COMMAND & CONQUER GENERALS

WORLD BUILDER

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INTRODUCTION

NOTE: The *Command & Conquer™ Generals World Builder* tool is provided on an "as-is" basis. It is not supported by Electronic Arts Technical Support. Please see the EA Tools End User License on boot-up for details.

Welcome to *Command* & *Conquer Generals World Builder*. This development tool is used by Electronic Arts designers to create single-player missions and multiplayer maps for *Command* & *Conquer™* titles, and now it's available to you. The full-featured 3D environment gives you unprecedented visual controls and a wide array of tools to get the details of your maps exactly as you want them. Building game maps is easier than ever, as the *World Builder*'s suite of tools lets you rapidly prototype your creations and then jump directly into the game to play them.

KEY FEATURES

- **Step-by-step process to build multiplayer maps.** Follow the steps listed in this document to get up to speed building multiplayer maps (➤ p. 36) for up to eight players. With a few extra steps, you can turn your finished multiplayer map into a Skirmish map (➤ p. 40).
- **Designed like an art tool.** The menus, tools, and their uses are derived from desktop art tools. If you're familiar with traditional art software programs, *World Builder* will feel very comfortable.
- **What You See Is What You Get.** Interact with your maps through the same engine as the game. Visual toggles and camera options in *World Builder* allow you to position the camera anywhere over the map and to view some or all of its components at any time.
- **Urban objects and textures.** The enormous library of 3D objects includes detailed touches to create realistic cities from all over the world. You can build dense Asian cityscapes, Middle Eastern villages, or modern American sprawl. Objects and textures are included for roads, highways, bridges, and railroads, too.
- **Many environmental settings.** Use textures and settings to place your map in a wide range of geographic locations at any time of day.
- **Small output.** Created maps are small enough to email to your *Command* & *Conquer* friends.

BEFORE YOU BEGIN

✯ Prior to starting *World Builder*, set your display to 800 x 600 or higher in the Display control panel. For information on how to set it, see your Windows® Help file.

To get up and running in *World Builder*, you should do the following:

✯ *World Builder* supports the use of dual monitors. You can design on one monitor and test your designs in the game on the other one.

1. To create a new map, select NEW from the File menu. As you read through this document, you can test out what you learn inside *World Builder*.
2. To get familiar with the components of a *Command* & *Conquer Generals* map, ➤ *Elements of a Map* on p. 8.
3. For explanations of the different elements of the desktop of *World Builder*, ➤ *The Desktop* on p. 10.
4. For explanations about the individual menu items and toolbar controls, ➤ *Command Reference* on p. 14.
5. Follow the step-by-step instructions to build your first multiplayer map. For more information, ➤ *Eighteen Steps to Creating a Multiplayer Map* on p. 36. With a few more steps, you can turn your multiplayer map into a Skirmish map. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

❍ To learn more about how to build specific features in your maps, ➤ *Tutorial: How To* on p. 43.

6. After you feel comfortable building multiplayer maps, you may want to try to create single-player maps. Since behaviors for CPU-controlled armies must be scripted, single-player maps are more difficult to create. For more information, ➤ *Building Single-Player Maps* on p. 42.

CONVENTIONS OF THE TOOL

✯ Length and width distances are measured in feet. To assist in measurement, you can toggle display of the map grid. Each square of the grid measures 10 scaled feet on a side.

❍ To toggle display of the map grid, select SHOW GRID from the View menu.

✯ The most commonly used tools are placed in the toolbar above the Work window. There are many more editing, viewing, and global tools in the menu system. For more information, ➤ *Command Reference* on p. 14.

✯ Depending on the command or object that you have selected, a window appears to the right of the Work window. Change the parameters in this window to alter the properties of the selected item or items.

❍ To select an object on the map, left-click on it. To rotate that object, click and drag the pointer at the end of the object's icon.

❍ To dolly the camera, right-click and drag the mouse to the edge of the screen. Release the mouse-button to stop the camera movement.

✯ If possible, use a mouse with a mouse wheel, which can be used to zoom and pivot the camera.

BEGINNING MAP DESIGNERS

After installing *World Builder* and reading this Introduction, beginning map designers should read the *Getting Started* (➤ p. 7) chapter to learn the basic elements of the application. In the *Laying Out a Map* (➤ p. 30) chapter, some fundamental concepts in designing maps are presented.

Start building a very simple multiplayer map by following the *Eighteen Steps to Creating a Multiplayer Map* (➤ p. 36). If you have questions during the process, you can refer to the *Tutorial: How To* (➤ p. 43) section, which describes in simple steps how to build individual terrain, texture, and object features of a map.

✯ Skirmish maps are made by adding a few more things to a multiplayer map. If you design a good multiplayer map, you can produce a good Skirmish map easily. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

When you have completed your map, be sure to test it in the game.

✯ Since you must script unit, team, and player strategies in single-player maps, they are more challenging to create. It is recommended that you wait until you have some skill in creating multiplayer maps before you start building single-player missions.

ADVANCED MAP DESIGNERS

World Builder is a graphical tool whose design is based on industry-standard graphics applications. If you are familiar with common art packages, the tools of *World Builder* should be fairly intuitive.

As you learn, you may want to review the *Command Reference* (➤ p. 14) section, which outlines every toolbar tool and menu item in some detail.

✯ It is highly recommended that all designers become familiar with the *Eighteen Steps to Creating a Multiplayer Map* (➤ p. 36) and *A Few Extra Steps for Skirmish Maps* (➤ p. 40) materials. These sections present a general, step-by-step approach to developing maps. When you're ready to build the more complicated maps for single-player games, ➤ *Eighteen Steps to Creating a Multiplayer Map* on p. 36.

Additionally, the *Tutorial: How To* (➤ p. 43) provides simple instructions for creating rudimentary features of maps.

✯ For definitions of terminology used in *World Builder*, ➤ *Glossary* on p. 82.

GETTING STARTED

Because the tools of *World Builder* are easy to use, you can begin building usable, multiplayer maps immediately. This chapter discusses how to develop multiplayer and single-player maps in *World Builder*.

- Since single-player maps require behavior scripting of CPU-controlled opposition, you should begin by building multiplayer maps.

At the conclusion of this chapter, you should have enough information to begin development of your own project and references to other parts of the documentation to explore topics in depth.

- Prior to starting *World Builder*, you should set your display to 800 x 600 or higher in the Display control panel. For information on how to set it, see your Windows Help file.
- To start *World Builder*, double-click *World Builder* icon or use the Windows Start menu. The program opens. To begin building a new map, select NEW from the File menu.

Note: *World Builder* requires significant computational and system resources to update the map and your computer screen. If it seems that your computer is updating too slowly, you can adjust the display settings in *World Builder* to improve performance. For more information, ➤ *Improving Performance in World Builder* on p. 81.

Each designer discovers his or her own strategy for designing in *World Builder*. Before you begin designing, you must decide whether your map is a single-player mission or multiplayer/Skirmish design. Multiplayer maps should be more open in design, while single-player maps can be more constrained to create a satisfying flow to the game.

After answering the above question, consider the following ones. What is the basic shape of the map? Is there a dominating terrain feature? Is there a slope to it? Where in the world is the map located? Where are the best locations to build a base? These questions can affect the concept that you begin to implement. For more information on beginning your designs, ➤ *Laying Out a Map* on p. 30.

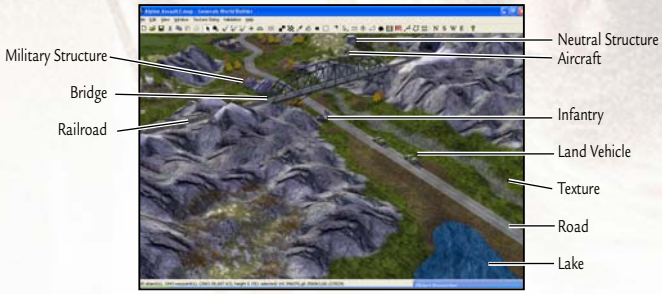
- As you build your map, you are likely to need to reposition the camera and change the scale of the display. For more information, ➤ *Camera Settings* on p. 11.
- When you want to test your work in the game, you can save your map for use in the game. For more information, ➤ *Making Maps Available to the Game* on p. 13.

The following sections provide further details on getting started.

- **Elements of a Map.** Defines the basic components of a map.
- **The Desktop.** Describes the windows, tools, and status information that is displayed in the application desktop.
- **Working with Map Files.** How to accomplish the basic tasks of loading, saving, erasing, and exporting your work.

ELEMENTS OF A MAP

All *Command & Conquer* maps are composed of three basic components: terrain, textures, and objects which are generally developed in that order. Using the tools of *World Builder*, you can add, remove, raise, lower, and shape the **terrain** to describe the land forms of your map. On top of the terrain, you layer **textures** that give the appearance of grasslands, desert, snow, asphalt, or any other earthly surface. Finally, **objects** such as military structures, neutral buildings, civilians, trees, and vehicles are placed around your map for strategic purposes or for a natural appearance.



The table identifies the components of a map and provides basic definitions. Following the table, you can read about the global parameters that you can set for your map.

✯ For more definitions, ➤ *Glossary* on p. 82.

Terrain	Terrain is the mesh underneath the surface that describes the shape of the hills and valleys of the map.
Textures	Textures cover the surface of the map and give the visual appearance of the varying land forms.
Military Structures	Each side has structures with specific military purposes.
Neutral Structures	Neutral buildings on your map can add a strong sense of place and are useful gameplay elements. They can be occupied, commandeered, or just blown up.
Infantry	Each side has multiple types of foot soldier.
Land Vehicles	The land war is usually won with jeeps, tanks, troop carriers, and other military vehicles.
Aircraft	The USA and China sides can develop air capabilities. Map designers should not forget the gameplay effects of aircraft.
Roads	These visual effects of the urban landscape are actually objects. In the game, they become textures.
Bridges	In almost any battle, a bridge becomes a key tactical objective. Bridges can be destroyed and repaired at the end points. Taller bridges require vulnerable support beams.
Railroads	Railroads are specialized road textures with supporting structures like stations, crossings, and tunnels.
Bodies of Water	Lakes and rivers are combinations of specialized shapes and textures. No land vehicle can cross a body of water.
Ambient Sound	You can apply ambient sound to areas of your map such as city streets, markets, and farms. Sounds are placed like other objects. You should have no more than three ambient sounds in any displayed map area.

Trigger Areas	You can define trigger areas as polygons to be referenced in scripts. These areas are invisible to the user but visible to every unit in the game. Through scripts, units can take actions based on activities inside and outside of trigger areas.
Waypoints	A waypoint is a marker that you place on the map. Through scripts, you can reference the waypoint as a location on the map. There are a number of specially named waypoints, which are mentioned throughout this document.
Waypoint Paths	A string of connected waypoints becomes a waypoint path, which can be referenced through scripts. Units and teams of units can be instructed to move along waypoint paths.
Other Map Elements	*World Builder* comes with a full library of miscellaneous man-made and natural objects to spice up your maps.

MAP ENVIRONMENTAL SETTINGS

Map Perimeter. Around the edge of your map, you need to define a map perimeter, which indicates the edge of the map for AI-controlled objects.

❍ To set your map perimeter, click the Border tool in the toolbar. For more information, ➤ *Border Tool* on p. 26.

Default Water Plane. If you scroll to the edge of a newly created map, you can see a blue rectangle. This rectangle is the default water plane for your map. Use this water plane to shape the largest body of water on your map, as its cost on system resources is low. For more information on creating bodies of water, ➤ *Water Tool* on p. 23.

GLOBAL LIGHTING

After you establish the time of day in your map, you can tweak the global lighting for terrain and objects.

❍ To change your global lighting settings, select GLOBAL LIGHT OPTIONS from the Edit menu.

✯ Although they are expensive in terms of performance, you can create custom shadows over individual objects. For more information, ➤ *Edit Shadows* on p. 17.

In the Global Light Options, you can modify the light source over the map.

✯ **Ambient:** Ambient light comes from no single source. Enter RGB values for the ambient lighting. The new color is displayed in the square.

✯ **Sun:** Set the angle of the sun and its 360-degree location around the map. Changes to these positions affect the lighting on the terrain. Set RGB values to change the color of the sun.

✯ **Accent 1:** Define an accent light source using the same controls as Sun placement. An accent is an additional lighting source to highlight a specific area of the map.

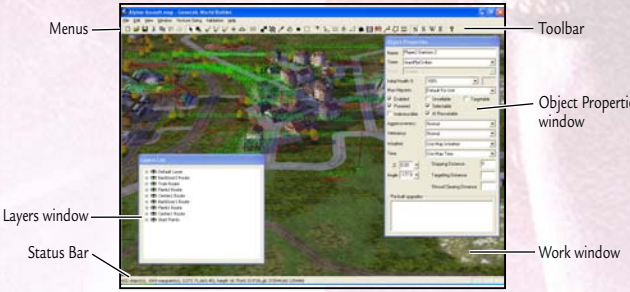
✯ **Accent 2:** Define a second light accent source using the same controls as Sun placement.

✯ **Lighting Applies To:** Apply the lighting settings to selected elements of the map. In rare cases, you may want to light the terrain and the objects differently for mood, but keep the position of the light source consistent.

To restore defaults, click RESTORE TO DEFAULT. To close the Global Lighting Options window, click the X in the corner.

THE DESKTOP

Read this section to learn more about elements found on the desktop of the *Command & Conquer Generals World Builder*.



- **Work window** – The main window in the application, the Work window is where all terrain, textures, and objects are placed and manipulated.
- **Toolbar** – Across the top of the Work window, the most commonly used tools are available as clickable icons. For more information, ➤ *Toolbar* on p. 22.
- **Context windows** – Depending on what tool is selected, a window appears in which you configure the settings of the tool or the object that you are placing.
- **Menus** – From the menu system, you can select commands to edit and view your map or change the textures and windows of it. For more information, ➤ *Menus* on p. 14.
- **Status Bar** – At the bottom of the screen, the Status Bar displays current cursor positional and color information. For more information, ➤ *Status Bar* on p. 27.
- **Layers List** – You can organize objects into visual layers for display purposes. Layers are listed and manipulated in the Layers List. For more information, ➤ *Layers List* on p. 27.

A NOTE ABOUT 3D DIRECTIONS

Movements in three-dimensional space can be described in three directions. Stand up from your computer. Let's call the position where you are located, "Point A."

The **X-direction** refers to steps to the left or right of Point A.

The **Y-direction** refers to steps forward or backward of Point A.

The **Z-direction** refers to changes in elevation from Point A. From where you're standing, movements in the Z-direction require you to jump into the air or dig into the ground.

- As a convention, the direction towards the top of the screen when you first load a new map is considered **North**.

MAP SETTINGS

Through the Map Settings window, you can name and describe your map, as well as set the time of day. The name and description of your map appear in the game.

- To change your map settings, select EDIT MAP SETTINGS from the Edit menu. In the window, enter a name and a description in the spaces provided. Select time of day settings from the drop-down. To accept the changes, click OK.

RESIZING YOUR MAP

To your map, you can add more space or subtract terrain to trim off the unused pieces. It's best to resize your map before you have added many objects or waypoints.

✯ You should have at least an extra 70 tiles (700 feet) on each side of your map as additional workspace.

❍ To resize your map, select RESIZE from the File menu. For more information on creating bodies of water, ➤ *Resize Map* on p. 15.

MAP GRID

You can toggle display of a grid to assist in the placement of objects and the measurement of distances between them. The grid actually displays the 3D wireframe underlying the terrain that you shape.

❍ To toggle display of the 3D wireframe, select SHOW WIREFRAME 3D VIEW from the View menu.

❍ To force placed objects to align with the underlying grid, select SNAP TO GRID from the View menu. Snapping to the grid facilitates placement, alignment, and spacing of objects.

For measurement of distances between objects, you can switch your view to a top-down orientation.

❍ To switch to a top-down view, select SHOW FROM TOP DOWN VIEW in the View menu.

✯ Each grid square is 10 scaled feet on a side. Distances can be measured by counting squares, or you can move the cursor over the two points and compare the locations displayed in the Status Bar. A calculator may help.

❍ To change the number of grid squares displayed on-screen at any time, select PARTIAL MAP SIZE from the View menu. In the sub-menu, select the grid size to display.

CAMERA SETTINGS

You can place the camera over any location on the map and vary its pitch and distance from the terrain. For more information on repositioning the camera, ➤ *Mouse Functions* below.

❍ To change the pitch of the camera, select CAMERA OPTIONS from the Edit menu. For more information, ➤ *Camera Options* on p. 17.

❍ To look in a specific compass direction, use the directional icons in the toolbar. For more information, ➤ *Other Tools* on p. 26.

✯ For information on changing the size of the Work window, ➤ *Window Menu* on p. 20.

VIEW TOGGLES

To simplify your view of the map and to improve performance in *World Builder*, you can toggle the display of various elements on your map.

❍ To toggle display of map components, use the commands under the View menu. For more information, ➤ *View Menu* on p. 18.

✯ For more information on improving the performance of *World Builder*, ➤ *Improving Performance in World Builder* on p. 81.

MOUSE FUNCTIONS

Your primary device for manipulating terrain and textures and placing objects is the mouse. By moving the mouse, you move the cursor over the section of map displayed in the Work window. When using the mouse in conjunction with its buttons, you change the view of the window over your map.

❍ To select an item, click the Select and Move tool in the toolbar. Then, move the mouse over the item and click the left mouse button. To select multiple items, click and drag a selection rectangle over the desired items. All items inside the rectangle are selected and can be manipulated together.

❍ To dolly the camera across the map, click the right mouse button and drag until you are over the desired location.

If possible, use a mouse with a wheel device in *World Builder*. The wheel can be used to zoom in or out of the map and to rotate the camera.

❍ To rotate the camera, click the mouse wheel (if available) and drag the mouse.

❍ To change the height of the camera, roll the mouse wheel (if available).

QUITTING THE PROGRAM

❍ To safely exit the program, select EXIT from the File menu.

✯ If prompted, save your work, or unsaved changes are be lost.

WORKING WITH MAP FILES

This section covers the basic file functions of making maps—from creating a new one to distributing a completed one to your *Command* & *Conquer Generals* friends.

CREATING A NEW MAP

❍ To create a new map, select NEW from the File menu. In the dialog box, enter the X and Y size of the map, as well as the initial height of the terrain. Click OK.

SAVING YOUR WORK

World Builder maps are stored as data, along with references to all of the art that they use. This storage method means that completed maps are usually less than 1.5MB.

❍ To save your map, select SAVE from the File menu.

✯ The default directory for saved maps is inside your My Documents folder. You can choose to save in any directory.

❍ To save a version under a different name or in a different location, select SAVE AS... from the File menu. To save the maps so that it is usable in the game, click USER MAPS. Save the map in that directory.

✯ The Save As feature is useful if you are engaged in major changes to your map or if you want to experiment without committing to the change.

LOADING A MAP

To load your map, you load *World Builder* file. These files end with the .MAP extension.

❍ To load a map, select OPEN from the File menu. Navigate to the folder where you saved your map. Select the .MAP file and press OPEN. Your map opens.

World Builder files contain all of the data necessary to describe the contents of your map. They do not contain the object and texture libraries; in a *World Builder* .MAP file, objects and textures are stored as references to the libraries that are automatically loaded when you load the *World Builder* file.

EARLIER VERSIONS OF *COMMAND* & *CONQUER*

World Builder does not support the loading, saving, or design of maps from earlier *Command* & *Conquer* titles.

ERASING YOUR WORK

In *World Builder*, a few mouse clicks can undo or erase your worst blunders.

UNDO/REDO

If you make a simple mistake, undo it.

- To undo the last action, select UNDO from the Edit menu, or press CONTROL + Z.

✯ The last 10 operations can be undone. Changes to your view of the map cannot be undone.

- To redo an undone action, select REDO from the Edit menu, or press SHIFT + CONTROL + Z.

DELETING OBJECTS

- To delete one or more objects, select the objects in the Work window. Then, press DEL.

DELETING TEXTURES

- To delete a texture, repaint it with a new one.
- To revert to the macrotexture, select the macrotexture with the Eyedropper (➤ *Eyedropper* on p. 24). You can fill in a texture field using the Flood Fill tool (➤ *Flood Fill* on p. 24).

DELETING TERRAIN CHANGES

- To undo a terrain change after you have completed it, press CONTROL + Z.
- To flatten the terrain to height of the surrounding terrain, use the Height Brush tool, configured to the base height of the terrain. For more information, ➤ *Height Brush* on p. 23.

DELETING MAPS FROM YOUR COMPUTER

- To delete a map from your computer, navigate the directory tree of your hard drive to the directory where you have saved your maps. Your map and its support files are contained in a directory named for the map. Click and drag the directory to the Recycling Bin on your Windows desktop.

MAKING MAPS AVAILABLE TO THE GAME

At any time, you can check out your map in the game.

- To load your map in the game, select JUMP TO GAME from the File menu, or press CONTROL + J.

For debugging purposes, you can dump all of the naming, positional and scripting information for the objects in your map to a text file.

- To dump your map to a text file, select DUMP MAP TO FILE from the File menu.

You can share completed maps with friends by sending the file as an email attachment. A completed map should be less than 1.5MB in size.

✯ In online multiplayer games, if the host selects a user-created map, that map is automatically transferred from his computer to all of the players in the game. Single-player maps must be manually transferred to other players.

COMMAND REFERENCE

The Command Reference contains all of the menu and toolbar commands available from the desktop. Additionally, you can learn more about useful displays such as the Layers List and the Object Properties window.

- **Menus** can be accessed from the menu bar at the top of the screen.
- The **toolbar** appears on-screen, and its display can be toggled in the View menu. For more information, ➤ *Toolbar* on p. 22.
- The **status bar** appears along the bottom of the application window. For more information, ➤ *Status Bar* on p. 27.
- The **Layers List** allows you to organize the elements of your map into visual layers whose display can be toggled. For more information, ➤ *Layers List* on p. 27.
- The **Object Properties** window lists the properties for any selected object. For more information, ➤ *Object Properties* on p. 28.

MENUS

FILE MENU

NEW

Create a new map. In the window, enter the dimensions, the basic height, and the background texture to be applied.

Keyboard Shortcut: CONTROL + N

Suggested dimensions:

- Single-player: no larger than 350 x 350 tiles.
- 2-player: 250 x 250 tiles.
- 4- to 6-player: 350 x 350 tiles.
- 8-player: 450 x 450 tiles. If you're creating a map over 400 x 400 tiles, you should have clear reasons to do so. For online games, you may not be able to find seven other players that can play such a large map effectively.

Suggested border:

- 70 tiles (700 feet) on each side.

Suggested initial height:

- 16, if terrain has very mild depressions. Use a setting of 50 if the terrain changes are more drastic.

OPEN

Open an existing map. In the dialog, navigate the directory tree to find the map. Then, click OPEN.

Keyboard Shortcut: CONTROL + O

CLOSE

Close *World Builder* and exit to the desktop. You are prompted to save any unsaved work.

SAVE

Save changes made to an existing project. If the current project is new, then you must enter a filename.

Keyboard Shortcut: CONTROL + S

SAVE AS...

Save the current map under a new file name.

JUMP TO GAME

Save the current map, exit *World Builder*, and load the map in the game.

Keyboard Shortcut: CONTROL + J

NOTE: If your system is capable, you can have *World Builder* and the game open at the same time and thus do not need to use this command.

RESIZE MAP

Add or subtract area on your map. In the window, the current size is displayed. Enter new dimensions for your map. In the Anchor area, click the square where you want to locate the current map inside of the new map. To resize the map, click OK.

NOTE: Resizing the map can change the location of waypoints, waypoint paths, and area polygons. After resizing the map, double-check the location of all of the elements.

PRINT...

Print the current map.

Keyboard Shortcut: CONTROL + P

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

PRINT PREVIEW

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Preview the printout of your map on-screen.

PRINT SETUP...

Windows-based print setup screen.

DUMP MAP TO FILE

Dump name, position, team, and scripting information of every object into a text file. The dumped file is useful for debugging purposes. For example, you can search for objects or waypoints that you can't find on-screen in *World Builder*.

RECENT FILES

List the last four maps opened in the editor. To open a recent map file, select it in the menu.

