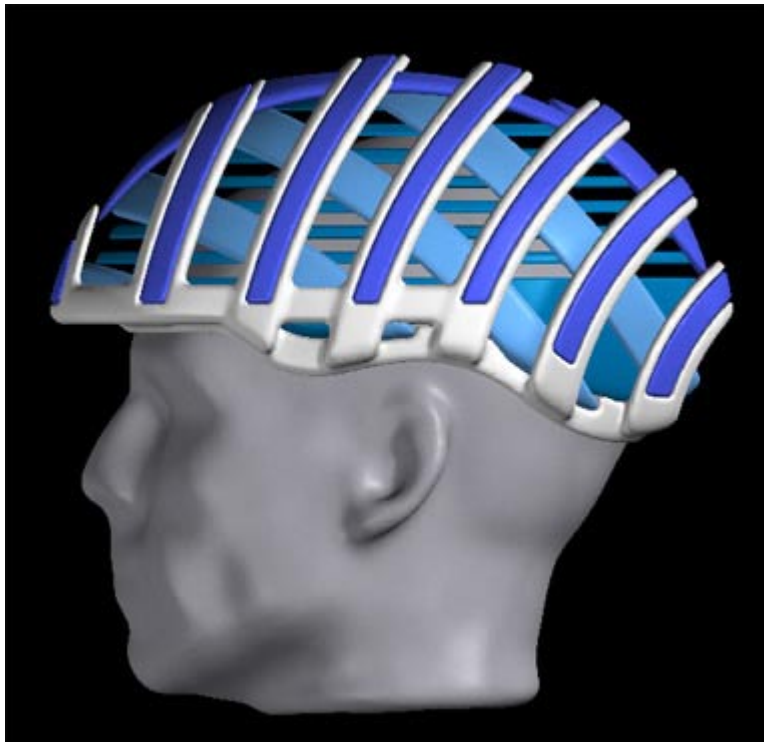




FREEFORM™  
FEEL THE DIFFERENCE

## FreeForm Modeling System Workflow Study Mountain Bike Helmet



**Artist:** Mark Conahan, FreeForm Product Specialist

**Description:** Follow the creation of a bike helmet, from its start, as reference data and safety standards, to its completion as a multi-layered, multi-piece model.

**Time:** 4 hours

**Software Version:** FreeForm™ Plus modeling system, Version 4


## Step 1) Setup

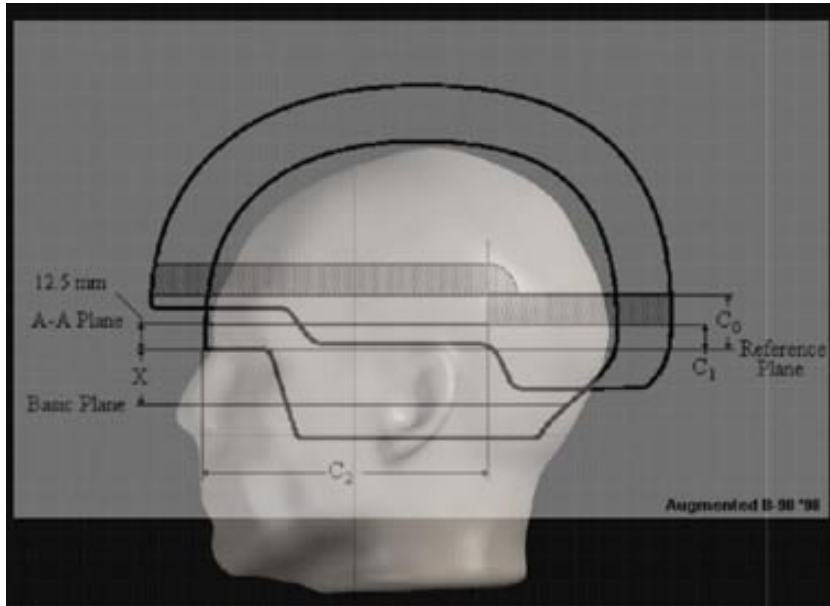
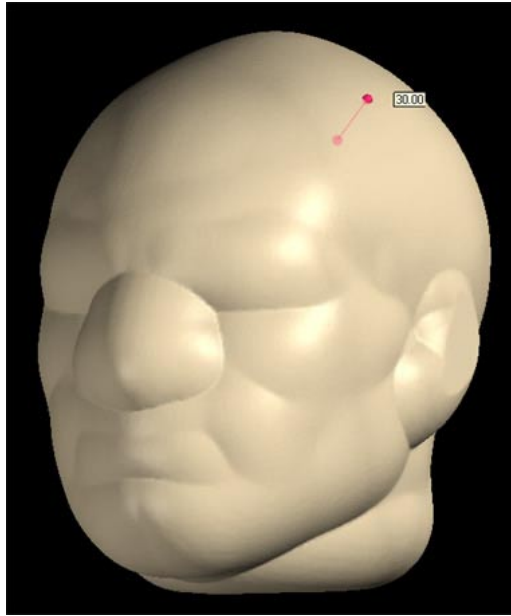
1. Create a new empty workspace via the **File** menu (**File**→**New**), with dimensions 250 mm x 300 mm x 300 mm.

