Mesh Refinement via Volume Controls

I. Overview
Goal is to create a refined mesh in a volume of the computational domain. This is useful when controlling the mesh by specifying surface mesh parameters is not sufficient. The technique described in this tutorial uses a volumetric control applied to a subset of a fluid region. The volumetric control is applied over a simple volumetric shape, e.g. block, cylinder, cone or sphere. The volumetric shape is not a separate part.

A. Create a Volume Shape (via the Tools menu)

B. Create a Volume Control in the Mesh continua

C. Specify a custom volume mesh (custom Polyhedral mesher)
   Use the custom mesh size to control size of cells inside the volume control

II. Import or create the geometry of the region
In this example we create a rectangular duct, but it could be a more complex shape.
It is helpful to record the dimensions of the duct and the coordinates of the corners.

A. Example: Create a rectangular duct

B. To view the mesh (that has not yet been created), create a plane section as a derived part

III. Create a Volume Shape

A. Tools --> Volume shapes --> New Shape --> Block
   Define coordinates of the near and far corners: two (x,y,z) points

B. Specify the shape by the corner coordinates

C. Rename the shape, e.g. refinement block

IV. Create a Volumetric Control in the Mesh
Note: As with all mesh specification in StarCCM+, you should first define Regions of the domain, and you should specify boundary conditions on all Region surfaces.

A. If you haven't done so, create a mesh continuum

   1. Specify Surface remesher, Polyhedral mesher and prism layer mesher

   2. Specify an appropriate base size.

   3. Specify surface mesh properties as desired, e.g. set a small maximum allowable mesh size on surfaces with critical boundary conditions.

   4. Generate the surface mesh for the domain, and inspect it. In particular, make sure the mesh is at a good resolution on critical surfaces. Volumetric mesh controls only determine how the mesh is built as it is extended away from the surfaces.

   5. Generate a solid mesh and create a mesh scene to view it
      This mesh will be replaced, but it's a good idea to work out the kinks in the simpler mesh.

   6. Create a Volumetric Control in the Mesh
      This step assumes that you have already created the Volume Shape

      a. Right click on Volumetric Controls --> New

      b. Expand the mesh conditions node

      c. Click on Polyhedral Mesher

      d. In the Properties pane, check the "Customize polyhedral mesher" box
         Note that this causes the "Mesh Values" node to be populated

      e. Expand the Mesh Values node
         i. Expand the Custom Size leaf
         ii. Select relative size, and inspect the value (default is 10 percent of base size?)

   7. Clear the existing mesh, and regenerate the surface and volume meshes
      At this point the volume mesh should be much smaller in the space defined by the volume shape

   8. Consider adding more prism layer meshes or other features, and regenerating the volume mesh.