

WORLD MACHINE USERS GUIDE

Chapter 1: Concepts

1.1: An Introduction to Heightfields

Terrain is something that the computer is not naturally good at representing. Terrain is the Real World – it's natural, irregular, and vast. Computers deal better with the geometric, manmade, and small. Computers can represent terrain in many different ways. Just like **topological maps** in real life, the easiest way to store data about a terrain is by storing the data into a square or rectangular map. The most popular way to store this data is with a **heightfield** (also known as a **heightmap**). A heightfield is essentially a bitmap image that stores the elevations of a rectangular section of terrain. It looks something like the below:



The brightness of a pixel in the heightfield specifies the elevation. The brighter (whiter) it is, the greater the elevation of the ground in that spot. So you can see that there is a valley at the top-right in the heightmap in the image above. The size of the bitmap controls the amount of terrain information you can contain. A bigger heightfield can hold either a larger area, or a more detailed representation of the same area. For example, a 1024x1024 pixel heightfield contains four times more information than a 512x512 pixel one does. This means you could either double the extent of the coverage of the terrain in both directions, OR have four times as much detail in the same area of the terrain.

Heightfields have many advantages:

- Tools to use them are widespread
- They are reasonably efficient in terms of storage space
- They are easy for humans to modify and use.

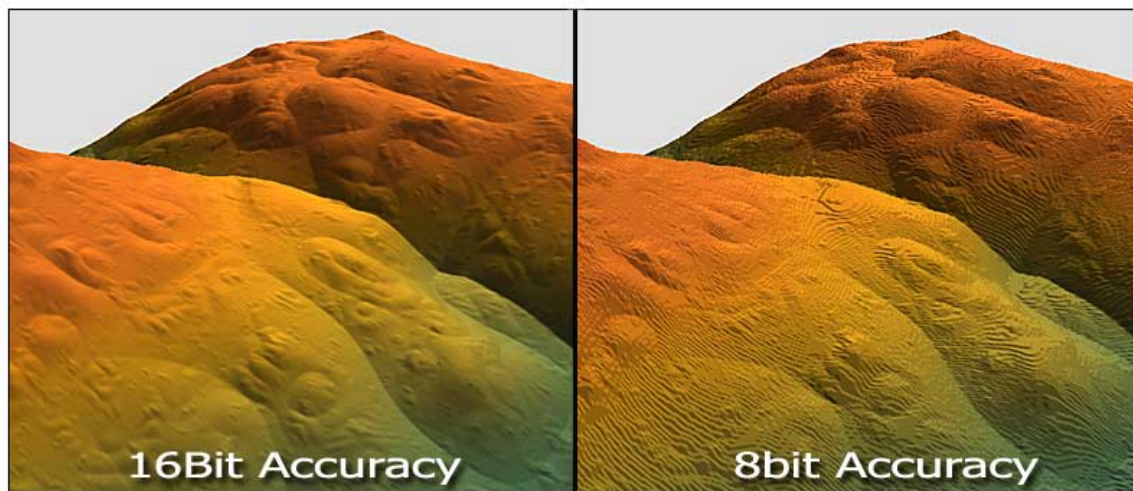
However, they also have two downfalls:

- Unless you use a high-resolution heightfield, they suffer from lack of detail.
- They only allow one height value at any (x,y) coordinate. This means that you cannot have things like caves or overhangs in the terrain.

World Machine uses heightfields to create and store terrain. Thus the output from World Machine can be used for many different applications: it can be fed to a rendering software package like [Terragen](#) or [POV-Ray](#); used as a map for computer games and simulations; or even used as the baseline for topological maps of fantastical places.

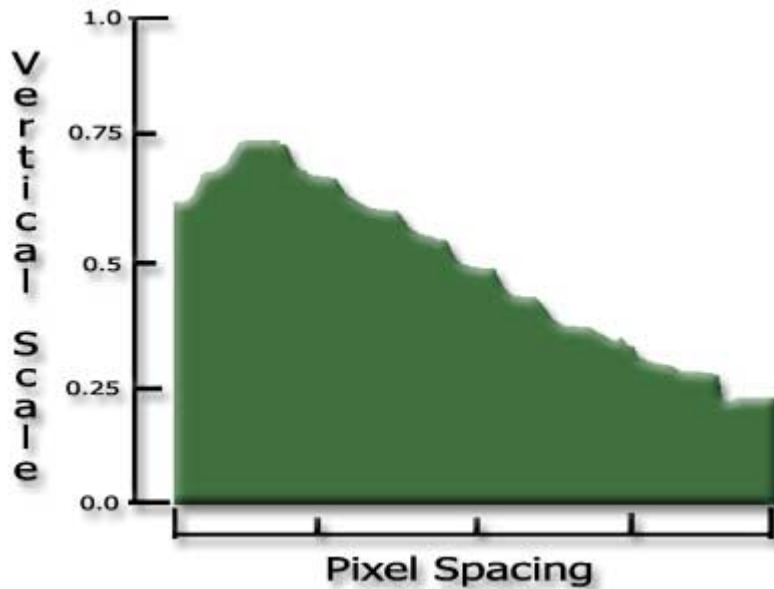
1.2: Terrain Scale and Representation

Let's take a closer look at how World Machine represents terrain. You could just use an image file, such as a Windows BMP file, to store a heightmap, but there are a few problems with that approach. The biggest one is that the BMP format contains only 8bits of brightness information per channel. 8bits of data can only hold 256 different values. This is fine for images, but when we use this for heights we can see ugly steps in our terrain called **quantization artifacts**. This simply means that the jump from one height level to the next is large enough to be noticeable - we need more than 8bits of data to describe smooth height changes. World Machine uses 32bits of precision internally to describe a height value. This means that a height value can be one of over 4 billion possibilities, which results in extremely high accuracy.



Note: Many file formats only support 8bits of accuracy; the File Output device documents which formats allow for 16bit or greater accuracy.

The height values inside World Machine are always kept at some fractional height value between 0 and 1. This means that a height that is half of the maximum possible would be 0.5; one quarter max elevation would be 0.25, and so on.



To convert from this internal representation to something more real world, World Machine scales the values to meters.

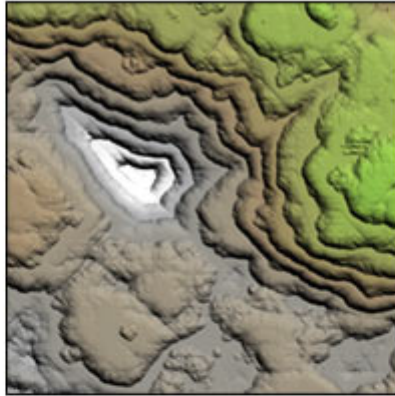
There are two scaling values:

Pixel spacing is the distance in meters between one pixel and the next in the heightfield; larger pixel spacing means the heightfield covers more “Real World” area. However this comes at a cost: a large pixel spacing means that the heightfield is *less detailed*. The heightfield covers more area, but with only the same amount of information, it’s impossible for it to look as good.

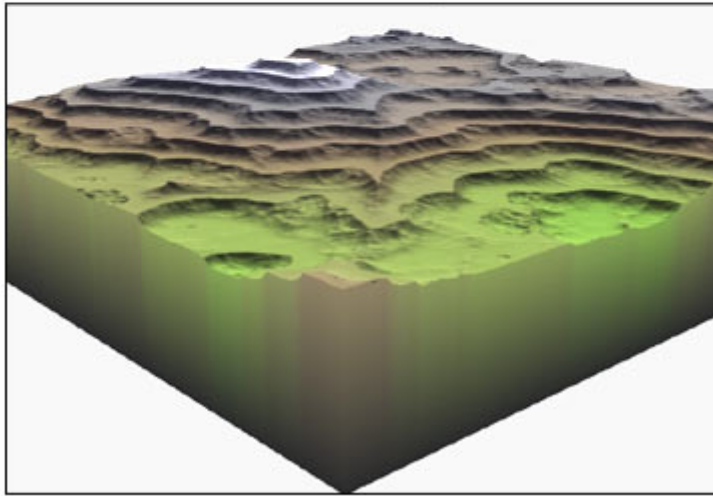
Vertical scale is how tall the tallest height value is. A value of 1200m, for example, means that a “highest peak” in World Machine that has a value of 1.0, would be 1200meters high in real life.

It’s important to note that these values in meters are only guides. The devices in World Machine itself don’t care if your mountains are mere foothills 300m high or rugged mountains 4,000m tall. A given height value will be treated exactly the same no matter the vertical scale. The only differences are in how the heights are shaded – and in how **you** look at them.

World Machine can show you what your terrain looks like in several different ways:



2D View



3D View

In a **2D View** (an overhead view, somewhat like a topological map), or a **3D view** (where your camera can be anywhere that a real camera could be). These two views are shown above.

1.3: Device Networks & Working with a Graph

Forget what you know about editing terrains. World Machine does things in a completely different way. This is the source of both its power and its complexity – it takes a bit to get used to thinking in a “World Machine” kind of way.

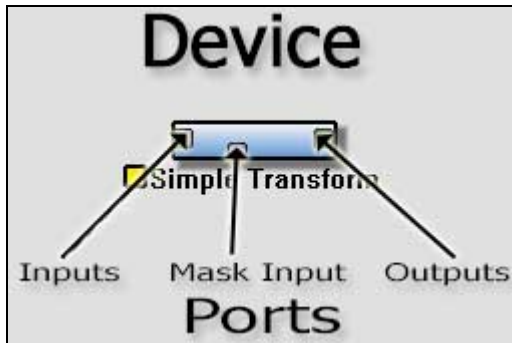
1.3.1: It’s all about the *Process*!

World Machine is essentially visualization for the terrain creation process. A World Machine world file is not the terrain, but the **process** that creates the terrain. Every step-by-step procedure you would act on in some other software has a visual equivalent in

World Machine. This focus on visualizing the process of creation is simultaneously very simplifying – and very confusing. So let's go through step by step just *how* the creation process is visualized.

1.3.2: Devices

Devices represent an *action*. They control the process of creating a terrain. In World Machine, devices are visualized as small, colored boxes:



A device has **Ports**. A port is simply a place where data can move in or out of a device. These can be divided into two main categories: **inputs** and **outputs**. Inputs are on the left side of the device, and bring data into a device to be acted on. After the action of the device takes place, the data is then taken out of the device via an output, on the right side. Lastly, Filter devices have a *mask input port*, the use of which is discussed in [Chapter 2.3](#).

There is one other type of port in World Machine, called a parameter port. These are located along the top edge of the device, and allow advanced users to adjust the settings of a device from a different one. Parameter ports are covered [later in this manual](#).

You can separate devices into three broad categories: In the World Machine system, terrains are:

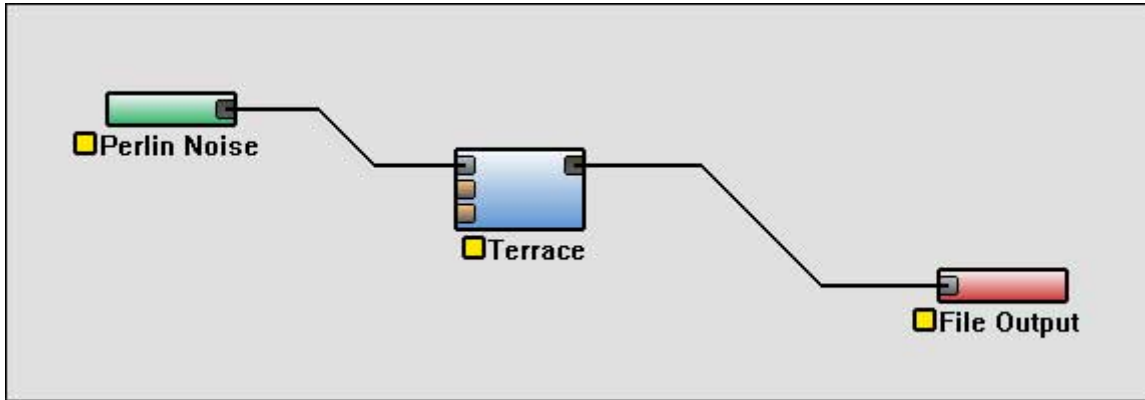
- Created** by **Generator** devices;
- Modified** by **Filter & Combiner** devices;
- Saved** by **Output** devices.

Each type of device has a different responsibility. Generators are devices that produce the basic terrain. The output of a generator can be either used directly, OR routed into the input of a Filter device to shape, change, and otherwise influence the terrain. Finally, Outputs are used to save the created terrain to disk.

1.3.3: Device Networks

Devices are wired together to form a **device graph, or device network**. This specifies what devices are to be used and how the terrain data should “flow” between the different devices.

Here is an example of a simple device network:



In World Machine a “world” is built in much the same way as an electric circuit is built up from components and wire. Wiring together different devices in interesting ways creates a terrain. But you don’t have to be an electrical engineer to use World Machine! Later, we’ll walk through the actual concrete steps of creating and using a device network. But for now, let’s focus on the concepts involved.

How do you “read” a device network? After all, at first glance they can be filled with many different devices, and look quite intimidating. Here are a few basic rules that should make it easier:

- 1) **Always start with a Generator** (green devices). World creation is always begun at these devices. By convention, many people put these on the left side of the work view as an organizational aid.
- 2) **Data moves one link at a time**. When a device has finished its action, it makes the results available on all of the output ports (the right side) of the device. The device linked to each output then takes that as its input, and the whole process starts again with that device. Thus, terrain information moves in a logical order from one step to the next.
- 3) **Data keeps moving**, and doesn’t stop until it reaches either an unconnected port, or an Output Device.

Let’s apply these rules to “read” the device network that was shown earlier.

Step 1) The Generator

On the left side you can see the green device that begins the network, a Perlin Noise Generator. This creates the basic terrain shape that we want. It then sends the terrain out to its output, which is then linked to the input of the Terrace device (a filter).

Step 2) The Filter

The Terrace device takes the terrain the generator has made and acts upon it, creating a terrain that has a terraced, multi-level look. It then makes this available on its output.

Step 3) The Output

The File Output device takes the terrain from the Terrace and turns it into a file on disk. The terrain is now in a form that can be read by a 3D rendering program, or anything else that can read a heightfield!

1.3.4: A Focus on the Process

One of the biggest and coolest concepts to grasp is that with World Machine you're not just creating some particular terrain. By creating the component devices and wiring network, you're creating the procedures with which that terrain is produced. That same procedure – the types of parts and how you've wired them - could then be used over and over again to create different terrains all sharing the same feel. What's more, you can at any time change any aspect of the terrain at any stage of the creation process – and your changes will be acted upon by everything that comes after.

For example, if at the end of a long creation process you decide you really wanted smaller mountains instead of large ones. In a normal terrain editor, you'd be out of luck. All of your changes were based upon that particular starting terrain and there is no way to change its basic characteristics without losing all of your changes since. With World Machine, you could change the details of the terrain right at the very beginning of the creation pipeline, and all the modifications you've been carefully making aren't lost at all – just applied to the new terrain base.

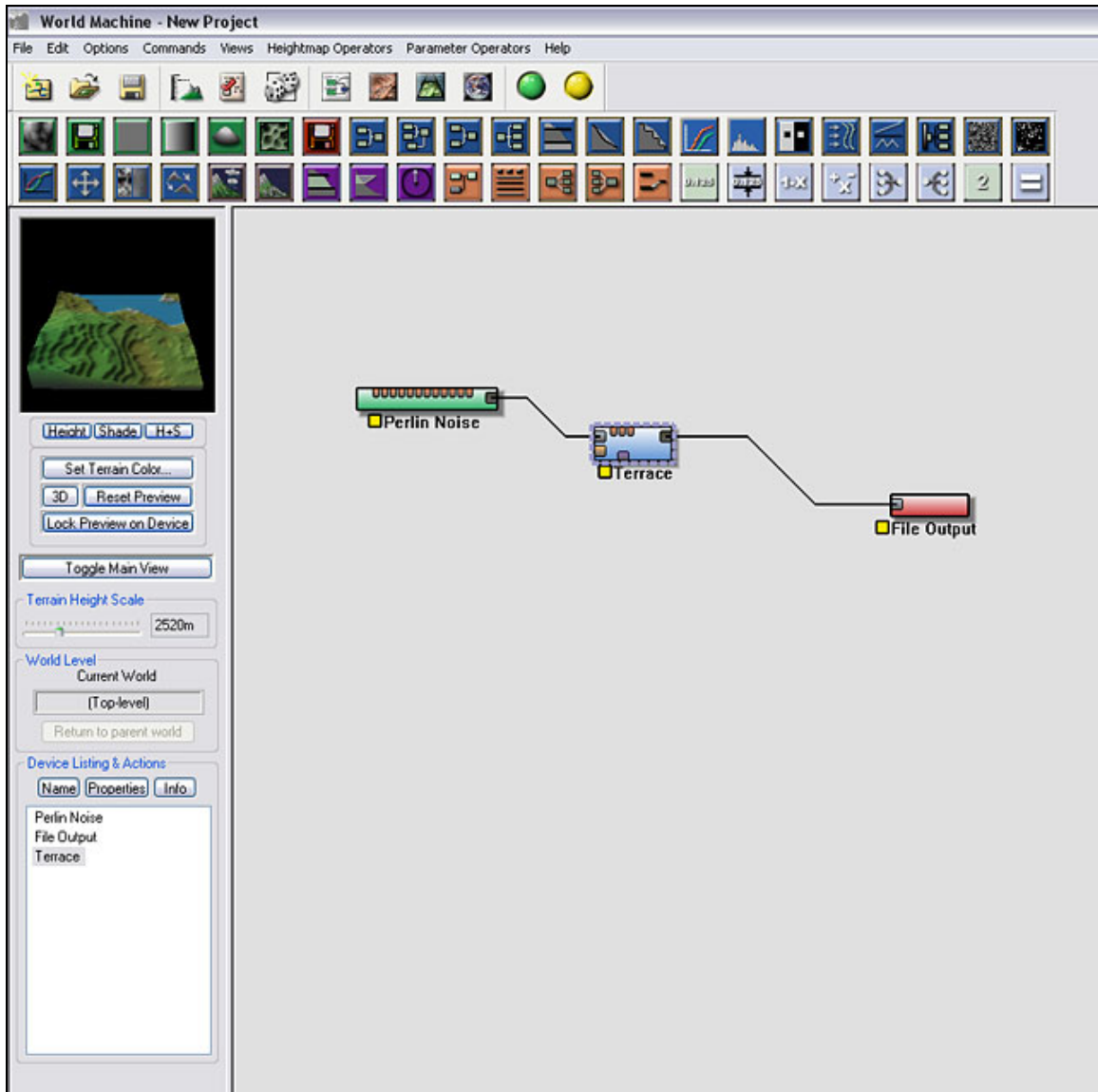
Chapter 2: Tutorials

2.1: “Help! Devices? Networks? What is all this stuff?”