Using

**File**→**Import**→**Model**, import the STL of the head at *Add Detail*.

Open the **Object List** (**View**→**Object List**, or the **o** hotkey), right-click on “Piece 1”, and choose *Reposition*. Open the *Advanced Settings* dialog

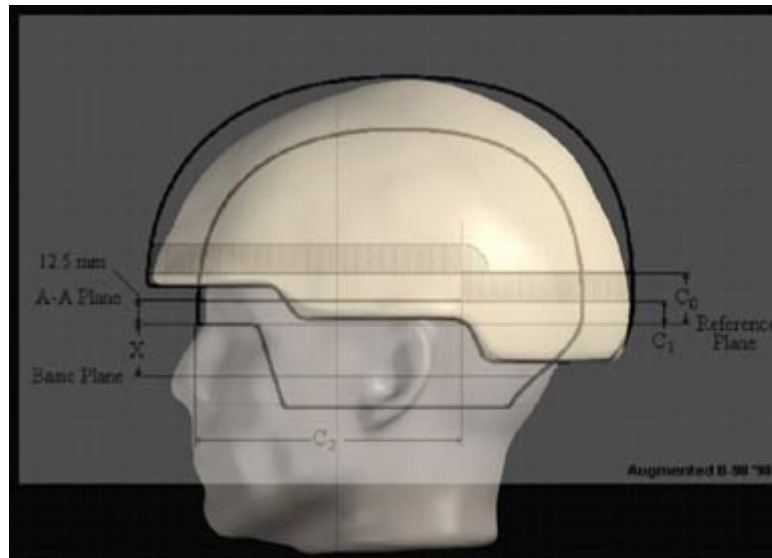
via the  button. Position the head at (0,0,0). Again, right-click on “Piece 1” in the Object List. This time, choose *Rename* and name the piece “Head.” Create a new plane on the side of the workspace (in the profile of the head). Enter **Sketch**, and then choose to import an image on to the plane (**File**→**Import**→**Image**). Import the helmet reference image.



