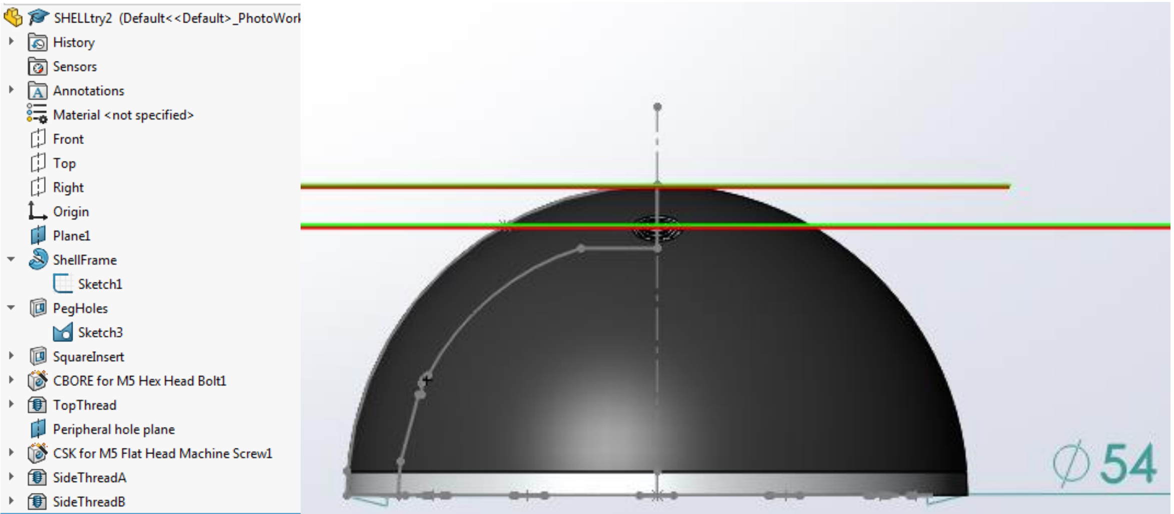
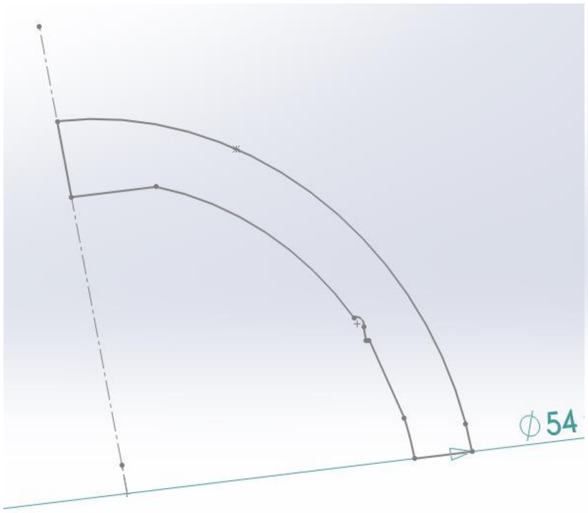
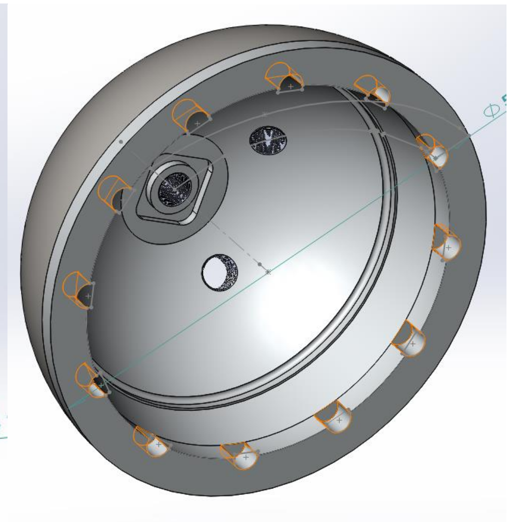
Hip Implant Model in SolidWorks

SHELL



Method Breakdown:Materials are allocated per surface, and there is a difference in the material around the bottom of the shell (seemingly negligible thickness). Must create multiple surfaces while maintaining full arc dimensions of shell (54mm). Revolution used to create the frame of the part, so first create an arc (sketch) to ensure bottom most point maintains position. Then, create line line from the bottom most point to another point on the arc. Once the arc is trimmed from the area that spans the new line, the distinguished surface is created upon revolution. Points/shape of inside of shell planned out to best replicate to images to fullest detail. Point on inside of shell created to use as reference for pegs to come in at correct height. Top inside of shell flattened to allow for easy extrusion of square like patterns.

