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Contents

Preface

How This Manual Is Organized	8
Documentation	8
Derivative Work	9
MAK Products	9
How to Contact Us	11
Telephone	11
E-mail	11
Internet	11
Post	11
Document Conventions	11
DI-Guy Conventions	12
Mouse Button Naming Conventions	12
Third-Party Licenses	13
Third-Party Libraries Supported	13
Library Licensing	13
Boost License	15
libXML and libICONV	16
Lua	16
Scintilla and SciTE	16

1. DI-Guy Content

1.1. Customizing DI-Guy Content	20
1.1.1 Encrypt Your Final Customized Geometry	20
1.1.2 Compressing Geometry Files	20
1.1.3 Where to Place Customized Files	20
1.1.4 The DI-Guy Data Directory Structure	20
1.1.5 Understanding DI-Guy Configuration Files	21

1.1.6 Autoload Configuration Files	23
1.2. Customizing Scene Objects	24
1.3. Customizing Motion	24
1.4. Customizing Texture	24
1.5. Customizing Sound	24

2. Tutorials

2.1. Customizing Appearances Using Texture Swaps	26
2.1.1 Select an Appearance to Modify	26
2.1.2 Change the Texture Map	30
2.1.3 Create Your New Texture Swap and Declare Your New Appearance	30
2.2. Customizing Appearances by Modifying Geometry	32
2.2.1 Creating a Custom Prop	32
2.2.2 Creating a Custom Vehicle	34
2.2.3 Creating a Custom Human: Skinned Characters Using Collada	36
2.2.4 Creating New Weapon/Equipment Combinations	41

3. Creating a Custom Character Type

3.1. Creating a Custom Character Type	44
3.1.1 A Custom Character Type Example: Vehicle with Turret	44

4. DI-Guy Expressive Faces

4.1. Introduction to Expressive Faces	50
4.2. How to Work with DI-Guy	51
4.2.1 Create a Script	52
4.2.2 Select an Avatar	54
4.2.3 Prepare a Base Scenario	55
4.2.4 Record Voice Performances	55
4.2.5 Create Lip-Synching Animations in FaceFX Studio Professional	56
4.2.6 Create a Simple Local Path for Each Response (Animation)	61
4.3. Creating a FaceFX Head Appearance	63
4.3.1 Creating and Exporting Data from 3ds Max	63
4.3.2 Setting Up and Publishing a New FaceFX Actor	65
4.3.3 Setting Up a Head for Use in DI-Guy	65
4.4. Considerations for Using Expressive Faces	66

5. Using the Character Viewer

5.1. Introduction to the DI-Guy Character Viewer	70
5.2. Viewing Characters, Appearances, Gestures, and Actions	71
5.2.1 Filtering the Character Type and Appearance Lists	72
5.2.2 Changing the Viewing Angle for a Character	73

5.2.3 Demonstrating a Character's Aim and Locomotion Capability	73
5.2.4 Viewing Different LOD Levels	74
5.2.5 Changing How a Character Is Rendered	75
5.2.6 Viewing Multiple Appearances at One Time (Army Mode)	77
5.2.7 Advanced Character Editing	80
5.2.8 Reloading Characters that Have Been Edited	82
5.2.9 Controlling Character Movement	82
5.2.10 Viewing Information About Character Movement and State	82
5.3. Improving Performance	83
5.3.1 Displaying the Performance Profiler	84
5.4. Running a Lua Script	84
5.5. Viewing Character Geometry Details	84
5.6. The Appearance Editor	85
5.6.1 Editing Configuration File Text	86
5.6.2 Editing Appearance Effects	87
5.7. Using the PBR Material Tester	87
5.7.1 Reloading Shaders	88
5.8. The Character Viewer Log Window	89
5.8.1 Setting the Notification Level	89
5.9. Broadcasting the Character Viewer over the Network	89
5.9.1 Joining a DIS Exercise	89
5.9.2 Joining an HLA Exercise	91
Index	93



Preface

This manual is written for people who want to add new characters to use with DI-Guy. Please see release documentation for information about changes and updates to DI-Guy since this manual was completed.

How This Manual Is Organized

The chapters are organized as follows:

"Chapter 1. DI-Guy Content" on page 19 briefly describes DI-Guy and its features.

"Chapter 2. Tutorials" on page 25 guides you through several ways to add content to DI-Guy.

"Chapter 3. Creating a Custom Character Type" on page 43 explains how to add a character that does not have a similar character already in DI-Guy.

"Chapter 4. DI-Guy Expressive Faces" on page 49 explains how to add an Expressive Faces head using FaceFX.

"Chapter 5. Using the Character Viewer" on page 69 explains how to view characters, appearances, and actions in the Character Viewer. It also describes the Geometry Viewer.

Documentation

DI-Guy comes with the following documentation:

- *DI-Guy SDK Developers Guide*. Online documentation that lists all the functions and classes of DI-Guy SDK and explains how to program using the DI-Guy SDK.
- *DI-Guy Documentation Center*. Includes HTML versions of all of the books listed below, allowing you to search the entire documentation set. It also includes links to developer documentation and the PDF versions of the guides.
- *DI-Guy Getting Started Users Guide*. Explains the basics of installing and using DI-Guy products.
- *DI-Guy Scenario Users Guide*. Explains how to use DI-Guy Scenario to create scenarios with realistic human activity.
- *DI-Guy Content Reference Manual*. Explains how to customize DI-Guy characters and add new character models. It also describes how to use DI-Guy Expressive Faces.
- *DI-Guy AI Users Guide*. Explains how to use DI-Guy AI to add intelligent behavior to DI-Guy characters.
- *DI-Guy Motion Editor Users Guide*. Explains how to import, edit, and customize DI-Guy motions.

These documents are available from the start menu under DI-Guy, or by browsing to `./doc`.