In this tutorial, you'll be guided to the sections of this manual you will need to read to understand how to operate the basic functionals of World Machine. We'll also take a look at how to modify simple terrain networks.

Before you start, it's highly recommended that you **read [Chapter 1](#) thoroughly**. It contains important information that will help you understand how World Machine works - like what in the heck a “device network” is.

Done reading that? Great. Let's continue.



Above is a view of the working environment in World Machine.

Read [Chapter 3.3](#) for assistance in using the views above!

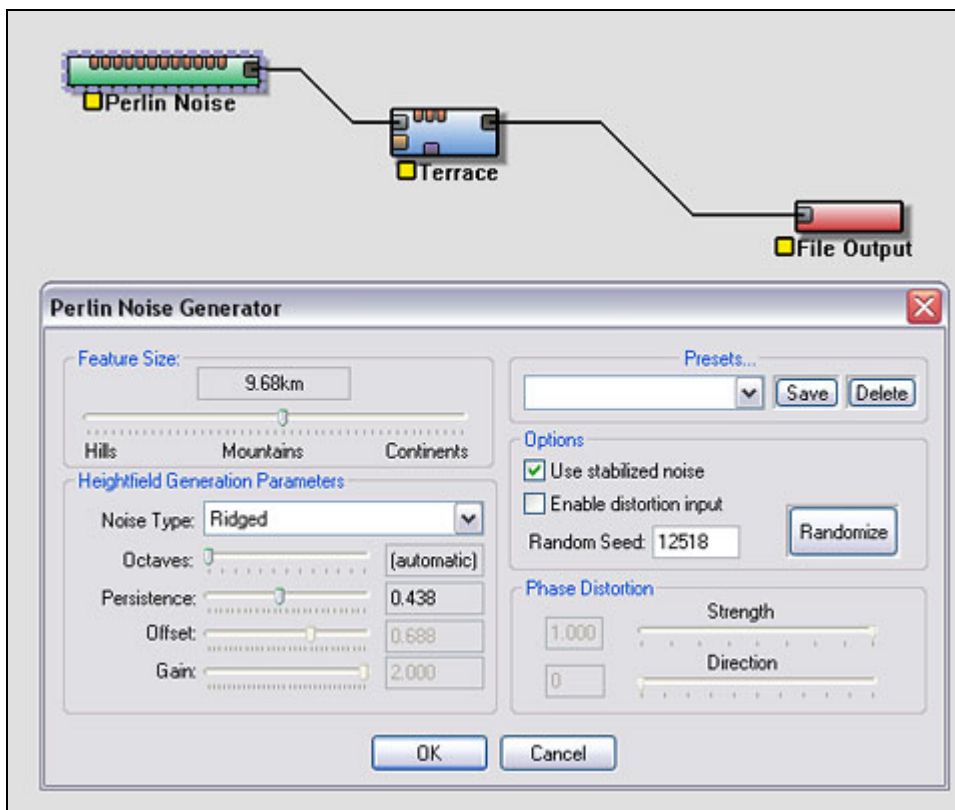
The critical components that you need to know about are:

- 1) The [Device Workview](#). This is the main window that contains the devices, located on the right side of the World Machine program window and defined by the neutral gray background.
- 2) The [Part & Command bars](#). The toolbars above the Device Workview and Leftside toolbar and below the main menu.
- 3) The [Leftside Toolbar](#). The toolbar on the left contains the preview window and other useful controls.

The most important operation you can perform in World Machine is editing a device's parameters. To do this, simply double click on the device in the workview. This will pop up a dialog box that will show you all of the various options for controlling that device.

The device reference has detailed information on what each control will do. In addition, many devices have tool tip text that will appear if you hover the mouse over the given control.

So, let's actually do something! Let's modify the perlin noise generator that is in the default world. Since generators create the terrain, modifying the generator is an easy way to modify the basic look of the world. Double click on the device to expose its parameters.



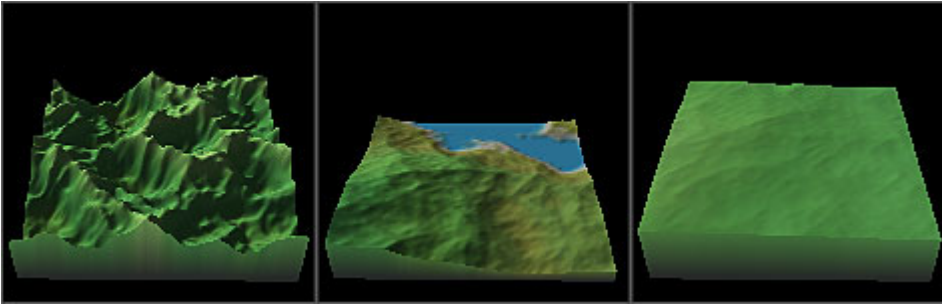
As you adjust any of the above settings, you will see the preview in the leftbar change to show you what the resulting terrain looks like.

The most important controls on this dialog are:

1) Feature Size

The feature size controls how far apart the peaks of this terrain shape are. Close together peaks may be used for sand dunes or hills, while at the other extreme a very large feature size can be used to define continents.

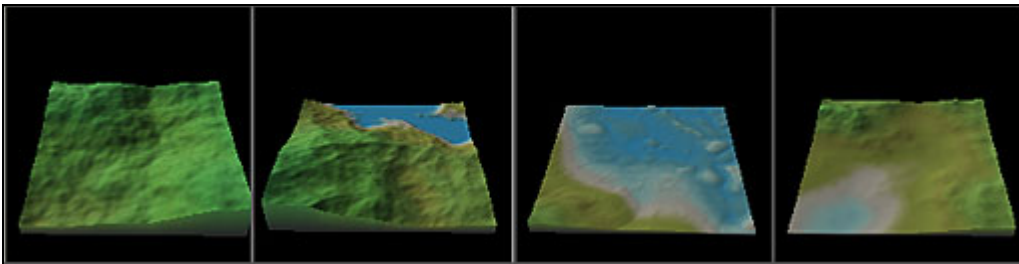
Some examples of adjusting the Feature Size:



2) Style (Noise Type)

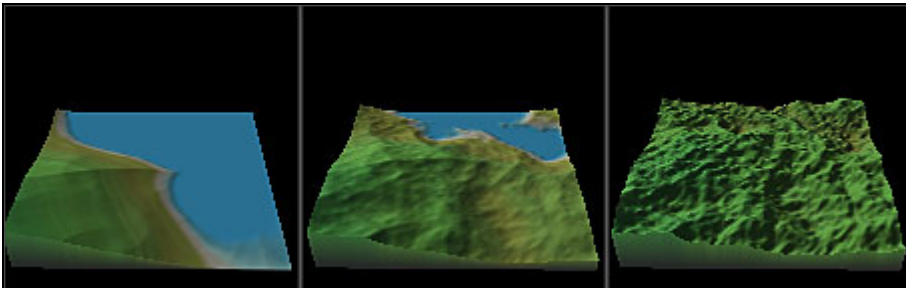
The style of perlin noise has a profound impact upon the look of the terrain. The device reference for Perlin Noise shows the various shapes that are produced.

Some examples of adjusting the Terrain Style:



3) Persistence

The persistence of a noise generator controls the relative amounts of low and high frequency noise. In non-geek-speak, this means that a low persistence will generate a very smooth terrain, whereas a high persistence will be very spiky and jagged. The default value of 0.4 to 0.5 is appropriate for a “typical” terrain.



Continue reading to learn about performing basic World Machine operations on your terrain.

2.2: How do I apply an effect to a terrain?

To use any of World Machine's extensive set of filtering devices, follow the steps below:

1) Make sure that you are in the Device Workview.

You can do this by clicking the Device Workview icon from the toolbar, or hitting Ctrl-1.

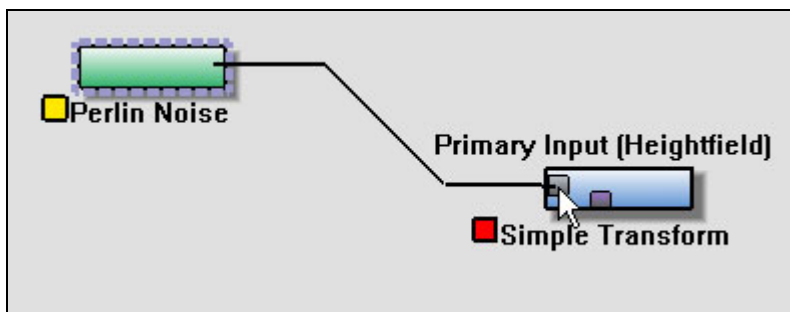
2) Pick out the effect you want to apply.

You can do this by either choosing a device from the Heightfield Operators menu, or the parts toolbar. Blue or Brown devices are filters; these are extremely simple to use. To peruse the kinds of effects available to you, look in the Filters section of the Device Reference. Click once on the part in the toolbar or menu, then click again in the workview and the device will be placed there.



3) Wire the new device into your network

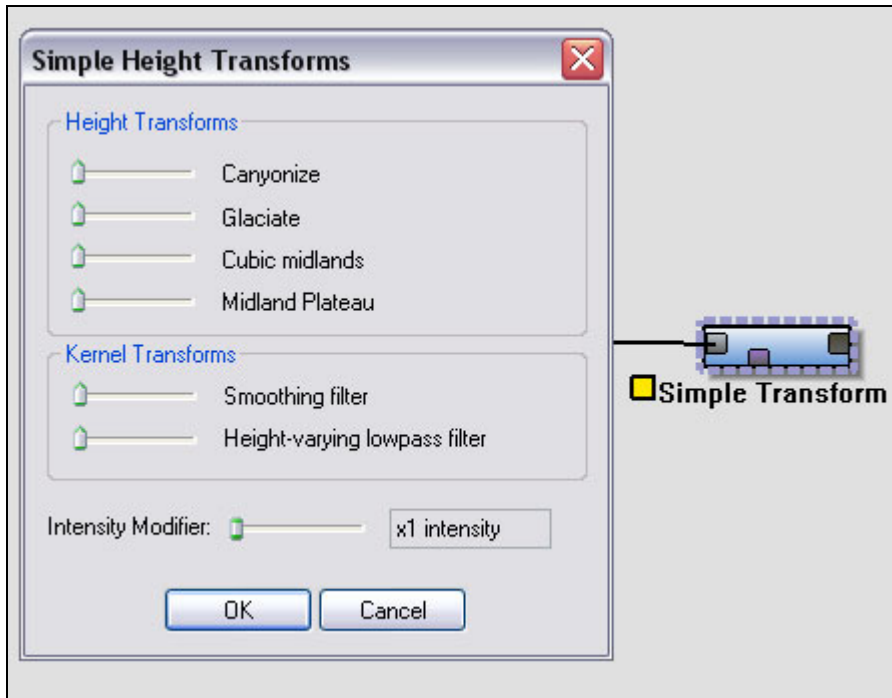
If you want that device to be the only effect applied to the terrain, make sure that it is the only device between the Generator (green) and the Output (red). To do this, you can disconnect any existing wires by clicking on one of the occupied ports to rewire it. A wire will become attached to your mouse. Then click on the Primary Input port of the filter you wish to use. The two devices will become connected together, and if all is well the status light for the new filter will turn yellow.



If you wish to chain together several filters and have them all affect the terrain (the most common scenario), simply take the output of one filter and wire it into the input of the next. It's that simple!

4) Adjust the settings for the new device

Double click on the device you have just connected. In the dialog that appears, select the settings you want to use; as you adjust the parameters, the preview in the left side view is changed in real time to reflect them.

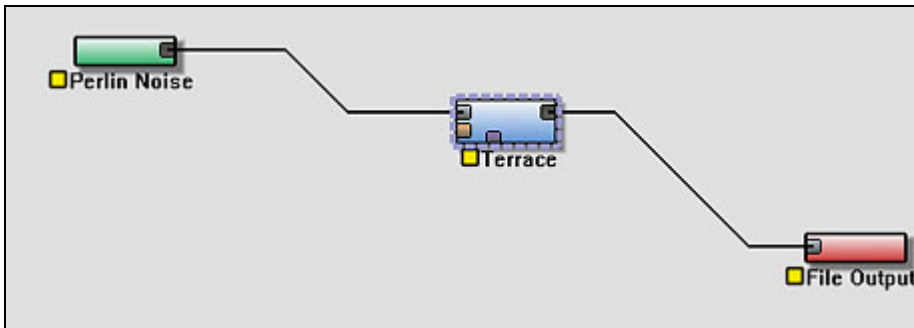


For many devices, you can hover the mouse over the parameter to see a brief description of its use in the tool tip window that will appear; or go to the Device Reference for a fuller description of each device.

2.3: How do I selectively apply an effect to the terrain?

Sometimes you want to apply a given effect only to specific parts of the terrain. Maybe you want erosion to only happen on the mountains, leaving the lowlands untouched. Or maybe you want to terrace only certain regions in your map. The possibilities are endless. Fortunately, there are several ways to apply effects to only a certain portion of the map. This mini tutorial will describe how to achieve this.

Follows the steps in [2.2](#) above to first setup your effect device into the network.



Then do the following:

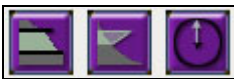
1) Decide how you want to determine what areas are affected.

If you want to have the effect only appear in certain geographical areas that are unrelated to the actual features of the main terrain, then you can use any generator to drive the mask input of the effect device – skip to [step 4](#).

But what if you want to apply the effect based upon terrain height, slope, or compass heading? World Machine uses a class of devices called **Selectors** for this purpose. Let's walk through that scenario below.

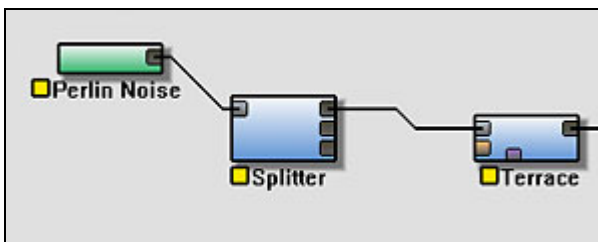
2) Create the Selector network

Selectors take an input terrain and produce a mask that shows the areas of the terrain that fall within the criteria you specify. Purple devices in the parts toolbar denote selectors.

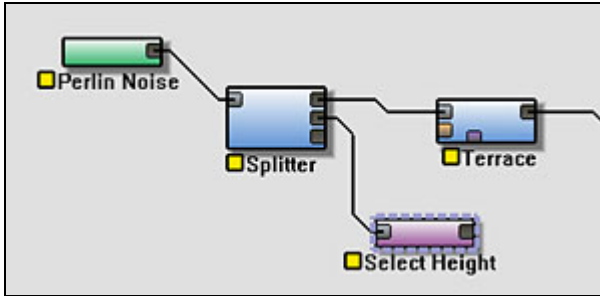


From left to right above, they are **Height Selector**, **Slope Selector**, and **Angle Selector**.

To use a selector, we will need to split the generated terrain before it reaches the Terrace device. Place a splitter device into the world and connect the generator to the input of the splitter, and the Terrace device to the first output, as shown below:

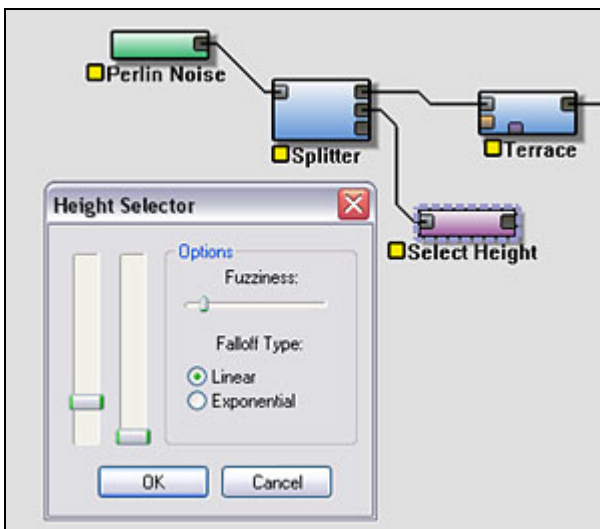


Then add a Height Selector device to the world and hook it up to the second output of the splitter, as shown here:



We're almost there! Now we need to setup what areas of the terrain we want to select with the Height Selector.

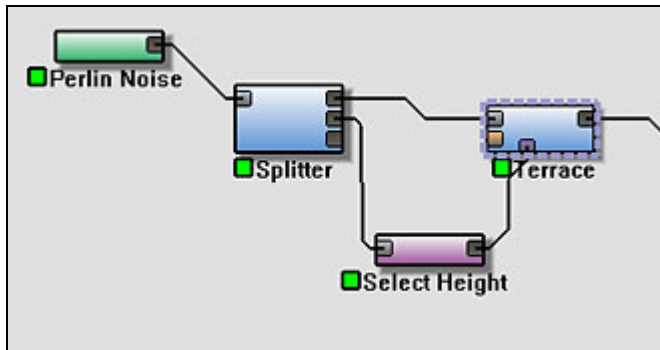
3) Setup the Selector device



The Height Selector configuration dialog allows us to set the range of heights that we are creating a mask for. The area between the two vertical sliders defines those heights that will be fully selected. Heights outside of the range will be either completely unselected, or partially selected, depending on the "Fuzziness" slider.