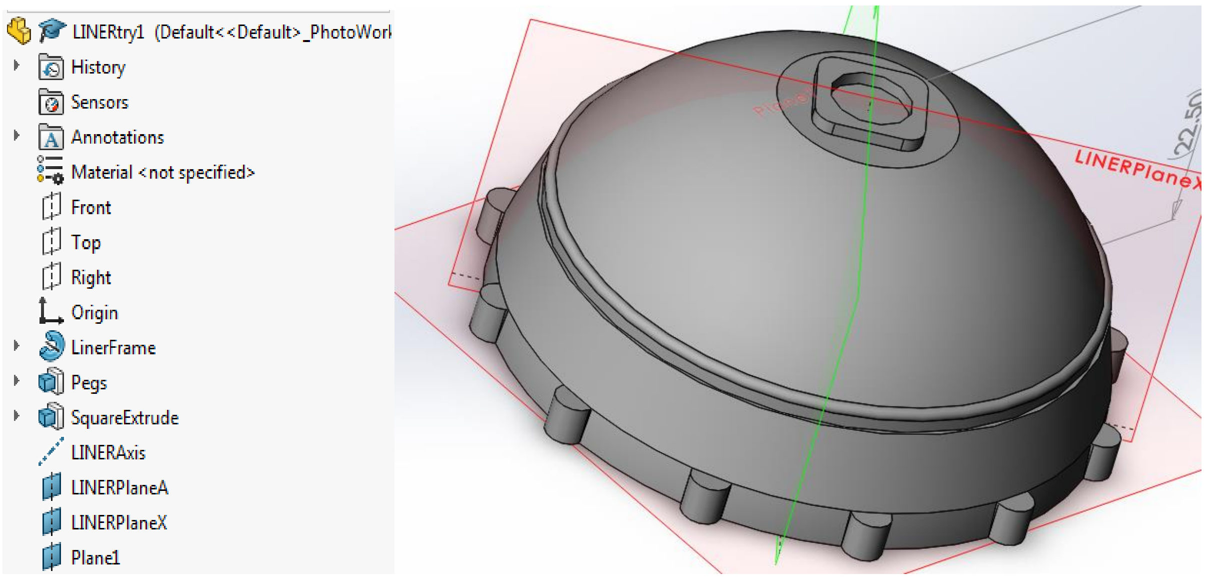




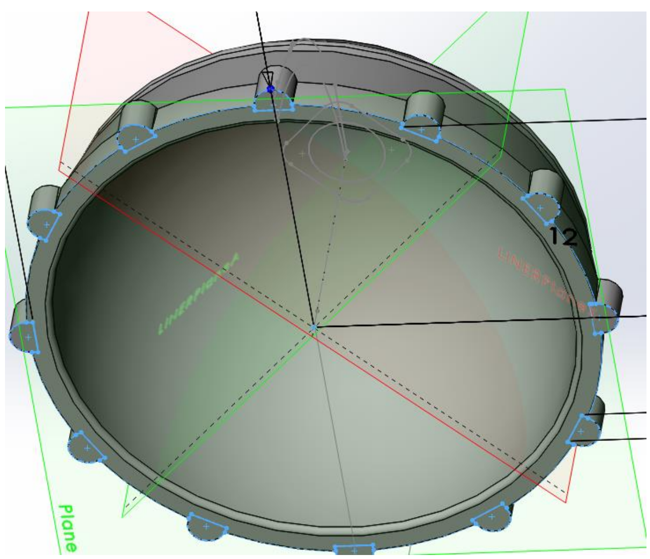
Peg holes along brim accomplished using extruded cut of 12 slightly elongated (towards center) profiles in order to ensure all of curved surface subtracted. Rounded square accomplished with slight extruded cut, holes created via hole wizard, dimensions customized to most accurately fit image depiction, 3D sketches used to mark center of non central holes after sketches traced

locations on edge of circle (90 degrees apart). All threads extruded from hole surface as close to accurate threading as possible.
Materials: Outer Shell: Cast Carbon Steel. Inner shell: polished Aluminum. Top hole indent: Sandblasted Steel.
Major issues: None specific to part

