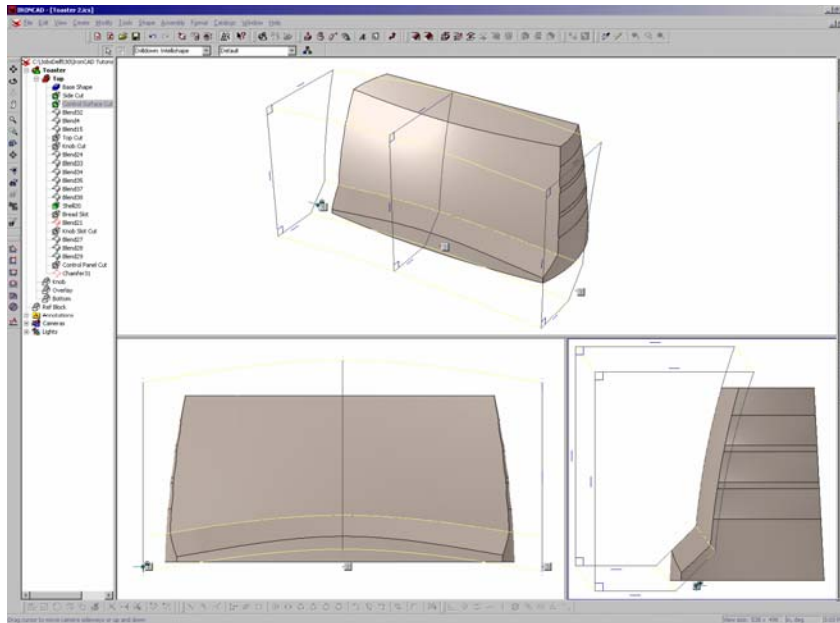


FIGURE 1.6 Front and Control Overlay Surfaces shown with Loft Cut in Perspective, Front, and Side Views

A Loft Shape Cut was used to create Front and Control Overlay Surfaces using 3 identical Cross-Sections along a 17 unit long Straight Line Profile Locator Curve. (See Figure 1.6) The Profile Locator Curve was centered between the Sides and aligned parallel to the rear edge of the Toaster Top Part. Unless this alignment done, the feature will not cut symmetrically.

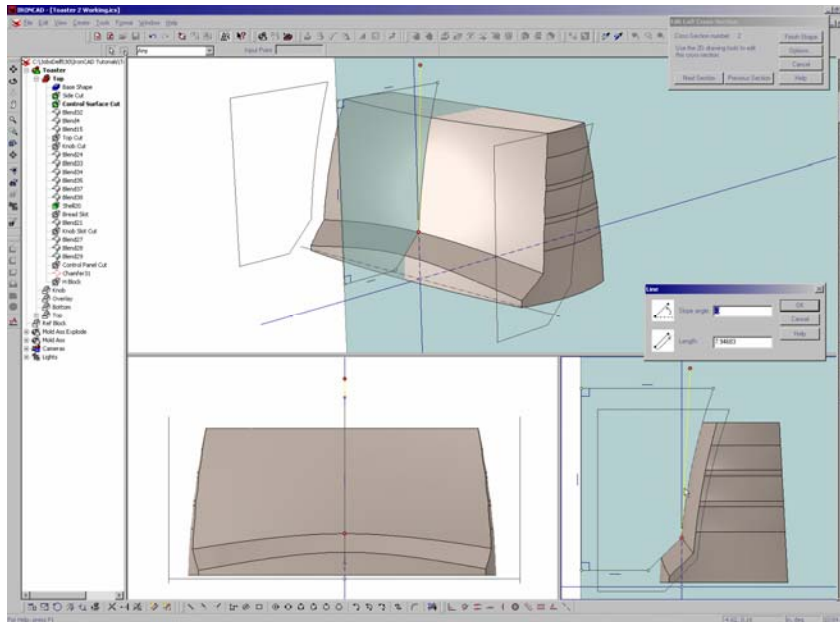


FIGURE 1.7 Loft Shape Cut with Section 2 highlight. Note the -3 degree Reference Line