EXIT

Quit *World Builder*. You are prompted to save any unsaved work.

EDIT MENU

UNDO

Remove the last operation performed on your map.

✯ The last 10 operations can be undone. Changes to your view of the map cannot be undone.

Keyboard Shortcut: CONTROL + Z

REDO

Perform again the last map operation that was undone.

Keyboard Shortcut: SHIFT + CONTROL + Z

CUT

Remove all selected objects and place them on the clipboard.

Keyboard Shortcut: CONTROL + X

COPY

Duplicate all selected objects and place them on the clipboard.

Keyboard Shortcut: CONTROL + C

PASTE

Place the contents of the clipboard at the selected location.

Keyboard Shortcut: CONTROL + V

NOTE: Pasting objects can produce unexpected results. For more information, ➤ *Select Duplicate Objects* below.

DELETE

Remove selected elements from the map.

Keyboard Shortcut: DEL

SELECT DUPLICATE OBJECTS

Select all objects that are located on top of another object. When you use the Paste command, objects are pasted directly on top of the originals so that they look like a single item. You should periodically search for duplicate objects.

✯ Don't place objects on top of each other; use this feature often.

SELECT BAD TEAM OBJECTS

When a created team is deleted, any objects remaining on the map from that team have no team association and can cause problems in the game. Periodically, use this feature to see if any objects have no team.

SELECT SIMILAR

NOTE: Pasting objects can produce unexpected results. For more information, ➤ *Select Duplicate Objects* above.

When you select an object, the Select Similar command selects all objects of the same type on the map.

✯ Select Similar is most commonly used to change properties of object types.

Keyboard Shortcut: CONTROL + M

SELECT MACROTEXTURE...

Note: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Select the background texture of the map.

REPLACE SELECTED...

Replace all instances of the selected object with another object. In the object library, navigate the object tree to find the object to replace. To make the replacement, click OK.

✯ Object properties are inherited by the replacement objects.

PICK CONSTRAINT

When you choose a constraint, all selection tools in *World Builder* select only objects of that type. For example, you can use Pick Constraint to click and drag a rectangle over an area to select all buildings in it.

❍ To return to the default selection mode, select ANYTHING from the Pick Constraint sub-menu.

✯ Use the keyboard shortcuts to pick constraints.

SCRIPTS...

Open the Scripts window (➤ *Scripts* on p. 61).

GLOBAL LIGHT OPTIONS...

Open the Global Lighting window (➤ *Global Lighting* on p. 9).

CAMERA OPTIONS...

You can set camera positioning for use during development. Use this information when developing cinematic scripts.

❍ To set the angle of the camera, enter a new figure in the Pitch textbox.

EDIT SHADOWS...

Set the color (in RGB values) and the opacity of shadows on your map. Raising the default intensity creates harsher shadows.

EDIT MAP SETTINGS...

Open the Map Settings window. Edit the name and description of the map that appear in the game. Select a time of day. To apply the changes, click OK.

NOTE: When you change the time of day and conditions, you may have to re-texture some elements and replace some objects with choices more appropriate for the new environment.

EDIT PLAYER LIST...

Open the *Player List* (➤ p. 55).

EDIT TEAMS...

Open the Teams window (➤ *Building Teams* on p. 56).

VIEW MENU

SHOW GRID

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Keyboard Shortcut: CONTROL + G

SHOW TEXTURE

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Keyboard Shortcut: CONTROL + T

SHOW TERRAIN

Toggle display of terrain changes on the map.

SHOW OBJECT ICONS

Toggle display of colored icons beneath objects to assist in selecting and manipulating them.

Keyboard Shortcut: CONTROL + B

SHOW WAYPOINTS

Toggle display of all waypoints.

SHOW TRIGGER AREAS

Toggle display of trigger areas created with the *Polygon Tool* (➤ p. 26).

SHOW SHADOWS

Toggle display of object shadows. Terrain shadows remain on and are determined by *Global Lighting* (➤ p. 9) settings.

✯ Object shadows impact performance in *World Builder*, so leave them OFF if possible.

SHOW LABELS

Toggle display of identifying labels for sounds and waypoints.

SHOW OBJECTS

Toggle display of objects.

SHOW GARRISONED

Toggle display of flags over buildings controlled by a side.

SHOW MAP BOUNDARIES

Toggle display of the map perimeter.

SHOW SOUND FLAGS

Toggle display of flags used to indicate the position of ambient sounds.

SHOW IMPASSABLE AREAS

Toggle highlighting of areas that cannot be crossed by land vehicles. Use this toggle frequently during development.

✯ Impassable areas should be identified with consistent texturing.

Keyboard Shortcut: CONTROL + I

IMPASSABLE AREA OPTIONS

In the window, you can enter, preview, and set the angle at which terrain becomes impassable.

EA TIP: You can set this tool at any angle to show slopes that are steeper than a desired angle. You can highlight slopes too steep for vehicles to climb or imperfections in base areas and other mesas. Use this tool in combination with the Smooth Height tool to polish your maps.

- To change the angle of impassability, enter a number from 0 to 90 in the Angle textbox.
- To preview the effects, click PREVIEW. The changes are displayed in the map.
- To accept the changes, click OK. To cancel and exit without changing the angle, click CANCEL.

SHOW ALL OF 3D MAP

Toggle display of the entire map. Use this toggle to see how your work in a local area fits into the entire map.

✯ This feature can impact performance, so keep it OFF when you don't need it.

Keyboard Shortcut: CONTROL + A

PARTIAL MAP SIZE

Change the displayed area of the map in the Work window to one of the available selections.

✯ If you are experiencing performance problems, keep this setting at the smallest grid size.

SHOW WIREFRAME 3D VIEW

Toggle display of the 3D wireframe that describes the terrain.

Keyboard Shortcut: CONTROL + W

SHOW FROM TOP DOWN VIEW

Toggle view of the map from a top-down perspective.

EA TIP: Use this feature with the 3D wireframe view to position objects and features relative to each other. If Snap to Grid is ON, then you can use all three tools for careful placement and alignment of buildings, roads, and sidewalks.

Keyboard Shortcut: CONTROL + F

SHOW 3-WAY BLENDS IN WHITE

When textures are blended with the *Auto Edge Out* (➤ p. 24) tool, more than two textures can be affected. Three-way texture blends can cause performance slow-downs in the game, so you should try to find and repair three-way blends. Limit their count to 300 in your map. For more information, ➤ *Three-Way Blends* on p. 76.

SHOW CLOUDS

Toggle display of clouds. In *World Builder*, clouds pass in front of the light source off-screen to create the sense of cloud cover. Showing clouds can affect performance in *World Builder*.

Keyboard Shortcut: CONTROL + U

SHOW SOFT WATER

Toggle display of a softer edge between water and land in *World Builder*. Turn it OFF to improve performance.

SHOW MACROTEXTURE

Toggle display of the background texture. Turn it off to improve performance.

CHANGE TIME OF DAY

Toggle between the four time of day settings: DAY, DUSK, NIGHT and DAWN. Each of the basic settings can be tweaked with custom *Global Lighting* (➤ p. 9) settings.

NOTE: Not all objects can be used during settings such as night. If an object does not have a "Night" image, it disappears from view yet still exists on the map. In the game, players may crash into objects that they cannot see. If you switch the time of day in the middle of development, be sure to double-check the existence of invisible objects.

Keyboard Shortcut: CONTROL + D

SNAP TO GRID

Toggle automatic snapping of any selected objects to align with the terrain mesh grid.

✯ Use this command when the 3D wireframe is visible. It's very useful for city layouts, road layouts, and sidewalks next to them.

Keyboard Shortcut: CONTROL + SHIFT + G

SHOW BRUSH FEEDBACK

Toggle display of the texture or terrain brush passing over the map.

RELOAD TEXTURES

Terrain, object and texture manipulations can cause textures to disappear or to get scrambled. Select RELOAD TEXTURES to reload the textures of your map.

TOOLBAR

Toggle display of the *Toolbar* (➤ p. 22). Some tools are available only through the toolbar.

STATUS BAR

Toggle display of the *Status Bar* (➤ p. 27) at the bottom of the screen.

LAYERS LIST

Toggle display of the *Layers List* (➤ p. 27) window.

WINDOW MENU

In the Window menu, you can set the resolution for the *World Builder* window.

- ✯ **800 x 600** is the default setting. Higher resolutions impact system performance.
- ❍ To reset the resolution and window positions to their default settings, select RESET WINDOW POSITIONS.

TEXTURE SIZING MENU

MAP CLIFF TEXTURES

When textures are stretched across cliffs over 80 feet in height, they can look stretched. To do a special mapping for a cliff surface, click the texture that is stretched, and then select this command. Textures are shrunk to their maximum height without distortion, leaving black areas above and below, which you can fill in with other textures.

REMOVE CLIFF TEXTURES

To remove all special texturing applied to cliffs, select this command.

EA TIP: If you have created a very tall cliff and cannot get textures to look nice on it, smooth the cliff into multiple slopes using the Smooth Height tool.

OPTIMIZE TILE USAGE

During development, you may create two- and three-way blended textures. These can slow down your machine. By optimizing textures, you allow *World Builder* to look at your blended textures to see if it can find similarities between them. Similar blended textures are replaced by a single texture. Optimize tiles before releasing a final version of your map.

REMAP TEXTURES...

Remap Textures lets you replace each texture of your map with a new selection. You may have to remap textures if you change the time of day, geographic location, or conditions.

- ❍ To replace a texture, navigate the texture tree in the window to find a replacement and click OK.
- ❍ To skip that texture, click CANCEL. You can now choose to replace the next texture in your map.
- ✯ After you have remapped textures, you should check your blended textures again.

TEXTURE SIZING INFO...

Display the amount of space and its percentage of the total available occupied by regular and blended textures.

Each map can contain up to 4MB of texture space for regular and blended tiles. You are unlikely to reach the maximum limit for blended textures, but you should check your usage for regular tiles.

- When you are selecting textures in the Terrain Materials Options window, a percentage is listed before each texture name. This percentage indicates the amount of space for regular textures occupied by the texture. Textures that have a 0% indicator are 128 x 128; although they repeat frequently, you are unlikely to run out of space for them. The 4% textures occupy more space, repeat less frequently, and are therefore more suitable for wide-open spaces on your map.

TILE 4 X 4

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Set the texture brush size to 4 tiles x 4 tiles.

TILE 6 X 6

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Set the texture brush size to 6 tiles x 6 tiles.

TILE 8 X 8

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Set the texture brush size to 8 tiles x 8 tiles.

VALIDATION MENU

GENERATE REPORT

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

FIX TEAMS

If you have units on your map that are not assigned to a team, you can use this command to place those objects in the first team listed in the Teams window. However, it usually makes better sense to fix them manually. For more information, ➤ *Fixing Teams* on p. 75.

HELP MENU

ABOUT *WORLD BUILDER*...

Learn more about *World Builder*.

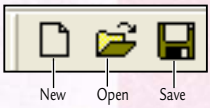
TOOLBAR

The most important tools for shaping the terrain, painting textures, placing objects, and adding waypoints and trigger areas to your maps are located in the toolbar above the main application window for easy access.

- To activate a tool, click its icon in the toolbar.
- To learn the name of a tool, move the mouse cursor over its icon in the toolbar.

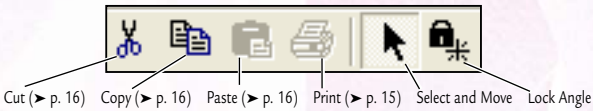
FILE TOOLS

All of the File tools in the toolbar are available from the File menu as well.



EDIT TOOLS

Edit tools that are not available in the Edit menu are described below.



SELECT AND MOVE

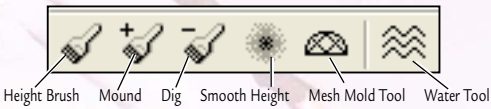
The default tool, the Select and Move tool lets you select, adjust, and move objects. When using this tool, each mouse button has a separate function. For more information, ➤ *Mouse Functions* on p. 11.

LOCK ANGLE

Toggle the locking angle for all selection and placement functions. When the angle is locked, all textures and objects are angled in the same direction, which is useful for urban development.

✶ You can use the 3D wireframe of the terrain as a guide. For more information, ➤ *Show Wireframe 3D View* on p. 19.

TERRAIN TOOLS



When shaping the terrain of your map, it is best to shape the largest elements first and then to work on the finer details. The Terrain tools can scale to accomplish both tasks.

The Terrain tools in the toolbar allow you to raise, lower, and flatten terrain in large and small brushstrokes. When you select a terrain tool, you can configure the settings of your brush in the Terrain Brush Options window. With the Ramp tool, you can create pre-fabricated forms in the terrain with a smoothness and finish that is difficult to achieve by hand.

✶ After manipulating terrain, double-check the placement of all objects located on the changed terrain. Some objects do not conform to the terrain.

After you dig out an area, the Water tool lets you fill the area with water and give it a current like a river or an undulating tide like a lake or sea.

TERRAIN BRUSH OPTIONS

In the Terrain Brush Options window, you can configure the options for the terrain brush used in the Height Brush, Mound, and Dig tools.

- **Brush Width.** The diameter in cells and feet that is affected by the Brush Height setting.
- **Brush Feather Width.** Distance beyond the center circle in which the changed terrain is blended into the surrounding terrain.
- **Brush Height.** The height by which each application of the tool raises or lowers the terrain.

HEIGHT BRUSH

The Height Brush raises or lowers the selected terrain to the height defined in the window. Set the height, width, and feathering circumference from the center point. Then, click on map locations to change the height. The Height Brush is useful for building base areas, cities, and riverbeds.

MOUND

The Mound tool piles more terrain onto the selected location.

DIG

The Dig tool removes terrain from the map based on the settings in the Terrain Brush Options window.

SMOOTH HEIGHT

The Smooth Height tool smoothes the terrain between the edges of the terrain brush. Use the Smooth Height tool to remove impassable areas and odd edges that can be created with the other terrain tools.

- **Brush Width.** Brush diameter in cells or feet.
- **Filter Radius.** The area beyond the brush width into which the tool attempts to smooth. Large values create more smoothing and more dramatic effects.
- **Feather Rate.** The rate at which smoothing takes place. Low values require scrubbing with the tool over an area to get the desired effect.

EA TIP: In many cases, the Feather Rate should be turned up to the highest settings.

MESH MOLD TOOL

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

Instead of forcing you to create common terrain shapes by hand each time, the Mesh Mold tool lets you apply pre-defined shapes into the terrain. The Curved Ramp and Ramp options are useful for creating inclines and declines suitable for roads.

- **Scale %.** Scales the mold applied to the terrain as a percentage of the displayed mold.
- **Height.** The elevation at the center point of the mold.
- **Angle.** The angle of the mold relative to the plane of the map.
- **Adjust Heights.** The Adjust Heights options let you adjust the heights of the surrounding terrain to meet the terrain surface of the applied mesh mold.
- **Preview.** Check this box to see a preview of the mold applied to the terrain.

❍ To apply the defined mold to the terrain, click APPLY.

WATER TOOL

The Water tool lets you fill an area with water to create lakes and rivers.

EA TIP: Bodies of water can be very costly on system resources. Where possible, use the default water plane that is part of any new map. For more information, ➤ *New* on p. 12.

- For more information on how to build lakes and rivers, ➤ *How to Build a Lake* on p. 52 or ➤ *How to Build a River* on p. 53.

TEXTURE TOOLS

When painting textures, you should follow a large-to-small approach as you do for defining terrain. Start with the Large Tile brush or Flood Fill tool to paint terrain over large areas that have few distinctive features. Then, you can use the Single Tile tool to get to the nitty-gritty.

In the Terrain Material Options window, you can select the texture to apply. A sample is then displayed. Behind it is displayed the texture that most closely blends the selected texture to the background macrotexture.

- To paint a texture, select it in the texture tree. Then, click on the location in the map to paint. A texture is painted.

* You can paint textures as passable or impassable for moving units. For more information, ➤ *How to Paint Passable and Impassable Terrain* on p. 46.

SINGLE TILE

Switch brushes to painting textures on individual tiles.

LARGE TILE

Switch brushes to painting textures across multiple tiles. Large tile sizes are set in the *Texture Sizing Menu* (➤ p. 20).

EYEDROPPER

- To select a texture already on the map, click the Eyedropper in the toolbar. Then, click the texture in the map. You can now paint this texture with the other texture tools.

* You cannot select and apply blended textures. Use the source textures and recreate the blend.

FLOOD FILL

- To fill an area with a single texture, select the texture. Then, click the Flood Fill tool in the toolbar. Then, click the area to fill.

AUTO EDGE OUT

This very important tool lets you blend one texture outward into the surrounding textures to create more natural effects. The Auto Edge Out tool blends a selected texture outward and into the surrounding textures.

- To blend one texture into another, click the Auto Edge Out tool in the toolbar. Then, click the texture to blend outward.

NOTE: In some cases, blending may not produce desirable results. You may have to repaint initial textures again before you blend them. Do not apply blends on top of blends.

* It is possible to apply three-way blends, but they can impact performance in *World Builder* and the game.

AUTO EDGE IN

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

BLEND SINGLE EDGE

This tool lets you blend a single edge of a texture tile inward. Use it for detailed work towards the end of your development process.

OBJECT TOOLS

The Object tools on the toolbar assist in the placement of single objects and sets of objects on your map. Using the Place Object tool, you can place single object types one or more times on your map. For specialized objects like roads, fences, and scorchmarks, individual tools let you get the right look. To place natural-looking groves of trees, use the Grove tool.

In single-player maps, each CPU-controlled faction must be directed to build its structures in a specific order through the Build List tool.

PLACE OBJECT

The Place Object tool is used to place any object in the library on your map. For more information, ➤ *How to Place Objects from the Object Library* on p. 47.

ROAD

Roads, bridges, railroads, and sidewalks are specialized textures that you can paint on your map. To create finished versions of these map elements, you should add other objects around them for polish.

✯ For more information, ➤ *How to Build a Road* on p. 49.

GROVE

The Grove tool can be used to create random, natural-looking groves of trees.

✯ For more information, ➤ *How to Build a Grove of Trees* on p. 52.

RAMP

Use the Ramp tool to place ramps in the terrain.

❍ To create a ramp, select the Ramp tool. Click and drag the length of the ramp in the map. In the Ramp Options window, enter a width for the ramp. Then, click PLACE RAMP.

✯ For more information, ➤ *How to Build a Ramp* on p. 43.

FENCE

Use the Fence tool to place fences of all kinds. These fences lack defensive strength.

❍ For more information, ➤ *How to Build a Fence* on p. 49.

ADD SCORCHMARKS

The Add Scorchmarks tool lets you add scorchmarks to the terrain to create battlefield effects. You can change the size and the type of scorchmark in the Scorch Options window.

❍ Like roads, scorchmarks are objects that get baked into the terrain during the game.

BUILD LIST TOOL

The Build List tool allows you to set the order in which CPU-controlled sides build their structures. For more information, ➤ *Build List* on p. 59.

LINE TOOLS

Waypoint Tool Polygon Tool Border Tool

With the line tools, you can create waypoint paths for units to follow, trigger area polygons for use in scripts, and the perimeter for your map.

WAYPOINT TOOL

The Waypoint tool lets you place single waypoints or waypoint paths for moving objects to follow.

- ❍ To place a set of waypoints, select the Waypoint tool. Click a location in the map, and the waypoint is created. Drag to another location, and click again. A waypoint path joins the two waypoints. Continue clicking and dragging until you create the **waypoint path**. In the Waypoint Path Label textbox, enter a name for your waypoint path. You can enter multiple path names for the same set of waypoints as a form of creating aliases.
- ❍ To rename a waypoint, select it. In the Waypoint Options window, enter a new name for the waypoint.
- ✯ Waypoints on the same waypoint path should have consistent names.

EA TIP: A single waypoint can be a useful bookmark or placeholder for unfinished work. Looped sets of waypoints can be used to assign patrols to units.

POLYGON TOOL

The Polygon tool lets you define areas that can be used to trigger script actions. If you are planning to create conditional events based on map locations, you must use the Polygon tool to define those locations.

- ❍ To create a polygon, click the Polygon tool. On the map, click the location for the initial corner. Click and drag to other locations to define the corners and the perimeter of the polygon. In the Polygon Options window, enter an appropriate name for the polygon.
- ✯ Scripts are used to control CPU-controlled units, teams, and players. For more information on scripts, ➤ *Scripts* on p. 61.

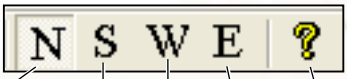
BORDER TOOL

The Border tool is used to define the perimeter of your map. Units and structures can operate only inside the perimeter of the map.

Although the orange perimeter is always the default perimeter, you can create multiple perimeters, each of which can be activated during the mission. Use multiple borders to open new areas of terrain as a reward for the player accomplishing partial goals for the mission.

- ❍ To define the perimeter, select the Border Tool. In the map, click and drag any corner of the orange perimeter to redefine the border.
- ✯ The lower-left corner of the perimeter is always fixed.

OTHER TOOLS



Look North Look South Look West Look East Open Help file

- ❍ To change the direction in which the camera is facing, click one of the directional icons in the toolbar.
- ❍ To open the Help file, click the Help icon in the toolbar.

STATUS BAR

OBJECT COUNT
The number of objects on your map. Try to keep it below 100 objects per player in multiplayer maps and 1,800 objects for single-player maps.

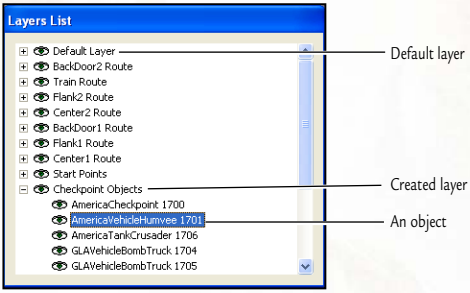
WAYPOINT COUNT
The number of waypoints on your map.

(X-COORDINATE, Y-COORDINATE)
The current X, Y coordinate of the cursor.

HEIGHT
The height of the terrain over which the cursor is located.

RGB COLOR VALUES
The RGB color values of the terrain over which the cursor is located.

LAYERS LIST



The Layers List window displays all map objects in layers. When an object is added to your map, it is placed in the default layer. You can then create a new layer and move objects into it. The display of a created layer can be toggled. Layers are a useful tool for visually sorting your map and hiding objects that don't need to be displayed in *World Builder*. Those objects do remain in your map and appear in the game.

- To toggle display of the Layers List, select LAYERS LIST from the View menu.
- To open the Layers List menu for any item, right-click on it.

The following commands are available in the Layers List menu.

INSERT NEW LAYER
Insert a new layer.

DELETE CURRENT LAYER
Delete the current layer without prompting.

MERGE OBJECT INTO
Merge the selected object into another layer.

MERGE VIEW SELECTION INTO
Merge multiple objects that have been selected into another layer.

SHOW/HIDE CURRENT LAYER
Toggle display of the current layer in the Work window.

OBJECT PROPERTIES

Whenever you select or place an object, the Object Properties window appears and lists the properties assigned to that particular object.

NAME

An object's name is used both in the game and in *World Builder* to identify the art asset.

TEAM

Identify the faction to which the object belongs.

SCRIPT

NOTE: This feature is disabled in the beta release of *World Builder*. It may be available in a subsequent version.

INITIAL HEALTH %

Select the amount of health with which the object begins.

- To enter a custom health level, select OTHER from the drop-down list. In the adjacent box, enter the percentage of health remaining.

MAX HIT POINTS

Select the maximum number of hit points available to the unit.

- ★ It's best to set custom values for hit points using the Initial Health % setting.

ENABLED

The object can move and respond to its environment.

POWERED

The object has power. Without power, an object does not animate and can do nothing.

INDESTRUCTIBLE

The object cannot be destroyed.

UNSELLABLE

The object cannot be sold.

SELECTABLE

The object can be selected.

AI RECRUITABLE

The object can be recruited by units on the same CPU-controlled side to execute scripted orders.

TARGETABLE

The object can be targeted by enemy units.

AGGRESSIVENESS

Select an aggressiveness rating from the drop-down list.

- To put the object in sleep mode, select SLEEP. An object in sleep mode responds to movement orders and nothing else. It is a good way to get units into a new position without allowing them to be distracted by the environment.

