I. Texture Mapping - a set of techniques that permit you to enhance the definition of the surface characteristics of a model with great subtlety.

A. Generating the texture map.

1. Scanning in photographs, or other hard copy images.
2. Digitally painting in a paint program.
3. Procedurally - by small subprograms which evaluate and determine surface characteristics.

B. Surface Texture Mapping (Projection/parametric mapping)

1. Most basic form of texture mapping.
2. A 2-dimensional picture is applied to the surface of a three dimensional model.
3. The 2-dimensional picture is the texture.

C. Solid Texture Mapping

1. Very complex texture mapping process.
2. 3-dimensional volumes generate textures on the surface of a three dimensional object based on how the model floats in the volume.
3. Objects that would be carved or extracted from a solid piece.

II. Texture Mapping Implementations - Textures can be projected onto an object, or stretched over that object.

A. Parametric (Normal) Texture Mapping - A surface texture is generated by stretching a 2-dimensional image or algorithm wrapped around a 3-dimensional model.

1. Each area, or pixel (x,y) in the 2-D image is applied to a corresponding area in the of the 3-D surface (u,v).
2. May cause image distortion as the 2-D image is stretched onto the surface.

B. Projection Texture Mapping - textures generated by projecting a 2-dimensional image through a volume onto an object.

1. Planar Projection - The 2D texture is projected along one of the X, Y, or Z-axis.
   a. Textures are projected only in one direction.
   b. Streaking may occur on portions of the surface that aren't perpendicular to the projection axis.
   c. Best for flat surfaces, like rugs.
2. Cylindrical Projection - The 2D texture is bent into an imaginary cylinder, with the object positioned inside the cylinder. The image is then projected inward from the surface of the cylinder to the axis of the cylinder.
   a. Very helpful texturing technique for cylindrical objects. (e.g. vase or can of beer.)
   b. Can cause streaking across the caps of cylindrical shapes.
   c. Alias sweeps the 2-D image around the y-axis.
3. Spherical Projection - The 2D texture is bent into an imaginary sphere, with the object positioned inside the sphere. The image is then projected inward from the sides of the sphere to the center.
   a. May be used to eliminate streaking in some objects.
   b. Most effective when used with an object that requires projection from all sides. (e.g. sphere or cube.)
   c. Alias wraps the texture in a spherical fashion centered on 0,0,0.
4. Ball - Candy wrapper style projection method, leaving only one pinch point instead of two(like in spherical or cylindrical mapping).
5. Cubic - Creates six copies oft he texture, then projects them outwards from 0,0,0 in a pyramidal fashion.
6. Tri-planar - Projects the texture by extruding along the three axes defined by the solid projection icon.

vii. Camera - Projects the 2-D image based on the orientation of the camera.

viii. Projection Mapping is limited by it's tendency to streak, but proliferates because it is easy to compute.

III. Texture Mapping Render Nodes – When creating Shading Groups in the Hypergraph, you can select to create render nodes that help you select, manipulate, and position textures onto a surface.

A. Texture mapping is done through the application of render and utility nodes to the shading group network.

B. Creating a texture node.

1. Select the object you wish to texture map.
2. Assign a material to the surface.
3. Open the materials attribute editor, and select the Map button next to the attribute you wish to map.

4. Use the Create Render Node dialog to select and set some basic texturing attributes.
5. When you close the dialog, several render nodes have been created in the Hypershade.