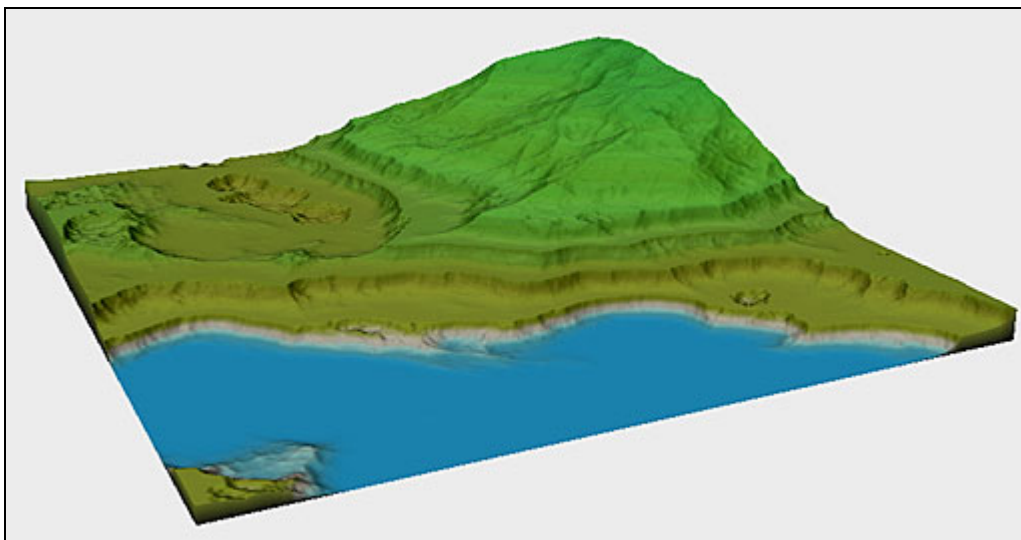
4) Wire the selection into the filter device

Every filter device has a "Mask Input" for selectively applying the effect. This is the purple-gray input along the bottom edge of the device:



Wire the output of your selection device into this port, and you will see the device preview change to show that the filter is only affecting the selected areas. If necessary, freeze the preview on this device, then go back and change the selection device if the area that has been affected is not what you desired.

Build the world or examine the preview: You can see that the terrace has been applied only to the lower areas of terrain:



2.4: Saving a terrain

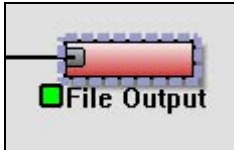
After creating an interesting terrain, the next step is to save it to disk so that you may then use it in your rendering software.

You cannot simply save a heightfield file from File->Save, as you might first try! Remember: World Machine world files store the **process** of creating a world, not the world itself. Thus, to save a heightfield file, you need to use a device that represents the action of saving a heightfield to disk – the **File Output** device.

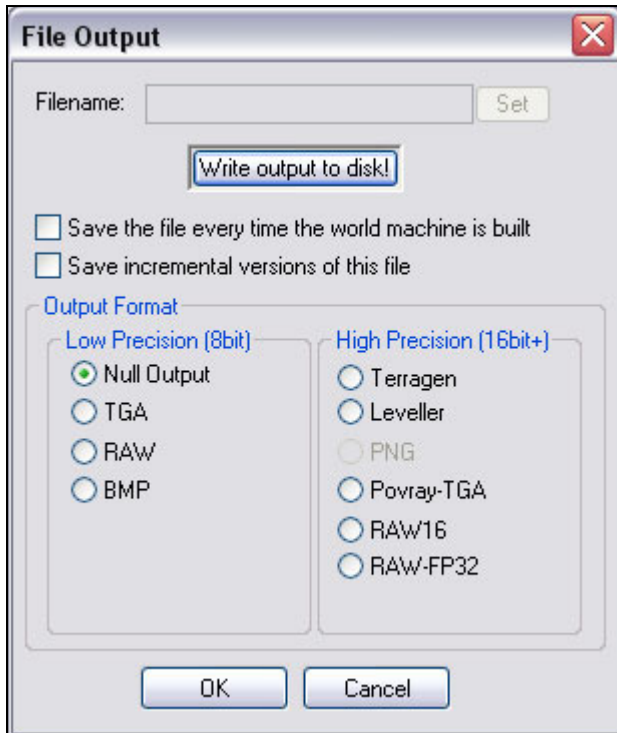
The File Output Device

Create the file output device by selecting it from the toolbar or Heightfield Operators menu. Then click in the workspace to place the device. Wire your terrain into the Primary Input of the device, and build the world (The Green toolbar button, or Commands->Build World from the main menu).

The File Output device will then look as shown below:



Double click on the device to get to the properties dialog, and you will see several options:



You need to do three things to save a heightfield:

- 1. Select an Output Format:** You must select the type of file you wish to create. The High Precision formats are preferred; see Chapter 1 for more details on heightfield precision.
- 2. Select a Filename:** After selecting an output format, push the “Set” button to set the filename and folder where the output will reside.

- 3. Write the File:** If you've already built the world (the File Output device status is Green), you can push the **"Write output to disk!"** button to save the file. Otherwise you must build the world before you can save the file.

TIP: By checking the box labeled "Save the file every time the world machine is built", the File Output device will automatically save its output every time you build the world.

2.5: Importing a terrain

In many cases, you may want to load a terrain into World Machine for processing. Perhaps you have a DEM heightmap of some real-world location that you want to run through erosion and other filters. Or, a custom-drawn base shape that you want to use as a mask or as a basis for more complicated terrain shapes.

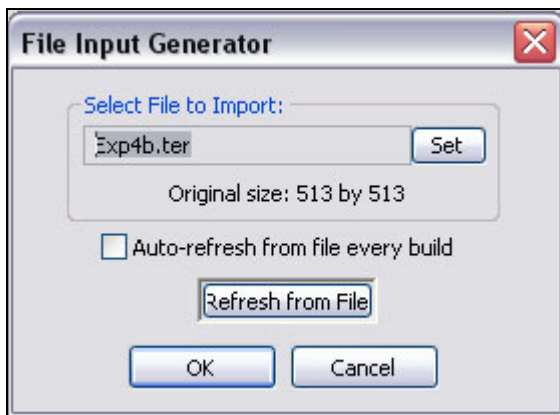
Once again you cannot simply open a heightfield file from the File menu, for the same reasons as in [2.4](#). To open a heightfield file, you need to use a device that represents the action of opening a heightfield from disk – the **File Input** device.

The File Input Device

Create the file input device by selecting it from the toolbar or Heightfield Operators menu. Then click in the workspace to place the device.



Double click on the device to get to the properties dialog, and you will see several options:



By clicking on the **"Set"** button, you can select a file to open.

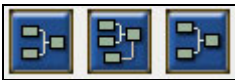
If you check the “**Auto-refresh**” box, World Machine will reload the file every time you build the world in WM. By using this, you could actually have an input file that is being exported by the very same network!

If you’ve changed the file on disk and you want World Machine to reload the contents, you may click the “**Refresh from File**” button.

Note that currently terrains are always scaled to fill the entire current world size. This means that if you pan the terrain (in Explorer mode, for example), you will get incorrect results. WM give notices of this by placing a red exclamation mark by the device icon, signifying that this device is not "stable" in Explorer.

2.6: Combining Terrains

Very often we want to combine several terrains into one. World Machine has three devices for this purpose; each does things in a different way. Collectively they are known as **Combiners**.



From left to right, they are the **Combiner**, **Chooser**, and **Arithmetic Combiner**.

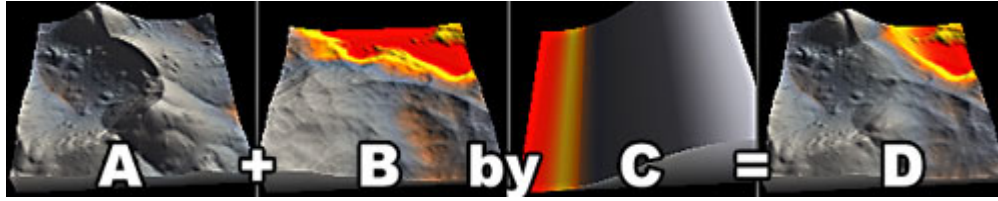
Combiner Types:

- **Combiner**: The most used combiner type; the combiner has two inputs and allows you to mix the two terrains in different ways. The most commonly desired operations are **Add**, **Multiply**, **Max**, and **Min**. Each of these mathematical operations has an artistic effect upon the terrain, shown below. See the device reference for further details on the other styles.



The character of the input terrains will heavily influence what the combination looks like.

- **Chooser**: The Chooser has three inputs: **A**, **B**, and **C**. As the name implies, the device allows you to *choose* either terrain **A** or **B**, based upon the value of **C**. This concept is illustrated below. It is very useful for a variety of purposes; such as creating areas of distinctly different feel in a terrain or applying an effect to only certain areas.



- **Arithmetic Combiner:** This is a special purpose device. It functions very similarly to the Combiner, with one important exception: If you combine two terrains in Add mode in the Combiner, you will get back the average of the two. If you combine them in the Arithmetic Combiner, you will have the actual addition of the terrains -- any values that go above 1.0 are clipped to 1.0. Likewise for subtraction. This makes this device very useful for situations where you need to add or subtract terrains with mathematical precision.

2.7: How can I achieve some particular effect?

One of the most common questions is "How do I achieve *some terrain effect* in World Machine?"

The answer is: As an artist, figuring out how to recreate or model some given terrain type is one of your challenges! World Machine is designed to be very flexible and powerful in how you can create things; just as there are an infinite number of ways to create an oil painting of mountains, so are there many ways to create similar-looking terrain in World Machine.

With that said, there are many resources at your disposal that may get you most or all of the way to what you envision. Some of the best resources available are macros made by the community, which are often shared freely and may achieve the effect that you're looking for with no further work required on your part. Read the section of this manual on [Using and Installing Macros](#), and then visit the [World Machine Community Forum](#) for more details.

If a macro doesn't exist that does what you want, you may also try looking for tutorials or Example World Machine World Files created by the community. Links to these are often posted in the forums. If none of these resources precisely fit your requirements, then you will need to model the terrain yourself.

There are many ways to discover things in World Machine. Knowledge of what kind of output each generator and filter tends to create is helpful. Consult the device reference for more specific knowledge about each device. Sometimes you will simply make happy discoveries almost by accident, and remember them for future use. While this is certainly helpful, "Hope for a discovery" is not a very useful guideline for creating terrain. Instead, it may help to use the following general process, illustrated with a specific example:

Step 1) Break down what you want into specific features

Say you want to create a canyon-like terrain. What do canyons look like? They usually are carved out of the surrounding terrain by rivers. The canyon is a deep, steep-walled valley. The canyon will tend to wind and meander. There may be several apparent layers or terraces where the river had to work against harder or softer rock. In nature the process is done entirely from erosion, so we likely are going to be using an erosion device at the end to get the same kind of feel. But we're getting ahead of ourselves...

Step 2) Decide how best to emulate the most important features in World Machine

It's difficult to simulate a river running for eons of geological time. We might be able to simulate the carving of a river by subtracting out a river shape from a terrain, but that could be fairly complicated.

Let's approach it from a different angle. If we take the typical output from a Perlin Noise generator, and expand it vertically so that the terrain has steep walls and relatively level areas at the top and bottom, we might end up with something like what we want!

Step 3) Always start from the most basic and work to the most specific

It's almost always the best idea to start developing the overall shape of the terrain first. After the general forms are shaped to your satisfaction, you can add specific effects and nuance. Failure to work in this order can often lead to a lot of frustration and can result in a terrain that just doesn't "feel right".

Step 4) If at first you don't succeed....

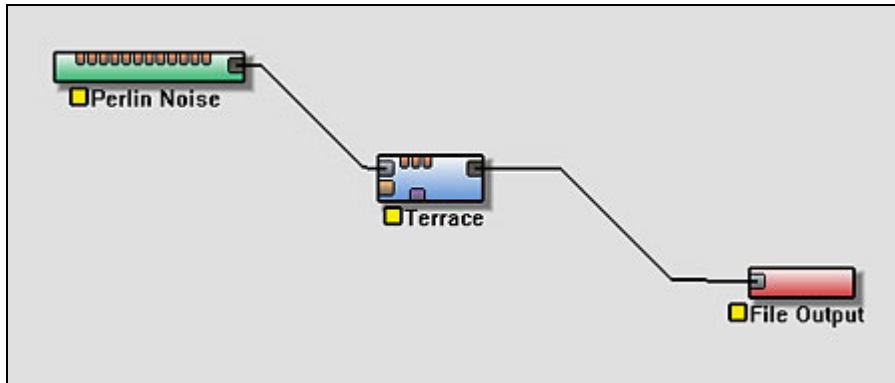
It's almost certain that you won't be able to create what you see in your head on the first try. Most good World Machine terrains are the result of trying and retrying different ideas and methods until something that looks like what you want appears. There are many, many ways to achieve similar effects! Just as in painting, don't expect the Mona Lisa on your first day; but you will find a way to produce at least part of what you desire. Lastly, never forget to both use and contribute to the World Machine community. Using well-made macros from other users who have figured out how to achieve certain effects is a great way to broaden the range of amazing terrains that you can create.

2.7.2: Example of the Terrain Process

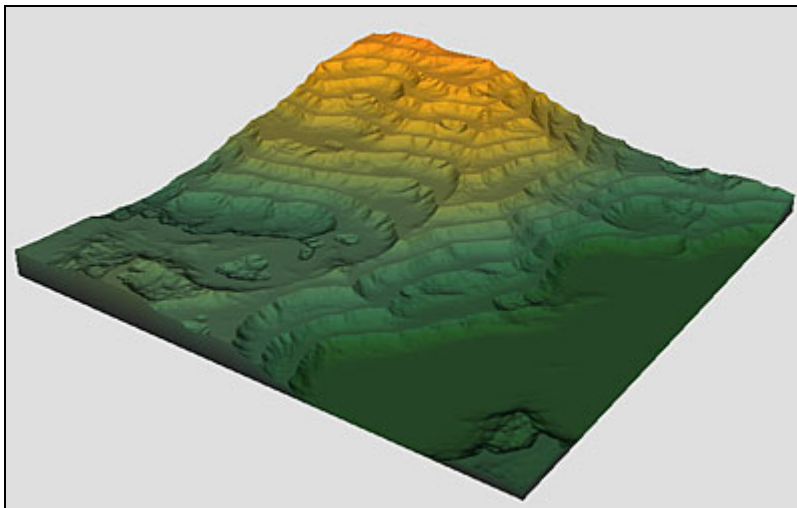
Let's apply the steps above to go ahead and create that canyon-type terrain that was discussed earlier.

2.7.2.1: Creating the Terrain

There is no special magic required here, so let's just use the default perlin noise generator from the startup world. In fact, when we were looking at the features that we wanted, we also mentioned terraces; so let's leave the terrace device in too! So now we have the following:



Which looks like this:



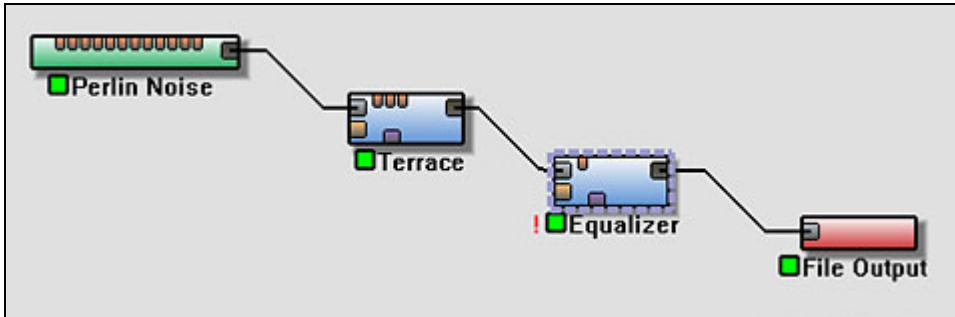
Doesn't look like a canyon at all yet, but just wait...

2.7.2.2: Getting into Shape

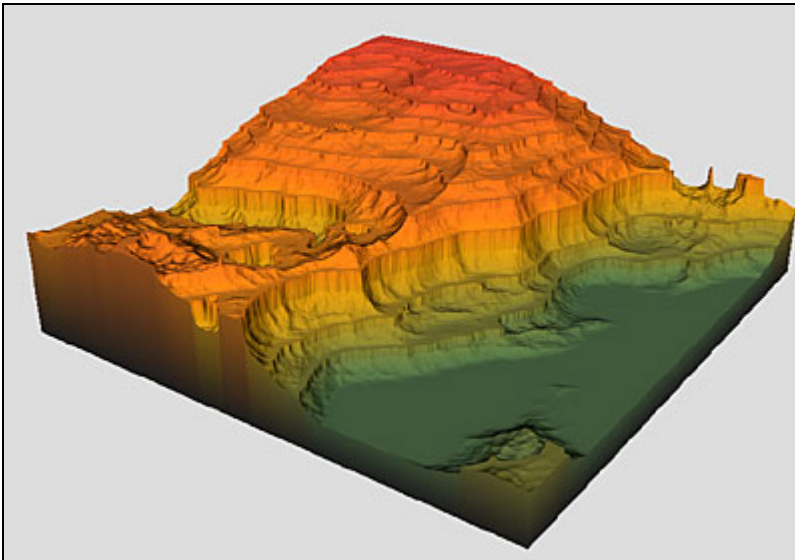
So, we need to change the relative shape of the terrain, move a lot of the terrain to the extreme top and bottom and leave the middle area steep.

There are many, many ways to achieve this step. We could use the Simple Transform device and set the Glaciation and Canyonization to maximum, which would. Clearly, some experimentation can be done here to find what works well.

There is one device that is almost perfect for our needs: the “Equalizer” device. What does it do? It expands the terrain so that each height is approximately equally represented in the output. That will push a lot of the land that’s currently at the middle heights out to the extremes. Here is the network with the Equalizer wired in, and the resulting output:



Which looks like this:

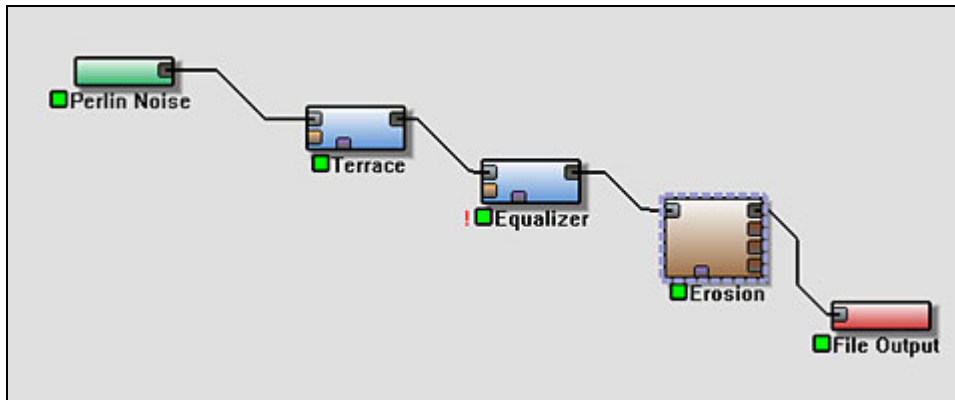


Who would have thought that one device could do so much? This is almost exactly what we want. As a bonus, the evenly dispersed terraces that we had earlier have been spaced out and compressed by the Equalizer device, giving a very nice, realistic canyon feel.