EA TIP: Through scripts, changes to a unit or team's aggressiveness are simple to do and significant in effect. With an elevated aggressiveness, units appear to be executing a series of commands. Yet, you did not have script them. It's an inexpensive way to respond to the player's actions.

VETERANCY

Select a level of experience and ability for the unit from the drop-down list.

- The default setting is **NORMAL**, which means units have no experience.

WEATHER

In rare cases, you may want to change the weather and time around an object to get a better appearance. To use weather effects other than those applied to the map as a whole, select an option from the drop-down list.

TIME

To apply a different time of day to the object's model, select from the drop-down list.

Z

Set the elevation of the object relative to the terrain (Z=0).

EA TIP: Negative values can bury the object for interesting visual effects. Be careful, though. Additional terrain changes can bury the object entirely.

ANGLE

To change the angle of the object, enter a figure in the space provided. East = 0. Positive figures climb towards North.

STOPPING DISTANCE

To change the stopping distance for moving vehicles, enter a new figure in the space provided.

- Changing the stopping distance is most useful for building cinematic scripts. For most map development, use the default settings.

TARGETTING DISTANCE

Set the maximum distance at which the object can begin targeting other objects.

SHROUD CLEARING DISTANCE

Set the maximum distance that the object can peel back the black shroud to reveal what is underneath it.

PRE-BUILT UPGRADES

If the object already has upgrades when it is created, list them here.

LAYING OUT A MAP

The best *Command & Conquer* maps tell a story. Whether it is a single-player or multiplayer map, a good one creates a sense of time and place, as well as establishing the nature of the gameplay. Based on the terrain and resources on the map, savvy players immediately begin formulating their strategies, which in turn shapes the struggle to win the campaign.

However, a good designer never takes control of the storytelling away from the player or players. In deciding the layout of your map, you always want to create situations with open-ended possibilities. For example, a good designer creates multiple entrances to a base area or critical piles of resources between two base areas.

★ For ambitious designers who are creating multi-mission campaigns, it's a good idea to have a sense of the content of each mission and the shape of the story before you begin.

This chapter can provide some useful tips and issues to consider.

BASIC DESIGN DECISIONS

A good design is a delicate, yet flexible balance between a myriad of decisions. A good designer is always looking ahead. To the degree that you can, make decisions at the beginning of your project about the following issues.

SINGLE-PLAYER OR MULTIPLAYER

The first decision: Are you creating a single-player or multiplayer map?

★ The third kind of map, a Skirmish map, is a multiplayer map with a few more elements. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

Successful designs for single-player and multiplayer missions vary greatly. A well-designed single-player map applies escalating pressure on the player as the battle progresses, with satisfying results for conquering the challenges.

★ When scripting behavior for single-player missions, remember that you are not creating a fair system. You are creating the *perception* of a fair one inside of a satisfying user experience. The difference is critical; if you can create more interesting challenges by providing information to CPU-controlled sides through scripting, do it. For more information on scripting, ➤ *Scripts* on p. 61.

Multiplayer maps are more open-ended. In a multiplayer map, you want each player to begin at relatively equal strength in terms of map position, tactical advantages, and available resources. Consequently, maps that favor an arena style of organization tend to create more interesting multiplayer missions.

DRAMA VS. REALISM

Before you begin to work on your map, you should make some essential decisions. Are you creating a realistic simulation of a location in the world? Or, are you creating a fantasy environment? A realistic map requires more detailed work in molding the terrain, choosing your textures, and placing objects. While it can be a lot of fun to create, for example, battles in your hometown, you may find yourself spending significant time looking at offline maps and photographs.

If you go for the dramatic approach, then you can focus on creating the most interesting gameplay for all participants in your map.

Of course, the best maps blend drama and realism. It's a good idea to have an impression of where your map fits along the spectrum.

THINK SPACE

Many user-created maps reflect the creator's preferred style of play. For beginning users and designers, that style favors turtling up in a base to develop an overwhelming army to crush the opposition. To support this style of play, designs tend to have only one way in and out of a base and are filled with objects. Lacking open space and containing too many units, maps of this variety produce slow, drawn-out games that tend to follow a predictable slugfest pattern. Try to keep plenty of open space in your map. Openness means flexibility, and a good designer tries to accommodate multiple gaming styles in his creations. For more information, ➤ *Accommodating Varying Styles of Play* on p. 33.

NOTE: You cannot limit a start location to a particular army, so do not design start areas of your map to be for the GLA only, for example.

- Don't isolate bases from each other. Isolation inherently favors sides with air power, so the GLA is at an immediate disadvantage on those maps.

GEOGRAPHIC LOCATION, AND TIME OF DAY

What time of day does the battle begin? Where is your map located in the world? Is it a desert environment? Is it up in the mountains? How many trees do you want in your map?

Making decisions about the location and time of day at the beginning of development can impact the design of your map. For example, if you're placing it in wooded terrain, remember that trees are objects that can impact performance. After you have decided the when, where, and what of your map, you should spend some time in the object library and texture library assessing which elements are going to work for your map. For more information, ➤ *Object Library* on p. 47.

DEGREE OF DIFFICULTY

Particularly for single-player missions, the degree of difficulty is an important consideration and covers many aspects of design.

Do the challenges grow as the player expands his control towards CPU-controlled locations? And finally, do you want the player to be able to have a different experience depending on the Normal, Hard, or Brutal difficulty setting that he selects in the game?

EA TIP: In general, the approach to difficulty ramping based on user-controlled settings is to create the map under either the easiest or the hardest setting. Then, you can scale up or back in units, structures, and behaviors for the other settings. For more information, ➤ *Ramping Difficulty* on p. 63.

Degree of difficulty also covers design elements that have nothing to do with hostile opposition. For example, if the base area closest to a player's start location is very small, then the player must fortify that location and expand into new territory early in the game. His forces are extended, making him more vulnerable.

OTHER DIFFICULTY FACTORS

- Are players able to begin building full bases easily? Most designs provide a supply depot close to the user's start point, but interesting possibilities are available if the user enters the map with a strike force that he must use to find supplies and start a base at some distance from his start point. Note that collection units cannot automatically collect supplies from depots far from the base; the player must direct them to the location.
- How hard is it to find additional resources? You can increase the challenge by placing supply depots close to or far from a player's start point. If one player must travel significant distance to reach a supply depot while another has two depots close to his start location, the first player faces a greater challenge.
- How many entrances are there for each base location? While each base entrance should have at least three entrances to it, you can create a different kind of challenge by having only one entrance to an area that is sunken below the surrounding terrain. So, while the player can defend the entrances to his base easily, it is important for him to gain control of the terrain above his base location.
- What are the terrain advantages? Are there terrain disadvantages? Is the shortest route to the enemy's base fraught with peril? Will the successful general drive a blitzkrieg force through a terrain disadvantage, or should he circumnavigate the danger area with a much larger, occupying force? The best maps, of course, allow all of these possibilities and more.
- Are there bridges? A bridge in a well-designed map offers a tactical advantage for the team that can control it, yet the advantage should be counterbalanced by the difficulty of defending the bridge. Never let a bridge be the only path between two areas of the map.

In multiplayer missions, the degree of difficulty is a factor, yet you should tend towards keeping the map open, even, and conducive to combat.

While you may not have answers to all of the above questions, it's important that you know what you don't know. It's reasonable to postpone resolution until you're actually shaping the map with the tools. However, you should be aware that making large-scale changes can take a long time when you are far into development.

EA TIP: If you have yet to resolve some of these fundamental issues, you should try to figure them out as soon as possible. Alternatively, you can regularly use the SAVE AS... feature to save copies of your map.

MAKE A SKETCH

Whether you do it by hand or in an art application, create a sketch of your map before you begin. While your final map is likely to change significantly from an initial sketch, it does give you a clearer view of the relative positions of large features on your map and the space that you need to create them.

- You should also write on your sketch major design decisions such time of day, geographic location, mission objective, and story synopsis (if applicable).

EA TIP: When planning your map on paper, use graph paper. You can scale each cell to a number of *World Builder* units, following the suggested map sizes. For more information, ➤ *New* on p. 12.

- For a good example of an initial sketch prepared in an art tool, ➤ *Appendix A: A Good Initial Sketch* on p. 85.

MAP DESIGN ISSUES

In very rough-cut form, plan your entire map before you begin. Keep in mind the following concerns:

- How big is the entire land plot on which the map sits?

EA TIP: Whatever you need to design a map, add 70 tiles (700 feet) in all directions. You can always trim back at a later time. You can also reposition your map on the land plot.

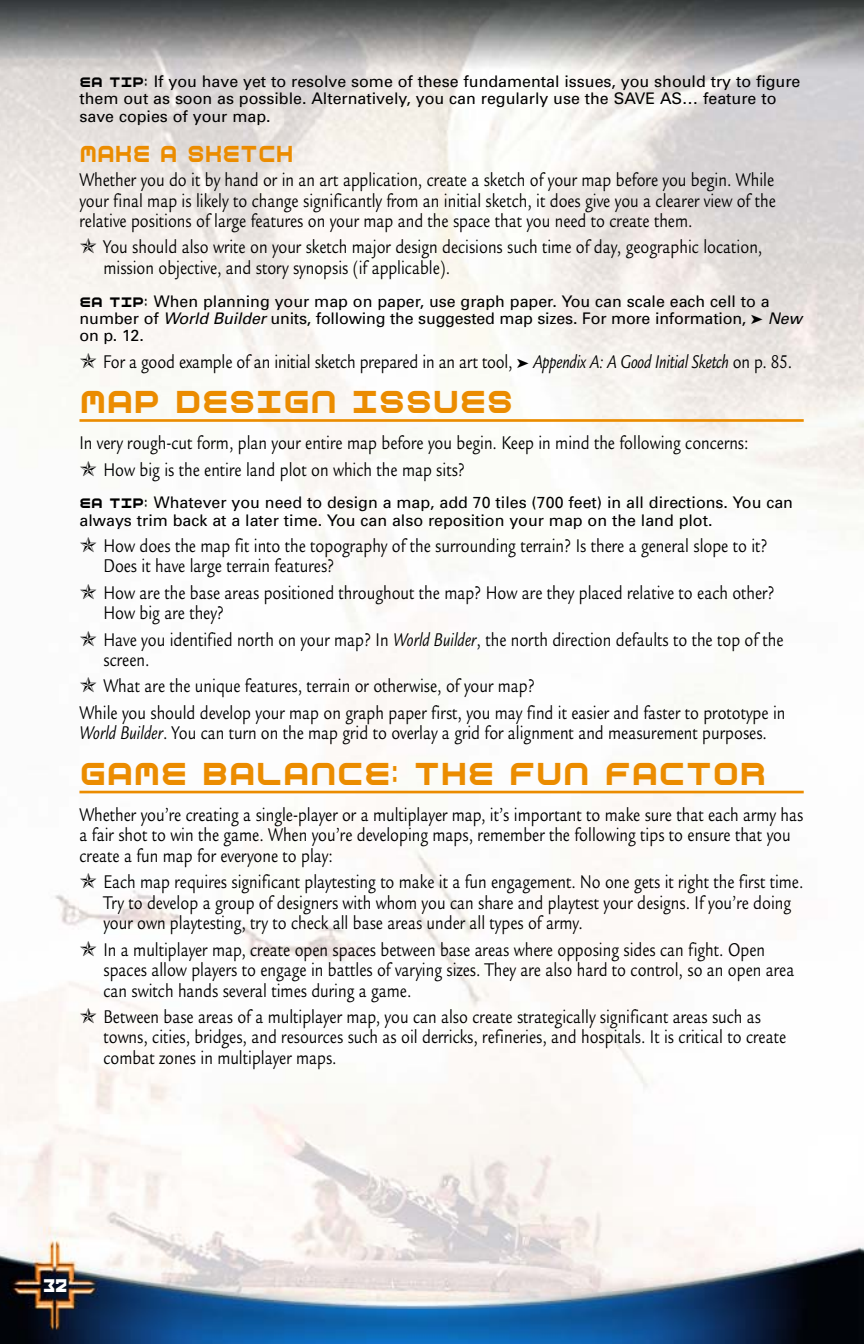
- How does the map fit into the topography of the surrounding terrain? Is there a general slope to it? Does it have large terrain features?
- How are the base areas positioned throughout the map? How are they placed relative to each other? How big are they?
- Have you identified north on your map? In *World Builder*, the north direction defaults to the top of the screen.
- What are the unique features, terrain or otherwise, of your map?

While you should develop your map on graph paper first, you may find it easier and faster to prototype in *World Builder*. You can turn on the map grid to overlay a grid for alignment and measurement purposes.

GAME BALANCE: THE FUN FACTOR

Whether you're creating a single-player or a multiplayer map, it's important to make sure that each army has a fair shot to win the game. When you're developing maps, remember the following tips to ensure that you create a fun map for everyone to play:

- Each map requires significant playtesting to make it a fun engagement. No one gets it right the first time. Try to develop a group of designers with whom you can share and playtest your designs. If you're doing your own playtesting, try to check all base areas under all types of army.
- In a multiplayer map, create open spaces between base areas where opposing sides can fight. Open spaces allow players to engage in battles of varying sizes. They are also hard to control, so an open area can switch hands several times during a game.
- Between base areas of a multiplayer map, you can also create strategically significant areas such as towns, cities, bridges, and resources such as oil derricks, refineries, and hospitals. It is critical to create combat zones in multiplayer maps.



ACCOMMODATING VARYING STYLES OF PLAY

In addition to getting feedback on bugs and overall quality in your map, playtesting with other people lets you see how your map might be played by players with different gaming styles. It's important to avoid forcing players to win a game with only one playing style. You also do not want to allow players to win by relying on a single gaming style. The following is a short list of some of the more common playing styles and how they can be accommodated and limited in your maps:

- **The Air Cavalry.** Some players rely heavily on air power to attack the enemy and defend their positions. Since air power is unavailable to the GLA, you should have AI-controlled GLA sides build Stinger sites early in a single-player game. For multiplayer maps, open space and buildings that can be re-enforced with anti-air infantry can effectively limit air power. One of the most effective tactics for the Air Cav types is to drop units at the back of an enemy's base, so be sure to leave a little space behind each base area to mount a surprise attack.
- **The Early Rushers.** Some players attack as soon as they possibly can. While you want to encourage combat, it isn't fun for other players if they get wiped out in the first two minutes. A choke point can limit Early Rushers, and multiple openings to each base area allows for effective counter-attacks.
- **The Turtlers.** New players in particular tend to hunker down in their base areas and build and build their bases and units. In all maps, it's good to have some worthwhile resources, such as strategic buildings, supply depots or oil derricks near each base area. These resources provide incentives for the Turtlers to expand out of their base areas. In single-player maps, an early attack from AI-controlled sides can rattle a Turtler's shell.
- **The Nukers.** A subset of the Turtlers, some players wait and wait until they can build and deploy their super weapons. These players tend to avoid combat, which makes for dull games for the other players. Again, base areas with multiple access points are harder to defend. For China and USA sides, their super weapons require a great deal of power, so in single-player games, you can script strikes on their power plants when these sides approach super weapon capability.
- **The Road Graders.** Some players prefer to build a massive mechanized army to crush the opposition. These players slowly and steadily build an army of tanks, which can clutter the board and slow down the game. While open spaces can encourage mighty battles, you as a designer can limit the scope of them by creating a variety of smaller objectives that cannot be won as easily with a huge army. For example, scattering resource depots on the map splinters an army. Additionally, strategically placed choke points can slow the progress of a large army, giving defenders a chance to thin the herd. In single-player games, regular attacks by AI-controlled sides can slow down the build-up.
- **The Commandos.** Particularly for fans of the GLA, the strike-and-move method of attack is appealing. To assist the Commando types, you can create strategically advantageous positions on your map from which to launch attacks. Buildings that can be garrisoned provide a great opportunity for a small force to effectively thwart a larger one. Also, units on higher terrain have a longer range of attack than the units on lower terrain, so it's never a bad idea to have ridges overlooking base areas. Multiple entries and space at the back of a base area allow for Commandos to make their mark. Commandos, however, are vulnerable to air attack and can be easily defeated at choke points. You certainly want to reward players that find clever and sneaky ways to bring a small strike force to bear against a larger and more powerful enemy.

When you are planning out your map, you may want to examine it from the perspective of all of these types of players. How would a Commando-style player approach each base area? Are there possibilities for the Road Grader to enjoy this map? While it's impossible to please every player and style, considering each style often illuminates mistakes and leads you to simpler and more effective ways to build a better map.

LAYOUT DO'S AND DON'TS

The previous section alludes to a number of the critical design considerations for any map. Whether it is a single-player, multiplayer, or Skirmish map, the following Do's and Don'ts apply.

DON'T

- Don't litter the map with sources of money. For good balance, each player should have access to $40,000 to $60,000 with comparatively the same difficulty in gaining and holding the resources. Be careful in the number of oil derricks that you leave on the map, as these permanent sources of funds can affect the balance of play at the end of a game. In general, too much money on a map results in massive slugfests that can take a long time to play and can slow frame rate in the process.
- Don't confine yourself to the rectangular or symmetrical map. Although the map perimeter is defined with a rectangle, you can build impassable terrain such as mountains or bodies of water along the edges to reshape the playable area of your map. Additionally, you can script changes in the active map perimeter, effectively opening new terrain. While maps of differing sizes, shapes, and symmetries do limit the possibilities, they can be a lot of fun to play.
- Don't put larger buildings and objects in the front and center of your maps. While players can rotate the camera, they tend to keep it in the standard view. So, objects that you place behind these larger objects can get hidden. Place large objects towards the rear and the extremities of the map.
- Don't become infatuated with choke points. It's easy to fall into the trap of creating choke points where a few units can hold off a whole army. If you have too many choke points, the game can be slowed down too much. It's probably a good idea to have, at most, one choke point per base. When you do create a choke point, it should be as wide as least five tank lengths at a minimum.
- Don't isolate bases. Don't make them difficult to access either through protection by natural resources, hiding them behind a maze of mountains, or on islands. The GLA, in particular, needs room to maneuver.
- Don't make the only access to a base area over a bridge. It sounds like a fun idea to make the Bridge Over the River Kwai, but such maps make for bad games. Bridges are frustrating attack routes and usually offer advantages to the defenders. If a bridge is a set piece to your map, make sure that there's at least one other way to cross the gap.
- Don't build King of the Hill maps. If you create one base area in the middle, then that army must fight all of the others. If that general is successful, then everyone else is frustrated. Either have all of the base areas in the middle or all of them on the perimeter.
- Don't overlap textures. Choose a good macrotexture, and build your texture fields so that they do not overlap. It's very easy to create long seams of three-way blended textures by overlapping. You can create nice effects without the overlap.
- Don't use massive objects like the Fortress Wall or a Dam in your maps often. If you must, make them Indestructible and Unselectable.
- Don't build lots of flowing rivers. Flowing rivers are expensive in terms of system resources. Instead, try to build rivers that cut into the map and then cut back out.
- Don't go crazy building fences. Each individual unit in a shrub fence, for example, is an object. A long string of fences of this type is a big hit on system resources.
- Don't build mazes in your maps. It causes problems for pathfinding units and slows down the game. Generally, maze maps aren't much fun either.

DO

- Do utilize space. Space, space, and more space. Create plenty of open space in your maps. You should physically lay out a base at the start points to provide ample room for the player or AI.
- Do choose a theme for your map and stick with it. Maps that change direction in the middle of development are easy to spot. Choose a climate, time of day, and a location (urban or rural) for your map. You can combine some of these elements; a number of good maps have been placed at the edge of a big city. Make a choice and stick to it; write down your commitments so that you don't forget them.
- Do build large areas for your bases. A rule of thumb that some designers have used is to make a base area the size of 5 x 5 Command Centers. Since they are the largest structures in the game, airfields can be useful in measuring out space for a base area.
- Do build space at the back of each base area where troops can be dropped for surprise attacks. Most players build their initial defenses to face the opposition and rarely consider the back of the base. Later in the game, as the conflicts have heightened, a well-timed attack by infantry units from the back can do serious damage, change the balance of the game, and make it more enjoyable (for everyone else).
- Do create open space between base areas in a multiplayer map. These areas become combat zones that often determine who controls which areas of the map. The early and middle games are all about control of the map, so create the spaces where these battles can be resolved.
- Even in an urban setting, create as much space as possible. Units can have a hard time finding paths through urban environments if they are too congested. The rule of thumb is to have at least five tank lengths of width for any choke point.
- Do check to make sure that there are at least three ways to access each base area. There should be two direct routes, and a third indirect route. Each entrance should be some distance from the other routes. In single-player games, an effective scripting technique is to have the initial attack come from the front for Normal and Hard difficulty and to have the first hit to come from the tertiary route on Brutal difficulty.
- Do create a palette of textures in use. As you use a new texture, it's a good idea to paint a small swatch of the texture outside the map perimeter. You can use the swatch to quickly select the texture and to track the number of textures in use on your map.
- Do give cliffs their own unique texture. It helps to identify them for the player who may be looking ahead to plan routes into the enemy's base, only to discover there's a "hidden" cliff in the way. It is critical to visually identify impassable areas like cliffs with artwork that is unique from playable terrain.
- Do build visual set pieces such as farms, oases, town squares, and the like. These set pieces give a real sense of place and add a lot to the atmosphere. Many user-created maps neglect these elements, and their maps look like arenas instead of environments. To build good-looking set pieces, determine the geographic setting for your map, build one set piece with which you are satisfied, and then add the other ones through copy, paste, and edit. If the set piece has no strategic value to the map, keep it small: no more than six objects.
- Do limit yourself to about 100 objects per player in a multiplayer map. Use your props wisely.

EIGHTEEN STEPS TO CREATING A MULTIPLAYER MAP

World Builder is a deep and sophisticated tool that you can use to create dynamic multiplayer maps. While our in-house designers have been using and perfecting this tool for years, you can begin right away to create exciting maps of your own by following these eighteen steps.

- Skirmish maps are created from completed multiplayer maps. By adding a few elements to your finished multiplayer map, you can create a good Skirmish map. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

CARDINAL RULES FOR MULTIPLAYER MAPS

- Space is key. Make as much space as possible between base areas and in the base areas. Lacking sufficient space, the Skirmish AI can place buildings in odd places.
- For each player, try to make $60,000 in resources, which is two supply piles of standard size. A single oil derrick is an optional addition, and, if used, it should be a goal to reach near the player's base. Refineries tend to be destroyed if they are captured by a side.
- Avoid using lots of civilians in multiplayer maps. They slow frame rate and get in the way of the fun. If you must use them, do so in limited numbers. A total of six civilians on a looping waypoint path is usually sufficient.
- **Maximum multiplayer map sizes.** While it's possible to exceed these map sizes, you should have good reasons to do so. For two-player maps, the max size should be 250 x 250 tiles. For four to six players, 350 x 350. Eight player maps should not exceed 450 x 450. If you make a map larger than 400 x 400, you should have a clear reason for doing so.
- Keep 70 tiles (700 feet) of space beyond the map perimeter on each side of your map. This overflow area serves as a staging area and a workspace for terrain features that flow into the map.

EIGHTEEN STEPS FOR MULTIPLAYER MAPS

- During the course of development, you may discover problems with your map that defy resolution. For more information, ➤ *Debugging* on p. 75.

1. **Decide the map layout.** Before you begin, you should have a good idea of what you're trying to develop in your map. What will it look like? What is the basic topography? Are there any distinctive features to the map? Is there a general slope to the map? Is it in an arid climate? Or is there snow on the ground? What time of day will the battle take place? How many sides will participate? A design decision is a commitment, and making more decisions at the beginning of development can streamline the process of finishing the map. For more information, ➤ *Laying Out a Map* on p. 30.

- You should have a good idea of the design unknowns, too. Try to resolve them as soon as you can during development. Use the SAVE AS... feature to experiment with those unknowns.
- For information on changing the settings for your map, ➤ *Map Environmental Settings* on p. 9 and ➤ *Map Settings* on p. 10.
- You can change the background texture of your map using the Flood Fill tool. For more information, ➤ *Flood Fill* on p. 24.

