Week 13 **Lecture Outline**

I. Clusters -
- A. What's a cluster?
  1. An entity that logically groups an arbitrary list of CVs and DAG nodes so that they can be transformed and manipulated as a single entity.
  2. Are a type of object with no geometry of its own, but refers to other geometry.
  3. Clusters can not contain objects without CVs, such as lights and cameras.
  4. Differences with Sets
     a. Sets can be a grouping of any item in the modeling world, including cameras and lights.
     b. Clusters are only groupings of CVs.
     c. Sets have no associated DAG Node in the SBD window, while Clusters have cluster node, and a DAG node above them for transformations.
     d.
- B. Creating Clusters
  1. Pick all of the objects and/or CVs that you want to put in the cluster.
  2. Select Edit -> New Cluster.
  3. A cluster node is generated in the SBD, with a Null DAG node above it.
  4. *NOTE:* The advantage of the DAG node in a cluster rather than simply a node with the CVs, is that adding a CV to the geometry under a DAG Node later will also add the CV to the cluster.
- C. Picking Clusters
  1. In the Modeling windows: Pick -> Point Types -> Clusters
  2. In the SBD window: Pick -> Object (Select the DAG Node above the cluster)
  3. *NOTE:* Don't try to select the cluster in the modeling window using Pick -> Object, you will be selecting the objects geometry, not the cluster.

II. Creating Clusters with Properties for Deformation
- A. Deformation Control
  1. When an object is required to change shape, the CVs controlling the surface can be modified, one CV at a time.
  2. Moving individual CVs becomes time consuming and tedious when animating an object with lots of CVs.
  3. Deformation Control provides a higher level of manipulating CVs by letting you create groups or clusters of CVs. (Like pushing and pulling clay.)
- B. Deformation Control Window - the dialog where you set deformation frame parameters. Window -> Deformation Cntrl
  1. Deformation Options - Frame Type
     a. Deformation Frame - a parameterized method of deformation attached to an object. The four methods are:
     b. Axis Frame
        i.. Creates a single cluster to achieve the deformation.
        ii. Most obvious uses: bend, twist and tapering operations.
        iii. Bend effects are achieved by rotating the cluster with respect to a perpendicular axis.

iv. Twist/Taper effects are achieved by rotating and/or scaling the cluster along the deformation axis.

c. Curve Frame
   i. A normal NURBs curve is used as a Curve Frame that influences deformation.
   ii. After attaching the curve frame to an object, manipulations on the curve are echoed in the object/clusters to which it is attached.
   iii. When a Curve frame is attached to an object, a deformation cluster is created for each of the CVs on the frame curve.
   iv. CVs become the handles which can be used to manipulate the frame.
   v. CV's on the curve should be close to the number of CVs in the object you are deforming.
   vi. Curve Frame CVs will be associated with CVs in close proximity in world space, if there are too many CVs on the curve frame, null clusters will be created and they will not effect anything.

d. Skeleton Frame
   i. Lets you attach an existing skeleton to an object, effectively creating a flexible body.
   ii. Body can be manipulated by modifying the skeleton only, resulting in faster feedback.
   iii. One cluster is created for each Joint or Bone on the Skeleton Frame.
   iv. Effect Area - determines the area of the Skeleton Frame.
      a. Bones: The CVs nearest to each bone are assembled into a cluster that is grouped under the upper DAG node of that bone.
      b. Joints: The CVs ion the region surrounding the joining are assembled into a cluster, grouped under that joint DAG Node.
      c. Geometry behavior around each bone or joint is specified by this act.
      c. *Note:* It is smart to limit the number of Joints in the Hierarchy that are effected by an applied skeleton deformation frame.
   v. Hierarchy Depth - Determines the scope of the skeleton Frame.
      a. None, considers only the joint selected.
      b. Below, includes the picked joint and all joints below it in the skeleton hierarchy.
      c. Partial Below, includes the picked joint and a user-specified number of joints below it.

e. Character Builder Frame

2. Frame Control -> Attach, to attach the Deformation Frame to the object/CVs.
    a. Once parameters are set and attached to a cluster/object, changes in the deformation control window doesn't effect the frame.
    b. Frame Control -> Detach, In order to change parameters of the deformation frame, you must detach the frame of a cluster/object.
    c. Frame Control -> Collapse, allows your object to keep deformation transformations after removing the Curve Frame.