Try the Help

MAK's HTML5 help (the *DI-Guy Documentation Center*) is the best way to use our documentation. It's easy to navigate, with improved natural language search tools and filters to focus your search. You can click the illustrations to see high-resolution enlargements that show more detail. It's built into the product and installed locally — simply press **F1** to launch the help in your browser. You do not need to be connected to the internet to use it.

i If you attempt to view the help in a browser that does not fully support HTML5, you may experience issues with some features.

Derivative Work

Any DI-Guy content (model, texture, motion, and so on) that you modify or copy is a derivative work that is protected under copyright law by the same rules that apply to content delivered with DI-Guy. This derivative content may be used only on computers that have a valid DI-Guy license. Please contact MAK Technologies to discuss licensing for other uses of derivative models.

MAK Products

The MAK Technologies product line includes:

- **VR-Link® Network Toolkit.** VR-Link is an object-oriented library of C++ functions and definitions that implement the High Level Architecture (HLA) and the Distributed Interactive Simulation (DIS) protocol. VR-Link has built-in support for the NETN FOM and RPR FOM and allows you to map to other FOMs. This library minimizes the time and effort required to build and maintain new HLA or DIS-compliant applications, and to integrate such compliance into existing applications. VR-Link includes a set of sample debugging applications and their source code. The source code serves as an example of how to use the VR-Link Toolkit to write applications. The executables provide valuable debugging services such as generating a predictable stream of HLA or DIS messages, and displaying the contents of messages transmitted on the network.
- **MAK RTI.** An RTI (Run-Time Infrastructure) is required to run applications using the High Level Architecture (HLA). The MAK RTI is optimized for high performance. It has an API, RTIsPy®, that allows you to extend the RTI using plug-in modules. It also has a graphical user interface (the RTI Assistant) that helps users with configuration tasks and managing federates and federations.
- **VR-Forces®.** VR-Forces is a computer generated forces application and toolkit. It provides an application with a GUI, that gives you 2D and 3D views of a simulated environment.

You can create and view entities, aggregate them into hierarchical units, assign tasks, set state parameters, and create plans that have tasks, set statements, and conditional statements. You can simulate using entity-level modeling, which focuses on the actions of individual people and vehicles, and aggregate-level modeling, which focuses on the interaction of large hierarchical units.

VR-Forces also functions as a plan view display for viewing remote simulation objects taking part in an exercise. Using the toolkit, you can extend the VR-Forces application or create your own application for use with another user interface.

- **VR-Vantage™.** VR-Vantage is a line of products designed to meet your simulation visualization needs. It includes VR-Vantage and the VR-Vantage Toolkit.

- VR-Vantage displays a realistic, 3D view of your virtual world, a 2D plan view, and an exaggerated reality (XR) view. Together these views provide both situational awareness and the big picture of the simulated world. You can move your viewpoint to any location in the 3D world and can attach it to simulation objects so that it moves as they do.
- SensorFX. SensorFX is an enhanced version of VR-Vantage that uses physics-based sensors to view terrain and simulation object models that have been materially classified. It is built in partnership with JRM Technologies.
- The VR-Vantage Toolkit is a 3D visual application development toolkit. Use it to customize or extend MAK's VR-Vantage applications, or to integrate VR-Vantage capabilities into your custom applications. VR-Vantage is built on top of OpenSceneGraph (OSG). The toolkit includes the OSG version used to build VR-Vantage.
- MAK Data Logger. The Data Logger, also called the Logger, can record HLA and DIS exercises and play them back for after-action review. You can play a recorded file at speeds above or below normal and can quickly jump to areas of interest. The Logger has a GUI and a text interface. The Logger API allows you to extend the Logger using plug-in modules or embed the Logger into your own application. The Logger editing features let you merge, trim, and offset Logger recordings.
- VR-Exchange™. VR-Exchange allows simulations that use incompatible communications protocols to interoperate. For example, within the HLA world, using VR-Exchange, federations using the HLA RPR FOM 1.0 can interoperate with simulations using RPR FOM 2.0, or federations using different RTIs can interoperate. VR-Exchange supports HLA, TENA, and DIS translation.
- VR-TheWorld™. VR-TheWorld is a simple, yet powerful, web-based streaming terrain server, developed in conjunction with Pelican Mapping. Delivered with a global base map, you can also easily populate it with your own custom source data through a web-based interface. The server can be deployed on private, classified networks to provide streaming terrain data to a variety of simulation and visualization applications behind your firewall.
- DI-Guy™. DI-Guy is an SDK that allows you to embed the DI-Guy library in your real-time application and populate your world with lifelike human characters. DI-Guy provides high-fidelity human characters that move realistically, respond to simple high-level commands, and travel throughout the environment as directed by the hosting visual application. It comes with thousands of ready-to-use characters, appearances, and motions. DI-Guy character simulation is an integral part of all MAK's visual applications, including VR-Engage, VR-Forces, and VR-Vantage.
- RadarFX. RadarFX is a client-server application that simulates synthetic-aperture radar (SAR). The server application, which is based on VR-Vantage and SensorFX, loads a terrain database and, optionally, connects to simulations. A client application requests SAR images from the server. RadarFX includes a sample client application.
- VR-Engage. VR-Engage is a multi-role virtual simulator that lets users play the role of a first person human character, a ground vehicle driver, gunner or commander, a sensor operator, or the pilot of a fixed wing aircraft or helicopter. It incorporates

the VR-Force simulation engine and the VR-Vantage graphics rendering capabilities.

- WebLVC Server. WebLVC Server implements the server side of the WebLVC protocol so that web-based simulation federates can participate in a distributed simulation. It is part of the WebLVC Suite, which includes the server and several sample applications that work with VR-Forces and VR-Vantage.
- MAK Legion. MAK Legion is a collection of applications and an SDK designed to support simulations with millions of simulation objects.