2. **Prototype your map.** When you're deciding your layout, you may choose to sketch your ideas on paper. To flesh out your ideas in the map, follow a top-down approach. Figure out the largest features of the map, such as lakes, mountain ranges, valleys, cities, and rivers. Also, you should have a basic idea of where you want the various sides to build their bases. Decide their location and begin using the tools in the order described in the following steps.

- For a good example of an initial sketch prepared in an art tool, ➤ *Appendix A: A Good Initial Sketch* on p. 85.

EA TIP: You can essentially create a graph paper overlay for your map. In the View menu, turn ON Show Wireframe 3D View and Show from Top Down View. The displayed squares are 10 scaled feet on each side.

- ✯ Units that come to the edge of your map can, in some cases, exit the map. To prevent such exits, create impassable terrain on the perimeter or paint impassable textures to prevent passage. For more information, ➤ *How to Paint Passable and Impassable Terrain* on p. 46.
- ✯ Build large areas for your bases. A rule of thumb that some designers have used is to make a base area the size of 5 x 5 Command Centers. Remember to consider that the USA and China may have to place airfields, the largest structures in the game, so check them, as well.

3. **Set waypoints.** It's a good idea to mark the locations of bases and resource depots early in the map development process. Since users cannot erect buildings on uneven terrain, you should identify these locations as soon as you can.

- ✯ Add waypoints for important features such as bridges, railroads, roads, and cities. Of critical gameplay value are the locations of resource depots, oil derricks, and crates.
- ❍ To set a waypoint in your map, click the Waypoint tool in the toolbar. In the Waypoint Options window, enter a name for your waypoint.

NOTE: If you are creating waypoints to identify where players are going to begin in a multiplayer map, the names must follow a specific format. For example, "PLAYER_1_START" is always the starting location for Player 1. For each player in a multiplayer map, you must also create a player in the Player List. For more information, ➤ *Player List* on p. 55.

4. **Build the basic terrain.** The Height Brush tool lets you flatten areas to the same elevation. Using the Mound and Dig tools, you can shape the terrain. As you move the mouse back and forth over an area, you begin piling (or digging) more terrain on the map. At this point, you just want to create the basic features in their approximate locations at relative heights to each other. For more information, ➤ *Smooth Height* on p. 23.

- ❍ To view the underlying mesh of the terrain, select SHOW WIREFRAME 3D VIEW from the View menu.
- ❍ To view the entire map, select SHOW ALL OF 3D MAP from the View menu.

EA TIP: The entrances and exits of each base area are very important for gameplay. Each base should have at least three entrances to it. Fewer entrances allow users to fortify their bases too easily. Also, don't create choke points that are tighter than five tanks across, or you may experience pathfinding problems for your units.

- ✯ If you're going to add bodies of water, make sure that you reserve space in your map for them.

5. **Check the size.** Now that you have created the basic terrain and the locations of your major gameplay elements, is the map big enough to contain everything? Remember that you have to add extra workspace to your map and should create impassable terrain at the edge. So, adjust your map size accordingly.

- ❍ To resize a map, select RESIZE under the File menu. For more information, ➤ *Resize Map* on p. 15.

6. **Build the terrain in detail.** You're now ready to get the terrain just right. Use the Mound and Dig tools to raise and lower terrain to the heights that you want. These tools can create rough-looking terrain, so use the Smooth Height tool to blend the peaks and valleys into a more natural appearance.

- ❍ To refine the brush used with each terrain tool, change the properties in the Terrain Brush Options window that appears when you select a tool. For more information, ➤ *Terrain Tools* on p. 22.
- ❍ To see if a piece of terrain can be passed over by a vehicle, select VIEW IMPASSABLE AREAS in the View menu. Use the Smooth Height tool to make these areas passable, if desired.

7. **Add a perimeter to your map.** To create a more natural appearance, you should have a fringe of unplayable terrain around your map that is at least 70 tiles on each side. You should also have terrain on the edge of your map that units cannot cross. Terrain shapes that begin on the map can use this perimeter area as overflow, so that you avoid abrupt edges to your maps.

- ❍ To create a map perimeter, click the Border Tool in the toolbar. Then, click and drag any corner of the orange perimeter to resize the actual playable surface of your map.
- ✯ Make sure that the orange border and the blue border cover the same area.
- ✯ All maps are rectangular in shape, and the lower-left corner of your map perimeter is always fixed.

EA TIP: If you don't want to create a set of natural elements at the edge of your maps to create impassable terrain, you can paint textures along your perimeter as impassable. These textures should be unique and appear impassable. Do it at the end of your development process. For more information, ➤ *Texture Tools* on p. 24.

8. **Create waterways.** Next, create the bodies of water on your map. Left-click on the Water Tool in the toolbar. Then, click and drag in the map to create the perimeter of the water polygon. Adjust the settings in the Water Tool Options window to set the height of the water and the density of control points in it.

✯ When shaping a water polygon, you do not need to fit it exactly to the shape. In fact, you can shape a water polygon around multiple lake beds or rivers. Create the polygon so that it merely encloses the area.

EA TIP: When possible, use the default water plane in your map. For more information, ➤ *New* on p. 12.

❍ To reshape your body of water, click and drag any control point.

❍ To create a lake, click CREATE WATER POLYGON. To identify the shape as a river, click RIVER. Then, click in the area to begin the flow of the water texture.

✯ While lakes have tides, river water textures have flowing currents. For more information, ➤ *How to Build a River* on p. 53.

9. **Paint textures.** Now that all of your terrain shapes have been created, you can paint textures on them to create realistic map features. In the toolbar, select the Large Tile tool to begin. In the Terrain Material Options window, you can select the texture and define your texture brush.

✯ Textures are organized in folders based on appearance and geographical connections. All textures in the same folder should work well together.

❍ To select a texture from the map with which to paint, select the Eyedropper tool in the toolbar. Then, click the texture to use. That texture can now be painted with the other texturing tools.

✯ You can also fill a defined area with a single texture. For more information, ➤ *Terrain Tools* on p. 22.

EA TIP: When you select a new texture to paint, place a single-tile swatch of it outside the perimeter of your map. A texture palette simplifies the selection, tracking, and replacement of textures on your map.

10. **Refine and blend textures.** After using the Large Tile and Flood Fill texturing tools to define the large texture areas, you can use the Single Tile tool to tweak the textures of individual cells. Additionally, you can blend textures together.

❍ To blend two textures together, click the Auto Edge Out texture tool in the toolbar. Then, select the texture that you want to blend into the surrounding textures.

NOTE: You can add some three-way blends between textures, but be careful. Don't have more than 300 three-way blends on your map, or you may experience performance problems in the game. For more information, ➤ *Auto Edge* Out on p. 24.

❍ To blend a single edge of a texture inward, use the Blend Single Edge tool. For more information, ➤ *Blend Single Edge* on p. 24.

✯ **What about the funny textures on cliffs?** When you apply textures to steep surfaces such as cliffs, the textures are stretched to cover the area. The results can be ugly. To smooth a cliffside texture, select MAP CLIFF TEXTURES from the Texture Sizing menu. Then, click the texture to map as a cliff. For more information, ➤ *Map Cliff Textures* on p. 20.

11. **Place combat and civilian objects.** Now that you're satisfied with the terrain and textures of your map, you're ready to place objects on the surface.

✯ Place only objects that exist at the beginning of the game. Objects that are appear during the course of the game are created through scripts. For more information, ➤ *Scripts* on p. 61.

❍ To place an object on the map, click the Place Object tool in the toolbar. In the window, navigate the object library tree to find the object to place. Change its properties as needed. Click in the map to place the object.

❍ To move an object, click and drag it. To rotate it, click the edge of the icon and drag the object to a new angle. To delete an object from the map, click it and press DEL.

EA TIP: For a multiplayer game, don't have more than 100 objects per player on the screen, or users may experience performance problems. For single-player missions, limit yourself to 1,800 total objects.

12. **Roads, railroads, and bridges.** Roads, railroads, and bridges can be key tactical points on your maps and add color to your urban landscapes. These elements are specialized textures that are treated like objects. For more information, ➤ *How to Build a Road* on p. 49, ➤ *How to Add a Sidewalk* on p. 50, and ➤ *How to Build a Railroad* on p. 50.

✯ **Groves.** You can also use the Grove tool to place natural-looking groves of trees on your map with just a few clicks. For more information, ➤ *How to Build a Grove* on p. 52.

✯ **Fences.** Use the Fence tool in the toolbar to lay down non-military fences. For more information, ➤ *How to Build a Fence* on p. 49.

13. **Place resources on your map.** Supply docks, oil derricks and loose piles of supplies are key elements in balancing gameplay. Place these items in equal quantity at equal distance from the starting points for each player.

✯ In the Object library tree, resource objects are located under Civilian\Structure.

EA TIP: A good guideline is to budget $40,000 - $60,000 for each player on the map. If you exceed this range, you may experience performance problems later in the game due to a large number of created objects.

14. **Create and Name Waypoints.** If you're adding more waypoints for units to follow or as markers for the placement of other materials, do so now.

❍ To place a waypoint, select the Waypoint tool in the toolbar. Click a location on the map. The waypoint is created. In the Waypoint Options window, you can change the name of the waypoint. For more information, ➤ *Waypoint Tool* on p. 26.

✯ Sets of waypoints can be sequenced together into waypoint paths that units and teams can follow. For more information, ➤ *How to Build a Waypoint Path* on p. 48.

15. **What's the ambiance?** Ambient sound can be added to your map to add life to the civilian structures on it. You can add the sounds of dogs, birds, markets, and cars—among others.

✯ In the object library tree, ambient sounds are listed in Civilian\Audio.

EA TIP: Put no more than three ambient sounds in any screen. Test ambient sounds in the game for appropriateness.

16. **Test in the game.** When you have finished adding all of the elements to your multiplayer map, test it in the game. Spend some time in the map as a single player, and test it with a couple of friends who are willing to help you find problems with it. No one gets it right on the first pass, so be patient with yourself. The simplest answer is usually the best one.

❍ To open a user-created map in the game, select SOLO PLAY from the Main menu. Then, select SKIRMISH. In the Skirmish Setup screen, click SELECT MAP. User-created maps are listed under Unofficial Maps. Select your map, and click ACCEPT. In online multiplayer games, user-created maps are automatically transferred to all players who join the game.

17. **Optimize tiles.** During development, you may have blended textures together in order to create subtler, more realistic effects. However, blended textures can be a burden on the game. Prior to releasing your map, you should attempt to optimize your texture tiles.

❍ To optimize textures, select OPTIMIZE TILE USAGE from the Texture Sizing menu.

✯ For more information on steps to optimize your map, ➤ *Optimizing Your Map* on p. 78.

18. **Ship It!** When you are ready to distribute your multiplayer map, all of your gaming buddies must have it installed on their system. A completed map should be approximately 1MB and can be emailed as a set of attachments.

✯ When using multiplayer maps online, the creator of the map should host the game. The map is automatically transferred to all players that join. Single-player maps must be transferred via email, FTP, or the like.

❍ To install a user-created map, create a directory inside the Maps directory of the *Command & Conquer Generals* game directory. Give the directory the **exact** name of the map file, minus the filename extension. Place the map file, the .TGA preview file, and any other related files inside that directory. The map is then available through the Skirmish Setup screen in the game.

A FEW EXTRA STEPS FOR SKIRMISH MAPS

A good multiplayer map makes a good Skirmish map as well, because a Skirmish map is, in fact, a multiplayer map that is playable by only one player. All other players are controlled by the CPU. The design of a Skirmish map is identical to the method described to build multiplayer maps, with a few extra steps.

✯ For more information on creating multiplayer maps, ➤ *Eighteen Steps to Creating Multiplayer Maps* on p. 36.

1. Before you begin building your map, read all of these instructions so that you can plan ahead to convert your multiplayer map to a Skirmish map.
2. **Complete Multiplayer Steps 1 – 17.** Build a multiplayer map to completion, including playtesting.
3. **Save your completed multiplayer map under a different name.** You should work on a separate file for your Skirmish map.
4. **Set up trigger areas for each base.** For a Skirmish map, the AI opponents must have some information embedded into the map so that they can figure out what to defend, what to fight for, and how to attack the human player. The following steps provide the means for the AI to do so. Each base area needs two trigger areas defined for the AI, and another trigger area is shared by all CPU-controlled opponents.

❍ To create a trigger area, click the Polygon tool in the toolbar. Left-click the first location for defining the trigger area. Left-click at the turn points on the perimeter of the trigger area, and then left-click on the first location to finish creating it.

❍ To assign a name to the created trigger area, type the name in Area Name textbox of the Area Trigger Options window.

✯ **Outer Perimeter.** The outer perimeter of a CPU-controlled base is the first stage of alert. When an enemy unit breaches the outer perimeter trigger area of an AI-controlled base, the available units of the AI player address the threat. In defining the outer perimeter for a base, you want to make it neither too big nor too small. When it's too large, the AI reacts too soon, attacks small scouting parties needlessly, and exposes himself to counterattacks from other directions. If it's too small, the AI reacts too late to prevent damage to the base structures. The name of the outer perimeter for start location #X **must be**, "OuterPerimeterX" where X is the number of the start location.

✯ **Inner Perimeter.** When the inner perimeter of a CPU-controlled base is breached, the AI drops everything to address the threat. Consequently, the inner perimeter should not be much larger than the base area itself, as units and defensive structures already created by the AI can address less-than-immediate threats. However, if a tactical advantage such as a choke point is some distance from the base, it may make more sense to define the inner perimeter to include that point. The name of the inner perimeter for start location #X **must be**, "InnerPerimeterX" where X is the number of the start location.

✯ **Combat Zone.** Each map must have one and only one combat zone trigger area. The combat zone encompasses everything that is not part of the base areas or their perimeters. While incursions into the combat zone do not prompt automatic responses from AI opponents, they do signal to the AI that the stakes of the game have been elevated. Define the trigger area polygon for the combat zone to be everything that is not part of a base area. The name of the combat zone polygon **must be**, "CombatZone".

5. **Define entrances to each base with waypoint paths.** Did you build three entrances to each base in your multiplayer map? Those entrances must be identified and named so that the AI can figure out how to attack each base area. The names to these sets of waypoints are specific.

- To define an entrance to a base, click the Waypoint tool in the toolbar. Outside a base, click in a location that is beyond the outer perimeter and in front of one of the base entrances, and then drag towards the base to set the next waypoint. Click and drag waypoints until the final waypoint of the path is just inside the inner perimeter.
- To name the created waypoint path, click in the first text box below Waypoint Path Labels in the Waypoint Options window. Each base needs three waypoint paths under the following naming conditions:

- **Center Path.** The center path defines the most direct, obvious route into a base. The path **must be** named, "CenterPathX" for start location #X. On the easiest difficulty setting, the initial attack usually comes from this route.
- **Flank Path.** The flank path defines the secondary route into a base. The path **must be** named, "FlankX" for start location #X.
- **Backdoor Path.** The backdoor path defines the least obvious and often the most vulnerable route into the base. The path **must be** named, "BackdoorPathX" for start location #X. On the hardest difficulty setting, the initial attack may come from this route.

6. **Add Skirmish players.** Finally, you must add the AI players to your Skirmish map.

NOTE: Before you add Skirmish players, double-check to see that you do not have another named player in the Player List. If you add a building for a side that is not yet represented in the map, *World Builder* automatically creates the player. Maps with more than one player that have Skirmish players added to them are invalid for use in Skirmish games. Remove the extra players and any Skirmish players, and then add back the Skirmish players.

- To add Skirmish players, select PLAYER LIST from the Edit menu. Click ADD SKIRMISH PLAYERS. All of the information needed to add the required number of Skirmish players is included in your map. The hooks for the AI are integrated through these references. Click OK.

- **Save and play.** Save your map, and give it a try.

BUILDING SINGLE-PLAYER MAPS

Designing single-player maps is a bit more complicated because the designer is responsible for all of the challenges. Instead of relying on players to challenge each other, you must present a carefully constructed set of challenges for a single player.

The time you spent learning the nuances of each side's strategy and tactics can now be applied to your single-player designs. While the steps for single-player designs do overlap with multiplayer, there are a few extra steps to consider when building single-player maps.

1. **Additional Design Issues.** Before you begin, you should consider all of the issues outlined in Multiplayer Step #1. Then, you should think of issues specific to single player. What is the "story" of the mission? Are there any scripted events that happen at the beginning of the mission? Are there "plot points" at which events should occur? How many sides are on the map? With what resources, structures, and units does each side begin? Is the player started at a disadvantage? What are the civilian resources?

EA TIP: When designing the story of a single-player mission, keep in mind that the player is more interested in playing the game than reading text. Storylines should be very clear and easy to tell. Changes to the plot in the middle of the mission should be direct and re-inforced with displayed text and physical changes to the map, such as the arrival of new objects from off-screen.

2. **Complete Multiplayer Steps 2 – 10** (➤ *Eighteen Steps for Multiplayer Maps* on p. 36).
3. **Edit the Player List.** How many CPU-controlled players are going to participate in the mission? Are there multiple CPU-controlled players playing the same faction? Are there any alliances? These questions need answers in the Player List.

O To open the Player List, select EDIT PLAYER LIST from the Edit menu. To create a new player, click NEW PLAYER. In the drop-down, select the faction template to apply to the player, and click OK. For more information, ➤ *Player List* on p. 55.

4. **Complete Multiplayer Steps 11 – 14.**
5 **Write Your Scripts.** Scripts determine unit behavior based on events in the game. The essential structure of a script is: IF (condition), THEN (Action1) ELSE (Action2).

O Scripts are the keys to creating dynamic single-player missions. To open the Scripts window, select SCRIPTS from the Edit menu. For more information, ➤ *Scripts* on p. 61.

6. **Complete Multiplayer Steps 15 – 18.**

TUTORIAL: HOW TO

World Builder tools are easy to learn and versatile in application. While many of these tools take a few seconds to master, some of the core design tasks require attention to detail to produce professional-quality maps. This section covers the step-by-step processes for completing core tasks necessary to build a map, and you may find a tip or two to simplify development and improve results.

O To learn the names of tools in the toolbar that are referenced in this section, move the mouse and hold it over a tool.

HOW TO BUILD A HILL

In the *World Builder*, a hill is created using the Mound terrain tool. By painting over and over an area with the Mound tool, you heap terrain on top of terrain, creating mounding effects that are smoothed by the application into the surrounding terrain. With practice, you can learn to create sharp cliffs, craggy mountains, gentle knolls, and tiny undulations in the terrain.

1. To build a hill, click the Mound button in the toolbar. It looks like a paint brush with a plus sign (+) next to it.
2. The cursor changes, and the Terrain Brush Options window opens. In the Terrain Brush Options window, you can configure the Brush Width, Brush Feather Width, and Brush Height before you begin painting terrain. For more information, ➤ *Mound* on p. 23.
3. In the map, click and hold the mouse button when the mouse is at the location where you want to add terrain. As you hold down the mouse button, terrain is added around the cursor according to the parameters set in the Terrain Brush Options window. Continue clicking, holding, and moving the mouse back and forth until you've created the approximate shape that you want for your mound.
4. To soften the effects of the Mound tool, use the Smooth Height tool in the toolbar, which smoothes curves along the edge of your terrain shapes. For more information, ➤ *Smooth Height* on p. 23.

HOW TO BUILD A VALLEY

Building a valley is very similar to the process used to build a hill.

1. To build a valley, click the Dig button in the toolbar. It looks like a paint brush with a minus sign (-) next to it.
2. Repeat steps 2 – 4 for How to Build a Hill until you are satisfied with the results.

HOW TO BUILD A RAMP

No matter how carefully you add and remove terrain, you're going to have a very hard time creating smooth inclines and declines. For these terrain effects, use the Ramp tool.

1. In the toolbar, click the Ramp tool.
2. In the map, click the start location for the ramp and drag to its end location.
3. In the Ramp Options window, select the width for the ramp.
4. To create the ramp of terrain, click PLACE RAMP.
6. The ramp is placed.

O To undo the placement of the ramp, press CONTROL + Z.

HOW TO BUILD AN AREA FOR A BASE

When you design a map, you must designate areas where each side can build its base. A base area must be of sufficient size to accommodate all of the buildings that the side needs in order to win the map. What is this size? Unfortunately, there is no golden rule. However, if you follow these steps, you should minimize the amount of reworking required during the remainder of your designing process.

1. **Each base should have a minimum of three entrances to it.** Whether the base faces human- or CPU-controlled opponents, experience suggests that it's possible to defend two entrances effectively. However, defending a third entrance is very hard to do. If all bases face similar challenges, the game gets interesting in a hurry.

✯ For single-player base areas, you should consider the nature of the mission and how much of the tech tree is going to be available to the base creator. If he can access everything, then the confrontation is likely to be large and requiring of many base structures. However, for specialized single-player missions with a reduced tech tree, you may not need to build a large base area. It can be a good idea to give a human player a few buildings with which to commence the mission.

2. **The minimum width for each base entrance is five tank lengths.** You can create smaller entrances, but they are easy to defend and can inhibit CPU-controlled units from finding pathways through them.
3. **Place all of the structures that you think the player needs in order to win the game.** The USA and China sides tend to require more space, as they need power and have very large structures like the airfield. Place all of the structures with room between them so that tanks and infantry can maneuver.

✯ If you're building a single-player map, you may want to place the structures using the Build List, as you can see the power requirements needed for the base. If more power is needed, more power plants and, hence, space are needed.

4. **Draw a polygon trigger area around the base area.** When you are satisfied that you have enough space to build your base, draw a polygon trigger area around it. This polygon trigger area is just a marker.
5. **Delete the placed buildings.** Unless you have placed the buildings using the Build List and intend to keep them on your map, remove them.

❍ To remove a group of objects, use the Select and Move tool to click and drag a rectangle around the objects. Then, press DEL.

6. **Flatten out the base area.** When you have defined the polygon trigger area, you should make the space inside of the area as flat as possible. While the building of base structures can flatten some small undulations in the terrain, structures cannot be built on a slope of any significance. So, it's best to use the Height Brush tool to make the surface as even as possible. For more information, ➤ *Height Brush* on p. 23.

✯ Don't worry about scenery objects such as trees and rocks. They are excavated by the construction units when base structures are built.

HOW TO PAINT TEXTURES

You can paint textures in large or small tiles.

1. To paint a texture, select either the Large Tile or Single Tile tool in the toolbar.
2. In the Terrain Materials Options window, you can navigate the texture tree to preview and select the texture to paint.

✯ When you are selecting textures in the Terrain Materials Options window, a percentage is listed before each texture name. This percentage reflects the memory consumed by painting the texture. For more information, ➤ *Texture Sizing* Info on p. 21.

❍ To use the texture partially hidden in the Terrain Materials Options window, click SWAP. This texture reflects the "midpoint" between the current texture and the macrotexture.

✯ For the Large Tile tool, you can change the width of the brush in the Terrain Materials Options window.

EA TIP: As you paint a new texture, add a one-square swatch of it outside the area of your map. You can build a palette of all of the textures in your terrain, which makes for easier selection and replacement of them.

3. In the map, click and drag over the areas to paint with the selected texture. Cover the entire area, and don't worry about the shape of the edges.

✯ Don't overlap textures too frequently. Choose a good macrotexture, and build your texture fields so that they do not overlap. It's very easy to create long seams of three-way blended textures by overlapping. You can create nice effects without the overlap.

EA TIP: When painting textures over a large area, use one base texture over an area and add a couple of textures for nice effect. Apply the textures using the Flood Fill tool. Keep five grid cells between blended areas, or you may have to address three-way blends. When in doubt, start over and repaint.

HOW TO BLEND TEXTURES

After you have painted an area, you may want to blend the texture into the surrounding textures for better appearance and edging.

❍ To blend the texture into the surrounding areas, select the Auto Edge Out tool in the toolbar. Click inside the texture area to blend outwards.

❍ To blend a single edge of a texture and smooth its appearance, select the Blend Single Edge tool in the toolbar. Click and drag from one texture across the sharp edge and into the other. The edge is softened.

HOW TO COPY TEXTURES

While you cannot currently copy texture shapes from one location to another, you can quickly select textures from one area and apply them to a new one.

❍ To select a texture, select the Eyedropper tool in the toolbar. For more information, ➤ *Eyedropper* on p. 24.