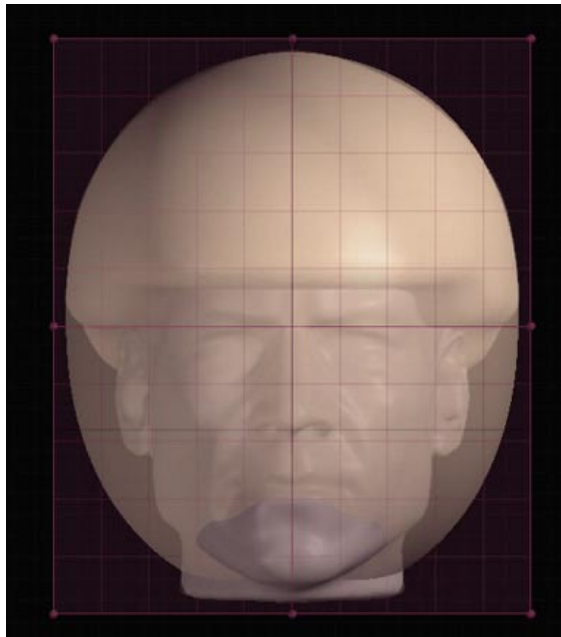
## Step 2) Roughing out the Helmet

1. Under the **Pieces** menu, choose **Create Offset Piece** (**Pieces**→**Create Offset Piece**). Offset the new piece 30 mm to the outside. In the **Object List**, right-click on “Head” and choose to *Remove Clay From* the offset piece. This will create a 30 mm thick shell. Again, right-click in the **Object List**, choose *Rename* and name the piece “Min Helmet.” This piece represents the minimum thickness that the helmet can be (according to our “safety standards”).

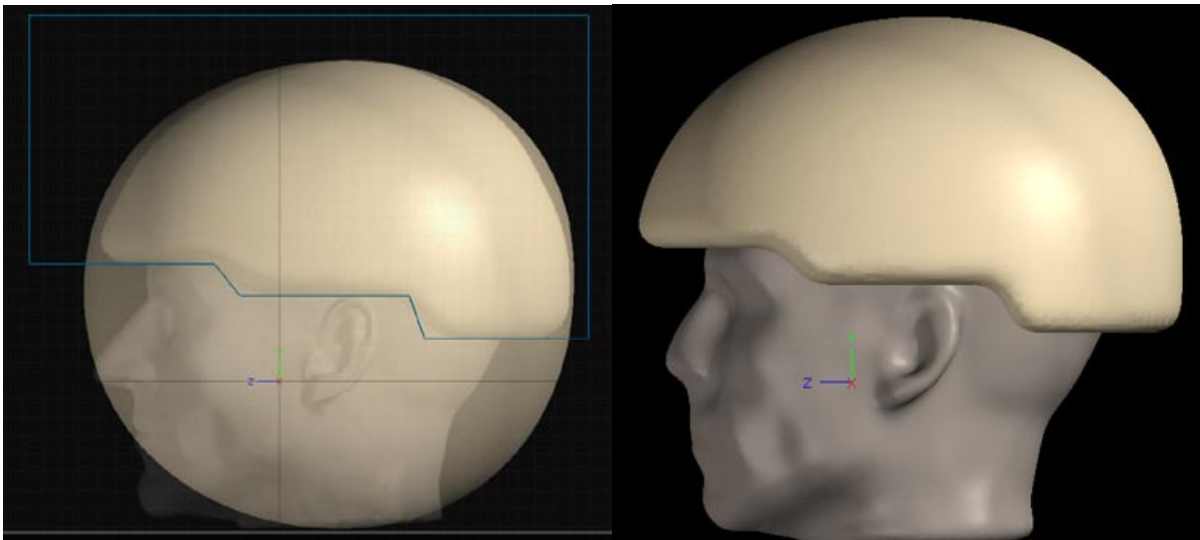
2. Create a new plane parallel to your reference image. Enter **Sketch**, and trace the profile of the helmet. Exit Sketch and start the **Wire Cut** tool. Select the just drawn sketch and then use *Cut Outside* to remove all of the clay outside of the sketch.