LINER



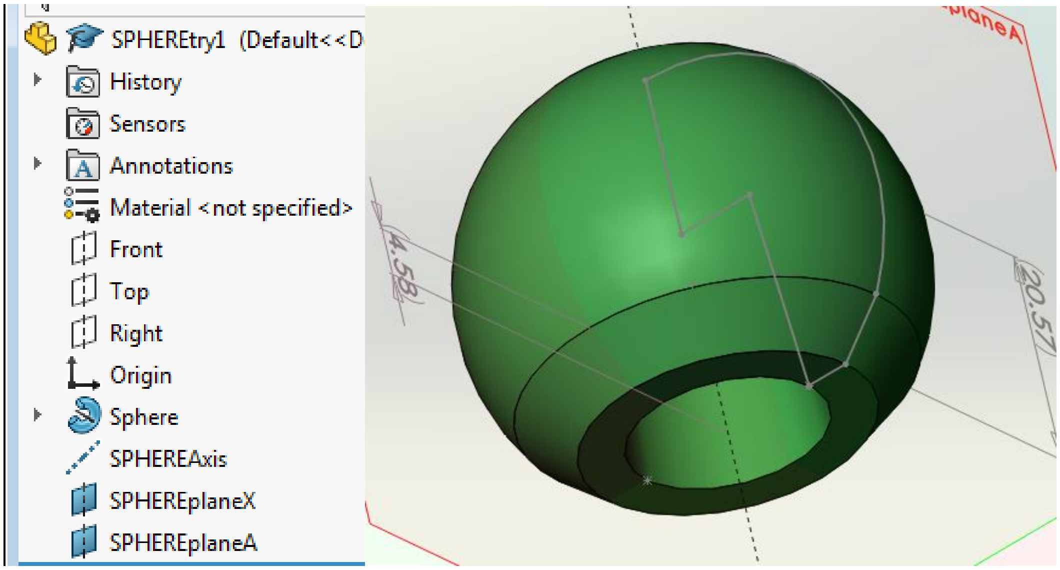
Method Breakdown: The same structure of the inner surface of the shell was maintained by copying necessary portion of the eventually revolved sketch. Additionally, square extrusion outline in center of liner, and the peg extrusions, were copied over from sketches on the Shell part. The additional planes displayed were created for later mating conditions/alignment. It appeared that the screw that holds the parts together was not part of the overall design displayed on the



The fillet of bottom inner edge was created on the sketch pre-revolve.
Material: White soft touch plastic

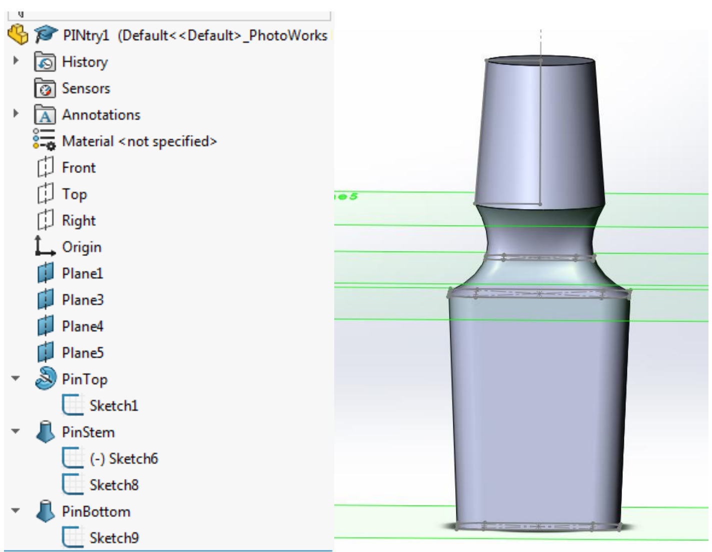
Major Issues: None specific to part

SPHERE



Method Breakdown: Revolve proved to be most efficient method again, as bottom angle was easily created on top of profile of inside of the liner. The Pin hole was created based on desired circular geometry of pin. Again, Planes created to resolve mating conditions/alignment.
Material: Green medium gloss plastic
Major Issues: None specific to part