NOTE: You cannot select blended textures, which are algorithmically created. When you select a blended texture, you select the texture beneath it. You can then recreate the blend in a new location.

HOW TO PAINT PASSABLE AND IMPASSABLE TERRAIN

During the course of development, your manipulations may create terrain forms that are impassable to vehicles and units. You can paint those units as passable. Similarly, you can paint passable terrain as impassable, which is more commonly done.

WARNINGS

It can be tempting to repaint the entire map as either passable or impassable as you see fit. However, doing so may cause problems, so please read the following warnings and paint with caution.

- If there is no gameplay reason for units to cross the terrain, make it impassable.
- Do not paint cliffs as passable terrain. It looks bad to have tanks climbing vertical surfaces, as the sense of a real-world experience is lost. The ability to climb cliffs can cause problems for the long-range targeting of some vehicles, too.
- In general, do not turn terrain that is naturally impassable into passable terrain. In *World Builder*, terrain that is steeper than 45 degrees is impassable—and should stay that way.
- Resizing the map will cause impassable areas to revert to default 45 degrees.
- Do not paint the terrain at the edge of a body of water as passable terrain. Vehicles that pass into water can get stuck underwater. It's a much better idea to paint the entire perimeter of a body of water as impassable.
- Do not create islands of passable terrain inside of seas of impassable terrain. For example, if there is a spot of passable terrain at the top of an impassable mountain, AI players may attempt to drop paratroopers inside the passable terrain. Units trapped inside a sea of impassable terrain spend the rest of the game trying to get out and cause a significant impact on the frame rate. Instead, paint the entire area as impassable.
- Do paint impassable textures around the outside of the map perimeter. Particularly for single-player maps, it's important to limit the ability to move beyond the map.
- Paint impassable terrain beneath boulder objects.

To Paint:

1. Under the View menu, select SHOW IMPASSABLE AREAS.
2. To set the angle at which terrain becomes impassable, select IMPASSABLE AREAS OPTIONS under the View menu. For more information, ➤ *Impassable Area Options* on p. 18.
3. To paint terrain as passable or impassable, select the Single Tile or Large Tile tool in the toolbar.
4. At the bottom of the Terrain Materials Options window, check the box next to Paint passable/impassable terrain. Choose whether you are painting Passable or Impassable terrain.
5. On the map, begin painting the selected textures. Remember to observe the warnings above.
6. When you complete your painting, it's a good idea to give a texture clue that the ability to pass an area is not what is expected. For example, if you painted a rocky slope as passable, you should repaint it with a softer texture. Such painting helps users figure out where to go.

HOW TO PLACE OBJECTS FROM THE OBJECT LIBRARY

Objects include structures, infantry, vehicles, aircraft, and all types of civilian items.

✯ Place only objects that appear at the beginning of the map. Objects that are created and appear later in the mission are placed using scripts. For more information, ➤ *Scripts* on p. 61.

1. From the toolbar, select the Place Object tool.
2. In the Object Selection Options window, navigate the tree to find the object to place. Click the object.

✯ Do not use objects with names beginning with "CINE_". These objects are for use only when creating cinematics. They should not be placed on the map.

3. In the map, click the location where you want to place the object. The object is placed.

❍ To place another instance of the object, click in a new location.

4. In *World Builder*, you can place any object anywhere on the map; the terrain beneath it is not considered. Either before or after placing the object, you should reshape the terrain for a more natural appearance.

✯ You can partially bury some objects for a different look. For example, a half-buried tree becomes a bush. However, it's recommended that you don't try these effects until you have settled on the shape of your terrain.

5. After the object has been placed, you can configure its properties. For more information, ➤ *Object Properties* on p. 28.

HOW TO ROTATE AN OBJECT

❍ To rotate an object, select the Select and Move tool in the toolbar. Click and drag the outer line of the icon in the middle of the object. The object rotates.

HOW TO REPOSITION AN OBJECT

❍ To move an object, select the Select and Move tool in the toolbar. Click and drag the object to a new location. Adjust the terrain and texture underneath the object, as needed.

HOW TO COPY AND PASTE AN OBJECT

❍ To copy and paste an object, select the Select and Move tool in the toolbar. Click the object. Select COPY from the Edit menu. Then, select PASTE. The object is pasted **directly over the original**. Click and drag the copy to a new location.

HOW TO ADD ANY STRUCTURE ON YOUR TEAM

Assigning a placed structure to a defined team requires just a few more steps.

1. Follow Steps 1 – 5 in How to Place Objects from the Object Library.
2. In the Object Properties, select the player team to which the structure belongs from the Team drop-down.

❍ To define a player team, select EDIT PLAYER LIST from the Edit menu. For more information on defining player teams, ➤ *Player List* on p. 55.

HOW TO ADD AIRCRAFT

Depending on the type and role of the aircraft that you are adding, you should follow these steps.

HOW TO ADD A HELICOPTER

❍ For Chinooks and Raptors that are part of a mission at its beginning, place them on the map like any other object.

HOW TO ADD A JET AIRPLANE

Only the USA and China sides have jet aircraft.

1. USA Auroras and Chinese MiGs require airfields. Prior to adding these jet planes, you must provide them with an airfield. To place an airfield, ➤ *How to Place Objects from the Object Library* on p. 47.
2. After the airfield is placed, you can place up to four jet aircraft at each airfield. To add a fifth aircraft, you must build another airfield.

✯ At the start of a mission, planes do not have to be placed on an airfield. Planes that begin at an airfield are assigned to that airfield, while planes that begin away from an airfield try to find one with an available hangar.

HOW TO ADD AN AIRCRAFT FOR ONE-TIME USE

For cinematic effect or other one-time use, you may want to create aircraft to enter the map, perform a function, and then exit.

1. To create the aircraft, use the Place Object tool. Place the aircraft outside the perimeter of the map. For more information, ➤ *How to Build a Map Perimeter* on p. 54.
2. Define the waypoint path that you want the aircraft to follow. For more information, ➤ *Waypoint Tool* on p. 26.
3. Create the script events that 1) create the plane object, 2) define its target and action, 3) cause it to egress along the waypoint path, and 4) get destroyed after its job is done.

HOW TO BUILD A WAYPOINT PATH

You can develop waypoints or sets of waypoints called **waypoint paths** which units can be ordered through scripts to follow during patrols, attacks, or reconnaissance assignments.

✯ Try to design your waypoint paths to be essentially straight. At most, give them a nice arc. Avoid S-turn paths, as they cause pathfinding problems for units.

1. To begin placing waypoints, select the Waypoint tool in the toolbar.
2. At the location of the first waypoint on the map, click and hold the mouse button. The first waypoint is created.
3. Drag the mouse to the location of the second waypoint. Click and continue dragging until you have created all of the waypoints of the path.
4. When you have finished creating the waypoints of the path, enter a unique name for the path in the Path Labels textbox.

❍ To select all of the waypoints in a path, press CONTROL and then click one of the waypoints.

HOW TO BUILD A FENCE

NOTE: While fences can add nice touches to your maps, each section of fence is an individual object. Your object counts can climb very quickly if you build a long fence. So, use them cautiously, and try to select longer fence objects from the object library.

1. Before building your fence, flatten the terrain beneath its location. While you can place fences over uneven terrain, the results are mixed.
2. Select the Fence tool in the toolbar.
3. In the object library, select the fence object to place. Remember the name of the object that you used.
4. Click and drag each segment of the fence that you want.

❍ To place fence objects one by one, press SHIFT as you click locations.

5. Be sure to examine the fence that you placed. You may have to place individual instances of the fence object to smooth corners or fill in gaps.

✯ It's a good idea to use the *Snap to Grid* (➤ p. 19) feature to align fences with the underlying terrain.

HOW TO BUILD A ROAD

A road is treated as an object in *World Builder*. In the game, however, it is baked into the terrain and becomes a texture.

✯ You can automatically create intersections that have up to four different roads of the same type. To create larger intersections or ones involving dissimilar road types, you must take additional steps.

1. Before you place the road, you must prepare the terrain. While roads can climb hills, you should avoid placing the road on terrain that slopes across the grain of the road. Placement of roads on such terrain can cause unnatural spiking in the road object. Use the Smooth Height and Height Brush tools in the toolbar to create a flat bed for your road.
2. To place the road, select the Road tool in the toolbar.
3. In the Road Options window, select the type of road to place.
4. From the start position of the road, click and drag a small section of road. Right-click to move the screen a bit. Click the end of the first section of road and drag a new section. The corners are automatically smoothed. Repeat this technique (click-and-drag, right-click, click-and-drag) until you have created the road.

✯ Don't create turns in your roads that are greater than 90 degrees. They are unsightly and can cause performance problems. Create very sharp turns as a series of more gradual turns.

5. When you have finished placing the road, you should check the corners. You can change the smoothness of the corners.

❍ To change the shape of a corner, click the middle of the corner. An icon should appear. In the Road Options window, select a different corner type. Click APPLY TO SELECTION. The corner is changed.

6. **Intersections.** Roads of the same type automatically connect when you bring them together. However, you can create new intersections after you have placed your entire road.

❍ To create a new stretch of road off an existing road, click in the middle of the existing road at the point where you want the new road to begin. Drag a stretch of road away from the existing road. The intersection is automatically formed.

❍ To create an intersection between dissimilar road types, drag the second road to the edge of the main one. Do not try to overlap the two roads; get them as close as possible without touching. Select the end of the second road. In the Road Options window, select Add End Cap and click APPLY. A nice overlapping touch is applied from the second road onto the first.

✯ For intersections involving more than four roads of the same type, you must offset the additional roads from the main intersection.

How to Add a Sidewalk

The process of adding a sidewalk next to a road is simply adding a second road object parallel to the first.

1. Click the Road tool in the toolbar.
2. In the Road Options window, select the sidewalk to apply.
3. In the map, click the start location of your sidewalk. Try to match the turnpoints and shape of the road.
4. Change the type of corners as needed to get the proper appearance.
5. After you have placed the sidewalk to your satisfaction, you may want to examine the seam between sidewalk and road. Sometimes, inadvertent gaps appear, which you can cover using specialized textures. Select either the Single Tile or Large Tile tool in the toolbar. Browse the texture library to find a texture that blends well between the look of the sidewalk and the road. When it is applied, the texture appears beneath and between the two road objects.

How to Build a Railroad

Building a railroad can take some time to do, but the positive effect on the ambiance of your map is worth effort.

A train does not associate much with the rest of the map or the elements on it. It destroys almost anything in its path, except for civilian buildings, which may be train stations.

- Trains are also very hard to kill. While some cars, including the locomotive are combustible, the locomotive is the hardest unit to destroy in the game. Only a GLA Demo Trap placed directly in the path of the locomotive can destroy it.

Follow these steps to build a railroad for your map:

1. **Read all of these steps first.** Early steps affect later steps.
2. **Flatten the terrain for the tracks.** If the slope of the terrain is more than one percent (1%), the train's appearance may be ugly.
3. **Lay down the tracks.** Select the Road tool from the toolbar. In the object library, select a railroad type. Lay down the tracks in the desired arrangement. Get the layout to your satisfaction. It's best to create looping track. For more information, ➤ *How to Build a Road* on p. 49.
4. **Lay down the waypoint path for the train.** When you set waypoint paths, you need to lay out the waypoints according to the following rules:

- The order in which the waypoints wind must be consistent and in one direction. Do not double-back your waypoints.
- To make the train persist on the map, you must have a closed loop. Trains on tracks with a terminus are present one and only time in the map.
- In turns on your track, place the waypoints very close together. Each change in direction should be slight in order for the train to see the next waypoint.
- Interrupt long, straight stretches of track with waypoints. A rule of thumb is to place a waypoint every 100 map units, which is roughly the length of one reactor object. The train can follow long stretches of track, but the sound effects are less satisfying.
- You cannot have diverging waypoint paths or tracks. You can have two tracks converge into one, and the second track must join the first in one and only one place.
- For more information on building waypoint paths, ➤ *How to Build a Waypoint Path* on p. 48.

5. **Associate the train with the track.** Select the Place Object tool from the toolbar. Select a train engine object from the Civilian Vehicle category of the object library. Place the icon of the engine on top of a waypoint, its arrow pointed in the direction of the next waypoint.

- ✯ You can have only one engine per train.
- ✯ You can place multiple trains on a single track. If they collide, they can explode.

6. **Place the cars of the train behind the engine.** Each car must be placed directly behind the car in front of it, and its arrow must point towards the center of the car in front. You can string trains around corners.

- ✯ If no car is placed behind the engine, a default set of cars is used.
- ✯ Trains can be of any length.

7. **Add stations.** To define Waypoint12 as a station, for example, change its name to "Waypoint12Station" with a capital "S." In the game, the train stops at that waypoint for 10 seconds before continuing.

- ✯ **Ping-Pong stations.** A train leaving a Ping-Pong station exits in reverse to create a shuttling behavior. To define a waypoint as a Ping-Pong station, give it the name, "NamePingPong". To create a Ping-Pong railroad, you must have two Ping-Pong stations and a closed loop, and the train must be started between stations.

8. **Add a station object if you want.** Although they are not necessary, train stations are in the Civilian category of the object library.

9. **Bridges and Tunnels.** Trains normally follow the changes in terrain. However, to build a tunnel or a bridge, the train must follow the direct line between two waypoints.

- ❍ To define an upcoming segment as a bridge or tunnel, select the first waypoint and give it the name, "NameTunnel". The train follows the straight line between that waypoint and the next one.

10. **Add tunnel entrances.** For tunnels, you should place a Civilian tunnel entrance object in front of the hill.

11. **Test your railroad in the game.** Watch a few cycles of the train's path to see how well it works.

HOW TO BUILD A BRIDGE

When you build a bridge, you must prepare the terrain before laying down the bridge. The heights of the two ends of the bridge must be roughly equal. While you can have discrepancies of a couple feet, you should avoid creating bridges that have significant slope to them, as they create pathfinding problems for the units.

- ✯ You cannot create turns in bridges. To create a turn in your bridge, build a an island at the turnpoint. The island should be wider than the bridge and large enough to serve as a gathering point for armies crossing the bridge.

1. Check the height of each terminus of the bridge or bridge segments. The heights of a segment should be within a few feet of each other.
2. Select the Road tool in the toolbar.
3. Navigate the Bridges category of the object library to find the bridge you want to place.
4. Click and drag from one bridge endpoint to the other. Make sure that you have plenty of overlap onto the ground next to the gap. Do not create bridges that barely touch the edges of the gap, as units may not be able to cross them.

HOW TO BUILD A GROVE OF TREES

Using the Grove tool, you can create random groups of multiple types of trees to give your vegetation a natural appearance. Some tips:

- ✯ Trees are objects and can impact performance in large numbers. You can create nice effects with as few as six total trees. Create groves of more than 40 trees only if you're sure you want them.
- ✯ When creating forested areas, remember that you are creating the impression of a forested area; you are not creating an entire forest. If the player is not going to spend much time in the area or won't cross the forest at all, then you might be able to just place trees around the edge of the area.

1. Select the Grove tool from the toolbar.
2. In the window, enter the total number of trees to create in the Total Tree Count textbox.
3. To allow placement of trees in water, click the appropriate box. Make sure that water is shallow enough. Submerged trees are hard to find.
4. To allow placement of trees on cliffsides, select the appropriate box. Avoid placement of trees on nearly vertical cliffsides.
5. In the tree drop-downs, select the types of trees that you want to add to your grove. Enter the percentages for the selected trees.

- ✯ The total number of trees is always created, regardless of whether the percentages add to 100.

6. On the map, click and drag a rectangle for your grove. When you release the mouse button, the trees are placed.

- ❍ To undo the placement of the grove, press CONTROL + Z.
- ❍ To delete an individual tree, click and press DEL.

7. When you have placed your grove, check to make sure that all trees are in good positions. You can move trees individually, select them using the Select Similar menu command, or rotate the camera to view the grove from another angle.
8. If you need to add trees, you can add them individually or use the Grove tool again.

HOW TO BUILD A LAKE USING THE DEFAULT WATER PLANE

Each map contains a **default water plane**, which sets the "sea level" for the entire map. Whenever possible, use the default water plane, as it is inexpensive in terms of system resources in *World Builder* and the game.

The default water plane can be raised and lowered. Where possible, create your largest body of water using the default water plane.

1. If you have not done so, use the terrain tools to dig the bed of your lake.
2. Click the Water tool in the toolbar.
3. In the map, find the blue polygon on the perimeter of the map. That blue polygon defines the default water plane.
4. To reshape the default water plane, click and drag any corner. When shaping the water plane, you are not defining the perimeter of the lowest lake; you are using the polygon to define the water level for a specific area of the map. The default water plane does not have to mark the perimeter; it simply must encompass it.
5. In the Water Options window, you can apply a name to the default water polygon, and you can use the slider bar to change the height of the water level. Changes to the water level update in real-time.

- ✯ The other options in the Water Options window do not apply to the default water plane.

HOW TO BUILD A LAKE USING WATER POLYGONS

If you are building more than one body of water in your map, you can create additional water polygons to turn into lakes.

1. If you have not done so, use the terrain tools to dig the bed of your lake.
2. Click the Water tool in the toolbar.
3. In the Water Options window, click CREATE WATER POLYGON.
4. Click the start point for the water polygon. Click the location of the next point. Continue clicking at the turn points around the perimeter of the bed of the lake until you return to the start point. The water polygon is created.

✯ Note the control points that define the shape of the water polygon; these are expensive resources. If possible, increase the Point spacing for your polygon. A water polygon does not have to form-fit the hole. It just needs to surround the lake bed. A good starting point for the Point spacing for a lake is 50.

5. Use the Water Height slider to adjust the water level of the polygon until you have created a desirable lake.
6. If needed, you can reshape the terrain around the lake bed to get a more desirable appearance to the shape of your lake.
7. When you are satisfied with the appearance of your lake, it's a good idea to paint impassable terrain tiles around its perimeter. For more information, ➤ *How to Paint Passable and Impassable Terrain* on p. 46.

HOW TO BUILD A RIVER

Building a realistic river takes a few more steps than building a lake.

1. If you have not done so, use the terrain tools to dig the bed of your river. Due to technical considerations, rivers tend to look better if they are wider at both ends. You can put the ends of your river outside the map perimeter to hide them while creating a better appearance to the river on the map.

✯ Remember that a real river flows down a slight grade.

2. Click the Water tool in the toolbar.
3. In the Water Options window, click CREATE WATER POLYGON.
4. Click the start point for the water polygon. Click the location of the next point. Continue clicking at the turn points around the perimeter of the bed of the lake until you return to the start point. The water polygon is created.

✯ The water texturing system uses the control points of a river polygon as anchors in shaping the image of the flowing water. So, you need to pay attention to their count and positioning while creating rivers. If you are creating a bend in the river, there should be roughly an equal number of control points on the inside and the outside of the bend, with the points on the outside of the bend spaced further apart.

5. When you are satisfied with the shape of the water polygon, click the control point from which the river flows. Click RIVER. The water now flows away from this point.
6. You may have to manually tweak the positioning of the control points to get the flowing appearance of the water to look correct.

HOW TO BUILD A MAP PERIMETER

The map perimeter defines the playable area for the player and all of the units in the game. Each map must have at least one map perimeter. During the course of a mission or game, you can activate and deactivate map perimeters to change the boundaries of your map on the fly. This technique is particularly useful for single-player missions in which the user should proceed step-by-step from one challenge to the next.

1. To show the current map perimeter, select SHOW MAP BOUNDARIES in the View menu.
2. In the toolbar, click the Border tool.
3. If you have not yet made changes to the map perimeter, the default orange one encompasses the exact size of the map.

❍ To resize the default orange perimeter, click and drag the northeast corner of the perimeter.

4. To create a new map perimeter, go to point 0,0 on the map. Click and drag to create a new perimeter.

✯ You can create up to nine map perimeters. Each perimeter always starts at point 0,0, which is always the lower left corner even if you resize your map.

5. After you have created a new perimeter, you can reference all perimeters through scripts by color. In the Script window, look for the "Change Active Script Boundary" action. Select the color of the new map perimeter from the drop-down list.

HOW TO CHANGE THE TIME OF DAY

You can create map environments set at any time of day.

NOTE: When you change the time of day for your map, all structures, bridges, and some other props are automatically re-textured. However, many map elements are not re-textured, so it's recommended that you decide the time of day at an early stage of development.

1. From the Edit menu, select MAP SETTINGS.
2. In the Map Settings window, select a different time of day under the Time of Day drop-down. Click OK.

HOW TO MAKE A MAP AVAILABLE TO THE GAME

If you have saved your map in a non-standard directory, you must follow these steps to make it available to the game.

1. From the File menu, select SAVE AS....
2. In the Save dialog box, click USER MAPS.
3. Enter a name for your map. Click SAVE.

✯ If the User Maps directory is a new location for your map, remember to reconcile the new file with the old one. Do not have two files with the same name containing different versions of your map.

❍ To open a user-created map in the game, select SOLO PLAY from the Main menu. Then, select SKIRMISH. In the Skirmish Setup screen, click SELECT MAP. User-created maps are listed under Unofficial Maps. Select your map, and click ACCEPT.

HOW TO BUILD A DAM

In a word: don't. The dams in the single-player campaigns took a great deal of time and special coding to create. If you would like to have the visual of a dam in your map, you can place the object, but be sure to check that it is Indestructable and Unselectable in the Object Properties window.

PLAYERS, TEAMS, AND THE BUILD LIST

Using the Player List and the Build List, you can define the CPU-controlled players in the map and the order in which they develop their bases.

Teams are groups of units that can be assembled by CPU-controlled players based on a set of priorities and conditions and then given orders. For more information, ➤ *Building Teams* on p. 56.

PLAYER LIST

In the Player List, you can add new players to your map, and edit their settings, including any alliances.

❍ To open the Player List, select EDIT PLAYER LIST from the Edit menu.

In the Player List window, the current players in the game are listed at the top of the screen. All objects that have been placed in the map yet have not been assigned to a player are part of the Neutral player.

To create a new player:

1. In the Player List window, click NEW PLAYER.
2. In the window, select the faction for the player from the drop-down list. Click OK.

✯ For multiplayer maps, you can create an Observer faction to allow players to view the game without participating. Defeated players are switched over to the Observer faction.

❍ To delete a player from the Player List, select the player's name. Click REMOVE PLAYER.

3. **Player Name.** The new team appears in the Player List. To change the name of the player, enter a new name and the displayed name in the appropriate boxes. Click SET NAME.

✯ The Player name is its reference for use in scripts. Display name appears on-screen in the game for CPU-controlled players.

4. **Human or CPU.** To register the player as a CPU-controlled side, check the appropriate box.

✯ By definition, single player maps have only one human-controlled player. For multiplayer maps, a human-controlled player must be created for each potential participant in a game.

5. **Factions and Colors.** To assign the player to a different faction, select a new one from the Faction drop-down. To change the color of the player's units and structures, select a new color from the appropriate drop-down.
6. **Allies and Enemies.** At the bottom of the screen, you can review the allies and enemies for the selected player. The other players are listed in each box.

❍ To make a player an ally of the selected player, click the player's name in the Allies box. The player listing changes under How Player Regards Others.

❍ To make a player an enemy of the selected player, click the player's name in the Enemies box. The player listing changes under How Player Regards Others.

NOTE: It is possible for Player A to see Player B as an ally while Player B sees Player A as an enemy. Player B can then massacre Player A without any return fire. Such possibilities are useful for scripting set pieces, but be careful in using them.

❍ To toggle the selected player's regard for an enemy between ENEMY and NEUTRAL, click the player name under Enemies. The player listing changes under How Player Regards Others.

✯ The How Others Regard Player box displays the views of other players towards the selected one.

❍ To make a player an enemy, click the player name in the Enemies box. The player listing changes under How Player Regards Others.

7. **Skirmish Players.** If you are making a Skirmish map, you add Skirmish players as the final step to creating your map. The Skirmish players are controlled by AI. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

❍ To add Skirmish players to your Skirmish Map, click ADD SKIRMISH PLAYER.

8. To finish editing the Player List, click OK. To cancel your edits, click CANCEL.

BUILDING TEAMS

In *World Builder*, you can create team structures so that CPU-controlled players can assemble groups of units to attack opponents, defend their bases, and secure territory on the map. In no small measure, the presence and structure of teams determine the ability of a computer opponent to present a worthy challenge.