How to Contact Us

For DI-Guy technical support, information about upgrades, and information about other MAK products, you can contact us in the following ways:

Telephone

Call or fax us at:	Voice:	617-876-8085
	Fax:	617-876-9208

E-mail

Sales and upgrade information:	info@mak.com
Technical support:	support@mak.com

Internet

MAK website home page:	www.mak.com
License key requests:	www.mak.com/support/get-licenses
Technical support:	www.mak.com/mak-one/support/portal
Product version and platform information:	www.mak.com/support/product-versions
For the free, unlicensed MAK RTI:	www.mak.com/support/bonus-material

Post

Send postal correspondence to:	MAK Technologies 10 Fawcett Street, Suite 204 Cambridge, MA 02138 USA
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When requesting support, tell us the product you are using, the version, and the platform on which you are running. If you are using VR-Vantage, VR-Forces, VR-Engage, or DI-Guy, please also include your data compatibility version and date.

Document Conventions

This manual uses these typographic conventions:

Sans Serif Bold	Indicates a key on the keyboard or menu options. Mentions of letter keys do not require you to press the Shift key. If Shift is necessary, that will be included, for example, Shift+Q . Also indicates parameters.
------------------------	--

Monospaced	Indicates values you enter such as commands or arguments.
<i>Monospaced</i>	Indicates command variables that you replace with appropriate values.
<i>Italic</i>	Indicates required arguments.
{ }	Indicates optional arguments.
[]	Separates options in a command where only one option may be chosen at a time.
	In command syntax, indicates equivalent alternatives for a command-line option, for example, (-h --help).
()	Indicates a directory. Since MAK products run on both Linux and Windows PC platforms, we use the / (slash) for generic discussions of pathnames.
/	Indicates a file name, pathname, or a class name.
<i>Italic</i>	Indicates a procedure.
►	Indicates a menu choice. For example, an instruction to select the Save option from the File menu appears as:
Menu > Option	Choose File > Save .
	Indicates supplemental or clarifying information.
	Indicates additional information that you must observe to ensure the success of a procedure or other task.

Directory names are preceded with dot and slash characters that show their position with respect to the DI-Guy home directory. For example, the directory *./PRODUCT DIRECTORY13.7.1/doc* appears in the text as *./doc*.

DI-Guy Conventions

The DI-Guy documentation uses these conventions used for entity coordinates.

Convention	Indicates
XYZ	X = forward, Y = to the left Z = up
Yaw, Roll, Pitch	Orientation is applied in the order YRP. Yaw = rz – orientation about the vertical axis Roll = rx – orientation about the fore-aft axis Pitch = ry – orientation nose down, nose up

Mouse Button Naming Conventions

An instruction to click the mouse button refers to clicking the primary mouse button, usually the left button for right-handed mice and the right button for left-handed mice. The context-sensitive menu, also called a popup menu or right-click menu, refers to the menu displayed when you click the secondary mouse button, usually the right button on right-handed mice and the left button on left-handed mice.

Third-Party Licenses

MAK software products may use code from third parties. This section contains summary license information and, where required, specific license documentation required by these third parties.

Third-Party Libraries Supported

DI-Guy 13.7.1 uses the indicated versions of these libraries:

- VR-Link 5.9.1
- Qt 5.15.2 (VC 15 and Red Hat 8)
- OpenSceneGraph 3.6.4
- Boost 1.63.0
- FreeGlut 2.4.0 (Windows), 2.6.0 (Linux)
- GL Studio 8.2
- DI-Guy 13.7 (development version)
- Triton 4.43
- SilverLining 6.20
- SpeedTree 6.3.2
- CDB API 2.2 (Windows), 2.1 (Linux)
- osgEarth 3.2
- CUDA 11.7

Library Licensing

These libraries are covered by the GNU Lesser General Public License (LGPL) license:

- CIGI
- Devil
- GEOS
- GStreamer
- LibIconV
- LibWebSockets
- OPCode
- OpenAL
- OSG
- OsgEarth
- Pthread
- Qt
- Qwt

These libraries are covered by the ZLib license:

- Bullet Physics
- LibPNG
- LibSDL
- Minizip
- Zlib

These libraries are covered by the MIT license:

- Expat
- FreeGLUT
- GDAL
- GeoTIFF
- GLM
- HarfBuzz
- LibCURL
- LibSquish
- LibXML
- LUA
- LuaBind
- Proj
- SMHasher
- TCLAP
- Qt Visual Graph Editor
- ZeroBrane Studio

These libraries are covered by the BSD license:

- FreeType
- GLEW
- JPEG
- LibTiff
- Protobuf
- PCRE
- Ogg Vorbis
- WebP

These libraries are covered by the commercial licenses:

- FLEXlm
- Gameware
- GLStudio
- JRM Technologies SenSimRT and SigSimRT
- OpenFlight
- SpeedTree
- Sundog Triton
- Sundog SilverLining
- CDB API

These libraries are covered by custom licenses:

- NVIDIA CG Toolkit
- FreeImage (FreeImage Public License)
- Boost (Boost Software License)
- Poco (Boost Software License)

COLLADA DOM is covered by the SCEA Shared Source license.

Thread Building Blocks is covered by the GPL license:

SQLite is in the public domain.

SWIG is covered by the GPL license.

Boost License

VR-Link, and all MAK ONE products that use VR-Link, uses some code that is distributed under the Boost License. All header files that contain Boost code are properly attributed. The Boost website is: www.boost.org.

Boost Software License - Version 1.63 - August 17th, 2003

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libXML and libICONV

VR-Link, and all MAK ONE products that use VR-Link, links in libXML and libICONV. On some platforms the compiled libraries and header files are distributed with MAK products. MAK has made no modifications to these libraries. For more information about these libraries, see the following websites:

- The LGPL license is available at: <http://www.gnu.org/licenses/lgpl.html>.
- Information about IconV is at: <http://www.gnu.org/software/libiconv>.
- Information about LibXML is at: <http://xmlsoft.org>.

