CEE 498A – AutoCAD Design

Civil Design

Grading

- Midterm: 40%
- HW/Labs: 30%
- Final Project: 30%
  - Report: 5%
  - Presentation: 5%
  - Deliverables: 20%

Designing the Finished Grade for a Building Site

- Issues to consider
  - Are slopes useable and constructible?
    - How steep are proposed driveways? ~2%
    - Do parking lots have enough slope to accommodate drainage needs? ~1%
    - Are cut-fill slopes acceptable? cut - 3:1 / fill – 4:1
    - Are slopes sufficiently steep / flat that they can be constructed easily? (> 0.5%)
  - Are cut and fill quantities balanced
  - How does runoff from the post-construction site differ from the original site?

Autodesk Civil Design Menus

- Grading
- Hydraulics

Designing the Finished Grade with Autodesk Civil Design

- Create an existing surface from survey data
- Draw the footprint of the new structure, which may be a parking lot, foundation, road, etc.
- Assign an elevation to the new structure
- Design grading objects that transition between the grade of the new structure and the existing site
- Determine cut-fill volumes and adjust finished elevation and slopes to balance volumes

Creating the New Structure

- Draw the structure using a 2D/3D polyline, line or arc (i.e. an object that has no elevation)
- Create additional points (set Actual Elevations on the Insert Points menu) at a prescribed slope or a prescribed distance & elevation using
  - Points -> Create Points-Slope -> Slope/Grade - Distance
  - Points -> Create Points-Slope -> Slope/Grade - Slope
- Example using Distance above to create points on the perimeter of the parking lot
  - 2% grade on driveway (between points PI1 and PI3)
  - -1.4% grade (E to W) on the south end of the parking lot
  - -0.9% grade (S to N) on the west side of the parking lot
- Build a new surface using the new points

Creating Grading Objects

- Grading objects "connect" the grade of the new structure to the existing grade
  - Define the new surface
  - Define the target surface for the grading operation
    - Often this is the existing surface
    - May be a height relative to the new surface
  - Define cut / fill slopes and finish details (i.e. what to do at corners)
- Examples: Using Grading -> Slope Grading -> Grading Wizard
  - Creating grading for the parking lot
    - Use the parking lot polyline to define one side of the grading object
    - Assign elevations to the parking lot polyline using Set Elevations from Selected Surface and the proposed surface created previously, Paking1
    - Set Target Surface as the existing surface
    - Set Cut / Fill slopes
    - Create grading objects

Creating Grading Objects

- Examples: Using Grading -> Slope Grading -> Grading Wizard
  - Creating grading for building pad and curbs
    - Use the building pad to define the outside perimeter of the grading
    - Assign elevations to the parking lot polyline using Set Elevations from Selected Surface and the proposed surface created previously, Paking1
    - Set Target Surface using select Elevation option and select a Relative elevation of 0.5 ft.
    - Set Cut / Fill slopes to 0.5 so that the curb is approximately vertical
    - Create grading objects

Modifying the Grading Plan

- It may be appropriate to modify the grading objects created by Autodesk Civil Design:
  - Accommodate contours in the existing surface grade. It is easier to construct cuts / fills if the grading meets the finished grade at a contour.
  - Increase / decrease slopes to meet construction needs

Modifying the Grading Plan

- In Autodesk Civil Design, grading objects may be modified by
  - Changing the slope along a specific length
    - Add slope tags to the region you want to change using Add Slope Tag when you right-click a grading object
    - Edit the slope for a specific slope tag by right-clicking on the grading object, selecting the Slope Tag to modify and changing the slope values
    - Note that this change can be deleted by right-clicking the grading object and choosing Delete Slope Tag from the menu
  - Editing the Target Region for the grading object
    - Add a new target region using Add Target Region when you right-click a grading object
    - Edit the target region using Edit Target Region when you right-click a grading object
    - Edit the grading object in the vicinity of the target region by changing the distance of the cut / fill or the slope of the cut /fill

Modifying the Grading Plan

- In Autodesk Civil Design, grading objects may be modified by
  - Dragging and dropping the *slope tag location grips* on the grading object (in a double-grip pair, choose the grip located midspan of the grading projection)
  - Dragging and dropping the *slope value grips* on the grading object (in a double-grip pair, choose the grip located at the grading limits)
  - Dragging and dropping target region grips on the grading object (a single grip located at midspan of the grading project)
  - Dragging and dropping a vertex of the grading object

Modeling Surfaces & Grading Objects

- We can create a new surface from grading objects and then model that surface
  - Create contours for use in construction
  - Compare existing and new grade to compute and balance cut and fill quantities

Modeling Surfaces & Grading Objects

- Using the file ../Land Desktop 3/Tutorial4/Lesson-35.dwg
- Construct a new surface from grading objects
  - Create a new surface from the grading objects
    - Grading -> Slope Grading -> Create Surface
  - Add breaklines to the surface to represent the top of the building pad
    - Set Proposed Surface as the current surface
    - Grading -> Slope Grading -> Create Breaklines
    - Re-build the surface using Terrain -> Terrain Model Explorer
  - Create contours
    - Terrain -> Create Contours
    - Choose new layers for new surface contours

Evaluating the Design – Cut/Fill

- Using the file ../Land Desktop 3/Tutorial4/Lesson-36.dwg
- Compute cut & fill volumes
  - From grading objects
    - Grading -> Slope Grading -> Calculate Volume
    - Choose the grading object
  - From a surface
    - Define strata for use in computing volumes in Terrain -> Select Current Stratum
    - Define Surface 1 for use in calculations as the existing surface
    - Define Surface 2 for use in calculations as the new surface
    - Terrain -> Site Definition -> Site settings can be used to set units for calculations

    Terrain -> Site Definition -> Define site is used to compute volumes
      - This is done using a volumetric grid, more grid points gives greater accuracy

Re-Designing the Surface

- To balance cut / fill volumes it may be necessary to raise or lower a surface. This can be done
  - Manually
  - Using Grading -> Slope Grading -> Balancing Volumes
- Example
  - Using Grading -> Slope Grading -> Balancing Volumes and select the grading object to determine the finished elevation that balances volumes
  - Here the result is a proposed lowering of the finished elevation by 1.3 feet
  - Assuming that the finished surface will include an 8-inch gravel base course and 4-inches of pavement, we really only need to lower the finished elevation by 0.3 feet.
  - Adjust the grading object by selecting the object and ctrl +/-
    - First, use Grading -> Slope Grading -> Grading Properties to set the increment to 0.3 ft
    - Then, select the object and use ctrl- to bring it down 0.3 ft.
  - Next, adjust the points on the grading object that must match existing grade
    - Select the perimeter grading object, right click and select edit Vertex and bring points at the end of the driveway up 0.3 ft
  - Next, adjust points not on the grading object but used originally to define the parking lot surface
    - Use Points -> Edit Points -> Datum to edit the elevation of the points
    - Click the reset button to clear previous point selection
    - Include points with description Perimeter