Teams can be created from units that are on the map at the beginning of the game or from units that the player has yet to create. Each team can be assigned a set of scripted behaviors to be applied on a variety of triggers.

- To open the Teams window, select EDIT TEAMS from the Edit menu.

TEAMS WINDOW

In the Teams window, a list of available players is displayed on the left side of the screen. Created teams for the selected player are displayed on the right.

- To create a new team, select a player. Then, click ADD NEW TEAM. For more information, ➤ *Creating a Team* below.
- To copy a team, select the team and click COPY TEAM.
- To delete a team, select the team and click DELETE TEAM.
- To edit a team, double-click on it. For more information, ➤ *Creating a Team* below.
- To move a team up or down in the list of teams for organizational purposes, select the team and click MOVE TEAM UP or MOVE TEAM DOWN.
- To display the number of units on the map already associated with the selected team, click SELECT TEAM MEMBERS.
- To accept the team definitions, click OK. To cancel edits, click CANCEL.

CREATING A TEAM

When you choose to create a team, the Edit Team window opens. Each of the four tabs is fairly detailed, so it's recommended that you start by building simple teams to complete basic actions.

- To create the team, click OK. To cancel, click CANCEL.
- To apply changes to the team, click APPLY.

EA TIP: Since some units require faction structures in order to be created, your Build List for the player should be synchronized with the priorities of teams created in the Teams window.

IDENTITY TAB

In the Identity tab, you configure the basic characteristics of the team.

- **Name.** The name of the team must be unique and is the reference used in scripts.
- **Owner.** Select the player to which the team belongs.
- **Maximum Quantity.** Enter the maximum number of teams of this type that can be on the map at any time.
- **Home Position.** The reference to the named waypoint where the team rallies as it is assembled.
- **Condition.** A reference to the script that allows the AI to build this team. The script must be a subroutine that has a condition. When the script condition is met, the AI considers building the team, based on the priorities of all active teams.
- **Execute associated actions.** When it's checked, the AI executes the actions of the script referenced as the Condition. By default, the script's actions are ignored.

NOTE: The condition checked under Production is examined when the team has been authorized to be built. This subroutine is not a substitute for On Create under the Behaviors tab. If you are referencing a subroutine through the Condition drop-down, that subroutine must contain a condition, as the subroutine may fire before the team is actually produced. To execute the associated actions of that subroutine, check the box next to Execute associated actions.

- **Priority.** The priority for a team indicates to the AI the importance of building the team. A higher priority number is more important. You can set the priority to be any positive integer, yet be sure to use a consistent range.
- **Build for.** When a team's script condition and priority have been met, the AI attempts to build the team for the number of frames in this field. Time in the game corresponds to 30 frames/second in most cases.
- **Success/Failure Priority Increase/Decrease.** Whether a team succeeds or fails in completing its objective, you can increase or decrease the priority for creating another instance of the team.

NOTE: In the Success and Failure priority settings, you can enter both positive and negative numbers. While you are learning to develop teams, you should ignore changing priorities.

- **Min, Max, and Unit Type.** On each line, you select a type of unit to include in the team. Select a unit type from the drop-down list, and enter minimum and maximum numbers for the units in the team. If a team reaches its Build For limit, the team is deployed if it contains the minimum number of units. Else, it continues building until that minimum is reached.
- **Automatically reinforce whenever possible.** When it's selected, the AI attempts to bring reinforcements to this unit until it reaches maximum strength.
- **Team members are AI recruitable.** A team with higher priority settings than the current one can recruit members from this team to it.

NOTE: Team settings, such as AI Recruitable, override settings for individual units.

- **Team created once and only once.** This team is created one and only one time during the game.
- **Team Description.** You can add a custom description and notes pertaining to the team and its function.

REINFORCEMENT TAB

Under the Reinforcement tab, you define the reinforcements for this team.

- **Deploy by.** To deploy reinforcements by another vehicle, check the box and select the vehicle type from the drop-down list. The deployment vehicle appears on the map, delivers the reinforcements, and then leaves the map forever.
- **Start teams or transports at waypoint.** Select the waypoint where reinforcements rally before deploying.
- **Load members into transports (if applicable).** When it's checked, all members of the team are automatically loaded into the transport.
- **Veterancy level.** Units must be at least at the minimum veterancy level to be recruited. This setting does not affect units that are created to become reinforcements.

BEHAVIOR TAB

In the Behavior tab, you can define the team's behaviors based on the events listed in this tab.

- In subroutines referenced in this window, you can use the drop-down selection, "<This Team>" to indicate this defined team.

NOTE: Scripts referenced in the drop-down lists must be subroutine scripts. When the condition in this tab is met, the subroutine is activated, and its condition is tested. If you want the subroutine's actions to be executed in all cases, leave the subroutine script's condition to be the default (TRUE).

- **On Create.** Subroutine is activated when the team is created.
- **On Enemy Sighted.** Subroutine is activated when an enemy is sighted.
- **On All Clear.** Subroutine is activated when the team detects no enemies.
- **On Destroyed.** When the selected percentage of units in the team is destroyed, the AI activates and tests the selected subroutine script.
- **On Idle.** Subroutine is activated when the team is in the Idle state.
- **On Unit Destroyed.** Subroutine is activated when a unit of the team is destroyed.
- **Transports return to base after unloading.** When it's checked, all transports in the team return to base after their cargo has been released.
- **Team avoids threats.** When it's checked, the team makes an effort to circumvent threats when headed to its goals.
- **Initial Team Behavior.** Select the initial AI aggressiveness, which overrides the setting of any individual unit.
- **Attack:** Does this team focus on a single target at a time in Hard and Brutal (never in Normal)? When it's checked, the team aggressively pursues a single target in the harder difficulty levels, which creates a greater challenge for the player.

GENERIC TAB

Under the Generic tab, you can select one or more subroutine scripts to be active and tested after the team has been built.

- To apply a generic subroutine to the team, select the subroutine from the drop-down list. Another slot appears so that you can select another subroutine.

TEAM BUILDING TIPS

- For single-player missions, check what the player is doing through scripts. Then, depending on player action, you can build teams to present a good challenge.
- To just keep the player busy, create and send teams with just one type of unit. For a better challenge, create teams of mixed unit types.
- Attack the player early. Speed matters.
- Through scripts, you can learn more about the player than he can learn through radar. Build "radar" scripts to increase the challenge. Avoid this technique in multiplayer.

BUILD LIST

The Build List tool lets you sequence the construction of structures for all CPU-controlled players. Through the Build List, you can add buildings aligned with a player to the map, choose whether they exist at the beginning of the mission, and sequence their order of construction.

NOTE: You must create a Build List for CPU-controlled players in a single-player map. In multiplayer maps, these players can default to use a template.

❍ To open the Build List window, click the Build List icon in the toolbar.

Through the Build List window, you can add structures or assign existing ones to a player's side.

❍ To begin assigning structures for a CPU-controlled player, select a player from the drop-down list.

✶ For more information on creating CPU players, ➤ *Player List* on p. 55.

For each CPU player, buildings are constructed in the order that they appear in the Build List.

EA TIP: You can use the Build List to influence the overall challenge of your mission. Prioritizing the buildings to construct affects the quality and nature of the strategy of the CPU-controlled player. For example, if an enemy base is located far away, you may set the Build List to rapidly achieve air power so that it can begin to inflict damage on the opposition earlier in the campaign. As your skills in the game improve, you can apply what you learn into the Build List.

To add a structure to the Build List:

1. To add a structure to the Build Map for the selected player, click ADD BUILDING.
2. In the window, navigate the structure library tree to find the structure to add.
3. With the window still open, click a location on the map to place the structure. The structure is placed and listed in the Build List. On the map, structures placed through the Build List have a multicolor glow to them.
4. You can click again to place another instance of the selected structure, or you can select another object in the window to place.
5. To finish placing objects, click OK.

NOTE: Faction structures that are added to the map with the Place Object tool are assigned to the faction and can be referenced in scripts. However, if they are destroyed, they cannot be rebuilt by the faction. So, place faction buildings through the Build List tool.

RE-ORDERING THE BUILD LIST

After you have placed objects, you can change the order in which they are built through the Build List.

- To indicate a structure is on the map at the beginning of the mission, select the structure. Then, check the box next to Structure Already Built.
- To change the placement of a structure in the Build List, select the structure. Then, click the UP or DOWN buttons to move it in the Build List.
- To remove a structure from the Build List and the map, select the structure. Then, click DELETE.

BUILD LIST PROPERTIES

For each structure in the Build List, you can assign properties to it.

- **Z.** The Z distance refers to the elevation of the structure above or below the terrain. A figure of 0 is on the terrain, and negative values embed the structure in the terrain.
- **Angle.** A structure can be placed at any angle of the circle. A figure of 0 points the structure due East, and positive value turn it towards the North.

EA TIP: For best visual effect, place your structures at an angle of –45 degrees.

- **Rebuilds.** You can set the number of times that the structure can be rebuilt by the player if it is destroyed. In the Rebuild drop-down, select NONE to disallow rebuilds or UNLIMITED to allow perpetual rebuilding.
- **Power Used.** The structure's power meter indicates the total amount of power used by the side after the selected structure has been built—assuming that all previous structures in the Build List have been created and are still standing.
- **Object Properties.** A placed structure is also an object that has configurable properties. For more information, ➤ *Object Properties* on p. 28.

SCRIPTS

The Scripts facility is the mechanism for creating mission briefings, introductory sequences, ramping of difficulty, behaviors of ambient objects, and the tactics of CPU-controlled opponents. Using a simple, descriptive format, you can build very powerful scripts to govern game events, unit actions, and other environmental variables in your map.

NOTE: Scripts are not the only way to change unit and team behavior. Setting the basic aggressiveness level for a unit or team goes a long way towards creating worthy opposition.

❍ To open the Scripts tool, select SCRIPTS from the Edit menu.

In the Scripts window, you can see the Scripts library tree at the top of the screen, and a folder for every player that you have created.

✯ You may end up creating up to 100 scripts for your mission, so the folders in the Script window become an important organizational tool. For more information, ➤ *Organizing Your Scripts* on p. 64.

CREATING AND EDITING SCRIPTS

The structure of a script is fairly simple:

IF (condition), THEN (Action1) ELSE (Action2).

Conditions are triggered by various kinds of events in the game. So, you can trigger a script at a specific time during the mission or when a trigger area has been breached. You can also trigger scripts when objects are created or destroyed.

However, the results can have huge and sometimes conflicting effects on events during a mission. So, as you learn to create scripts, start with very simple ones, and then slowly add complexity.

✯ It's very important to test your scripts in the game as you develop them. If you write many scripts before testing, then you may have difficulty figuring out which ones are creating problems.

TO CREATE A NEW SCRIPT

EA TIP: Avoid creating scripts that must occur after the start of the game. You want to keep single-player missions as open as possible, and the outcome should always be determined by user action.

1. To create a new script, click the folder in which you want to place the script.
2. Click NEW SCRIPT. In the Script Builder window, enter a name for the script in the Script Name textbox.

EA TIP: It's a good habit to name your scripts in a logical and consistent manner. For example, the names of scripts that apply to one player might all begin with the player's name followed by an underscore (_) and an identifier for the script.

3. **Script Properties tab.** you set the flags and difficulty settings that apply to the script.

✯ **Subroutine.** A subroutine script is referenced by another script. Until it is specifically called by another script, a subroutine script is not executable and does not consume any CPU resources to check its conditions.

✯ **Active.** Active scripts can be triggered as soon as the mission starts. Scripts can be activated and deactivated by other scripts.

✯ **Deactivate upon success.** After a script has been executed, you can prevent it from being executed again.

✯ **Active in.** Use the Active In settings to establish the difficulty levels in which the script can be used. For more information on ramping difficulty, ➤ *Ramping Difficulty* on p. 63.

✯ **Script Comment.** This catch-all field is useful for writing notes to yourself about bugs, implementation tricks, version control information, or tasks to complete related to this script.

4. **Script Conditions tab.** You define the condition or conditions to be tested and met before the script is executed.

EA TIP: The default condition for a newly created script is TRUE. If this condition is not changed, then the script actions are executed as soon as the map is loaded and the game begins. Use a True condition to execute scripts at the beginning of the mission. If you are not using the default condition, delete it.

❍ To create a new script condition, click NEW. In the window, select a condition from the drop-down list. The condition is displayed. Click any blue links to define the condition from the available list of parameters. To define the condition, click OK.

NOTE: There are quite a few different conditions from which to choose, and you can build very complicated scripting conditions if needed. However, it's recommended that you begin with simple conditions to learn how the Script tool works.

✯ When you create multiple conditions, it is assumed that they are connected by a logical AND. To create a second condition with a logical OR, highlight the condition to compare, click OR and then click NEW to define the second condition.

❍ To duplicate a condition, select it and click COPY. To delete a condition, select it and click DELETE.

❍ To move a condition in the window, click MOVE UP or MOVE DOWN.

5. **Actions if True tab.** You define what happens if the condition or conditions are met. The controls are similar to the Script Conditions tab.

✯ By default, a script does nothing if its conditions are true. To create an action, delete the default action. Then, click NEW to create the new one.

6. **Actions if False tab.** You define what happens if the condition or conditions are not met. The controls are similar to the Script Conditions tab.

✯ The False condition does not often need to be defined. In most scripts, you can leave this area blank.

7. Your script has been defined. To create the script, click OK. The script is now listed in the script directory.

❍ To view a created script, select it in the Scripts window. The contents of the script are displayed at the bottom of the window. To edit the script, click EDIT.

✯ For more information on the Scripts window, ➤ *Organizing Your Scripts* on p. 64.

MAP TOOLS FOR SCRIPTING

Two tools in *World Builder* can be very useful to identifying locations and areas for use in scripts.

✯ **Polygon Tool.** Use the Polygon tool to define trigger areas that can be referred to by name in scripted conditions and actions. For more information, ➤ *Polygon Tool* on p. 26.

✯ **Waypoint Tool.** In addition to defining unit movements, you can use waypoints to identify locations on the map for your scripts. For more information, ➤ *Waypoint Tool* on p. 26.

MISSION INTROS

You can create mission briefings and scripted introductory sequences using scripts.

✯ **Start Mission events.** Unless they are subroutines, scripts created with the default TRUE as the condition are executed as soon as the map is loaded.

✯ **Multimedia.** You can create a wide assortment of visual effects. Look in the Multimedia category for available actions.

✯ **Disabled Input.** In the User category, you can disable user input until the scripted intro sequence is completed.

✯ **Camera effects.** You can script a variety of camera effects including letter box and black-and-white modes. See the Camera category of actions.

✯ **Variables.** Under the Scripting category, you can define and use variable counters, as well as set and manage timers. Variables and timers can be referenced by any script in the map.

RAMPING DIFFICULTY

The Active In settings are the primary mechanisms for ramping difficulty in your maps. When building maps with variable difficulties, you should begin by creating all scripts on the either the hardest or easiest difficulty setting.

When you have completed the map to your satisfaction for the defined difficulty level, adjust the Active In settings of your scripts to test them under other difficulty settings.

EA TIP: When you create a team under Brutal difficulty setting, break it up into multiple teams. Then, you can reduce the number of teams for easier difficulty settings. For Hard and Brutal settings, you can set the Attack checkbox under Behavior to make units more aggressive.

As a final resort, you can write new scripts for the other difficulty levels. The Copy feature works well if you need scripts that are identical except for a few small changes.

ORGANIZING YOUR SCRIPTS

In the Scripts window, you can organize your scripts to simplify their development and editing. By creating and moving folders, you can keep track of the location of your scripts.

- To toggle the active state of a script or folder, right-click on the folder. Select the menu item to toggle the state. All scripts inside an inactive folder are not available, which is useful for debugging purposes.

NOTE: You cannot delete or disable the base folders for players that have been created.

- If a script has a red question mark over its icon in the Scripts directory, some element of the script has not been defined.

SCRIPT FOLDERS

The Scripts window organizes scripts like the files in a directory. Scripts should be placed in the same folder if they refer to each other, apply to a set piece event in the mission, or link together through another grouping mechanism.

- To create a new folder, click NEW FOLDER. In the window, enter a name for the folder. Select whether the folder is full of subroutine scripts and whether the folder scripts are active at startup.

Some folder creation tips:

- Put scripts that apply to all players in the Neutral folder. These scripts include map initializations, win conditions, and loss conditions.
- Scripts that apply a player should be placed in the player's folder.
- Inside a player's folder, you can organize scripts by geographic area, stage of the game (Begin, Middle, or End), or another logical convention.

COPYING AND DELETING SCRIPTS

After scripts are created, you can use them as templates to build other scripts. You can also move them to other folders.

- To copy a script, select it and click COPY. The copied script is placed in the same directory as the source and given a name with a "C" at the end.
- To move a script, click and drag it to a different folder.
- To delete a script, select it and click DELETE.
- To cancel your edits in the scripting window, click CANCEL. All unsaved changes are discarded.

IMPORT AND EXPORT

Scripts can also be imported to and exported from a map for use in other maps.

- ✯ If you are logical and consistent in the naming of your map elements, then it is much easier to reuse scripts from one map in another.
- ❍ To export a script, select it and click EXPORT SCRIPTS. In the dialog, select the options for your export. Click OK. Select a destination for the .SCB file, enter a name, and click OK. The selected scripts are exported.
- ✯ Exported scripts are in a binary form and should not be edited in a text editor.
- ❍ To import a script, click IMPORT SCRIPTS. Navigate your local computer to find the .SCB file to import. Select the file, and click OK. The script or scripts are imported.

SCRIPTING VARIABLES

As part of your map designing toolkit, variables can be defined for all kinds of information in the game. You can use flags to track binary states, timers to monitor game time, and counters to watch numbers of units on a side or in a trigger area.

- ✯ Due to technical limitations, you cannot compare a variable to another variable in scripts. Variables can be compared to fixed values.

FLAGS

A **flag** is variable that you can set to TRUE or FALSE. Flags are very useful in testing and tracking whether events have occurred in the game. For example, you may want to change the behavior of the AI after a player has crossed into a new area of the map.

- ❍ To create a flag, use the action **[Scripting] Set flag to value**. Click the links to enter a name for the flag and an initial value for it.
- ✯ When a flag has been defined, its default value is FALSE. After it has been defined anywhere in your map's scripts, the flag exists and can be accessed by any script.

USEFUL ACTIONS

- ❍ To change the value of a flag, use the same action (**[Scripting] Set flag to value**) that was used to create it. Enter a different value for the flag.

COUNTERS

A **counter** allows you to count integer numbers. You can use counters to track the number of times a repeated event occurs, such as attacks by one player against another. They are also useful in missions in which the player must destroy a fixed number of units before the mission is successful or switches to a new phase. Since the scripting system of *World Builder* contains so many inherent counters for things such as the number of units, counters are not used frequently.

- ❍ To create a counter, use the action **[Scripting] Counter – set to a value**. Enter a name and an initial value for the counter.
- ✯ When a counter has been defined, its default value is 0. After it has been defined anywhere in your map's scripts, the counter exists and can be accessed by any script.

After a counter has been created, it is available through drop-downs in the scripting system wherever a counter can be applied.

USEFUL CONDITIONS

- ✯ **[Scripting] Counter Compared to Value:** Use this condition to compare a counter's value to an entered value.

USEFUL ACTIONS

You can fire actions when a timer has reached 0 seconds or frames. The Timer Expired condition is useful for scripted cinematics or for delaying action.

- ✯ **[Scripting] Counter – Increment:** Add the entered value to the selected counter.
- ✯ **[Scripting] Decrement Counter:** Subtract the entered value to the selected counter.

TIMERS

Countdown timers monitor the passage of time in the game. **Timers** come in two varieties: **Seconds timers** and **Frame timers**. Both timers assume that in the game one second equals 30 frames. On faster machines, the game can perform at this rate. On a machine that is producing 18 frames/second, the rate for timers is still assumed to be 30 frames/second. So, on a slower machine, while 30 frames may last nearly two seconds in real time, they are treated as a single second in game time.

- ✯ Avoid using timers in multiplayer missions.
- ❍ To create a Seconds timer, use the action **[Scripting] Seconds countdown timer - set**. Enter a name for the timer and its initial value in seconds. The timer begins as soon as the script is executed.
- ❍ To create a Frame timer, use the action **[Scripting] Frame countdown timer - set**. Enter a name for the timer and its initial value in frames. The timer begins to count down frames as soon as the script is executed.
- ✯ The **[Scripting] Frame countdown timer – random** action lets you set up frame timers of random duration, which is useful for creating the appearance of random behavior in your maps.

Timers always count down from the start time that you set. A timer can be used as a counter, too. You can perform all of the operations on a timer that you can perform on a counter.

USEFUL CONDITIONS

When scripting timers, there are some useful conditions that you can test to determine if action should be taken:

- ✯ **Timer Expired:** You can fire actions when a timer has reached 0 seconds or frames. The Timer Expired condition is useful for scripted cinematics or for delaying action. For pacing purposes, you may want to use timers to delay counter-attacks from the AI.
- ✯ **Counter Compared to Value:** Use this condition to compare a named timer to an entered value. Note that the default setting is "less than zero." If you don't set a positive value for the counter, the condition never fires.

CONDITIONALS

When you have multiple conditions to test in a script, you can compare them with AND or OR conditionals.

- ✯ The NOT conditional is not available.

AND

If a script contains two conditions, Condition 1 AND Condition 2 must be TRUE for the Action if True to be executed.

Whenever a new condition is added to a script, the conditional AND is automatically applied. Unless otherwise defined, in any list of scripted conditions, the conditions must all be TRUE for the action to fire.

- ✯ The AND conditional always has precedence over OR. In a list of scripted conditions, all of the conditions joined by the default AND conditional are tested before any of the OR conditions.

OR

If a script contains two conditions connected by an OR conditional, Condition 1 OR Condition 2 must be TRUE for the Action if True to be executed.

- ❍ To change a conditional to an OR condition, click OR. Use the MOVE UP and MOVE DOWN buttons to reposition the OR condition. The conditions before the OR are compared to the conditions after it.
- ❍ To remove an OR conditional, click the Or line in the list of conditionals, and then click DELETE.

NOTE: When you delete an OR conditional, all of the conditions below the OR are deleted as well. If you are going to use OR conditionals, be sure to check the logic of them before you build the scripts.

TRIGGER AREAS

Trigger areas are created with the Polygon tool. When you create a polygon on the map, you can name it and then reference it in scripts. They are very powerful elements of the scripting library.

It becomes apparent very quickly that you can create scripting systems that know everything about every player on the map. However, testing many trigger areas simultaneously can slow down the frame rate. Also, it is less realistic to have all-knowing armies. When using trigger areas, remember that the overarching goal is to create a fun and lively experience that seems like real combat.

NOTE: Don't have more than five overlapping trigger areas. The outer ones tend to get forgotten.

- When creating trigger areas, be sure to give them descriptive names. For more information on creating trigger areas, ➤ *Polygon Tool* on p. 26.

The following sections describe the key conditions for using trigger areas to test for the presence of teams, individual units, and players.

TEAMS AND TRIGGER AREAS

- **[Team] One Unit Enters an Area:** Select the team name, Area name, and whether the team can enter via ground, air, or both. You must select how the team enters. A player's default team includes all of the units on his side that have not been assigned to a team.
- **[Team] One Unit Exits an Area:** The assumption of this condition is that the team is already in the area, so don't activate scripts using this conditional unless you are sure that the team has already entered the area.
- **[Team] Team Completely Inside an Area:** This script state becomes TRUE when all surviving members of a team are inside an area. It is a good way to time events. For example, when all units are in an area, you can launch an attack on them.
- **[Team] Team Entirely Enters an Area:** This script state becomes TRUE when all surviving members of a team have at one point or another entered an area. Use it to pass between the beginning, middle, and end of your mission, for example. A common technique is to change the map perimeter during various stages of the game, and this condition can be used to assess when to change it.
- **[Team] Team Entirely Exits an Area:** This condition assumes that all surviving team members were in the area at some time. Use it carefully.
- **[Team] Team Has Units in an Area:** The team has entered the area in some form. This condition is a catch-all trigger test.
- **[Team] Team Is Completely Outside an Area:** The team has no presence at all in an area. This script is useful for managing retreats or scripted exits of units from the map. You can also use it for checking outer perimeter and inner perimeter breaching in Skirmish missions. For more information, ➤ *A Few Extra Steps for Skirmish Maps* on p. 40.