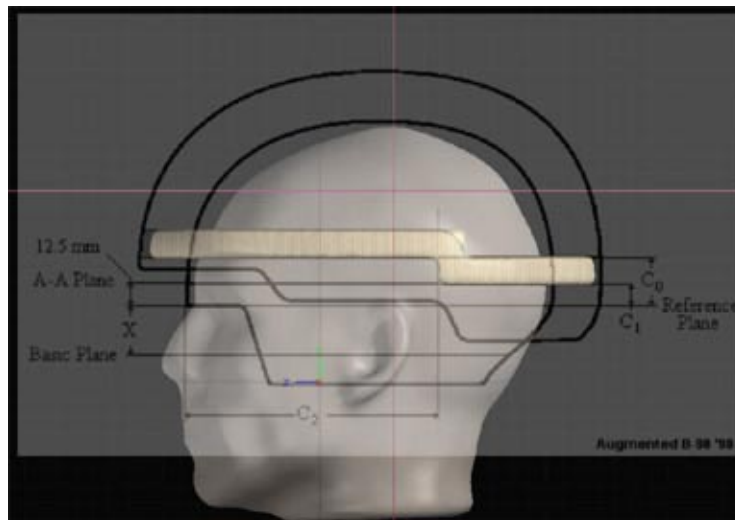
3. Create a new piece (**Pieces**→**New Piece**) and choose a sphere as the starter shape (the default Clay Coarseness and dimensions are fine). Right-click on the newly created piece in the **Object List** and *Rename* it “Helmet.” Start the **Deform** tool and pull the sphere shape until it is a good approximation for the helmet in the reference image. The minimum thickness piece should not show through the sphere (meaning the helmet will meet the “safety standards”).
4. To achieve the proper thickness and shape for the front profile of the helmet, some sort of reference data is needed. Here, a simple technique will be employed that can often be used in FreeForm modeling. In the **Object List**, activate the “Min Helmet” piece. Press **F2** or choose **View**→**Standard Views**→**Front** to view the model from the front. Take a screenshot of the model choosing **File**→**Save Screen to File**. Save the file. Activate the “Helmet” piece. Place a new plane on the front of the model. Enter **Sketch** and import the image just saved. This, in essence, is using the minimum thickness model as the reference data. Once again, enter **Deform** and shape the sphere so that it approximates the helmet shape, while not allowing the minimum thickness model to show through.



5. Activate the “Min Helmet” piece. Repeat the screenshot procedure from the previous step, this time taking a screenshot of the minimum thickness model from the side (**F3**, or **Views→Standard Views→Right**). Once again, activate the “Helmet” piece. Create a new plane in this right side view, enter **Sketch** and import the screenshot just saved. While still in Sketch, trace the curve used to cut the shape of the minimum thickness model. Enter **Wire Cut**, choose the just drawn profile, and use *Cut Outside*. This will give the helmet its initial shape.

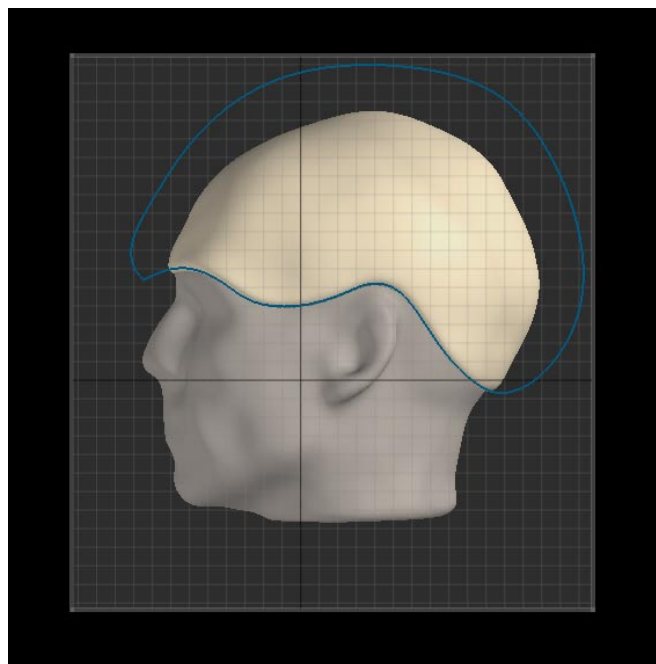


6. Right-click on “Helmet” in the **Object List** and choose to *Hide* the piece. Still in the right side view, ensure that the “Min Helmet” piece is active. Enter **Sketch** and trace the profile of the “safe band” area. Start the **Select Clay by Profile** function on the Select flyout. Select the clay defined by the “safe band” profile (as shown in the screenshot below), and choose *Copy*. Then, paste the clay back into the scene as a new piece via the **Pieces** menu (**Pieces→Paste as New Piece**). Rename this piece “safe band.”