Lua

Some MAK products use the Lua programming language (www.lua.org). Its license is as follows:

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1. DI-Guy Content

This chapter is an introduction to customizing DI-Guy content.

1.1. Customizing DI-Guy Content	20
1.1.1 Encrypt Your Final Customized Geometry	20
1.1.2 Compressing Geometry Files	20
1.1.3 Where to Place Customized Files	20
1.1.4 The DI-Guy Data Directory Structure	20
1.1.5 Understanding DI-Guy Configuration Files	21
1.1.6 Autoload Configuration Files	23
1.2. Customizing Scene Objects	24
1.3. Customizing Motion	24
1.4. Customizing Texture	24
1.5. Customizing Sound	24

1.1. Customizing DI-Guy Content

DI-Guy is highly customizable. Motions, geometry, textures, characters, and special effects (that is, DI-Guy content) can all be customized. Be sure to use the `./custom` directory, as described in this manual, when modifying DI-Guy. This will safeguard your changes so that you will be able to install future releases without losing your customizations.

 When editing configuration files, do not use Notepad. Use a text editor that preserves end-of-line information.

1.1.1 Encrypt Your Final Customized Geometry

When customizing `.flt` and `.dae` geometry files, always encrypt your geometry to protect DI-Guy intellectual property. This is required by the DI-Guy Model Use Agreement.

- To encrypt your customized geometry, open a command prompt and enter:

```
diguyEncryptGeometryFile filename
```

1.1.2 Compressing Geometry Files

As an alternative to encrypting geometry files, you can compress them. This allows you to distribute them without distributing source files. The geometry processor compresses all uncompressed geometry in the custom directory.

- To compress your customized geometry, open a command prompt and enter:

```
DIGuyGeometryProcessor
```

1.1.3 Where to Place Customized Files

When DI-Guy needs to access data, it looks in the `./custom` directory before looking in the default location for the file. The `./custom` directory acts as a shadow or mask directory to the default DI-Guy content directories. Therefore, the files in it should use the exact same directory layout as the default directories. For example, if DI-Guy normally loads `./geometry/flt/model.flt`, it will first search for the file `./custom/geometry/flt/model.flt` before loading `./geometry/flt/model.flt`.

 We strongly recommend that you leave all files installed by DI-Guy unchanged and place all your modified and new files in `./custom/`. This will allow your customizations to be portable to other DI-Guy installs and allow you to upgrade to new versions of DI-Guy with minimal or no changes to your custom content.

1.1.4 The DI-Guy Data Directory Structure

Here is a list of custom directories whose files mask identically named files in the standard directory:

- Geometry `./custom/geometry/`
 - Textures `./custom/geometry/rgb/`, `./custom/geometry/png/`
 - Scene Objects `./custom/geometry/sets/`
 - OpenFlight Models `./custom/geometry/flt/`
 - Collada Files `./custom/geometry/dae/`
- Configuration Files `./custom/config/`
- Motions `./custom/motions/`
- Sound Effects `./custom/sfx/`
- Scenarios `./custom/scenarios/`

1.1.5 Understanding DI-Guy Configuration Files

DI-Guy content is declared in and loaded using configuration files, allowing DI-Guy to be easily customized. By default, the configuration file `./config/diguy.cfg` is used by DI-Guy to define content. This file **includes** other configurations files, which may also **include** more nested configuration files, and so on.

If you want to better understand how DI-Guy organizes its data, we encourage you to examine, trace through, and modify files using the custom directory shadow technique. All of the configuration files are in ASCII text format, so they are easy to read and understand.

These concepts and terminology are used in the DI-Guy configuration file system:

- Actor. The flesh-and-blood actor whose performance was captured using motion capture. Motion files reference the original actor. The DI-Guy motion engine often performs mathematics to scale motions to fit the end dimensions of the virtual character's appearance.
- Appearance. The specific geometry and textures that describe the visual look of the character. DI-Guy appearances can be skinned (deformable mesh) or segmented (rigid interpenetrated polyhedral). Many skinned appearances include equipment that may be segmented.
- Character_type. The combination of the set of actions a character can perform with the set of visual appearances the character can use.
- Joint. Describes the way two rigid links are joined together. Popular joints include pin, frozen, 6DOF (degrees-of-freedom), ball, 3DOF, and slider.
- Link. A link is a joint plus an offset. Often shapes are associated with links. Links can be traversed and drawn. Sometimes links are referred to as "bones".
- Shape. A mesh or polyhedral associated with a link. Unlike the link, which is conceptual in nature, shapes are actual drawables.
- Shapeset. A collection of one or more shapes.

For definitions of other terms used by DI-Guy, see the Glossary in the *DI-Guy Scenario Users Guide*.

The entries in `diguy.cfg` can be organized into these sections:

- Preface. This section defines very basic things about the content.
- Main Section. This section defines the bulk of DI-Guy content, often by pointing at lists of Level Two include file content.
- Level Two File. Common files using common syntax to describe DI-Guy content.

 Paths in *diguy.cfg* are relative to the *./config* directory.

The Preface Section

The preface section of *diguy.cfg* defines very basic things. It is not usually modified except by very advanced DI-Guy users.