UNITS AND TRIGGER AREAS

You can also perform some of the team tests on individual units. Note that these units must be given specific names, so these tests are useful for examining the state of units that are placed on the map by the designer—not units created by a player.

Some conditions available for teams are not available to test for individual units. To make those comparisons, put the individual unit in its own team.

- **[Unit] Unit Enters an Area:** The named unit has crossed into a trigger area.
- **[Unit] Unit Exits an Area:** The named unit has left a trigger area.
- **[Unit] Unit Inside an Area:** The named unit is inside a trigger area.
- **[Unit] Unit Outside an Area:** The named unit is outside a trigger area.

PLAYERS AND TRIGGER AREAS

You can also perform checks for the presence of a player's army in a trigger area.

- **[Skirmish] Player Has Units in an Area:** The player has any number of units in an area.
- **[Skirmish] Player Doesn't Have Units in an Area:** The player is completely outside of an area.
- **[Player] Player Has Comparison Unit Type in an Area:** The player has more than, less than, or equal to the entered number of selected units in an area.
- **[Player] Player Has Total Value in an Area:** If the player has units and structures of value greater than the value you define, action is taken. This condition is useful for timing attacks.
- **[Player] Player Has Unit Type in an Area:** This condition tests for the presence of a minimum number of units of a selected type in an area. For example, you can script an AI attack on a player when 10 crusader tanks have been created. Use this condition to test for initial or large-scale attacks from the AI; you don't want the AI to overreact to small changes in a player's army.
- **[Player] Player Has Kind of Unit or Structure in an Area:** This condition tests for the presence of a minimum number of structures or units of a selected type in an area. For example, you can use it to change strategies. If a player has created 5 Stinger sites, you might tell the AI to stop attacking with helicopters and to use tanks instead.

SCRIPTING TUTORIAL

In the following section, you can read and learn how to script fundamental events in a scripted mission. The materials covered here are just the basics, so be sure to test your scripts thoroughly.

- Keep it as simple as possible. No one cares if the AI made a right turn at a specific point. Avoid being very specific. If your scripts are very specific, then re-examine your design goal. You could be setting up a debugging nightmare for yourself.
- When developing for multiple difficulty settings, build either for the easiest or hardest difficulty setting. Then, you can select or deselect scripts for the other difficulty settings.

HOW TO ACTIVATE THE SCRIPT DEBUGGER

World Builder includes a utility for debugging your scripts inside the game. For more information, ➤ *Script Debugger* on p. 77.

HOW TO SET WIN CONDITIONS

You can tell a player that he has won the game at any time with any condition. When your chosen condition has been met, the action to select is, **[User] Announce quick win**. The game is immediately over.

You may choose to take other script actions, such as destroying the remaining faction buildings, before you announce the win.

HOW TO SET LOSS CONDITIONS

You can declare a player loss at any time with any condition. If the game is over for all players, use the action, **[Multiplayer] Announce Defeat**. If the game has ended for only one player, use **[Multiplayer] Announce Local Defeat**.

HOW TO CREATE SUBROUTINES

A **subroutine** is a script that is accessed via another script. You do not perform a test to run a subroutine. Instead, you call it from another script.

- ✯ When defined, subroutines are always active and can never be tested.

Subroutines are useful for optimizing your scripts, especially if you call actions multiple times under multiple conditions. Through subroutines, you can create a generic set of actions that can be applied to multiple teams. For example, you can use subroutines to instruct a team to hunt.

- ✯ Most AI orders are triggered through subroutines. When you are creating a team, the conditions that you select under the Identity and Behavior tabs are subroutines only. These scripts are created as subroutines, and the indicated condition is applied to them.

To define a subroutine:

1. Under Script Properties in the Script Builder window, check Script is Subroutine. Since subroutine scripts are always active, deselect Deactivate upon success, which is not needed.
2. In almost all cases, leave the script condition to test empty (TRUE).
3. Define the action.

- ✯ Again, a subroutine cannot be enabled or disabled. So, be careful in using subroutines, which can run and run over again.

To execute a subroutine:

1. To run the subroutine from another script, select a script action called, **[Scripting] Script – Run**.
2. Select the name of the subroutine from the drop-down.

HOW TO CREATE SEQUENTIAL SCRIPTS

A **sequential script** is configured to execute its sequence of actions one after the other. Typically, all actions in a script are executed at the same time. In a sequential script, the first action is executed to completion, followed by the next one, until all actions have been completed. Sequential scripts are useful for scripting end-game sequences.

1. Create a standard script with the desired test conditions in place. Do not script any actions.
2. Build a subroutine that contains all of the actions to be taken in sequence.
3. For the first script, find and add the action **[Team] Execute Script Sequentially - Start**. Select the subroutine that contains all of the sequential actions.

- ❍ To script the stoppage of a sequential script, use **[Team] Execute Script Sequentially – Stop** and select the subroutine containing the scripted sequence.
- ❍ To loop a sequential script, use the action **[Team] Execute Script Sequentially - Looping**. Looping sequences are useful for building railroads.

HOW TO SET DIFFICULTY LEVELS

In the Script Panel for each script, you can select or deselect whether the script applies to Normal, Hard, or Brutal difficulty settings.

- ✯ If a difficulty setting is not selected, the script cannot run at all in that difficulty setting, even when it is explicitly called.

HOW TO SPAWN OBJECTS

You can add flavor to your maps by spawning objects that execute scripted actions to change the nature and course of the mission. For example, you can script civilians to walk across the map, requiring your protection.

✯ Be sure to spawn objects outside the map perimeter, as they appear out of thin air when spawned.

1. To spawn an object, use the action **[Unit] Spawn – Object**. Select the object and team to spawn.

❍ To spawn an object without assigning it to a team, select a player's default team.

2. Enter the X, Y, and Z coordinates on the map where the unit should spawn.

✯ X, Y, and Z coordinates can be found in the status bar. If you do not specify a Z (height) coordinate, the object is placed on the terrain. Do not place objects below ground.

3. Enter a figure for its angle of rotation. Object angles can be found in the Object Properties window for each object.

SPAWNING UNNAMED UNITS

❍ To spawn an unnamed unit, use the action **[Unit] Spawn - unnamed unit on a team at a waypoint**. You must specify the team to which it belongs and its starting waypoint.

SPAWNING NAMED UNITS

You can also spawn units that have defined names. Naming spawned units is useful for missions in which a known event must occur at some point during the mission. You can write scripts for the named unit, spawn the unit, and then execute the scripts accordingly.

1. To spawn a named unit, use the action **[Unit] Spawn – named unit on a team at a waypoint**.
2. Select the name of the unit from the drop-down list, or enter a name of a unit that has not been created.
3. Select the type of unit, and assign it to a team.
4. Select a waypoint where the unit spawns.

✯ After you define this particular script, the three question marks (???) in front of the listed action do not necessarily indicate an error; they may indicate that this script is the first instance of the named entity. Ignore them. Click OK, and your script may be fine.

HOW TO SCRIPT RE-INFORCEMENT TEAMS

Re-inforcement teams are a common tool in *Command* & *Conquer Generals* missions to keep the battle fresh. A **re-inforcement team** is created off-screen and brought on-screen and into the battle, often via a transport. Since these teams are created off-screen, they can be spawned, instead of accumulated in a base area.

✯ When you are learning to build re-inforcement teams, use air transports to bring them to their destination, as by default, these teams take a straight-line path to the target waypoint. A straight path can be problematic for a land-based team. It is more challenging to script a re-inforcement team to follow a set of waypoints across the terrain.

1. Select EDIT TEAMS from the Edit menu.
2. In the Team Builder, select the player, and then click ADD NEW TEAM.
3. Define the team as needed.
4. Under the Reinforcement tab, check the box next to Deploy by. From the drop-down, select a transport to bring the team onto the map.

✯ If you do not specify the Start team waypoint, then the waypoint specified in any script is the waypoint where the team spawns.

NOTE: The game automatically creates enough transports to bring in the entire team. If you want the team to be brought in one transport over multiple trips, you must create multiple teams. Be sure to destroy each transport through scripts after it has completed its mission.

✯ If you do not check the Deploy by box, the team enters the map on their own.

5. Select a waypoint at which to spawn the team. Make sure that it is outside the map perimeter.

6. If the team should spawn inside the transport, click the box next to Load members into transports.
7. In the Script Builder, build a subroutine to get the transport to move to a defined waypoint and to drop the team.
8. In the Behavior tab of the Edit Team window, select the defined subroutine from the On Create drop-down list.

HOW TO SPAWN TEAMS

- **[Team] Spawn a reinforcement team:** Use this action to spawn a reinforcement team that you have defined. If no waypoint is specified in the Edit Teams window, then the waypoint defined here is where the team appears.

HOW TO MOVE A TEAM TO A NEW LOCATION

One of the most commonly used actions is to move teams into new positions. It's particularly important for scripting attacks, as a good designer places units near to the target so that they are not distracted en route and their inherent AI can manage attack functions.

MOVE TEAM ON A WAYPOINT PATH

- **[Team] Set to follow a waypoint path:** Use this action to tell a team of units to follow a named waypoint path. Select the team and the waypoint path from the drop-down lists. If the team does not travel as a team (FALSE), then each unit of the team travels the waypoint as an individual. Using this flag on a branching waypoint path is an inexpensive way to create the appearance of flanking attacks. You can also use it to add randomness to civilian behaviors.

MOVE TEAM ON A WAYPOINT PATH - EXACTLY

- **[Team] Set to EXACTLY follow a waypoint path:** Use this action to tell a team to follow a named waypoint path exactly as it is laid out on the map. This action should be used only if you are creating scripted cinematics and need units to behave in an exact manner. Units that follow a path exactly pass through buildings and other objects without effect, so it is impractical for game actions.

MOVE TEAM ON A WAYPOINT PATH - WANDERING

- **[Team] Set to follow a waypoint path - wander:** Use this action to tell a team of units to follow a named waypoint path in a wandering manner. Each unit of the team uses the waypoints as a general guideline. Teams that wander tend to spread out more, which avoids traffic jams and looks more natural. However, a unit of a wandering team can venture into territory that it should not, so use this action carefully.

MOVE TEAM ON A WAYPOINT PATH - PANIC

- **[Team] Set to follow a waypoint path - panic:** For civilian use only. Use this action to tell a group of civilians to move in panic along a named waypoint path. The civilians are displayed in their "panic" animation state.

MOVE TEAM TO A WAYPOINT

- **[Team] Set to move to a location:** Use this action to move a named team to a defined waypoint. The team takes whatever route it can find and is available. Sometimes, teams following this script action can end up in unexpected places. However, it can be a useful means of gathering units from diverse sources. In general, rally the team at a waypoint some distance from its current location and leave space around the waypoint for units to cluster.

MOVE TEAM TOWARDS AN OBJECT OF A SPECIFIC TYPE

- **[Team] Move team towards the nearest object of a specific type:** This action allows you to direct a named team towards the nearest object of a type. You can use it in combination with other scripts. For example, when a team has finished moving along a set of waypoints, you can direct it to move towards the nearest enemy tank. When this action finishes executing, the team should be able to attack. It's useful for scripting GLA commando-style attacks from Hijackers and Terrorists.

UNIT

All of the above script actions are available for individual units, except for Panic and Wander actions.

HOW TO SCRIPT ACTIONS FOR AI TEAMS

When you create a new player, whether it is human- or CPU-controlled, a default team for the player is created. The team name is "team" followed by the name of the Player. This team contains all units for the player. You can script actions to apply to this team, which apply to all units for that player.

INITIAL ACTIONS

When a team is created for the AI, it's a good idea to have a set of scripted actions for the team to follow. Otherwise, it sits in the base area, doing nothing. A good structure for a team's initial action is to send it along a waypoint path to get it closer to combat. When the team reaches the end of the waypoint path, you can assign it to move towards the nearest enemy vehicle, guard, or hunt through scripts. If the team is scripted to attack a specific target and succeeds, its final action should be to hunt enemy units. Otherwise, the team sits, doing nothing. For more information on sequential scripts, ➤ *How to Create Sequential Scripts* on p. 68.

- You can create basic responsiveness of the AI by setting the Aggressiveness of each team in the Behavior tab of the Edit Team window.

AI ATTACK TEAMS

An attack team for an AI player should consist of two or so attack teams. For easier difficulty settings, you may consider sending only one attack team. A high number of teams in an attack is hard to defend and hard for the designer to manage. Keep it simple, if possible.

You can establish priorities for your attack teams by setting attack priorities (➤ *How to Configure and Execute Attack Priorities for the AI* on p. 72) for object lists (➤ *How to Create Object Lists* below), or by sequential scripting (➤ *How to Create Sequential Scripts* on p. 68) for specific targets.

AI DEFENSIVE TEAMS

Following the principle of having three entrances to each base, an AI army should have three defensive teams or one for each entrance to its base.

Defensive teams for the AI can be set to varying levels of responsiveness. You can tell a unit to simply guard an area, changing the Aggressiveness setting to a low level. Or, you can have one fast defensive team that is responsible for attacking anything that breaches perimeters that you define with the *Polygon Tool* (➤ p. 26).

- The condition, **[Skirmish] Player has discovered another player**, can be used to switch the AI into a different defensive posture.

NOTE: Be sure to create a subroutine to be called when the situation is all clear for a defensive team. This script should tell the units to resume their original behaviors. You select the On All Clear subroutine in the Edit Teams window. For more information, ➤ *Edit Teams* on p. 17.

HOW TO CREATE OBJECT LISTS

Object lists are sets of multiple choices of objects that the AI can use to establish a valid target. Anywhere in the Script Builder that you can specify a type of object, you can use an object list. When you do so, the available object lists are listed below the types of objects.

- **[Scripting] Object Type List – Add Object Type:** Use this action to create new object lists and add objects to existing ones. To create a new object list, enter a name in the drop-down. Then, select an object to add.
- **[Scripting] Object Type List – Remove Object Type:** Use this action to remove object types from an object list. This action is useful for re-assigning priorities if an enemy's capabilities have been destroyed.

HOW TO CONFIGURE AND EXECUTE PRIORITY LISTS FOR THE AI

A **priority list** can be applied to a team or unit to rank the importance of destroying targets. Items with a higher priority are always targeted first, even if there are targets of opportunity in the vicinity. You can use priority lists to create better strategies for base attack, base defense, reconnaissance, anti-tank, and anti-air.

1. Use the action, **[Attack Priority Set] Set modify priorities for all of a kind**.
2. Give the priority set a name.
3. Select the type of element from the drop-down list.
4. Enter an integer for the priority. The default value is 1, while object types with a value of 0 are never attacked. Higher values have greater priority. You define the scale yourself.
5. To create a priority for another type of object, copy the priority action. Do steps 3 – 4 for the new object type. For the new object type, you can enter a different number for the priority to rank the desirability of the targets.

ATTACK PRIORITIES FOR A SINGLE UNIT TYPE

- **[Unit] Modify priority set for a single unit type:** You can modify an existing priority set for a single type of unit. Use this action for a more fine-tuned list. It's also useful for special-purpose units like the Hijacker, Black Lotus, and Colonel Burton.

ATTACK PRIORITIES FOR A TEAM OR UNIT

- **[Unit] Apply a team's attack priority set:** Use this action to apply a defined attack priority set to a named team. Specify the team and the priority set to use.

ATTACK DEFAULT PRIORITIES

- **[Attack Priority Set] Set the default priority:** Use this action to reset the default priorities for a priority list to a specified number. You can use this action to essentially overwrite all of the priorities in that list.

HOW TO GET THE AI TO ATTACK

You can use scripts to define specific attacks against other players. Attack scripts can be applied to individual units, teams, or every unit in a player's army. Use the following actions to get units on the attack.

AI TEAM ATTACKS

- **[Team] Set to hunt:** Select the team to begin hunting. In hunt mode, teams scout for enemies and attack them when they are discovered. Hunt mode can be superseded by priority lists.
- **[Team] Set to attack – another team:** Select the team that is attacking. Then, choose the team to be attacked.
- **[Team] Set to attack – specific unit:** Select the team that is attacking. Then, choose the named unit, such as Colonel Burton, to attack.
- **[Team] Set to attack – trigger area:** Select the team that is attacking. Then, choose the trigger area to attack. The team moves to the trigger area and attacks any enemy units or structures in the trigger area.
- **[Team] Set to attack – trigger area:** Select the team that is attacking. Then, choose the trigger area to attack. The team moves to the trigger area and attacks any enemy units or structures in the trigger area.
- **[Team] Set the general attitude of a team:** Select the team. From the drop-down list, select a new behavior. These options match those available in the Initial Team Behavior drop-down in the Behavior tab of the Edit Team window. For more information, ➤ *Edit Teams* on p. 17.

AI UNIT ATTACKS

All of the above actions can be applied to units, too.

AI PLAYER ATTACKS

You can put an entire army in motion. While these all-or-nothing scenarios can be exciting in concept, they can ruin the frame rate if the army is large. However, in dire circumstances for the player, user it.

- **[Player] Set all of a player's units to hunt:** Any available unit of a player begins hunting for enemies.

HOW TO CONFIGURE THE AVAILABLE TECHNOLOGY TREE

In the single-player campaigns, you may have noticed that the entire technology tree may not be available on some missions. Through scripts, you can make specific structures, units, or abilities unavailable. Additionally, you can define the beginning and limiting rank for a mission, which limits the Generals Abilities available to players.

MAKING SPECIFIC OBJECTS UNAVAILABLE

- **[Map] Adjust the tech tree for a specific object type:** Select the object in the drop-down list. Then, select the availability of the object. IGNORE_PREREQUISITES means that the object is immediately available at the beginning of the mission, no matter where it is located in the standard technology tree. ONLY BY AI prevents human players from building the object.

MAKING SPECIFIC OBJECT ABILITIES UNAVAILABLE

- **[Scripting] Remove a commandbutton from an object type:** You can use this script to remove a specific power from a specific object type. For example, in your map, you may want the American Ranger to be unable to capture buildings. If you reference a CommandButton that does not exist for the selected object type, the results are unpredictable. Use and test this script carefully.

SETTING PLAYER RANK LEVELS

- **[Map] Set Rank Level Limit for current Map:** This script action limits the number of Generals stars that a player can achieve on the map. Set the rank from 1 to 5.
- **[Player] Set Rank Level:** Set the starting rank level from 1 to 5 for the selected player.

HOW TO CHANGE THE MAP SIZE DURING A MISSION

In some of the single-player missions, the player appears to open new parts of the map by completing objectives in the game. You can do the same thing in your maps by changing the map boundaries through scripted events.

CREATING MAP BOUNDARIES

When you create a new map, the default map perimeter is displayed as an orange rectangle around the perimeter. You can adjust this perimeter or create up to eight additional ones. For more information, ➤ *How to Build a Map Perimeter* on p. 54.

CHANGING THE ACTIVE MAP BOUNDARY

Through scripts, you can designate which of your created map perimeters is active.

- **[Map] Change the active boundary:** Use this action to change the active perimeter. From the drop-down, select the color of the map perimeter that you are now activating.

WARNINGS:

- If your map size must change during the mission, start with a smaller-sized map using the orange default map perimeter first. Then, grow the size of the map over the course of the mission. Shrinking the map can cause problems.
- If you peel back the entire shroud through scripts and then change the borders, the new border's shroud may still be partially obscured.

HOW TO TRIGGER AUDIO

You can use the conditions and actions in the Multimedia section of the Script Builder's lists to manage the audio in your map. The following conditions and actions are useful.

PLAYING SOUND

- **[Multimedia] Play a speech file:** Use this action to play back a speech file. Select a speech file from the drop-down list. To hear a preview, click PREVIEW SOUND. You can select whether to allow sound overlap. If it is set to FALSE, all other scripted audio gets turned off as it plays. You can use that flag to ensure that mission-critical voice-over is heard by the user.

NOTE: Never rely on speech to be the exclusive means by which players hear critical information. Always back up any mission-critical audio with text messages on the screen.

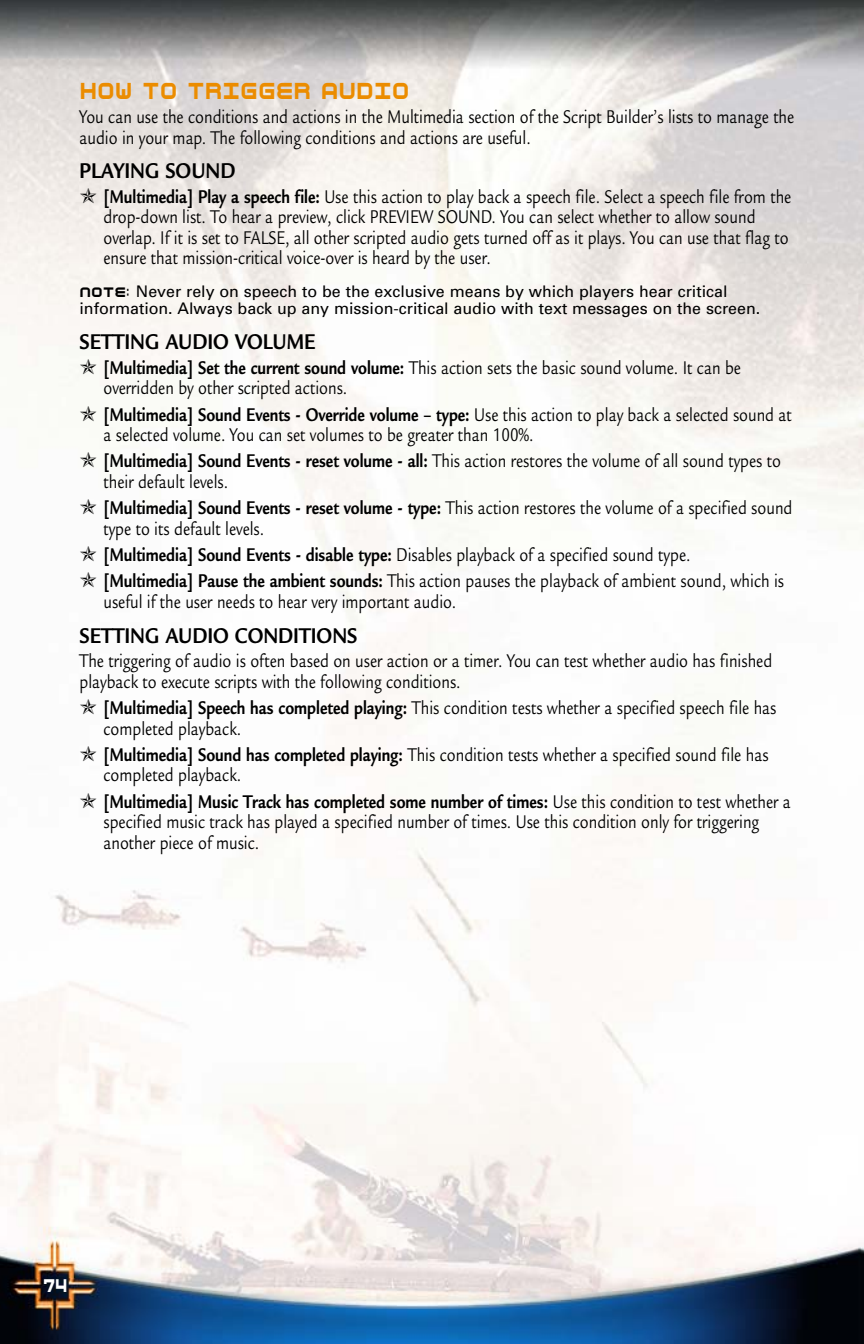
SETTING AUDIO VOLUME

- **[Multimedia] Set the current sound volume:** This action sets the basic sound volume. It can be overridden by other scripted actions.
- **[Multimedia] Sound Events - Override volume – type:** Use this action to play back a selected sound at a selected volume. You can set volumes to be greater than 100%.
- **[Multimedia] Sound Events - reset volume - all:** This action restores the volume of all sound types to their default levels.
- **[Multimedia] Sound Events - reset volume - type:** This action restores the volume of a specified sound type to its default levels.
- **[Multimedia] Sound Events - disable type:** Disables playback of a specified sound type.
- **[Multimedia] Pause the ambient sounds:** This action pauses the playback of ambient sound, which is useful if the user needs to hear very important audio.