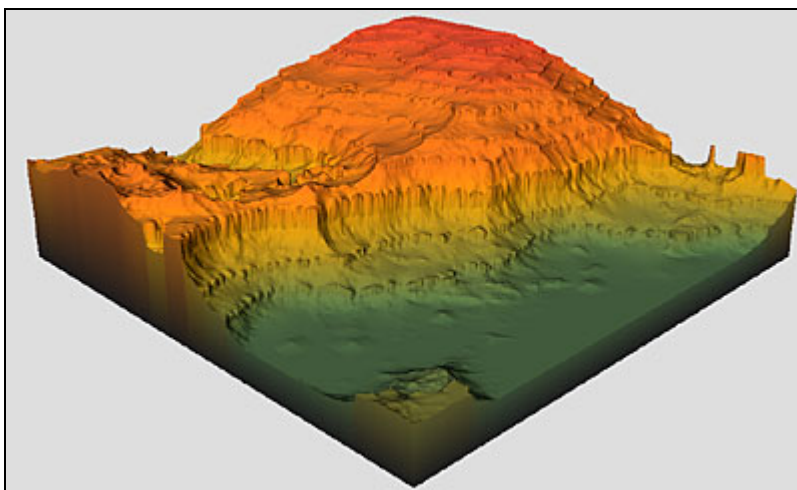
2.7.2.3: Let Nature Work

Finally, we'll apply some erosion, set to the preset named "Good with Terraces".

Here's the network:



And here's the result:



The end result is a pretty nice looking canyon! It also happens to be the example file "Sweet Canyon Mesas" included in the Examples folder with World Machine.

We could do lots more with this if we wanted to. Perhaps there are areas of different erosion, or outcroppings of a different type of terrain; maybe the canyon is on an alien planet with strange looking rock formations. Only your imagination limits what else you could apply.

Chapter 3: Menus, Views, and Dialogs

3.1: Menus

File Menu Commands:

New	Create a new world
-----	--------------------

Open	Opens an existing world from a World Machine file (.tmd)
Import Devices	Add the devices from a different world file to this one
Save	Save the opened world using the current file name
Save As	Save the opened world using a new file name
Save Viewport As	Save an image file to disk of the current view
Run Automation	(WM Pro Only) Run an automation script file

Edit Menu Commands:

Cut	Deletes the currently selected devices from the world and places them in temporary storage for pasting elsewhere
Copy	Copies the currently selected devices to temporary storage.
Copy Heightfield	Copy the output heightfield from the current device to the Windows clipboard in Daylon Graphic's HF-Clip format
Paste	Paste devices back into the world from temporary storage
Delete Device	Permanently delete a device from the world
Select All	Select all devices in the current world

Options Menu Commands:

Preferences	Set options and preferences for how you interact with World Machine
World Size	Control the resolution and world size of the rendering box
Landscape Colors	Set the color table used to shade the heightmap view

Commands Menu Commands:

Set device name	Set the name of the currently selected device
Set device properties	Access the parameters and properties of the currently selected device
Lock preview on device	Freeze the Leftside preview on the currently selected device. This allows you to make changes to parameters on a parent of the locked device, and view the changes on the frozen device.
Disable device	Temporarily stop a device from being able to build. All devices that depend on the output of this device will not build. Useful for temporarily disabling parts of the network.
Convert devices to Macros	Take the currently selected devices and move them into a macro world
Save device to Library	Save the currently selected macro device to the library on disk
Build World	Build the world and create all heightfields
Build World to Current	Build the world only up to and including the current device

Randomize World Changes the random seed for all generators. This will change the specific features of the terrain but retain the same overall settings and thus the same feel.

Views Menu Commands:

Device Workview View the device network
2D View View the output of the current device as a 2D Overhead view
3D View View the output of the current device from the 3D View
Explorer View [Explore](#) the larger world created by the current device

Heightfield Operators Menu Commands:

Generators Access the list of generators available to add to the world
Combiners Access the list of combiners available to add to the world
Filters Access the list of filters available to add to the world
Natural Filters Access the list of natural filters to add to the world
Selectors Access the list of selectors available to add to the world
Outputs Access the list of outputs available to add to the world
Utilities Access the list of utility devices to add to the world
Macro from Library Load a macro from the macro library on disk

Parameter Operators Menu Commands:

Parameter Operators Access the list of parameter operations available to add to the world
Scalar Operators Access the list of scalar parameter operations available to add to the world

3.2: Toolbars

3.2.1: Command Toolbar

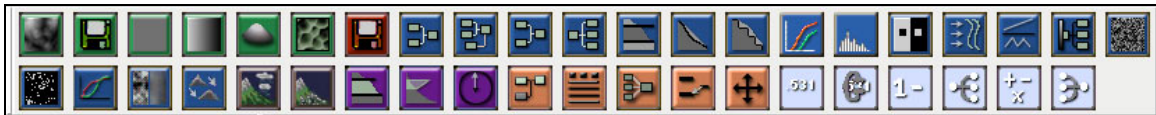


The Command Toolbar contains the most-frequently accessed commands from the menus. From the left they are:

[File New](#)

[File Open](#)
[File Save](#)
[World Size](#)
[World Machine Program Preferences](#)
[Randomize](#)
[Device Workview](#)
[2D View](#)
[3D View](#)
[Explorer View](#)
[Build World](#)
[Build World to Current Device](#)

3.2.2: Parts Toolbar



Each icon in the toolbar represents a device available for placement into the world. Hovering the mouse over an icon should bring up a tool tip naming the device. To place one of the devices into the world, click on the icon for the device and then click the location in the world where you wish to place it at.

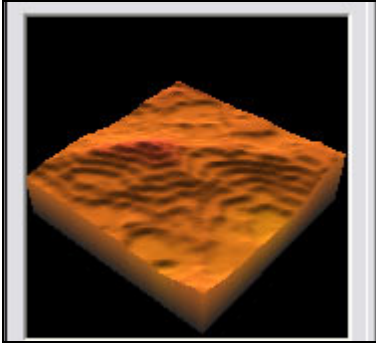
Note: If the toolbar is grayed out, it simply means that the [Device Workview](#) is not the active window. Click in the workview to make it active, and the toolbar should no longer be grayed out.

3.3: Views

3.3.1: Leftside view

The “Leftside view”, as it is called, is the toolbar running vertically along the left side of the screen. For clarity, we will examine each section of the toolbar by itself.

3.3.1.1: Terrain Preview Window



This window allows you to view a small, preview version of the current terrain area before it is built. This window is updated in real-time as you adjust device settings, allowing you to quickly see the effect your modifications have on the terrain.

The preview window can be set to either 2D or 3D modes. Depending on the mode, you may be able to perform different actions, shown below. To toggle the preview mode, click the “**2D/3D**” button below the preview window.

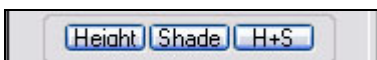
Click dragging will perform the following actions:

2D: You may change the direction of the current terrain lighting in the preview area.

3D: You may rotate and zoom the view to find a new viewing angle of the terrain. In addition, you may change the direction of the current lighting of the terrain.

The exact operation performed when you click and drag in this window depends upon your [view navigation options](#).

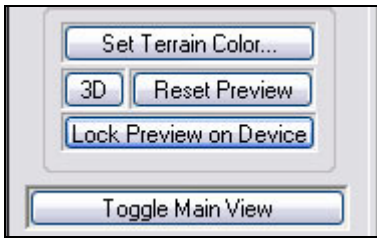
Shading Buttons:



The three buttons right below the preview window allow you to change how terrains are shaded in World Machine:

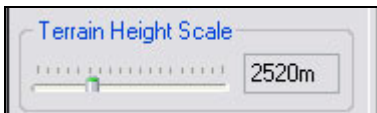
- **Height:** Do not shade maps; Assign color by height only.
- **Shade:** Shade by terrain features (diffuse lighting)
- **H+S:** Assign color by height and also shade the terrain features

3.3.1.2: Leftside Control Buttons



- **Set Terrain Color:** Choose a color scheme for the terrain. This is a cosmetic choice only and will not affect the terrain in any way.
- **2D/3D:** This button toggles the preview window between 2D and 3D display modes.
- **Reset Preview:** Resets the lighting and camera angle of the preview window to default. Useful if you ever “get lost”.
- **Lock Preview on Device (*f hotkey*):** This very useful function allows you to ‘freeze’ the preview window onto a device other than the currently selected one. For example, you may wish to freeze the preview onto a terrain filter device, and then go back and modify the settings of the generator device and see the *filtered* changes in real-time. Toggling the lock button again will disable the preview freeze.
- **Toggle Main View:** This button will toggle the display in the main window between the Device Workview and the last active Viewing mode. *Right-clicking on any empty region in one of the other views will also accomplish this.*

3.3.1.3: Terrain Height Scale



Adjusting the Height Scale slider will control the maximum possible height that a terrain can reach in the world. All terrain features are vertically scaled by this height. See [Chapter 1](#) for more details on the Height Scale in World Machine.

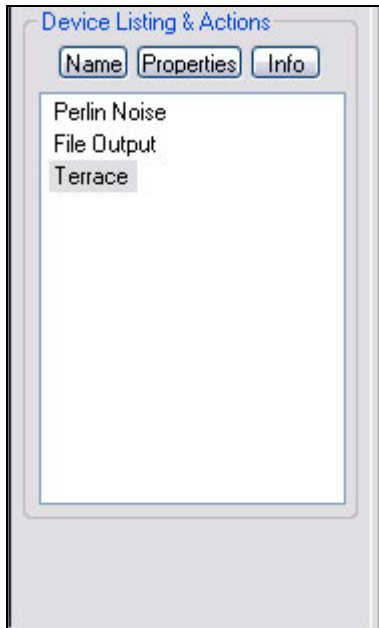
3.3.1.4: World Level



The World Level display is only useful when dealing with Macros. It shows the name of the current Macro being edited, if any. In addition, the “Return to parent world” button

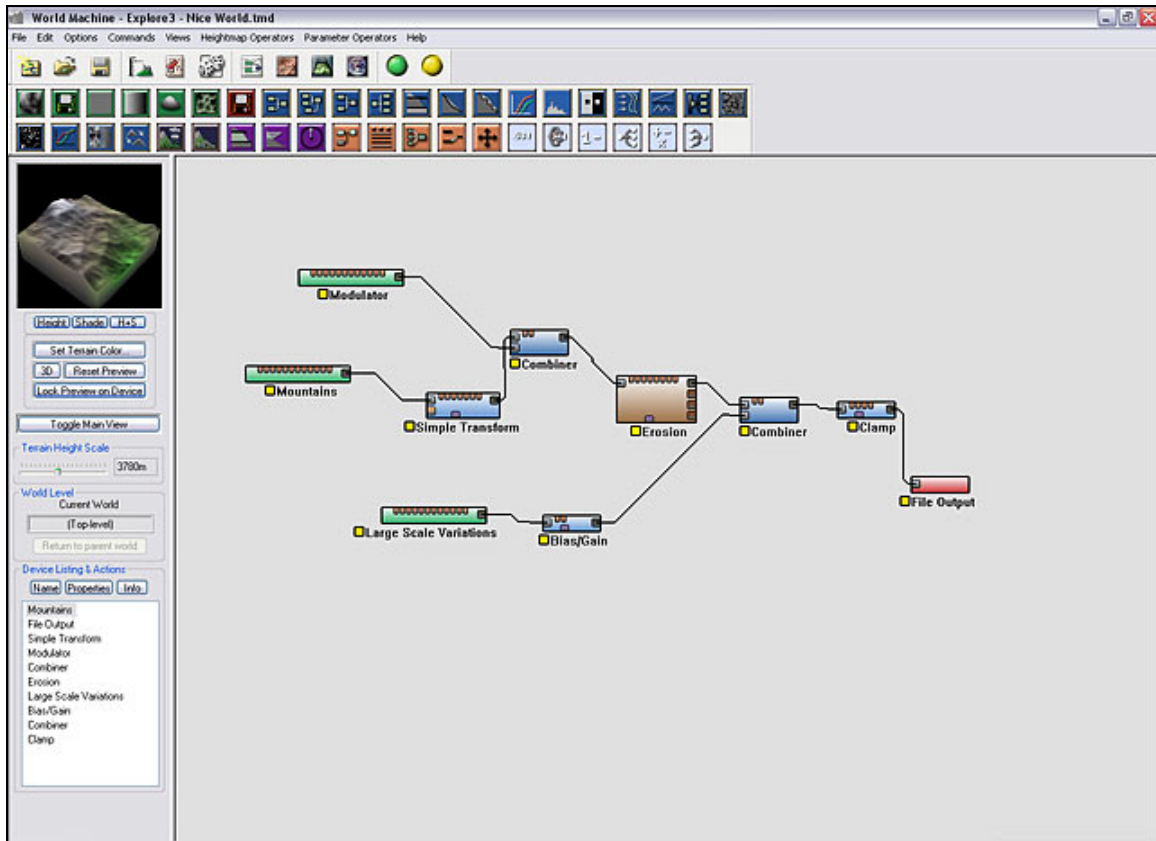
will become enabled if you are inside of a macro world; clicking the button will return you to the macro's parent world.

3.3.1.5: Device List



The device list shows every device that exists in the current world. Devices are listed by the order they were added to the world. You can change the currently selected device by clicking on a new one; double-clicking will change that device's properties. The three buttons **Name**, **Properties**, and **Info** will allow you to, respectively, change the name of the selected device, edit its properties, and pop up a dialog with a brief description of the purpose of the device.

3.3.2: Device Workview



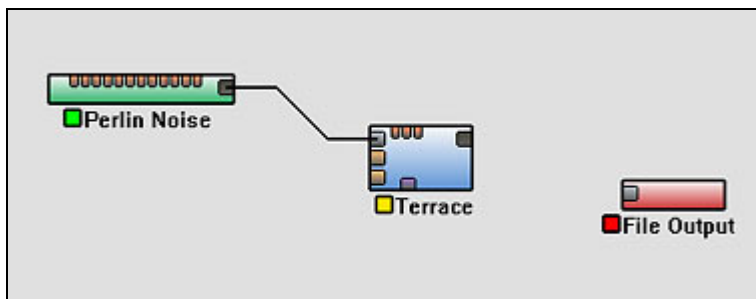
The Device Workview can be selected from the [Command Bar](#), or by pressing Ctrl-1.

The Device Workview is the primary means of interacting with World Machine. It presents the Device Graph that represents the current world. For an introduction to what a Device Graph is, please read Chapter 1 of the Users Manual.

3.3.2.1: Basics

Device Build Status:

Devices in World Machine always have a build status; this tells you if the device is connected properly and if it has been built yet.



Pictured above are three devices in various build states. The build state is shown by the colored rectangle just to the left of the device name.

- **Green:** The device is properly connected and Build results exist for the device.
- **Yellow:** The device is properly connected, however it has not yet been built.
- **Red:** The device is unconnected, or otherwise not operating.

You can make a device go from *red* to *yellow* status by connecting any required inputs. You can make a device go from *yellow* to *green* by building the world with the [Build World Command](#).

Adding Devices:

To add a device to the world, you can select one from either the menu bar, or the parts toolbar. To select a device from the menu, simply go to *Heightfield Operators*, select the category of device you wish to add, and then a device from that Category.

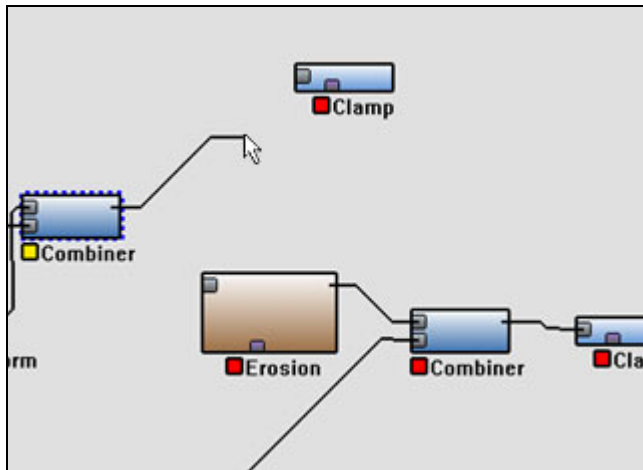


Alternatively, and more conveniently, you can select any device from the parts toolbar, covered [here](#).

Once a device is ready to be placed into the world, the mouse cursor will have a + sign next to it in the workview. Clicking the left mouse button anywhere in the workview will place that device there. You may place multiple devices of the same type simply by clicking multiple times in an empty region of the workview. You may stop placing devices by either right clicking, or clicking on any device present in the world.

Connecting Devices:

To connect two devices together, you must wire an output port on one device to an input port on another, or vice versa. To do this, click on one of the ports. A wire will become attached to that port on one end, and the mouse cursor on the other. All ports will disappear except the ports that you are allowed to wire that device to.



Once you have clicked on both ports there should now be a wire connecting the two devices, if there is not then either you attempted to wire an incorrect combination or you missed the port you were trying to connect to.

Modifying a Device:

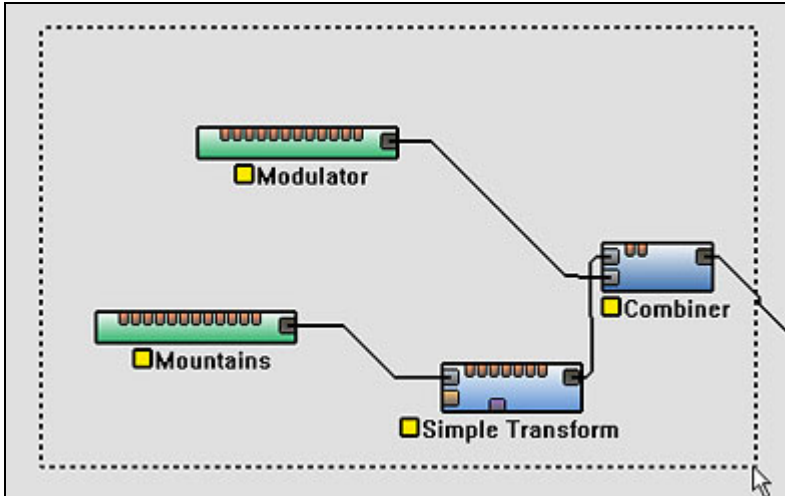
To change the properties of a device, simply double click it in the workview. A dialog will appear that allows you to change the parameters and settings of the device. The Leftside preview will show you the results of any adjustments you make.