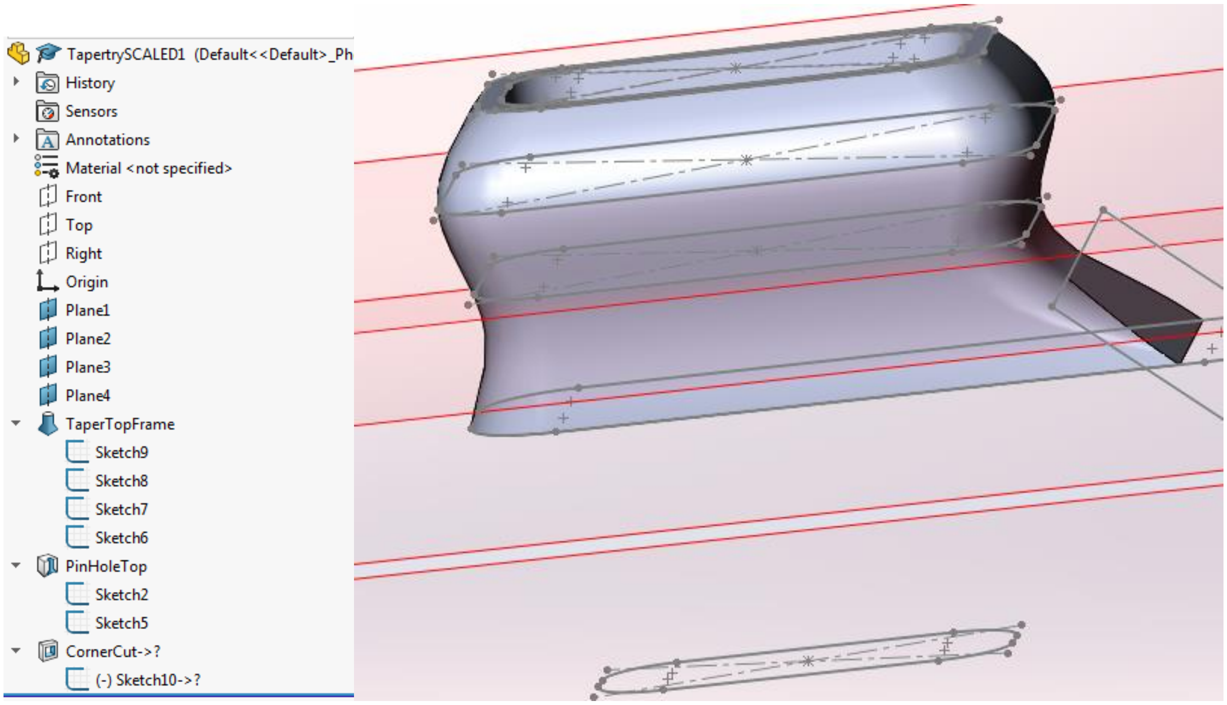
PIN



Method Breakdown: Top portion of pin most efficiently accomplished by copying over necessary part of Sphere sketch outline and revolving. Middle section created using loft feature through 3 different rounded rectangles with equal sketch fillet values. Separate loft necessary to create bottom portion, must be separate to ensure flat sides and uniform sloping, combining the

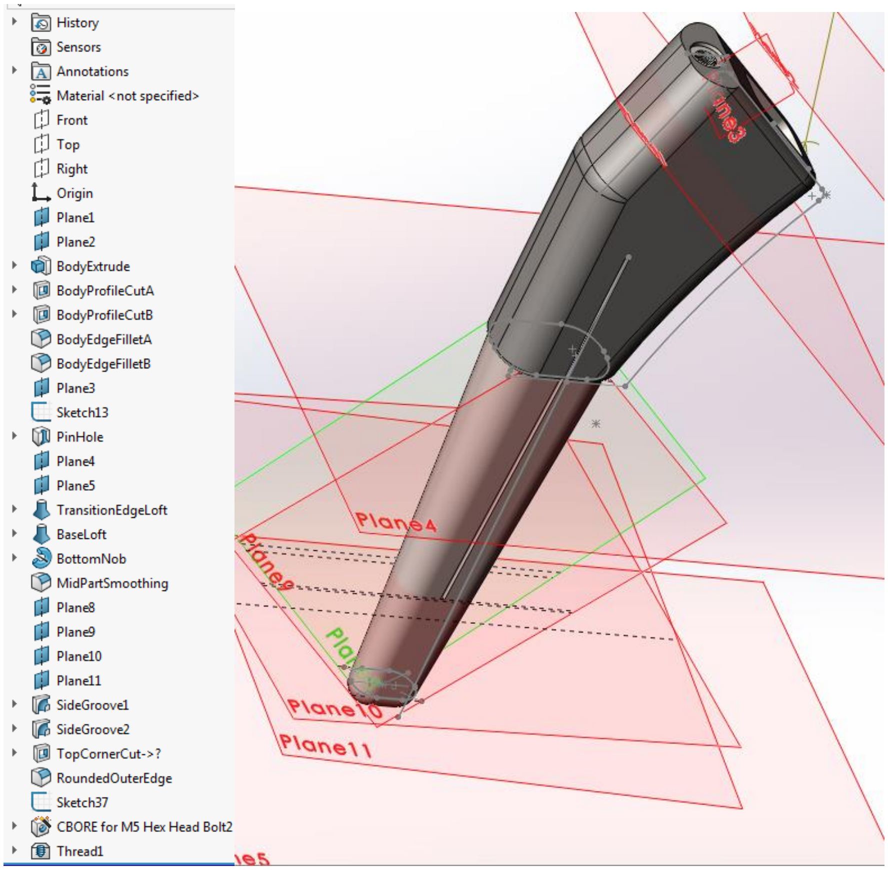
two lofts results in curvature along the bottom portion as well as slight deformation from desired middle section shape.
Material: Burnished titanium
Major issues: None specific to part