- *geometry_set_priority_list*. Order of operation for geometry file search.
- *data_version*. Specifies the DI-Guy version of the data, include the configuration files themselves.
- *required_sdk_version*. Specifies the version of DI-Guy software that this data is compatible with.
- *common/loaders.cfg*. Motion data loaders. Specifies the exact name of every variable for a particular DI-Guy character_type. Each loader has a name, and that name is referenced in the character_type definitions.
- *common/shader_matrix_index_tables.cfg*. A list of different object types and bones that a DAE file has, needed to map a skinned character to a DI-Guy skeleton.
- *common/common_links.cfg*. The variables for popular links, as well as the joint type and some skeletal hierarchical information.
- *common/shape_and_joint_data.cfg*. The name of a shape is joined to the name of the joint. Therefore you can determine what shapes will be drawn when a joint is drawn.
- *common/common_actors.cfg*. The actor object is described by its shapeseets and links.
- *common/common_characters.cfg*. Various DI-Guy primitive characters, such as lines, are described in this file. Character definitions usually have a *graphics_class*, *actor*, *link list*, and *default_equipment*.
- *diguy/required_characters.cfg*. Defines the character waypoint.

The Main Section

This section of *diguy.cfg* defines most of the DI-Guy content. If you want to customize DI-Guy content, you need to understand this section and the Level Two content it references.

- *diguy/diguy_actors.cfg*. Lists individual actor configuration files. See *diguy/actor_<actor_name>.cfg* for more information.
- *diguy/diguy_characters.cfg*. Contains a list of character_type definitions. See the *diguy/char_<character_type>.cfg* definition for more information. The file also includes *diguy/diguy_character_type_maps.cfg*, which associates a single word (for example, soldier) with a character_type and appearance combination to support generic requests for a type of character where DI-Guy responds with the best

match.

- *diguy/character_types_list.cfg*. Defines the set of character_types that match simple descriptions. For example, more than a dozen character types are deemed relevant when querying which character_types are available as male pedestrians. Like *diguy/diguy_character_type_maps.cfg*, this list supports wizard-type queries into the DI-Guy content database for best matches to user search criteria.
- *diguy/exface_shapesets.cfg*. Defines expressive face appearances and geometry available to particular actors.
- *diguy/gestures.cfg*. Defines lists of gesture motions available.
- *diguy/motex_arcs.cfg*. Defines a list of available motion textures, used to add visual noise to character motions.
- *diguy/default_particle_descriptions.cfg*. Defines default particles and the parameterizations that define them.
- *diguy/appearances.cfg*. Lists of DI-Guy appearance category include files. See *diguy/appearances_<appearance_category>.cfg* for more information.
- *diguy/default_appearance_effects.cfg*. Appearance effects are particle effects that augment appearances, particularly of DI-Guy vehicles. Appearance effects also are used to support incoming DIS/HLA designations such as "smoking" or "on fire".

The Level Two Files Section

- *diguy/actor_<actor_name>.cfg*. Each actor configuration file defines the shapesets available to the character, the links that compose the actor, and an actor definition. The actor definition includes the *standing_hip_height* used to scale actor motions to end appearance dimensions. The actor definition also includes *common/links_<link_category>.cfg*, which tells DI-Guy what variables will be found in the motion file. Finally, the actor definition includes a *shader_matrix_index_table* assignment.
- *diguy/actor_<actor_name>_shapesets.cfg*. Defines the geometry and textures that will be made available to character appearances that are supported by the actor.
- *diguy/actor_<actor_name>_links.cfg*. Defines the skeletal hierarchy of the actor as a set of links, each with a name, offset, associated joint, and DOF variable names.
- *diguy/appearances_<appearance_category>.cfg*. Defines an appearance. An appearance consists of its name, the actor with which is associated, a number of "items" which designate shapesets used by this appearance, and information that helps categorize the appearance for wizard-like queries.

1.1.6 Autoload Configuration Files

Any files placed in the *./custom/config* directory mask their counterpart in the *./config* directory.

In addition, any configuration file in *./custom/config/* that begins with "autoload_" is read automatically during DI-Guy configuration initialization.

1.2. Customizing Scene Objects

- To add custom scene objects (terrains), copy the OpenFlight format database to `./custom/geometry/sets`.

1.3. Customizing Motion

You can customize motion using the DI-Guy Motion Editor. See the *DI-Guy Motion Editor Users Guide* for details.

1.4. Customizing Texture

Textures use the RGB, RGBA, and PNG format.

- To customize textures, edit an existing texture and save it with the same name in `./custom/geometry/rgb` or `./custom/geometry/png`.

Alternatively, you can create a new appearance that uses your new texture instead of overriding the existing appearance.

1.5. Customizing Sound

- To customize sounds, edit an existing sound file and save it with the same name in `./custom/sfx`. You can also add new sounds to this directory.



2. Tutorials

This chapter has examples of customizing DI-Guy content.

2.1. Customizing Appearances Using Texture Swaps	26
2.1.1 Select an Appearance to Modify	26
2.1.2 Change the Texture Map	30
2.1.3 Create Your New Texture Swap and Declare Your New Appearance	30
2.2. Customizing Appearances by Modifying Geometry	32
2.2.1 Creating a Custom Prop	32
2.2.2 Creating a Custom Vehicle	34
2.2.3 Creating a Custom Human: Skinned Characters Using Collada	36
2.2.4 Creating New Weapon/Equipment Combinations	41

2.1. Customizing Appearances Using Texture Swaps

Perhaps the easiest and most popular customization is to simply take an existing DI-Guy appearance and tweak its texture file without modifying geometry to create a new appearance. Uniforms can be changed to be specific to a country; clothing can match a target culture; sensorized appearances can be created to simulate UV or infrared visualization, and so on.

DI-Guy uses texture swapping to add variety to its character appearances while keeping the memory footprint small. Here are two mped_07 appearances, male_suit_1 and male_suit_2. Note how the polygons of the bodies are the same but the texture maps make it appear that the men are wearing different jackets, ties, and pants. This tutorial guides you through the process of creating a new appearance.