Deleting Devices:

To delete a device, simply select it and then choose Delete Device from the Edit menu, or simply hit the Delete key. By default, you will be prompted to confirm the decision to delete the device – if you wish to avoid this prompt, hold the shift key while you hit Delete.

3.3.2.2: Working with Devices

Selecting & Moving Devices:

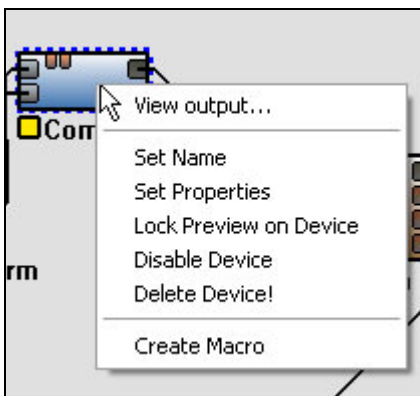


- You may select a single device by simply clicking it.
- You may add another device to the selection by holding **SHIFT** and clicking on that device. Clicking a selected device with shift held will toggle it out of the selection.
- You may select multiple devices at once by drag-selecting a group of devices, by holding down the mouse button and drawing a box around the devices you wish to select.
- Holding down shift while drag-selecting will add the drag-selected group to the currently selected devices.

You may move any selected device(s) by simply clicking and dragging on the device.

Device Menu:

Right clicking on any device will bring up the device menu:

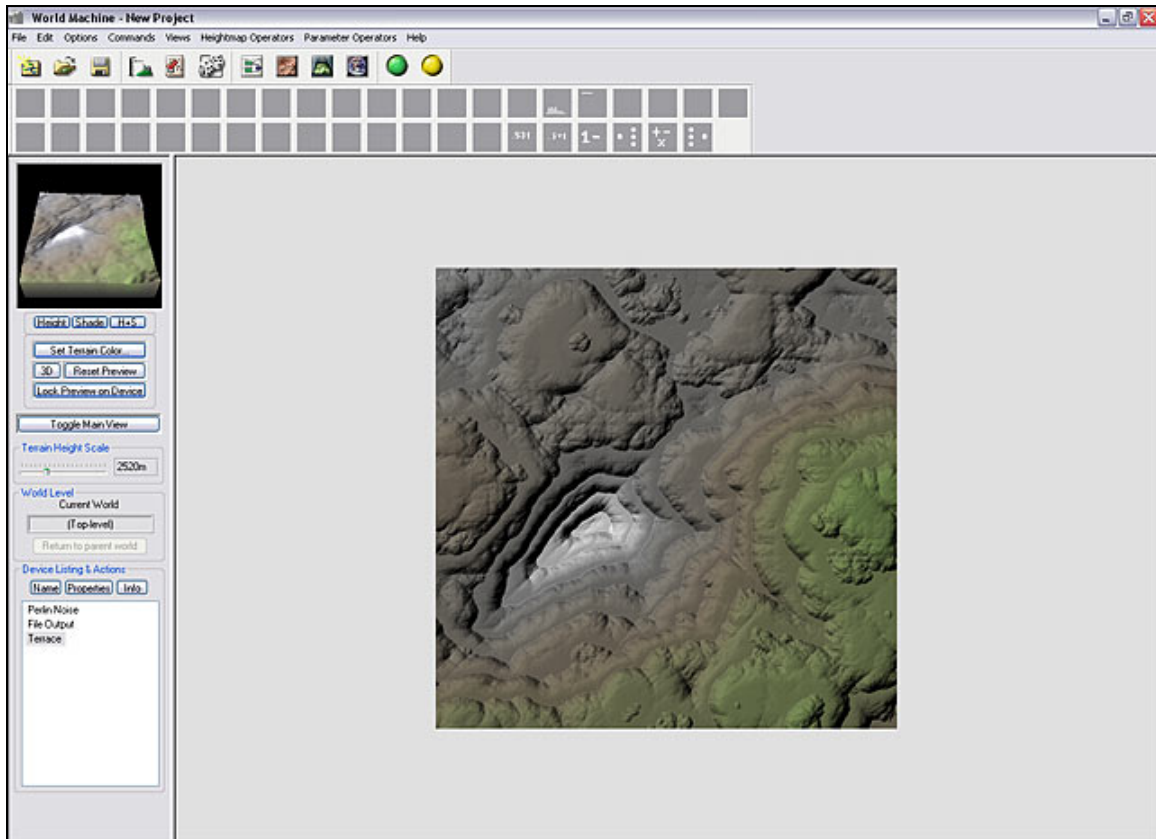


- **View output:** Swaps the main view to the last-used view (2D or 3D view) to view the build results at this device.
- **Set Name:** Renames the device.
- **Set Properties:** Sets the properties of the device (same as double-clicking).
- **Lock Preview on Device:** [Freezes the preview](#) on the currently selected device.
- **Disable Device:** Disables the device. A disabled device is grayed out, and will not be activated when the world is build. Any devices depending on its output will also fail to build. Selecting this again will re-enable the device.
- **Delete Device:** Deletes the device.
- **Create Macro:** Converts the selected device(s) to a macro. Any links leading into or out of the collection of selected devices are converted to macro ports. See [Chapter 4: Macros](#) for more information.

Copy & Paste:

You may cut, copy, and paste any set of devices you wish with the standard Windows keyboard shortcuts (Ctrl-X, Ctrl-C, and Ctrl-V respectively).

3.3.3: 2D View

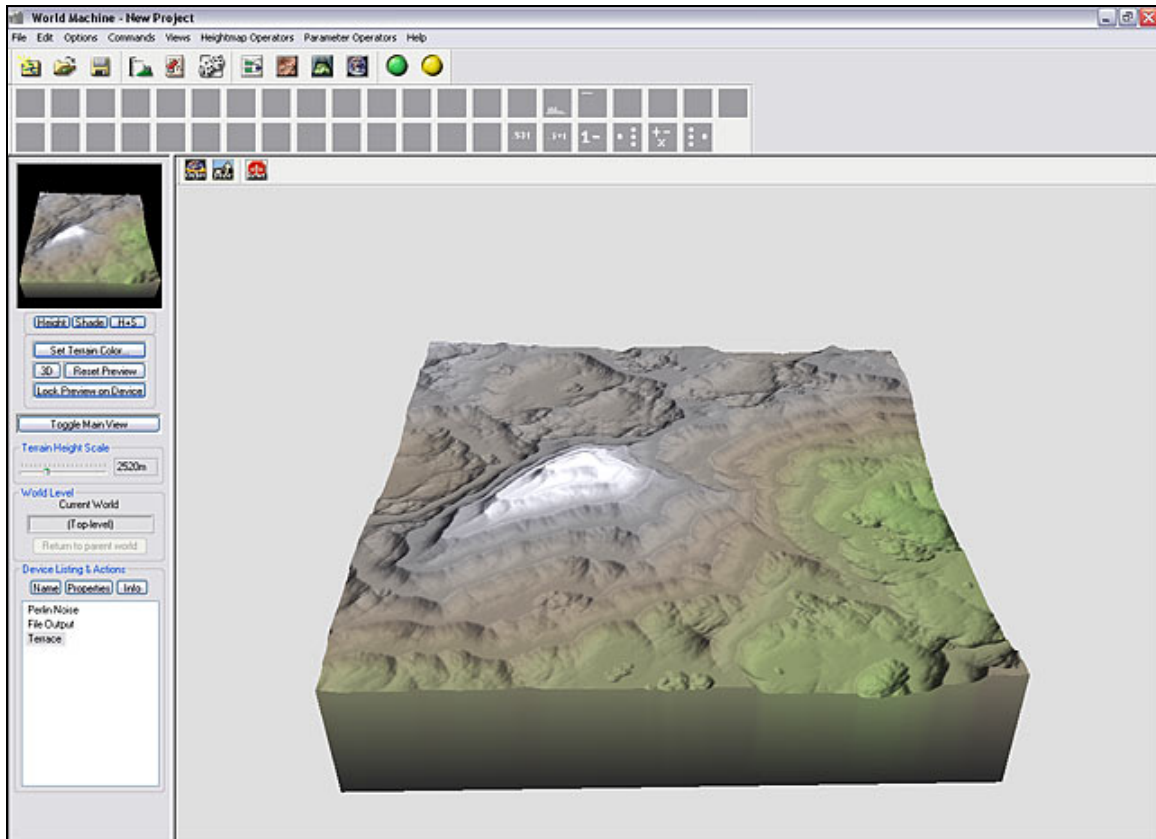


The 2D View can be selected from the [Command Bar](#), or by pressing Ctrl-2.

The 2D View offers you an overhead view of the terrain with optional shading applied to show the relief of the terrain. The 2D View does not use OpenGL or other 3D systems and so is a good viewing choice for very large maps, systems with slow 3D cards, or other conditions that favor 2D use.

The 2D View offers very little interactivity. The display will update to reflect new sunlight conditions when you use the [Leftside view](#) to adjust the lighting. When the map is large enough to extend past the view boundaries, you can use the scrollbars to view different areas of the terrain.

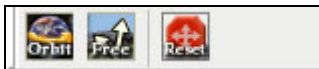
3.3.4: 3D View



The 3D View can be selected from the [Command Bar](#), or by pressing Ctrl-3.

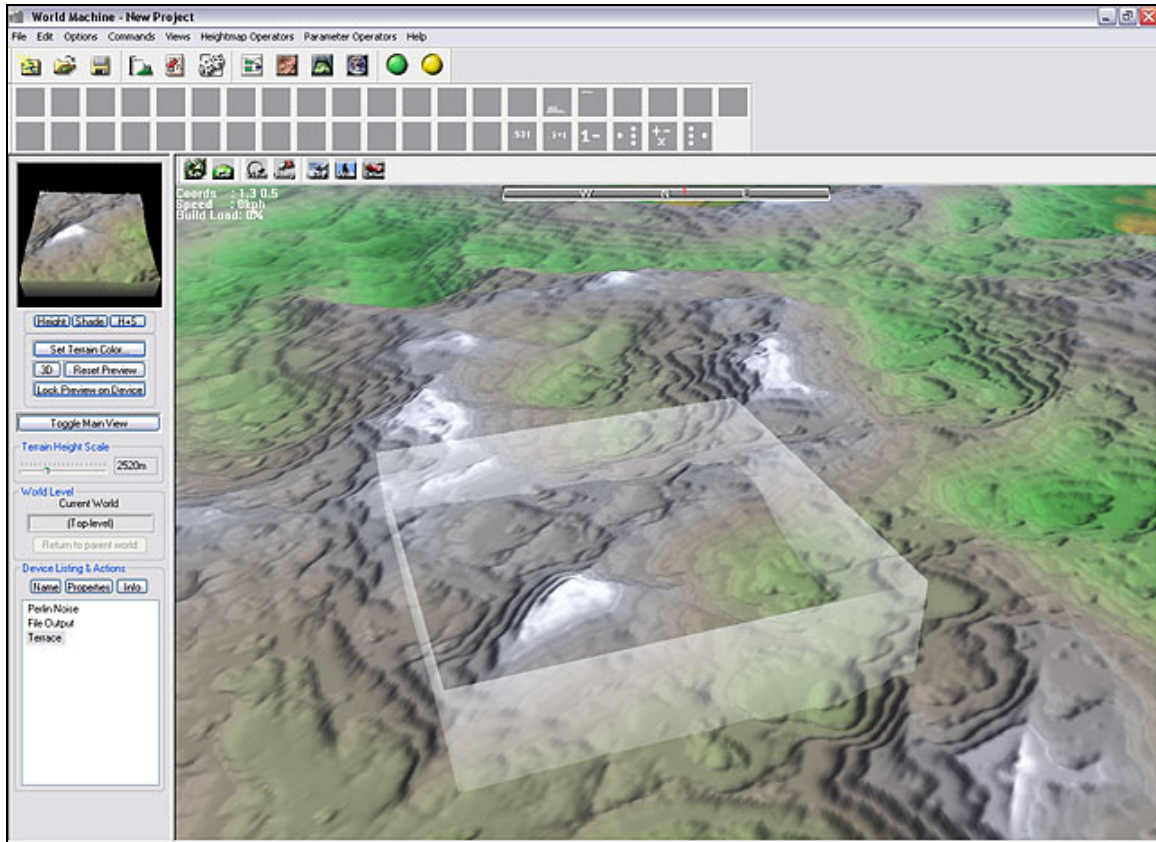
The 3D View will always show the current contents of the active terrain. If the currently selected device has not been built yet (displays a yellow rather than green light in the Workview), the 3D View will show the lower-resolution preview results rather than the full-detail build results.

The 3D View also has its own toolbar:



- **Orbit:** This button puts the 3D View into Orbit mode. In this mode, moving the mouse will orbit the view around the terrain. This mode makes it easy to inspect the terrain from a variety of angles.
- **Free Look:** The Free Look mode is similar to the traditional camera controls in WM 0.99. You can rotate the camera in any direction you want by left-clicking and dragging with the mouse; right-clicking and dragging up and down will move the camera vertically; and the arrow keys on the keyboard move the view in the direction you are facing. This allows you to freely navigate and inspect the terrain from wherever you wish.
- **Reset View:** This resets the current mode to its default rotation – useful if you’ve navigated somewhere strange and can’t find the terrain anymore!

3.3.5: Explorer Mode



The Explorer Mode can be selected from the [Command Bar](#), or by pressing Ctrl-4.

3.3.5.1: What is Explorer Mode?

Explorer Mode is quite a bit different than the rest of the views in World Machine so we'll spend more time here examining it in detail. There is one main difference in how Explorer functions versus the rest of World Machine; while all of the other views show and modify the terrain in the current render quad, Explorer shows the entire virtual world!

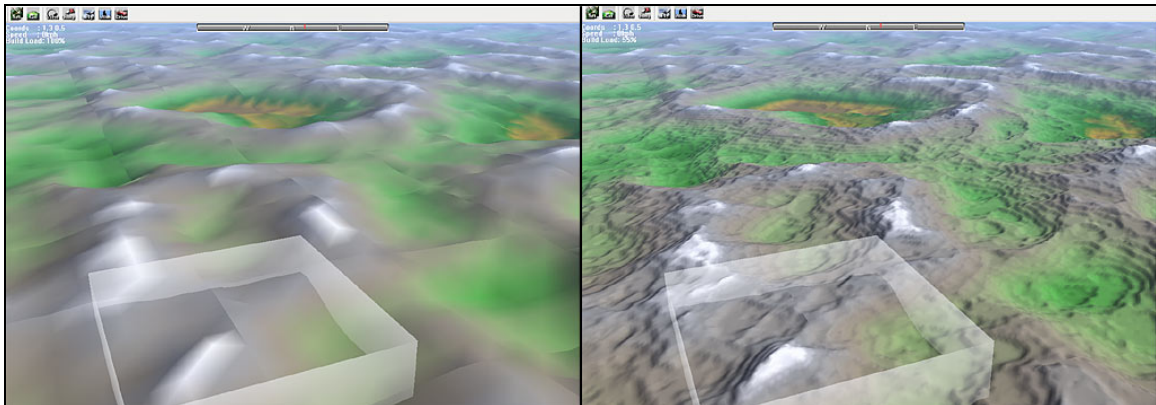
The current render quad is shown by a semi-transparent white rectangle; notice that the features inside of the box are the same as those shown in the 2D and 3D views as well as the Leftside preview. However, there is more. We can see the terrain **outside of the box**.

This is *extremely* useful for locating interesting areas of terrain in the current world defined by your device networks. You can then change the current render quad location

to the new area. In addition, it can be quite a bit of fun to explore the artificial world that you have created.

3.3.5.2: Explorer Details

What exactly Explorer mode looks like depends greatly upon the power of your computer system and the settings you selected in the [Explorer Performance Options](#) dialog.



Explorer mode uses a *refining progressive level of detail* system. In non-technical terms, this means that the world starts out in very low detail, as seen on the left, and then is continuously refined so that nearby areas are shown with greater resolution, as on the right. In addition, beware that an old or underpowered system might be only able to run Explorer mode at a detail level equal to the left view above. A high-end computer with a powerful 3D card can look like the right side or better.

There are several displays in the Explorer window; Let's take a closer look at some of the information.



You can see that in the middle of the screen, there is a compass; the red marker indicates the current view direction. North is in the middle, indicated by N; the extreme sides of the compass both represent south.

On the left, there are three lines of text. They indicate the **current coordinates** of the view along the x and y axis, the **speed** with which you are moving, and the **build load**. Although the first two are self explanatory, the build load is less obvious.

Build load: The percentage of time during the last second that Explorer mode has been actively building tiles. Thus, if this value is greater than 0%, tiles are currently being created that will increase the level of detail of the current scene.

3.5.5.3: Exploring Explorer!

To use Explorer mode, you can simply jump in and go! Explorer starts in flying navigation mode. You can use the arrow keys and/or the mouse to move around the landscape.

If you ever get lost, simply push the “View” button on the Explorer Toolbar. This will reset your current position so that you are looking at the current terrain render quad.

When you find an interesting location that you want to use as the basis for a terrain, hit the “Set” button. Then click on the center of the desired terrain area. The terrain render quad will be set to that location. Then you can click the “Go” button to resume navigating in Explorer.

If the terrain render quad is too large or too small for your purposes, you will need to adjust the world size in the [Terrain Size](#) dialog.

3.3.5.4: Explorer Toolbar



The Explorer Toolbar is divided into three segments that deal with different aspects of Explorer. They are, from left to right across the toolbar:

Explorer Operating Mode:

- **Set:** Stops all movement and allows you to set the render quad location. Clicking on the terrain will change the location of the render quad.
- **Go:** Navigation Mode. This is the normal operating mode of explorer.

View Locations:

- **View:** Move the camera to bring the current render quad into view.
- **Jump:** Jump to a particular location by specifying X/Y coordinates.