Care was taken to ensure that the Front Surface 29.4 R unit Arc falls within the 3 degree Draft similar to the Side Spin Shape Cut. (See Figure 1.7) Loft Sections 1 and 3 were equally moved with the Triball, 1 Unit down and .75 units toward the rear of the part. This Loft Cut creates a spherical shape for the Front Surface and a Conical shape for the Control Overlay Surface. The advantages of using a Loft Cut include:

- Very complex surface creation
- Some geometry can only be created using Loft Features

The disadvantages of the Loft Cut are the same as the Spin Cut. Other disadvantages include:

- More time consuming to create and modify then other features
- Lofts require longer regeneration time because of the increased surface complexity

Cutting the Top Face

TIP: Ellipse Construction

There is no Ellipse Creation Tool. Ellipses are created from Circles using the Curve Property Dialog and unchecking the Circle Option. The Major and Minor Ellipse Radii can then be adjusted numerically or manually by dragging Points on the Circle.

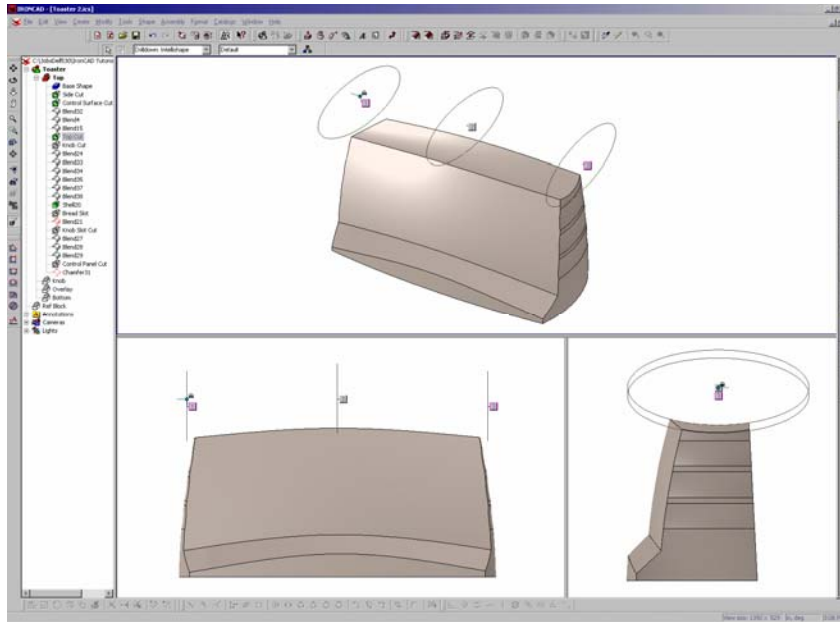
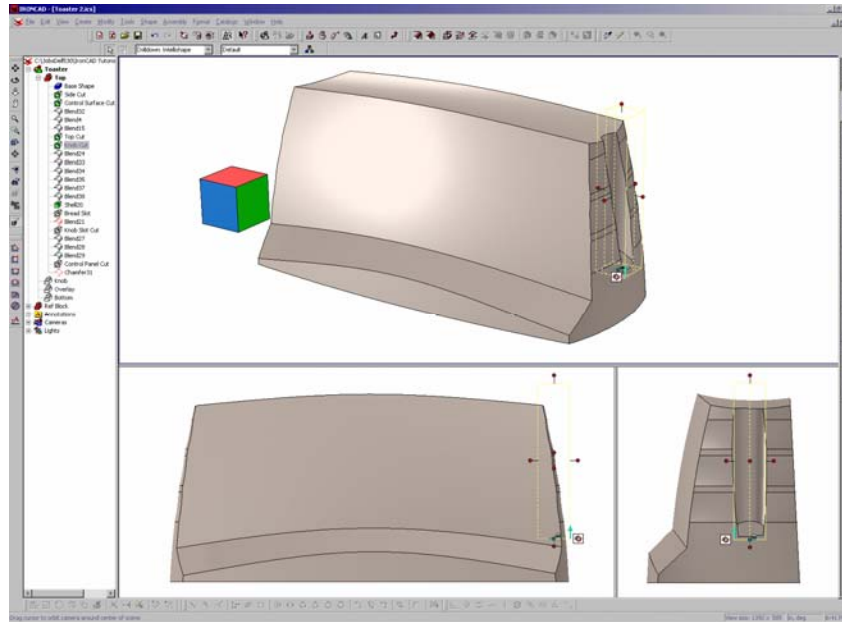