Figure 1. Texture swapping to create different appearances

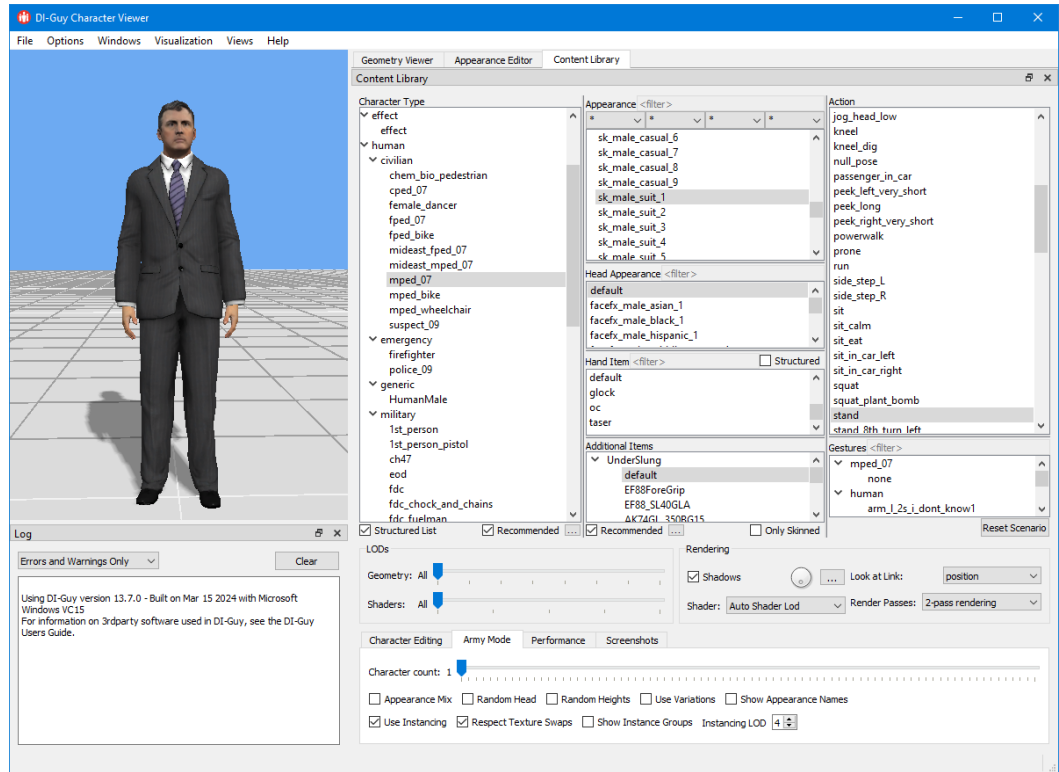


i This tutorial references *.dae* files. The *.dae* files are in the DI-Guy data installer. If you did not install that data, please do so before trying out this tutorial.

2.1.1 Select an Appearance to Modify

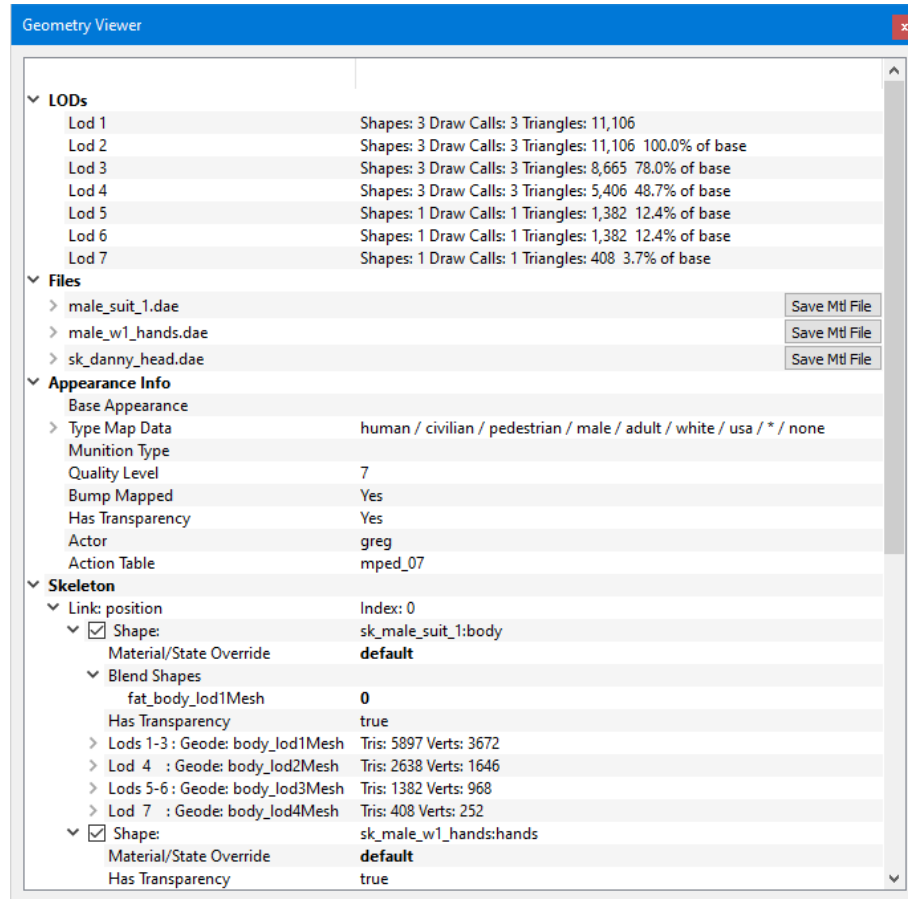
1. On the Start menu, choose **MAK Technologies > DI-Guy Character Viewer (64-bit)**. The Character Viewer opens.
2. In the Character Type list, select mped_07.
3. In the Appearance list, select sk_male_suit_1.
4. Hold down the left and right mouse buttons, and rotate the character so that it faces you (Figure 2).