SETTING AUDIO CONDITIONS

The triggering of audio is often based on user action or a timer. You can test whether audio has finished playback to execute scripts with the following conditions.

- **[Multimedia] Speech has completed playing:** This condition tests whether a specified speech file has completed playback.
- **[Multimedia] Sound has completed playing:** This condition tests whether a specified sound file has completed playback.
- **[Multimedia] Music Track has completed some number of times:** Use this condition to test whether a specified music track has played a specified number of times. Use this condition only for triggering another piece of music.



DEBUGGING

During the course of developing a map, you may discover problems with it. Textures can get blended poorly, objects can get misplaced, scripts can acquire bugs, and designers can get confused. The following chapter offers some basic suggestions for how to debug problems with your maps and their scripts.

DEBUGGING OBJECTS

SELECTING DUPLICATE OBJECTS

When you copy an object and then paste it, the new object is pasted on top of the original one. Looking at the two objects, you see one image. If you forget about the object, you can end up with duplicate objects. Use this command to select objects on top of each other. It selects the top instance of every object that has a duplicate on the map. From time to time, you should select duplicate objects to locate these errors.

- To select duplicate objects in your map, choose SELECT DUPLICATE OBJECTS from the Edit menu.

FINDING LOST OBJECTS

Have you misplaced an object? If so, you can use the Select Similar tool to select items of the same class. When a building is selected, for example, apply the Select Similar tool to select each building on the map. You can use this tool to select for all types across the entire map. For more information, ➤ *Select Similar* on p. 16.

- If you have a mouse wheel, you can use it to rotate the camera to other perspectives, which may reveal smaller objects hidden behind larger one.

Additionally, you can scan through the Layers List to search for the missing item.

- To reveal each layer in the Layers List, right-click on the icon next to the layer. Then, deselect HIDE CURRENT LAYER. Check the map to see if the missing object is revealed.

FIXING TEAMS

If you delete a player from the Player List for your map, any units or structures that were assigned to the player now have invalid associations. They belong to no team.

You can fix teams in two ways:

- To let the application fix teams as best as it can, select FIX TEAMS from the Validation menu.

When the application fixes teams, it assigns unaligned units and structures to the remaining teams in the map. However, if a Chinese MiG airfield is assigned to the GLA, for example, then the GLA side now has air power, which could reshape the balance of power in the map. It's much better to try to identify unaligned units and structures and then to manually assign them to teams.

- To manually assign units to team, choose SELECT BAD TEAM OBJECTS from the Edit menu. All objects that have invalid team assignments are selected. You can then fix them manually.
- To fix a unit's team, select the unit. In the Object Properties window, select a new team from the drop-down list. The unit has been re-assigned.

REPAIRING TEXTURE ERRORS

To produce good texturing requires plenty of design work in *World Builder* and lots of computation by the application. During development, you may see bad blends between textures, or you may accidentally create the computationally intensive three-way blends.

HARD TEXTURE EDGES

While painting textures, you can create hard edges to your texture fields and need to soften them with blending. Instead of blending the whole texture field outward, you can blend a single edge inward.

1. To blend a single edge, select the Blend Single Edge tool in the toolbar.
2. Place the cursor just outside the hard edge. Click and drag across the border into the other texture. Release the mouse button.
3. The edge is softened.

BLENDS IN THE MIDDLE OF A TEXTURE FIELD

If you discover an accidental dab of incorrect texture in a field of color, you can remove it easily.

1. Click the Eyedropper tool in the toolbar.
2. Click the texture to paint over the incorrect texture.
3. Click the Single Tile or Large Tile tool in the toolbar.
4. Paint over the incorrect texture with the correct texture.
5. Blend the texture as needed.

THREE-WAY BLENDS

When three fields of texture are blended together, you can create three-way blended textures. While these are not errors in the strictest sense, you do want to limit the number of three-way blends in your map.

✯ A good rule of thumb is to keep the number of three-way blends to less than 300 in a map and no more than 50 in any area displayed on the screen.

1. To show the three-way blends in your map, select SHOW 3-WAY BLENDS IN WHITE. The three-way blends appear as white tiles on your map.
2. Use the Eyedropper tool to select one of the textures contained in a three-way blend.
3. Select the Single Tile or Large Tile tool in the toolbar. Paint over the area.
4. Use the Auto Edge Out or Blend Single Edge tools to blend from one texture to another.
5. If another three-way blend is created, it is displayed in white. The process can be repeated.

NOTE: There is no easy way to reduce three-way blends. When in doubt, start over and reduce the amount of overlapping textures. That method often produces better results.

STRETCHED CLIFF TEXTURES

When textures are stretched over cliffsides, the effects can be grotesque. You can try these three approaches to get a better effect:

1. **Smooth Height tool.** In the toolbar, select the Smooth Height tool. After setting the options for the tool, click and drag all over the cliffside to scrub out the roughness on the cliffside. Turn up the Feather Rate to its highest setting. For more information, ➤ *Smooth Height* on p. 23.
2. **Map Cliff Textures.** If the Smooth Height tool fails to produce the desired results, select MAP CLIFF TEXTURES from the Texture Sizing menu. Then, click the bad-looking textures. How do they look? If there is a black band at the top or bottom of the texture field, apply textures to those areas and blend them.

❍ To undo the cliff texture mapping, press CONTROL + Z.

3. **Reshape the Cliff.** If mapping cliff textures fails to work, you should reshape the face of the cliff. Instead of a single long face, make the cliff multiple shorter and slighter grades.

SCRIPT DEBUGGER

NOTE: The Script Debugger may not be available in your version of the game.

One of the more useful tools in *World Builder* is accessed outside of it. The Script Debugger allows you to see the real-time progress of your variables, counters, flags, and timers as you play your designs inside the game. It is an invaluable resource to the process of completing quality maps.

✯ If your computer is good enough to do so, you can open *World Builder* and the game at the same time. Such an arrangement allows you to jump back and forth between design and debugging tasks. *World Builder* supports dual monitor usage.

ACTIVATING THE SCRIPT DEBUGGER

1. Exit *World Builder*.
2. Navigate your local computer to the *Command* & *Conquer Generals* directory.
3. Create a shortcut for GENERALS.EXE. To create a shortcut, right-click GENERALS.EXE and select CREATE SHORTCUT. The shortcut is created in the directory.
4. Cut and paste the shortcut to the desktop.
5. Right-click on the shortcut.
6. Create shortcut to GENERALS.EXE.
7. Under the Shortcut tab, select the Target text field. Add " -**win –scriptdebug**" to the end of it, outside the quote mark. These switches tell the game application to activate the Script Debugger.
8. When you are designing and debugging maps with scripts, double-click this shortcut to open the game. The Script Debugger opens with it.

SCRIPT DEBUGGER SCREEN

When you open the game with the Script Debugger activated, the Script Debugger screen is displayed over the game screen.

✯ **Frame.** A counter indicating the current frame of the game session. After a map is started, this counter does not reset.

✯ **Variables.** In the Variables pane, you can review the current state of all of your scripted boolean flags, timers, and counters.

✯ **Messages.** The Messages pane lists all of the scripts that have been fired and some other messages from the AI. The left-hand number of a message indicates the frame in which the event was fired.

❍ To pause the game momentarily, click PAUSE.

❍ To step through the game frame-by-frame, click PAUSE, and then click STEP. Continue clicking STEP to step additional frames.

❍ To step in 10-step frame jumps, click RUN FAST 10X.

❍ To remove all of the messages from the Variables and Messages panes, click CLEAR.

OPTIMIZING YOUR MAP

As you build your map, it's important to optimize periodically. It's very easy to use the tools of *World Builder* to create maps that play too slowly on even good machines. When the frame rate for the game gets too low, the gaming experience is degraded. From time to time, you should perform these tasks to optimize your maps for good performance on all platforms.

- If you're having problems with performance in *World Builder*, consult the suggestions at the end of this section.

ELEMENTS TO OPTIMIZE

OBJECT COUNTS

- The number of objects on your map is displayed on the far left side of the status bar at the bottom of the screen.
- Limit the number of objects you use. A good limit is 100 objects per player in multiplayer maps. If you have two players on the map, you can increase this limit somewhat, as there are many players creating objects on the map.
- In single player, 1,800 total objects is the recommended limit.
- Be careful when creating cities and forests with high object counts. Remember that you are creating a battleground with the impression of a city or a forest; you are not creating the city or forest itself. You need fewer objects to create a simple impression. For example, you can create the impression of a forest with no more than 40 trees. Practice to see what you can get away with, and remember that the quality of the gameplay is always the overriding factor.

STEEP SLOPES

- Don't build unnecessarily steep slopes. Units cannot target up a steep slope. To see which slopes are steep, select SHOW IMPASSABLE AREAS and then select IMPASSABLE AREA OPTIONS from the View menu. In the dialog, enter the maximum angle that is acceptable and click OK. You can now see impassable areas in your map. Use the Smooth Height tool to smooth them down.
- Remember to reset the Impassable Area option to 45 degrees.
- Before you release your map, use the Smooth Height tool on all of the cliffs and across all of the flat areas. Use it to smooth as much as possible. Don't be afraid to turn up the Feather Rate to its highest setting. Lots of smoothing makes your map look nicer and perform better.

BLENDED TEXTURES

- You must blend textures to create more natural effects, but do not blend textures unnecessarily. There is always a resource hit on blending textures.
- Three-way blended textures are resource hogs. Limit yourself to no more than 300 three-way blended textures in your map. Fewer such blends make for better game performance.
- There should never be more than 50 three-way blends in a single shot of your map from the standard camera position.
- When in doubt, start over painting textures, and try to avoid overlaps.
- For information on reducing the number of three-way blends, ➤ *Three-Way Blends* on p. 76.

MAP SIZE

- If your map has grown to larger than 400 x 400 tiles, you should consider reducing the open space between areas of your map. Alternatively, you can save two copies of the map and continue developing two separate maps.
- There is a script available called, "Oversize Terrain." Do not use it. Used mostly for cinematic sequences, the script allows the camera to display a larger area of the map during pans and tilts. However, it is a huge hit on the frame rate and is not worth the cost. In the single-player campaigns, the script is no longer used.

MAP PERIMETER

- Before you release your map, check the map perimeter. Click the Border tool in the toolbar. The orange border marks the play area, and the blue border marks the edge of the workspace. If they do not match, players may not be able to access all of your map. However, if you change map borders during the course of the mission, this caution may not apply.

TRIGGER AREA POLYGONS

- Don't have more than five overlapping polygons. The outer ones tend to get forgotten.

SUFFICIENT SPACE

- Avoid creating choke points. Too many choke points slows the game, turns it into a slugfest, and kills the frame rate. Open maps are better in most cases.
- If you are creating a choke point, it should be wider than the length of five tanks at a minimum.
- Even in urban settings, create as much space as possible. Extremely narrow spaces between buildings can cause pathfinding problems for the units. If the group is sufficiently large, the units in the rear tend to twitch as they search for various paths. It slows the game down. Open up your maps where possible.

OBJECT PLACEMENT

- Avoid overlapping objects. While you can sometimes produce interesting visual effects, these screen elements are interactive objects that can result in some strange behaviors in the game.
- Did you raise your terrain recently? Some objects may be buried now. Use the Pick Similar command or the Layers List to find missing objects.
- Roads, as objects, are different from regular objects. You can overlap roads of the same type to create intersections, but you cannot overlap dissimilar roads. For more information, ➤ *How to Build a Road* on p. 49.

BODIES OF WATER

- Use the default water polygon as much as possible. If you consider the water polygon as sea level in your map, you can use it to build multiple lakes and even the border of the ocean.
- Never overlap water polygons. It drastically increases the number of control points. Instead, create a single, more elaborate water polygon.

RESOURCE COUNTS

- There should be $40,000 – $60,000 of resources per player on the screen.
- Limit the number of units that generate resources on your map. Oil derricks are continual sources of funds. Too many of them can turn each game played on your map into a slugfest.

WAYPOINT PATHS

- Avoid having S-turns in your waypoint paths. They should be straight lines, simple turns, or at most, arcs to their target.

SCRIPT MANAGEMENT

- Use the Script Debugger to track your scripts during a mission. For more information, ➤ *Script Debugger* on p. 77.
- Don't activate a script and check its condition unless it is necessary. Enable scripts only when they are needed. Scripts that check to see if units should take actions such as move, attack, or guard are expensive to check. So are trigger areas. They can cause a reduction in frame rate.
- If you are giving out attack or move commands, don't give them all out in a single frame. Dispense orders over a sequence of frames.
- Similarly, spread out the spawning, destruction, and deletion of objects over time. When a unit is spawned, its AI immediately begins working, which impacts the game. Space these events out.

SELECT OBJECTS

- A good checkup before you publish a map is to check each type of object to make sure that every instance is accounted for and intended to be part of your map. Use the Select Similar tool to select objects of the same type.
- Prior to release, use the Select Duplicate tool to check to see if you've accidentally placed objects on top of each other, which is an artifact of the copy and paste functions.

IMPROVING PERFORMANCE IN *WORLD BUILDER*

World Builder is a high-performance application that makes significant demands on your system's resources. If you are experiencing slow-downs in screen updating, try the following to improve performance of *World Builder*.

- **Reduce the amount of map displayed on-screen.** *World Builder* slows down if the display area is too large. Under the View menu, select VIEW PARTIAL MAP SIZE. Choose a smaller size of map to display.
- **Close all other applications.** While *World Builder* can work while other applications including the game are open, it works better if all others are closed.
- **Display only what needs to be displayed.** Use the View toggles to hide elements of the map that are not germane to your current task. For more information, ➤ *View Menu* on p. 18.
- **Turn OFF object shadows.** The shadowing of objects can significantly impact the performance of *World Builder*. To turn off shadows, deselect SHOW SHADOWS in the View menu.
- **Turn OFF display of clouds.** Similarly, clouds can significantly impact the performance of *World Builder*. To turn off cloud display, deselect SHOW CLOUDS in the View menu.
- **Get acquainted with layers.** You can organize objects in your map into layers whose display can be toggled. For more information, ➤ *Layers List* on p. 27.
- **Lower window resolution.** If you set the window resolution too high, you may experience slow-downs in performance. Try lowering the window resolution through the Window menu. If the Work window becomes too small on the screen, set the screen resolution through the Windows control panel. For more information, see your Windows documentation.
- **Use the default water plane.** Each map comes with one default water shape that has much less impact on performance then any custom water shapes. For more information, ➤ *Water Tool* on p. 23.
- **Avoid soft water display.** When displaying soft water, you soften the edges between water shapes and the land that surrounds them. While this effect is much more pleasing to the eye, it slows down *World Builder*. To toggle display of soft water, select SHOW SOFT WATER in the View menu.
- **Use default object shadows.** While customizing shadows for individual objects can produce some nice effects, there are more important design tasks. Additionally, it can slow down your speed in completing those more important ones. Use customized object shadows sparingly.
- **Check the amount of map displayed on-screen.** Are you displaying the entire map? To toggle display of the entire map, select SHOW ALL OF 3D MAP from the View menu.
- **Watch your object counts.** As a general rule, keep the number of objects below 100 per player in multiplayer/Skirmish maps and 1,800 total objects for single-player mission maps. Object counts can impact performance in *World Builder* and the game.
- **Toggle OFF display of the macrotexture.** To toggle display of the macrotexture, select SHOW MACROTEXTURE from the View menu.

GLOSSARY

Term	Definition
3D Wireframe	The underlying mesh that describes the shape of the terrain. To see the 3D wireframe, select SHOW WIREFRAME 3D VIEW from the View menu.
Ambient Sound	Ambient sounds can be placed on your map to create a nice sense of environment.
Auto Edge Out tool	The Auto Edge Out tool blends a selected texture outward into the surrounding textures, creating new blended textures between them.
Blend Single Edge	Painting with textures often leaves the sharp edges of the tiles on your map. You can smooth individual edges using the Blend Single Edge tool. For more information, ➤ *Blend Single Edge* on p. 24.
Build List tool	For CPU-controlled players, a Build List indicates the order in which its structures should be created. For more information, ➤ *Build List* on p. 59.
Camera	The position of the camera over the terrain can be manipulated with the mouse. For more information, ➤ *Camera Settings* on p. 11.
Cliff Textures	Due to the sharp change in elevation, cliffs can cause stretching of the textures that looks unnatural. *World Builder* can assist in the placement of cliff textures. For more information, ➤ *Map Cliff Textures* on p. 20.
Dig tool	Use the Dig tool to remove terrain and dig valleys, riverbeds, and canyons in the map. To remove terrain, select the Dig tool from the toolbar.
Global Lighting	Using global lighting options, you can set the overall lighting for the map and can vary the lighting for objects and structures. For more information, ➤ *Global Lighting* on p. 9.
Grid	A square grid can be displayed over your map to assist in measuring distances and aligning the placement of objects. To toggle display of the grid, select SHOW GRID from the View menu.
Grove tool	The Grove tool can be used to place natural-looking collections of trees of different types. For more information, ➤ *How to Build a Grove* on p. 52.
Impassable Area	When the terrain is too steep, vehicles cannot pass directly over it. To toggle display of the impassable areas of your terrain, select SHOW IMPASSABLE AREAS from the View menu. You can also paint impassable textures onto your map. For more information, ➤ *How to Paint Passable and Impassable Terrain* on p. 46.
Impassable Area Options	You can set the angle at which a slope becomes impassable to ground units. To set the angle, select IMPASSABLE AREA OPTIONS from the View menu.
Layer	A layer is a collection of objects on a map whose display can be toggled through the Layers List.
Layers List	Through the Layers List, you can organize objects into layers whose display in *World Builder* can be toggled to simplify your view. For more information, ➤ *Layers List* on p. 27.
Macrotexture	The macrotexture is the default background texture on your map. When you first create a map, the macrotexture is displayed over its entirety.
Map Perimeter	Around the edge of the map, you must define its perimeter for AI-controlled units. For more information, ➤ *Border Tool* on p. 26.

Mesh Mold tool	The Mesh Mold tool can be used to add pre-formed shapes to the terrain. For more information, ➤ *Mesh Mold Tool* on p. 23.
Mound tool	Use the Mound tool to raise the elevation of the terrain under the cursor. For more information, ➤ *Mound Tool* on p. 23.
Object	An object is a structure, vehicle, sound, or other element that you place on your map. Depending on the type of object, other parameters and behaviors must be defined as well.
Object count	In the lower-left corner of the Status Bar, the number of objects in the map is displayed. Try to keep below 100 objects per player in multiplayer maps and 1,800 objects for single-player maps.
Object Library	Through the Object Library, you can find and place objects on your map.
Object Properties	Associated with each object is a set of properties that describe its side, health, visual appearance, and behaviors. When the object is selected, these properties are displayed in the Object Properties window. For more information, ➤ *Object Properties* on p. 28.
Pick Constraint	To select a type of object on the map, use the Pick Constraint tool. For more information, ➤ *Pick Constraint* on p. 17.
Player	A Player is any human- or CPU-controlled army on the map. Each player must defined through the Player List. For more information, ➤ *Player List* on p. 55.
Player List tool	The Player List tool lets you define the players in the game. For more information, ➤ *Player List* on p. 55.
Polygon tool	Using the Polygon tool, you can define trigger areas that can be referenced in scripts. For more information, ➤ *Polygon Tool* on p. 26.
Ramp tool	The Ramp tool lets you build ramps in the terrain. For more information, ➤ *How to Build a Ramp* on p. 43.
Road tool	Use the Road tool to create roads, sidewalks, and railroads. For more information, ➤ *How to Build a Road* on p. 49.
Scripts	Using scripts, you can generate actions based on events that occur during gameplay. For more information, ➤ *Scripts* on p. 61.
Shadows	You can create shadowing effects that are different from those implied by the global lighting settings. For more information, ➤ *Edit Shadows* on p. 17.
Smooth Height tool	The Smooth Height tool lets you smooth the roughness out of shaped terrain. For more information, ➤ *Smooth Height* on p. 23.
Status Bar	At the bottom of the screen, the Status Bar displays important information on object counts, waypoint counts, and cursor position. For more information, ➤ *Status Bar* on p. 27.
Team	A team is a collection of one or more units that can be controlled as a single entity. Users can create teams in the game, and designers can create teams for CPU-controlled sides. For more information, ➤ *Building Teams* on p. 56.
Terrain	Terrain is the general term used to describe the land forms of your map. Using the tools of *World Builder*, you can add, remove, smooth, and shape the terrain.
Terrain Brush Options	When using the terrain tools, you can configure the size and effects of the brush used to shape the terrain. For more information, ➤ *Terrain Tools* on p. 22.

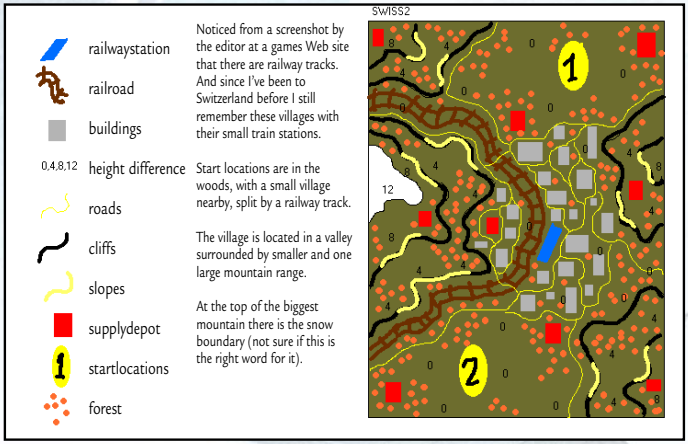
Texture	A texture is a two-dimensional graphic image that is laid across the terrain to give the appearance of a land form. For example, textures can look like grass, mountain, sidewalk, or road.
Three-Way Blends	When the Auto Edge Out tool is used to blend more than two textures together, three-way blends can occur. Three-way blends can significantly slow down the game. To see the three-way blends in a map, select SHOW 3-WAY BLENDS IN WHITE from the View menu.
Time of Day	You can set the time of day on your map. For more information, ➤ *Change Time of Day* on p. 19.
Toolbar	Across the top of the screen, the toolbar contains a set of icons that, when pressed, activate map tools.
Trigger Area	A trigger area is an area of the map that you define and name. The trigger area can then be referenced in scripts. For example, when a unit enters an area, a scripted action can be taken. For more information, ➤ *Polygon Tool* on p. 26.
Unit	An individual infantry, vehicle, or airborne unit. A unit is the fundamental piece of an army.
Water Plane	Appearing as a blue rectangle in a newly created map, the water plane can be used to define large bodies of water in your map. For more information, ➤ *Water Tool* on p. 23.
Water tool	The Water tool allows you to create rivers or lakes. For more information, ➤ *Water Tool* on p. 23.
Waypoint	A waypoint is a location on a map. Units can be ordered to move to a waypoint or through a sequence of them.
Waypoint count	In the Status Bar at the bottom of the screen, the total number of waypoints used in the map is displayed. For more information, ➤ *Status Bar* on p. 27.
Waypoint path	A sequence of waypoints on the map, which can be accessed through scripts. Units can be ordered to follow a waypoint path to complete a scripted task.
Waypoint tool	Using the Waypoint tool, you can define sets of waypoints for units to follow. For more information, ➤ *Waypoint Tool* on p. 26.

APPENDIX A: A GOOD INITIAL SKETCH

The enclosed drawing is the original concept sketch for the Skirmish map titled, "Alpine Assault." In the drawing, you can see how closely it compares to the final produced map. Additionally, the artist has indicated where passable slopes are located. One suggested improvement to this drawing would be to differentiate between supply depots and oil derricks, which are technically limitless.

You might want to print out this page and compare it to the map in the game. In the final design, the designer did a good job of freeing up more space in the middle by moving the railroad to the left and cutting back significantly on the number of trees. Also, the number of supply depots was cut for both sides, and the railway station was removed.

✯ Original Alpine Assault concept sketch by Ejah.



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