TAPER
Taper Top

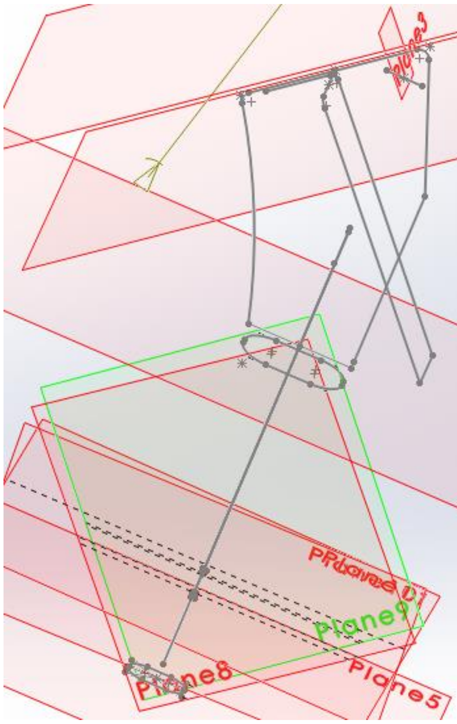


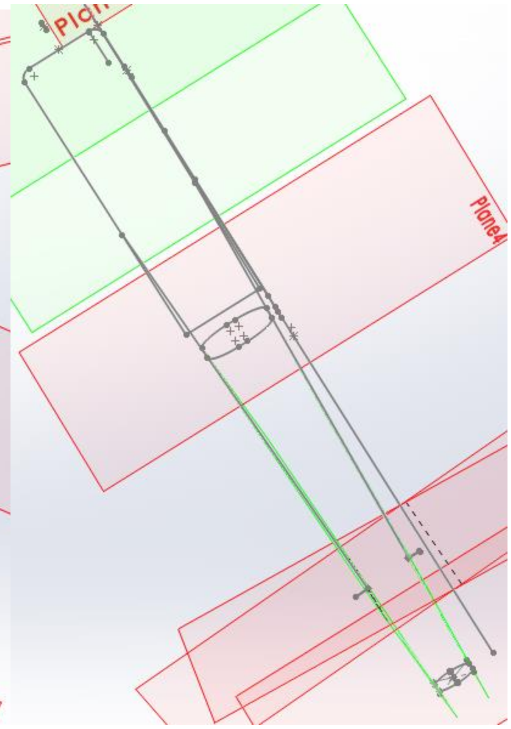
Method Breakdown: Profiles of loft shown, chosen to best replicate product on website. Sketches from pin bottom (loft) transferred to ensure correct curvature of insert hole, which was created by a <u>lofted cut</u>. In hindsight, multiple parts for taper not essential, but somewhat simplifies process of sculpting top edges of Taper body
Material: Burnished Titanium
Major issues: Cut made along bottom right corner difficult to align perfectly with curvature. Problem solved with extruded cut on part, with plane derived on Assembly file and translated to both parts. Cut continued to the body of the Taper, but precision was not essential on the intersection of the parts because the parts contained the same plane from the assembly and sketches could overlap to result in a continuous, flat cut.