Figure 2. Character viewer



5. Select the `sk_male_suit_5` appearance to see the differences.
6. If the Geometry Viewer window is not visible, choose **Windows > Geometry Viewer**. The Geometry Viewer window opens (Figure 3). (It may be tabbed.)

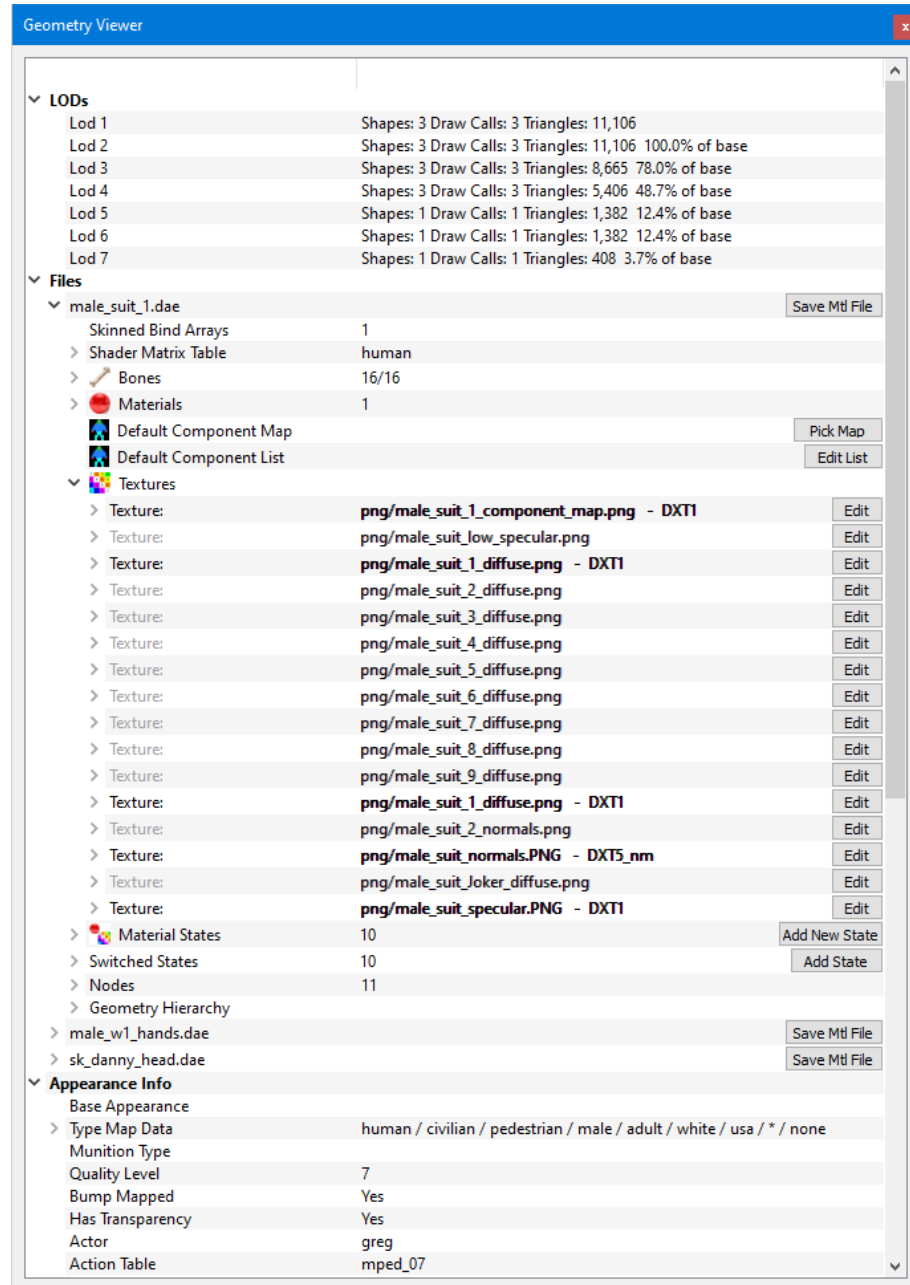
Figure 3. Geometry Overview window



The Files section lists three files. Their names indicate that they are for the suit, hands, and head. For our customization, we will make a simple change to male_suit_1. First, we need to find the texture map that male_suit_1 uses.

- Expand the *male_suit_1.dae* entry and then expand the textures entry. You can see there are many textures associated with the character. The textures in bold indicate textures already loaded into memory. In the image, *male_suit_1_diffuse.png* and *male_suit_5_diffuse.png* are also highlighted because they were visualized when you switched appearances. The naming conventions indicate how the textures are used. The convention *_diffuse* is used for the diffuse texture, *_normals* for the normal map, and *_specular* for the specular map.

Figure 4. male_suit_1 textures



8. We need to make a copy of the male_suit_1 configuration file. However, to do that, DI-Guy requires that the .dae file be in the custom directory.
 - a. In `./custom/geometry`, create a new directory called `dae`.
 - b. Copy `./geometry/dae/male_suit_1.dae.enc` to `./custom/geometry/dae/male_suit_1.dae.enc`.
9. In the Geometry Overview window, on the `male_sui_1.dae` line, click Save Mtl File. You are prompted to save to the custom directory and may receive informational prompts.