FIGURE 1.8 Top Surface shown with Loft Cut in Perspective, Front, and Side Views

The design called for the Top Surface to be concave so that bread crumbs would fall into the Toaster. (See Figure 1.8) The Top Surface was created exactly the same way as the Front and Control Overlay Surfaces, using a Loft Cut with 3 loft sections. Identical ellipses (major axis: 4.17 units, minor axis: 1.73 units) were used for all 3 loft sections with loft sections 1 and 3 moved down .375 units using the Triball. Again, the key to this correctly working is centering the 15 unit, Straight Profile Locator Curve between Sides of the Toaster Top and aligning the Locator Curve parallel to the rear edge of the Toaster Top Part.

Cutting the Knob Pocket



TIP: Orienting Features

Orienting features can be difficult on curved surfaces. A feature dropped from a catalog will orient normal to the surface its dropped on, which is sometime undesirable. To reorient the feature parallel to the X,Y, and Z world axes, use the Triball along with the Orient Tribball to Global function.

FIGURE 1.9 Knob Pocket cut from H Block shown in Perspective, Front, and Side Views. Note Reference Block

The Knob Pocket is created by dropping an H Cylinder from the Shapes Catalog onto the Top Surface of the Toaster Top Part, reorienting its extrusion direction perpendicular to the Bottom Surface of the Base Shape (which is also the parting line in this case), and moving it into the final position using the Triball. (See Figure 1.9) The diameter of the H Cylinder was changed to 1.25 units and the Taper set to 1 degree (Properties>Side>Taper). The Draft Angle was chosen to minimize the changing gap between the Knob and Toaster Top as the Knob moves up and down. This area of the part will not be textured and will be polished to aid part removal from the mold.

The bottom of the Knob Pocket is tilted at 30 degrees to improve cleanability. This was accomplished at the Surface Reshaping Properties>Start Section>Taper. The Orientation Angle was set to 180 degrees, Tile Angle to -30 degrees, and the Start Taper at extremum checked. Tapering the Start or End Sections usually requires several attempts to get it into the proper orientation but is an effective way to create this type of geometry.

Comment [BEK1]:

Because the H Block Cut was dropped onto the top spherical surface of the Toaster Top Part, its orientation will be normal (perpendicular) that surface. This requires realignment so that its extrusion direction is parallel with the Die Draw of the part. (See

Figure 1.1) This allows the H Block to be square to the workspace and the part. The Base Shape has several straight edges and planar (flat) faces, which can be used to orient the cut. Unfortunately, in many cases, the part will not have any straight edges or planar faces to use as an alignment feature. In those cases, there are two solutions for orienting the Cut.

One solution is to select the H Block Cut, active the Triball, right click inside the Triball, and select *Orient Triball to Global* from the Popup Menu. This will reorient the cut square to the part and the workspace but many times requires one or more 90 degree Triball rotation(s) to get the cut into the desired location.