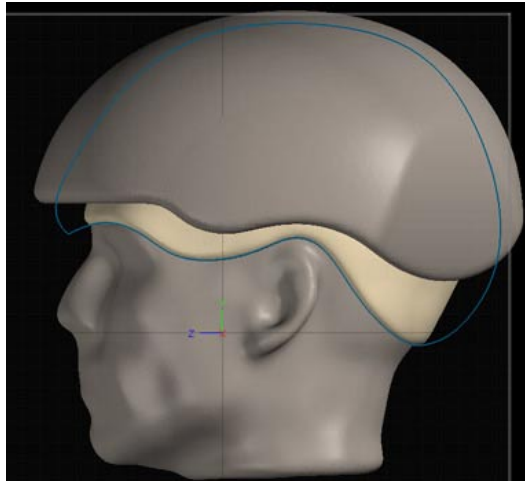


### Step 3) Creating an Inner-Helmet Liner

1. To create the inner helmet liner – the layer that resides inside the helmet and is fit to the rider’s head – hide all of the pieces with the exception of “Head.” Via the **Pieces** menu, choose **Create Offset Piece** (**Pieces**→**Create Offset Piece**). This new piece should be 5 mm thick, offset to the outside. In the **Object List**, choose “Head” and choose to *Remove Clay From* the new offset piece. This will leave just the 5 mm offset piece. Rename this piece “liner.”
2. Create a new plane in the right side view of the “liner.” Enter **Sketch**, and draw a curve the roughly approximates the shape that an inner liner would take on the head. The curve should go across the forehead, over the ear, and then down around the back of the head. Use **Wire Cut**, select the profile just drawn, and *Cut Outside*. This will leave the proper shape for the inner helmet liner.

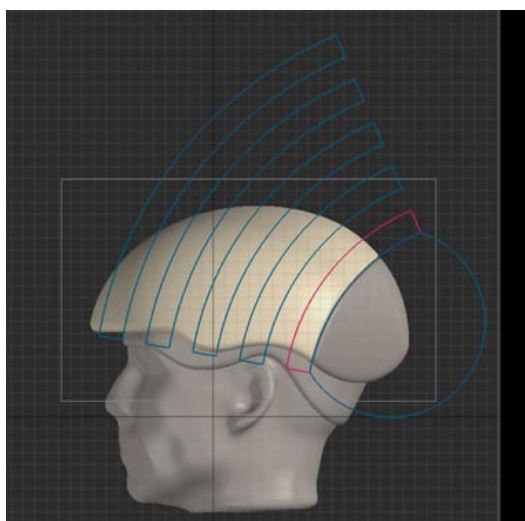


3. Activate the “Helmet” piece and refine the edge of the helmet to better flow with the liner. Use the carving tools (**Smudge** and **Smooth**), as well as a **Wire Cut** (if necessary). This is a purely cosmetic step, so feel free to experiment.



#### Step 4) Creating the Helmet Layers

1. Start by creating two new pieces offset from the “Helmet” piece: one offset at 6 mm to the inside; the other at 12 mm to the inside. Right-click on “Head” in the **Object List**, and choose to *Remove Clay From* each new piece. Rename the outside layer piece (offset 6 mm) as “Outside Layer” and the inside layer piece (offset 12 mm) as, not coincidentally, “Inside Layer.”
2. To create the “weave” effect, activate the “Outside Layer” piece, create a new plane in the right side view, and enter **Sketch**. Create a series of arcs, making liberal use of the **Offset** function, along with *Copy* and *Paste*, to speed the creation. Create a circular cutout at the end of the arcs. The next image can best describe how the arcs should be laid out (of course, this is again, cosmetic, and can the look can be experimented with).