C. Create Render Node Dialog

1. **With New Texture Placement** – should be checked on. His automatically creates a 2d/3d placement node for each texture you create.
2. **2D Textures** – this is where you determine the method and type of placement for your texture.
   i. Normal – creates two nodes, a texture node, and a utility node.
      1. **Place 2d Texture** node – a utility node that controls how a 2d texture is wrapped around the surface.
      2. Defines a texture rectangular texture frame in which the texture will appear on the surface.
      3. The **OutUV** attribute is connected to the **uvCoord** attribute of the texture node.
      4. Texture node is linked to the material node via the input of the texture-mapped attribute.
      5. Typically, a texture map is connected from the **outcolor** attribute to **color** attribute on the material node.
   ii. Projection – creates several nodes including the projection, Place 2D Texture, Place 3d Texture, and texture node.
      1. **Projection** – a utility node that determines the type of projection method used to apply the texture to the surface.
         - **Proj Type** – determines the type of projection.
         - **Image** – the input from the texture file.
      2. **Place 3d Texture** – utility node that's used to interactively place the texture volume around the selected objects.
         - It is a transform node, attached to your texture.
         - **Interactive Placement** – lets you alter the texture volume interactively.
         - **Fit to group bbox** – automatically fits the Place 3d manipulator to the selected objects bounding box.
      3. **Place 2d Texture -** a utility node that controls how a 2d texture is placed onto an object.
         - **Coverage** – how much of the surface is covered by the texture.
         - **Repeat UV** – how many times the texture is repeated on the surface.
         - **Interactive Placement** – lets you alter the texture volume interactively.
   iii. Stencil – lets you apply textures that act as labels.
      1. **Stencil Node** – used to determine edge and transparency properties of the input image node.
      2. **uvcoord** input is connected to the **OutUV** of a Place 2D Texture node.
      3. **image** input is connected to the textures **color** output.
3. **3D Textures** – creates algorithmically generated textures that simulate solid objects.
4. **Environment textures** – generates textures that describe the modeling world.

C. Utilities Tab – used to create utiliy nodes independent of a texture or material node.

1. **Place 2D Texture** - a utility node that controls how a 2d texture is placed onto an object.
2. **Place 3d Texture** - utility node that's used to interactively place the texture volume around the selected objects
2. **Stencil Node** – used to determine edge and transparency properties of the input image node.

III. Texture Mapping Controls (Common Surface Parameters)

A. Color Balance Parameters - Allows you to fine tune your texture's color balance.

1. **Default Color** – determines the surface color at points where there is no texture mapped.
2. **Alpha** – used to determine transparency, you can assign luminance as transparency with a check box.

B. **Place 2d Texture** parameters
   1. Rotate - Let's you rotate the texture map on the surface of the object.
   2. Offset - Let's you offset the pattern of the texture map without actually moving the map itself.
   3. Repeat - Let's you specify how copies of your texture are mapped within the coverage area.
      a. Values less than one show only a portion of your texture.
      b. Values greater than one cause your image to repeat along the chosen axis.
   4. Mirror - If repeat is greater than one, this mirrors repeat areas of your surface, helping to hide seams in the texture.
   5. Stagger - Offsets alternate rows of repeats exactly half the repeat value. Creates a brick-like texture.

IV. Texture Mapping Effects - Interpretations on the surface.

A. Color Map - Uses the color information in the texture to generate the color at each point on the surface.

B. Transparency Map - Uses tones of gray to create the appearance that the surface is transparent.

C. Bump Mapping - Uses tones of gray to create the illusion of relief on the objects surface. Note: The illusion of depth is only created, the surface geometry isn't effected.

D. Displacement Map - Similar to a bump map that physically displaces the surface of an object during rendering.
   1. Apply a displacement material to the Shading Group node through the **Displacement Mat.** attribute.
   2. Determines the level of displacement based on levels of gray in the displacement material.

E. Reflectivity Map - Uses tones of gray to create the illusion that parts of the surface are reflective, and other parts are not. (***Only available in surface with specularity.)***

F. Specular Map - Uses tones of gray to create the illusion that parts of the surface are more specular than others.

V. Loading Image Files for texture mapping

A. Select the Map button next to any parameter you wish.

B. The Create Render Node dialog opens.

C. To load in an external scan or digitally painted texture select **File**.

D. Editing the File texture attributes
   a. **Filter Type** – Determines the anti-aliasing technique applied to image files during rendering.
      i. **MipMap**(default) – Standard anti-aliasing.
      ii. **Box** – Higher quality, slower performance.
      iii. **Quadratic** – Higher Quality, slower performance.
      iv. Do experiments to determine which is the best for each situation.
   b. **Image Name**
      i. Select the folder icon to import an image.
      ii. The image needs to remain in its original folder so that it is available to Maya.
      iii. If the image is missing, the render will fail.