Taper Body



Method Breakdown: Extrude and extruded cut used to extract unsmoothed block of top portion (non stem) of Taper Body. Fillets in sketch round out applicable edges at the top and bottom via the BodyExtrude. Fillets along outer edges created with standard fillet feature. The flattened top corner was made to fit with Taper Top on the assembly derived shared plane. To perfect the transitional section between the body and stem, a profile was created just below bottom surface of the body. By again lofting on 2 separate lofts, the edge on the bottom of the body (main) can be then filleted to create a symmetric, realistic imitation. The stem's separate loft ends at the sketch profile shown at the bottom, and that sketch is then used to revolve half of it 180 degrees and create the cap like end of the stem. Revolve proved to be essential to preserve the rounded-rectangle shape and continuity with the stem. There are other features that could have accomplished many of these part components, and an effort was made to do so, but none seemed more efficient and effective.

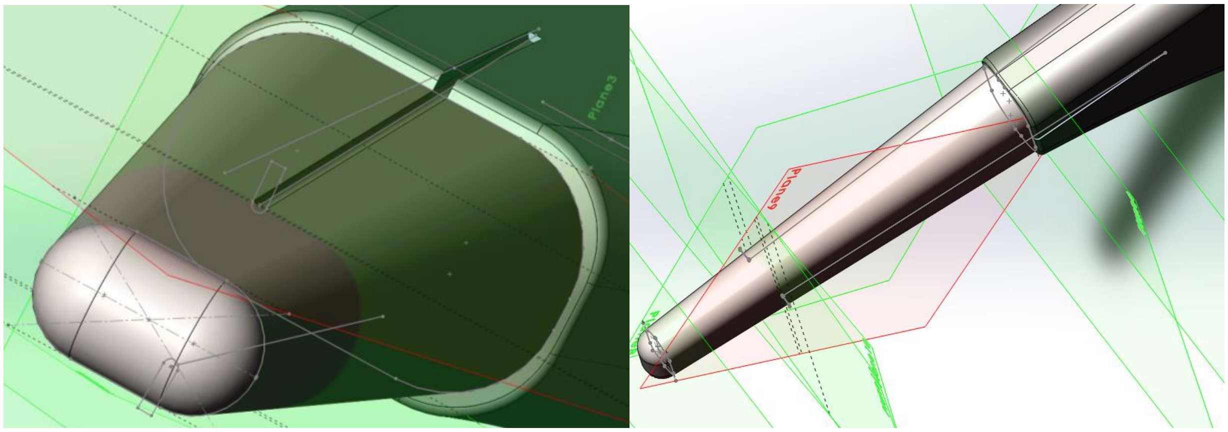




The above images show the sketches from which the profiles originated, left image showing the side view, and right image showing a view from the back (perpendicular to each other). The profiles and planes from the lofted cut of the bottom part of the Pin were replicated to ensure identical dimensions and a clean fit. The side grooves were done separately using sweep cut. Mirror was also used to transfer in another version of the part, but as both sketches and planes may be useful for material reduction, the mirror feature seemed less productive long term. The advanced hole feature used to create on top corner surface along midplane of the Taper, and the thread feature was implemented accordingly.

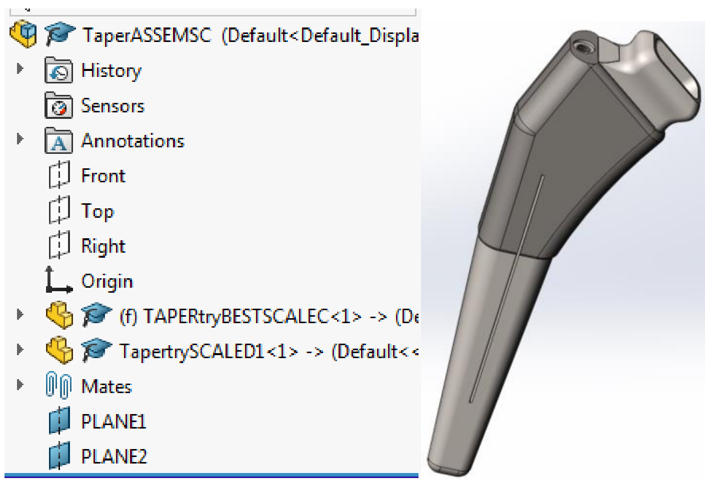
Materials: Body (main): Cast titanium. Body (stem): burnished titanium. Corner surface/grooves/hole/thread/Pinhole: burnished titanium.