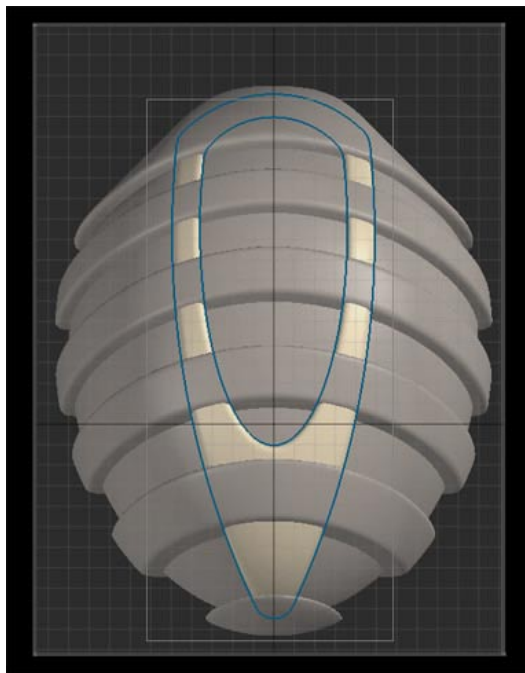


3. Use **Wire Cut**, with the *Cut Inside* option, to cut the bands into the outer layer. Then, use **Select Clay by Profile**, choose the back circular cutout, *Cut* the back area away, and then use **Paste as**

**New Piece (Pieces→Paste as New Piece)** to paste the clay as a new piece, as the back of the helmet should remain a solid piece for safety reasons. Rename this piece “back.”

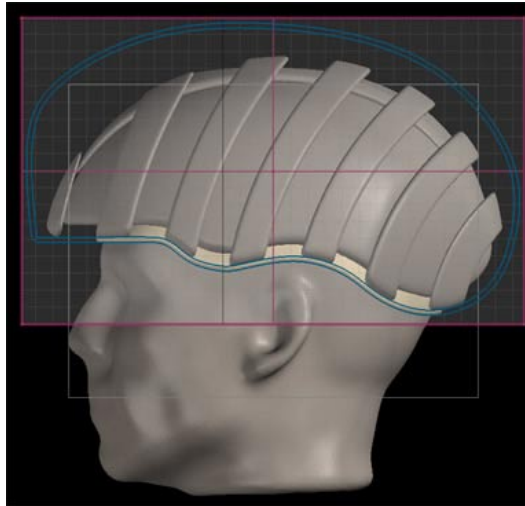


4. Activate the “Inner Layer” piece. Create a plane on the top of the model and enter **Sketch**. Sketch a “V” shape band. Start **Wire Cut** and choose to emboss the “V” shape a distance of 3 mm. Using **Select Clay by Profile**, select the band of clay just embossed (using the same “V” shaped profile). Via the Dynabar, *Cut* the clay, then **Paste as New Piece (Pieces→Paste as New Piece)**. Rename this new piece “V Band.” Right-click on “V Band” in the **Object List**, and choose *Remove Clay From* “Outer Layer.”

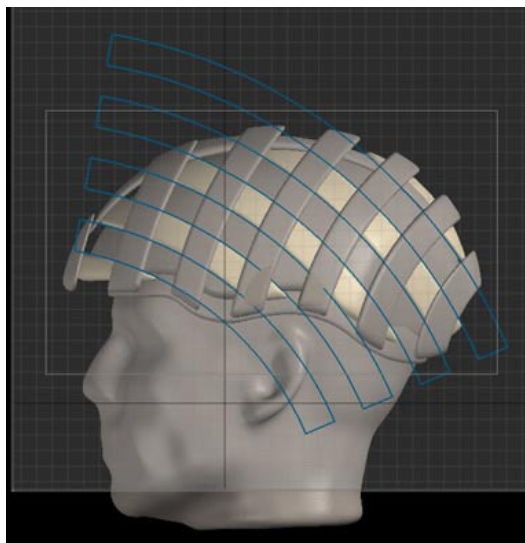


5. Revisiting the decision to leave the back of the helmet as a solid piece, it seems it may be better to include it in the “weave” pattern. Right-click on the “back” piece, and choose to *Combine Into* “Outer Layer.” Choose the plane containing the various arcs. Enter **Sketch**, create the arcs that will cut the back of the helmet. Use **Wire Cut**, choose the new arcs, and *Cut Inside* to form the weave.