Navigation Mode:

Each navigation mode uses the keys in a slightly different way:

- **Fly:** Fly above the terrain.
 - **Up/down arrow controls speed**
 - **Left/right arrow AND/OR mouse controls heading and elevation**
 - **Right mouse button + mouse up/down adjusts elevation**
- **Walk:** Walk over the terrain.
 - **Up/down arrow steps forward/back**
 - **Left/right arrow sidesteps**
 - **Left mouse button + mouse left/right adjusts heading**
 - **Hold down the right mouse button to step forward**
- **Drive:** Drive around the terrain in a buggy.
 - **Up/down arrow accelerates/brakes**
 - **Left/right arrow turns**
 - **Holding the ctrl key puts the buggy into “hover” mode**
 - **Holding the shift key acts as a “turbo boost”**

3.3.5.5: Explorer Caveats

Explorer Mode is a very powerful and useful feature. However, because of its demanding nature, it requires a lot from your computer system. Specifically: a fast CPU to generate terrain tiles, and a fast video card to display them. You will likely need to play with the quality presets in the [Explorer Performance Options](#) dialog to find a performance level acceptable for your system.

In addition, not every device in World Machine will work properly with Explorer Mode! World Machine marks these devices with an [optional](#) warning symbol in the Device Workview. The warning symbol is a red exclamation point: !

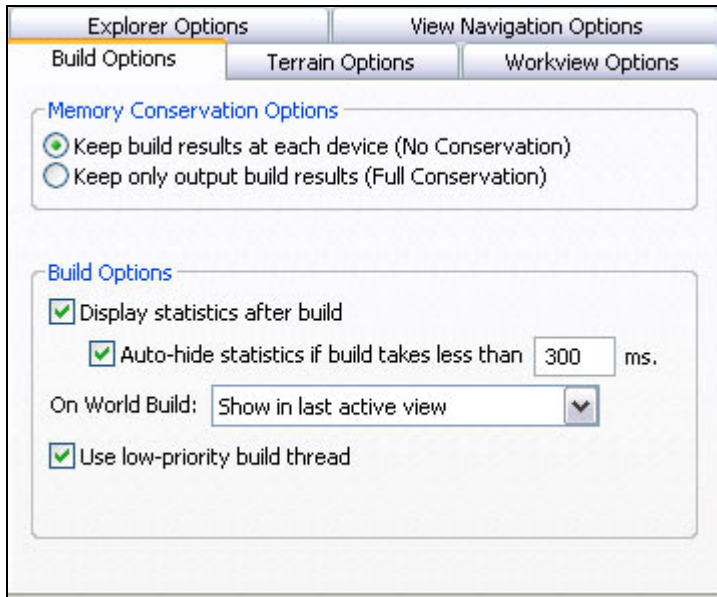
Attempting to use Explorer view with one of these devices will *not* lead to catastrophe – however, often you will encounter odd artifacts or misleading terrain features. Some of this will be improved in future versions of World Machine.

3.4: Dialogs

3.4.1: Preferences

The Preferences dialog allows you to configure various options in World Machine to match either your tastes or your machine’s abilities.

3.4.1.1: Build Options



Memory Conservation:

Controls how World Machine allocates memory when performing a final build.

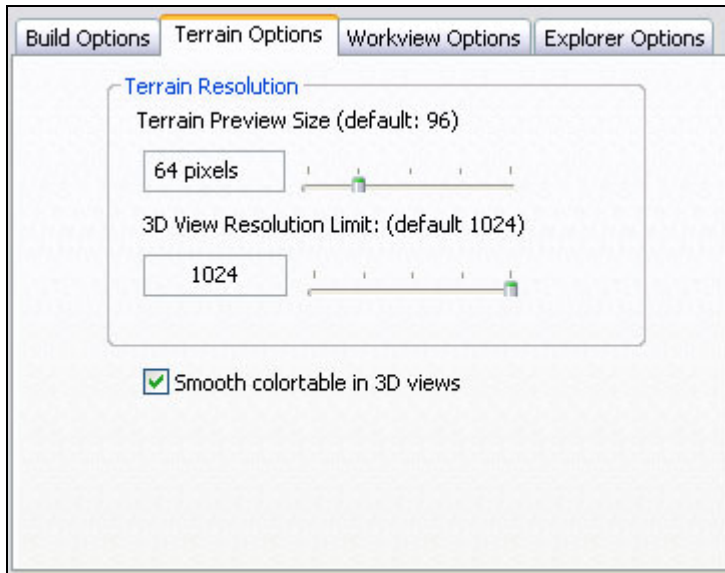
- When **No Conservation** is selected (the default), each device retains its output. This way, you can look through the device network and see what the changes are from device to device.
- When **Full Conservation** is selected, the build results are kept only at the last device in the network. This can dramatically reduce memory consumption, as instead of dozens or hundreds of heightfields, only a handful need be allocated. However, you will lose the ability to see the intermediate build results. This option is often required for high-resolution builds of complicated networks.

Build Options:

- **Display statistics after build** toggles whether the [progress dialog](#) that appears when the world is built disappears after the build process has completed, or if it remains for you to examine.
- **Auto-hide statistics** can intelligently hide the [progress dialog](#) if the build takes less than a certain amount of time in milliseconds. This is handy, as when you're building just a few devices it saves you a few mouse clicks, while still showing the build stats for longer builds.
- **On World Build** allows you to control what World Machine does by default after the world is built. You may *Do Nothing*, *Show the Last Active View*, *Show the 2D View*, or *Show the 3D View*.
- **Use low-priority build thread** means that World Machine will not monopolize the processor, allowing other applications to pre-empt the build process easier and enabling you to have a build proceeding in the background with less noticeable

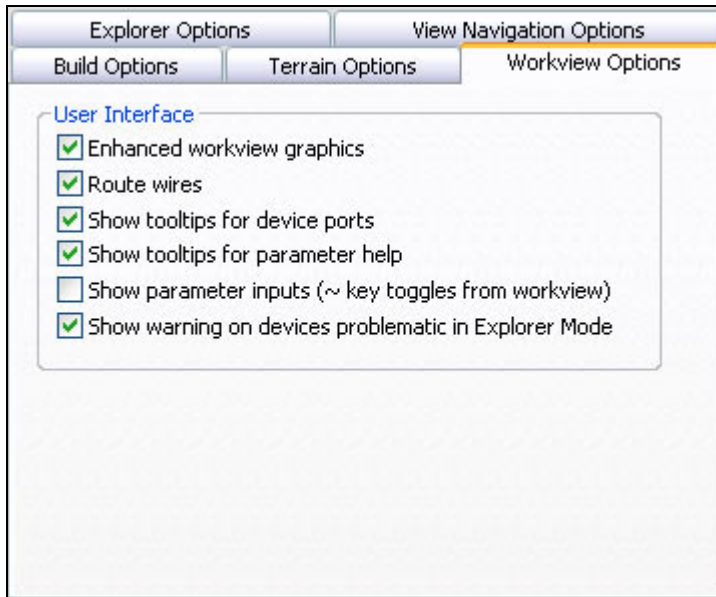
impact to your other computing activities. However, the build will take longer to complete.

3.4.1.2: Terrain Options



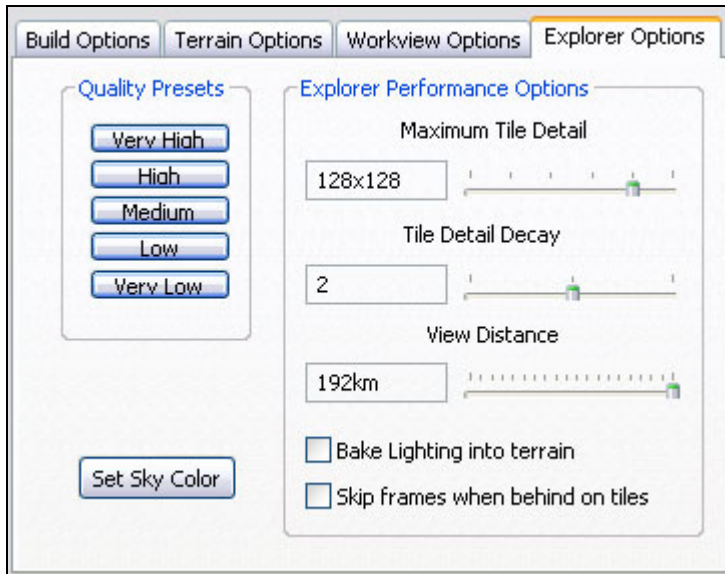
- **Terrain Preview Size:** Controls the detail level of the preview terrains that World Machine creates (used for the Leftside preview window and the 3D View before a device is built). The higher the resolution, the greater the amount of detail in all of the previews, however, they will take longer to create. A value of 64 to 96 is appropriate for most computer systems.
- **3D View Resolution Limit:** Limits the maximum amount of detail that World Machine will allow in a 3D view. This is intended to allow users with less-powerful video cards to throttle down the 3D views to a level that works smoothly on their computers. Modern systems can leave this at 1024; older computers may need to limit to less.
- **Smooth colortable:** Smooths the color transitions between the different heights. There is no performance hit for this option, therefore it is recommended that it remain enabled.

3.4.1.3: Workview Options



- **Enhanced workview graphics:** Shades the device network using gradients and a more aesthetically pleasing method than the older, traditional shading.
- **Route wires:** Makes all wires run at only 0, 45, and 90 degrees, providing more clarity to the device network.
- **Show tooltips for device ports:** Displays the type of data that the port accepts, as well as the current range/value for parameter-type ports.
- **Show tooltips for parameter help:** Controls the help displays for parameters in the device configuration dialogs. To display help text, simply hover the mouse over the parameter name.
- **Show parameter inputs:** Toggles the display of the parameter input ports along the top edge of the devices. The ~ (or `) key toggles this option from the workview.
- **Show warnings on devices:** Displays a red ! mark next to the name of any devices in the network that are likely to not properly display when using Explorer mode. Any devices that display this symbol will not accurately represent the real shape of the terrain when viewed in Explorer mode, as explained [here](#).

3.4.1.4: Explorer Options



Quality Presets:

- **Very High:** Modern systems with a powerful video card (NVIDIA GeForce4/ATI Radeon 9600 or better)
- **High:** Modern systems not designed for 3D graphics
- **Medium:** Older systems or modern laptops
- **Low:** Low end systems or laptops
- **Very Low:** Very low end systems or low end laptops

Explorer Performance Options:

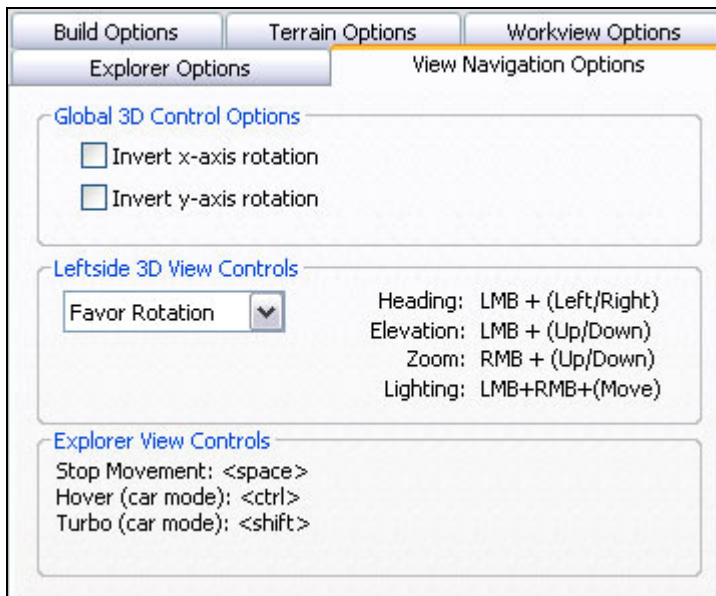
If you want more control over the performance of Explorer mode, you can change each parameter individually from this section:

- **Maximum Tile Detail:** The maximum resolution of any individual terrain tile in Explorer. Larger tiles will take much longer to generate, and may also slow down the display. Thus, the detail should be set to a level where navigation remains fluid (30 frames per second).
- **Tile Detail Decay:** This setting controls how fast the detail falls off as distance from the viewer increases. Higher settings preserve more detail, while lower settings fall off quicker. This setting strongly interacts with the Maximum Tile Detail in determining the performance of Explorer Mode.
- **View Distance:** This slider controls how far out World Machine will draw before the terrain meets the horizon. In most cases it can be left at its default value for maximum view distance.
- **Bake Lighting into terrain:** When enabled, this setting turns off the real-time lighting of the terrain, and uses light maps to create shadows. This tends to be faster for most video cards. Note that with this enabled, moving the sun will cause all tiles to be regenerated.

- **Skip frames when behind on tiles:** This setting should only be enabled on problematic systems where the tile generating threads are being “starved” of CPU time. It will automatically limit the frame rate to 15 frames per second, using the remaining time to generate tiles at a faster rate.

Set Sky Color: This option sets the color of the sky. The default is a light blue. You didn’t really expect it to do something else, did you?

3.4.1.5: View Navigation Options



Global 3D Control Options:

These settings change the navigation behavior of ALL 3D views in World Machine (Leftside, Main 3D View, and Explorer Mode).

- **Invert x-axis rotation:** When this is checked, moving the mouse left and right will cause the view to rotate in the opposite direction from the usual.
- **Invert y-axis rotation:** Turning on “Invert-y” is a popular option that makes the 3D views behave more like an airplane; pulling back on the mouse moves the view up instead of down.

Leftside 3D View Controls:

This option allows you to change the navigation functions of the Leftside preview when it is toggled to the 3D mode. There are four functions that are controlled via the mouse:

Heading, Elevation, Zoom, and Lighting.

- **Heading** controls the rotation of the terrain around its vertical axis.

- **Elevation** controls the angle above the terrain.
- **Zoom** is how close to the center of the terrain the view is located.
- **Lighting** controls the heading and elevation of the light source that is illuminating the terrain.

By choosing between Favor Rotation and Favor Lighting, you can control which functions get assigned to the Left Mouse Button (LMB), the Right Mouse Button (RMB), or the Middle Mouse Button (MMB).

Note that if you don't have a middle mouse button, you can press the left and right together to simulate it.

More precise control over function assignments may be allowed in future versions of World Machine.

Explorer View Controls:

The commands listed in this section are just for reference – they cannot be changed at this time.

3.4.2: Terrain Size



World Size Control:

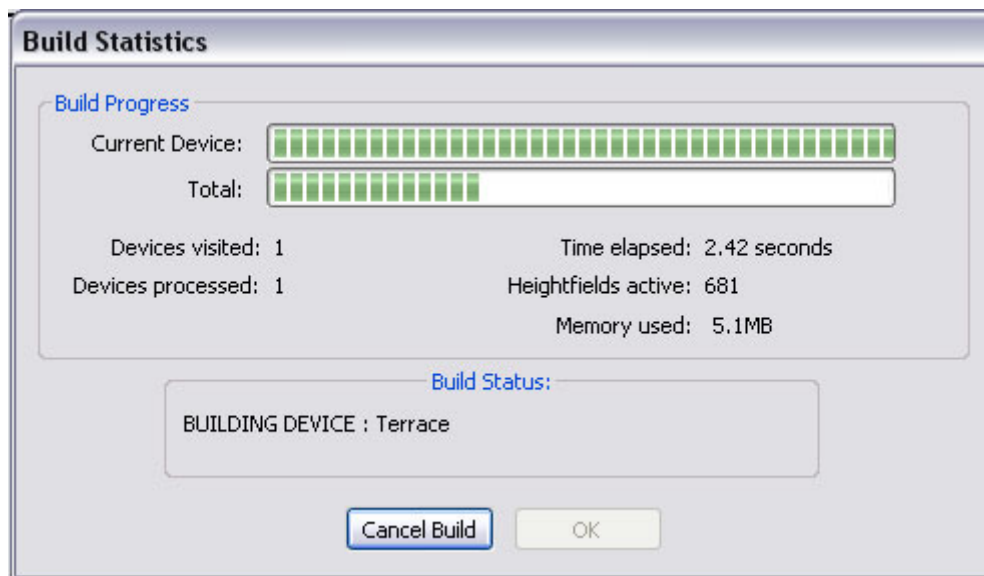
The size of the current terrain quad can be controlled from this dialog. By default, the terrain will be a square, where the width and height are controlled together. By enabling **Allow non-square terrain**, you can set the Width/Height separately.

- **Width & Height:** The size of the terrain in pixels. The size is constrained to a value that is a power of two (e.g. 256, 512, 1024, etc). Sizes greater than 512x512 are allowed only in the *Standard Edition* and above.
- **Largest World Size:** Adjustments here control the amount of world-space that the terrain covers, in kilometers. A larger value will increase the size of the render quad; a smaller value will decrease it. *Notice that if the file size is not increased to compensate, a larger world size will reduce the detail of the terrain.* See [Chapter 1.2](#) for more details on this fundamental.

Global Terrain Location Control:

If you are unable or disinclined to use Explorer mode to adjust where in the virtual universe the render quad is located, you may pan the location using the X/Y buttons, or by entering the X/Y coordinates into the edit boxes.

3.4.3: World Building Stats



The build progress dialog, as you might expect, gives you a progress report on how the build procedure is going. You can see the status of building the current device (top progress bar), and of the entire world building progress (bottom progress bar).

- **Devices visited/processed:** This stat is a measure of how many devices have had changed data since the last build. Each device in the network is visited once. If it is out of date, World Machine will build that device. Thus, a network that hasn't

been built before will have both the number of devices visited and processed equal to the number of devices in the network.

- **Time elapsed**, logically, measures the time taken so far to build the world.
- **Heightfields active** reports the total number of active heightfields. Depending on the memory conservation mode, and the use of Explorer mode, this number may vary greatly. Thus, the exact value contained should not be a great concern.
- **Memory used** reports the total memory used by World Machine for heightfields. It does not include any memory used by the program for other purposes, such as 3D vertex data. Thus, it should only serve as a rough guide to the amount of memory used.

Chapter 4: Macros

4.1: Using Macros

What is a macro?

Essentially, a macro is a single device that captures the functionality of an entire network of World Machine devices. Macros consist of an inside macroworld that is connected via ports to the outside world. Macros are user-created, and can be saved and traded between users, essentially offering an easy way to encapsulate and exchange useful effects. The power of macros come especially into play when they are parameterized, as they then can contain options, controls, and parameters just like any other device you can place into the network. Extremely powerful macros rivaling custom-programmed device plugins can be created.