Major Issues: defining plane to accurately sketch a consistent groove to run through depicted parts of Taper body. In order to get a consistent groove, a sketch must be drawn on a predefined plane to set up the sweep cut and ensure a continuous groove across all surfaces. Creating the planes was accomplished by defining it based the top and bottom profiles of the taper stem. The lines were traced on such planes, but only after the body’s (main) faces were sketched upon to give the desired start point, in reference to the bottom of the main part of the body. Drawing the desired lines on the stem planes, and starting at the traced points already defined on the surface is not the most perfect way to exactly align the grooves, but as it only offsets by a pixel or so and the grooves don’t seem to require unbelievable precision, it was the optimal method, considering the development process of the taper. Perpendicular planes were created to the planes of the groove lines, and the sketches drawn on them were exaggerated to cut safely beyond the heightened edges as the sweep cut moves up the body of the taper (to thicker sections). The sweep cut then is clearly shown to make continuous grooves on both sides, as desired and depicted in the product.



The left image depicts the sketches and paths that created the grooves, while the right image above depicts the necessary planes to resolve the problem of defining the sketches appropriately.

Mated Taper



Method Breakdown: Advanced mate using profile center feature before the top corner was cut from both parts to ensure exact alignment and continuous Pin hole. Planes 1 and 2 not displayed, as both were created to extrude cut the top corner.

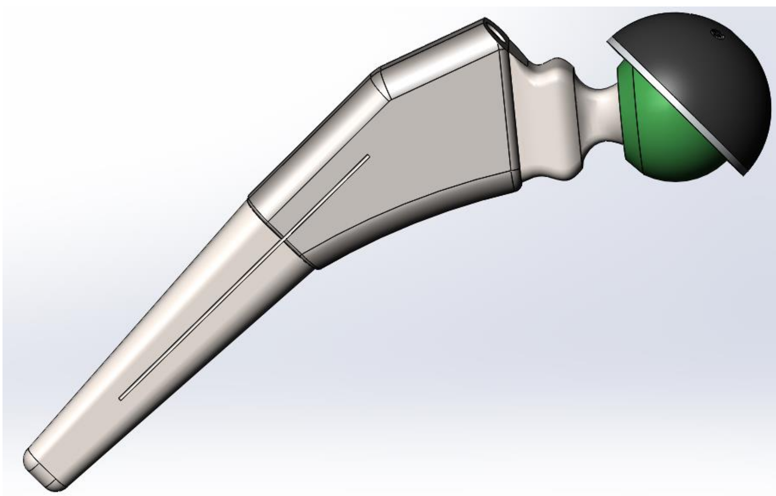
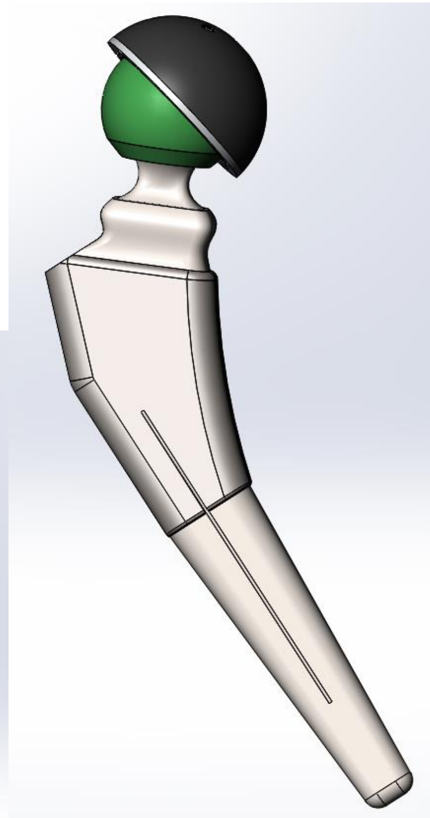
MATED ASSEMBLY ISSUES