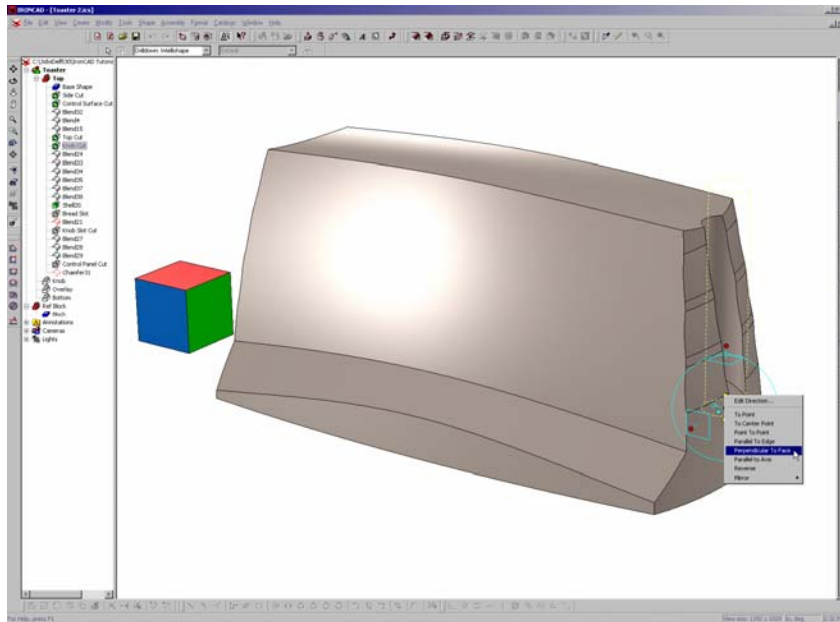


FIGURE 2.0 Triball with the Align to Face Option

The second and sometimes faster realignment solution is to use the Triball along with a Block dropped from the Shape Catalog. The Block is used as a Reference Block where its faces and edges are square to the part and World Coordinate System. The Triball has alignment options including *Alignment to Edge* and *Perpendicular to Face* that are activated by Right Clicking on the Triball Center Handle Dots. (See Figure 2.0) Since the Reference Block Faces square to the Part, they are perfect to select after activating the Triball *Perpendicular to Face* option.

TIP:
Reference Block

Reference Blocks are simply Blocks dragged from the Shape Catalog that can be used for the following actions:

- Aligning features after they have been dropped onto Conical, Spherical, or other Non Planar Surfaces.
- The Look At (F7) command can be programmed to activate with most 5 button mouse. Tagging the sides of the Reference Block with the Programmed Look At command allows rapid view changes.
- The block can be used as a measurement tool by snapping its sides to part geometry when the SmartDimension fails.

Shelling the Part

TIP: Shelling

- More than one surface can be removed during the Shelling Operation by Shift, Left Clicking on the multiple surfaces.
- It is always a good idea to test shelling the part early on in the construction process. If the shelling fails, it is much easier to isolate and correct the offending feature with fewer features to sort through.

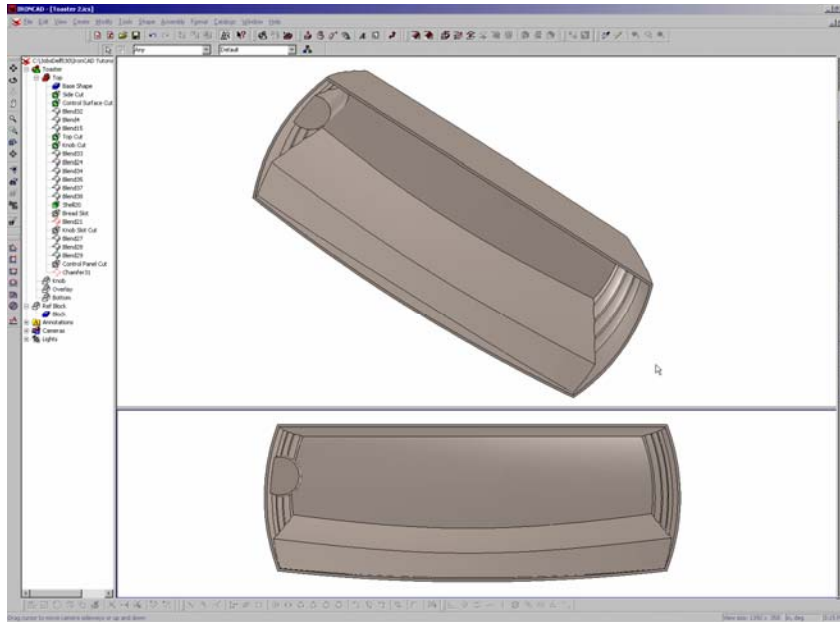


FIGURE 2.1 The Shelled Toaster Top Part, Perspective and Bottom Views

With all the major Feature Cuts complete, it's now time to Shell the part. Select the Toaster Top Part at the Drilldown: Part/Assembly, click the Shell the Interior Button, Set the thickness to .100 units, and Left Click the bottom surface of the Toaster Top Part. The Toaster Top Part should now be shelled as shown in Figure 2.1.

Adding Blends

Add the Blends as shown in Figure 2.2. The Rear Edge is 1.00 radius, Finger Grips .2875 radius, and Control Overlay Face .375 radius. The blends may fail at this point because they are cutting through the shell. To correct this, move the Shell Feature to the bottom of the Toaster Top Stack in the Scene Browser. This will Shell the newly created Blends.

Add additional Blends as shown in Figure 2.3. The Front Edge is 1.00 radius, Knob Cut .2875 radius, Top Edge .25 radius, and the Front Surface/Overlay .0625 radius. Again move the Shell Feature to the bottom of the Toaster Top Stack in the Scene

Browser. All Blends should now be shelled. The Blends are done at this stage because additional Feature Cuts for the Bread Slot, Control Panel Overlay, and Knob Arm Slot will key off the Blends.

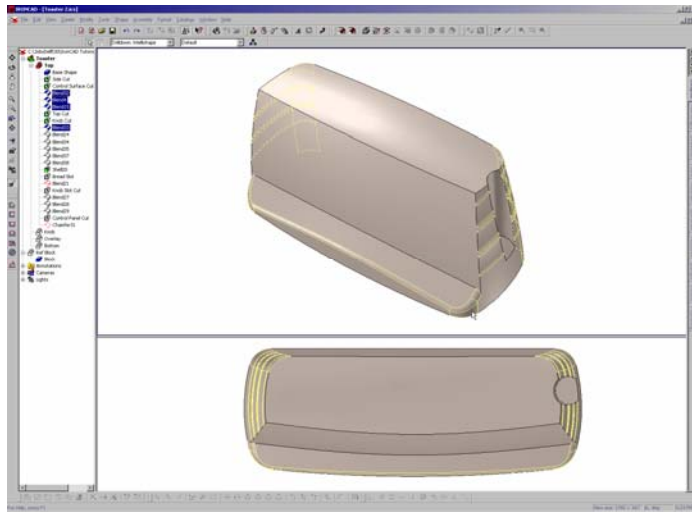


FIGURE 2.2 Adding Blends, Perspective and Top Views.

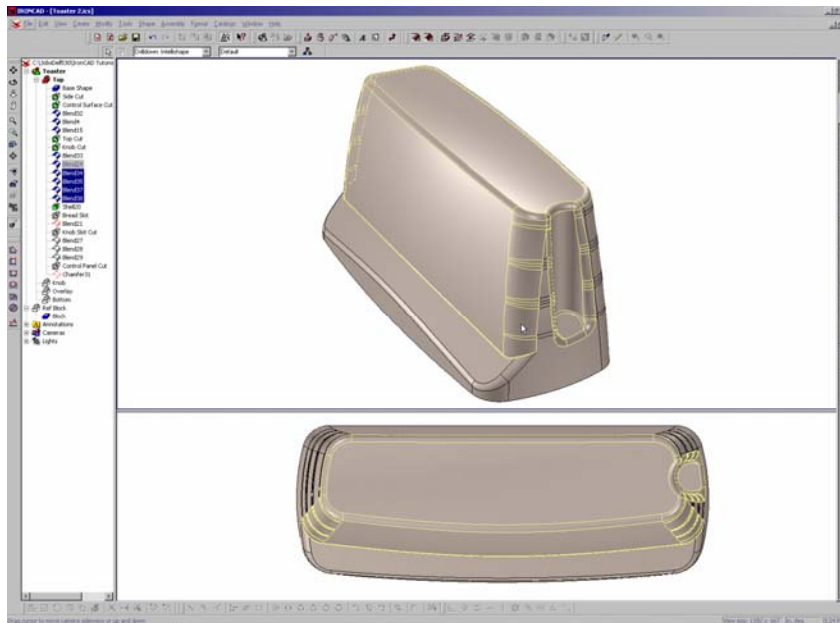


FIGURE 2.3 Final Blends, Perspective and Top Views

Adding Toast Hole and Knob Slot

TIP: Drafted Holes

Be aware that with a Drafted H Block or other Extruded Cutting Feature, the Taper starts from the Cross-Section Sketch Plane. The resultant hole will be a slightly different size from the Cross-Sectional Sketch and the draft effect will magnify this effect depending on the specified Taper, the distance from Cross-Section Sketch Plane to the Surface being cut, and the curvature of the surface. Therefore, the Cross-Section Sketch will probably have to be adjusted to get the desired hole size in the part.

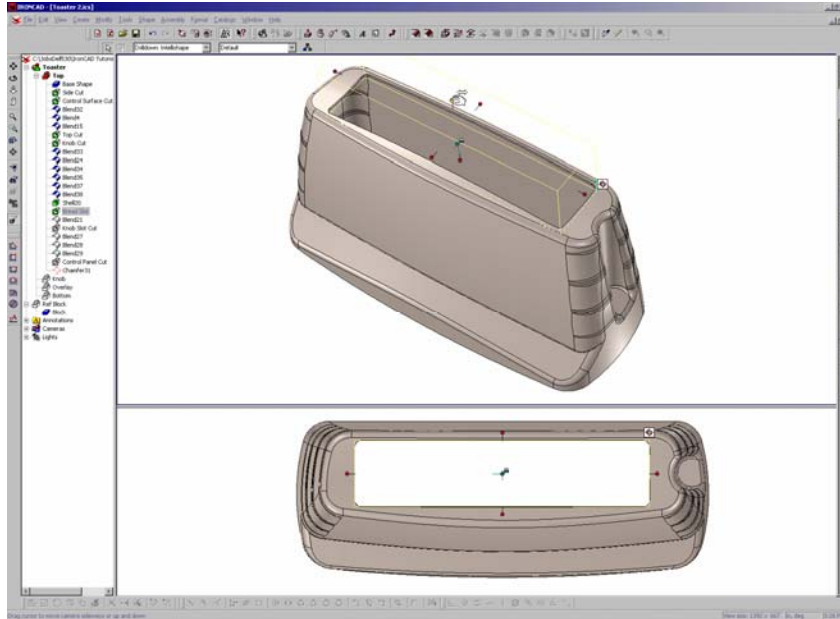


FIGURE 2.4 Adding the Bread Slot with a H Block, Perspective and Top Views

Drop an H Block from the Shapes Catalog onto the Top Curved Surface of the Toaster Top Part. Using the Triball, reorient the H Block so its extrusion direction is perpendicular to the bottom surface of the Toaster Top Part and one of its edges is parallel to the Bottom Rear Straight Edge of the Toaster Top Part. (Or use the Reference Block method to reorient the feature, See Figure 2.0). Center the H Block on the Top Curved Surface using the Triball and Center Points of the Vertical and Horizontal Blend Edges as seen from the Top View. Flip the Extrusion Direction and move the H Block Lower Box Handle so that it completely cuts through the Top Curved Surface. Activate the Extrude IntelliShape and select the Size Box Tab. Change the Dimensions Length to 2.5 units and Width to 11.25 units. Change the Resizing Behavior Length and Width Behavior to About Sizebox Center. This allows for future H Block resizing while maintaining a centered position on the Top Curved Surface. Next, go to the Surface Reshaping Tab, select Side, and change the Taper to 3 degrees. Select the Bevel Tab>Side Selection Edges, Select the Blend checkbox and change the Blend to .25 Units. Left Click the OK Button to exit the Extrude Intellishape Dialog Box. The H Block may have to moved .1 unit forward if its not centered. See Figure 2.4 for the completed feature.

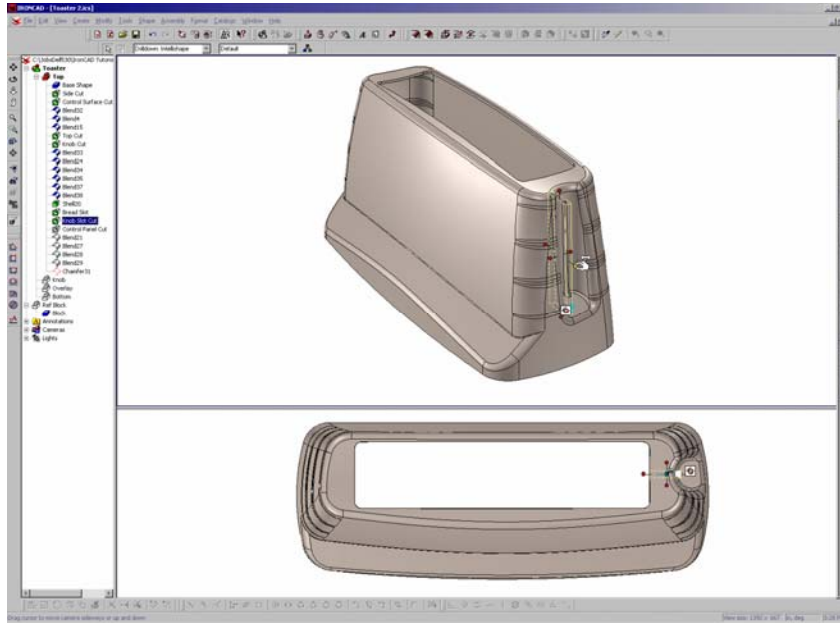


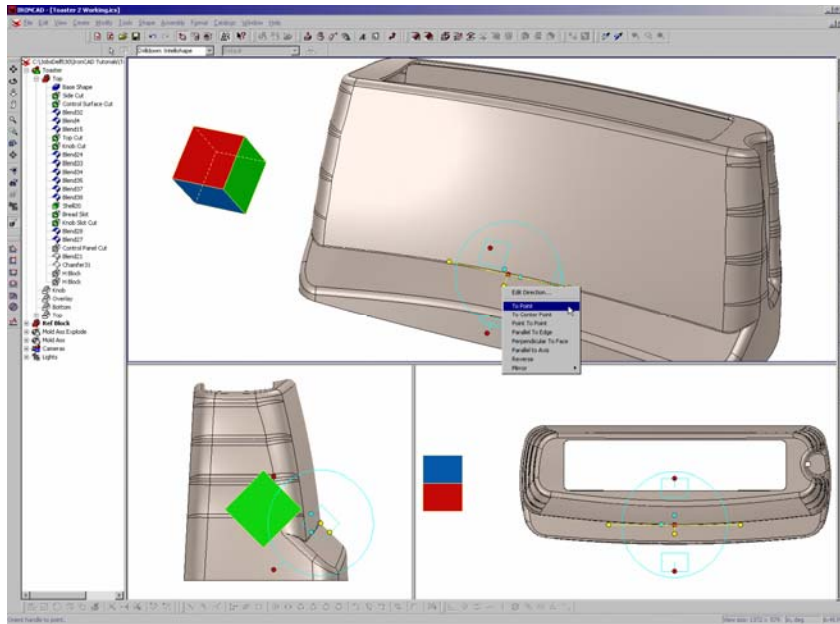
FIGURE 2.5 Adding the Knob Slot Cut with an H Block, Perspective and Top Views

The Knob Slot is created the same way as the Toast Hole. An H Block is dropped from the Shapes Catalog onto the Angled Bottom Surface of the Knob Cut. The H Block is reoriented with the Triball so that its extrusion direction is perpendicular to the bottom surface of the Toaster Top Part and one of its edges is parallel to the Bottom Rear Straight Edge of the Toaster Top Part. The H Block Width is set to .25 units with a Side Taper of -.5 degrees. The H Blocks Height and Length are adjusted by eye, just make sure that the feature cuts through the Angled Surface of the Knob Cut as the Knob Slot is part of the Male Mold Cavity.

Adding the Control Panel Overlay

The Control Panel Overlay Hole is created in the Mold by a Sliding Cam that operates independently of the Male and Female mold opening. (See Figure 1.1) In effect, the Overlay Hole has its own Die Draw Angle. The extrusion direction for the H Block that creates this hole must align with the Die Draw Angle of the Sliding Cam. The Die Draw Angle for this feature is normal at the Center Line Section of the Control Panel Overlay Surface. This can be determined by reorienting the Reference Block using

TriBall as shown in Figure 2.6. The Reference Block Triball is repositioned (*Position Triball Only*) on the center point of the Control Panel Top Edge and rotated (*Move Shape and Anchor*) using the *To Point* selection and left clicking the opposite edge center point. The Blue/Green Face Edges of the Reference Block are now parallel to the Die Draw and the Red Face is perpendicular. This makes it the perfect surface for aligning the H Block Cut.



TIP:
Editing
Suppressing
Features

The Cross-Section of a feature can be edited after the feature has been suppressed. This is useful in situations where the feature is removing or interfering with geometry that require Project 3D Geometry command when modifying the Cross-Section Sketch.

FIGURE 2.6 Orienting the Reference Block to the Die Draw for the Control Panel Overlay. Perspective, Side, and Top Views

Now, drop the H Block from the Shapes Catalog onto the Control Panel Overlay Surface. Note how the H Block is normal to the Control Panel Overlay Surface. The H Block extrusion direction must be parallel to the Die Draw of the Sliding Cam that creates this feature in the mold. To align the H Block, use the Triball and reorient the H Block so that its extrusion direction is perpendicular to the Red Face of the Reference Block or so that the extrusion direction is parallel to any of the Reference Block Blue/Green Face Edges. That fixes the feature in one axis. The H Block must also be reoriented so that any axis other than the extrusion axis is parallel to the Reference Block Blue/Red or Green/Red edge. Next, flip the Extrusion Direction and move the feature back so that it again cuts through the surface using the Triball or Handle on the Bounding Box. The H Block is then suppress and its Cross-Section is modified by deleting the existing profile and creating a new profile using the Project 3D Geometry tool and left clicking the Control Panel Overlay Surface. The resulting Splines are drawn over with the Arc: 3 Points tool and deleted. The Splines are deleted because they contain too many points and may cause problems with the Shell or future Blends or Chamfers. The new Arcs are selected, offset .06 units inward, and set to *Use*

Outline for Construction Only, for future reference. The H Block feature requires a Side Taper of 1 degree set in the Surface Reshaping Properties Dialog Box. Don't forget to Unsuppress and rename the H Block feature. See Figure 2.7 for the result of the cut.

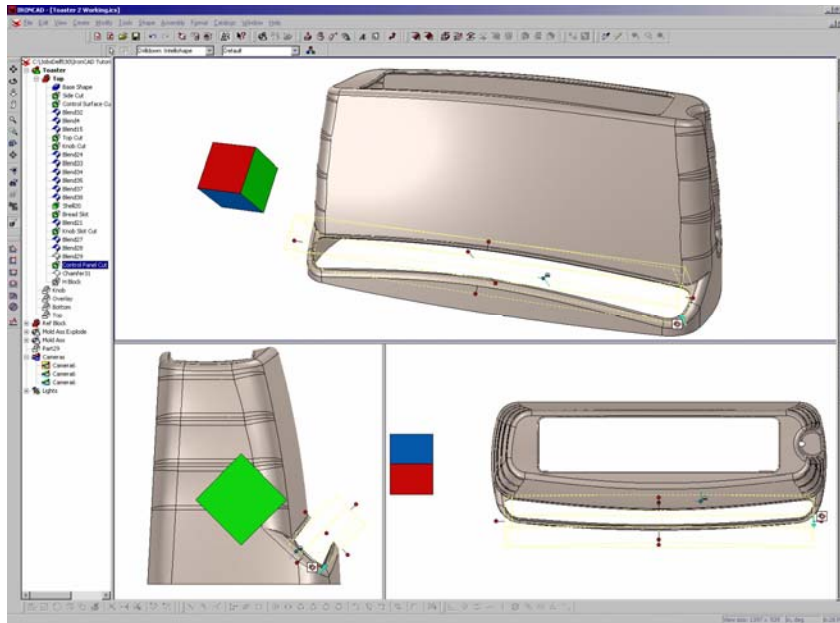


FIGURE 2.7 Adding the Control Panel Overlay with a modified H Block, Perspective and Top Views

Final Blends and Chamfers

To finish the part, add a .0625 R unit Blend to the Bread Slot Hole and a .015 by .015 unit Chamfer to the Control Panel Overlay Hole. (See Figure 2.8)

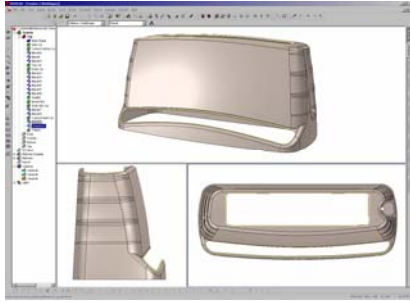


FIGURE 2.8 Adding Final Blends and Chamfers, Perspective and Top Views

That completes the construction of the Toaster Top. Future tutorials will highlight the construction of interior details such as the ribs, bosses, and the interlocking joint detail. Construction of the Toaster Bottom, Control Panel Overlay, and Knob Parts will also be featured.



FIGURE 2.9 Completed Plastic Assembly

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