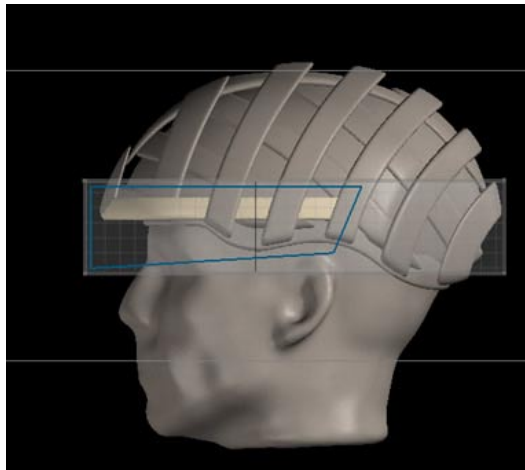
- At this point, it appears that the inner liner may extend down too far. Activate the “liner” piece, and choose the plane that contains the profile previously used to cut the shape of the liner. Using the **Offset** tool, offset a new curve that is 3 mm inside of the previous profile. Exit Sketch, start **Wire Cut**, and use *Cut Outside* to trim the liner.



- Activate the “Inner Layer” piece. Create a new plane in the right side view. Enter **Sketch**, and create arcs to again cut the layer into bands. This time, the arcs should face in the opposite direction. Exit Sketch, start **Wire Cut**, and choose the newly created arcs. *Cut Inside* the arcs to create the “weave” on this layer.



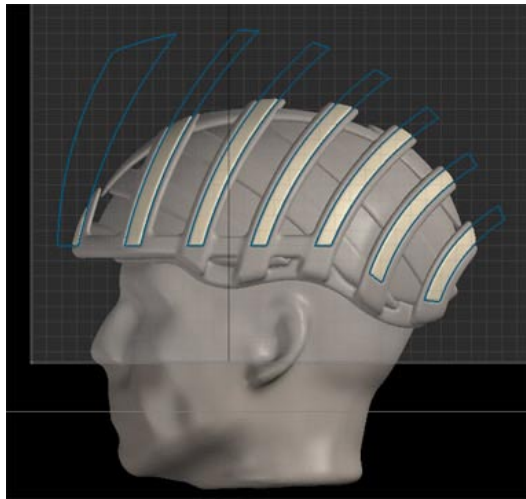
- At this point, the “safe band” will be incorporated into the structure of the helmet. Activate the “safe band” piece. Create a new plane in the right side view, enter **Sketch**, and create a profile that will be used to cut the safe band just beyond the ear. Exit Sketch, once again start **Wire Cut**, and use the profile to cut the safe band piece.



9. To create a strong frame for the helmet, combine the “safe band” and “liner” pieces into the “Outer Shell” by right-clicking on each piece and choosing *Combine Into* “Outer Shell.” Use the **Smooth** tool to smooth the intersections of the pieces, and then choose to increase the Clay Coarseness via the Tools menu (**Tools**→**Clay Properties**→**Clay Coarseness**). Increase the coarseness to *Add Fine Detail*. Again, use the **Smooth** tool to smooth the intersections of the pieces.



10. With the “Outer Shell” piece active, create a new plane, again in the right side view. Enter **Sketch**, and create concentric arcs that will be used to cut out the center of the bands. Use **Select Clay by Profile**, select the clay contained within the just drawn profiles, *Cut* the selected clay, and then use **Paste as New Piece** to paste the clay back in as a new piece. Rename this new piece “Inserts.”



11. Open the **Object List** and right-click on the “Inner Shell” piece. Choose to *Remove Clay From* “Helmet,” creating airflow through the helmet.
12. Again, activate the “Inner Shell” piece. Create a new plane in the right side view and enter **Sketch**. Sketch a large group of thin, parallel horizontal boxes. Start **Wire Cut**, and use the horizontal boxes to *Cut Inside*.
13. As a finishing touch, change the color of each piece. Here’s the final result:

