Visual Nature Studio 3
Tools and Applications

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Introduction

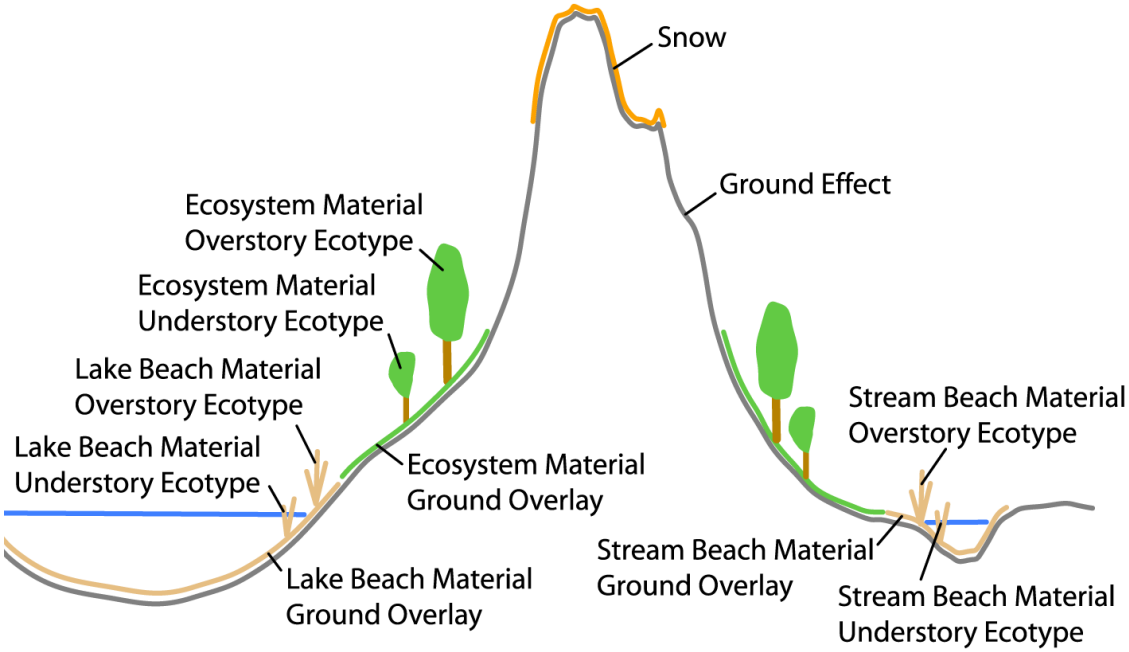
Summary	• Basics about WCS and VNS, a guided tour of the User Interface, and how to do a basic project from scratch
Why 3DN?	• Why use WCS/VNS instead of conventional 3D or GIS applications you might already know well? • Advantages, Disadvantages, Use the right tool for the job.
Interface Overview	• Three Key Interface Concepts: Scene-at-a-Glance (S@G), Task Modes, Active Item • Icon Toolbar: Task Mode Buttons, Window Buttons, Interactive Buttons, View Buttons • Animation Toolbar: Anim Controls, Active Item Display/Lock, Progress/Abort, Status Log • S@G: Two Lists, only upper is affected by Task Modes. Drag & Drop. Top S@G Buttons. • Matrix: Many layout options – ALT+SHIFT+1, etc. Editors/Views, Docked/Undocked. • Views: Multiple open at once, many Camera Types • Editors: Lots of 'em. Will explain more. Common Icon buttons on the right side of all. • Other Windows: Database Editor, Import Wizard. Will cover individually. • Prefs Window: Common program settings, units, etc.
Components	• Virtually all project elements can be saved as components • Reusable/Sharable nature – encourage to save often.
Vectors	• The heart of positional info in WCS/VNS • Can be imported/created/modified/exported
DEMs	• The all important landscape surface • Nothing happens in WCS/VNS without some Terrain for it to happen on. • Can be imported/created/modified (and sort of exported)
Building a Project	• There are no hard and fast rules. Observe nature. Think about the scale of what you need to visualize. • Choose your tools. Don't worry, it's all non-destructive. You can change your mind at any time.
Save Often	• Cool Save Rule – When you say "Cool!", SAVE! [Ctrl-S] • Use Save-As or Clone when appropriate. • Use multiple project names: Proj1, Proj2 etc to keep multiple revisions
Really Simple Project	• Use New Project Wizard to create a scene. • SimpleVaried, Rocky and Mossy, Tutorial Environment, Spectacular Blues, AltoCumulous, 3DNAQuick

Land Cover: Ground

Goals	• Understand Land Cover basics • Explore Material properties • Give Ground a stratified-rock look • Create an elevation-driven Material Gradient
Required	• Land Cover: Ground discussion (*Land Cover-Ground* and *Axes* handouts) • **3DNA\Ground.proj**
Material Properties	• Open the **Ground** project from the **3DNA** folder. • Ground Editor > Material page. Show Advanced Features. Increase **Luminosity** to **50%** to soften shading. • Render a preview. • Terrain Parameters Editor. Increase FD to 3. Render the other preview. Note little change. Maximum Pixels per Polygon defaulted to 1 in VNS 2; defaults to 10 in VNS 3. Change to 1 and render a preview.
Strata	• Ground Editor > Material page. **Create Strata**. Render a preview. • By default, only Strata Lines are enabled. Enable **Apply Color Strata Bands**. Render a preview. • Open the Color Editor for each Strata Color Band and select an Earth Tone from the Swatch Selection. Render a preview. Not bad for sedimentary rock. • Let's metamorphose the sediments. Create a **Deformation texture** with Selected Element **Marble** and Size **100 m** along all axes. To preview it in the TE, change Previews Size of **100** m and View From to **Cube**. Render a preview. • Strata are great for adding and deforming rock layers. The down side is that you don't have any control over the thickness of the strata. For that you need a Material Gradient.
Material Gradient	• Ground Editor > Material page. Show Material Controls. Rename the Material **Metasediments**. • **Add** a new Material and assign it a gradient position of **100%.** • Change the name of the Material to **Sandstone**. • Hide Material Controls. Make the **Diffuse Color** a sandy one. • Material Gradient page. Confirm that the Material Gradient Driver value is **0%**. Render a preview. • Show Material Controls. Change the **Material Gradient Driver** value to **100**%. Render a preview. • **Add a texture** to Material Gradient Driver. Change the texture element to **Dynamic Parameter**. • Set the Parameter to Elevation. Use the Diagnostic Data window to find the elevations halfway up the cliff and near the top of cliff. • Set the **Input Low** to **1550** m and **Input High** to **1800** m. Render a preview. • Real sandstone would not be deposited this way. The contact would be sharp. Change the **Blend Type** to **Sharp Edge** and change the **Position** value to **75**%. Render a preview. • If you want to break up the sandstone, add Strata, disable Add Strata Lines, enable Bump-map Strata Lines, and increase the Line Bump Intensity to 200%.

Recreating the Natural World

WCS and VNS were created to allow users to recreate the natural world using data readily (and not so readily) available. Since it's the natural world we're simulating, the toolset reflects those roots. This will take getting used to if you're familiar with the way other applications work.



The Basics

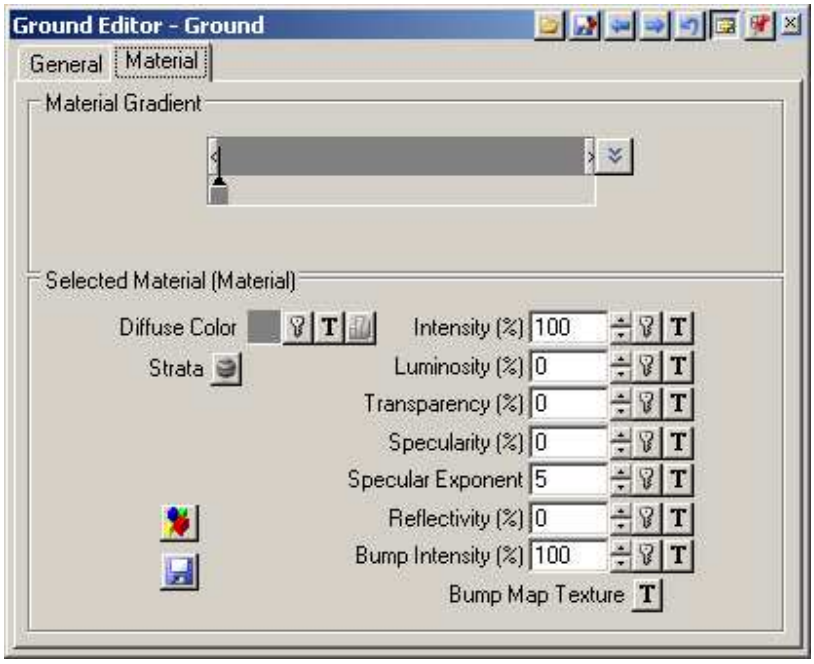
Terrain is made up of polygons. Before each polygon is rendered VNS must decide what to put on it. Land Cover includes the following in order of decreasing render priority.

Snow covers polygon texture
Ecosystems have at least one Material that places a color or texture on polygons and may place Foliage with Ecotypes
(While not a part of VNS Land Cover, Lake and Stream **Beaches** should not be forgotten. They override Ecosystems.)
Ground Effect renders if no Snow or Ecosystem is present

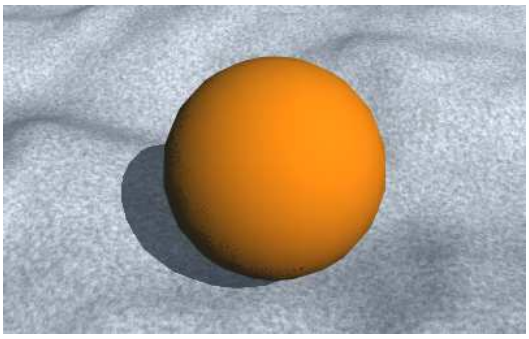
Ground Effect Highlights

- A Ground Effect is under everything and every project must have one enabled.
- Every new project created has one.
- If no Ground Effect is enabled, VNS will create a new one by default.
- Vector Ground Effects have priority over unbounded Ground Effects.
- Ground can be made transparent.

Ground is made up of at least one Material. Materials are the building block of all Land Cover categories.

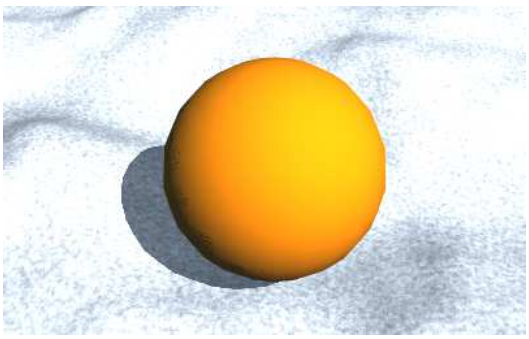


Material Properties



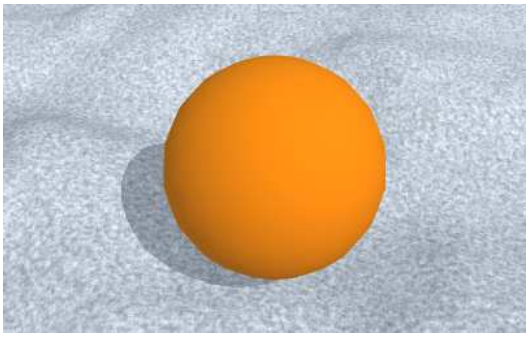
Diffuse Color is a property of all Materials and is often a texture. The sphere has a diameter of 1 km.

For more information refer to the Interactive Reference Manual.



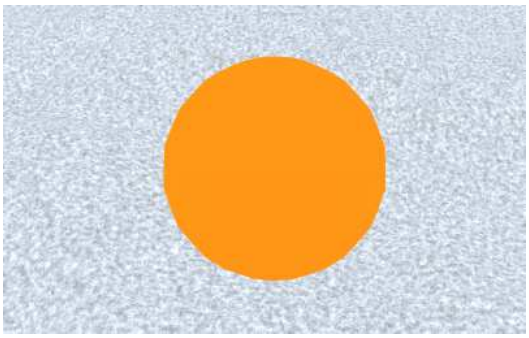
Intensity controls the overall lightness of the Material. Shadows are only slightly affected.

Intensity150%



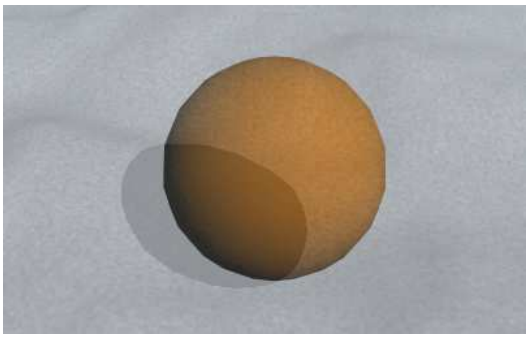
Luminosity controls how the Material responds to shadow and shading. Shadows and terrain shading are lightened.

Luminosity 50%



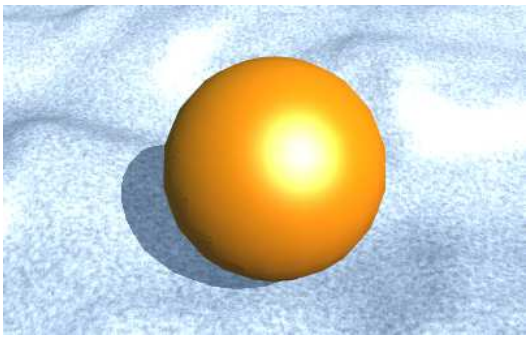
Fully luminous Material has no shadows or shading and has lost its 3D look.

Luminosity 100%



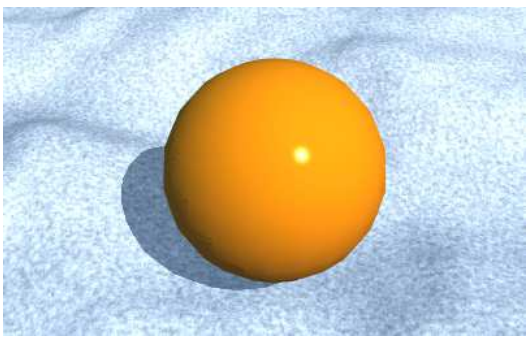
Transparency allows you to see through the Material. It was lightened in this render because the sky is white.

Transparency 50%



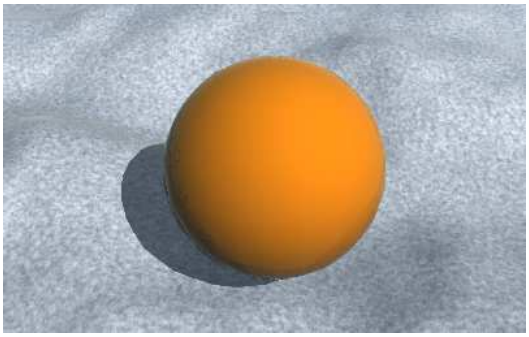
Specularity is specular reflection, the reflection of light sources. The **Specular Exponent** controls the size of the specular highlight.

Specularity100%
Specular Exponent 5



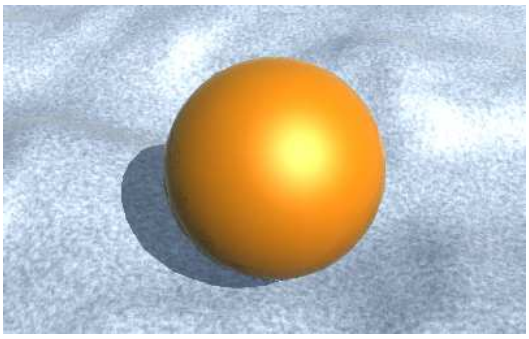
The higher the Specular Exponent, the smaller the specular highlight and the more glossy the Material. Wet rock often has high Specularity and Specular Exponent.

Specularity 100%
Specular Exponent 200



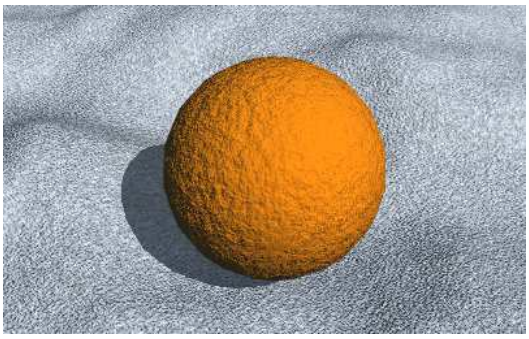
Reflectivity controls the degree to which the rendered scene is reflected on the Material.

Reflectivity 100%



Since light sources are invariably reflected, Reflectivity is rarely used without Specularity.

Reflectivity 100%
Specularity 50%
Specular Exponent 5%



Bump Intensity gives the impression of surface texture without modeling. It is one of the most commonly used (and misused) textures.

Bump Intensity 100%
Fractal Noise Texture, size of 50 m along X, Y, and Z axes (sphere has a diameter of 1 km)

Exercise: Material Properties

Exercise: Strata

Exercise: Material Gradient

What does the size of a polygon have to do with anything?

The polygon is the smallest unit of land cover we can draw. VNS divides each DEM cell into 2 triangular polygons at a fractal depth of 0. If the fractal depth is greater than 0 then the smallest land unit will be smaller than the DEM cell size. The table shows the size of a polygon relative to fractal depth.

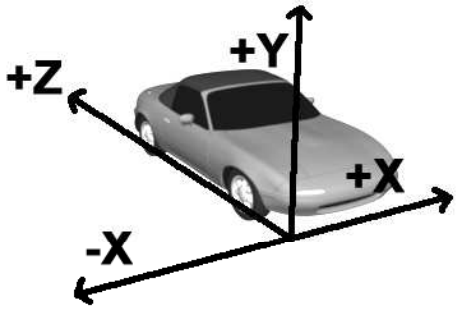
Fractal Depth	Area relative to DEM cell area ($1 / (2 * 4^{fd})$)	Side length relative to cell side ($1 / 2^{fd}$)
0	½	1
1	1/8	½
2	1/32	¼
3	1/128	1/8
4	1/512	1/16
5	1/2048	1/32
6	1/8192	1/64
7	1/32,768	1/128

For example, at a fractal depth of 7 a DEM with 10-m cells will render as triangular polygons with sides of at least 7.8 cm (10 m/128). You won't see these polygons unless you disable Phong Shading in the Terrain Parameter Editor.

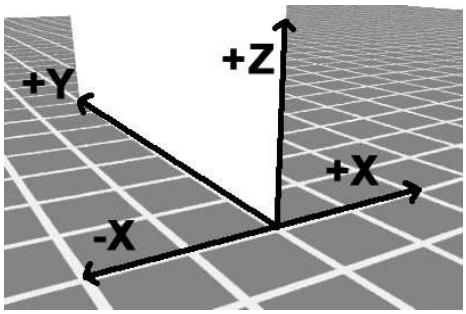
Ground Hierarchy

Ground
Material Gradient Driver controls Material placement
Material Gradient contains Materials
Material with properties like Diffuse Color, Specular Exponent (size of highlight), etc.

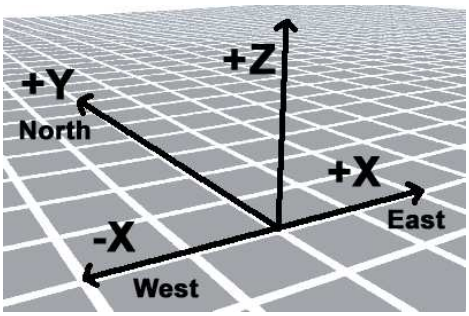
3D Object, Wall and Terrain Axes



3D Object Axes: Y is upwards (3D modeling convention).



Wall and Terraffector/Vector-Aligned Axes: Z is upwards (GIS convention).



Terrain Axes: Z is upwards (GIS convention).

Land Cover: Ecosystems

Goal	• Understand Ecosystem Rules of Nature
Required	• Land Cover: Ecosystems discussion (*Land Cover: Ecosystems* handout)
Base Project	• **3DNA\Ecosystems.proj**. The instructor will demonstrate the following.
Elevation Line	• Create an Ecosystem named **Red**. Change the Material Ground Overlay Diffuse Color to red. • Add the Red Ecosystem to the Environment. Render a preview. The Red Ecosystem is everywhere because the Rules of Nature defaults are all-inclusive. • Create an Ecosystem named **Yellow**. Change the Material Ground Overlay Diffuse Color to yellow. • Add the Yellow Ecosystem to the Environment. Render a preview. The Yellow Ecosystem does not render because it is second in render order and the Red Ecosystem leaves no polygons available. • Red Ecosystem Editor > Rules. Decrease the Elevation line for Red Ecosystem to **7000** m. Render a preview. • Raise the Yellow Ecosystem render priority in the Environment. Render a preview. Lower it again.
Maximum/ Minimum Slope	• Change the Red Ecosystem **Maximum** Slope to **35º**. Render a preview. • Change the Red Ecosystem **Minimum** Slope to **20º**. Render a preview.
Elevation Skew	• Change the Red Ecosystem Maximum Slope to **90º** and the Minimum Slope to **0º**. • Increase the Red Ecosystem Elevation Skew to **1000 m.** Activate the second View window and render a preview. • Lower it to **–1000** m. Render a preview. • Change it back to **1000** m. • Increase the Red Ecosystem Elevation Skew Azimuth to **45**º. Render a preview. • Change the Elevation Skew Azimuth and Elevation Skew back to **0**. Render a preview.
Relative Elevation Effect	• Change Red Ecosystem Relative Elevation Effect to **10**. Render a preview. • Change it to **-10**. Render a preview. • Change the Relative Elevation Effect to back to **0**.
Maximum/ Minimum Relative Elevation	• Open the Diagnostic Data window and sample a ridge within the Red Ecosystem. Now sample a valley. Sample somewhere in between. • Change the Red Ecosystem Maximum Relative Elevation to **0**. Render a preview. • Return the Maximum Relative Elevation to **10000**. • Change the Red Ecosystem Minimum Relative Elevation to **0**. Render a preview. • Return the Minimum Relative Elevation to **-10000**. • Set the Red Ecosystem Maximum Relative Elevation to **+5**. • Set the Red Ecosystem Minimum Relative Elevation to **-5**. Render a preview. • Return the Maximum Relative Elevation to **10000** and the Minimum Relative Elevation to **-10000**.

Ecosystems Discussion

In its simplest form, an **Ecosystem** is comprised of a Material with one or two Ecotypes and a Ground Overlay that covers the ground between. Ecosystems can have more than one Material placed by a Material Gradient Texture.

Ecosystems have render priority over Ground unless the Ecosystem is transparent.

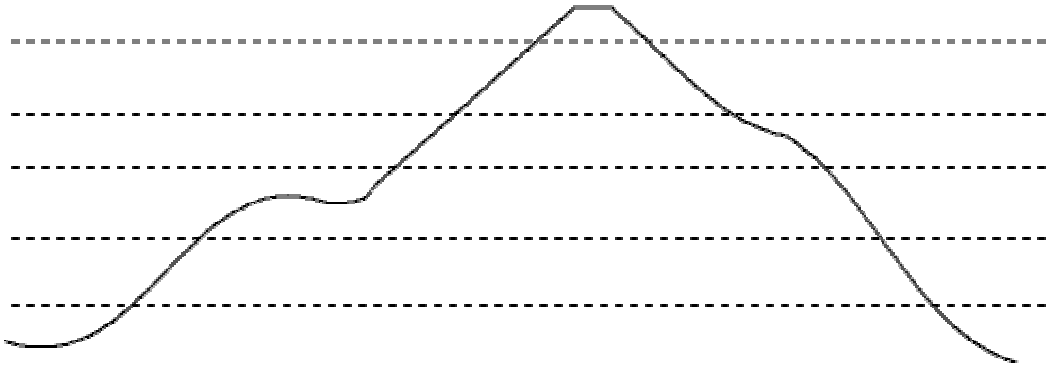
How are Ecosystems placed?

In order of render priority, Ecosystems can be placed in the following ways:

1. **Terraffector Profile** and **Approach Slope.** Terraffector-placed Ecosystems override all others. Priority among Terraffectors is based on Terraffector priority, evaluation order, and segment priority. This will be covered in the section on Terraffectors.
2. **Vector-bounded Ecosystems**, hard-linked or dynamic link via Search Queries. Ecosystem Priority controls placement when more than one vector-bounded Ecosystem is present.
3. **Color Map Ecosystem** matching up to 16.7 million different Ecosystems from one image. Color Maps can overlap with each linked to many Ecosystems. This will be covered in the Color Maps section.
4. **Vector-bounded Environments**. Ecosystem render order within the Environment controls placement.
5. **Environments** via **Rules of Nature**. Render order within Environment control placement. Environments can be vector-bounded.

Rules of Nature

Rules of Nature define polygon parameters for Ecosystem placement regardless of what is controlling the Ecosystem. New Ecosystems always default to rendering everywhere.



Elevation Lines

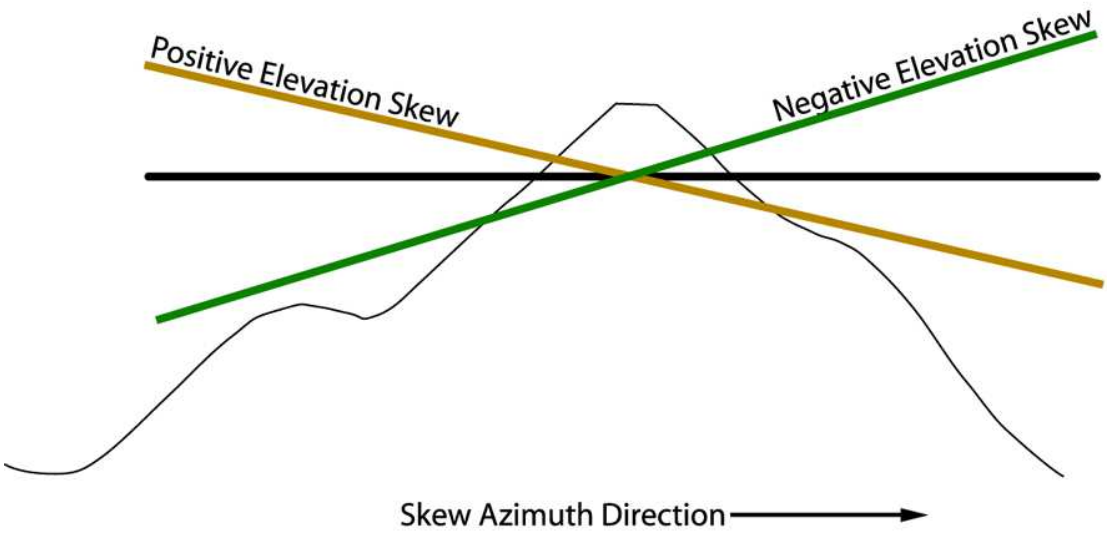
The **Elevation Line** is the upper limit for Ecosystem rendering. (With Snow, the Elevation Line is the lower limit of rendering). Think of it as “tree line” and “snow line”. Relative position in the Environment list has everything to do with how the Rules of Nature in each Ecosystem translate into rendered ground cover. Elevation simulates environmental gradients that result from elevation change such as temperature and moisture (adiabatic precipitation).

Demonstration: Base Project, Elevation Line

Maximum Slope limits Ecosystems and Snow to terrain polygons that have a lesser slope or equal slope to the specified value. For instance, a value of 35º might be useful to keep treed Ecosystems off cliffs and unstable steep slopes.

Minimum Slope limits Ecosystems and Snow to terrain that slopes more or equal to the value. This might be useful to keep trees out of flat marshy areas. Minimum slopes are generally less useful than maximum slope limits.

Demonstration: Maximum/Minimum Slope



Elevation Skew causes the elevation line to be slanted if you are looking at the cross-section of a mountain. A positive number makes the line slant down to the north; negative makes it slant down to the south. Elevation skew simulates environmental gradients from one side of a hill to the other: Gradients mimic the effects of temperature, moisture, insulation and wind exposure.

Elevation Skew Azimuth rotates the axis that the skew applies most strongly along. If 0 then the axis is north south, 90 degrees is east west. 180 degrees is the same as changing the sign of the skew and using 0 for azimuth. This variable accounts for gradients that are not aligned with the north-south axis for some reason. An example would be a predominant wind direction from the west or the fact that soil dehydration depends on surface temperature which reaches a peak on southwest slopes where the sun is shining in the afternoon when the ambient air temperature is highest.

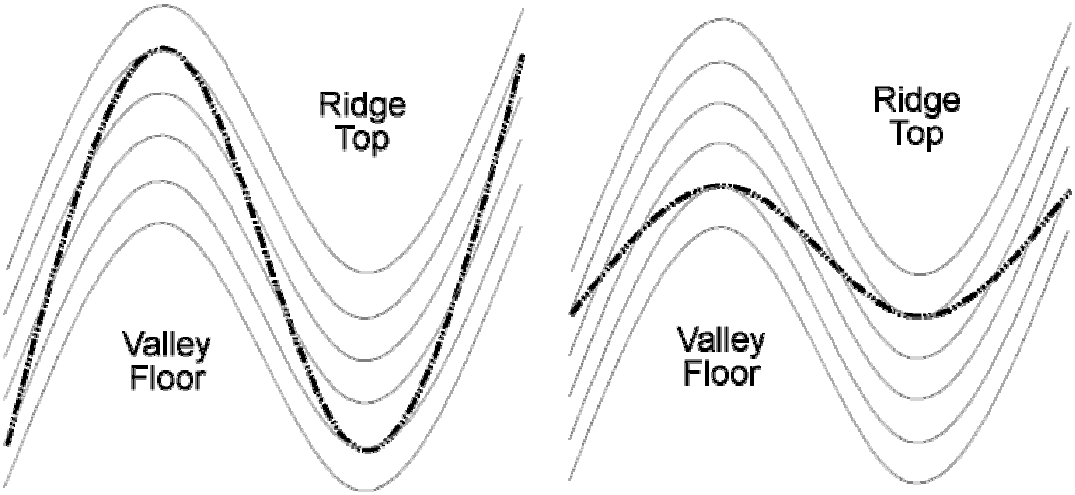
Demonstration: Elevation Skew

Relative Elevation is a measure of the curvature of the terrain. It is a measure of a polygon elevation relative to the surrounding polygon elevations. A valley has a negative Relative Elevation, a hill has a positive Relative Elevation, and flat terrain has a 0 Rel El. Open the Diagnostic Data window and sample terrain to get an idea of Rel El range.

The **Relative Elevation Effect** raises or lowers the Elevation Line proportional to its value multiplied times a Relative Elevation attribute of the terrain. At any spot on the terrain, the landform is flat, concave (depression or valley) or convex (hill or ridge). Convex shapes are positive relative elevations and when multiplied times a positive relative elevation effect, increase the elevation line. The table shows the effects of combinations of Relative Elevation Effects and terrain landforms.

Landform Relative Elevation	Relative Elevation Effect	Change in Elevation Line
Flat (0)	+	None (0)
Flat (0)	0	None (0)
Flat (0)	-	None (0)
Ridge (+)	+	Increase (+)
Ridge (+)	0	None (0)
Ridge (+)	-	Decrease (-)
Valley (-)	+	Decrease (-)
Valley (-)	0	None (0)
Valley (-)	-	Increase (+)

Relative Elevation Effect values and resulting change in Elevation Line

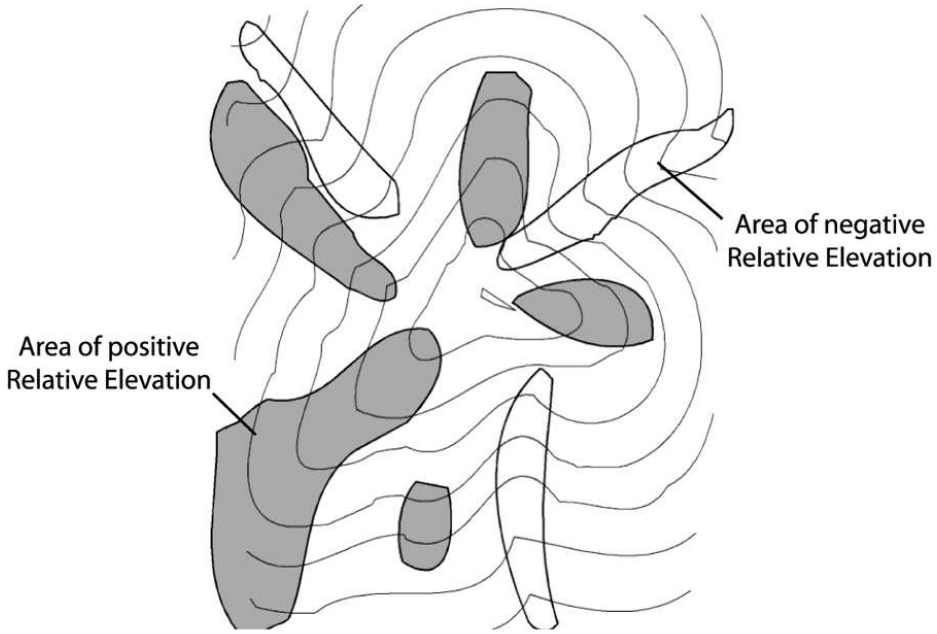


Effect on Elevation Line of a positive Relative Elevation Effect (left) and negative Relative Elevation Effect (right).

A positive Relative Elevation Effect raises the Elevation Line in valleys and lowers it on ridges. This is typical of riparian plant communities. A negative Relative Elevation Effect (right) lowers the Elevation Line in valleys and raises it on ridges. This is useful for ridge-dwelling plants, plants that need less water, and those that thrive under more exposure.

Demonstration: Relative Elevation Effect

Maximum Relative Elevation is a lateral limit rule that restricts rendering of Ecosystems (or Snow) in a lateral sense rather than an elevation sense like Elevation Line. The Maximum and Minimum Relative Elevation rules can be used to restrict Ecosystems to relatively high or low areas. The same terrain attribute that is invoked by the Relative Elevation Effect above is invoked as a limiting value here. Use a rendered view to sample relative elevations from the terrain to use as limiting criteria. Maximum Relative Elevation is used to restrict Ecosystems to relatively low areas.



A **Maximum Relative Elevation Effect** of **0** restricts an Ecosystem to polygons with a non-positive Relative Elevation (depressions). This mimics the natural world where plants prefer high root moisture in valleys. A **Minimum Relative Elevation Effect** of **0** limits an Ecosystem to hills and ridges of better-drained soils. Maximum and Minimum Relative Elevation can be combined to keep Ecosystems or Snow away from topographic highs and lows.

Demonstration: Maximum/Minimum Relative Elevation Effect

Why would you use multiple Materials instead of using multiple Ecosystems?

Smooth transitions are possible when using a Material Gradient. Material transitions can be based on one or more dynamic texture parameters whereas each Ecosystem is discrete and Rules of Nature are used in a different way to select between them. Multiple Materials can also be very useful in Terraffector-applied Ecosystems for things like gradational changes from weedy roadsides to dirt tracks.

Ecosystem Hierarchy

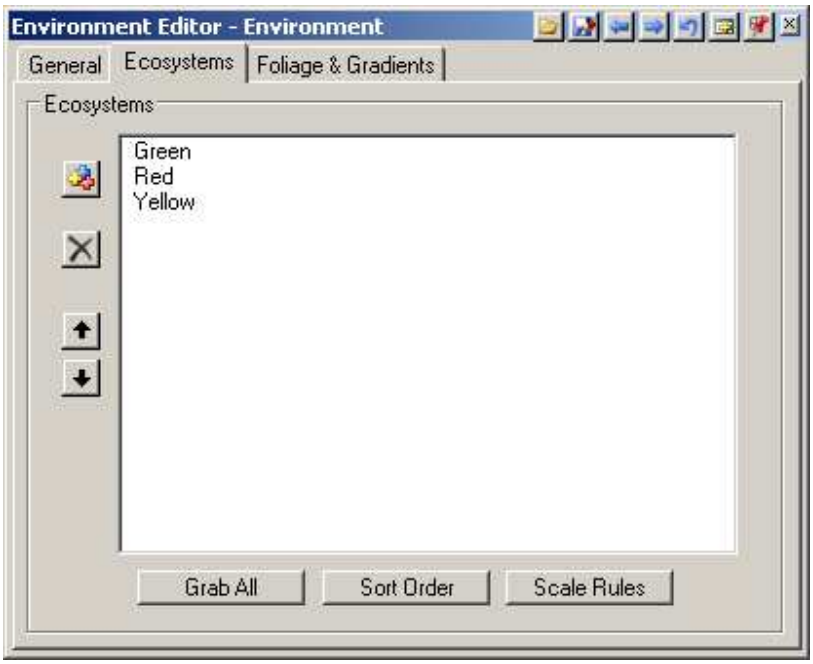
Ecosystem - as many as you want
Rules of Nature determine vertical and lateral extent
Material Gradient Driver controls Material placement
Material Gradient contains Materials
Material - as many as you want
Ground Overlay with properties like Diffuse Color, Bump, etc.
Overstory Ecotype for foliage, usually bigger stuff
Height
Density
Foliage Group, as many as you want, usually by species
Height
Density. Foliage Group percents don't have to add to 100; will be normalized to 100%. For example, a Foliage Group Density of 25% and another of 50% total 75%. The first will render 1/3 of the time, the second 2/3.
Foliage Object, as many as you want, the more the more varied
Height
Density
Object, Image Object or 3D Object
Image Object
Random Flip X
Apply 3D Shading
Back Light %
Replace Gray
3D Object
XYZ Rotation
Understory Ecotype for foliage, usually undergrowth
Same as Overstory

Land Cover: Environments

Goal	• Understand Render Order and how Ecosystems render.
Required	• Land Cover: Environments discussion (*Land Cover: Environments* handout) • **3DNA\Environments.proj**
Render Order	• Open the **Environments** project in the **3DNA** folder. The DEM is about 28 km on a side with a grid cell size of approximately 92 m. Three color-only Ecosystems exist. • Edit Ecosystem Rules of Nature and Environment Ecosystem Render Priority to achieve the following: ◦ Green Ecosystem in negative Relative Elevation areas ◦ Red Ecosystem on slopes less than or equal to 5º at elevations below 8000 m ◦ Yellow Ecosystem everywhere else under 8000 m

Environments Discussion

Environments control the render order of unbounded Ecosystems. An unbounded Ecosystem must be part of an Environment to render. In its common form a single Environment is global and unbounded. Complex projects may contain several vector-bounded Environments.



Many more than two Ecosystems can be combined in one Environment. Arranging their order in the Environment list and adjusting the Rules of Nature can achieve quite complex and realistic spatial arrangements. In general, the most restrictive Ecosystems in terms of Rules of Nature should be at the top of the Environment list on down to the least restrictive at the bottom. Think in terms of which Ecosystem should have priority over which others and move the higher priority ones above the ones with lower priority.

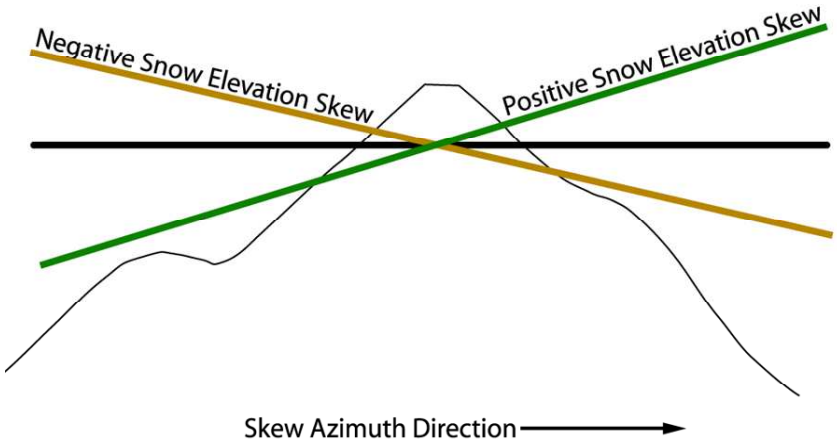
Land Cover: Snow

Goals	• Understand Snow Rules of Nature • Learn how vector-bounded Snow works • Experiment with other properties to change the look of Snow
Required	• Land Cover: Snow discussion (*Land Cover: Snow* handout) • **3DNA\Snow.proj**
Rules of Nature	• Open the **3DNA\Snow** project. Render a Main camera preview. • Open the Diagnostic Data window and sample the render to pick an elevation for the snow line. • Create a Snow Effect. The default Elevation Line is based on the terrain elevation range. • Change the Elevation Line to **7700** m. Render a preview. • Show Advanced Features and change the Relative Elevation Effect to **5**. • Set the Elevation Skew to -**500** m.
Vector-bounded Component	• Select the Snow Component in the S@G. Digitize a vector above and below snow line. Name the Vector "Snow Region". Render a preview. • Note that the Snow is now limited to the vector area and the Rules of Nature were honored. • Delete the vector.
Other Properties	• Snow Editor > General page. Increase Feather Edges to **100**%. Render a preview. • Return the Snow Editor Feather Edges to **0** and render the other Main camera preview for comparison. • Snow Editor > Material. Set the Transparency value to **100**%. • Create a texture for Transparency. • Set the texture's size to **100** m on all axes and the Preview Size to **300** m to see its thumbnail pattern. Change the number of octaves to 2. • Render a preview.

Snow Discussion

Snow covers Ecosystems (Material Ground Overlay) and Ground Effects. Ecosystem foliage is not affected. Ecosystems can override snow priority with the 'Snow Cannot Cover this Ecosystem' parameter. Snow Rules of Nature are similar to Ecosystems except:

- Elevation Line is the *lower limit* of Snow coverage
- Elevation Skew works the *opposite* of Ecosystems, raising it on Elevation Skew Azimuth slopes.



Snow covers ground wherever it exists according to the Rules of Nature and the Snow transparency is less than 100%. Transparencies between 0 and 100 create a blend of colors between the snow and either Ecosystem or Ground, whichever would render if there were no Snow.

Exercise: Rules of Nature

Vector-bounded Snow

Snow can also be placed by attachment to a vector. The vector limits the areal extent of the snow but all the Rules of Nature still apply, including the Elevation Line. This allows you to animate snow line melting or advancing even though the effect is vector-bounded. Remember to set the Elevation Line low enough to include your vector regions if you do not want this effect.

Exercise: Vector-bounded Component

Other Snow Properties

- Snow can have multiple Materials, just like the Ecosystem and Ground discussed previously.
- One way to achieve soft edges to snow is using the feathering feature found on the Miscellaneous tab.
- Snow can be made patchy using a transparency texture.

Exercise: Other Properties

Why is the snow so bright?

Specularity, white snow and a bright sun combine to make the snow a brilliant white.

Snow Hierarchy

Snow Component - as many as you want
Rules of Nature determine vertical and lateral extent
Material Gradient Driver controls Material placement
Material Gradient contains Materials
Material with properties like Diffuse Color, Specular Exponent (size of highlight), etc.

Land Cover: Foliage

Goals	• Create an Ecotype • Learn how to reduce render time with Distance Dissolve • Explore other foliage properties
Required	• Land Cover: Foliage discussion (*Land Cover: Foliage* handout) • **3DNA\Foliage.proj**
Ecotype Density	• Open the **Foliage** project in **3DNA** folder. Render a Hillside camera preview. The Ecosystem renders everywhere. • Open the "Green" Ecosystem on the Ecosystem Editor Foliage page. Add an **Overstory** Ecotype. • Settings tab. Area Units set to **Hectare**. • Parameter tab. Set **Maximum** Height to **30** m, **Min** Height to **20** m., and **Density** to **50**. • Add a Foliage Group, **Conifer**. • Add New Image Object and multiple-select **EnglemannSpruce2**, **Ponderosa2**, and **Spruce5**. • Render a preview.
Distance Dissolve	• Ecosystem Editor > Foliage page. Select the **Overstory**. On the General sub-tab, select **Dissolve Enabled**. • Set **Dissolve Height** to **4** pixels so the effect can easily be seen. This is probably too high for many cases. • Change the Dissolve Color to something bright so it can be seen easily. Leave Color Editor open. Render a preview. • In Color Editor for Dissolve Color check **Sample Color from Image**. • Click on trees in foreground of rendering and note color updating. • Color Editor. Select **Average** radio button. • Click and drive the mouse around the foreground trees getting an average color. Be sure not to sample from areas that have haze applied (distance). When satisfied that you have a representative color, close Color Editor. • Render a preview. Note speedy render time. • Ecotype Editor > Ecotype page. Select **Relative to Image Height** in Common Distance Dissolve section. • Render a preview. Dissolve now begins at the distance where the maximum tree height of 30 m for this Ecotype is 4/480 of the rendered image height.

Foliage Discussion

An Ecosystem Material has a Ground Overlay (always), an Overstory Ecotype (optional), and an Understory Ecotype (also optional). The Ground Overlay is a color or texture that is rendered on terrain polygons. Ecotypes are comprised of Image Objects and/or 3D Objects "planted" on the terrain polygons.

What are the options for controlling foliage density?

Density of foliage in an Ecotype can be controlled either in the overall Ecotype body or in each Foliage Group. Which one you choose may depend on what data is available to you by way of database attributes if you are using VNS. Otherwise it is your choice.

What are the options for controlling foliage height?

Height can also be controlled in either the Foliage Group or Ecotype. Choose the one most appropriate to your data and personal preferences.

Two heights must be specified to fully define the range of foliage heights. The second height can be one of the following:

- Absolute minimum height
- Minimum as a percent of maximum
- A percent of the maximum either above or below the "maximum."

In both height and density cases, absolute measurements are specified in either the Ecotype or Foliage Group. The height value is in linear units and density is the number of average stems per unit area.

If the absolute values are specified in the Ecotype, the values in the Foliage Groups and individual Foliage Objects are relative percentage amounts. If absolute values are in the Foliage Groups then the fields in the Ecotype will be grayed out and the values in the Foliage Objects will still be percentages.

Percentage values do not need to add to 100. For density they are relative to each other. The densities are normalized to a sum of 100 before rendering. If two Foliage Groups exist and one has a density of 10% and the other 20%, then the latter will be rendered two thirds of the time and the former the remaining third. The actual values do not determine the total stem count.

Foliage Object normalized density percents are multiplied by Foliage Group normalized density and then by the actual number of Ecotype stems to determine how many of each to draw.

Foliage Object height percents are multiplied by Foliage Group heights and then by the actual height in the Ecotype to determine how tall to draw them.

Does VNS offer more height and density options?

Yes. In VNS you can drive either Ecotype or Foliage Group heights and densities with values attached to vectors in the database. This subject is discussed more in the Thematic Maps section.

Exercise: Ecotype Density

Can render speed be improved when using density in stems per unit area?

Yes, you can use Distance Dissolve to render a texture instead of foliage stems when they get too small to see in detail.

Exercise: Distance Dissolve

Can trees be rendered in a special color or even a color derived from a texture?

Happily, once again the answer is yes.

Exercise: Replace-Color Trees

What about the other foliage object settings?

Other settings are available for special uses. For instance if you do not want to apply pseudo-3D shading to foliage images turn off 3D Shading. If you are using foliage to make floating billboards you would want to turn 3D Shading off.

Back Light Percent may be something you would like to adjust to get a stronger back light luminosity for small vegetation like grasses and weeds. It can also be used to add punch to billboard signs.

Exercise: Back Light

Land Cover: Forestry
(VNS 3)

Goal	• Understand the basics of how shapefiles, Search Queries, and Thematic Maps work together
Required	• **3DNA\Forestry.proj** • Data from the **3DNA\data** folder
Abstract	• Placing and populating Ecosystems with shapefile vectors and attributes is not as hard as it sounds. It comes down to 3 steps: 1. Import the shapefile. 2. Link the shapefile vectors to the proper Ecosystem with a Search Query. 3. Map shapefile attribute values to Ecotype parameters with Thematic Maps.
Exercise	• Open the **Forestry** project from the **3DNA** folder. Explore the project. Render a Plan Default preview. Aside from the highway, only Ground Effect renders. **Step 1: Import the shapefile** • Import **landcover_fd.shp** from the **3DNA\data** folder. • Import Wizard **LOAD AS** page. **Deselect Render Enabled**. • Click Next until you get to the **SHAPE OPTIONS** page. **Deselect Assign DB Names** from an Attribute Field. Import. • Database Fields window. Select all attributes **except VectName** and click OK. • The realtime views will update to show the imported vectors. This is a simplified shapefile from a larger area with many tree species types. The shapefile has 2 tree species, FD (Douglas-fir dominant forest) and MD (meadow), with the following attributes: TREE_SPECI is the tree species code FC_TAG is the polygon identifier STEMS_PER_ is the number of stems per hectare HT_MAX is the maximum height in meters HT_MIN is the minimum height in meters • The project includes FD and MD Ecosystems for use with the shapefile we imported. Note the Rules of Nature and the disabled Diffuse Color texture and Ecotypes. This will render only the bright Diffuse Color initially. **Step 2: Link the shapefile vector to the proper Ecosystem with a Search Query** • FD Ecosystem Editor > General page. Use the Link Operations button to add a **New Search Query**. • This will open a new Search Query. It will default to the Ecosystem name, which is what we want. The types of objects to search have been taken care of for us. • FD Search Query > Filter Criteria page. The FD vectors have a TREE_SPECI = FD attribute. Use the **Attribute Field** dropdown list and select the **TREE_SPECI** attribute. Make it **=** the value **FD**. • FD Search Query > General page. **Select Items Now**. The Database Editor will open with **43 of 58** objects selected. • FD Ecosystem Editor > General page. The Vector Placement section will confirm the linked vectors and the FD query. • Material page. The Diffuse Color texture and the Ecotypes are disabled. Only yellow should render within the FD vectors. • Render another Plan Default preview. The yellow FD Ecosystem renders. So far, so good. • **Enable** the Diffuse Color **texture**, **Overstory**, and **Understory**. • Foliage page > Settings tab. Note settings: Absolute Size in the Ecotype, Absolute Density in the Ecotype, and Unit Areas set to Hectare.

Exercise (cont.)

Step 3: Map shapefile attribute values to Ecotype parameters with Thematic Maps

- FD Ecosystem Editor > Foliage page. The Overstory is made up of Fir, Lodgepole, and Aspen Foliage.
- Parameters tab. We'll use vector height and density attributes to control foliage placement. **Create a Thematic** Map for the **Maximum Height**.
- Thematic Map Editor > Data page. Choose **HT_MAX** for the Channel 1 value.
- FD Ecosystem Editor > Foliage page. We've taken care of mapping the Maximum Height but what about the minimum? There is no Thematic Map operation available.
- Settings tab. Change the Second Size to **Min %**.
- Change Min Height to **50%.**
- Parameters tab. Next is the Density. We'll use the STEMS_PER_ attribute to map this value to each vector area. Create a Thematic Map and choose the **STEMS_PER_** attribute for the Channel 1 value. That takes care of the Overstory.
- The Understory Ecotype is meadow foliage: weeds, flowers, and grass. This is not controlled by any vector attribute; it will render in all FD vector areas. When the Overstory is empty, as it is for many areas, this will be the only foliage that renders.
- Render a Main preview. Sample the different foliage areas and check the Diagnostic Data pane in the S@G. The brown treeless areas are FD vectors that have no stems; only the meadow-like understory.
- Right-click an area to get more Info About Point in the S@G. Now for the MD vectors.

Repeat Steps 2-3 with the next Ecosystem

- MD Ecosystem Editor > General page. **Add** a New Search Query.
- MD Search Query > Filter Criteria page. Make the Attribute Field **TREE_SPECI** and **= MD**.
- The Ecosystem Editor's Link Widget will show that **3** objects are linked.
- Render a Plan Default preview. The MD Ecosystem Diffuse Color texture and Ecotypes are disabled so only the Diffuse Color should render.
- The MD areas are not solid red as they should be. Go to the MD Rules of Nature and you'll see that the Maximum Slope is 10º. All slopes steeper than 10º will render the next item in the render order, which is the Ground Effect.
- Increase the MD Ecosystem Maximum Slope to **60º**.
- Render another Plan Default preview. The MD Ecosystem should almost fill its vectors.
- For more information on the 3 MD Ecosystem vectors, right-click and check the Point tab in the S@G.
- Everything looks good. **Enable** the MD Ecosystem Diffuse Color texture and Overstory.
- Foliage page > Parameters tab. All the foliage is in the Overstory. Like the FD Ecosystem, Maximum Height will be controlled by a vector attribute.
- Select the Overstory. Click the **Maximum Height** Thematic Map button, select **Link Thematic Map**, and choose Overstory Foliage Height.
- Click the **Density** Thematic Map button, select **Link Thematic Map**, and choose Overstory Foliage Density.
- Settings tab. Change the Second Size to **Min %**.
- Back on the Parameters tab, change the Min Height to **50%**. Render a Main camera preview.

Sky, Celestial Objects, and Starfields

Goal	• Explore these cosmic Components

Sky Editor	• Demonstrations based on **3DNA\Sky.proj**
	• Sky Task Mode
	• Color Gradients
	  ‣ Zenith–Horizon–Nadir
	  ‣ Towards Light-Away from Light
	• Nadir as background for floating terrain or block diagram

Celestial Object Editor	• Image Object, Size and Position parameters • Lock Position to Lights(s)
Starfields Editor	• Like the real world, Starfields are dim when Sky present

Other Uses	• Saving Components
	• Multiple Skies
	  ◦ Animate Intensity to dissolve between them
	  ◦ Scenarios to activate individuals

Atmosphere

Goal	• Use the Atmosphere Component for haze, fog, and volumetrics
Atmosphere Editor	• Demonstrations based on **3DNA\Atmosphere.proj** • S@G Sky Task Mode • Simple Atmospheric Types ◦ Haze, Cloud Haze, Fog ◦ Adds realism inexpensively • Volumetric Atmospheres ◦ Simulates real atmospheres, light interaction ◦ Slower to render but more flexible ◦ More complex to set up • Ambient Light ◦ From Sky ◦ From Ground ◦ Additive if multiple atmospheres • Uses of Haze and Fog ◦ Water Vapor ◦ Pollution ◦ Realism ◦ Artistry ◦ Depth cueing • Visual Depth Scale
Other Uses	• Multiple Atmospheres ◦ Switch between with Scenarios ◦ Cumulative Effect

Lighting

Goals	• Understand Light Color and Intensity • Position Light by time and interactively • Use a fill Light to Include/Exclude for selective lighting • Target a spotlight
Required	• **3DNA\Lighting.proj**
Light Color & Intensity	• Load **Lighting** project from the WCSProjects\3DNA folder. • Render the **Main** view. Really boring! • Go to Light Task Mode. • Open Sun Light Editor. • Color and Shadow page. Click the **Light Color & Intensity** color well and change the color to **255**, **210**, **172**. Leave the Color Editor open. • Render another preview. Too dark. • Increase Color Intensity to **125**. • Render a preview. Light too flat. Close the Color Editor now.
Light Position	• Switch Main view back to realtime mode. • Activate planimetric view. • **Zoom View Way Out**. • The yellow dot is the sun Light. If it is not yellow, alt-click it to activate it. • Switch to **Move** mode in the toolbar. • **Drag** the sun to a position south and a little west of the terrain/camera icons. • Render a perspective view. Much more dramatic but hides some detail of pinnacles. • **Drag** again to slightly east of due south. • Render another preview. Good terrain modeling and detail.
Fill Light	• Clear the preview from the Main view. • **Add a new Light** from the Scene-at-a-Glance. Name it **Spotlight**. • Light Editor > General page. Turn off the **Distant** Option. • Set the Light Type to **Omni-directional**. The new Light should be the active object. • Control-click on the terrain right of the base of the leftmost pinnacle to place the light there. Click OK in the Input Request window to set the Light elevation at terrain level. • Restore the Planimetric view to the Default Camera Position. • Use the Zoom Box tool to zoom in on the area where the light and pinnacle are. • Alt-click to activate the Light, switch to **Move** mode, and **drag** it **northeast** of the pinnacle. • Render a Main preview. Pinnacle should now be well lit from the northeast as well as the south. All features are lit by this light. We want to make it a spotlight so it only lights the nearest pinnacle. • Clear the Main preview. • Light Editor > General page. Change the Light Type to **Spotlight**. The shape of light will change in the Main view. • Light Editor > Position & Orientation page. Set the Heading to **–135°** (SW). Set the Pitch to **–25**° (up). • Change to **Rotate** mode on the toolbar. Click and drag in the Main view to fine tune the spotlight direction. Use the light shining on the satellite dish as a reference. • Render a preview.
Include/ Exclude	• Light Editor. Use **Edit next object of same type** button to bring up the Sun editor. • Go to Include tab and check the **Enabled** checkbox. • In the **Add New Items of the Class** dropdown list at the bottom, select **Ecosystem**. • Click the **Add Item** button. Select **Yellow Rock** and **Pink Rock** from the item list and **Add Items**. • Render a preview. The Sun Light is now illuminating only those selected items. The spotlight

Include/ Exclude (cont.)

is non-specific. The Include list only applies to the Sun but each Light can have its own list.

- Now make it an Exclude list by selecting the **Exclude** radio button.
- Render a preview. Now the opposite items are illuminated. Areas that were lit are now dark. Note that ambient light and atmospherics are still lighting other entities in the scene.
- **Disable** the Include/Exclude list.

3D Object as Spotlight Target

- Spotlight Light Editor > Position & Orientation. Select the **Satellite Dish** to be the **Target Object**.
- Set Heading and Pitch to **0**.
- Render a preview.
- Spotlight Light Editor > General page. **Disable** the Spotlight. Render a preview.

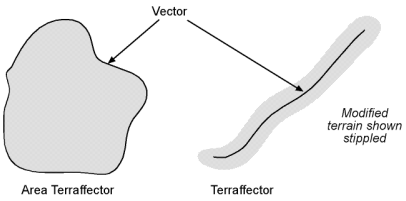
Other Effects

- Luminosity. If an object needs to be full intensity color, use Material Luminosity. Luminosity prevents shading from being applied to a color but it also prevents any Light color or intensity from affecting the Material.
- Yellow Rock Ecosystem Editor > Material page. Set the **Luminosity** to **100**%.
- Render a preview.

Earth Moving with Terraffectors™

Overview

- Two types of Terraffectors: Area and Linear. Linear is known as “Terraffector”, Area is known as “Area Terraffector”
- Linear Terraffector (TFX) is used to make streambeds, roads, and other straight or curving linear features that involve cutting or building a shape along a path defined by a vector.
- Area Terraffector (ATFX) is used to make quarries, hills, building sites and other features that involve raising, lowering or flattening the terrain within a contained area defined by a vector.

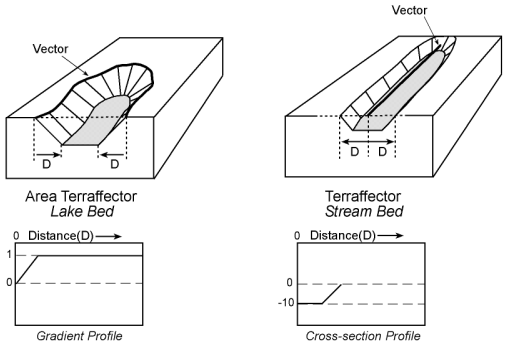


- Both can use profiles. Profiles can be envisioned like woodworking router bits, sculpting the edge of an altered region.
- Both can have animated parameters and both can be masked using textures.
- **Neither performs cut/fill estimations.**

Area Terraffectors™

Area Terraffector

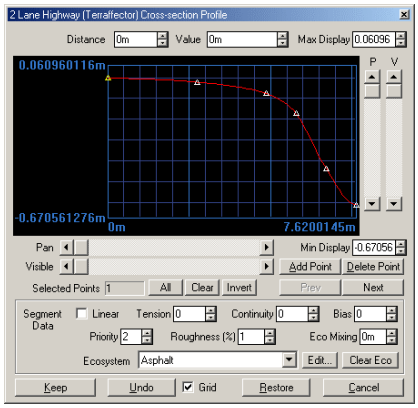
- Area Terraffectors can be Relative (Raise/Lower) or Absolute (set a specific elevation regardless of original elevation)
  - Relative is good for making hills & quarries that build up or cut into existing terrain, but still may inherit some of the shape of the original terrain.
  - Absolute is good for making building sites / flat areas where none of the original terrain influences the new form.
- Both Relative and Absolute can have an abrupt edge of influence, or can blend into the terrain with a Profile.
- Profiles in Area Terraffectors define Edge Feathering. Edge Feathering is a graph of the amount of influence the ATFX has on the terrain, starting at the outside (the bounding vector) and working inward. Profiles *always* blend inward.
- A default 10m wide profile will be created when you first elect to use a profile.
- Left edge of Profile (as seen in the Profile Editor) is the outer edge, the controlling vector. To the right is inward.
- Profile specifies the percent of change (0 to 100) that the Terraffector will apply at that distance from the outer vector.
- Profile can be envisioned like a woodworking router bit traversing the edge of a raised or cutout region.
- Area Terraffectors don’t explicitly alter the Vegetation. If needed to, use an Ecosystem with the same Vector.
- Other incidental Area Terraffector parameters: Roughness, Evaluate after Fractals

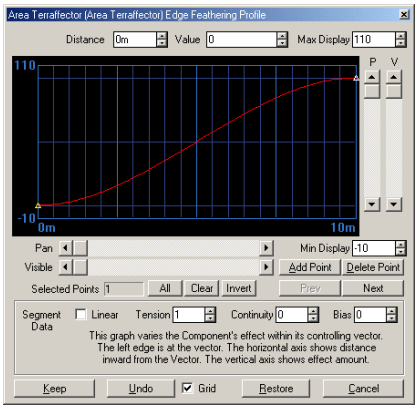


Linear Terraffectors™

Linear Terraffector

- Linear Terraffectors *always* have a Profile.
- A Linear Terraffector Profile is mirrored outward on either side of the controlling Vector. The Vector becomes the centerline of the feature.
- A default one-segment flat profile is created by default.
- Envision a Profile as a woodworking router bit plunge-cutting into the middle of a plank.
- Linear Terraffectors are typically symmetrical – Texture-based masking can circumvent this.
- Linear Terraffectors can optionally alter the Land Cover/Vegetation of the terrain within their control.
- Each segment of the Profile may specify a different Ecosystem, Roughness and may blend to adjacent segments.
- VNS 2-3 has a "Spline Vectors" option that smoothly interpolates the controlling vector in X, Y and Z. Great for roads.
- Linear Terraffectors can work in Absolute, Relative to Ground and Relative to Vector.
  - **Absolute** is rarely used, but available for completeness. The Y value of each Profile node is the actual elevation that will be enforced onto the terrain, regardless of original terrain height or vector height. The Vector is only used for horizontal placement and guidance of the Profile.
  - **Relative to Ground** is often used for making berms, gullies and other features that will conform to the changing terrain. The Y value of each Node is added (or subtracted if negative) to the existing terrain elevation, regardless of the vector elevation. The Vector is only used for horizontal placement and guidance of the Profile.
  - **Relative to Vector** is used for making Roads that must follow a vertical path somewhat independent of the underlying terrain, potentially creating cuts and fills where necessary. The Y value of each Node is added (or subtracted if negative) to the elevation of the Vector at that location, regardless of the original terrain height. The Vector is used as a 3D guide to drive the Profile through the terrain, building or cutting as necessary.





Profile Segments

- Profiles (for Linear or Area Terraffectors) are made of nodes connected with Segments.
- Each Segment has several settings unique to it
  - Linear/Spline
  - Spline Tension, Continuity, Bias (curvature adjustment)
- Segment-unique settings apply to segment to *left* of the selected node. (Exception: Mixing involves adjacents)
- Linear Terraffector Cross-Section Profile has additional Segment controls
  - **Priority** – determines which segments take precedence whenever this Linear Terraffector overlaps itself
  - **Roughness** – Roughness of terrain within this segment, akin to Area Terraffector's overall Roughness Parameter
  - **Ecosystem** – Land Cover to force (if any) within this segment. May be blank, allowing other methods of Land Cover specification to determine the fate of this region of terrain.
  - **Mixing** – forces the specified Ecosystem (if any) to blend with adjacent ecosystems.

Texturing	• Frequently, Ecosystems specified by various Segments will be textured. • Commonly, it is useful to specify that the Textures within these Ecosystems should follow the Terraffector's Vector ◦ Stripes and oil-streaks following a road. ◦ Choose "Vector Aligned" Coordinate Space in Texture Editor's Size & Position section. ◦ VNS will properly spline Texture alignment to match Terraffector if Terraffector is Splined (smoothly curving road striping)
Linear Terraffector Effect Intensity	• Intensity field / Texture can further be used to mask or modulate where a Linear Terraffector actually alters the terrain. • Field value defaults to 100%, no texture, causing no further restriction of Terraffector impact. ◦ Field value can be reduced to 0, resulting in no Terraffector impact whatsoever. ◦ Value can be animated to show change -- creation or removal of Terraffector-depicted feature. • Texturing ◦ Textures can be used to restrict / modulate impact of the Terraffector in a non-uniform way over different areas. ◦ White/high areas in Texture result in the Terraffector reaching the full Intensity amount, black will equate to none. ◦ Textured can be animated, and/or used in conjunction with animated Intensity field value. ◦ Textures modulating Terraffector Intensity frequently utilize the "Vector Aligned" Coordinate Space (above). ◦ Careful use of Texture-driven Intensity can create asymmetric Terraffectors.
Precedence	• Frequently, it is useful to apply more than one Terraffector to a given area of terrain. • Area Terraffectors are *always* applied to the terrain before Linear – no exceptions. VNS 2 Freeze can work around this. • Within same-class Terraffectors (Area, Linear) there are several ways of sorting out overlapping regions. ◦ **Priority** – Mutual Exclusion between TFX of differing Priority. Not very useful, WCS4 only had this available. ◦ **Evaluation Order** – Consecutive application of Components of the same Priority but differing Evaluation Order ▪ Evaluation order can frequently be very useful. ▪ Think of it like a Construction Schedule, listing operations to be done to a piece of terrain, in order. ◦ **Apply to Modified** ▪ Apply to Modified is the default, and it continues the Construction Schedule metaphor. ▪ Each successive step inherits the terrain as altered by all of the preceding steps, like an earthmoving crew. ◦ **Apply to Unmodified** ▪ Puts the terrain back to the condition it was in before the Terraffectors (of this class) started their work. ▪ Can be used in special circumstances to make a region of terrain un-Terraffected for differing treatment. ▪ Can be used as a limited-area Terraffector Undo, as found in the supplied Revert Components. • Comparison: Increase or Decrease, Increase Only, Decrease Only ◦ Example: Can be used to ensure an Absolute-elevation leveling operation only cuts, never fills.

Viewing, Freeze and Export	• All VNS versions have an option to display the impact of Terraffectors (all classes) in real-time Views. (View Prefs/View Popup Menu) ◦ This can take some time to calculate and update. ◦ The Auto-Update option will attempt to refresh the terrain model whenever any Terraffectors change the terrain. ◦ If making several incremental changes to a Terraffector (or working interactively with a profile) it is recommended that Auto-Update be turned off, and manual Force Refresh be used when finished to update the view of Terraffectors. • VNS Export (To DXF, LWS or 3DS) always incorporates the impact of Terraffectors, WCS does not. • VNS 2-3 Freeze Area or Linear ◦ VNS 2/3 have a “Freeze All” button available in the Area or Linear Terraffector Editors ◦ This builds a new set of DEM files that incorporate the impact of all currently Enabled Terraffectors of the desired class ◦ Prompts for prefix to use for these new DEMs ◦ Does not alter Original DEMs, allowing reversion to unmodified state and re-freezing if the already-Frozen Terraffectors change. ◦ Permanently frozen-in Terraffectors can then be disabled, taking no more processing time, and appearing in Views even with Terraffector Preview off. ◦ Freeze can be used to permanently apply the impact of Linear Terraffectors to the terrain, allowing them to be further acted upon by Area Terraffectors, thus appearing to violate the normal class order of Terraffector operations.

Cameras

Overview	• Cameras are the device used to setup a viewing position or moving viewpoint path • Cameras contain settings that often mimic properties of a real camera rig (not just the camera itself): Position, Orientation, Lens/Zoom, Targeting, Terrain-following, Stereo, Panoramic • Cameras contain some settings that have no clear real-world analog: Floating, Orthographic, Projection • Cameras lack some settings that a real-world camera has: Film Size/Shape (In Render Options) • These organizational decisions generally work out the way you'll find you want them to work!
Camera Editor	• Cameras have tools to aid positioning: Floating, Interactive Elevation Follow Terrain • Cameras come in multiple types that primarily control their aiming behavior: Targeted, Non-targeted, Align-to-Path, Overhead, Planimetric, (VNS: Projected Planimetric) • Cameras also have numerous options (not always available in all combinations): Panoramic, Orthographic, Stereo, Realistic Lens Distortion (VNS: Projected Planimetric) • Lens options include Field of View, Depth of Field effects, and Blur/Motion Blur effects. • Position and Orientation can be animated for obvious reasons. Automated Banking (no fees!) is available. • Keeping camera aimed at a (potentially animated) Target point or object is possible. • Center Shift permits exotic perspective framing tricks (infrequently used). • Stereo pair generation is just a few button clicks away, for those who like crossing their eyes. • Basic Compositing with background images or animations is very simple. • Field Rendering is available for motion fringe elimination in interlaced broadcast video applications. • Several exotic optimization settings permit near/far cutaways, and reflection adjustment.
Camera Summary	• A project may have numerous cameras of varying types. 10+ cameras is not unusual. • Cameras are the entity used to record temporary viewing positions during project editing, as well as permanent final viewpoints or animation paths. • When used in a realtime View, a Camera is associated with a Realtime View Options (immediately below) as well as a Render Options for doing Preview Renders within the View window. No Render Job is used. • When used in final renderings, a Render Job component is used to group a Camera with a Render Options Component. No Realtime View Options are involved.

Views

Realtime View Options	• Realtime View Options control what appears and how it appears in Realtime Views. • Each View has its own individual Realtime View Options. They are not shared in any way. • VNS: A few Realtime View Options are common to/shared between all Views: Tfx Preview • Realtime Options do not affect final renders in any way. • Can be used to simplify what appears in a View for performance or decluttering reasons. • Numerous realtime-only options offer extra info: Fractal Maps, Gradients, Contours, Framing • Certain types of foliage can be displayed in Realtime Views. This is performance-intensive. • Image drapes (Color Maps) and basic ecosystem coloration can also be displayed in Views. • Views cannot always display all data perfectly accurately all the time due to computer limitations. • Realtime View Options can be accessed either from the Popup Menu or through View Prefs. • Certain Realtime View Options (Max Polygons, Grid Unit) are not conducive to representation in a text menu and are only available in the View Preferences Window. • Views can be temporarily completely disabled to improve response/redraw time when needed. • Newly opened Views get their Realtime Options from one of several sets of Defaults, depending on the Camera type initially installed into the View. These defaults can be customized by the user. • Realtime Options are analogous to Render Options. Not all Options available (or make sense) for both. • Realtime Options can be saved as default for each type of view (Perspective, Plan, etc) • Render Options (below) are also accessible through View Preferences Window, and Popup Menu.
View Tips	• Easy access to Realtime and Render Options via View Prefs Window. Key shortcut: ? • You can save what you see in a View at any time (realtime or rendered) from the View Popup Menu (F7) • You can save a realtime preview of your animation from the View Popup Menu. Make Quick Sequence • Various objects can be moved, rotated, scaled, etc with the mouse in a View. • Easily drive cameras around in a View with mouse or joystick. Different camera types ‘drive’ differently.

Render Options

Overview	• Render Options (RO) controls what appears (and somewhat how it appears) in preview or final renderings. • A project can contain multiple Render Options. Two are created by default, one for previews, one final. This allows the user to tinker with settings to experiment with or speed up previews without the risk of interfering with a perfected set of final render settings. • By default, newly opened Views will search for a Render Options with the name Preview in them. • If a "Preview" Render Options is not found, one will be created. • A Render Job (see below) is used to group a Camera and a Render Options for final renders. • Render Options: Specify 'film' settings like film size/resolution, shape/aspect of a frame of film • Define time span and frame rate to be used when generating an animation. (Ignored in View previews) • Render Options define one or more file saving actions. (These are ignored in View preview renders) • Render Options specify Post Processing operations, if desired. These *are* used in View Previews. • Multiple Render Options allow you to have multiple variations on tap for creating low-res rough-cut test animations and high-res final output. You can switch out the Render Options within a Render Job without disturbing the associated Camera, or even have multiple Render Jobs, each with the same Camera and different Options. Multiple Render Jobs can be queued up and executed in one operation.
Render Options Editor	• Access to all of the settings in a Render Options Component. • Some settings are also accessible via the View Preferences, when associated with a View. • Render Options Components can be named -- make effective use of this! • **Size and Range** tab: ◦ Image/film resolution and proportion. Scaling/Lock maintains shape during changes. ◦ VNS: 2D Tiling controls to handle massive images or image sets. WCS has 1D segments. ◦ What is Overscan? Why do you need it? ◦ Time Range and frame rate. Output can be in different frame rate(s) than UI shows. • **File Output** tab: ◦ Multiple simultaneous outputs are possible. Output to frames and AVI/QuickTime all at once! ◦ Some formats have various options: Compression, Precision, Features, World Files, etc. ◦ Some formats support additional channels: Alpha, Z-Buffer, Elevation (DEM savers), Exotics ◦ Image can be saved before and/or after Post Processing ◦ Still images can have variable number of frame digits appended -- will warn if insufficient! • **Post** tab allows for scheduling of Post Processing Components (discussed elsewhere) • **Enabled** tabs allow for omitting certain classes of entities from rendering for speed or effect. ◦ Render Diagnostic Data is not usually needed for most renderings, and can consume more memory ◦ Diagnostic Data is needed when writing more exotic channels like ELEVATION, etc. • **Misc** tab offers controls for Rendering Quality, Vector effects and Foliage Offset ◦ Pixel Fragments are the high-quality rendering method in WCS6/VNS2/VNS3. ◦ Fragments offer better transparency and reflections, but consume more memory. ◦ Large hi-res cartographic projects often do not need these features and are memory-constrained. ◦ Fragments can be disabled for this type of work. Also: Use tiling. Disable Diagnostic Data. ◦ Antialiasing quality is almost never adjusted in practice. ◦ Control for enabling/disabling Vector rendering in final output is located here. ◦ Vectors can ignore or be affected by haze and/or lighting, for effect. ◦ Vectors often need to be 'lifted' closer to the viewer to prevent dropping into terrain or foliage. ◦ Foliage also often needs to be lifted closer for the same reasons (in overhead/planimetric renders)

Render Jobs	• Render Job simply groups a Camera with a Render Options for final output scheduling. • You can have many Render Jobs. Name them usefully. • Render Jobs can be enabled and disabled and have Priorities. • The Render Controller executes all enabled Render Jobs in the order dictated by their Priority. • VNS: Render Jobs can associate with one or more Scenarios to further dictate what gets rendered. • VNS: You can test Scenario setups with the Action Now button. Recommended before long renders!
Render Control Window	• The launch pad for all final renders. • Lists all current Render Jobs, disabled are shown grayed • Jobs can be moved up and down in priority and enabled and disabled from here. • CPU priority for rendering can be adjusted. • Various settings from the current Job (and its Camera and Render Options) are summarized here. • Access to Render Job, Camera and Render Options editors available. • Thumbnails of current and previous completed frame. • Show Rendering checkbox -- can slow down rendering significantly. • GO! STOP! PAUSE!

Animation

Summary	• Animation is varying something over a range of time: ◦ Camera/Observer position (fly-throughs) ◦ Local conditions ▪ Lighting, landcover (vegetation height/density) ▪ VNS 2 & 3 Scenarios: presence or absence of entities ◦ Changes that are not actually significant but add realism: ▪ Clouds moving, water/waves, etc. • Many examples of different types of animation on Demo Reel.
Time Units	• WCS/VNS can display and interact with time in units of Seconds (decimal) or Frames • Main Preferences window, Units tab. • Even if Prefs set to one unit (e.g., Seconds) you can enter in units of Frames by using the proper suffix. For example, typing 15f (15 Frames) or .5s (one half second) are equivalent (if program is set to 30fps)
Frame rate	• Video: ◦ 30 frames per second (actually 60 fields per second – see field rendering later) ◦ 25 frames per second (50 fields per second) outside NTSC US (PAL/SECAM) • Movies: 24frames per second (no fields) • Web/computer: Variable, often 10-20 frames per second (no fields)
FPS in WCS/VNS	• Project Prefs (affects all areas of user interaction *except* Render Options) • Render Options (used to produce one or more outputs, can be same as prefs, or different) ◦ You can have several Render Options in a project, each set up to output the same length of animation at different frame rates (e.g., different numbers of frames will be rendered). ◦ Don't be too clever, you can often forget what frame rate(s) you're working with.
Types of Animation	• Keyframed Items: ◦ Motion: Cameras, Lights, Celestial Objects, etc ◦ Non-Motion: Colors, Textures, Materials, Tree Heights, Tree Densities • Velocity: Water Waves , Cloud Waves, Cloud Evolve, Texture Velocity • Image Object Sequences and Dissolves
Controls & Procedures	• Frame field and Frame scrollbar in bottom animation toolbar • Next and Previous Keyframe buttons • Making Keyframes ◦ Groups Toggle button – keyframes multiple related channels (Lat/Lon/Elev) in one step ◦ From Key icon in editors – works on adjacent control – very common ◦ From key icon in bottom animation toolbar – works on active item – less common • Deleting Keyframes (also sensitive to Group button) ◦ Parameter ◦ Group ◦ Object ◦ Object Class ◦ Entire Project • When you change an existing value that already has a keyframe, you must update the keyframe (by making a new one at that 'moment') or the change will not 'stick'. • Timeline can be used to view a graph of the value of an animated channel over time, and edit it! • Scaling keyframed values or time-shifting entire key frame ranges is possible. • The Scene-at-a-Glance can be filtered to show only animated items ('list with key' icon at top). • Motion-based animation can be previewed by operating the slider at the bottom animation toolbar. There is a small Play toggle button that automates this. It will try to automatically 'keep up' with the desired real playback speed, regardless of the frame rate your video card and computer can keep up with. It may be smooth or choppy as a result. • Make Quick sequence basically records this output to a sequence of files. See Scott's tutorials.

Rendering	• Field Rendering – on or off. On for some types of TV/video output, off otherwise. • Output of frame sequence – sufficient frame number digits are important! • Writing to AVI and QuickTime ◦ When/Why you would, when/why you wouldn't? ◦ If the program stops, crashes or other problems arise during rendering of an AVI or QuickTime file, the file (and some or all of your rendered work) may be truncated or lost. ◦ QuickTime/AVI output is good for previews. ◦ We do NOT recommend for final output, due to the risk. ◦ Also, it is better to experiment with compression/quality tradeoffs when making AVI/QuickTime files. This is best done in other software where it can be done without time-consuming re-rendering. ◦ Rendering distributed across multiple machines does not permit AVI/QuickTime output, as frames must be written in order by one single machine.

Animation Applications

Goal	• Experiment with Components commonly animated
Cameras	• Targeted Camera ◦ View spot from several angles or focus on a special feature of interest • Non-Targeted Camera ◦ Fly through - can look at various features of interest • Aligned Camera ◦ Fly through - looks ahead along path
Ecosystems & Snow	• Ecotype ◦ Foliage height and density – simulate thinning and regrowth (see 3DN demo reel) ◦ Rules of Nature - simulate climate change • Snow ◦ Elevation line – simulate annual snowline migration or climate change
Lake & Stream	• Lake ◦ Elevation – simulate sea level rise, flooding, desiccation (Tutorials Part 2D) ◦ Beach Reference Elevation Simulate temporary flooding: Retain and submerge foliage as water rises vs. long-term permanent inundation • Stream ◦ Surface displacement with aligned velocity (see old video tutorial online at http://cherba.com/wcs/tutorials/wcs5/wcs5_animated-stream.zip)
Sky, Atmosphere, & Clouds	• Sky, Celestial Objects, and Starfields ◦ Horizon Color – simulate time of day (3DNA\animation\SkyAnimation.mov from SkyAnimation project) • Clouds (see *Clouds* session) (3DNA\animation\Clouds2D.mov and Clouds3D.mov)
3D Objects	• See *3D Objects* session (3DNA\animation\TurbineSpin.mov)
Tfx/ATfx	• Terraffector ◦ Elevation – simulate excavation or erosion • Area Terraffector ◦ Elevation – simulate excavation or erosion
Image Objects	• Image Sequence ◦ Simulate seasonal foliage change, burning vegetation, fire progression (3DNA\animation\FireProgression.mov) ◦ Sequences can be used in Foliage, Textures or Color Maps (3DNA\animation\FoliageEffectAnim.mov from FoliageEffectAnim project)

Scene Express and NatureView Express

Scene Express

- Scene Express is an add-on to WCS 6 or VNS 2/3 to export scenes into a variety of formats
- Formats for Rendering elsewhere: 3D Studio, LightWave
- Formats for Realtime use: NatureView, VRML, VTP, OpenFlight (optional)
- Other specialized formats: STL/VRML-STL
- Exporting via Scene Express is just like rendering a frame: Scene Exporter = (Render Job/Options/Camera)
- Export Control very similar to Render Control
- We'll focus on Realtime export here, VRML and NatureView
- Overview of various formats and their advantages and disadvantages in the Scene Express Formats reference

VRML

- The original "Web Virtual Reality" format, influenced by SGI, big in 1997
- Standardized, but over-ambitious, slow, large, inefficient
- Can be very flexible with programmable interactions, animations, sounds, web links
- Browser plugins: Cosmo, Cortona, Blaxxun. Few being maintained anymore, some awkward to install
  - Smaller scenes with less vegetation. Practical size of 2048x2048 image, 1024x1024 terrain
  - Scenes needing direct web-browser integration, or customized programming

NatureView

- 3D Nature's own file format and viewer, introduced Autumn 2003
- Designed exclusively to fulfill the requirements of Scene Express users
- Very fast, handles detailed scenes with lots of foliage well
- Based on OpenGL and OpenSceneGraph technologies – benefits strongly from modern graphics cards
- Compact compressed (ZIP) scene file format for easy Internet distribution
- Compact viewer that requires no specialized installation
- Is not yet available as a browser plug-in or with web links. Will be added in the future.
- Can be improved by 3D Nature. Better performance and numerous new features have been in every update.
- Offers many options specific to NatureView format (see below)
- Best for:
  - Larger scenes with more vegetation/objects
  - Up to 8192x8192 image, 2048x2048 terrain (or larger – system dependent)
  - Scenes needing fast and intuitive interaction, easy deployment
- NatureView can also be customized by 3D Nature for specialized customer applications

VRML Export

- REALLY easy.
- Open Urban-Park-Study.proj
- Do a test render to update shadowmaps if necessary
- Create Scene Exporter
- Change format to VRML
- Open a Planimetric camera into a view, zoom in
- Switch to Terrain tab, Set Bounds in View
- On Misc2 tab, select several cameras (avoid planimetrics)
- On General tab, Export Scene Now, Go
- View in viewer!

NatureView Export	• Just as easy • Open Urban-Park-Study.prj • Create a new Scene Exporter • Leave format as NatureView, change directory to ExportsNV • Terrain tab, Set Bounds in View • On Misc2 tab, select several Cameras • On General tab, Export Scene Now, Go • View in viewer! • Try higher resolution terrain (Terrain tab) • Try higher resolution image drape
NatureView Advanced Options	• Click Show Advanced Options on General tab of Scene Exporter • Constraints, Optimizations • Overlay Text and Logo (dynamic variables!), Watermark • Metadata can be used in Overlay Text dynamic variables

Database Editor

The Database	• The Database is the container for all DEM and vector/point/polyline data in WCS and VNS. • Contents can be seen in the S@G (DEMs in Terrain Task Mode, Vectors in Vector) • S@G is inefficient to display large numbers of entities, default to only showing first 6000 • Database editor is useful for working with more entities, viewing more detail, and manipulating entity properties. • Database entities are typically saved as part of the Project. ◦ VNS: Dynamic ReImport items are *not* saved as part of the project. Automatically re-imported on load. ◦ Database entities can be saved to a discrete .db file, and loaded/appended from other .proj or .db files. ◦ DEM data is not stored in the .proj file, only a reference to the data (stored externally in a .ELEV file) ◦ ELEV files are stored without a full path. DEM Directory List (Project Prefs) used to locate them. ◦ Be careful deleting .ELEV files. They may belong to multiple projects, especially if you use cloning. • Database entities can be disabled (completely inert) and made visible/invisible in realtime Views and Renders. • Entities can have both a Name and Label. Both are for user identification and can be used with VNS Queries. • Database entities can belong to one or more Layers. Layers are groupings in CAD/drafting sense. • VNS: Entities can also have named (shapefile) Attributes that store text or numeric data fields on each entity. • Entities can be hard-linked to one or more Components, defining the extent or region of the Component. • VNS: Entities can also be soft-linked with Search Queries. This will not appear in the Database. • Vector-type entities can have a unique color and line width/style. This can appear in final output.
Database Editor	• Database Editor (DBEdit, frequently) is the primary interface for working with quantities of DEMs/Vectors • Allows for multiple contiguous or non-contiguous selections, and selection by search text. • VNS: Search Queries offer more sophisticated selection criteria in Database Editor for immediate operations. • Entities can be opened in the Vector Editor, Vector Profile Editor, DEM Editor or DEM Painter as appropriate. • Entities are shown as grayed in the entity list if completely disabled. • Multiple tabs available (not all present in WCS) ◦ Properties tab page shows visual aspects of Vector-class objects. For DEMs, Maximum Fractal Depth. ◦ Extent tab page shows spatial and elevation ranges as well as statistics (area, length) as appropriate. ◦ Extent tab page also offers access to Conform and Topology (split/join) tools for Vectors. ◦ Components tab page offers viewing and management of hard-linked Component association. ◦ Components can be batch hard-linked by Name or Layer, an older technique similar to VNS's Search Queries. ◦ Layer tab page offers viewing/management of Layer groupings, and enabling/disabling all members of a Layer. ◦ VNS: Attribute tab page offers viewing/management of Attributes. • Titlebar of Database Editor displays total number of entities, and number currently selected (both DEM and Vector) • VNS: Database Editor can be used for testing Search Queries, in conjunction with selection count in titlebar.

Dynamic Objects	• Some objects visible in the Database may be "Dynamic" – the result of an Auto-ReImport shapefile template. This will say **[Templated]**. • Such objects cannot be permanently changed within VNS. • They are ignored during saving operations and discarded when VNS exits. A fresh copy is imported during next load. • Objects like these can be deleted, but will return "from the dead" next time the project loads. • Changes made to them will mysteriously revert next time the project is loaded. • These Shapefiles are useful for keeping a set of data fresh when it is changed outside of VNS. • Drag & Drop "hard" linkages to these objects break during ReImport – you must use Search Queries. • Auto-ReImport Shapefiles don't happen by accident. To get there you must: ◦ Check the "ReImport When Project Loads" checkbox during Shapefile Import in Import Wizard • Auto-ReImport shapefiles are a controlled in the Template Manager [File/Template Manager…] • The Template Manager can completely remove an Auto-Import Shapefile from the project permanently. • Can also embed contents of Auto-Import Shapefile into the project permanently, making it not Auto-Import anymore.
Other Tools	• Path/Vector Transfer window can make camera and 3DO paths from vectors ◦ Select source on one side, destination on other, and choose options in middle. ◦ Looks scary, but is actually simple and powerful. • Vectors can be interactively edited with View Toolbar icons ◦ Move, Rotate, Scale with mouse • Vectors can be numerically edited with the Vector Editor ◦ Move, Rotate, Scale, Smooth, Change Number of Points, etc • Vertical Profile of Vector can be edited with Vector Profile Editor ◦ Reshape grades, define cut and fill areas for Terraffectors, enforce grade limits

Data Import

Summary	• Import a variety of common data formats to explore common Import Wizard parameters and workflow.
Arc Grid / ADF	• NED_ArcGRID (Arc Grid / ADF) 30m Geographic DEM near Chatfield/Roxborough Colorado. • 3DNA\data\NED_ArcGRID\0950111120103\00001\disk01\area01\demgrid\w001001.adf • When importing, choose the file named like "w001001.adf", not "w001001x.adf" • ADF can also contain vector data – we only support raster variants.
Arc Export Grid / E00	• LafayatteCounty_Miss_E00 (Arc Export Grid / E00) 30m Geographic DEM of Lafayatte County Mississippi. • 3DNA\data\LafayatteCounty_Miss_E00\laf_geo.e00 • E00 can also contain vector data – we only support raster variants.
Shapefile	• CO_MuniBounds2001_SHP (Shapefile) UTM, Zone 13N, NAD83 All municipal boundaries of Colorado. • 3DNA\data\CO_MuniBounds2001_SHP \munibd01.shp ◦ Can select the .SHP file or any of the others, Import Wizard will figure it out. ◦ Don't be lured by a munibd01.shp "XML" file, if you have Windows set to hide extensions. This is not the .shp file, this is a non-useful .xml file. You would instead be looking for a munibd01 "SHP" file. ◦ Page through to the Attributes page. Select all desired Attributes from requester. WCS: Layers might be useful, in absence of Attribute support. ◦ Don't check ReImport unless you know what you're doing! ◦ Select NAMEUC as field to assign names from.
SDTS	• RMNP_SDTS (SDTS 10m) UTM Zone 13N NAD 27 10m DEM near Rocky Mountain National Park • 3DNA\data\RMNP_SDTS\Allenspark_CO_10_2_.100m\1101CATD.DDF • 3DNA\data\RMNP_SDTS\Isolation Peak_CO_10_2_.100m\1101CATD.DDF • 3DNA\data\RMNP_SDTS\Longs Peak_CO_10_2_.100m\1101CATD.DDF • 3DNA\data\RMNP_SDTS\McHenrys Peak_CO_10_2_.100m\1101CATD.DDF ◦ Note: There are four Quads here, all are 10m. ◦ To ensure seamless import, you must select one, then when prompted, select each additional quad, and let the Import Wizard import them as a batch so it can resolve edge discrepancies and gaps. ◦ Do not mix 30m and 10m SDTS DEMs during import. VNS2 users can combine with DEM Merging. ◦ Note that all four Quads are made of extremely similar-named (or identical) files. Do not try to combine all the DDF files into one subdirectory or they will massacre each other. Clever! ◦ When selecting a Quad, choose any one of the DDF files it comprises. Import Wizard will figure it out. ◦ If you use WinZip or Stuffit Expander to extract the original .tar.gz files, be aware that there is a setting (Smart CR/LF conversion) that must be turned off in the WinZip/Stuffit setting, or they will 'Smartly' corrupt your SDTS DEMs! ◦ Once imported as a large seamless block, you will need to run the resulting ELEV file back through the Import Wizard in order to let WCS/VNS tile it into manageable pieces, or it will probably require too much memory to render.
NTF	• UKNG_NTF (UK NTF, VNS Only) 10m British National Grid, Airy 1839, near Swansea Wales • 3DNA\data\UKNG_NTF\dtmss78.ntf
XYZ	• XYZ (XYZ ASCII for gridding) UTM Zone 13N, NAD 27 30m points of area north of Golden, Colorado • 3DNA\data\XYZ\Golden_CO_30m.xyz

	• Choose Control Points, uncheck Render Enabled. • Elevation (Z Units) are meters. • Will need to manually specify Coordinate System, as nothing in the XYZ file indicates this. • Check Grid Control Points and Import.
DXF	• UKNG_DXF (DXF, VNS Only, for gridding) UKNG British National Grid, Airy 1839 • 3DNA\data\UKNG_DXF\conss78.dxf ◦ Choose Load As: Control Points. Uncheck Render Enabled. ◦ Select 'UK National Grid' Coordinate System (DXF has no metadata) ◦ Choose 'Load Control Points, not 'Grid Control Points'. Some customization required before gridding. ◦ Need to tell gridder to ignore junk section map lines in file. After import, create a Terrain Gridder ▪ Choose 'UK National Grid' and let VNS set bounds automatically (click Default Bounds to be sure). ▪ On Output & Filters tab, observe resolution is 50m, one 100x100 tile. ▪ Change to 500x500 for 10m DEM. Change name to Swansea. ▪ On Current Filter tab, check Layer Equals, check Not, enter 'G8020572' (case sensitive!) into Layer to Match. ▪ On Output and Filters, click Grid & Save.

Basic Search Queries

Summary	• Search Queries are a way of selecting potentially large numbers of entities at once via simple or complex common criteria. They live in the Vector Task Mode since they mostly are employed with Vectors.
Capabilities and Uses	• Also referred to as “soft” or “Dynamic” linking as opposed to Drag & Drop style “hard” linking. • The only linkage type that work persistently with Dynamic ReImport Shapefiles where “hard” linkage doesn’t. • Can select one or more entities for use in Database Editor or linkage to Components. • Can select large numbers of common objects: All vectors named “Bob” • Can select by complex criteria: Named “Bob” and attribute “Amount” greater than 10. • Can select geospatially: Find all objects within a given bounds • Geospatial criteria: Inside/Outside Region (Completely or not), Point Within/Without • Characteristic criteria: Layer, Label, Name, Attribute, Line/Point, Enabled, Vector/ControlPoint/DEM • Comparisons <, >, =, <=, >=, similar. Text can be case sensitive or substring match. Expression Negation too. • Can do multi-stage selections: Find everything named “Bob” but remove anywhere “Amount” > 10. • Can quickly locate a single unique object in a large database: Find where ID = 239714 • Similar to an SQL query, only graphical instead of a rigid grammatical syntax • Are (re)evaluated at each render time, adapting to current data conditions • Usually associated with one or more Components, but can be used solo for convenience selection • Can do “Select Now” on a Query to select the results in the Database Editor • VNS3: Database editor can filter view using a Search Query
Dynamic Linking	• Components that are attached to Vectors through Dynamic linking can automatically adapt and attach to new vectors that meet the defined criteria without any additional interaction from the user. • MUST be used with vectors from auto-ReImport Shapefiles. Must. Must! MUST! • Practically a necessity when using large number (100+) of vectors. • Template projects (discussed later) require Dynamic linking to work. • Can be converted to hard links in the Search Query editor, if necessary. • Soft links evaluated at render time are slower than hard links, but the convenience is worth the penalty. • Scenarios also utilize Search Queries frequently. • Power users save TONS of time with Search Queries.
Quick Exercise Search Query	• Open **3DNA\ZackRMNP Undone.proj** • Open Database Editor • Switch to Vector Task Mode • Observe that there are several Search Queries already: Aspen, Doug Fir, Grasslands, Kobresia, etc. • Observe in the Database a large number of “roads_tr” vectors. • Right-click “Search Queries” category heading and select “Add Component of this type” • A new Search Query appears named “Search Query” – name it “Roadfinder” • In the “Filters Summary” we already have one generic Filter. The details of it are below, and on next tab. • Filter is enabled, and will add objects to the selection set (which starts out empty). Later filters could subtract. • Filter will consider Control Points, Vectors and DEMs, whether they are enabled or disabled, lines or points. • For this test, we only want to consider Vectors. Uncheck “Control Points” and “DEMs”. • When creating a Search Query directly from some Component Editors that only need Vectors,

Search Query (cont.)	"Control Points" and "DEMs" will already be unchecked for you. • We only want Enabled vectors, so uncheck Disabled. • Searching for disabled objects is useful when you want to find and re-enable a certain set of objects. • We probably only want Line-styled objects, so uncheck Points. • Switch to "Filter Criteria" tab. • Observe in Database Editor that our target vectors have a common naming and belong to "Roads" Layer. • Check Layer Equals, choose "Roads" from list. Hit Select Now on General tab. 88 selected. Try "Not": 1562 • Uncheck Layer Equals. Check Label Similar (NOT Name) and enter "roads_tr". Select Again. Same as above. • Let's make it more specific. Clone this Component in S@G by right clicking "Roadfinder" and Cloning. • Name one of them (probably the clone) "Asphalt Roadfinder". Open the original and name "Dirt Roadfinder". • With "Dirt Roadfinder" open, switch the Database Editor to "Attrib" tab. Observe "SURFACE" attribute. • Switch to "Filter Criteria" tab and choose "SURFACE" in Attribute drop-list. • Check "Similar" and enter "dirt" (any case or substring works with similar). Test select. Only 42 now. • Open "Asphalt Roadfinder" and do the same, only choosing SURFACE=asphalt. 46 of those.

3D Objects

Goals

- Understand the types of 3D Objects VNS can import and their limitations
- Demystify UV mapping and find out what it can do for you
- Apply good modeling methods to your models
- Place, align, and keyframe 3D Objects
- Use Path-Vector Transfer to save time and create smooth animation paths

Required

- 3D Objects discussion (*3D Objects* and *Axes* handouts)
- 3D wolf models and textures in WCSProjects\3DNA\objects and \images folders
- **Wolf**, **TurbineSpin**, and **Miata** projects from WCSProjects\3DNA folder

UV Wolf

- Open the **Wolf** project.
- Right-click the 3D Objects category in the S@G and **Add Component of this type**.
- 3D Object Editor > General page. Note that the message at the bottom of the page indicates, "No vectors are linked to this 3D Object."
- Click the **Load 3D Object from disk** button to open the Select 3D Object file requester.
- Go to the Animal folder and import the **Wolf.obj** file.
- Where's the wolf? Select it in the S@G to highlight it in views. Geographic Instance (Size & Position page) puts it in the center of the DEM, so zoom in until you see it.
- On the Size & Position page you'll see that the dimensions of the object bounding box are about 0.15m x 0.4m x 0.56m. That's a smallish wolf. Guess it wasn't modeled to scale.
- *Axes discussion*
- Increase the Scale % to **200** on all axes (you can use the Constrain button to set all at once).
- 3D Object Editor > General page. Change the Preview to detail.
- Rename the object **Wolf UV**
- 3D Object Editor > Size & Position page. Change Rotate Y to **–45**°.
- *Left-hand rule discussion (VNS and LightWave)*
- Render a preview. Note that the wolf is rendered with its UV texture with no help from us.
- Note the stretched texture on the wolf's back. Why is it stretched?
- 3D Object Editor > Materials page. Edit one of the Materials and find out how the texture is applied.

Model Rules

- *Model rules discussion*
- 3D Object Editor > Materials page. Note that the modeler used generic names for the body parts. These are not unique to the wolf. What would happen if we imported another animal model with the same Material names?
- Material names should be unique to the model. One way is to insert **Wolf_** at the beginning of each Material name. This would prevent problems when loading other animals modeled by the same person.
- Save the wolf as a Component in a new category, **Animal**, and use the preview render as the thumbnail. Check the Component Gallery for your new Component.

Vector Placement and Alignment

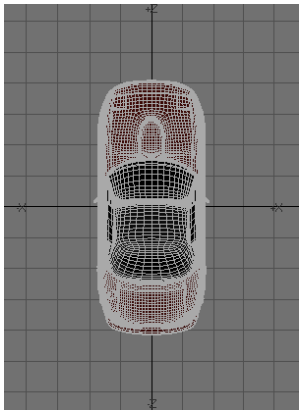
- Open the planimetric view and zoom in.
- Click to activate the 3D Objects category in the S@G and **Create** from the toolbar.
- Digitize a ring of vertices around the UV wolf named **Ring-o-Wolves**. Use the vector for position.
- Close the Component Gallery.
- 3D Object Editor. **Load 3D Object from disk** and select the **Wolf_ColorOnly.lwo**. Make the Preview **Detail**.
- These are smaller wolves, which is ok. Remember that the wolf model faces the –Z direction and its sides face the positive and negative X directions.
- 3D Object Editor > Align page. Show Advanced Features, if necessary.
- Check **Align Heading to Vector**. If the Z-axis is selected for alignment you'll have the new wolves lined up like a wagon circle. Select **X-axis** to have them align their side to the vector.
- Render a preview.

Keyframe Animation: Basic	• Zoom out the planimetric camera. • Activate the **Wolf UV** 3DO. • 3D Object Editor > Size & Position page. Click the Animation Operations button next to the Latitude value box and **Create Key** at **0** seconds. • Switch to Move Mode, and click and drag the wolf SE of the circle of wolves. • 3D Object Editor > Size & Position page. **Create Key** at **2** seconds. • Click the Play Animation button on the Animation Toolbar to watch the wolf run away. • Wolf_ColorOnly > Size & Position page. **Create Key** for the Elevation at **5** seconds. • Change the Elevation to **–2** m. • **Create Key** at **8** seconds. • Go back to 0 seconds, Play Animation, and watch the smaller wolves disappear after the big one runs away.
Wind Turbine Keyframe Animation: Multi-part	• Open the **TurbineSpin** project. • 3D Object Task Mode. Turbine Complete 3DO is enabled and set to rotate around all axes, 360º in 10 seconds. Play the animation. • *Discussion of rotation, objects, and object center*. • VNS manipulates object (except for Randomize). To move, scale, or rotate a discrete part, that part must be a discrete object and modeled accordingly. • *Discussion of modeling turbine for rotation*. • Disable the Turbine_Complete 3DO. • 3D Object Task Mode. Add 2 generic 3DOs. • **Load 3D Object from disk** and navigate to the Components\3Dobjects\Industrial folder. Load TurbineDXF_60.5m_Blade.lwo for one and TurbineDXF_60.5m_Stand.lwo for the other. When you load the stand, VNS will tell you the origin is outside the object. It's supposed to be, so don't center the object. • 3D Object Editor > Size & Position page. Disable Render a Geographic Instance. • Database Editor. Edit the Turbine_Complete vector and create 2 copies: TurbineDXF_Blade and TurbineDXF_Stand. • Link the TurbineDXF vectors to their respective 3DOs for Position. • 3D Object Editor. Change the preview to Detail. All you see is the top of the turbine because the model origin is on the blade's X-axis. • 3D Object Editor > Size & Position page > Move tab. The object names include the Y shift. Change the Move Y values to 60.5 m. • Rotate tab. Create keys for Rotate X: **0º** at **0** seconds and **–720º** at **6** seconds. • Play the animation.
Path-Vector Transfer	• Load **Miata.proj** from the **3DNA** folder. • Render a preview of the Driver Viewpoint camera. The view shows a rural road in Canada. • Let's animate a car driving north on the highway. Right-click the 3D Object category in the S@G, select **Add Component from Gallery**, and load the Miata from the Vehicles page. Don't center the object in the terrain. • Now for the car's path. We have a vector for the highway; all we need to do is transfer it to a car path. Go **Data** menu item and choose **Path-Vector Transfer**. You'll start with a blank window. • Go to the **Transfer From** dropdown list and choose **Vector**. The list will update with the project's vectors. Click the **Highway** vector to select it. • Go to the **Transfer To** dropdown list and select **3D Object**. The list will populate with the project's 3D Objects. Click the **Miata** to select it. • The **Transfer Parameters** let you specify the conditions of the transfer. The parameter you select and set will cause the other parameters to change accordingly. The easiest parameter to set is the **Constant Velocity**. The current value is in m/s but you don't have to use that unit. Check the **Constant Velocity** radio button and enter **60 kph**. VNS will convert kilometers per hour to meters per second. Click **Transfer**. • VNS tells us when the transfer is complete and the Miata will have a keyframed key in front of it in the Scene-at-a-Glance. • 3D Object Editor > General page. Change **Preview** to **Detail**. • 3D Object Editor > Size & Position page. Scale the car to **5000** on the X, Y, and Z axis

Path-Vector Transfer (cont.)

(remember the Constrain Proportions lock) to make it easier to see in views.

- Switch the Driver Viewpoint camera view back to real-time mode.
- Play Animation to watch the car drive in the real-time views.
- We have two obvious problems. First, the car is driving south, not north. Second, it's way up in the air.
- The second problem is easily remedied in the 3D Object Editor. The path-vector transfer made the Miata's elevation Relative to Ground. Change it to **Absolute Elevation** and the car will fall to Earth.
- The direction the car is moving has to do with the point order of the Highway vector we used for the path. To reverse the point order, open the Highway Vector Editor and confirm that **All Points** are selected on the Selected Points page.
- Turn to the Point Operations page and **Reverse Vector Point Order**.
- Path-Vector Transfer window. All the settings should be where you left them. **Transfer**.
- The Miata is now at the south end of the road driving north. Play Animation or scrub through the animation timeline to confirm the travel direction.
- Note that the car is not aligned to its path; it always faces due north.
- 3D Object Editor > Align page. Select **Align Heading to Vector**, **Align to this Vector**, and select the **Highway** vector from the dropdown list. This 3DO does not have a vector associated with it so we have to both align it to a vector and tell VNS which vector to use for alignment.
- Play Animation or scrub through the timeline to confirm the alignment.
- 3D Object Editor > Size & Position page. Scale the car back to **100** on the X, Y, and Z axis.
- Open the Hill Miata Detail camera in a View and target it on the Miata (Camera Editor > Target page). Open its View Preferences and disable realtime **Terrain** and **Cameras**.
- Go to time **98.3** seconds.
- Note that the car rests on the XZ plane throughout its path.
- 3D Object Editor > Align page. Check **Align Vertical Axis**. The Alignment Bias defaults to 50%, which is not enough to put four wheels on the ground. Increase it to **100%** and your Miata should take hills properly.
- Switch to the Driver Viewpoint camera and go to time **82** seconds.
- Open View Prefs and turn the terrain back on for real-time viewing. Render a preview.
- The center of the car model coincides with the vector path. If we don't want the car driving down the center of the road we'll have to shift it in a positive X direction. Why the +X direction? Recall that the 3D Object imported facing north, the +Z direction. In 3D Object space that makes the +X direction to the right.



- 3D Object Editor > Size & Position page. If the car is 2 m wide, a 2 meter shift should be enough. Click the **Move (m)** button and increase **Move X** to **2** m. Render a preview.
- Let's smooth out the angles in the road.
- Terraffector Editor > General page. Check **Spline Vectors**. This is a Terraffector property so you won't see the change in realtime views. The downside to this method is that the feature is not available for object and camera paths. Our Miata will follow the non-splined path.
- Render a preview.

Special Notes	• Ecosystem clearings. VNS does what you tell it. If you place a house in a forest, it will grow trees up through the house. Just like the real world, if you want to put something on the ground, you need to make a clearing first.

3D Objects Discussion

Whether it's buildings, bridges, cars, trees, or anything modeled outside of VNS, it won't be long before you start using 3D Objects. If you haven't discovered it already, you'll soon find that making sense of someone else's 3D models can be more difficult than importing their GIS data.

3D Model Sources

You have two choices: make them yourself or use someone else's (free or otherwise). Even if you're a proficient 3D modeler it's sometimes more cost-efficient to buy them than make them yourself. The 3DNWorld.com Data Sources page (under Links) is a good starting place for 3D model providers. Be warned about free models; you often get what you pay for.

Formats

For those of you not familiar with some of the common flavors of 3D models, here's a quick look.

> DXF. This is an old standard with many versions. R13 or earlier is best for WCS/VNS and only 3DFACE entities are allowed for 3D Objects. Materials are limited to polygons. No UV Mapping (more on UV mapping shortly).
>
> OBJ. Wavefront Object format. Text-based standard like DXF but much better. UV Mapping supported.
>
> 3DS. 3D Studio Max format, well-established though not necessarily well documented. UV Mapping supported. Limited to 65,536 points per object. Larger meshes must be broken down into sections with less than 65,000 points.
>
> LWO. LightWave Object format in LWO and LWO2 (LightWave 6.x+) flavors. LWO has the same point limit as 3DS. LWO2 has no point limitation. UV Mapping supported in LWO2.

What you need to know before importing 3D Objects

Different formats have different limitations and problems. The Wavefront OBJ format seems to be the most bombproof. LWO2 objects are almost as good. 3DS models can be troublesome, have entity restrictions, almost always need work before exporting from Max, and should be avoided when possible. DXFs are the ugliest of the bunch; even the company who developed the format doesn't follow the specifications.

Bad modeling is the biggest reason most 3D objects don't look right in WCS and VNS. Native 3D modeling programs let you get away with model problems that look fine when rendered in the native program. Unfortunately, WCS and VNS follow format specifications, which is much less forgiving. There's no substitute for good modeling and good models.

> **Rule 1. Model to scale**. Many, if not most, models available from free or inexpensive sources are not modeled to actual size. If you build your own, build it to scale.

Surfaces, materials, or whatever they may be called are one place some modelers cut corners. This laziness causes lots of wasted time down the road.

> **Rule 2. Assign unique material names** to 3DOs in the native program. Lazy modeling causes a lot of problems and using non-unique material names is a big one. This is should only be a problem with models you get from someone else.

Rule 3. If you're using someone else's model and they haven't followed Rule 2, correct the problem and create unique material names before importing. That way you've fixed the problem before it bites you.

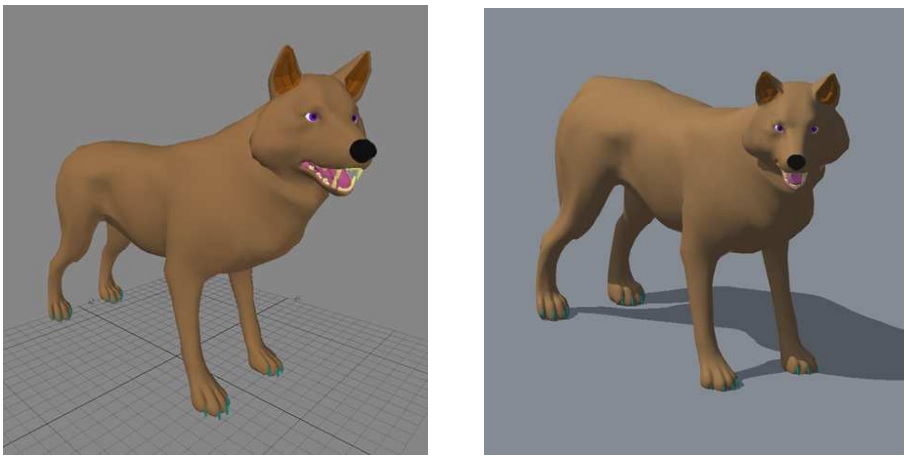
Rule 4. If you're importing someone else's model into VNS and haven't followed Rule 3, correct the problem and create unique Material names in VNS. If you don't have access to a modeling program or lack the expertise, fix the Materials problem in VNS and save the object as a Component.

Rule 5. Don't think that just because you paid good money for 3D models that they are set up for your use. For example, Xfrog pre-built trees are great and priced reasonably but the material names may not make sense, different models may have the same material name, and the UV textures need help in VNS.

Rule 6. Some bad models are faster to rebuild from scratch than fix.

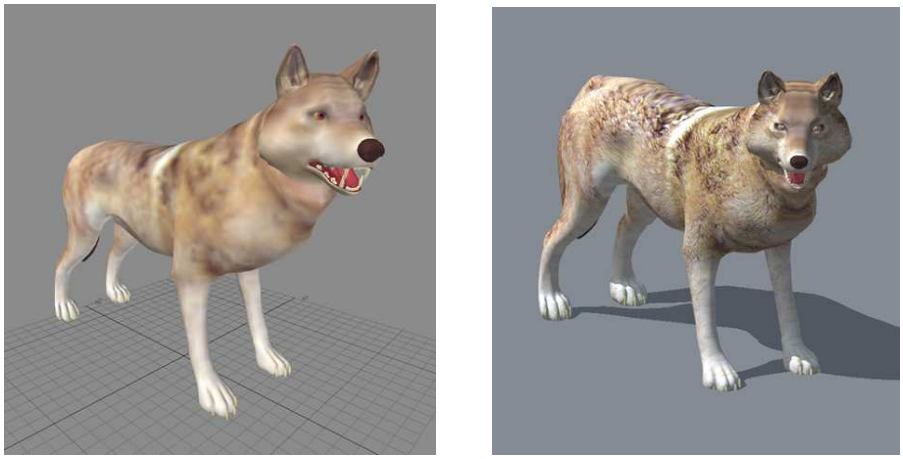
VNS Textures vs. 3D Model UVs

VNS only understands two 3D model surface types on import: polygon color and UV mapped textures. Polygon color is what we call Diffuse Color in VNS. It's the basic surface color you have when all other surface properties are removed. Color is great for identifying modeling surfaces but doesn't have any, well, texture.



Wolf LWO model, color only, in LightWave Modeler [8] (left) and rendered in VNS (right)

UV mapping is a bit more complicated. "UV" stands for the u, v, w coordinates of a UVW "map", a part of the model that maps its XYZ coordinates to texture image 2D coordinates. In UV mapping, texture image points are mapped to points on a model. Details of the process are beyond the scope of this section (but feel free to stay after class and ask questions). What's important to the typical un-UV-initiated VNS user is that advanced 3D modeling applications have a way to "bake" complex textures onto a UV mapped image. The 3D model and its UV mapped texture image are recognized on import.



Wolf LWO model, with UV texture, in LightWave Modeler [8] (left) and rendered in VNS (right)

Wolf UV texture – how many body parts do you recognize?

Should you apply textures before or after importing a 3D model into VNS?

If the 3D model is textured in the native modeling application, the best option is to bake those textures onto a UV-mapped image. If model surfaces are not textured or you are unable to bake the textures, texture your model in VNS.

How are 3D Objects placed?

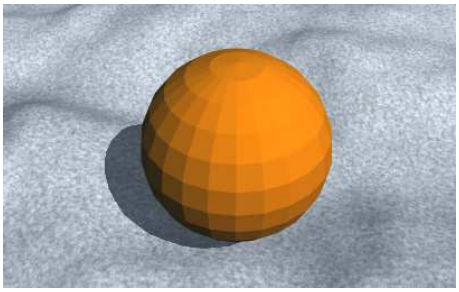
3D Object Components can be placed by Geographic Instance or attached to a vector. 3D Objects can populate Ecosystem and Beach Material Ecotypes and also Foliage Effects, though this can lead to excessively long render times.

Exercise: UV Wolf

Exercise: Model Rules

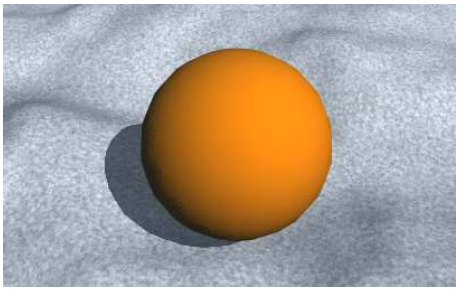
Exercise: Vector Placement and Alignment

3D Object Material Properties

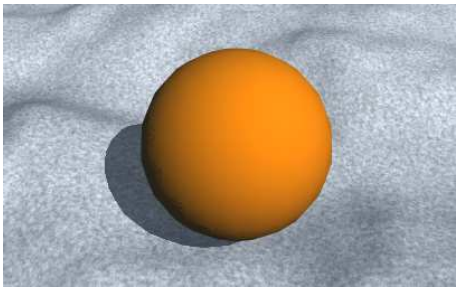


Flat Shading renders the Material as flat polygons.

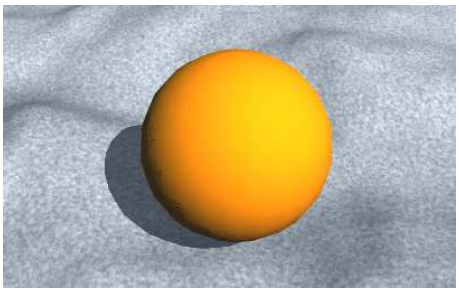
For more information on this and other properties, refer to the Interactive Online Reference Manual.



Phong Shading renders the Material with shading that hides the polygon edges, and creates smooth shading across polygon boundaries that are less than the Smoothing Angle.

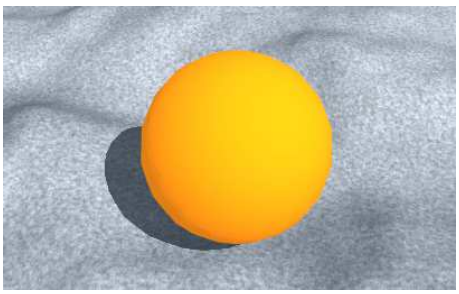


Diffuse Color is a property of all Materials and is often a texture.
.



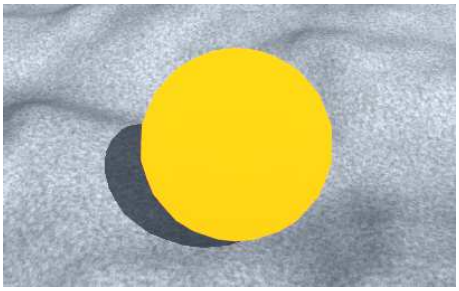
Intensity controls the overall lightness of the Material. Shadows are only slightly affected.

Intensity150%



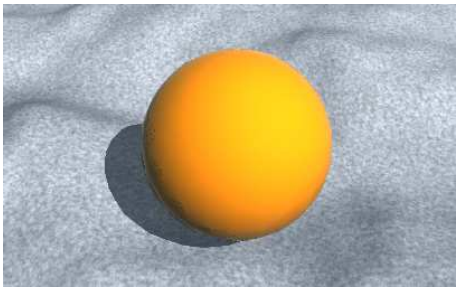
Luminosity controls how the Material responds to shadow and shading. Shadows and terrain shading are lightened.

Luminosity 50%



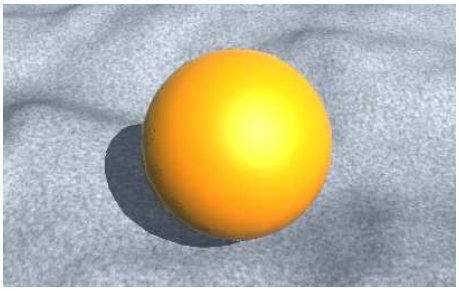
Fully luminous Material has no shadows or shading and has lost its 3D look.

Luminosity 100%



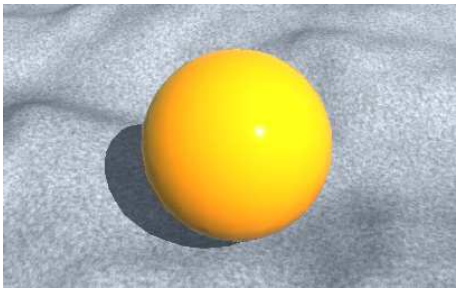
Reflectivity controls the degree to which the rendered scene is reflected on the Material. Since at least one light source (the sun) is usually present and reflected, Reflectivity is rarely used without Specularity.

Reflectivity 100%



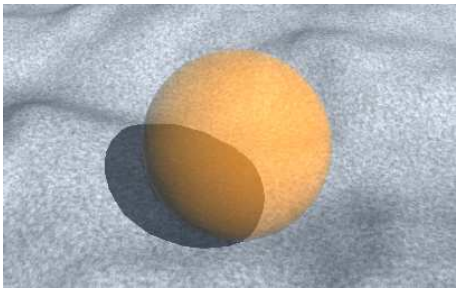
Specularity is specular reflection, the reflection of light sources. The **Specular Exponent** controls the size of the specular highlight. Specularity is rarely used without Reflectivity.

Reflectivity 100%
Specularity 50%
Specular Exponent 5



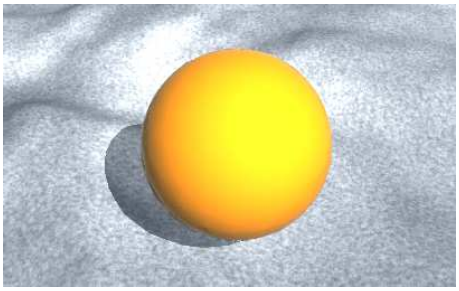
The higher the Specular Exponent, the smaller the specular highlight and the more glossy the Material. Wet rock often has high Specularity and Specular Exponent.

Reflectivity 100%
Specularity 100%
Specular Exponent 200



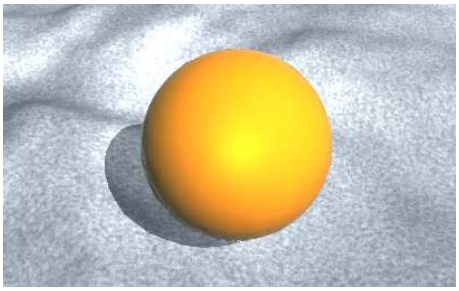
Transparency allows you to see through the Material.

Transparency 50%



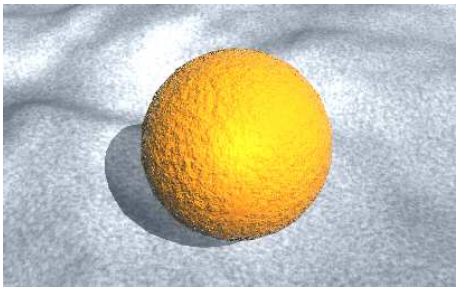
Translucency is light transmitted through the Material. The object must be between a light and the camera. This property is very useful for rendering realistic leaves.

Translucency 100%
Translucency Exponent 5
(An omni-directional and non-distant light was placed behind the sphere for this render.)



Translucency Exponent adjusts the cone of light transmission. Higher numbers produce a smaller cone.

Translucency 100%
Translucency Exponent 100
(An omni-directional and non-distant light was placed behind the sphere for this render.)



Bump Intensity gives the impression of surface texture without modeling. It is one of the most commonly used (and misused) textures and can effectively hide terrain polygons.

Bump Intensity 100%
Fractal Noise Texture

Material properties were explored in the *Land Cover: Ground* exercise. We'll look them again the *Textures* section.

How are 3D Objects animated?

3D Object animation falls into three categories:

1. Moving and rotating the 3D Object while keeping it intact
2. Scaling and deforming the object as an entity
3. Complex animation like walking, morphing, etc.

VNS has the tools to accomplish the first two tasks. For complex animation, such as jointed/parented motion and morph target/deformation modifiers, you'll need to use a dedicated 3D application to perform these functions. The output can be composited within VNS or WCS to create your final animation. Refer to *Integrating VNS with External 3D Programs* in the Interactive Reference Manual for more information.

Exercise: Keyframe Animation

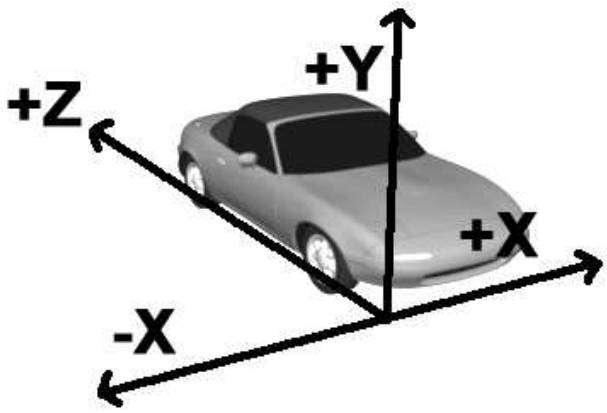
Exercise: Path-Vector Transfer

Additional Information

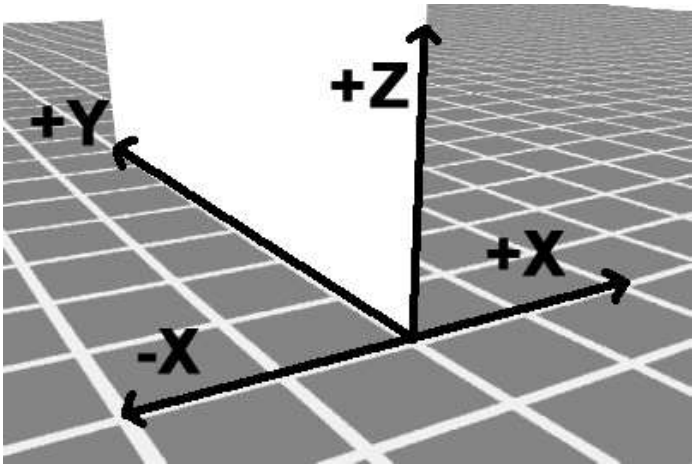
Inexpensive Modeling Tools

- Wings 3D (http://www.wings3d.com)
- Blender (http://www.blender.org)

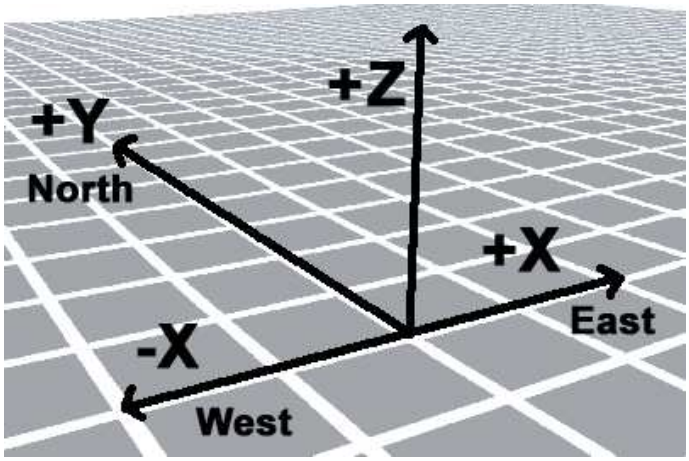
3D Object, Wall and Terrain Axes Revisited



3D Object Axes. Y is upwards (3D modeling convention).



Wall and Terraffector/Vector-Aligned Axes. Z is upwards (GIS convention).



Terrain Axes. Z is upwards (GIS convention).

Foliage Effect

Goal

- Use the Foliage Effect to place foliage or other objects as discrete locations

Foliage Effect Editor

- Land Cover Task Mode
- Vector attachment required
- Purpose is to place foliage at distinct points rather than random placement
- Height and type of vegetation can be randomly selected within user defined constraints
- Advanced methods permit control from vector attributes
- Forestry Edition has more size options
- Hierarchy
  - Foliage Groups
  - Foliage Objects
  - Image Objects or 3D Objects
- Size Controls
- Elevation
- Distance Dissolve
  - Distance Dissolve does not use a Ground Material Overlay color
- Group controls
- Object Controls
  - Image Objects
    - Backlight %
    - Grey Replacement color
  - 3D Objects
    - Random rotations
- Uses of Foliage Effect
  - Place specific tree at specific spot
  - Place a row of trees
  - Landscape architecture in residential or urban/ industrial environment
  - Arboretum management
  - Place people (as images) in a scene as images
  - Place 3D Objects that you want to dissolve away in the distance

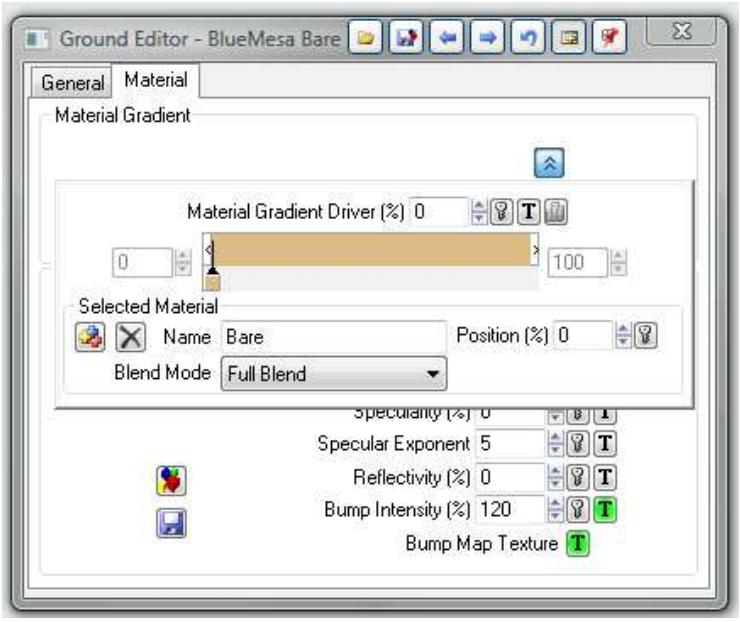
Practice

- Load the **FoliageEffect** project from the **3DNA** folder.
- Render a Clearing preview. We have a vector-bounded Grassland Ecosystem in the foreground and Spruce-Fir Forest beyond.
- Land Cover Task Mode. Select the Foliage Effect category and **Create** from the icon toolbar.
- **Digitize** a single point in the foreground. Name it **FE Spruce**. Close the Component Gallery when it opens.
- Database Editor. *Naming vectors*. You may find it helpful to code your vectors for their use. In this project, SHA is a Shadow vector and ECO is an Ecosystem. When you have many vectors, it can save time if you know why a vector was created.
- Foliage Effect Editor > Foliage page. **Add** a Foliage Group, **Spruce**.
- **Add** a Foliage Object, **EnglemannSpruce2.iff**.
- Foliage Effect selected, Parameters tab. Set the **Maximum** and **Minimum** Height to **12** m.
- Light Task Mode. Expand the **Shadows** category and enable the **Clearing**. This is a vector-bounded Shadow already set up for us.
- Render a preview.

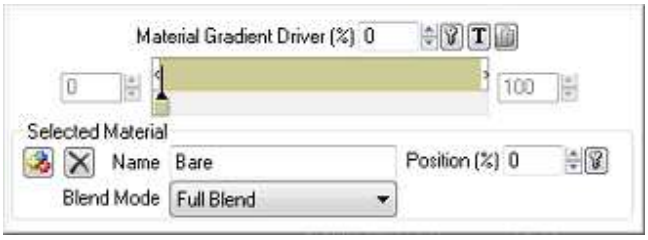
For use of an image sequence in a Foliage Effect, explore the FoliageEffectsAnim project (3DNA\animation\FoliageEffectsAnim.mov).

Textures: Terminology and Concepts

Component	A component is a set of attributes saved out to disk as a loadable "module" with predefined characteristics. A texture can be saved as a Component, then loaded and used or drag-and-dropped in the Scene-at-a-Glance to transfer texture settings from one texture to another.
Material	In WCS and VNS, a Material is any collection of textures applied (or not, as the case may be) to different channels in the surface being affected. In the case of a Ground effect, these would be things such as diffuse color, specularity and so on. In the case of a Lake, the channels would be somewhat different, including settings for foam, additional depth, and displacement mapping. In its most simple form, a Material consists of a diffuse color and default settings for other channels. This screenshot shows an arbitrary Material page. This is for the Ground effect Material, and is quite a plain one - other interfaces where this appears (such as the Lake and Stream editors) have more parameters associated with them:



Material Gradient	This powerful feature allows you to blend two or more Materials together in various ways. At the heart of this is a **Material Gradient Driver** that tells the materials how to blend with each other. This driver is itself a texture or animated value (or in VNS, it can be a Thematic Map), and is edited like all textures in the texture editor. You can see an example of a Material Gradient interface, using one material, in the screenshot below:

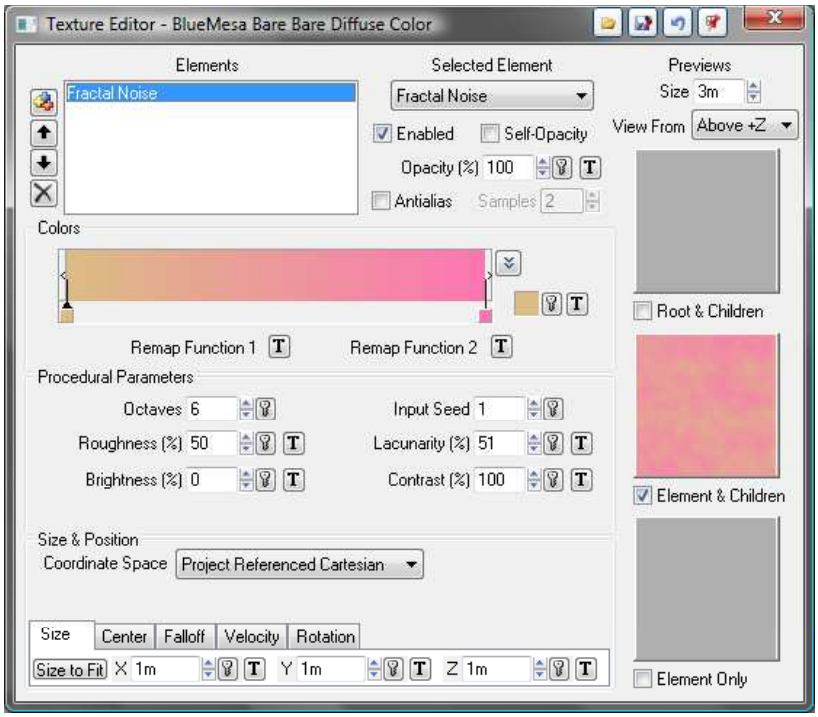


Texture

A texture in WCS and VNS can be used to do many things. Wherever you see T in the interface, a texture can be used to affect that function in some way, shape or form. It can control the color, reflectiveness, or specularity of an object's surface. It can also be used with effects to create variations in height or width (e.g., Terraffectors). Among other things, it can be used to control placement and shape of clouds in the sky and change the patterns of displacement on water bodies (Streams and Lakes).

Texture Editor

- Textures are edited using the **Texture Editor**
- Do not be intimidated! It's not as complicated as it looks (really!).



- Texture Editor Organization
  - Elements
  - Previews
  - Properties
- Elements
  - Image Objects
  - Procedural
  - Function
  - Scene
- Preview
  - Size
  - View From
  - Thumbnails
- Components

Texture Element

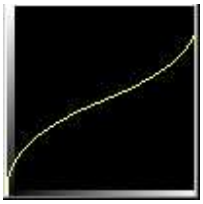
- An **element** is a part of the overall texture. It can be an Image Object or a procedural texture. WCS and VNS let you use both procedural and image texture types.
- **Image textures** are pictures. You can use any Image Object as a texture. You can even use animated image sequences.
- **Procedural textures** are mathematical formulas that create patterns. WCS and VNS give you more than 30 procedural texture components to work with, along with extensive controls for fine-tuning the patterns they produce. Procedural textures can be combined with image textures.

Image Texture	• **Image textures** are pictures. • Advantages: ◦ Usually render faster ◦ Faster to antialias ◦ Look more realistic • Disadvantages: ◦ Less efficient use of memory ◦ Often shows recognizable repeating patterns ◦ Fewer animatable parameters available • Best uses ◦ When real detail is desired, like insects and pine needles on a forest floor ◦ Adding images and text to 3D Objects and terrain • Common uses: ◦ Planar Image for draping on terrain as Color Map or Ground Effect. Usually geo-referenced. *Project: 3DNA\Walls.proj* *Exercise: Planar image on 3DO building*
Procedural Textures	• **Procedural textures** are mathematical formulas that create patterns. • Advantages: ◦ Use less memory (usually) ◦ More seamless, hiding recognizable repetitive patterns ◦ Have parameters that you can animate • Disadvantages: ◦ Often take longer to render ◦ Take longer to antialias ◦ Some types of may not look as real as an image • Best uses ◦ To create a general impression of detail ◦ When image textures aren't available • Common uses: ◦ Fractal Noise for Ground and Ecosystems *Project: 3DNA\Walls.proj* *Exercise: Stratified rock, grass variation* ◦ Brick *Project: 3DNA\Walls.proj* *Exercise: Brick, weathering, moss, vines*
Function Elements	• Common: Remap *Discussion*
Additional Reading	• Remap Functions • Textures Within Textures!

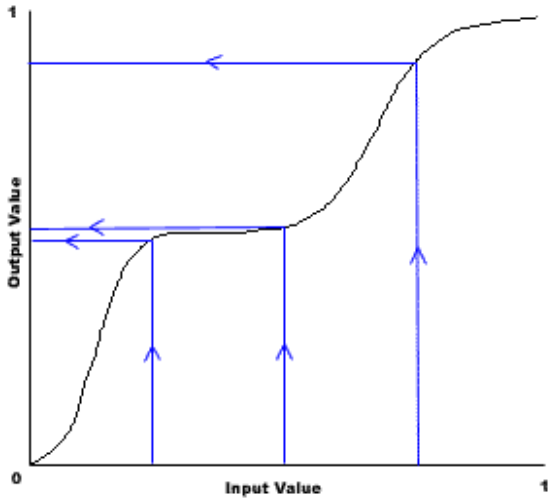
Textures: Remap Functions

Remap Functions

- For those Texture Components that support them, WCS and VNS let you use two Remap Functions. Remap Function 1 is evaluated first followed by Remap Function 2.
- Remap Functions can be likened to the curves function in Photoshop, or similar products. Each remap function takes the value of the texture at the sampled point in x,y,z space and remaps it (hence the name) to another value.
- The remap function is represented as a graph in the Preview windows of the texture editor, for example:



These graphs should be interpreted in the following way:



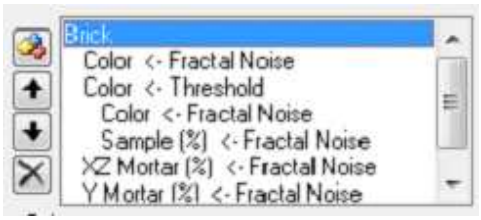
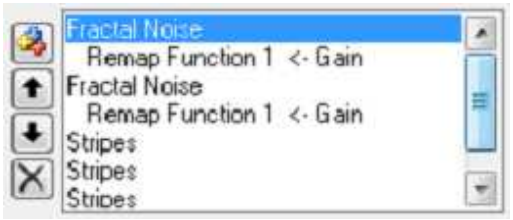
So, in the original example (a square wave remap with some slightly modified settings), values in the original texture between 0 and 0.5 (RGB 0,0,0 to mid grey RGB 127,127,127) will be pushed to black (RGB 0,0,0). Values above 0.5 (RGB 127,127,127) will be pushed to white.

This will have the visible effect of increasing contrast in the texture.

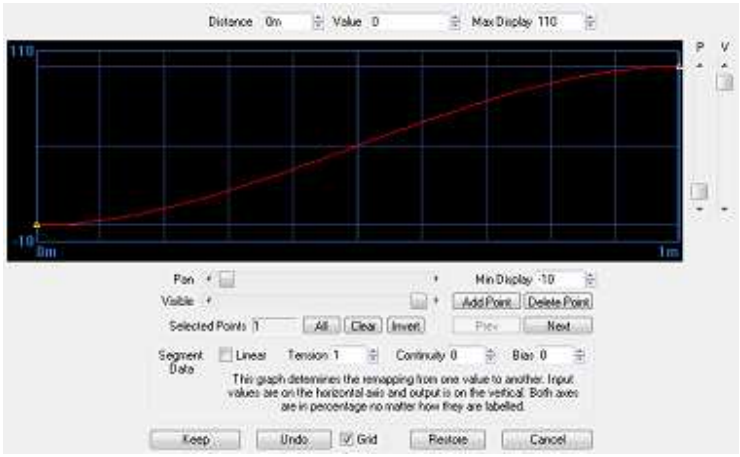
- There is also a "Custom Curve" type of remap function that allows you to design a custom remap spline curve (similar to an effect profile or animated value). This type of Remap element is quite a bit slower than the "canned" remap types.
- Note the Grayscale bars at the bottom and left edges of the preview swatch. These can be used to get a visual idea of the way in which the values will be remapped. The black end of the bar represents values of 0 and the white end, values of 1. These correspond directly to the grayscale colors that you will observe in the texture previews.

Textures within Textures

Plan	• Plan how to accomplish the goal. Visualize what you want to do. • Creating a texture involves thinking about patterns within patterns. • If the texture you want to recreate comes from nature, it's a good idea to observe nature itself, or at least a photograph. Look at the patterns of light and dark. Try and find a basic pattern that encompasses the texture, and then identify any smaller patterns within the basic pattern. • As you consider your plan, take a pencil and paper and create a rough sketch of the texture you want. • Determine the largest basic pattern that divides areas between two different basic colors. For example, a brick wall texture would have brick and mortar as its major features. • Think about which WCS/VNS texture component might best represent the basic pattern you want your texture to show. For example, to create a brick wall, the Brick component would be the obvious choice. • Visualize inside each area in the basic pattern and think about what needs to happen. You may want to divide one area into smaller areas with more patterns and colors. For example, you might want the reddish brick part of a brick wall texture to have a roughened, weathered pattern. • Continue this process by thinking about ever-smaller areas and whether they should also be divided with additional patterns and colors. • As you consider the patterns you want to combine, decide on the size you want for your texture components. Size parameters are measured in meters. • *Note: All size parameters start out at 1 meter*.
Preview	• Set up the Preview section. • Think about the appropriate size to preview the texture, based on how large it will appear in the rendering. Set the Previews Section's Size field to that size, in meters. For example, if you want to preview an entire forest, set the size to that of your forest. If you want to preview a few bricks for a wall, set the size to that of a few bricks. You can change the value in the size field at any time, to zoom the preview displays in or out on your texture. • Select an appropriate orientation for the preview in the View From drop box. • For Ecosystems, choose the top view. For 3D Objects choose whatever is appropriate. The default view is to look from the front (from the south), which is also referred to as negative Z-axis. A view from another perspective might be useful depending on what you are texturing. There are also choices to see the texture projected onto a 3D cube or sphere. • If you preview the texture from a perspective that is perpendicular to the one from which texture is being applied, you may only see a solid color or streaks. Make sure you are looking from an appropriate perspective. • After you've chosen an appropriate view, choose the appropriate axis for the texture in the Size and Position section of the Texture Editor. If the Preview display doesn't look right, you either have the wrong "View From" perspective selected in the Preview section, or the wrong texture axis selected in the Size and Position section. • The XYZ space is different for Ecosystems and 3D objects/Walls. The way you set the Preview "View From" perspective and the "Texture Axis" for a texture component will differ, depending on whether you are creating a texture for an Ecosystem or for a 3D object/Wall. • For Ecosystems, here's what the X, Y and Z alignments mean: X is longitude, Y is latitude and Z is elevation. X is the axis along a line from east to west, which is also called longitude. Plus X is toward the east. Y is the axis along a line from North to South, which is also called latitude. Plus Y is toward the north. Z is the axis along a line from down to up, which is also called elevation. Plus Z is up. • For 3D objects and Walls, here's what the X, Y and Z alignments mean: X is left to right; Y is up and down; and Z is front to back. X is the axis along a line from left to right or east to west. Plus X is toward the east (right). Y is the axis along a line from down to up. Plus Y is up. Z is the axis along a line from front to back or north to south. Plus Z is toward North. (Refer to **3D Object, Wall and Terrain Axes**, page 156.)

Texture Type	• Select the basic Texture Type  • Select a texture type that best lets you define the basic look of the texture you want to create. For example, the Brick texture will let you create the basic look of a brick wall.
Expand	• Vary the basic texture type with other textures as desired. • You can apply other texture types to the basic texture's two color areas to further refine the look of the texture.  • For example, you might want to apply fractal noise to the area within the bricks but not within the mortar, to give the bricks a rougher look. You might want to apply a different texture to the mortar area.
Self Opacity	• Try to use Self-Opacity to achieve the same results. • If you are finding that achieving the result you want is getting very complicated, try breaking it down into layers. By turning on Self-Opacity, you will be able to create transparent areas in each texture element that will show through lower “layers” of texture elements. 

Custom Remap	• Custom Remap curves are really powerful! This is not to say that the other remap elements are not powerful, but the Custom Curve element is so much more intuitive and user-controllable. Practice using it to change the output values of a texture element to your requirements, rather than arbitrarily changing the parameters of the other remap elements in the hope you might get the result you want.



Save	• Save your Textures as Components. This will save you hours of texture editing – you can load your pre-built textures into any texture channel using the component gallery.

Control	• Use the Texture Controls • There are controls in the texture popup menus that allow you to copy, paste and disable texture elements. Use these extensively to make sure that your different texture channels are based around the same texture element combinations where necessary. For example, if you have a material where you wish to match the specularity to the distribution of color in the diffuse color channel, simply copy the diffuse color texture to the Specularity channel and adjust as necessary, rather than trying to remember all the settings used originally, and building the texture again from scratch.

Texture Applications

Texture Applications	

- Haze
  - Visual Depth Scale
- Light
  - Cloud shadow simulation
- Terraffectors
  - Stream channel irregularity
- Area Terraffectors
  - Hill irregularity
- Ground
  - Bump map to simulate fractures in rock, mud cracks
- Ecosystem
  - Diffuse color to simulate forest floor
  - Distant Foliage Dissolve
  - Foliage density and height, simulate clumpiness and patterns
  - Foliage Image Object Grey Replacement color
- Lake or Stream
  - Added Roughness to make waves
  - Beach Material gradient
- Terraffector Ecosystem
  - Vector aligned stripes for roads
- Wall
  - Diffuse color and bump map to simulate brick or stone

Water: Lakes & Streams

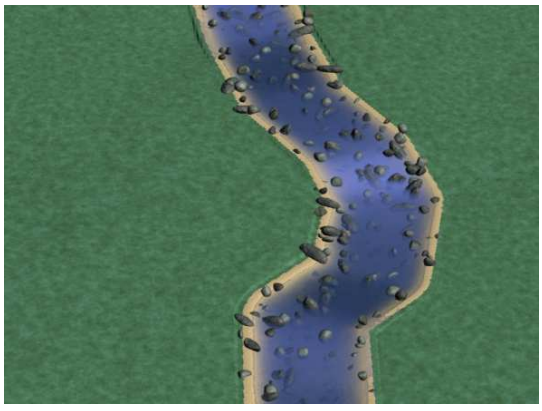
Summary	• Both Lakes and Streams inhabit the Water Task mode (along with Wave Models, which are uncommon). • Lakes fill a basically-flat region with water. Typically they are bound within a containing bounding vector, but if unbound they become "Oceans" that go everywhere. You can have many overlapping Lakes. • Streams are always bound to a vector path, and follow it across and up/down the landscape.
Required	• Both Lakes and Streams are very particular about cooperation from the surrounding terrain. • If the landscape does not have a suitable lake/stream bed, ugly artifacts can occur where you "see behind the curtain" to the magician's dirty secrets. • If necessary, you may have to carve a stream channel or dig a lake bed with a Terraffector or Area Terraffector. • Lakes and Streams inherit some of their realistic appearance from the shape of their bed/channel. It's important. • Water bodies derive much of their appearance from the underlying bed texture, water material color/texture and reflectivity. Prerequisite understanding and mastery of Materials and Texturing is therefore critical.
Overview: Lakes & Oceans	• Lakes not bound to a vector go everywhere and are referred to as "Oceans". Lakes that are bound to one or more Vectors fill the interior of those vectors with water to a specified height and are just called "Lakes". • Lakes have a simple Elevation control, which can be animated or even controlled by a Thematic Map. • Lakes also have an "Additional Elevation" (in Water Material's "Elevation" tab) that can be animated independently. • Water Material's "Waves" tab offers another "Added Roughness" control that can be animated and/or textured. • Lakes automatically clear away certain types of vegetation and substitute their own "Beach Material" landcover. • This simulates the long-term lake occupancy of a region, and the adaptation (vacation) of the landcover from it. • To simulate flooding, where existing landcover stays put but is inundated, a "Use Reference Elevation" checkbox and numeric field in the Beach Height tab allows you to specify the "Normal" waterline elevation used for landcover placement independently of the "current" or "flood stage" waterline elevation. • Foliage Effects deliberately do not vacate inundated regions -- we assume you meant for them to be there since you specifically placed them there. This can be used to plant submerged stumps, snags, reed patches, etc. • The Beach Material (used for all submerged areas, as well as areas between the waterline and Beach Height) can contain foliage and texturing. • Beach Material can react to a dynamic "Water Depth" factor to make submerged vegetation only in shallows, or alter texture of lake/stream bed as it gets deeper. • Beach Height can vary naturally, can be non-varying, or can be virtually eliminated. • Water is transparent (or translucent anyway). You can see a distance into it from above. The distance you can see is called the "Optical Depth" and can be set in the Water Material. • Lakes can have multiple Water and Beach Materials that are selected by various criteria. This permits flat sandy and steep rocky beaches. An icy frozen water material could occupy shallow shores but not deep waters. • Animated Textures on the "Added Roughness" can simulate waves. Texturing the Bump map channel is often just as effective at a distance and can be much faster. • Real sinusoidal Wave Models can be placed to create coherent converging or diverging ripples if needed. • Water can have Foam that automatically appears on Waves as they approach shallows.

Overview: Lakes & Oceans (cont.)	• In the event that it is not practical to dig a lake bed, you can simply make a blue shiny Ecosystem without any foliage, and texture it to look like water. It will then simply cover the existing terrain shape within the polygon. • **Lakes (and Streams) in WCS/VNS do not attempt to calculate or estimate water inundation volume.** • VNS 3 has lakes that can automatically determine their proper water elevation based on their linked vector, saving enormous amounts of effort.
Exercise: Lake	• Load **Water-Lakes.proj**. • Create a new Lake component. Set **elevation to 104m**. Render. Already not too shabby! • Some nice transparency, a slight beach area, cool reflections. It could be that easy. Increase elev to **112m**. • Make Water Material Diffuse Color totally **grey** but don't close Color Editor. Render. See how much of the reflected sky color is involved in the appearance, especially in the distance at shallow reflection angles? This is Fresnel reflectivity – more at glancing angles, less straight-down. Cancel color editor to go back to Blue. • **Show Advanced**. On **Water tab** increase **Optical Depth to 15m**. Very clear ephemeral water. Hard to see even. • Increase **reflectivity to 300%**. You can make very exotic "impossible" appearance. 100% is normal water. • Go back to **2m Optical Depth**. • Switch to **Beach Height tab**. **Beach Height Minimum to 3m** and **variation to 5m**. Much bigger and more varied beach, suggestive of changing water level and occasionally more wave scouring action. • On **General tab**, drop **Water level to 100m** and render. Notice Beach follows water level. • If we want to simulate a temporary water level change without affecting Beach and Landcover, we need to check "**Use Reference Elevation**" on Beach Height tab and set the adjacent elevation to the "long-term" waterline **elevation (112m)**. Now, with the **main Lake Elevation at 100m** we'll see a temporarily drained lake. • Similarly try raising the main **Lake Elevation to 120m**. Notice, beach and vegetation stay put and are inundated. • Go back to **112m**. (All of these numbers could be animated!) Lake Elevation can even be Thematic Mapped. • Let's break up the smooth water surface appearance. On **Water tab**, Waves sub-tab, create a **Texture on the Bump Map** Texture channel. Don't change anything, just render. Rough and choppy! Note distance fade. • Change **Texture Element to F1 Cell Basis**. Now it's sort of weirdly cuspy. Change **XYZ size to 4m**. • We can use limited region to speed up our render tests by just focusing on the foreground area. Render. • Increase **Octaves to 4** to get a ridgy/crusty sort of water surface disturbance pattern. • Adding a Velocity on the Z axis would make a different vertical "slice" of this pattern visible every moment, making it look like it is changing or "evolving". This can't be demonstrated in a still image though. • Close Texture Editor, set **Added Roughness to 1.5m** and create a new texture on it. • Set **XYZ size to 15m** and reduce **Octaves to 3**. (Octaves is like "complexity" and we want big simple swells). • Now we have larger swell-like disturbances too. We could animate this texture's Z velocity to make it churn too. • Bump-map looks great up close, slow and looks "noisy" in the distance. We can fix this by making it fade away at a certain distance from the viewer. Create a **Texture on Bump Intensity** and choose **Dynamic Parameter**. • Choose "**Z Distance (m)**" as Parameter. Diagnostics shows it should disappear between 45 and 90 meters away. • So, **Out Low** should be **100%** (bumpiness) and **Input Low** should be **45(m)**. **Out High 0%**, **Input High 90m**.

Exercise: Lake (cont.)	• Now bumps fade out visually and render much faster beyond the 90m distance. Much nicer. • To see swells better, let's add some Foam, which will highlight the tops of swells. • Switch to **Foam sub-tab** and **Create Foam**. Set **Foam Coverage** to **25%**. Render. Uniform sparse coverage. • We want foam to show where waves would break, more in shallow areas. Easy enough! **Set Coverage to 100%**. • Create **Texture on Foam Coverage** – **Dynamic Parameter** again, this time "**Water Depth (m)**". • As Water Depth goes from 0m (shallow) to deeper, Foam coverage will go from a max of 50% to none (0%). • **Input Low: 0m, Input High 15m, Output Low 50% Output High 0%**. Notice foam reacts to depth now! • Technical detail: The percentages cranked out by the Texture modify or modulate the 100% value in the "Foam Coverage" field. So, if you wanted to uniformly lower the foam coverage, or animate it, it could be done with the Foam Coverage control, outside of the Texture Editor, without disturbing your texture settings. • Wave Models are groups of one or more sinusoidal point emitters that can be attached to a Lake or Stream to add organized traveling waveforms for surf-like situations. They're not frequently used anymore. • We won't tinker with the Beach Gradient/Material here – it's just like an Ecosystem with color, bump, reflectivity (wet sand look?) and foliage. Any textures involved with a Beach can access the Water Depth Dynamic Parameter to make things behave differently in shallower or deeper areas. Water Depth is positive in inundated areas and negative in beach areas above the current waterline.
Lake Tips	• In VNS, Lakes bound to vector polygons automatically obey ESRI Shapefile negative-space "island topology" to prevent water from happening in interior spaces. • Alternately, you can just use a higher-priority Lake component with a very low elevation line to accomplish the same thing manually. • However, if using an Area Terraffector to dig a Lake bed, VNS 2 can not apply a Profile to the "island" polygon. • The 3D Nature FAQ has some tips about doing advanced flood visualization from hydrologic simulation data.
Overview: Streams	• Virtually everything that applies to a Lake also pertains to Streams, except perhaps their vector association. • Streams MUST be attached to a Vector to do anything. Streams dutifully follow the Vector around, using it as their centerline. They also track the elevation change of the Vector in order to ascend or descend. • Stream elevation is relative to the Vector but can be above or below and can be animated. • Streams extend out symmetrically a specified distance on either side of the Vector (Total Effect Radius). This distance is constant over the entire length of the Stream, and must be chosen carefully. Too little, and the stream will end abruptly before reaching its banks. Too much and it will spill out, and THEN end abruptly. In unusual cases like canals, one stream Vector might need to be split up and attached to multiple nearly-identical Stream components with differing Effect Radii. • Streams can be very difficult to use in contrived terrain that doesn't obey normal dendritic and local-low rules. • In VNS, Streams can be splined to follow a curving path, just as Terraffectors can.
Exercise: Stream	• We'll do a very simple stream with a man-made channel to demonstrate the practice of stream-making. • Load Water-Stream • We will make a gradually descending stream from the highest (white) point down to brown. • Switch to **Terrain Task Mode** – first we will need to dig an artificial stream channel. • Right-click **Terraffectors** (**not Area Terraffectors**) category and choose "**Create Component/path…**" • Using about 10 left-clicks, draw a gradual descending stream bed. Start just below the "peak".

Exercise: Stream (cont.)

- Don't go too crazy turning and don't cross over yourself. Right click or Escape when done. "Stream". Ok.
- Choose **Boulder Creek Bed** from Component Gallery and answer "Yes" (unimportant to this).
- VNS users should now see a stream bed courtesy of Realtime Terraffector Preview. Render if you want.
- This is a no-frills uniform stream bed. It is no more than 6m wide and 1.5m deep.
- Switch to **Water Task Mode** and "**Add Component of this type**" for a Stream.
- Reduce **Total Effect Radius to 7m** (just over the 6m we know we might need).
- Drag & Drop "**Stream**" from Vectors category in lower S@G to "**Stream**" in Streams category in upper S@G.
- You now have a basic Stream! Change **Water Material Optical Depth to .4m** for more opacity.
- ALL of the techniques you learned for texturing and controlling Lake appearance still apply.
- What else might you want to do? How about making it react to slope?
- Textures hosted by Stream components have a "Vector Slope" Dynamic Parameter available to them.
- Create a **Texture on the Diffuse Color** of Water Material. Choose **Dynamic Parameter**, "**Vector Slope (%)**".
- Here, slope is expressed in %, Civil Engineering style.
- Right click on **Stream (Vector)** in S@G and choose **Edit Vector Profile** from popup menu.
- This shows vertical profile of the vector (and the terrain under it) from start (left) to end (right).
- Since we drew our vector starting at the high point to the low point, our left side is high and right is low.
- Descending shows as negative slope %, flat as 0, ascending as positive. Mine maxes near –6%.
- In the Texture editor, Vector Slope is only considered in the positive sense, so ignore the negative sign.
- Choose two distinct colors in Dynamic Parameter color gradient. Enter **0% for Input Low, 6% for Input High**.
- Render. You should see the Water appearance smoothly changing with the slope of the Stream vector.
- Normally you would make multiple Materials for placid, fast and rapids water and use a Texture on the Material Gradient Driver to choose between them. This was just a simple example. Change colors to blue and whitish.
- One more interesting thing we can do – add some boulders to the stream's Beach material.
- Go to "**Beach**" tab and "**Create Ecotype**" on the Understory. Immediately open Component Gallery.
- Choose "**Stream Bed Boulders**" and load. Render. Your stream bed (both on-shore and underwater) has rocks!
- This is the technique used in the well-known "Boulder Creek" project that forms the WCS 6 box cover.
- This could have just as easily been foliage. Multiple Beach Materials driven by Water Depth could place vegetation and small rocks in the shallows, and larger boulders in the main stream channel.



Advanced Coordinate Systems and Projections

Coordinate Systems

- There are two common ways of specifying positions
  - Cartesian X/Y/Z (LightWave, Max, most other 3D and CAD software) measured from an origin point
  - Projected or unprojected map coordinates (Lat/Lon/Elev, North/East/Elev, X/Y/Elev) that assume knowledge of a round globe to measure from.
- When using Cartesian XYZ coordinates to define positions on a planet, one or more of the coordinates would be of great magnitude.
  - If the XYZ origin were at the center of the Earth, all positions on the surface of the planet would involve at least one coordinate being in the awkwardly-large range of 4453878 to 6362683 meters.
  - Computers using floating-point math represent numbers of smaller magnitude more accurately than those of large magnitude
  - Lat/Lon/Elev notation, by assuming a known Earth-shape as a constant, provides more convenience and greater accuracy when dealing with positions known to be on (or just above/below) the sphere-like shape.
- For this reason, WCS was originally designed around Geographic/Unprojected/Lat-Lon coordinates on a perfectly spherical Earth.
- Other early or low-end 3D terrain programs (Vista, Scenery Animator, Bryce, World Builder, etc) rely on Cartesian XYZ, and are thus generally limited to smaller areas, and cannot properly represent Earth curvature.
- Geographic is the only major Projection Method/System that works equally well throughout the world without need for additional parameters like Zones, Scales, etc. (Geographic does become awkward near the poles, but few people care).
- WCS's globe is defined as exactly 6362.6832Km, an approximation since the Earth isn't exactly spherical.
- VNS supports a Coordinate System known as "WCS Back-compatible Sphere" (aka BCS) that mimics this behavior exactly. This is similar to 6371Km spherical definitions found in ESRI products. We do not recommend it.
- If VNS loads a project or data in WCS/VNS format that has no Coordinate System associated with it, it assumes it is BCS, so that you can easily load existing WCS data / projects into VNS and have them still operate the same (naively).
- A VNS Coordinate System is a composite object that defines how to interpret X and Y values into positions on a 3D globe. It contains:
  - **Projection Method**
    - A Projection Method (Geographic, Mercator, etc) with its associated projection parameters (if any).
    - If a Zone-based Method (UTM, State Plane, etc) is selected, a Zones table may be consulted to populate the parameters with the well-known definitions for each Zone (False Easting/Northing, Scale, etc).
      - Zones are a way of further dividing up the coordinate space and measuring from a relatively-close local origin (often referred to as a Central meridian and/or Projection Origin).
      - Zones additionally minimize the magnitude of coordinate values (for convenience and accuracy) and restrict the projection's optimal area, thus concentrating its effectiveness and accuracy within that area.
    - VNS supports over 30 Projection methods. A few are very common (UTM), a few are very localized (UKNG, NZMG, etc) many are very exotic and rarely used (Hammer, Wagner, etc).

Coordinate Systems (cont.)

- **Datum**
  - A Datum contains an Ellipsoid (see below) and a set of parameters that align that ellipsoid preferentially with certain areas of the imperfectly-round Earth.
  - The area where the Datum is the optimal description of the Earth's curvature is known as the Fundamental Point. Often the Fundamental Point is a well-known location used by the surveyors that originally defined the Datum while surveying an area.
  - In areas further from the Fundamental Point, the shape defined by the Ellipsoid differs more significantly from the shape of the actual Earth as defined by the Geoid (the gravitational field of the Earth, or where Mean Sea level would be if there were not land in the way).
  - VNS provides over 300 Datum definitions. Perhaps a few dozen are common. Custom Datum definitions are possible, and occasionally necessary.
  - VNS utilizes the three-parameter Molodensky method of interoperating with multiple Datums (translating all Datums into WGS84 as intermediate stage before converting to the desired destination Datum). The three parameters define the shift of the center of the ellipsoid in 3D space.
- **Ellipsoid**
  - An Ellipsoid is a Sphere stretched or squashed in one or more directions.
  - Ellipsoids are defined by a semi-major and a semi-minor axis. If both are the same, it is a perfect sphere.
  - Two other ways of describing the distortion of the Ellipsoid are the Eccentricity and its opposite, Inverse Flattening. Less Eccentricity correlates to more Inverse Flattening. 0 Eccentricity is a perfect sphere, most Ellipsoids have a very small amount of Eccentricity, for example 0.0066943801. Perfect Spheres have an Infinite Inverse Flattening, represented simply as a 0.
  - More info about these topics and definitions in VNS printed manual appendices.
  - VNS provides about 53 Ellipsoid definitions. Few are commonly used. Custom definitions possible, but rare.

- Selecting a pre-defined Datum automatically selects the pre-defined Ellipsoid associated with that Datum.
- Selecting a pre-defined System automatically selects the Method / Datum (and Ellipsoid) associated with that System.
- Custom Methods, Datums, Ellipsoids and even full Coordinate Systems can be saved as Components for re-use.

Projection Types

- All Projection Methods are at heart a way to turn a curved portion of a planet into X and Y coordinates on a flat map, **while preserving certain attributes such as distance, direction or area at the expense of others**.
- Different applications of mapping choose different Methods depending on which of these criteria are most important for the requirements of the mapping task important to the surveyor or cartographer.
- VNS works with a full 3D curved planet, so it must turn all projections back into their original 3D curved representation, and ensure that the same location, surveyed in different Systems, still lines up in the same place.
- VNS 2 can also render projected planimetric (2D) maps, thus offering the mapmaker once again the choice of which Projection Method best suits the demands of their map's application.

World Files

- World Files are an early method of specifying the positional (georeferencing) metadata (info about your data) for files such as images (BMP, TIFF, JPG, etc). World files lack units or Coordinate/Projection System / Method.
- Originally defined by ESRI. Others followed suit.
- Later, more sophisticated formats like GeoTIFF, ECW (and MrSID, unsupported by VNS) superseded this detached metadata storage.
- World files have the same base name as the image file they associate with, but have a mangled extension.
  - The first and last letters of the original image extension, followed by a W. BMP->BPW, TIF->TFW, JPG->JGW.

World Files (cont.)	• World Files can be hand-edited, with difficulty. See NLCD Tutorial 4 for instructions and calculations if necessary. • World files are text files that specify on 6 lines (not in this order): ◦ The Position of the center of the upper-left pixel of the image, in real-world world coordinates (Coordinate System is not specified) ◦ The Size (width and height) of each pixel, in the same coordinates as above ◦ The Rotation of the image about some origin. This field is essentially unsupported and vestigial. • VNS reads World Files if found accompanying JPG, BMP or TIFF images added to the Image Object Library. • VNS writes World Files if requested when writing some image formats (BMP, TIFF).
PRJ Files	• Similar to World Files, attempt to define the Coordinate System associated with a particular file. (also orig ESRI) • Naming Convention: Blah.PRJ goes with Blah.JPG, Blah.BMP or Blah.SHP. Potential for file naming clashes! • Two variants: Old and New. Both textual. VNS tries to read both. ◦ Old style has multiple simple lines, is fairly human-readable and editable, but limited. Much information is left unspecified. File reader is expected to know which numeric values are implied by a particular named string like “NAD27” ◦ New style (defined by OpenGIS Consortium, also known as WKT “Well Known Text”) can be multi-line, but often is one long jumble of text jammed together, wrapping onto several lines. New style is much more complete, specifying each important name and value. Easier for humans to read, harder to write or edit. • Not all PRJ-reading applications understand the new WKT form yet. • VNS writes new WKT form when creating georeferenced raster output.
HDR Files	• Similar to World and PRJ files, some forms of GIS data (BIL files) often have a HDR file accompanying them • Textual, multi-line, and has a KEYWORD and VALUE on each line • Keywords and Values attempt to specify the same types of information as World and PRJ files. • VNS reads HDR files where possible for formats (BIL) it understands, writes HDRs to accompany Arc GRIDFLOAT.
GeoTIFF and ECW Metadata	• Full GeoTIFF files embed the equivalent of a PRJ file and a World File in special blocks of data within the TIFF file. • Unaware TIFF readers ignore these blocks, GIS-aware applications can read and use them. • Loading and resaving a GeoTIFF file with a non-GeoTIFF-aware application can destroy the GeoTIFF data blocks. ◦ Detached World and PRJ files don’t suffer this fate. ◦ Use GEOTIFCP (below) to extract all metadata to a text file beforehand, and reinsert it after saving. ◦ Resizing, rotating, cropping or otherwise geometrically changing the image in a GeoTIFF-naive application can make the image no longer agree with the original GeoTIFF metadata, even if reinserted. ‣ Use GIS/GeoTIFF-aware apps like Arc, ERDAS, ERMapper, GlobalMapper, to do these operations. ‣ Cropping (and scaling) can be done in Photoshop if the user recalculates metadata by hand. See NLCD Tutorial 4. • If VNS finds a GeoTIFF file with a World/PRJ file, it uses info in the GeoTIFF itself in preference to the World/PRJ.
GeoTIFF Examiner	• Free Windows GUI-based utility from Mentor Software • Can be used to examine, modify, extract or insert positional data to/from GeoTIFF and World files

Cropping GeoTIFF	• Refer to GeoTIFF cropping tutorial, part 4 of NLCD Tutorials. • VNS 2/3 obsoletes cropping for most GeoTIFF, BMP and ECW images, other formats might still need it.

GeoTIFCP	• Command-line based utility for processing GeoTIFF files in a variety of ways.
	◦ Insert GeoTIFF metadata into file.
	◦ Alter compression method
	◦ Change tile/strip storage method and tile/strip size
	• Tiled Tiffs are most efficient for use with Image Management
	• Convert file from any storage method to tiled 256x256:
	`GEOTIFCP –t –w 256 –l 256 InputFile.tif OutputFile.tif`
	• Convert file to tiled 256x256, ZIP compression :
	`GEOTIFCP –t –w 256 –l 256 –c zip InputFile.tif OutputFile.tif`
	• Insert GeoTIFF metadata from text file:
	`GEOTIFCP –g metadata.txt InputFile.tif OutputFile.tif`
	• Insert positional data from World file:
	`GEOTIFCP –e InputFile.tfw InputFile.tif OutputFile.tif`
	• Not all applications support the efficient, patent-free TIFF-ZIP compression method. Photoshop 7 and VNS 2 will.

Rendering	• VNS 1 can produce georeferenced output from Geographic Planimetric Cameras (World File, no PRJ file) • VNS 2 can produce georeferenced output in any supported Coordinate System (with World and PRJ files) • Select Planimetric Camera Type in Camera Editor. VNS 2/3: Check Projected in Options, choose Coordinate System. • Select an Image Output Event image format (TIFF or BMP) that VNS can write World Files for. Choose “With World File” in Options list.

Render Scenarios

Summary	• Scenarios are a very powerful tool for managing multiple variations (scenarios) of one project. • Katy Appleton has a free downloadable Scenarios tutorial on 3DNWorld.com
Typical Uses	• Show the same landscape in still images of Past, Present, Future • Show changes in landscape during an animation by having Past/Present/Future groups appear/disappear. • Show current situation, as well as multiple potential future changes. • Slim down a project for certain outputs (e.g., Scene Express) by disabling unimportant details. • Manage multiple visualizations occurring in one region with a common dataset. • Deactivate unimportant data while working but **ensure it gets automatically re-enabled for final output.**
Rationale	• Added in VNS 2 as a result of user feedback about organizing large visualization jobs. • In the Bad Old Days, we made one base project and close it multiple times for the unique changes in each. • They would initially share a common base data, but any later changes had to be manually replicated to all. • VNS can't load & render frames from multiple projects unattended, so rendering all results was difficult. • Keeping them in one project but manually enabling/disabling components/vectors/DEMs was error prone.
Overview	• Scenarios occupy the Render Task Mode and are utilized by Render Jobs. • Put simply, they control the enabled/disabled state of one or many entities: Components or Database items. • Having a discrete Component allows the same common Scenario to be used with multiple Jobs. • Job "Historical A": Camera A, Render Options A_H, Scenario "Historical" • Job "Historical B": Camera B, Render Options B_H, Scenario "Historical" • Job "Present A": Camera A, Render Options A_P, Scenario "Present" • Job "Present B": Camera B, Render Options B_P, Scenario "Present" etc. • Can be hard-linked or **dynamically linked by Search Queries**. • Can simply force everything on or off, or control the state over time with animated timeline. • Can be "Actioned Now" without being part of a Job for testing or as a UI management tool. • Scenarios require CAREFUL planning in advance to use effectively. • Often you will have MANY Scenarios in one Project, even several per Render Job. • **In VNS 3, one scenario can turn some items on and others off, making them much easier to manage.**
Simple Exercise	• We'll use an existing "developed" project: Demos/UrbanParkStudy and regress it to several states. • For testing purposes, we will open our View's Render Options and disable all Shadows on "Enabled 2" tab. • We can typically control visibility by either disabling Components, or sometimes the Vectors they bind to. • Use whichever method makes more sense for your projects. • Here we'll start with Components: Terraffectors , Area Terraffectors, 3D Objects, Foliage, Lakes. • We'll make a couple of Scenarios managing groups of Components. We could then group and/or animate them. • Switch to Render Task Mode and create a Scenario by double-clicking the empty "Render Scenarios" heading. • Name it "All On". Go to the "Control" tab, and choose "3D Object" from "Add New Items" list. Grab All of this type. • Repeat for "Area Terraffectors", "Foliage Effects", "Lakes", "Shadow", "Terraffector", "Walls"

Simple Exercise (cont.)

- Clone this Scenario and name it “All Off”. On the General tab check the This Scenario: Disables Items.
- Typically you will use these to manage your states in complex projects. Either turn everything on, and then selectively turn items off, or vice versa. While working, you can use these to reset the situation. Even when you’re not really utilizing Scenarios, an “All On” component like this can be useful to add to the final render job to ensure you don’t inadvertently turn some items off for testing and forget about them.
- Create a new Scenario named “Pool On”. On the Control Tab, choose “Lake” and “Add Item” (not “Grab All”)
- Choose “The Pool”, hit ok. Change to Area Terraffector, Add, choose “The Pool” and “Pool 6.6m flattener”, ok.
- This Scenario now controls the state of the Pool digging Terraffector and the Pool filling Lake.
- Set “Disables Items”, “Action Now” and see what happens. Pool is (mostly) gone.
- Set “Enables Items”, Action, render. Pool is back! Disable. Action. Render. Gone. So, what is that that’s left?
- Right-clicking drill down in the area shows it’s “Urban Driveway” ecosystem attached to “Pool Patio” vector.
- Can’t just add “Urban Driveway” Ecosystem to Pool Scenario to turn off when needed as driveways would too.
- Instead, we should control the “Pool Patio” vector, which doesn’t impact other driveway usages.
- On “Control” tab, choose “Database Object”. [ALT+D] ensures Database Editor is open, find/select “PoolPatio”
- Hit “Add” in Scenario Editor. Read message and hit Ok to add this vector. Since “Pool Flattener” is bound to this vector too, this makes our linkage to “Pool 6.6m flattener” redundant.
- Now on/off actioning makes the pool completely appear/disappear. Should add “PoolPatio” vector to On & Off.
- State of Pool visibility could be animated over time with On/Off timeline. Easy to add and alter keys.

Labels
(VNS 3)

Goal	• Understand Label properties
Label Editor	• 3D Object Task Mode • Labels are signs or tags that convey textual information in a rendering • Must be attached to a vector. ◦ Vectors can have multiple vertices • Label Styles ◦ Bordered or Plain ◦ Simple Rectangle ◦ Flag on a pole (left or right) ◦ Sign on a stick ◦ Pointed base ◦ Transparency • Elevation • Text • Parts ◦ Text ◦ Outline ◦ Flag ◦ Border ◦ Pole • Style Controls • Size of Parts ◦ Master Size ◦ Scale all Actual Sizes • Anchor Point Option ◦ Used in planimetric and overhead views
Exercise	• Open the **Labels** project in **3DNA** folder. • This is a trail map from the Santa Catalina Mountains in southern Arizona. It has a trail vector and several point vectors identifying features. • 3D Object Task Mode. Add a generic Label and name it Table Mountain. Copy the name as we'll use it shortly. • Text page. Paste the name into text field. • Parts page: ◦ Text, Border, and Pole Colors: black ◦ Outline disabled ◦ Flag Color: R 240, G 190, B 100 • Controls page: ◦ Pole Position: Centered ◦ Pole Base Style: Tapered • Sizes page: ◦ Pole Height: 50 m ◦ Pole Width: 2 m ◦ Max Text Width: 200 m ◦ Max Text Height: 20 m ◦ Border Width: 2 m ◦ Text Outline Width: 2 m ◦ Text Line Height: 20 m ◦ Text Line Spacing: 0 m ◦ Text Letter Spacing: 5 m • Link the Table Mountain vector to the Table Mountain Label. Render a preview. • The proportions are right but the Label is too small to read. Increase the Master Size to 300%. Render a preview. • Clone the Table Mountain Label and name it **Pima Saddle**. Copy the name.

Exercise (cont)

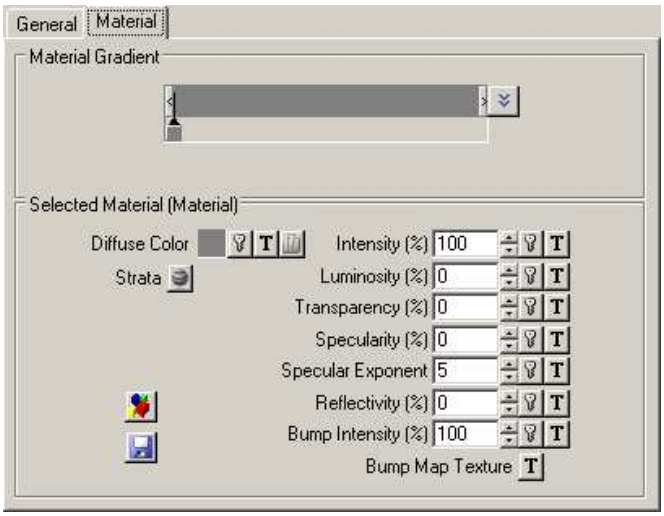
- Text page. Paste the name into text field.
- Parts page:
  - Flag Color: R 255, G 255, B 0
- Link the Pima Saddle Label to the Pima Saddle vector.
- Render a preview.
- If you have lots of Labels, this could take awhile. We haven't talked about Search Queries and Thematic Maps yet, but we whet your appetite by using them here.
- Clone the Pima Saddle Label and name it **Trail Markers**. Disable the Pima Saddle Label.
- Label Editor. Link Operations, Select Query, select Trail Markers.
- Text page. Clear the text field. Double-click **TXT** in the attribute list to insert it as text.
- Render a preview.
- Clone the Table Mountain Label and name it **Features**. Disable the Table Mountain Label.
- Label Editor. Link Operations, **Select Query**, select **Features**.
- Text page. Clear the text field. Double-click **TXT** in the attribute list to insert it as text.
- Render a preview. Much faster than creating all the Labels manually.
- The labels get smaller with distance, as you'd expect.
- Pima Saddle is about 2800 m away. The trailhead is about 8900 m distant. Wouldn't it be nice if we could increase the more distant Labels to make the readable?
- Label Editor > Sizes page. Create a texture for the Master Size.
  - Selected Element: Dynamic Parameter
  - Parameter: Z distance
  - Input Low: 2800 m
  - Input High: 8900 m
  - Out Low: 50%
  - Out High: 100%
- Change the Master Size to **600**%. Why? Render a preview.
- Copy the texture. Switch to the Features Label Editor and paste the texture to its Master Size.
- Change the Master Size to **600**%. Render a preview.
- The text for the label has many special codes for inserting Label, Camera or Project data. Vertex Longitude is &VX%3, where the 3 indicates how many decimal places to display. Vertex Elevation is &VZ%3m. The m is just a suffix.
- A % sign followed by a number defines the number of decimal places to be displayed for that variable when rendered as text. In the case of the Frame Number variable, the 4 represents 4 digits of frame numbering, i.e. filename0001, filename0002, filename0003.

Exporting a Profile

- Open the **Database Editor**.
- Select the **Pima Cyn Tr** vector. Click the **Edit Vector Profile** button on the toolbar.
- **Export Graph** in the Vector Profile Editor.
- Vector Profile Export window. Change the following parameters, check **Launch Illustrator**, and **Export**:
  - Distance Axis: **1** mi/inch
  - Elevation Axis: **1000** ft/inch
  - Distance Tics: **0.5**
  - Elevation Tics: **100**
  - Distance Labels: **1**
  - Elevation Labels: **1000**
- The exported profile will open in Illustrator.

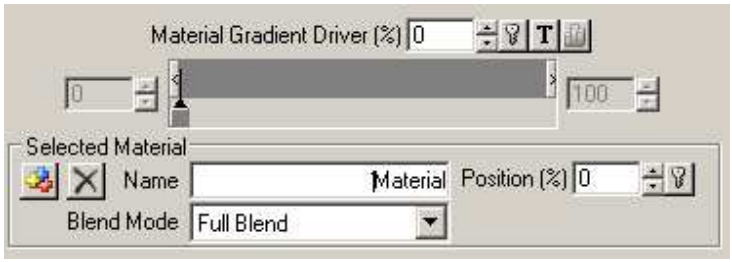
Material Gradients

Materials



- Materials encapsulate a variety of surface properties. Not all Materials have all properties.
  - Diffuse Color, Strata, Intensity, Luminosity, Transparency, Translucency, Specularity, Reflectivity, Bump
- Materials can be named. Choose useful names for your Materials.
- Materials can be copied, pasted, saved, reloaded and re-used. Many materials are provided in the Component Gallery.
- In some cases (Ecosystems, etc.) a Material may also contain Overstory and Understory Foliage definitions.
- Every Component that uses a Material creates a default Material for you.
- Multiple Materials can be combined into a Gradient (below) with some technique for selecting between them.

Gradients



- A Gradient is one or more items arranged into an ordered set, typically with some method for choosing between them.
- Each item in the Gradient is referred to as a (Gradient) Node.
- The Gradient space is numbered from 0% to 100% and each Node has a unique position within the Gradient.
- A Gradient Driver is the method for choosing between Nodes based on some controlling influence.
- The Gradient Driver generates a percentage based on some criteria. This percentage chooses the desired Node.
- A Gradient Driver often generates a different output percentage for each unique location in the landscape.
- If the percentage falls between two nodes, a blend of the two nodes is created and the blend is used.
- Nodes can be moved around within the Gradient and even be animated.
- Nodes can have different Blending Styles to control the mixing between it and the next Node.
  - Sharp Edge, Soft Edge, Quarter Blend, Half Blend, Full Blend (default), Fast Increase, Slow Increase, S-Curve

Drivers

- A Gradient Driver can be:
  - A constant number (boring, but sometimes useful)
  - An animated value, uniform over the entire landscape (useful for showing progression of a Material or Foliage)
  - A Texture, varying randomly over the landscape but uniform over time (Grass and Weeds mix, above)
  - A Dynamic Parameter Texture that reacts to local conditions (Rock with Strata only on the steepest areas)
  - VNS: A Thematic Map
  - All of the above, in combination!

Material Gradients

- In a Material Gradient, Nodes represent full Materials, often each with foliage.
  - For example, a Meadow Ecosystem might contain Nodes for Grass and Weeds and a Material Gradient Driver Texture to randomly place one, the other, or an intermediate blend of the two.
- A Lake Beach might have two Materials: Wet and Dry, driven by a Dynamic Parameter Texture of Water Depth.
  - The Wet Material could have darker sand/gravel to look wetter, and small reeds for Foliage.
  - The Dry Material could have lighter colored sand with more of a dirt appearance and no foliage.
  - As the Water becomes shallower, the Water Depth Driver transitions from the Wet Material to the Dry.
  - Additional Materials could be added: Deep and Transition.
    - Deep could be a reed-free silty material for the main part of the lakebed.
    - Transition could be added at the other (top/Dry) end of the gradient to match and blend gradually into the surrounding vegetation.

Thematic Maps

Summary	• Thematic Maps directly channel numeric data from polygon Attributes to control visualization parameters. • Useful for Height, Elevation, Density, etc. Not useful for textual attributes as they have no numeric meaning. • Search Queries are used to make choices based on textual information.
Overview	• Thematic maps come in two variants, the common single channel version for a simple numeric quantity, as well as a three-channel version that can combine three attributes into an RGB color. • Can also perform basic unit conversion on the fly. VNS wants values to be input in its own internal unit, which is usually metric. Shapefile attributes usually don't have any way to indicate their unit, so you must specify. • The same facility can be used for arbitrary value scaling.
Simple Exercise: Foliage	• We'll use a basic project and create a single Vector with an attribute to work with. Open the **Flat** project from the **3DNA** folder. • Save as "3DNA-TMWork". • Go to Vector Task Mode, left-click once on "Vectors" category and click the "Create" button. • Draw a square (no need to close to starting point) by clicking with left button. Escape or Right Click. "Box" • ALT+D opens Database Editor. Locate "Box" and switch to "Attrib" tab, click "Show Properties" in. • Click "Add…" enter "Height" and "100". Add again, "Quantity" set to "200". • First we will employ Attributes via a Thematic Map to control vegetation settings. For simplicity this will be a generalized form of what is typically done in real forestry work, and won't use queries, etc. • Switch to Landcover Task Mode, right-click on the Ecosystems category, select "Add Component From Gallery". From Flowers choose "Iris". Answer No. • Expand Vectors in lower S@G. • Drag "Box" vector from bottom onto "Iris" Ecosystem at top. Tip of mouse pointer is drop location. Say ok. • Edit "Iris" Ecosystem. Go to "Foliage" tab and edit the Overstory Ecotype. • On "Parameters" tab, Max/Min, Density are all plain ordinary numbers. Max/Min: 10, 10 Density: 1/sft. Render. • Ok, now that we have some Iris, let's bind the Height attribute (containing "100") to the actual height. • Click the "Thematic Operations" icon button next to Maximum Height and "Create Thematic Map". • New Thematic Map Editor appears, named "Overstory Foliage Height (m)". This indicates necessary units. • Change to "Data" tab. This will be a Single Value Thematic Map. • Choose "Height" from drop-list (only shows numeric attributes) and try rendering. Whoa! 100m tall irises! • Maybe you meant 100 Feet. Select "Feet to Meters" in Multiplier Presets. Render. Maybe "Inches to Meters". • This just sets Data Multiplier, you can set any value you require. Other conversions available. Set back to Feet. • Now hook up Density. If we jam "200" into our current Density control, it'll be 200 stems per square foot. Yow! • Ecosys editor, "Settings" subtab, change "Area Units" to "Hectare". Render. 1 stem/hectare isn't much here.

Simple Exercise: Foliage	• Parameters sub-tab: Create Thematic Map for Density. • Data tab: Choose "Quantity" as your Channel 1 attribute. No multiplier needed, it'll be stems/hectare. Render. • Imagine: **A handful of Ecosystems and thousands of vectors with each unique Height/Density attributes.**
Walls	• Disable "Iris". Switch to 3D Object Task Mode and create a new Wall Component. Drag & Drop Box onto it. • Turn on "Connect Ends", "Roof Enabled" and "Separate Roof Material". Render. Ugly little 1m tall building. • To build a city out of attributed polygons, you need only one Wall component linked to all vectors. • We'll reuse our "Height" TM from "Iris". Next to Roof Height's Thematic Operations: "Link Thematic Map". • Choose "Overstory Foliage Height (m)". Normally we'd rename for clarity. Repeat for Panel Top Height. • Presto! Nice big building. Open "Overstory Foliage Height (m)" Thematic Map in LandCover Task Mode. • On Data tab, notice we're still converting the "100" through a feet-to-meters conversion. So, it's 100ft tall. • Notice realtime Views now show the proper size. • In the Database Editor, find "Box" and use "Set Attribute Value" on "Height" to change to "35". Observe the immediate change. • Notice on the Wall Editor's "Roof Material" tab, a Thematic Map button next to Diffuse Color. This creates a color 3-channel TM that would select three Attribute values to bind to the Red, Green and Blue color values.

Color Maps

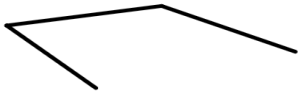
Goal	• Use a Color Map to drape the terrain and place Ecosystems
Required	• **3DNA\ColorMap.proj**
Render Order	• Color Maps take priority over all Land Cover *except* Ecosystems attached to Terraffectors and vector-bounded Ecosystems.
Draping a Color Map	• Open the **ColorMap** project from the **3DNA** folder. • Explore the project. Render a Perspective camera preview. Nothing so far. • Land Cover Task Mode. Add a Color Map named **Landsat**. The default mode will **Drape Image on Terrain**. • Select **GC Landsat** from the Image Object dropdown list. Render a preview. Not too bad from this distance. • Render a Bright Angel Canyon camera preview. Not very good at this distance. • Disable the **Landsat** Color Map.
Color Map Ecosystems	• Enable the **Geology - South Rim** Ground Effect. It has a higher Priority so it will render instead of the grey Ground. • Render a Bright Angel Canyon camera preview. Explore the **Geology - South Rim** Ground Effect. • Color Maps are very useful for placing Ecosystems, especially when the images have been created for that purpose. • Add a Color Map named **NLCD**. It stands for National Land Cover Data (or Database, or Data set, or…). • Select **NLCD BrightAngel** from the Image Object dropdown list. • Open another Bright Angel Canyon camera. Render a preview. Different colors represent different land cover designations. • Expand the Ecosystems category in the S@G. This project has 21 Ecosystems, modified from the 3DN NLCD disk. We're going to use colors in the image to place Ecosystems. • Color Map Editor. **Match Ecosystems to Image Colors**. • Render a preview. We don't have Ecosystems assigned yet. • Color Map Editor. **Randomize Edges**. • Ecosystems page. **Grab All Ecosystems**. • Nothing happens . Try **Add Ecosystem** and select a couple of the Ecosystems. • Note that they are added to the list but grayed out. That's because each Ecosystem has to be set to Match Ecosystems to Colors. If not, VNS doesn't let you use them for matching. • Ecosystem Editor. Select **Match Ecosystems to Colors** for each Ecosystem. • The NLCD 42 Boreal Ecosystem is now bold in the Color Map Editor. Normally we'd have to assign Match Color RGB values or a range. Since these Ecosystems were set up for you, we've saved you the drudgery (this time). • Color Map Editor > Ecosystems page. **Grab All Ecosystems**. • Render a preview.

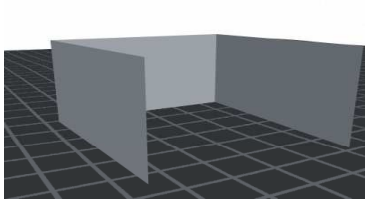
Walls

Summary	• Used for extruding linear features upward or downward from a line. • Good for creating fences & walls. • Optionally VNS can create a Roof on top of a closed Wall feature. • Good substitute for large numbers of custom-made 3D objects in simple situations. • VNS-specific: ◦ Good for creating roofed buildings, extruded features like storage tanks, even peaked roof houses. ◦ Can be used with Search Queries to mass-attach to large number of imported polygon footprints with Elevation attribute – instant city massing! ◦ VNS 3: Can also be used with 3D Analyst 3D Shapefiles made of actual 3D facet geometry – like a 3D object in a shapefile.
Elements of Walls	• Panels ◦ Specify top and bottom height. (Heights can be animated!) ◦ Specify material/texture with all associated capabilities (transparency, bump map). ◦ Can automatically connect ends of an unclosed vector/polygon if necessary. ◦ Limited to +-5m height in WCS. • Roofs (VNS) ◦ Specify height of roof. Doesn't need to be same as top of Panel. ◦ Can use same material as Panel, or different material (air photo drape)
Heights	• Heights can be specified in three ways: ◦ Relative to ground (useful for building upward) ◦ Relative to vector (useful for building upward or downward) ◦ VNS: Absolute (useful for building from GIS attribute elevations)
Building	• Building upward (Relative to Vector or Ground). Specify panel bottom and top (and roof) heights as positive numbers measured from the height of the ground or vector. Useful with vectors conformed on import. Final height of all features built this way with this components will basically be the same. Difficult to make numerous varying-height buildings with one Wall component. Can use Thematic Maps to drive height to solve this. • Building downward (Relative to Vector). Loft vectors to the height of the top of the feature. (Can be done during Shapefile import if elevation is in attribute, not actual 3D Vector). Specify panel top as 0m. Specify roof (if available) as about 0m. Specify panel bottom as a large negative number, sufficient in magnitude to be equal to the height of the largest feature (Above Ground Level, not absolute elevation). Excessive numbers not usually a problem but may slow the rendering slightly. See NYC demo project. • Absolute is infrequently used for either upward or downward.
Texturing	• The usual suspects. Transparency and bump mapping can be very powerful. Note GIS Axes. • Align to Vector is often useful on Panel textures to make Texture 'Wrap' around building. • Transparency can be used to turn a continuous linear feature into a set of periodic or other extruded flat features. ◦ Road-side or median markers. ◦ Extruded Guardrail (with or without 2d posts) ◦ Chain-link or split-rail fences with integral posts. • Bump maps can make flat extruded features look less flat and have more convincing surface detail. ◦ Window insets, doors, architectural detail on building exteriors. ◦ Mechanical detail on storage tanks. ◦ Building material (brick, block, textured concrete, stones) on fence/wall features.
3D Objects	• Same or derived vector can be used to place actual 3D entities like real posts (fences and guardrails). • See free Guardrail component download on 3DNWorld

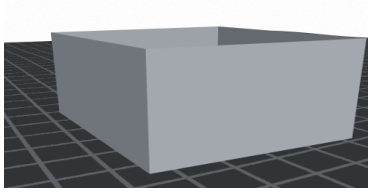
Add-Ons	• Fence and Building pack components for sale on 3DNWorld.
Additional Tutorials	• 3DN World ◦ Planar Textures on 3DOs and Walls (http://www.3dnworld.com/tutorials.php?id=33) ◦ Texture Buildings with Walls (http://www.3dnworld.com/tutorials.php?id=32) ◦ Wraparound Wall Texture: Building Exterior (http://www.3dnworld.com/tutorials.php?id=35)
Practice	• Load the **Walls** project from the **3DNA** folder. • Render a Perspective preview. This is high-resolution aerial imagery on LIDAR terrain from McKinley, Alaska, gateway to Denali. • 3D Object Task Mode. Select the **Walls** category and **Create** one. • **Digitize** around the building in the **Plan RedRoof** view. Don't close the vector. • Name it **J Building**. • Walls Editor: ◦ Roof Enabled ◦ Separate Roof Material ◦ Panel Top Height: 10 m ◦ Roof Height: 10 m • **Connect Ends** to close the vector and enclose the building. • Walls Editor > Panels page. Make the **Diffuse Color white**. • Roof page. **Create** texture. • Texture Editor: ◦ Selected Element: Planar Image ◦ Image Object: McKinley.tif • Render a Perspective preview. • **Switch** to the **Peaked Building** view. The **Peaked Roof** vector represents the roof line of the structure. This is the type of vector we need for peaked roofs on a Wall. • 3D Object Task Mode. Select the **Walls** category and add a generic one called **Peaked Building**. • Find the **Peaked Roof** vector in the lower S@G and link it to the new Wall. • Walls Editor: ◦ Connect Ends ◦ Roof Enabled ◦ Separate Roof Material ◦ Panel Top Height: 0 m ◦ Panel Bottom Height: -12 m ◦ Roof Height: 0 m • Walls Editor > Panels page. Make the **Diffuse Color white**. • Go to the J Building Roof page and **copy** the Diffuse Color **texture**. • In the Peaked Building Wall Editor, **paste** the Diffuse Color **texture**. • Render a preview.

Building Up (Relative to Ground or Vector)

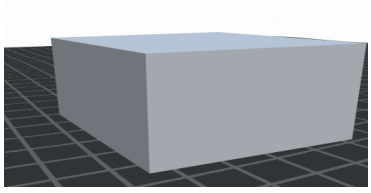




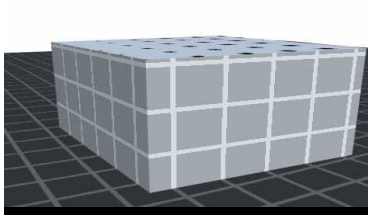
Without Connect Ends



With Connect Ends

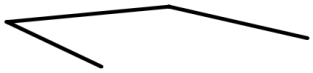


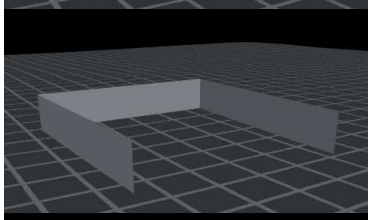
With Roof (VNS Only)



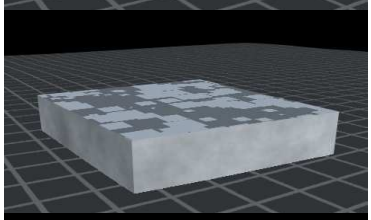
With Two Materials

Building Down (Relative to Vector)

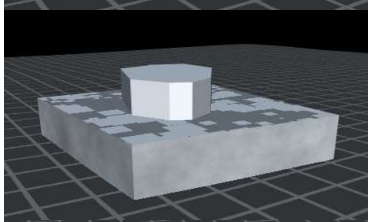




Without Connect Ends

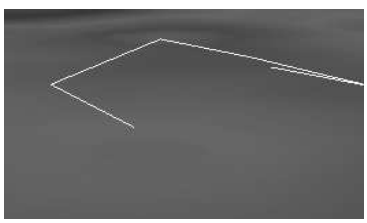


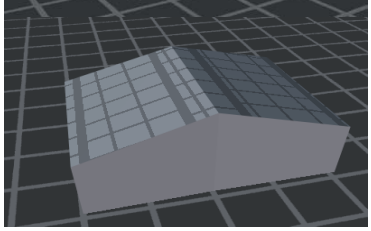
With Connect Ends & different Roof /Panel Materials



Two coexisting Wall Vectors create complex buildings

Peaked Roofs Building Down (Relative to Vector)





Peaked Roof with different Roof & Panel Materials

Forestry Wizard

Summary	• The Forestry Wizard automates mapping of forestry data to visualization components
Required	• The Forestry Wizard is part of the Forestry Edition, a special optional add-on to VNS 2/3. • You can purchase authorization to enable the Forestry Wizard at any time (that our sales office is open anyway). • We will send you a new authorization code to enter into VNS that will unlock the Forestry Edition features.
Overview	• The Forestry Wizard is part of the extra functionality found in the Forestry Edition of VNS, and relies on the other extended features of the Forestry Edition (like coverage/dbh/age mapping). • Forestry Wizard is designed to work with classified raster, attributed vector polygon, or attributed point data. • There isn't really a tutorial for the Forestry Wizard, because it is designed to be self explanatory. • At every stage, there is a short explanation of what the Forestry Wizard expects you to do, so just follow along. • The Wizard includes several generic Ecosystems that it can place into your project. You can customize these. • Typically, the output of the Forestry Wizard can be used with different datasets utilizing the same convention. • The Forestry Wizard uses Search Queries and Thematic Maps extensively with vector data and leaves these auto-configured components visible for your inspection and customization/modification/reuse. • The ground textures used by the Forestry Wizard are the Wiz*.mat files in the Components/3DObject folder.
Classified Raster	• Used with satellite or aerial imagery that has been classified by its spectral response into several discrete landcover units. • You will need to know what specific colors in the image correspond to what landcover types, or species. • You do not need to have the imagery loaded in advance, VNS will walk you through loading if needed. • Once loaded, you will be prompted to identify one or more classes by color. • For each identified class, you will assign it an Ecosystem type and optionally set up foliage appearance.
Attributed Vector	• Used with the majority of GIS forestry data. Involves a set of polygon areas, each with attributes indicating the composition. MANY different conventions exist for coding of species/composition into attributes. • Since there is no one defined standard, the Forestry Wizard offers several typical options to choose from, and then walks through the schema definition from there. • Each schema type has a different level of compositional complexity, from one species per polygon, to two species (Dominant/Subdominant) to a great number of species per polygon. • Once the species/composition structure is known, the Forestry Wizard will identify the number of unique species, and walk through specifying the surface and foliage appearance of each. • To specify size and stocking, you can employ a mixture of size/age/dbh/density/closure with a mapping curve.
Point Data	• Useful if you have high-precision point forestry data where every stem has been surveyed. • The Wizard will have you indicate how to determine species and size from attributes. • Sometimes used with facilities CAD data, or processed LIDAR data.

Clouds

Goal

- Explore clouds and volumetric clouds

Cloud Model Editor

- Sky Task Mode
- Map Bounds
  - Large enough to cover visible sky
  - Set bounds interactively and drag cloud map
  - Work in conjunction with a bounding vector if present
  - Animate cloud map position
- Aerial Attributes
  - Define spatial cloud pattern
  - Feather bounds: Turn off for initial set up
  - Coverage and Density
  - Density Texture
- Vertical Profile
  - Thickness
  - Layers
  - Coverage, Density, Shading Profiles
  - Volumetric interpretation of profiles
- Colors and Backlighting
  - Color Gradient
  - Forward Scatter
  - Backlight Exponent
  - Backlight color and percentage
  - Volumetric expression of Scatter and Backlight
- Waves
  - Concentric sinusoidal waves
  - Good for simulating clouds that form over and leeward of mountain ranges
- Vector bounded or not
  - Vector is additional spatial restriction – works in conjunction with Map Bounds
  - Multiple vectors allowed for same model
  - Good for creating plumes of cloud that remain stationary with cloud matter animated within.

Applications

- Component Gallery is good place to start. Change one and save it as your own.
- Layered Clouds: Great for high wispy clouds
  - Load **Clouds** project from **3DNA** folder
  - Project has Fluffy Clouds from Component Gallery; we'll reload them.
  - Load **Fluffy Clouds**. Bounds will have to be redefined.
  - Commonly used controls:
    - General page: What do types do? *Notice layers and render time changes*
    - Basic page: Aerial Attributes, Feather Bounds, Base Elevation
    - Density increases apparent thickness, Shading makes underside darker
    - Advanced page: Number of Layers
    - Color page, *Shadows and Waves discussion*
  - Animation
    - Edit **Density** texture, **1000 m/s** in **X** direction (west to east), **100 m/s** along **Z** axis
    - Evolve Slowly, Evolve Fast add Z axis velocity

Applications (cont.)	• Volumetric Clouds: Great for thick clouds ◦ Load **Clouds3D** project from **3DNA** folder ◦ Project has layered Fluffy Clouds from Component Gallery. Refresh your memory with a preview render. ◦ Let's make the clouds volumetric… ◦ Cloud Model Editor. Show Advanced Features, if necessary, and **enable Volumetric Rendering**. ◦ Basic page. Set Density to **50**%. ◦ Advanced page. Increase the **Thickness** to **500 m**. ◦ To speed rendering during testing, open the Atmosphere Editor and change the **Speed Boost** to **25x**. ◦ Render a preview. ◦ Cloud Model Editor > Advanced page. Try a **Thickness** to **2500 m**. Render a preview. ◦ Turn the **Thickness** back down to **500 m**. ◦ Animation: Edit **Density** texture, **1000 m/s** in X direction (west to east), **100 m/s** along Z axis

Shadows

Goals	• Understand how Shadows work • Create terrain and foliage shadows
Required	• **3DNA\Shadows.proj**
Shadow Basics	• Shadows add additional cues that tell us the scene is real. • Shadow controls at the Component level allow flexibility but make for a multi-step process: ◦ Cloud Models and 3DOs have their own controls to cast and receive shadows ◦ A Shadow Component is required to cast terrain and foliage shadows and receive shadows ◦ Shadows are bound by vectors to maximize shadow quality and minimize render time • Load the **Shadow** project from **3DNA** folder. • Render a **Camp E** preview. • Sun Light Editor > Color & Shadow page. Note that **Cast Shadows** is enabled. • Why are there no shadows? There are two reasons. Nothing is set to cast shadows and the terrain is not set to receive Shadows. It is not enough to cast shadows; a Shadow Component must receive them as well. • 3D Object Editor > Shadow page. Enable **Cast** shadows for all objects. They are set to receive them from Terrain, Foliage, and 3D objects. • Light Task Mode. **Add** Shadow Component. • Shadow Editor > Cast Shadows page. Enable **Cast** to cast shadows from foliage and terrain. Choose **High** Quality. • Shadow Editor > Receive Shadows page. Note that the Shadow is set to receive shadows from everything but volumetrics. • Render a preview. • Notice the progress bar indicating shadow calculations. Shadow calculations are being made for all DEMs. This is because a vector does not bound the Shadow. A shadow map has a finite resolution based on the Quality setting in the Shadow Editor. The larger the area covered by the shadow map, the larger the pixels will be in the map
Optimizing Shadows	• We have 3 issues to address in our render: 1) Shadow map is calculated for all DEMs, adding to render time 2) Shadow map has low resolution; shadow edges are pixelated 3) Some trees have no shadows and some shadows have no trees. • Light Task Mode. Select the Shadow Component and **Create** a vector from the icon toolbar. • **Digitize** around the camera view in the Plan Camp view. Name it **Shadow**. • **Switch** the Plan Camp view to the **Camp E** camera. • Render a preview. Fewer DEMs are involved in shadow calculations this time. • **Compare** the renders. In addition to a shorter render time, the vector-bound shadows have a higher resolution. • Mismatched trees and shadows happen when rendering with Variable Fractal Depth. Fractal Depth Maps (FDMs or Fractal Maps for short) yield accurate shadows. If animation or accurate shadows are important to you, always use Fractal Maps. • Before creating Fractal Maps, we need to add the Camp E camera to an enabled Render Job. Fractal Maps are only calculated for enabled Render Job Cameras. • Camp N Render Job Editor. We don't have a Camp E Render Job but that's easy to fix. Change the Name and Camera in the Camp N Render Job to **Camp E**. Now we're ready for Fractal Maps. • Terrain Parameter Editor. Select **Fractal Maps**. • **Create Fractal Maps Now**. Start and end at frame **0**. • VNS will give us an FD suggestion, but we know **0** gives us the look we want. • Render a preview. • What happens if your Fractal Maps are out of date or were calculated for a different camera? **Switch** a view to the **Camp N** camera and render a preview. Note the missing terrain outside of Camp E camera view.

Optimizing Shadows (cont.)

- Once you've finished moving foliage, 3DOs, and Lights, you can save render time by selecting the **Use File** option on the Shadows page of the appropriate Editor(s). This will calculate shadows once, save to a file, and reuse the file on subsequent renders. This will save render time, especially in animation, as long as nothing involved in shadow casting moves.

Gridding

Summary	• Settings, Controls and Techniques applying to the gridder.
Required	• Input dataset (contour lines or control points) in a supported coordinate system • WCS6 gridder declines in performance as input points exceed 6000. VNS does not. • Golden XYZ data is UTM Zone 13N, NAD 27, approximately 30m point spacing, 165016 points. • VNS 3 offers the new Gridder Wizard to help you. We'll skip it to explain all the internals.
Project	• New Project: Grid. Import: Yes. "3DNA\data\XYZ\Golden_CO_30m.xyz" • Click Next to Coordinate System: UTM NAD 27, Zone 13N. Load Control Points. • Open a Plan View. Observe dense, regularly spaced points.
Gridding	• Create a Terrain Gridder component. • Select a Coordinate System (UTM NAD27). WCS only grids in Geographic. • Floating bounds should auto-snap to boundaries of data selected by default Gridder Filter (simple Query). • Switch to Current Filter tab: Observe filter is set up to use Enabled Control Points, either lines or points. Layer, Name and Label are ignored. • This can be used to filter out 'junk' data (neatlines, transportation or landcover polygons) that might be in the same input file as the contour lines or control points you wish to grid. • In this case, we have no need for sophisticated filtering. Switch to Output and Filters. • Currently set up to create a single tile (1x1) Tiling is used to handle very large gridding jobs that might produce output DEM rasters in the tens of thousands of cells in each dimension. Overlap (below) is used to ensure edge continuity when tiling. • Columns and Rows default to 100. In this case, this will produce a DEM with cells 108m by 140m. • Set Cols and Rows to 350 and 450 respectively. VNS estimates this will produce a nominally 30m DEM. • NULL value is elevation used to fill areas where input data is not present if extrapolate is off. Extrapolate tells VNS to fill NULL data areas with data extrapolated from the nearest valid area. Extrapolate defaults to on, and this dataset has no missing areas anyway, so this value is not important to us. • Enter "Golden30m" into Terrain Model Name field. Switch to General tab. • Smoothing value should usually be left at 100%. Typically not much need for faceted terrain models. • Outlying Point Search Region is used to ensure edge coherence when tiling. • Turn off Extrapolate. • Output and Filters: Grid and Save. 25s. Many progress bars are non-linear/non-indicative of work remaining as the gridder may have no way of estimating the remaining work to be done, only the worst-case scenario.
Results	• Select and Disable the Golden_CO_30m input control points in the database editor. Render. • With Densely-spaced input data like this, smoothing has little impact on the output as it would in a contour line dataset. With smoothing set to 0%, gridding takes only 20 seconds.
Tips and Techniques	• The gridder only operates on points. Any lines and topology connecting the points (contour lines) are essentially ignored. This means long straight stretches between vertices of contours may not have the necessary impact. Densifying input contours to a minimum inter-point spacing will avoid this, and will not detrimentally affect the gridder performance. VNS 3 includes a Densify checkbox to automatically do this for you. (See notes on 'Work Speed' below.) • The TIN will connect the input points in the organization it feels is 'Natural'. This means in areas of sparse input contours, large triangles may end up spanning very flat spaces between contours. Visible creases and seams may be noticeable in these areas. This is a result of the gridder having too little input data in these regions. Adding interim contours and/or control points may improve the tessellation and resulting surface.

Tips and Techniques (cont.)	• The gridder gets faster the less ‘work’ it has to do. Work is defined by interpolating data in places where the input dataset leaves the question open. Feeding the gridder a dataset that has one or more input data points in every output cell will result in the fastest gridding, as the gridder realizes there is little for it to do! • Extrapolation is comparatively slow, and cannot generate ‘valid’ data, only filler data. Turn it off and let the unavailable areas be NULLed out. • The gridder builds a Delauney or Natural Neighbor TIN of the input points, fits splines across the nodes and edges of the network, then rasterizes the surface defined by these splines. Prior to building the network, it attempts to combine points that will end up occupying the same output cell. This corresponds with the “Merging Points”, “Processing Network” and various “Smoothing” and “Rasterizing” stages. • The VNS gridder algorithm was internally codenamed during development as DEFG: “**D**ecent **E**xtremely **F**ast **G**ridder.” • VNS 3 now offers the Gridder Wizard, which will allow you to go through answering only the critical questions in a step-by-step manner.

DEM Merge

Summary	• The numerous techniques, benefits and powerful applications of DEM Mergers.
Required	• Two DEM datasets with different Coordinate Systems, Zones, Resolutions and/or qualities: ◦ Large 90m Geographic NAD83 (USGS from RMNP project) ◦ Small 6m Geographic (cropped from original USGS 10m SDTS UTM Zone 13 NAD 27)
Project	• New Project: "DEMMerge". Import: No. Open Database Editor. • Rather than importing a dataset, we'll just Add some DEMs already in WCS/VNS format. • Add Object "3DNA\data\RMNPMerge\HiresSite.elev" • Open a Plan view. Render. AutoCenter. Feature of interest is small hill near: N40°10'8.35266955", W105°34'34.2203057". • Add Object "3DNA\data\RMNPMerge\RMNP90M.ELEV"
Search Queries	• Because of the complex combinations of datasets that might go into a Merge, DEM Mergers derive all of their input data by way of prioritized Search Queries. • We will create two Queries, each will select a different set of DEM data • Here, we only have a single DEM file for each dataset. In real-world applications, each dataset would often be numerous files, awkward to select individually, perfect for selection by search Query • Queries can select based on name/label, layer and attributes using exact or substring matching • Vector Task Mode: Right-click Search Queries, Add Component of This Type. • Name: "Find90mData" [RETURN] • Uncheck: Control Points, Vectors, leave DEMs checked. • Uncheck: Disabled Objects • Uncheck: Line Objects, Point Objects • Filter Criteria tab: Check Similar next to Name field, enter "90M" (substring). • Expand Search Queries category, right-click Find90mData and Clone Component. • General tab: Name "FindHiresData" [RETURN]. • Filter Criteria tab: Enter "Hires" into name field, select Similar. • Find90mData Component, Selected Filter tab: Enter "90M" into name field, select Similar. • Try "Select Items Now" on the General tab to ensure each Query grabs the desired items, no more, no less.
Coordinate System	• Output merged data can be produced in any VNS supported CoordSys. Need not be the same or any relation to any of the input Coordinate System(s)! DEM Merger can be used as a DEM resampler and reprojector. • Coordinate System: Create Component of This Type • System tab: US State Plane - NAD 83, Colorado North. Close CoordSys Editor.
DEM Merger	• Terrain Task Mode: Create a DEM Merger • Name: RMNP 90m+Hires Merger • Select "US State Plane - NAD 83" in Merged Coord Sys field. • Change Output DEM File Name field "WCSProjects:DEMMerge**90Plus6at20**" • Queries tab: Grab all Queries. (In practice, one would add Queries individually in order, as a typical project might already have numerous Queries not intended for use with DEM Merging). • Order of Queries is significant: Queries are searched in top down order for each sample in the output DEM, until a valid piece of input data is found for that location. • Put Queries for higher quality, resolution or priority DEM data above others in the list. • Currently, 90m may be at the top, and Hires below, the reverse of what we want. Use order buttons to fix. • General tab: Update Bounds. Queries will run, and all selected DEMs will contribute to the bounds. • Merge X Res: 20m, Merge Y Res: 20m (1066x1392 cells in output DEM) • Perform Merge. Merging (~12sec) is CPU and disk intensive, computer may be sluggish or unresponsive.

Result	• Examine the 90PlusHires DEM created by this process. Disable the other RMNP90M and HiresSite DEMs. • Render. Note that the new DEM is 20m, incorporating 6m data downsampled to 20m and surrounding 90m data upsampled to 20m. Differences in quality and features of two datasets make seam obvious. • Higher quality of interior DEM is very apparent in hill feature. • Subsequent to Merging, there are no gaps/tears and no areas of double-coverage where two DEMs coexist (at potentially different elevations) resulting in double-placement of groundcover, etc. • DEM Paint could be used to smooth out rough edge caused by disagreement of datasets. • Entire area is still all one resolution.
Multi Resolution	• What if one needed to merge a low-res surrounding dataset with a hi-res interior dataset, with no seams, but keep the advantages of the lower region's lo-resolution and the interior's high-resolution? • MultiRes Merge to the Rescue! • Disable "90Plus6at20" and re-enable "RMNP90M" and "HiresSite". • Clone "RMNP 90m+Hires Merger" and name it "RMNP MultiRes Merger". • Turn on the Advanced Features button if it isn't already. • Output DEM File Name "WCSProjects:DEMMerge\Merged90". • Merge X Res: 90m, Merge Y Res: 90m (239x311 DEM) • Queries tab: First Query is implicitly understood to contain the high-res data, and high-res region of MultiRes merge will by default snap to the bounds of the dataset selected by this query. • MultiRes tab: Check "Hi Res Insert". Set Divider to "15" (so estimated resolution reads 6.0m x 6.0m) • Hi Res Insert must be an exact multiple of cell dimensions of lo-res DEM, so Divider value is used instead of allowing input of resolution directly. • Click Update Bounds, note snapping to bounds of data resulting from FindHiresData query. Bounds could be adjusted in or out by hand here, if desired. Insert DEM cell sizes: 834x831. • Output DEM File Name "WCSProjects:DEMMerge\Merged6". • Perform Merge. Approximately 8 seconds. (Large jobs can take much longer!)
Result	• Uncheck Render for the other RMNP90M and HiresSite DEMs. Don't Disable. • Examine the Merged6 and Merged90 DEMs created by this process. • Views may show a visible gap around the insert because they do not show full DEM fidelity. Render. • Higher quality of interior DEM is very apparent in hill feature. • Subsequent to Merging, there are no gaps/tears and no areas of double-coverage where two DEMs coexist (at potentially different elevations) resulting in double-placement of groundcover, etc. • Entire area is now no longer a single resolution. The surrounding area is still very lo-res (90m), and the insert is the original hi-res (6m). The surrounding area renders very quickly due to the low DEM detail. The inset has all the detail and fidelity of the original hi-res DEM. The surrounding DEM has a precise hole cut into it with NULLs (visible if you disable Merged6 and re-render) where the inset will perfectly fit. The inset has a slight amount of padding built into it, adjusted so the inset DEM data will perfectly match up with the adjacent elevation values on the surrounding lo-res DEM. • DEM Paint could be used to smooth out rough edge caused by disagreement of datasets. You should never alter the edge values in the inset DEM or it may not line up with the surrounding DEM anymore. It is a good idea to expand the boundaries of the HiRes inset a bit before merging, so that the actual transitional seam falls well within the inset DEM and can safely be painted on with DEM Paint smoothing tools.

Other Uses	• DEM Merging can combine DEMs of different resolutions, and write a new DEM that is the same or different resolution from the input(s). • DEM Merging can create a hi-res inset using purely lo-res data. This hi-res inset could then be sculpted and painted with the DEM Painter to give it better definition and detail. • DEM Merging can combine DEM of different Coordinate Systems, Projections, Zones and/or Datums, and can create a new DEM in an entirely different System/Projection/Zone/Datum. This can easily unify diverse datasets, and solve problems involving raster DEM orientation mismatches at Zone boundaries (Hawaii). Simply merge the data from the adjacent Zone in with the data from the primary Zone and write the output using the desired Zone (or a completely different, more convenient Coordinate System that does not experience the Zone boundary problem). • DEM Merging is designed to process and combine raster DEM data in quantity, in resolution, in variety, in complexity, and without limits. When you encounter problems involving DEMs that mismatch in any of the ways listed above, ask yourself if DEM Merging can solve your problem.
Wrap-up	• DEM merging does not automatically re-tile DEMs it creates. Thus, the output from DEM merge may be one or two very large DEMs, which are too large for the renderer to handle in one chunk. Feeding these DEMs back through the Import Wizard and letting it seamlessly break them up is recommended. Tiling will not create seams or damage the merge. • VNS 3 now introduces the Merger Wizard, which streamlines the input selection and output configuration process.

DEM Painter

With the addition of the DEM Painter users now have the ability to modify their DEMS interactively. This has a wide range of applications – you can create terrain from scratch using this tool, you can edit existing DEM data to add, remove or modify existing features, and you can use it to clean up and "mend" voided or artifacted datasets.

The exact function of each tool provided in the DEM Painter interface are covered in detail in the online reference manuals under the DEM Painter section. The following sections will help you better understand how to utilize these tools in your personal projects.

Interface Interactivity

The speed with which the DEM Painter interface responds to your "painting" will be dependent on a number of things:

- The speed of your OpenGL hardware
- The size of the DEM Painter window
- The Speed with which you move the brush
- The size of your Brush

There is little you can do to reduce the size of your brush, since it will have almost certainly been selected by size in the first place! Therefore, if your DEM Painter interface is slow to update, first try reducing the size of the window itself. It is not a requirement that you operate the DEM Painter window at the same resolution as the source data (i.e.: 100 cols and rows at 100 by 100 pixels). Find a size that gives you an acceptable mix of detail and responsiveness. Try to reduce the speed with which you paint until the interface updates in the way you expect. If all else fails, you should consider upgrading your OpenGL hardware, although this is obviously an extreme solution.

Realtime Preview

When using the Realtime Preview option in the DEM Paint module, the responsiveness of the interface is dependent on a number of things, all of which should be taken into account when using the tools:

- Max Polys Setting (View Preferences)
- Number of OpenGL viewports open
- Number of DEMs enabled
- DEM Resolution

To optimize interactivity, the following things should be observed relative to each of the above points:

- Keep Max Polys as low as possible, while still maintaining sufficient resolution to see the effect of your changes
- Keep the number of unnecessary viewports to a minimum
- Use the "Solo" checkbox to disable the OpenGL preview of all DEMs except the one you are currently editing.
- There is little you can do to optimize this for DEM Painter usage. Changing the resolution (number of columns and rows) in your data source is counter-intuitive to the task being attempted (editing of the DEM at its original resolution)

Sample Applications

Creating custom terrain models

- Start with a relatively flat terrain model, created in the Terrain Generator, or edit something a little more complex – the choice is yours.
- Add and subtract elevation from the model using the paint tools.
- Use Relative mode to keep the general terrain features

Editing multi-res DEM data after a DEM Merge operation (See DEM Merging handout)

- Use the Smear and Smooth tools on the edges of your Hires DEM insert to reduce the visible impact of the unavoidable "seam" that will be created during the DEM Merge process. This seam results from the "stitching" of the edges of the two datasets.
- Increase the bounds of your Hires dataset on the Multires Page of the DEM Merger editor interface. This will give you a little more of a "buffer in which to operate. If you do not do this, and instead snap the bounds exactly to the hires DEM insert, any editing of the edge cells themselves will cause the edges Hires and Lores datasets to no longer match.

Creating bathymetry for water bodies

- The data sampling process frequently results in a DEM with consistent elevation data wherever water bodies were encountered. Also, cleaning up bathymetry in datasets where artifacts are noticed in water bodies (See Mike Mundy's DEM Painter tutorial on http://www.3DNWorld.com)

- Mike's Tutorial covers this subject well – including selecting the correct elevation range within your DEM and using the paint tools (again, in Relative Lower mode) to "dig out" bathymetry. This allows the rendering of the correct water elevation in cases where the terrain model might be "breaking" through the water surface.

Smoothing datasets

- If data integrity is not vital, the smooth tool can be used to remove some serious data artifacting.
- Smoothing involves applying a blur convolution to the cells of the terrain model. This will cause new elevation values to be computed. The dataset that results may exhibit considerably different elevation values if you use it without care.

Adding localized detail to existing datasets

- Similar to the Smooth tool, the Roughen tool can be used to add detail to areas that are particularly flat and uninteresting.
- Use a small brush with a low opacity level to add detail to foreground terrain.

Copying terrain features

- Select a terrain feature using a combination of the selection tools (Marquee, freehand and Magic Wand tool) - You will find the Magic Wand tool to be most useful for this purpose in most cases
- Use the tolerance setting to select just the range of elevations you desire.
- Remember that you can add to your selection by holding down Shift while selecting a new area. You can subtract from your selection by holding down Alt while selecting a new area to subtract.
- Once the required area is selected, choose the "move selection" tool and drag the selection to a new area. Note that the original terrain feature will be unaffected.

- Once copied to a new location, the other DEM Paint tools (especially the smear and smooth tools) can be used to better merge the new feature into its surrounding terrain.

Remember that all the DEM Paint tools can be applied in ANY view, as well as the DEM Paint window itself. This can be a more accurate way of placing details relative to the camera, but with the inherent speed issues mentioned on page 1.

Additional Resources

Other Handy Tools

Plants

3D Plants ($29.95 or less, free samples)	http://www.3dplants.com
ImageCels ($79-$299 each set)	http://www.imagecels.com
Onyx GARDEN Suite ($495)	http://www.onyxtree.com
Plant Studio (free, on CD)	http://www.kurtz-fernhout.com
Bishop Digital Images ($25-45 each set)	http://www.bishopdigitalimage.com

Terrain/GIS

CORPSCON (free)	http://crunch.tec.army.mil/software/corpscon/corpscon.html
Global Mapper ($249, demo on CD)	http://3dnature.com/global-mapper.html
Leveller ($149.95, demo on CD)	http://www.daylongraphics.com
MicroDEM (free)	http://www.usna.edu/Users/oceano/pguth/website/microdem.htm
Manifold GIS ($245 for base Win32)	http://www.manifold.net

3D Objects Conversion

3DWin (~$66, demo on CD)	http://www.tb-software.com/products_2.html
Quick3D Geo/Pro ($129/$199)	http://www.quick3d.org/index.html

3D Object Modelers (cheap)

Blender (free, on CD)	http://www.blender.org
Rheingold3D (~$66, demo on CD)	http://www.tb-software.com/products_1.html
SketchUp (free/$495, demo on CD)	http://www.sketchup.com

Image Conversion

IrfanView (free/~$13, on CD)	http://www.irfanview.com
XnView/NConvert: (free-26€, on CD)	http://pagesperso-orange.fr/pierre.g/xnview/enhome.htm

Viewers

ACDSee ($50-$650, demo on CD)	http://www.acdsee.com
IrfanView (free/~$13, on CD)	http://www.irfanview.com
Quick3D Viewer ($59)	http://www.quick3d.org

Other

TightVNC (free)	http://www.tightvnc.com
UltraVNC (free)	http://www.uvnc.com
FileZilla (free, on CD)	http://filezilla.sourceforge.net

See also, 3DNWorld.com Links, Software, Utilities pages for more!

Many more utilities in the Software folder of your 3DNA CD-ROM.

Useful Data Resources

Misc Indexes

USGS	http://ask.usgs.gov
GNIS	http://geonames.usgs.gov
GIS Data Depot: (free and $)	http://data.geocomm.com
3D Nature	http://www.3dnature.com/data.html

Global DEM

USGS GTOPO30, 1Km (free / $)	http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html
Ultimate Earth (GTOPO30+Bathymetry, $200)	http://3dnature.com/ue.html

USGS Regional DEM

USGS 250k (3 arc second/90m) (free)	http://edc.usgs.gov/geodata

USGS Seamless Data Distribution System

LOTS of data types (free / $)	http://seamless.usgs.gov

DLG

USGS SDTS (free)	http://edc.usgs.gov/geodata

Regional Clearinghouses

Crater Lake (free)	http://craterlake.wr.usgs.gov
Lake Tahoe (free)	http://tahoe.usgs.gov
SF Bay (free)	http://bard.wr.usgs.gov

Imagery

Terraserver ($)	http://www.terraserver.com
Rhode Island (free)	http://ortho.edc.uri.edu
GlobeXplorer (US, international, $)	http://www.globexplorer.com
GLCF HUGE Landsat archive (free)	http://landcover.org
USAPhotoMaps (Win – free)	http://jdmcox.com
NAIP (newer - pay)	http://www.fsa.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai-or
USDA NRCS Geospatial Data Gateway (free)	http://datagateway.nrcs.usda.gov/GatewayHome.html

Search

Google (free)	http://www.google.com
Clusty (free)	http://clusty.com
Copernic (free - $80)	http://www.copernic.com

Information

Wikipedia	http://www.wikipedia.org

Importing Data Tips

Pre-planning questions

1. What kind of data do you need?
   a. DEM
   b. Contours
   c. Elevation Control Points
   d. Vectors (Roads, Streams, etc)
   e. Imagery
   f. Land Cover
2. Where can you get it?
   a. See Data Resources handout for starting points
   b. Use search engines heavily, most data providers have web sites now
   c. Bruce Gittings' Catalog as a last resort
3. What data formats is it available in?
4. What data formats match up with WCS/VNS?
   a. See File Formats reference and VNS expanded File Formats handout
   b. Not all combinations of file formats and projections (see next item) are always supported.
5. What projection, coordinate system, datum is the data in?
   a. WCS: Spherical geographic for all
   b. WCS: UTM-NAD27 for some vector/contour/controlpoint data and USGS ASCII/SDTS DEM
   c. WCS: Limited 'arbitrary local' coordinates for some vector/contour/controlpoint formats.
   d. VNS: Over 30 projection system types, over 300 datums with ellipsoids
   e. VNS: Many more file formats (see VNS file formats handout)
   f. VNS: Virtually every format and every coordinate system can be used together.

Some formats (USGS DEM, GeoTIFF, ECW, SHP+PRJ) will/may have coordinate system info stored in the file for WCS/VNS to read automatically. For others you will need to know ahead of time what the horizontal (and possibly vertical) units are, what coordinate system and datum (VNS) and any other info you can gather.

Decompression

Most data found on the Internet is stored and downloaded in a compressed form (using GZIP .gz , ZIP .zip or possibly StuffIt .sit). WCS and VNS do not do automatic decompression of these files. You will need to do this in advance, and will need various other utilities to do this.

Many of these utilities (WinZIP, StuffIt) have an option to automatically translate Carriage Return (CR) and Line Feed (LF) data bytes into the style typically used on your platform and OS. This is **bad**. You must turn this off as many of these file formats are very rigidly defined and will not be properly readable if this translation has been done.

1. WinZIP: "Options/Configuration/Miscellaneous": "TAR file smart CR/LF conversion" must be off.
2. StuffIt: Has a similarly-named option

Renaming

We *highly* advise you *not* rename any files provided to you before importing them into WCS/VNS. Many formats (USGS, any multi-file format) assign special meaning to the (sometimes cryptic) contents of their filenames, and WCS/VNS expect this information to be intact.

The import process

1. Use the Import Wizard
2. Select the input file
3. Multi-File data formats
    a. Shapefile: select the .SHP file, .DBF is required, .PRJ is recommended with VNS, .SHX not used currently
    b. SDTS DEM
        1. select any of the numerous files, WCS/VNS will figure it out
        2. Do not extract numerous SDTS files into the same subdirectory as they can stomp on each other
    c. SDTS DLG (VNS only)
        1. select any of the numerous files, WCS/VNS will figure it out
        2. Do not extract numerous SDTS files into the same subdirectory as they can stomp on each other
        3. WCS can use if you run through SDTS2DLG.exe utility
    d. ADF (VNS only)
        1. You may be able to select any file (except log), but we recommend selecting the largest file
        2. Will often be named something like " w001001.adf", not " w001001x.adf"
    e. BIL
        1. Choose the file that has the .BIL suffix if present
        2. File should also have a .HDR file in order to work
        3. VNS: .PRJ file will be recognized if available
    f. GTOPO30 (sub-case of BIL)
        1. Need all files (.PRJ, .HDR and .DEM at minimum)
        2. Select the .DEM file (not required, but recommended)
        3. Make sure you have the Bonus files in WCS/VNS Tools directory so edge-matching can be done
        4. Antarctic GTOPO30 does not have edge-matching Bonus files at this time.
    g. DTED
        1. Clever trick: feed the uncompressed TAR file straight to WCS/VNS and it will find the necessary data automatically
4. Multi-file input for USGS 7.5minute ASCII or SDTS 30m or 10m
    a. In order for adjacent tiles to meet seamlessly, all of the tiles must be loaded as a batch
    b. You cannot mix SDTS and ASCII files
    c. You cannot mix UTM zones
    d. You cannot mix 30m and 10m
5. DXF import
    a. Only POINT, LINE, POLYLINE and LWPOLYLINE entities supported
    b. Remove excess junk (text, borders, markings) from file before import
    c. Older DXF variants (r13) are simpler and more likely to read properly
    d. Check file with VoloView Express to see what's *really* in it.
6. VNS Coordinate System Editor
    a. If CoordSys Editor does not open itself during import process, VNS believes it has all necessary CoordSys info
    b. If CoordSys Editor does appear, VNS is asking for input or verification of CoordSys data

Post-Import Verification

1. Check general position of data
2. Check Datum and Projection System type against known metadata
3. Check elevation ranges in Database Editor to verify vertical units translation
4. If data from different sources disagree, it is important to determine which is wrong and which is right.
5. Often, importing a third dataset will indicate which of the first two is correct and which is improperly placed.

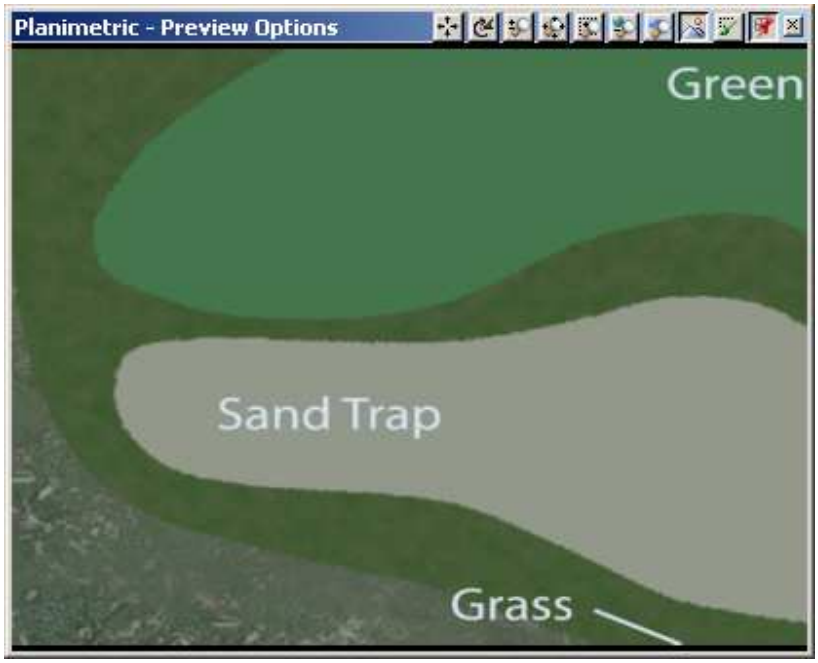
Files to try importing

1. Arbitrary DXF (contours)
2. ArcASCII
3. USGS 90m DEM
4. USGS SDTS 30m DEM
5. Shapefile, Geographic, no PRJ
6. Shapefile, with PRJ (VNS)
7. Arc ADF DEM (VNS)

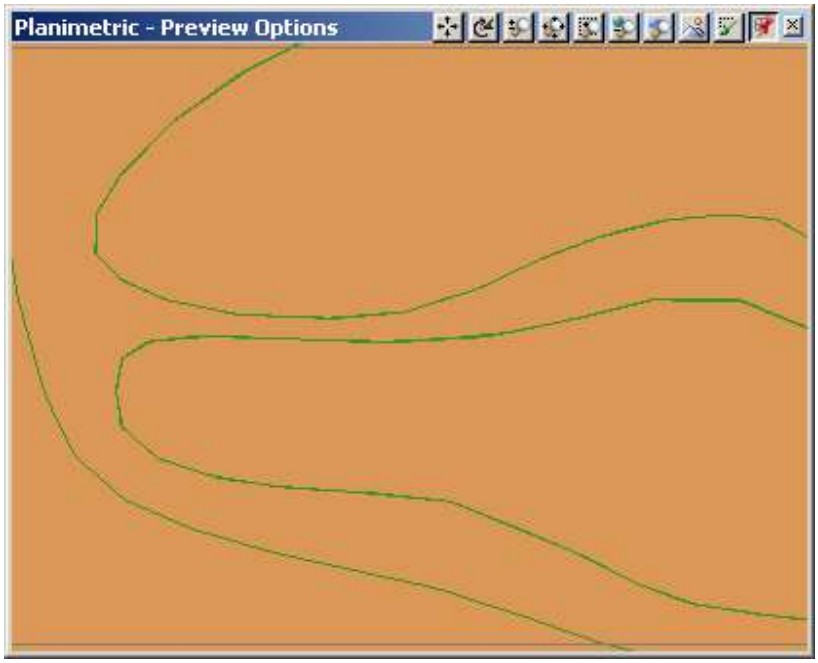
Feathering Vector Ecosystems
(VNS 3)

In VNS 2, the relationship between vector-bounded Ecosystems, Environments, and Ground was often misunderstood, leading to confusion. VNS 3 represents a major shift in the way effects are rendered on polygons, with amazing results. Unfortunately, some users remain confused. Let's see how Ecosystem blending and Edge Feathering Profiles work with render order and how we can best use them.

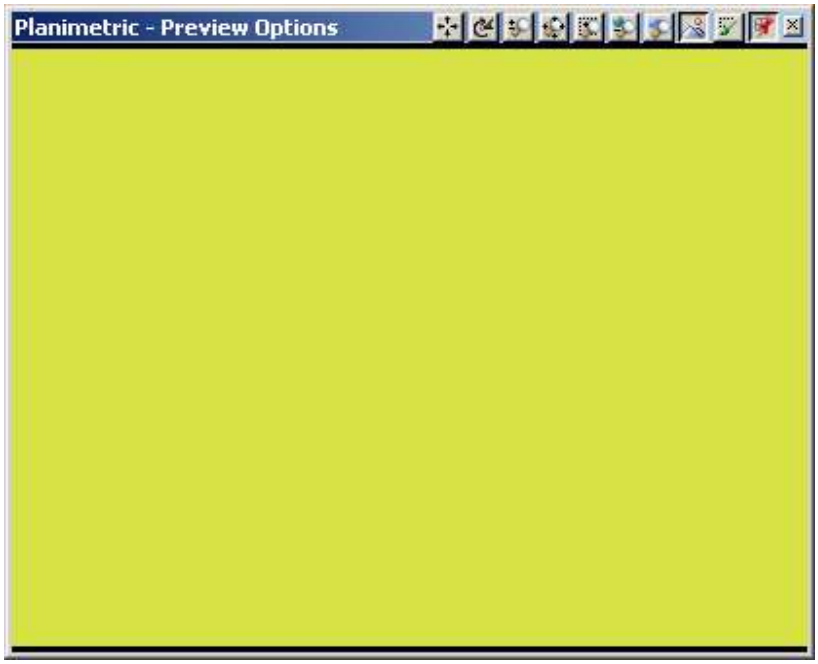
Here's a planimetric view, 25 meters wide, of an idealized golf green. A Color Map image was draped for reference. We have a green and sand trap surrounded by grass and rough.



Here's an OpenGL view showing vectors for the green, sand trap, and grass.

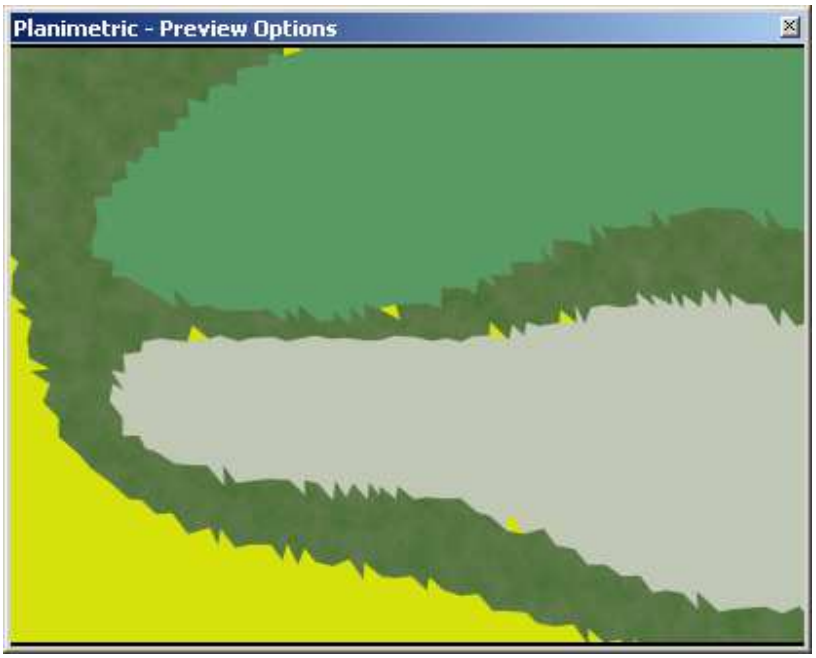


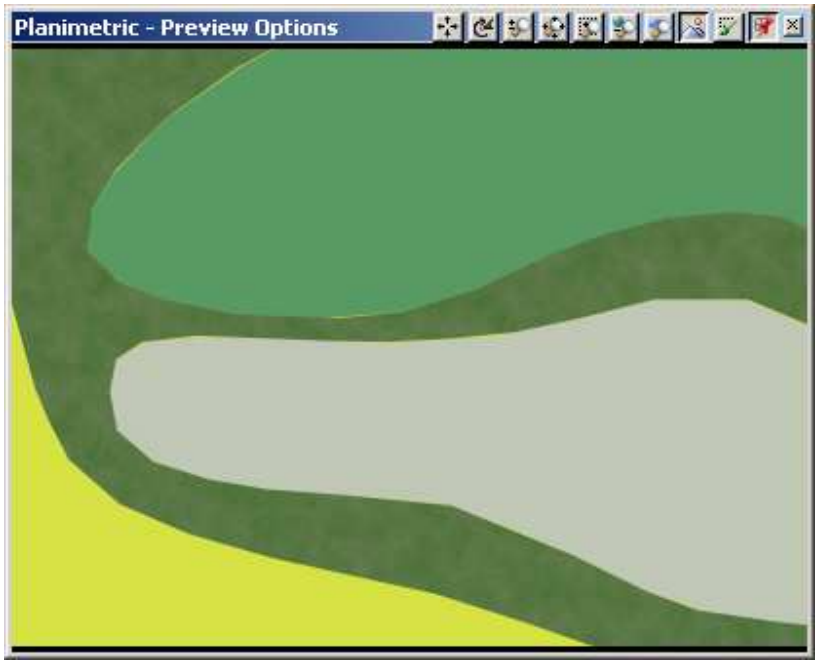
With the Color Map disabled, the Ground renders. A bright color has been used to make it easy to see where Ground renders later on.



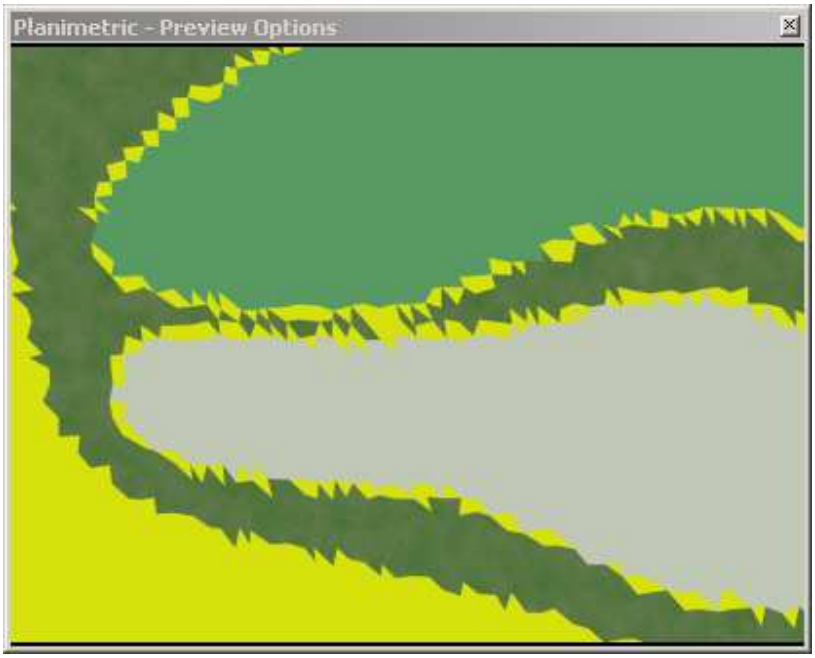
Ecosystem Blending

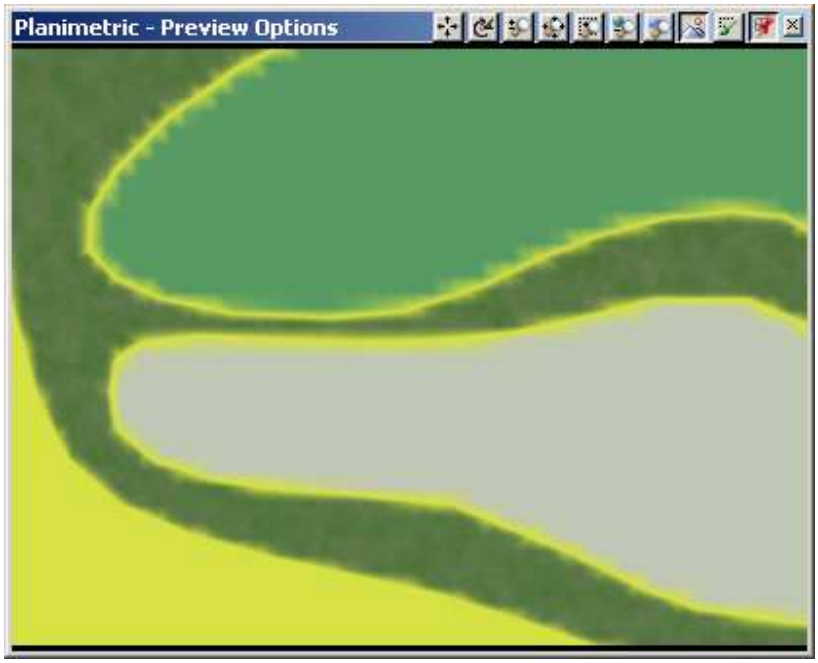
The terrain grid cell size is 0.5 m. At a Maximum Fractal Depth of 0, here's how the vector-bounded Ecosystems render in VNS 2 (top, with Hi-res Edges and Effect Resolution of 0.1 m) and VNS 3. Ground appears where Ecosystems are not placed by vectors. Whereas VNS 2 can only render a single Ecosystem per polygon, VNS 3 can render an unlimited number of Ecosystems on a single polygon. This is what 3D Nature refers to as **Ecosystem blending**. This blending of Ecosystems removes the need for Hi-res Edges and Effect Resolution controls.



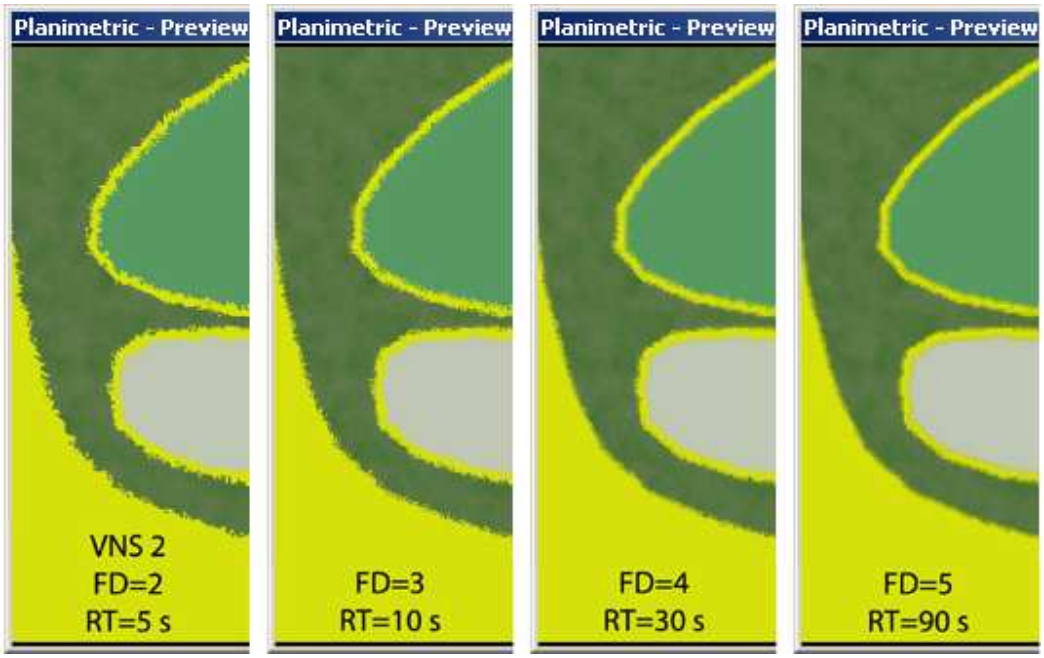


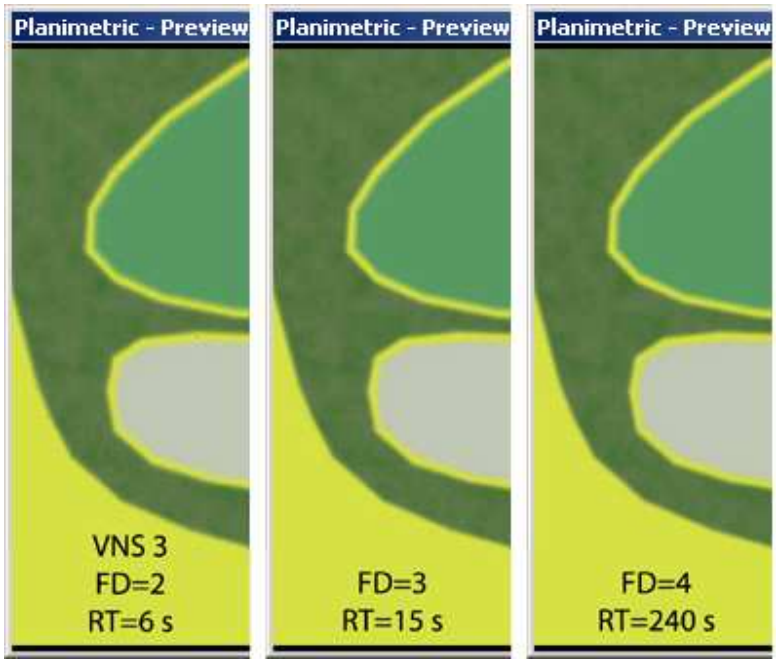
Many users prefer Ecosystem edges to feather into each other in closer views. To soften the transition, a 0.3-m Edge Feathering Profile has been added to each Ecosystem using the default S-curve (top: VNS 2, bottom: VNS 3).





Profiles require higher fractal depths. In VNS 2, most of the render quality improvement was achieved at a constant Maximum Fractal Depth of 4, which took 30 seconds to render. With VNS 3, better results rendered faster (6 seconds) at a lower constant Maximum Fractal Depth of 2.





Using Environments to fill in Profiles

The question we often hear at this point is, "What's the yellow?" The yellow is Ground effect. An Edge Feathering Profile operates from the vector inward, revealing the next available Component on the render priority list. There are no other Land Cover Components in the project so yellow Ground renders.

If we want another Ecosystem to show through instead of Ground, we need to place it with a Component that has a render priority below vector-bounded Ecosystems and above Ground. Remember that Ecosystems can be placed in the following ways, in order of descending render priority:

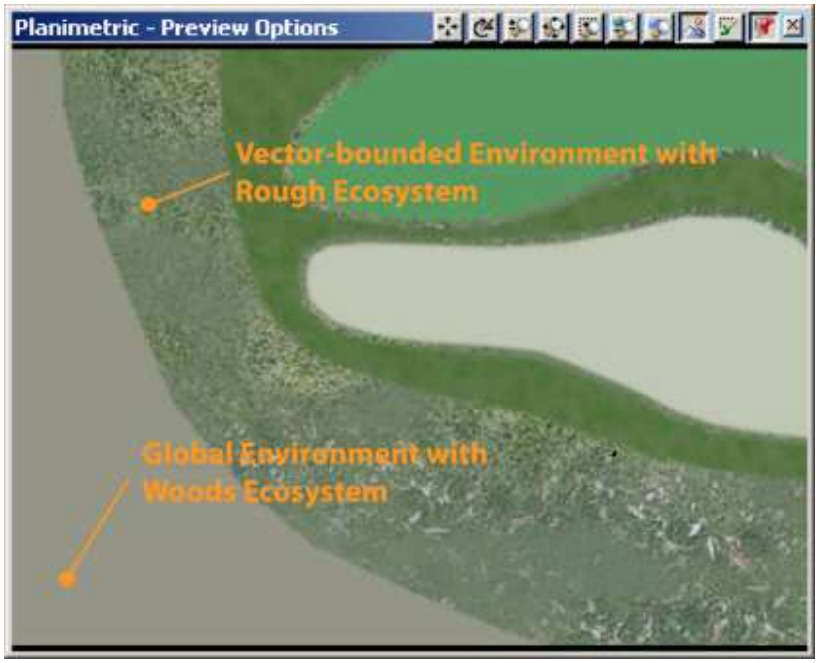
1. Terraffector Profile and Approach Slope. Terraffector-placed Ecosystems override all others. Priority among Terraffectors is based on Terraffector priority, evaluation order, and segment priority.
2. Vector-bounded Ecosystems, hard-linked or dynamic link via Search Queries. Ecosystem Priority controls placement when more than one vector-bounded Ecosystem is present.
3. Color Map Ecosystem matching up to 16.7 million different Ecosystems from one image. Color Maps can overlap with each linked to many Ecosystems.
4. Vector-bounded Environments. Ecosystem render order within the Environment controls placement
5. Global Environments via Ecosystem Rules-of-Nature.

If we want another Ecosystem to show through instead of Ground, we have two options. Our choice depends on how the existing vector-bounded Ecosystems function in the scene:

1. Create a vector-bounded Environment with the Ecosystem we want to show through the edges of the vector-bounded Ecosystems.
2. If we need an additional catch-all Ecosystem to render where the vector-bounded Environment doesn't, add it to the global Environment. Global Environments render everywhere its Ecosystem Rules-of-Nature allow.

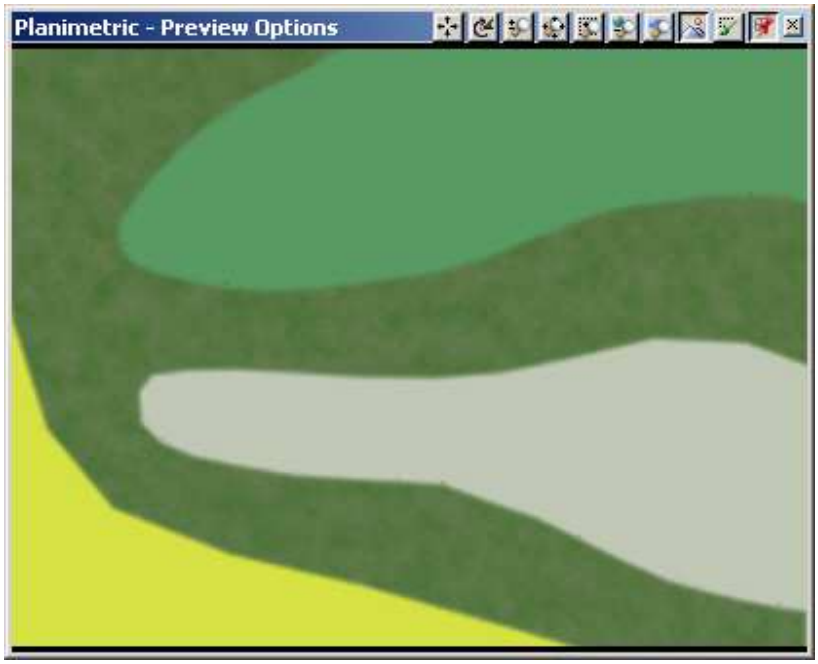
Both were applied in this render. A vector-bounded Environment with Rough Ecosystem encloses the vector-bounded Ecosystems and renders through their profiles. A global Environment with Woods

Ecosystem (tan) renders everywhere else. While this provides a solution, it can mean creating several vector-bounded Environments to fill different areas and is limited by the amount of "filling" you can do.



Solving the problem with buffered polygons

If you have lots of shapefiles and plan to feather the edges, start with polygons designed for rendering with profiles. Shapefile polygons typically come together in a jigsaw puzzle and cover everything. It's either one polygon or another with no overlap. The most VNS-friendly way to use profiles is to use buffered polygons that overlap, thereby eliminating the need to "fill in" the profiles. In this render the polygon edges overlap and the Ecosystems feather into each other.



Post Processing

With the inclusion of Post Processing in WCS 6 and VNS 2-3, users now have the option of applying a range of effects to their rendered output.

Here is a list of some of the things you may wish to consider when using Post Processing in your WCS or VNS projects:

1. In order to work, some Post Processing events require either the extended diagnostic data provided by the Pixel Fragment render engine. If you disable Pixel Fragment rendering or diagnostic data for any reason (memory issues, render time etc), then Post Process events that require those features will not work in that project.

2. Post Process events do not need to be applied individually. You can create a Post Process event "stack" where each Post Process event will be individually and successively applied to the output created by previous applications of Post Processing. Using this method, extremely complex image manipulation effects can be achieved.

3. You can apply as many Post Process components to rendered output as you desire. Each Component can contain as many events as you desire also.

4. In order to see the effect of Post Process components in your scene, you must have added the required Post Process components to the relevant Render Options. This includes your project Preview Render Options – preview renders will not show the effect of any Post Processing in your scene if you do not do this.

5. Use the Post Process Preview checkbox extensively while changing Post Process parameters. This is the best way to see the effect of your changes without having to re-render. Be aware of the following things though:

    - If you leave the Preview feature enabled while changing parameters in the Post Process editor, you will find that the entire interface becomes very sluggish. Depending on the complexity of your Post Process component(s) and the speed of your machine, this may result in anything from minor irritation to a complete loss of sanity! Disable the checkbox, make a change, and then re-enable the Preview checkbox to see the effect of that change.
    - Some Post Process events need to be applied to a full render to properly display. WCS and VNS are capable of generating High Dynamic Range output, and with some events, you may find that the preview incorrectly represents certain areas of your image in previews. This is especially noticeable with certain extremely "hot" areas of sky and cloud, where the intensity of light in that area of the image exceeds 100%. In these situations, the only real solution is to do a proper Post Process render and see what the end result looks like.

6. By creating two output events in your Render Options, and setting one to save the image before Post Processing, and one to save after Post processing, you can create two images at once. One will have your Post Processing applied and one will not. This is a good way of seeing the exact changes you have made.

7. Post Processing is now the preferred method for compositing your WCS and VNS content with supported external programs (LightWave, 3D Studio Max). Scene integration between products is still achieved using the Scene Export function in WCS or VNS, but the actual compositing process no longer requires the use or understanding of the somewhat esoteric z-buffer plugin(s). All that is required is an image (or image sequence) in RLA or RPF format(s), with depth information included in them. The alternative is to use an RGB image sequence along with a

corresponding IFF z-buffer sequence, although this will require a basic understanding of the z-buffer plugins to generate it.

8. Post Processing takes advantage of the full floating point precision of the WCS and VNS render engines, as well as the enhanced diagnostic data generated by the Pixel Fragment renderer. This means that Post Process events can use (amongst other things) the depth information in a scene. For example, a Text Overlay event can be animated to travel across the screen, and can be set up to pass behind foreground foliage, in front of distant terrain features, and reflect in visible water bodies! When used with textures such as Turbulence, and Fractal Noise, this gives you the control necessary to create rolling fog banks, low-level cloud, and so forth, without the render overhead of the new volumetric engine.

9. Since WCS and VNS are using High Dynamic Range output (i.e. pixels can actually be “brighter” than RGB 255, 255, 255), you can adjust exposure of your image as you would with a real world camera by incrementing the f-stop value. If you are familiar with the manipulation of exposure settings in real-world photography, this can often be a great boon.

10. Do not assume that Post Processing is only applicable to image “enhancements” (Contrast/levels/saturation/brightness/exposure adjustment etc). Although these are excellent applications of Post Processing (allowing you to bypass the Post stage in another image editing product), you are only limited by your imagination and the inventiveness with which you combine events to create a Post Process component. Crosshatch, Lithography, Photographic bloom, Sepia tinting and so on are all easily achievable with the Post Process editor.

11. Dissect other people’s Post Process components: a number ship with both WCS and VNS as standard. There are also a number of excellent examples in the Components section of http://www.3DNWorld.com. You will find that breaking these down, by enabling and disabling individual Post Process events in conjunction with the Post Process Preview checkbox, will give you a much better understanding of the workings of some of the Post Process event types.

SuperConductor

Summary	• Set up and operate a small network of WCS/VNS render clients controlled by SuperConductor.
Required	• WCS/VNS Render Engines, operating File Server and TCP/IP networking, SuperConductor. • SuperConductor requires WCS6, VNS2 or newer in order to operate. WCS 5 and VNS 1 do not have the required capabilities for remote control.
Note	• This information is derived from the material in the original SuperConductor tutorial written by Scott Cherba and found on the Super-Conductor.org web site and included with WCS 6 and VNS 2. The tutorial includes steps and illustrated screenshots.
Important	• Unless you understand the possible side effects, please do not divert from the exact steps found here. Network rendering is very tricky, requiring the precise coordination and configuration of many different computers. Once you have the setup working, you can experiment with changing the design, but we recommend initially following this setup exactly in order to get the render farm working right away.
Pre-Planning	• Decide on how you're going to configure your render farm. • Your network and computers need both file-sharing and TCP/IP networking set up in order for SuperConductor to operate. • There are three roles that need to be fulfilled: ◦ The Clients will be the various machines that do the rendering work. They need not have hardware keys, and they don't even need to have WCS or VNS installed on them. The client will need to be a Windows or Mac computer. ◦ The Server will hold common files for the rendering work – most notably the Project file(s) that the Clients will be rendering, and possibly the output images produced by the clients. The Server may also hold a central common copy of the WCS/VNS software and supporting Content files (WCSProjects and WCSContent directories). To lessen network load (and increase render farm reliability) it is often advantageous to have each Client have its own local copy of the WCS software and Content so they don't need to read those files across the network continuously. The server can be any suitable server hardware/software platform: Windows NT/2K/XP, Linux or MacOSX. Windows NT Workstation, Windows 2000 Pro, Windows XP Home/Pro, and any non-Server edition of Windows is limited in the number of Clients it can simultaneously support (approximately 5-10 clients). Linux and MacOSX use the Open Source Samba file server software, which does not have such artificial limits. The Server has no need for hardware keys. ◦ The Controller will run the SuperConductor application. The Controller needs to have access to the same files and shares that the Clients will access in order to render. The role of the Controller does not consume large amounts of network or CPU capacity, and it can be performed by a low-power system. The SuperConductor controller application currently runs on Windows and is also available for Linux. It could be compiled for MacOSX, but has not yet been. The Controller has need for hardware keys. • Roles can sometimes be shared: ◦ The Server could also perform as the Controller ◦ The Server could possibly also be a Client, but this is not recommended. Due to importance of the Server and the possibility of serving unavailability during heavy processing, it is suggested that the Server not render. ◦ The Controller could possibly also be a Client. This also may not be optimal. Though the Controller does not need much processing power, it needs to be available to communicate with other Clients, and might stall the entire farm if the Controller's rendering copy of WCS/VNS were to occupy the machine heavily. ◦ The Server/Controller machine might also be a WCS/VNS workstation machine where projects are created before farming out. • All Clients must have the same view of the Server's files as each other, and as the Controller. Choose an unused drive letter to use to represent the Render Farm file system. For example, the W: drive may be unused, on the Controller and each Client we'll map that to a common place on the Server.

Pre-Planning (cont.)	• The Controller and the Clients must be informed of each other, and the Clients must give their explicit consent to be controlled by SuperConductor running on the Controller. In order to accomplish this, you must know the IP address (or DNS name) of the Controller and each of the Clients. We recommend using IP addresses, as these will continue to work even if your DNS server is unavailable. • Make a table showing the network ID (IP address) of each client, and of the Controller. • You will not need to know the IP address of the Server. • Clients with multiple CPUs need extra setup to maximize their benefit. Initially, they will be set up as singles. • It is simplest if the Clients, Server and Controller all reside on one network or subnet. SuperConductor can work across switches, bridges, routers or even the entire Internet, but security and reliability issues may complicate such setups greatly, and are outside this scope.
Configure Clients	• If all Clients will share one copy of WCS/VNS and support files residing on the Server ◦ From any one of the Clients, start WCS/VNS ◦ Open the main Prefs window to the Paths tab. ◦ Ensure that all the Master Paths (WCSContent, WCSFrames, WCSProjects) point to the common shared copy of the WCS files on the Server by way of the shared W: drive. ◦ Select the Config tab. ‣ In the Option Name field, enter “netscript_permit_addr” ‣ In the Option Value field enter the IP address (or DNS name) of the Controller computer. ‣ Click Set, and verify that the Name and Value now appear in the Advanced Config Options list. ‣ In the Option Name field, enter “netscript_port_num” ‣ In the Option Value field enter “4242”. (This number might be different for multi-CPU machines) ‣ Click Set, and verify again. Any spelling errors or typos here could cripple the render farm. ◦ Open a simple project. The actual project does not matter, but changes to the WCS/VNS Preferences (such as we have just made) will not be resaved on exit unless some sort of project was loaded prior to exiting. ◦ Exit WCS/VNS. • If each Client will have its own copy of WCS/VNS and supporting files ◦ From any one of the Clients, start WCS/VNS ◦ Open the main Prefs window to the Paths tab. ◦ Ensure that all the Master Paths (WCSContent, WCSFrames, WCSProjects) point to the local copy of the WCS files. ◦ Select the Config tab. ‣ In the Option Name field, enter “netscript_permit_addr” ‣ In the Option Value field enter the IP address (or DNS name) of the Controller computer. ‣ Click Set, and verify that the Name and Value now appear in the Advanced Config Options list. ‣ In the Option Name field, enter “netscript_port_num” ‣ In the Option Value field enter “4242”. (This number might be different for multi-CPU machines) ‣ Click Set, and verify again. Any spelling errors or typos here could cripple the render farm. ◦ Open a simple project. The actual project does not matter, but changes to the WCS/VNS Preferences (such as we have just made) will not be resaved on exit unless some sort of project was loaded prior to exiting. ◦ Exit WCS/VNS. ◦ Copy the WCS.Prefs or VNS.Prefs file from the WCS directory of the Client just modified to the WCS directory of all other Clients.

Configure Controller	• Run SuperConductor • Go to the Resources tab • Ignore the Search for Available Clients button it doesn't do anything. Yet. • Individually add the Clients to the Available Clients list ◦ For IP addresses (like 192.168.1.1, etc), make sure the DNS Suffix field is blank ◦ For DNS names, fill in the common domain name suffix (.mycompany.com) in the DNS Suffix field ◦ Make sure the Socket field is set to 4242. ◦ Enter the IP address or base name of the DNS name (fred part of fred.mycompany.com) into the Find Client field and click OK. ◦ The Client will be added to the Available Clients list. ◦ When all Clients are added to the Available list, click Add All to transfer them to the Clients Used list. ◦ Click Save Client List and save this data to a config file so it can be recalled later without re-entering it.
Prepare Project	• Ensure that the project does not refer to files via local paths (like C:blahblah) that will be different or unavailable when the project is rendered on the Client machines. • Detecting and dealing with dependencies in your project is the single most important aspect of successful render farming. This can be best dealt with while building projects. Always move dependent files into the WCSProjects or WCSContent directories. • If all Clients will share one copy of WCS/VNS and support files residing on the Server ◦ Copy the project (and any files it depends on) to the Server's WCS directory. This is made easier if the Server is also the WCS/VNS workstation, or if the WCS/VNS workstation has no local copy of WCS/VNS but instead uses the same Server copy the Clients will. • If each Client will have its own copy of WCS/VNS and supporting files ◦ Copy the project (and any files it depends on) to each Client's WCS directory.
Start the Clients	• Go to each Client machine, and start WCS or VNS. • This process may be automated using utilities like ApptoService. • Certain command-line arguments (ENGINEONLY) may also help automate unattended Client startup.
Start Controller	• If SuperConductor is not running on the Controller, start it, load the Clients list and ensure all Clients are in the Clients Used list. • Select the Render File tab. Click the Browse button next to the Source File field. • Navigate via the shared W: drive to find the .proj file you wish to render. • Adjust the Priority field if necessary. • Ignore the Destination Path field, it is not used here. • Click the Add Project button. • Any Render Job(s) from the Project will be entered into the list. • Switch to the Server Info tab. • Click Start Render! • Watch textual communications with nodes in the text display. • Switch back to the Render File tab to see an overview of the Job(s) in progress. • Jobs will finish when complete. If you wish to stop a job before it finishes, select it and click Delete Project.
Multi-CPU Clients	• Start multiple copies of WCS/VNS on each SMP Client, one copy for each CPU you wish to use. • Each copy will need to bind to a different port number. First: 4242. Second: 4243. Additional: 4244, 4245… • There is nothing special about the port number 4242, the 4200 range is unlikely to be used by other programs. • Add each SMP client to the Available Clients list multiple times, once for each instance of WCS/VNS that will be running on it. Specify the corresponding port number for each additional

Multi-CPU Clients (cont.)	entry in the Available Clients list. • SuperConductor treats multi-CPU machines like multiple individual computers each occupying different port numbers of the same IP address. • Port number is saved as part of Prefs file, which normally is WCS.prefs or VNS.prefs stored in the WCS directory. If WCS/VNS finds its assigned port already in use (usually by another instance of WCS/VNS on a multi-core machine) it will try the next higher port number. Up to 8 automatic port jumps are allowed.
Notes and Tips	• 3D Nature can also do rendering for you. Bid on a per-project basis. • SSH tools like TeraTerm with TTSSH and SSH Tunneling/Port forwarding can be used to direct SuperConductor control traffic through firewalls and across the Internet if necessary. ◦ Drive mapping and project/dependent file synchronization still important. ◦ Drive mapping can be 'faked' – SC only needs to read the Project file.

Synthetic Object Bitmap Texturing
Highway Sign | Advanced 3DNA

Overview	• How to build and texture a man-made type object with bitmapped image(s) controlling color and luminosity.
Steps	• Plan Design, Build Object, Create Textures, Apply Textures.
Plan Design	• Know dimensions and positions of areas to be texture-mapped • Make sketches, record dimensions and coordinates
Build Object	• Know your axes ◦ Typically X & Z are horizontal and Y is vertical in most 3D software (LightWave, Max) ◦ Typically X & Y are horizontal and Z is vertical in GIS software (WCS/VNS) • Build in the proper orientation and position in your 3D modeler ◦ Y axis is up ◦ 'Planting Point' of 3D object is at 0,0 X,Z position, and base of object is typically at Y=0 • Note textured-area coordinates once object has final positioning and scaling • Note axes that textured areas will have their textures 'projected' along • Ensure each area that will receive different texturing is a unique Surface/Material.
Create Textures	• Start with a blank image of correct proportion/size • Easy way to create this is to do a screen-grab of model being viewed in 3D software • Bonus: Irregular features and model details can easily be seen in screen-grab for reference • Create new layer in Photoshop to actually create texturemap on, keep reference image in BG layer • Use layer opacity in Photoshop to see reference layer if necessary while working • When finished, crop to rectangular area specified by noted texture-area coordinates • Discard BG layer or ensure it won't show up in final texturemap.
Apply Textures	• Load model into scene, place, test-render for optimum visibility during texturing. • Turn up ambient light or luminosity for better visibility while texturing. • Select material to be textured, Create texture for diffuse color. • Element type: Planar Image • According to notes, apply texture along 'Z' axis • Turn on Tile Width and Height temporarily to wallpaper entire texture universe. Render. • Should see something, though not sized or positioned correctly. • Texture Size: X=10m, Y=3m (3D axis convention not GIS axis convention) • Center: X= -7.7187m, Y=12.67m (coordinates of CENTER of textured area on sign) • Render. Turn off tiling, unnecessary now that settings are correct
Bonus Illumination Texture	• Create a new layer in Photoshop, paint 'lit' areas on it in white. • Use Layer opacity to see areas of text to guide lighting placement. • When finished, create a 'Black' layer below Light layer, above sign text layer. • Fill 'Black' layer with black, leaving white lit areas on black. Save texture. • In WCS, add a texture to Sign's Luminosity channel. Set up size/pos as Diffuse texture above. • Use illumination texturemap. • Set Luminosity to 100%. Can be animated to 'switch on' lights. See also: Snack Shack from Content CD/Golf Course.