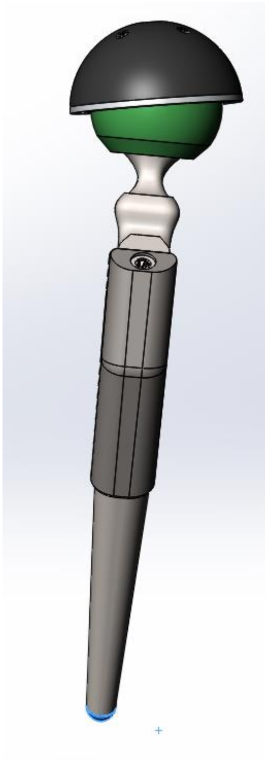
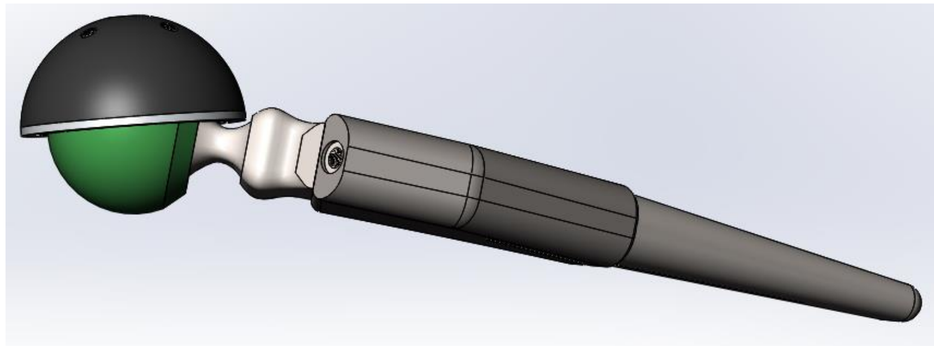
All mates other than the Sphere-to-Liner mates fit perfectly and should not allow for any freedom or movement. To perfect the range of motion between the sphere and liner, the range of motion for a typical human hip must be accurately depicted using 2 different LimitAngle mates. The planes created and depicted earlier are used to offset from each other and distinguish the degrees of freedom. Applied range of motion (mean) values are listed below.

Flexion	120.3 degrees (modified to 75 degrees)
Extension	9.4 degrees
Adduction	30.5 degrees

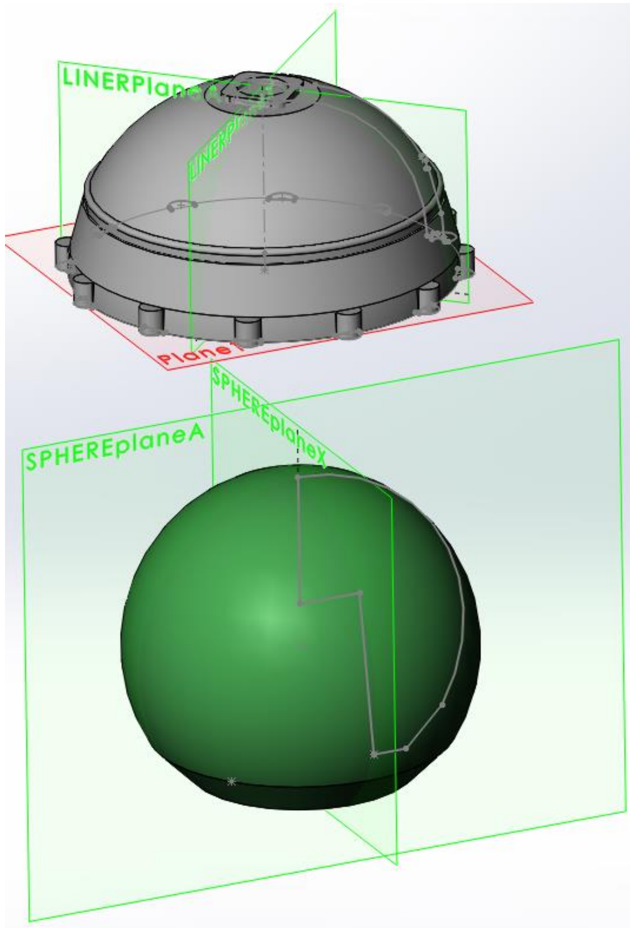
Abduction	33.8degrees

Images of the restricted angles are shown below

Because these are numbers evaluated for the hip as a whole system and not just the joint, they cannot give a full and accurate picture for what our hip joint should move like. The Flexion capabilities would overlap the pin and the shell/Liner, so it is cut (to 90 degrees) below the mean above. The muscles and rotational capabilities of the hip system is much harder to quantify, but applying the dimensions above to the forward/back or side to side motion schemes of the hip joint are a rough start and more accurate/proportionate than raw approximation.



The planes that correspond to different degrees of freedom are distinguished as [part_name]planeA for abduction/adduction and [part_name]planeX for extension/flexion. The bottom plane was put in place to correct irregular behavior where the mate would allow for the Pin to intersect directly through the middle of the shell, the wrong way, which cannot be permitted.