4.1.1: Installing Macros

To install a macro into World Machine, copy the macro file to the World Machine Macro folder (*/macros*). You may create a subfolder under this directory to organize the macro if you wish (see section [4.1.2](#) below).

The macro will then appear the next time you start World Machine.

4.1.2: Organizing Macros

The macro system has been designed to be easy for you to organize into whatever hierarchies you prefer. To do so, simply open up the World Machine Macro folder (*/macros*) from the folder you installed WM into.

You can now create subfolders and drag and drop macros to and from them using Windows Explorer. Your changes will be reflected in World Machine upon startup.

4.1.3: Using Macros

Adding a macro to your world is simple: from the menu bar, select Heightfield Operators->Load Device from Library. You will be presented with a list of the macros installed on your machine.



Clicking on a macro reveals details about it on the right, such as the author, what version of World Machine the macro was created for, and a description of the macro. After you've selected the macro you want, simply click OK to choose that macro. It is now the active drop-device just as if you had clicked on a device in the toolbar. Click anywhere in the workview to place the macro device there.

From the outside, macros behave exactly like any other device. They have required and optional input ports, parameters that can be adjusted, and so on.

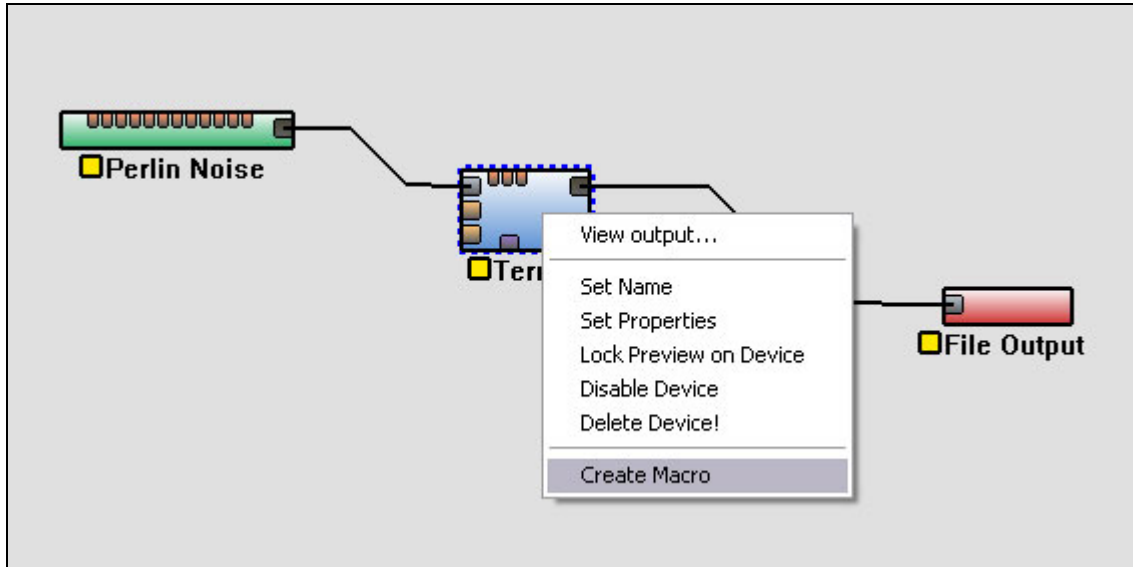
4.2: Authoring Macros

4.2.1: Creating the macro

There are two methods you can use to create a macro.

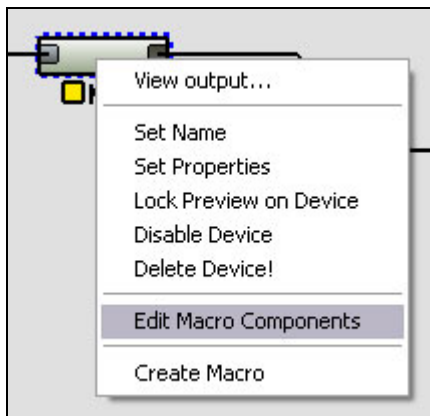
1) You can create a blank macro. Do this by executing the command Heightfield Operators->Utilities->Blank Macro, and click in the work view. The macro will default to having no ports and no internal devices - it is a blank slate ready for your customization.

2) You can convert an existing section of your network into a macro. This option is particularly useful if you've created a specific effect that you want to save and possibly use again in the future.



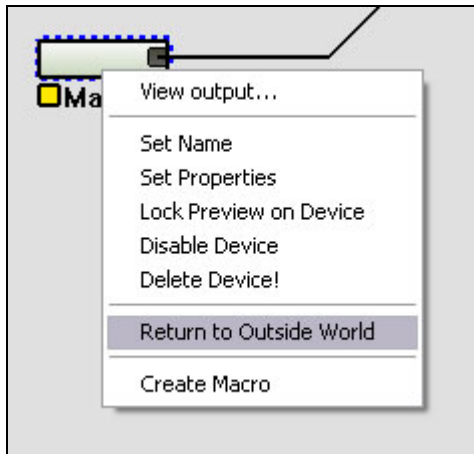
To do this, select one or more devices and then right-click on one of them and choose "Create Macro" from the pop-up menu. The selected devices will be placed inside of a new macro, and ports will be created on the macro device so that all links into and out of the internal devices will be re-routed with no change in overall network functionality.

4.2.2: Inside the Macro World

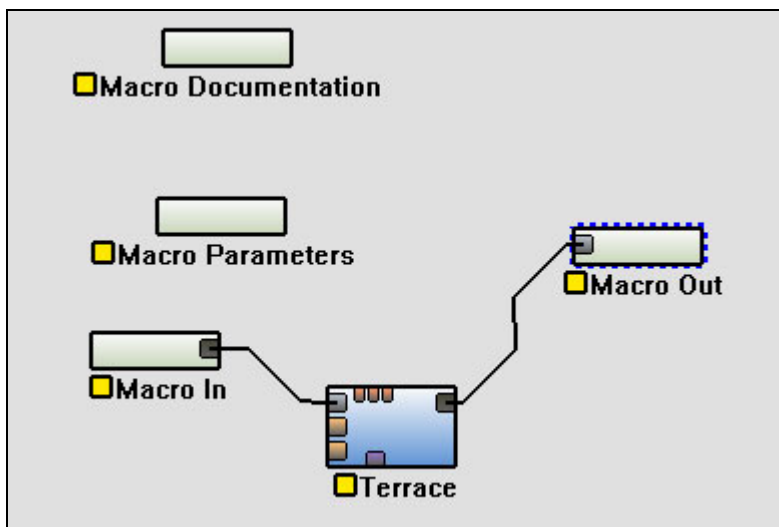


Once your macro is created, you can edit the macro by right clicking on it and selecting "Edit Macro Components". Doing so will change the workview dramatically. The outside device network is gone! Instead, you see several new unfamiliar devices, plus any devices you might have converted to a macro earlier in [4.2.1](#).

Don't be worried; the outside world is not actually gone. Instead, WM is now showing you the inside of the macro device. There is a [status readout](#) on the leftbar that shows you the current world you're in. You can move back and forth from the outside world to the inside of the macro by right clicking on any macro-related device (light gray in color) and selecting "Return to Outside World" or "Edit Macro World", respectively.



Alternatively, clicking on "Return to Parent" in the Leftbar will always back you out of any macro device you're currently in. Macros can be more than one layer deep - your macros may also use macros that consist of still more macros, and so on. You can "tunnel" in as far as you want.



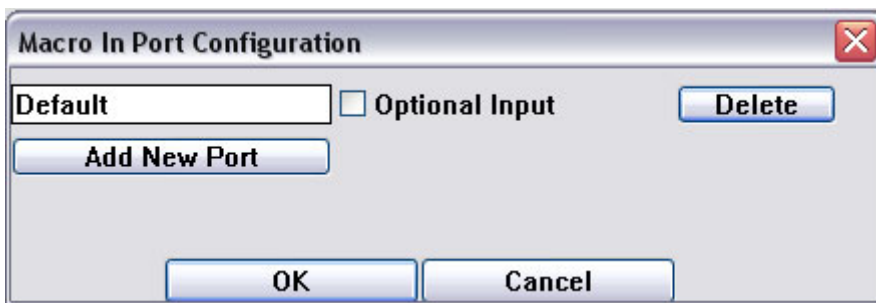
There are four permanent devices inside of all macros. They cannot be deleted -- they are integrated parts of the macro that are exposed for your use. These devices are:

- **Macro In**: Represents the place where outside information flows into the macro world
- **Macro Out**: The place where the results of the macroworld's calculations return to the parent world
- **Macro Documentation**: A place to provide a description of the macro, as well as information such as the author's name
- **Macro Parameters**: The most complicated of the four macro devices, The Parameter device allows the outside user to interact and change device network settings inside the macro without having to open the macro up to modify it. This is an extremely powerful ability, so much so that several entire chapters will be devoted to describing how best to use this feature.

These four devices are the portals through which information can flow between the outside world and the inner world of the macro. You can configure them in the same way as any other device – by double-clicking them.

4.2.3: Ports

The **Macro In** and **Macro Out** devices control the ports on the macro. They are identical except that for the fact that one is devoted to input; the other to output.



To add another port to the macro, simply click "Add New Port". You can then give it any name you want to describe the purpose of it.

Similarly, to delete a port from the macro, click the delete button next to that entry to flag it for deletion. The port will be deleted when you click "OK" on the dialog.

You can flag a port as "optional" as well. A "normal" port is required for operation of the macro. If a normal input is not connected, the macro will not function. An optional input signifies a port that is not absolutely required for proper operation. A typical use of this might be, for example, for an input to allow the user to override a default terrain used inside of the macro, or to specify an optional mask whereby the macro is only applied in certain areas.

For outputs, the optional flag is usually used to denote an auxiliary output; perhaps an erosion mask for texturing or something else that is a useful but unnecessary result of the macro.

4.2.4: Help/Documentation

The macro documentation device looks like this:



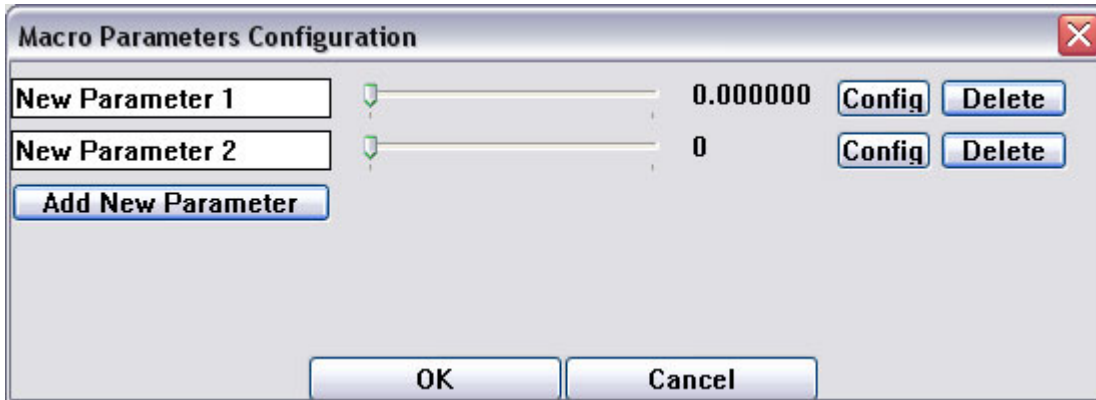
You can enter your name and a description of the macro into this space. In the description, it is often useful for other users if you describe the general effect that the macro gives, the impact of the most critical parameters, and anything significant that should be known about any input ports.

Lastly, in WM-Professional edition only, you may specify that your macro should be locked. This means that other users can only use your macro - they cannot open the macro world or edit it. In the spirit of information sharing, this option should be used rarely, and is mostly intended in the case of authors that might wish to sell or otherwise protect their exceptionally well-made macros. World Machine uses a one-way hash of your registration key to determine macro access; thus, only you, using your registration code can access the internals of the macro.

4.2.5: Parameters

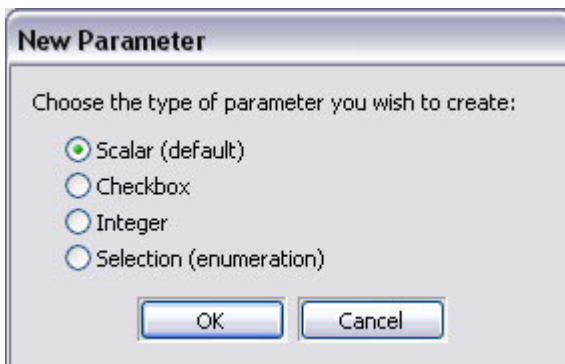
Parameters are the most powerful aspect of macros. [Section 4.3](#) will delve into them in great detail; here we only concern ourselves with the actual options shown in the dialogs.

The parameter device looks like this:



As can be seen above, from the main Macro Parameter screen you can do the following things:

1) Add new parameters. Click on the "Add Parameter" button to add a new parameter to the macro. You will then be presented with a choice of the type of parameter you wish to create.



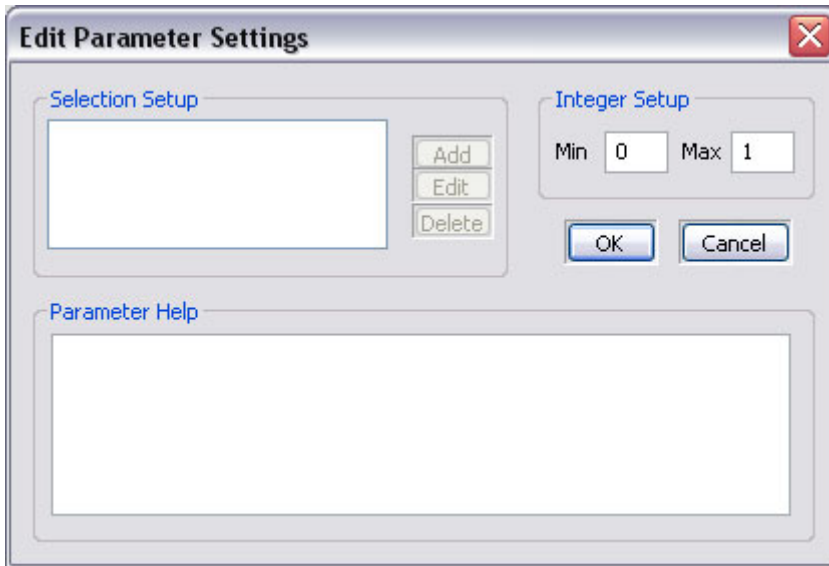
The default parameter type is a scalar; this can be directly used to adjust any device parameter in World Machine. However, several other types are possible and will be useful depending on the purpose of the macro. For a full discussion of parameter types, see [section 4.3](#).

2) Change the current value of a parameter. Adjusting the slider or entering a new value is exactly equivalent to doing the same thing to the outside of the macro device.

3) Rename a parameter. This is pretty self-explanatory!

4) Flag a parameter for deletion. Like the Port device, parameters are only deleted once you click OK in the parameter dialog.

5) **Configure any advanced options** and help tool tip for each parameter.



For every parameter, you can assign help text that will appear if the user hovers the mouse over the parameter. The tool tip text should be one or two sentences that give the user a better idea about what adjusting the parameter will do.

The other sections in this dialog are only valid for particular types of parameters:

Selections

You can add, edit or delete selection entries. Every entry you add here will show up as an option to select from in a list box in the macro.

Integers

You can specify the minimum and maximum values of an integer to control the range of the parameter.

See [section 4.3.3](#) for more details about using these types of parameters.

4.3 Macro Parameter System

Understanding the way that macro parameters, scalar networks, and device parameters interact is critical to being able to create useful and effective macros.

Device Parameters Inputs:

Way back in [Chapter 1](#) we mentioned Parameter Input ports along the top of the devices. They are essential for controlling parameters inside of macros, but can be hidden for convenience and simplicities' sake at other times. The difference is shown below.

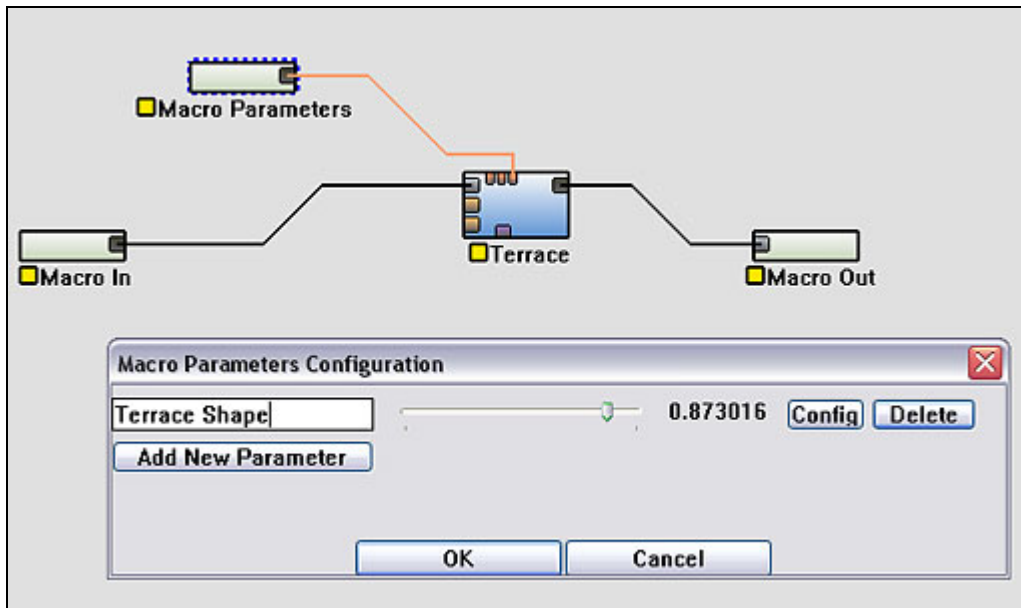


You can toggle the Parameter Inputs by going to the Device workview and hitting the ``` key on the keyboard. It will make the inputs either appear or disappear. Alternatively, you can go to [Preferences->Workview Options](#) and make sure Show Parameter Inputs is checked.

Turn them on before proceeding to the sections in this chapter!