Panoramic Images

Summary	• Generate panoramic image(s) from one or more viewpoint(s). • Good for high-detail interactive viewpoint with restricted position interaction. • Works ok with reflections, may be some problems.
Software	• PhotoVista (IseeMedia, old limited Demo Version included here, sufficient for our needs) • Recommend PanoramaFactory or other tools for production use of Panoramic images • Demo version of PanoramaFactory included on CD, workstations • Additional information: http://www.panoguide.com/software/
WCS	• WCS can produce automatically-stitched seamless panoramic images • Photovista can view these panoramically, and export them for Web usage • Other programs (Apple's, PanoramaFactory, etc) could also be used.
Steps	• Load BlueMesa demo project, Save As BlueMesaPano.proj. • Render Task Mode, expand Cameras category. • Click once on BlueMesa Camera, click Add or Clone S@G icon. • Change name to BM Pano Cam. Check "Panoramic" in Options. • Select BM Pano Cam into UL View with popup menu. • Some types of Cameras make no sense as Panoramic (Planimetric, Overhead) • Change to Lens tab. • Horizontal Field of View controls width of each 'panel' of panoramic image. • Enter 30°. 360° divided by 30° equals 12 panels. • Ensure Box Filter is off, while we're here.

Diagram of a single Panel

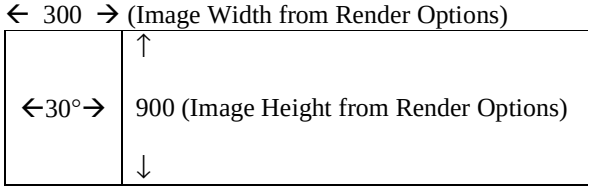
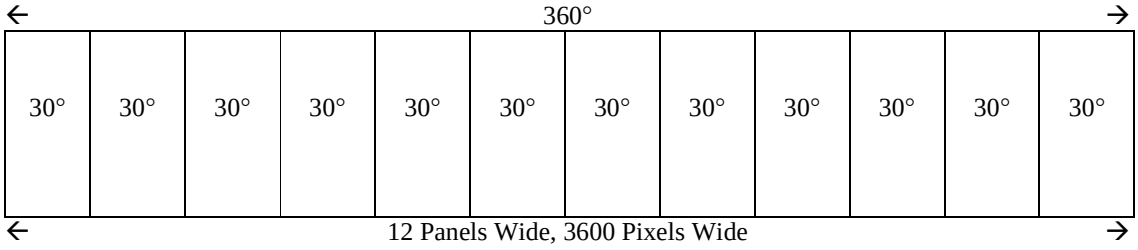


Diagram of full 12-Panel Panorama, assembled and output to a single image



Render	• Open "Blue Mesa Render Options" • Width and Height specify pixel dimensions of each panel • Panels will automatically be merged into one large (Width*Panels by Height) image • Width: 300, Height 900 • Go to File Output tab. Save as BMP. Insert Frame Digits: 0 • No motion blur or field render • Select "Blue Mesa Render Options" into UL view with popup menu • Open Render Controller. Edit Render Job to use BM Pan Cam. Render.
Photo Vista	• Open Panorama. • Accept suggested values (seem correct) Cylinder, ~76, 360. • Panorama menu, Show Viewer. Enjoy!

Cubic Panoramic Images

Summary	• Generate six images in the four cardinal directions plus up/down from one or more viewpoint(s). • Give better all-directions performance than QTVR or other cylindrical/sphericals. • Fewer 'panels' render faster, but may have more seam/crease distortion. Reflections may be odd. • Works best with Targeted Cameras, as we utilize the Heading/Pitch controls to make the Cube face renders. • KubeGL good for testing cubic panos. Other software better for distribution. • Additional information: http://www.panoguide.com/software

WCS	• Load BlueMesa sample project, Save As BlueMesaCubic.proj. • Render Task Mode, expand Cameras category. • Right-Click on BlueMesa Camera, Clone Component.Works best with Targeted Cameras, as we utilize the Heading/Pitch controls to make the Cube face renders. • Change name to BM FW Cam. Select BM FW Cam into UL View with popup menu. • Change to Lens tab. Enter 90° for Horizontal Field of View. Ensure Box Filter is off, while we're here. • Clone five more Cameras: BM LT, BM RT, BM RR, BM UP, BM DN. • LT: H=-90, RT:H=90, RR: H=180, UP: P=-90, DN: P=90

Diagram of a single Panel

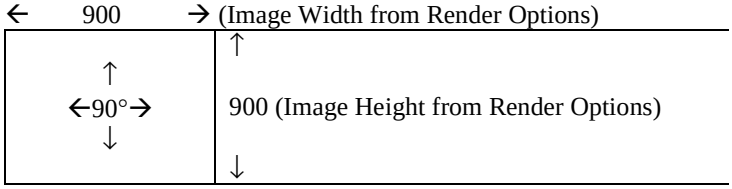
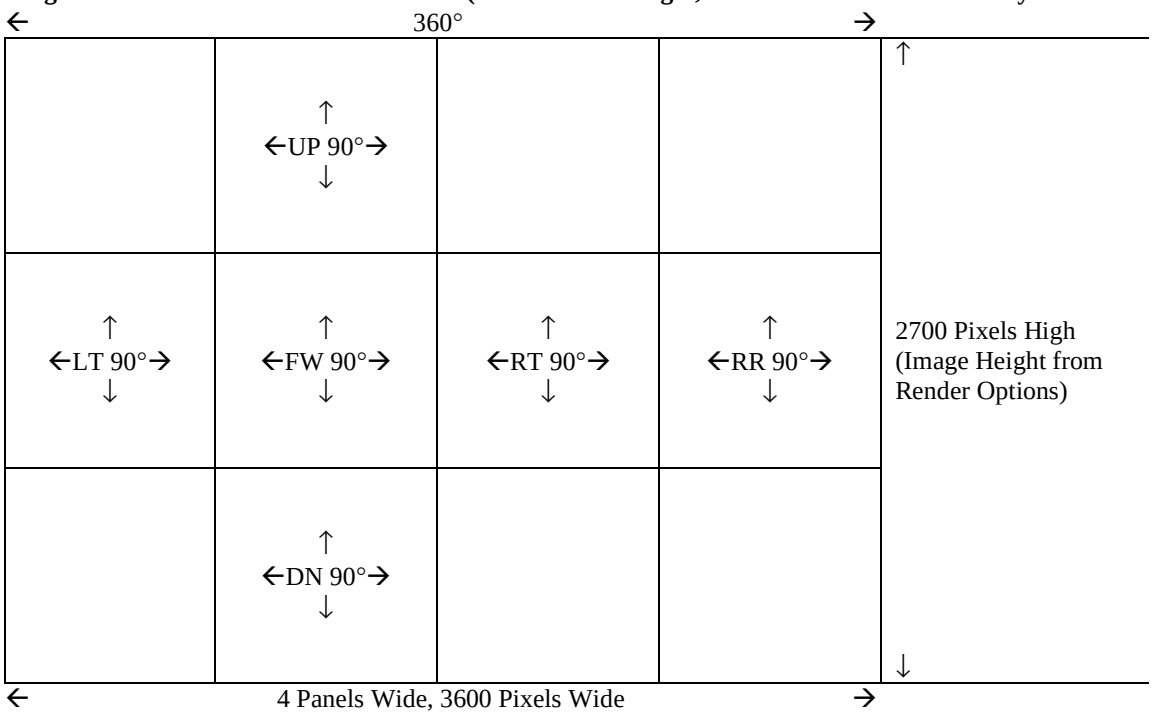


Diagram of full 6-Panel Cubic Panorama (Written as 6 images, need to assemble into this layout manually)



Render & Merge	• Open "Blue Mesa Render Options". Width and Height specify pixel dimensions of each panel. • Panels will need to be merged into one large image manually in Photoshop/etc. (see diagram above) • Unlock Size Lock. Width: 900, Height 900, Aspect 1.0. • Go to File Output tab. Save as BMP. Insert Frame Digits: 0 • Clone six times: FW, LT, RT, RR, UP, DN, customize Options Name and Image File output names. • Clone six Render Jobs, select corresponding Camera and Options into each. • Open Render Controller. Render. • Manually merge images in Photoshop according to diagram above. Guides are helpful.
KubeGL	• Run KubeGL, select large merged image, enjoy!

External 3D Integration

Summary	• Compositing renderings from 3DS Max/Viz into WCS and VNS scenes.
Note	• See relevant documentation in Online Reference Manual: Integrating with External 3D Applications. Covers both Old (plugin) and New (PostProcess) styles, for LightWave and Max/Viz.
Required	• LightWave 3.x-7.5x (Current), 3D Studio Max 1.x-5.x (current), Viz 1.x-Current
Plugins vs PostProcess	• Previously done with ZBCOMP plugins in LW/Max. Viz didn't support ZBCOMP (no video post). • Now done in PostProcess in WCS6 and VNS2 with many advantages: ◦ No need to update plugins for incompatible incremental versions of Max. ◦ Works with Viz! ◦ More control over the process – more data available to compositor when run within WCS/VNS. ‣ Better anti-aliasing ‣ Composited objects can now reflect in WCS/VNS lakes and other reflective surfaces
WCS/VNS Process Overview	• Set up terrain scene portion first in WCS/VNS • Place marker vectors if desired • Optionally set up camera motion in WCS/VNS • Export a framework scene with crude terrain model, camera motion, lighting and marker vectors ◦ Does ***not*** include vegetation or texturing. ◦ Not suitable for rendering terrain within LW/Max/Viz. not intended to. ◦ If final camera motion was set up in WCS/VNS, export key on every frame to ensure exact correspondence. If not, export only existing keyframes to make editing easier in LW/Max/Viz.
LightWave Max/Viz Process Overview	• Use terrain model and marker vectors to place and animate hero characters, buildings, vehicles, etc. • Update or create camera motion if desired. ◦ If camera motion changes in LW/Max/Viz, you must export scene back to WCS/VNS and reimport. ◦ If exporting back from LW/Max/Viz to WCS/VNS, must have keyframe on every frame on return trip to ensure perfect correspondence. • When motion is finalized and all additional LW/Max/Viz items are placed and animated, disable terrain mockup (within LW/Max/Viz) and render just added objects. • Save to RLA or RPF with as many channels as are available. • Terrain mockup could be used to 'catch' shadows from animated objects.
WCS/VNS	• If motion was modified within LW/Max/Viz, reimport necessary channels (camera, lighting) • Set up PostProcess component with RLA/RPF image file sequence. • Render scene in WCS/VNS. When each frame completes, the LW/Max/Viz imagery will be loaded and merged into WCS/VNS scenery. Reflections will then be calculated, incorporating the merged imagery. • RLA/RPF files may be 'deep', including obscured pieces, allowing them to reflect like Render Obscured.

Step by Step	• 3D Studio Max 4.2 covered here. Process is basically the same in LightWave.
WCS/VNS	• Open BlueMesa. Save as BMComp. • Place a single-point Vector in mid-ground beyond nearest spires, in front of mesa. Name: ObjLoc. • Export with Scene Export. File Units: Meter
Max	• Customize/Preferences, General: 1 Unit = 1.0 Meters. Needed to write RPF files in proper meter units. Automatic Unit Conversion. • File/Import, select PRJ (not ESRI PRJ!) Completely replace current scene. Convert Units. • Select BlueMesa C[amera] into LR Perspective view. Nothing visible. Max clips at 100m by default. • Select BlueMesa C as active object. Modify panel, Clip Planes, clip manually. Set far to 100000. • Create Panel, create moderate-sized sphere off to one side. • ALT-A (Align tool), Select by Name, choose ObjLoc. • Align Selection dialog: X Position, Y Position, Z Position. Sphere should move into place. • Disable terrain rendering: Select by Name, Spires.A, Spires.B. Object properties. Uncheck Renderable. • Activate Viewport: BlueMesa C (if not already selected) • Render: F10. Set Output size to same as WCS: 720x480, 1.0 pixel aspect. • Click Files. Animation subdir, BMSphere.rpf, RPF format. • Choose channels: Z and sub-pixel Weight & Mask. Render!
WCS/VNS	• Render Task mode, create a PostProcess component “MaxComp”. Add PostProcess event. Composite. Yes. • Detail1 Tab: Select New Image Object. Choose Animations/BMSphere.rpf. • Add MaxComp to BlueMesa Render Options with drag & drop in S@G. • Open Render Control. Render. See big ugly sphere. • Render Task Mode: Edit BlueMesa Render Options, turn on Reflections in Enabled1. • Water Task Mode: Create new lake. Control click to set elevation. • Render again.
Result	• Admire reflecting big ugly sphere.

Tips to Successful Foliage Object Creation

Be creative. You can use photos of things other than plants to populate your landscape.

1. **Take photographs**.
    A. If possible, photograph trees that have a simple background like sky. They will be easier to edit.
    B. Position yourself so the sun is as close to directly behind you as possible. Morning is best, both for the light angle and light color.
    C. Get as close to the tree as possible while still getting the entire tree in the frame.
    D. Use a normal, telephoto, or perspective control lens. Avoid a wide-angle lens.
    E. Shoot level to minimize distortion. If you are photographing a plant shorter than you are, lower yourself to shoot from about half the plant's height.
    F. Take lots of pictures. Many will not turn out as well as you hoped.
    G. Make sure you have at least 3 different trees of each species so that you do not have obvious duplication in your VNS rendering. If you do not have multiple samples of the tree, take photos of it from different angles. This can help reduce the visual duplication.
    H. If you are using a digital camera, shoot with the white balance manually set to 'sunlight' (not auto) and save the images in an uncompressed format at high resolution. Do not save images as JPGs; it will be much more difficult to edit them.

2. **Scan the photos or download them from the digital camera**.
    A. Some color correction can be done at this stage but is not usually necessary.
    B. Scan or download all images at the same time to expedite the process.
    C. Save the images in an uncompressed format at high resolution. Do not save them as JPGs; it will be much more difficult to make them look good if you do!

3. **Mask the images**.
    A. Whether you use selection, paint, or pen tools to remove non-foliage pixels, choose absolute black (RGB 0,0,0) as the background or active color. VNS makes RGB 0,0,0 transparent when rendering foliage images. As an alternative, use a bright non-foliage color and later replace it with black.
    B. Regardless of the tool, **disable anti-aliasing**. Pixels must be either RGB 0,0,0 or foliage. Anti-aliasing leaves an almost black 'rind' around the foliage that will ruin the effect of your tree images in renders.
    C. If the background is sky or a non-green color, use a non-anti-aliased selection tool (Magic Wand in Photoshop) to select and delete the color.
    D. For areas not easily selected, use a non-anti-aliased paint or pen tool to trace and fill non-foliage areas with black (RGB 0,0,0).
    E. Remove wayward branches and fill in distracting holes in the foliage. Anything that makes the tree unique will make copies of it stand out in renders.
    F. The same idea can be used to make different versions of the same tree. Why not trim a branch here and there to make the tree look different? That way you will have even more samples of the species to avoid replication!

4. **Is your image really clean?**
    A. From the color palette in your paint program select a REALLY bright color that is not represented in your photo. Yellow is a good choice.
    B. Select your fill tool and click in the black outskirts of your image. If there are any spots that do not turn this bright color paint them this color.
    C. Select your black and fill the bright color back in with black.
    D. Take your time. It usually helps to do a tree and then leave it for a couple of days. Then check it again for absolute perfection.

5. **Final touches**

A. Crop the top of the image as close to the tree as possible.
B. Crop the bottom of the image so the base of the trunk rests on it.
C. Crop the left and right sides so the base of the trunk is at the center of the bottom edge. If the image is not wide enough to do this, add real estate as necessary (increase the Canvas width in Photoshop).
D. Save the image in PNG format. Do not save the image in a lossy compressed format like JPG.
E. If you resize the image downward, resample using an algorithm that does not blur the foliage-black boundary. In Photoshop, use Nearest Neighbor to Resample Image when reducing image size.

Walls for Fences

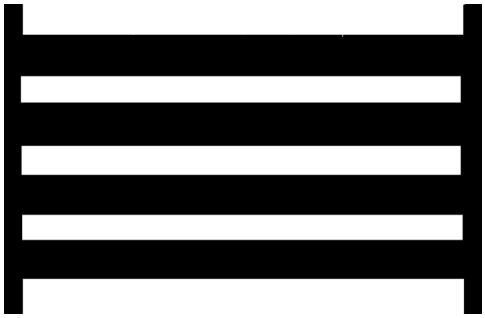
Goals

- To place a fence using a Wall Component.

Required

- **3DNA\Flat.proj**

Explanation



A fence photo (above left) and matching transparency mask (above right) can be applied to the Diffuse Color and Transparency channels, respectively, of a Wall Component.

Steps

- Open **3DNA\Flat.proj**.
- Go to the **3D Object Task Mode**, select the **Walls** category in the S@G, and **Create** from the Icon Toolbar. Planar Image texture.
- Left-click start and end points for the Wall and right-click to stop digitizing.
- Name the Vector and Wall **Fence**.
- Close the Component Galley when it opens.
- In the Wall Editor make the Heights **Relative to Ground Elevation**.
- Change the **Panel Top Height** to **1.5** meters.
- Panels page. **Create Texture** for the Diffuse Color.
- Choose **Planar Image** from the Selected Element dropdown list.
- Add a **New Image Object** from the Image Object dropdown list.
- Load **WCSProjects\3DNA\images\Fence_4-plank-log-post.png**.
- In the **Image Settings** section **enable Tile** for the Width.
- Change the **Texture Axis** to **X**.
- Change the **Size Y** to **2.3** m and the **Z** value to **1.5** m.
- Change the **Center Z** to **0.75** m.
- Render a preview. If you're looking at the west side of the fence it will be black because it's in shade.
- Bring the **Wall Editor** forward and increase the **Luminosity** to **50**%.
- Rotate and zoom the camera for a better view of the fence.
- Render a preview.
- **Copy** the Diffuse Color **Texture**.
- **Paste Texture** to the **Transparency** and confirm the operation.
- Increase the **Transparency** value to **100**%.
- **Edit** the Transparency **Texture**.
- Add a **New Image Object** from the Image Object dropdown list.
- Load **WCSProjects\3DNA\images\Fence_4-plank-log-post_trans-mask.png**.
- Render a preview.

Modeling and Matching 3D Objects to Terrain

Goals

- To export terrain for modeling reference and import the correctly located 3DO.

Required

- **3DNA\Matching3DOs.proj**

Explanation

- Complex 3DOs may need to be modeled using terrain as a reference. This method ensures that the models are positioned correctly upon import into VNS.

Steps

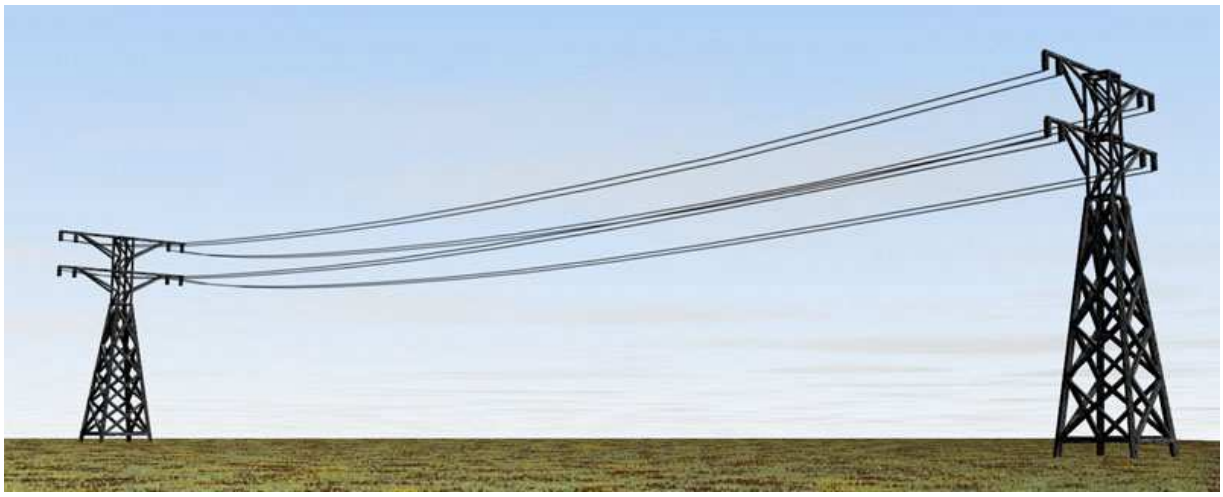
- Open **3DNA\Matching3DOs.proj**.
- Choose **Export Scene** from the **File** menu.
- Select the Export File Format your 3D application imports. For this demo we'll use the **LightWave 3D 7.x** format.
- For the **Export Entity** choose **DEM Only**.
- Assign a **Content Dir**ectory**.**
- **Export**.
- For the LightWave format, a file requestor will open to select DEMs for export. Choose the DEM listed.
- A second file requestor will open for the LW Object path/file. **Save** the default.
- Close the **Scene Export** window.
- The following steps will be demonstrated in LightWave but can easily be modified for other 3D modeling applications.
- Open the DEM LWO. The terrain's southwest corner is at the origin.
- Center the object along the X and Z axis to center the terrain. Do not center along the Y axis.
- Find the height of a known VNS elevation and move the terrain model accordingly.
- Model a **Redhouse** object, save, and copy to the **WCS\Components\3DObject** folder. Return to VNS.
- The 3DO object was built with an origin at the center of the rendered DEM and an elevation of 0 meters. That LWO center coincides with a default planimetric camera above the DEM.
- Open a planimetric view and set the camera to its default location.
- Vector Task Mode. **Create** a new single-point vector anywhere named **Redhouse**.
- Right-click the planimetric view to open its popup menu and select **Edit View's Camera**.
- Vector Editor. Deselect **Conform to Terrain when coordinates change**.
- Copy the camera latitude and longitude values to the vector point.
- 3D Object Task Mode. Add a new 3DO and load the Redhouse LWO from the **3DNA\Matching3DOs** folder.
- **Do not** recenter the object.
- 3D Object Editor: Size & Position page. Deselect **Render a Geographic Instance** and make it **Relative to Vector Elev**ation.
- Drag the **Redhouse** vector from the lower **S@G** pane and drop it on the **Redhouse** 3DO in the upper **S@G** pane.

Suspended Wires & Cables

Visualizations involving power transmission lines or ski lift cables challenge many users. The best solution is to model the cables. This allows precise control over position and catenary, is the most true-to-life, and looks the best in animation and stills. The modeling involved requires only rudimentary 3D skills and a basic 3D modeler. Here we'll look at transmission wires rendered as 3D Models, Walls, and Vectors.

3D Models: The Best Solution

Parts of 3D Objects are best modeled in 3D. This ensures the best results in the least time with the fewest problems. Properly modeled 3D elements look realistic from all angles in stills and animation. Except for assigning materials to surfaces, no subsequent work is required in VNS.



Problematic Walls

A carefully textured and aligned Wall-of-wires can look as convincing as modeled wires - almost. But several issues emerge when you try to use them.

- » Vector points used to loft or drop the Walls must be precisely matched to 3D tower connections.
- » Towers must be equally spaced to match the texture image size.
- » The catenary will be incorrect. Wire sag depends on the distance spanned. Wall wires have the same sag regardless of span.

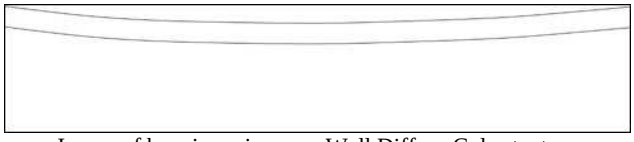
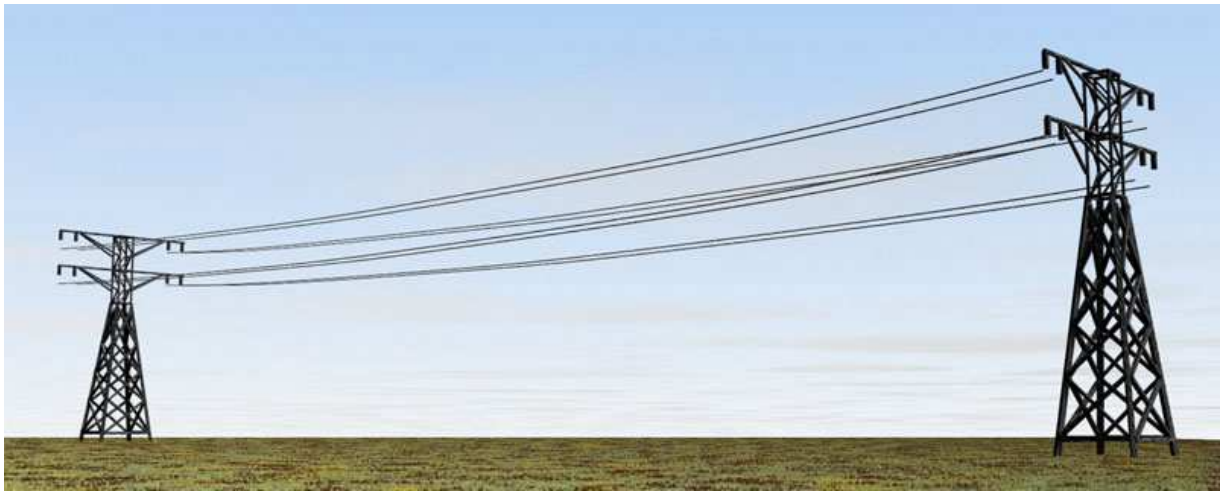
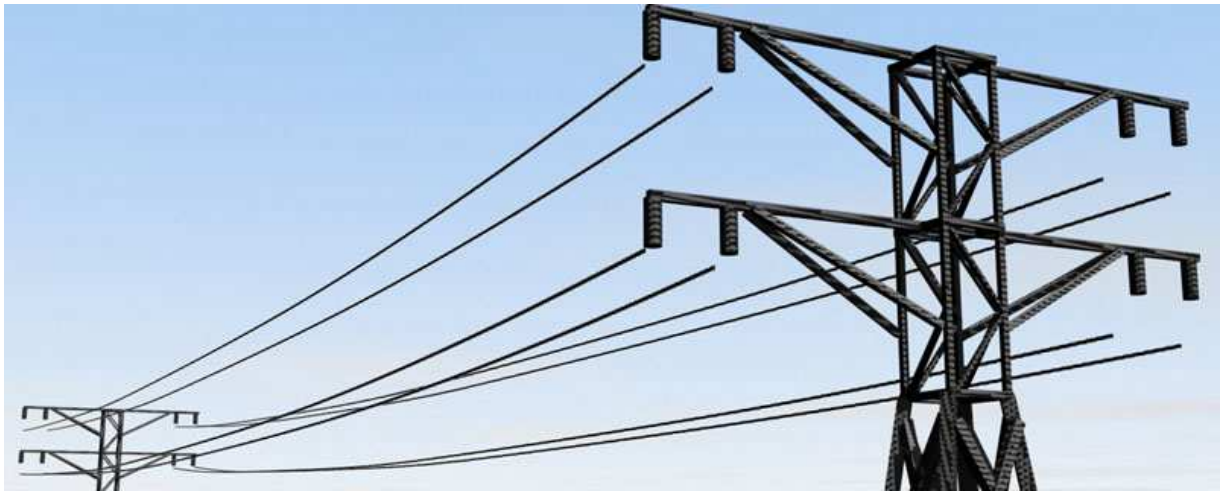


Image of hanging wires as a Wall Diffuse Color texture

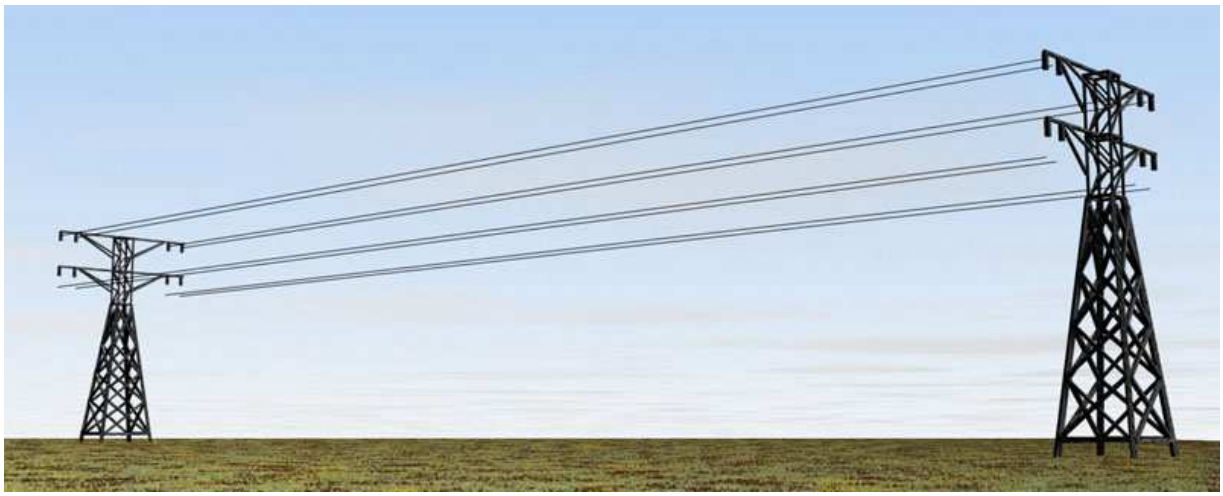




Distant Vectors

The use of rendered vectors only works for wires viewed in the distance.

- » Vector points must be matched to 3D tower connections, although precision is less important for distant views.
- » Vector width is constant. As the camera moves closer to the vector it grows smaller relative to the tower.
- » No wire sag.



Still not convinced?

Set up a simple test project and see how long it takes you to render acceptable results using each method.

The Animation Process

For those familiar with the world of print graphics, animation requires a different way of thinking. By understanding the process, clients can reduce costs and help keep their production on schedule. Start to finish, a project usually takes 4-6 weeks to complete.

Data Evaluation. Landscape animation is based on terrain data, aerial and/or satellite ortho-imagery, and 3-dimension computer models. The quality of the final product is highly dependent on the quality of data. Before starting a project, the client provides data for evaluation. High-quality geo-referenced data in standard GIS formats minimizes the cost of converting data to a usable format.

Planning and Storyboard. Given client data and goals, a project timeline is established. The animation is graphically outlined in a storyboard, a production version of a comic strip. The storyboard is submitted for client approval before work continues.

Scene Setup and Rough Animation. With an approved storyboard in hand, actual scene development begins. Data and scene elements are combined in 3-dimension landscape and modeling programs to create a virtual world of the client's site. Detailed still images and a rough version of the animation is output for client approval before work continues. At this stage the project is 2-4 weeks into production.

Rendering and Post-Production. The scene is output to frames, 30 of which are required for each second of animation (60 fps for broadcast). Rendering of frames usually requires 1-2 weeks depending on animation length and scene complexity. Once rendered, the frames are assembled into the final animation, effects added, and the product delivered for approval. While some superficial changes can be made in post-production, some may require revising the original scene and re-rendering the animation. This is costly and time consuming and should be avoided. Careful review of the rough animation before committing it to rendering can prevent these additional costs.

Factors Influencing Production Cost

Data. Is all data available in standard GIS or 3D formats? Data is submitted for evaluation prior to the cost estimate. The less work the data requires, the lower the project cost.

Animation size, length and format. Unless the client has already prepared a storyboard or is revising an existing animation, length is a question difficult to answer. While format may also fall under this category, *how* the animation will be used doesn't. Knowing what the client wants to use the animation for greatly impacts how it is produced.

Specific format? AVI, QuickTime, other..
Specific maximum size? 720x480, ...
CD for desktop viewing?
Video-DVD for television viewing?
PowerPoint?
Web delivery?
Real-time interactive? NatureView Express, …
Other?

Cost

This is difficult to estimate precisely without data and without knowing length, format, or target uses. Roughly, it's $5,000 per 30 seconds of finished video. This isn't much help because clients rarely know how long their video will be.

The VNS Process
(Scott's Animation Cheat Sheet)

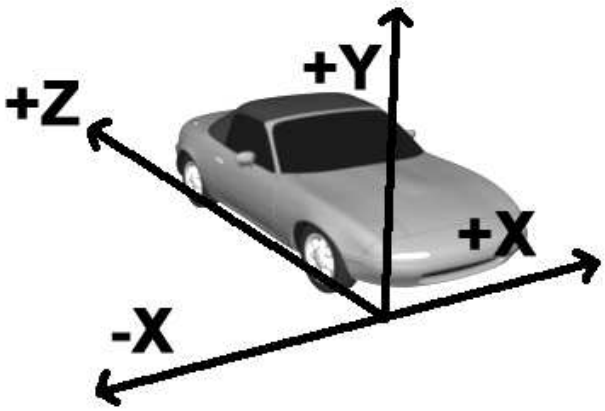
-Review in OGL with Play Animation
-Output a Quick Sequence, assemble, and review
-Render a low-resolution QuickTime or AVI movie
-Render full resolution frames
    Image sequence at 30 fps (60 fps for broadcast)
    Render larger than final size
    Render from project files on local machines

Appendix

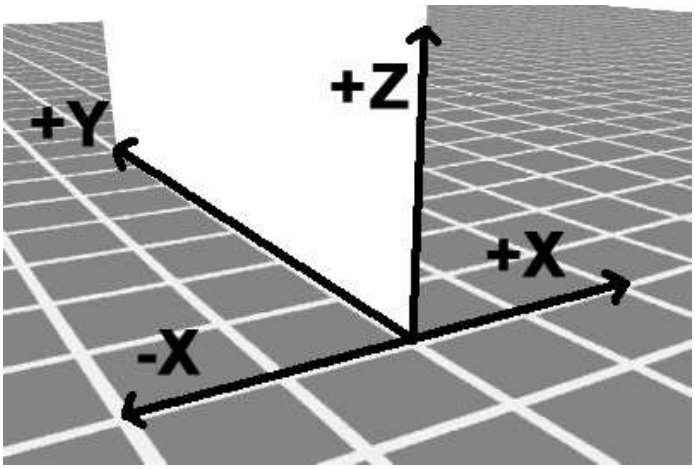
Land Cover: Environments: Key

Goal	• Understand Render Order and how Ecosystems render.
Required	• Land Cover: Environments discussion (*Land Cover: Environments* handout)
Render Order	• Open the **Environments** project in the **3DNA** folder. The DEM is about 28 km on a side with a grid cell size of approximately 92 m. Three color-only Ecosystems exist. • Edit Ecosystem Rules of Nature and Environment Ecosystem Render Priority to achieve the following: ◦ Red Ecosystem on slopes less than or equal to 5º at elevations below 8000 m ◦ Green Ecosystem in negative Relative Elevation areas at elevations above 8000 m ◦ Yellow Ecosystem everywhere else under 8000 m Key: • Environment Ecosystem Render Priority: Red, Yellow, Green • Red Ecosystem: Max Slope 5º, Elevation Line 8000 m • Yellow Ecosystem: Elevation Line 8000 m • Green Ecosystem: Max RelEl 0

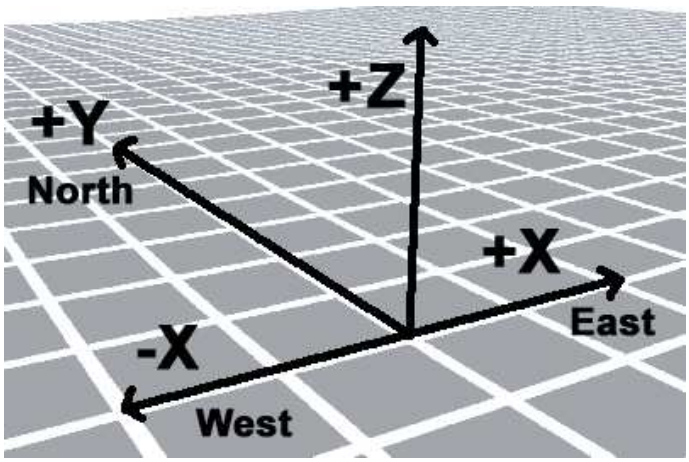
3D Object, Wall and Terrain Axes



3D Object Axes: Y is upwards (3D modeling convention).



Wall and Terraffector/Vector-Aligned Axes: Z is upwards (GIS convention).



Terrain Axes: Z is upwards (GIS convention).

Standard frames per second

Film	24 Frames per second
NTSC Video	30 Frames per second
PAL Video	25 Frames per second
Field Rendered Video	60 Frames per second

Standard (recommended) resolutions

Film	2000-4000 pixels wide height depends on film size
NTSC Video	700-725 pixels wide 480-485 pixels high
PAL Video	700-725 pixels wide 480-485 pixels high

Poster (2 foot by 3 foot)

1200-3600 pixels wide *50-150 dots (pixels) per inch
1800-5400 pixels high *50-150 dots (pixels) per inch

Magazine (or other print)	300 dots (pixels) per inch
HDTV 1080I standard	1920 pixels wide 1080 pixels high
HDTV 720P standard	1280 pixels high 720 pixels high