4.3.1: Simple Parameters

In this case the parameter that you manipulate in the macro is a direct link to the internal device's parameter. It's as if the user could reach into the macro and adjust that device directly. This is the simplest and easiest to understand use of macro parameters.



To create a simple parameter, create a scalar parameter as in [4.2.5](#), naming it as you desire.

After you click OK, the Macro Parameter device will have a new output port. Simply wire that port into the parameter input port of the parameter you want to change.

Note that wires that carry scalar or parameter data are **orange**, not black. Each type of data that is carried in the network has a different wiring color code. Any future data types added to World Machine would similarly have different link colors.

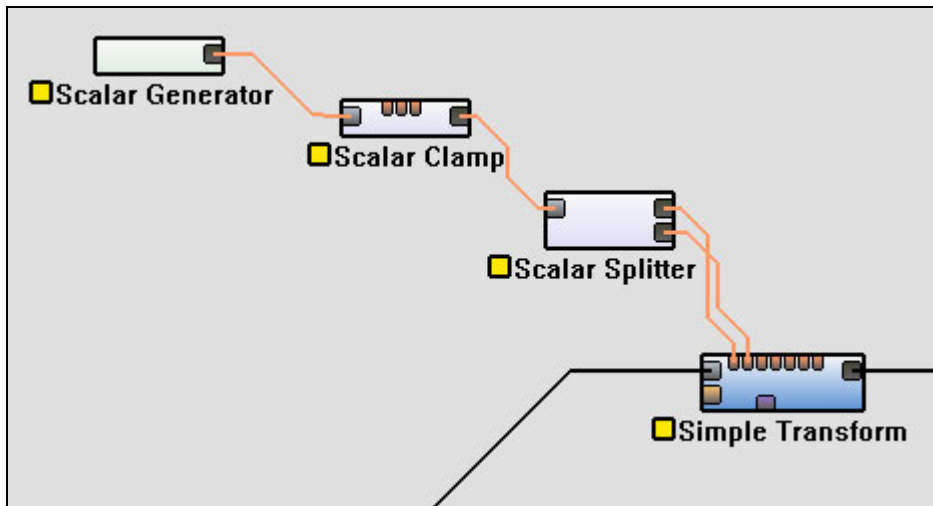
4.3.2: Scalar Device Networks

Sometimes you want to do more than is possible with simple parameters. For example, you may want to adjust two related parameters at the same time when the user adjusts a control. The solution to this is **scalar device networks**.



The scalar devices are accessible from the Parameter Operators menu bar. They are also the devices in the parts toolbar with a light blue background shown above.

From left to right, they are the **Scalar Generator**, **Scalar Clamp**, **Scalar Inverter**, **Scalar Arithmetic**, **Scalar Combiner**, and **Parameter Splitter**.



Above is a typical scalar device network. What is it doing?

- 1) The Scalar Generator creates a number, such as **.35**.
- 2) The Scalar Clamp rescales the range of values. Thus, a **0.0** input into the clamp might become a **.25**, and a **1.0** input might become a **.75**. Our value of **.35** would be rescaled according to those new ranges – so it would become **0.425**.
- 3) The Scalar Splitter has multiple output ports so that you can use the value for several parameters
- 4) The scalar value is wired into the Simple Transform device, controlling both the *Canyonize* and *Glaciate* parameters.

So in effect, adjusting one control now adjusts two parameters instead of one – and the adjustments are constrained to be in a smaller range. With the addition of more devices to the scalar network, we could control more parameters, or have them change differently in regards to each other.

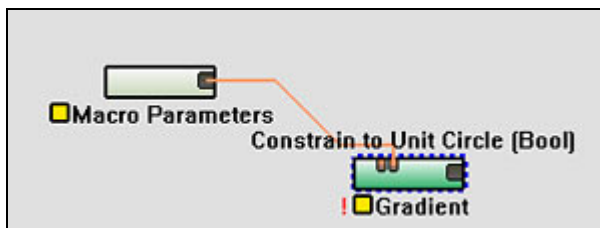
As you can already tell, Scalar networks are strongly mathematical in nature, and can be quite complicated. Most of the challenge lies in figuring out how you want the different driven parameters to change as the Scalar Generator output changes.

Lastly, notice that you can replace the Scalar Generator in the network with the output from a Macro Parameter device. They are interchangeable.

4.3.3: Non-scalar Parameters

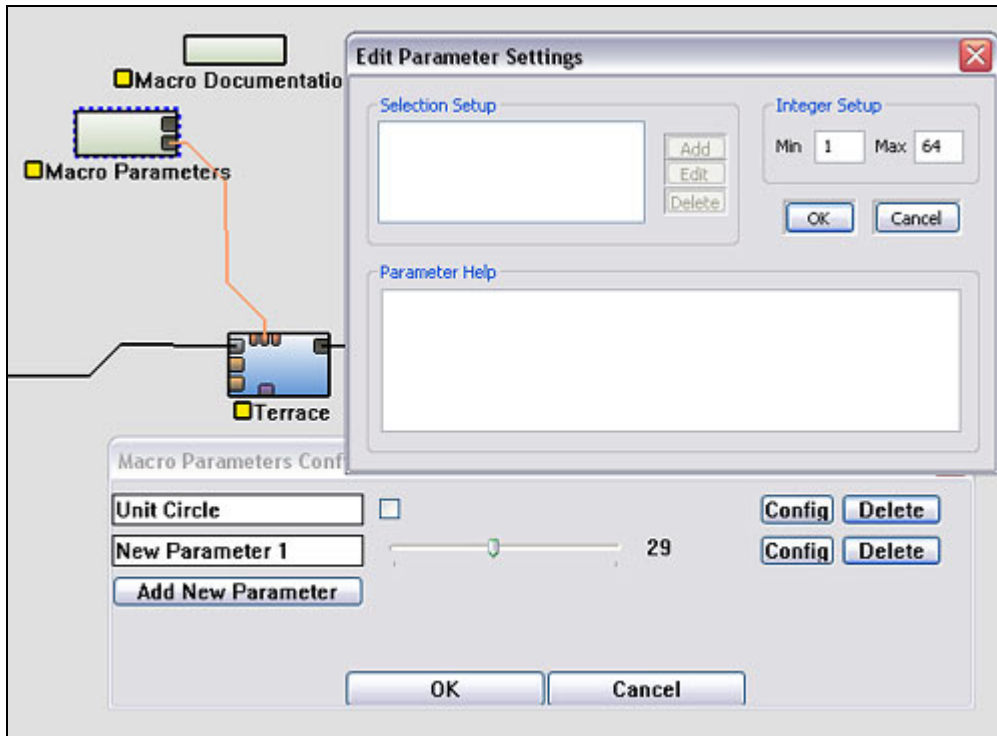
Scalars are not the only type of parameter that you can drive from a macro:

4.3.3.1: Booleans



A Boolean (checkbox) parameter should be used when you want to drive a Boolean device parameter. Above, a Boolean is being used to drive the “Constrain to Unit Circle” parameter on the Gradient device, which as can be noted by the (Bool) on the right of the parameter name, takes a Boolean parameter.

4.3.3.2: Integers



Integer Macro Parameters are useful for driving the integer parameter input ports of some devices. Above, an Integer parameter is being used to drive the “Number of Terraces” parameter on a Terrace device.

Note that as shown above, in order to use an Integer parameter, you must push the “Config” button in the Macro Parameters dialog for that parameter, and set the range of values that the integer can take on.

4.3.3.3: Selections

A Selection parameter is, at its core, essentially an integer. However, each value (0,1,2,etc) is labeled. World Machine then presents the user with a list of the labels and allows the user to choose. When used in conjunction with a Bank Selector (see below), Selection parameters become extremely useful.

4.3.4: Bank Selectors

The Bank Selector is a powerful utility device designed for parameters. Its purpose is to allow you to drive many scalar values with the input of a single parameter. Doing this allows you to setup “Styles” inside of your macro, so that with a selection from a simple list box, the user can change many (hidden) parameters at once.

The Bank Selector consists of “tabs” and “variables”. Each variable has an output port on the Bank Selector, and will output a scalar value reflecting its current value. A tab

contains a set of values for all of the variables. Thus, by choosing a different tab, you can radically change a whole host of parameters that the user need not be exposed to.

The dialog for it is shown below:



There are 6 actions that can be performed in this dialog:

- **Add a variable:** Adds a new variable to the Bank Selector. Each variable can be named, and drives a single scalar output value.
- **Add a tab:** This option creates a new bank of values for all variables
- **Copy tab:** Copies the variable configuration from the current tab
- **Paste tab:** Pastes the stored variable configuration to the current tab
- **Name a variable:** Type a name into the blank area in the variable configuration
- **Adjust a variable's value:** Adjust the slider to change what the variable's value should be in the current tab
- **Change tabs:** Adjust the tab to be modified by clicking the numbered buttons above the sliders. The number of buttons will depend upon how many tabs you have created.

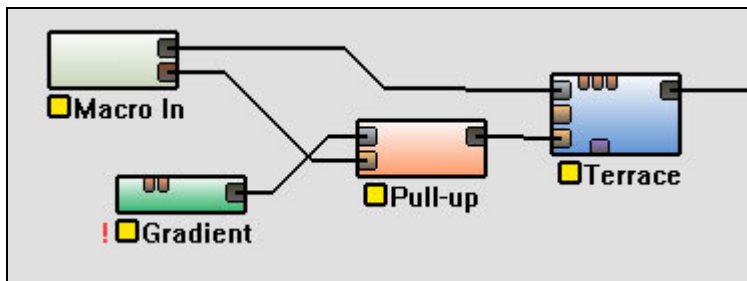
The parameter input to a Bank Selector chooses the current tab, and can be either an integer or a selection – the latter is preferred for user friendliness reasons.

4.4: Using Heightfield Utility Devices with Macros

Utility devices are those that don't directly affect the contents of a map; instead, they typically affect the flow of heightfields in the network.

The following utility devices are helpful inside of macros to help direct the flow of data:

4.4.1: Pull-up device

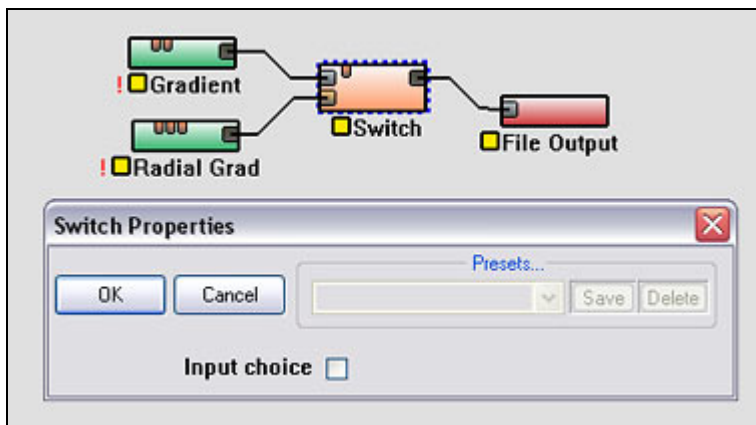


The function of the Pull-up device is to provide a default heightfield if one is not specified. To do this, hook up your reference (default) heightfield to the Reference Input, as shown above. Then the optional heightfield is plugged into the Override Input.

If the Override Input is wired, it will always pass that heightfield along. Otherwise, it will pass the Reference Input along.

4.4.2: Switch device

The Switch device allows you to control which heightfield is passed along to the output with a parameter.

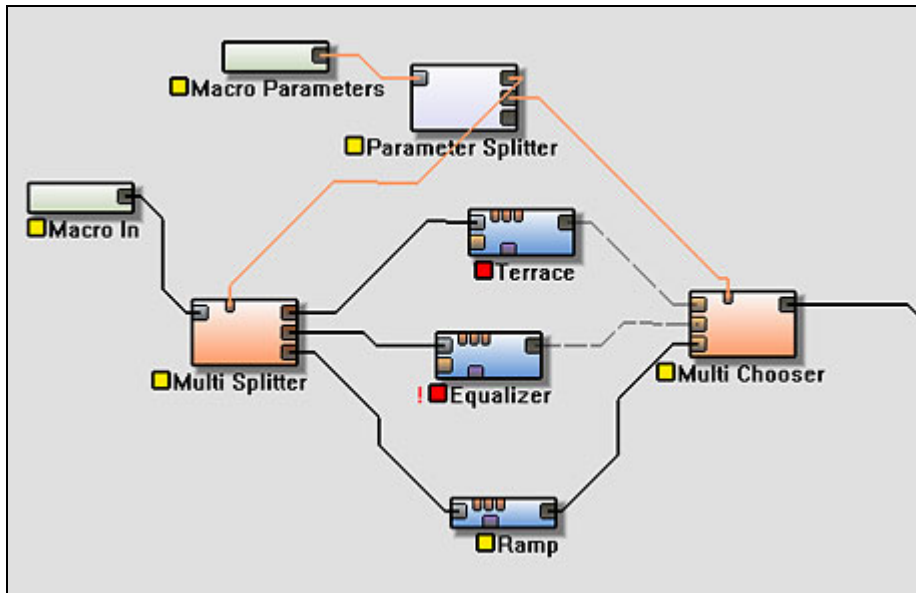


Depending on the value of the “Input choice” checkbox parameter, in the example above either the Gradient or the Radial Gradient will be passed along to the File Output device.

4.4.3: Multi-Splitter & Multi-Chooser

The Multi Splitter and Multi Chooser are designed to allow you to send the terrain data through only one of many paths through the macro at a time. You can set the maximum

number of inputs or outputs, as well as control the chosen input or output through a parameter.



This ability is extremely useful for macros that might have several different effects paths, and where you want to allow the user to choose only one in particular, as in the above illustration. Notice that the paths not currently selected are not built (they have red status icons). This saves the build time and memory for those paths!

4.5 Guidelines for Professional Quality Macros

Once you understand the concepts, macros are relatively easy to create. However, to create a professional-quality macro is a different story. There are many design elements, some subtle and others obvious, that go into designing a quality macro. The following guidelines are a good starting point.

4.5.1: Focus!

The first guideline is extremely simple - and the most important. The most successful macros are those that are focused and targeted on achieving a certain effect. Try not to do too much in your macro - not only will it become overly complicated, but it loses the reusability that makes macros special. When in doubt, create several macros that can be strung together rather than one monolithic macro that attempts to do many tasks.

4.5.2: Use the right number of parameters

This is perhaps the most often ignored guideline for macros, and the results can be disastrous. There are two sides to err on here:

Too few a number of parameters is the less common problem. It happens when very important or essential user controls have been left out of the interface. The desire for a professional macro is to have something that will be useful to many people and is focused on the task at hand; this means that having a macro where you constantly need to open it up and change things in the macro world is very counterproductive.

On the other hand, a far more common mistake is to expose too many parameters to the user. The first impulse of most macro creators is to include as many parameters as possible, under the assumption that more control is always better. The problem is that presenting a smorgasbord of options to the user is extremely confusing - especially when they have non-descriptive names or only change the output very subtly! Every parameter you add dilutes the attention that a user can give to any particular parameter. It's all too easy to drown the extremely important parameters under an ocean of irrelevant options.

The best macros will strike a balance between tune-ability and usability. For each parameter, ask yourself if this control is an important addition to the overall operation of the macro. If you cannot answer yes, then don't provide that parameter! The latest research shows that humans can keep between 4 and 7 'chunks' of information in their mind at the same time. Keeping this in mind, it would seem to be best to limit the number of parameters to the lower side of that range if possible; and if not, then to group together parameters that do similar things spatially in the dialog, a technique called 'chunking'.

Another method to reduce the number of parameters is to use scalar device networks or bank selectors to adjust multiple parameters at a time by just controlling a single parameter in the macro itself. See [section 4.3.4](#) for more details on them.

4.5.3: Use the right parameter for the job

In version 0.99 of World Machine, scalars were the only parameters a macro could have. This resulted in people driving integers and even booleans with a scalar parameter. This is both inefficient and very confusing for the user who expects to be able to smoothly change a setting when they adjust a scalar, and instead sees the output suddenly jump from setting to setting!

The rule is simple: if a device uses an integer parameter, drive it with an integer, not a scalar. Likewise for booleans.

4.5.4: Allow only valid parameter ranges

This may be the second most common sin involving macros. A scalar has a valid range of 0.0 through 1.0. If a certain effect is only really useful in the range of 0.2 to 0.5, then why let the user go outside of that range? It's far more likely to confuse than empower. Use a

scalar clamp device to rescale the 0 to 1 range of a macro to the useful range of the effect you're trying to create.

If you have parameters that are valid only at certain times in certain ranges, a far better option is to use the Bank Selector device to setup banks of settings that change according to a list box parameter in your macro. This allows you to change the parameters that need changing without exposing the user to all of them and potentially leading to confusion.

4.5.5: Use bank selectors! I'm not kidding!

This new capability of World Machine has been mentioned several times already in these guidelines, simply because they are such a simplifying influence on the user experience for otherwise complex macros. List boxes are an easy and labeled way for the user to interact with the macro. [Go here](#) to see details on how to use these devices.

4.5.6: Short-circuit untaken options when possible

If you have several different paths through the inside of the macro world, evaluating all of the devices can be expensive. This is particularly true if, for example, you have a parameter that allows the user to choose between two different erosion devices. A naive implementation of this would calculate both of the devices and then choose between them only at the end.

Instead, you can deactivate those paths that will not be taken! This saves the processing time and memory of those paths that no longer will be built. This is particularly important with macros that are going to be used at high resolutions, as the memory used by a set of devices might spell the difference between what can be created on a machine with a certain amount of RAM and what cannot.

See [chapter 4.4.3](#) for more details on using a Multi-Splitter & Multi-Combiner combination to accomplish this.

Chapter 5: Credits & Links

CREDITS

World Machine has been designed, created, and maintained by Stephen Schmitt. It is protected under US Copyright Law, ©2002-2005.

Stephen Schmitt also wrote the World Machine documentation. Oshyan Greene and Filipe Dias assisted in editing; Filipe Dias has written the device reference framework and large sections of the device descriptions.

The World Machine v1.0 Testing Team members have volunteered their time to help improve World Machine. They have been invaluable in bug finding and software testing work. Those members are:

Oshyan Greene
Filipe Dias
Raphaël Vilette

Once again, thanks guys.

LINKS

World Machine Official Site:

<http://www.world-machine.com>

World Machine Forums:

<http://forum.world-machine.com>