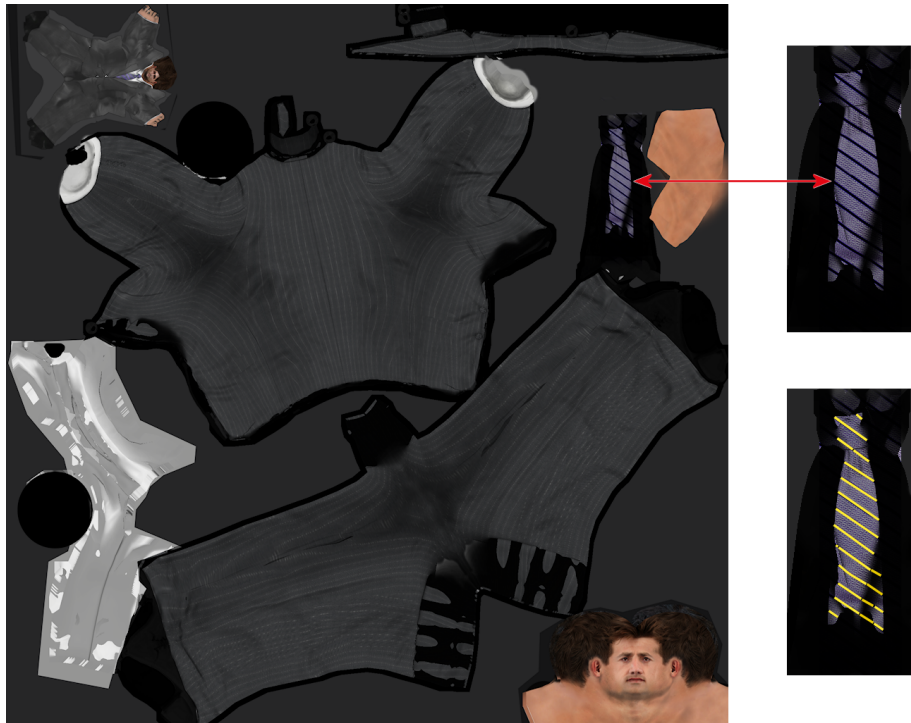
10. Click Yes. The file `./custom/geometry/dae/male_suit_1_mtl.cfg` is created.
11. Use a text editor to open the file `male_suit_1_mtl.cfg`. Near the top of the file, are some texture entries. One of them is `male_suit_1_diffuse.png`. We will edit this file.

2.1.2 Change the Texture Map

To change the texture map, you need a paint program, such as Photoshop or Gimp.

1. In your paint program, open `./geometry/facefx/male_suit_1_diffuse.png` (Figure 5). The tie is in the upper right quadrant of the file.

Figure 5. `male_suit_1_diffuse.png`

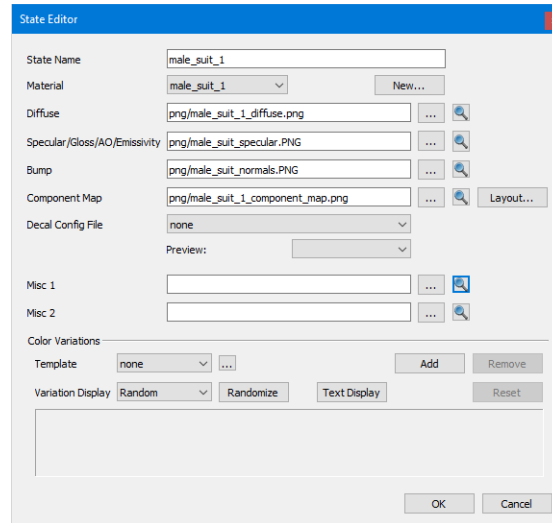


2. Change the tie's stripes to yellow.
Be careful not to change the topology. That is, do not move any of the individual images. The x,y coordinates of the image map to the u,v of the target mesh. Changing the topology would require a re-mapping.
3. Create a new directory `./custom/geometry/png`.
4. Save the texture as `male_suit_1_g_diffuse.png` in `./custom/geometry/png`.

2.1.3 Create Your New Texture Swap and Declare Your New Appearance

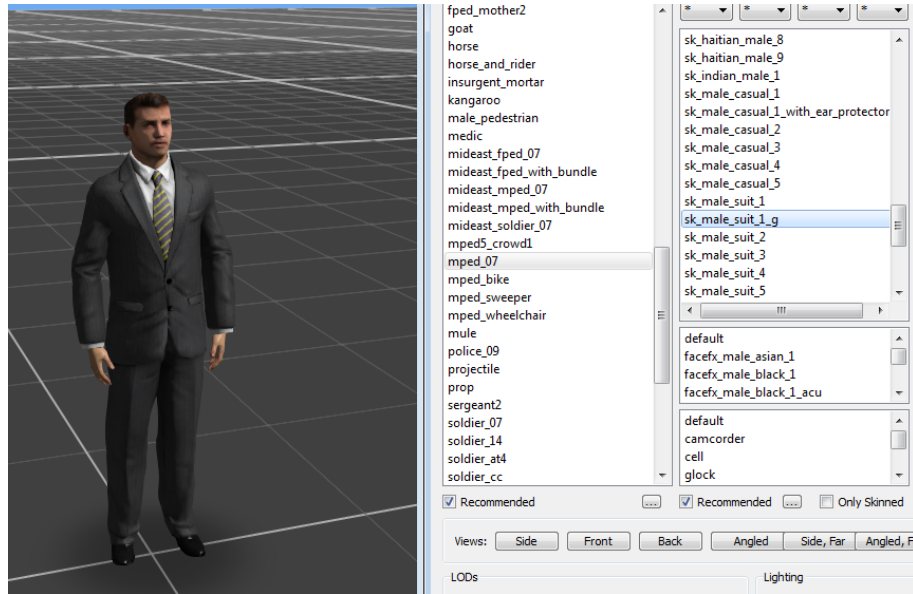
1. In the Geometry Viewer, in the Material States line for `male_suit_1.dae`, click Add New State. The State Editor opens (Figure 6).

Figure 6. State Editor



2. Set the State Name to "male_suit_1_g".
3. In the Diffuse field, click the browse button and then navigate to `./custom/geometry/png/male_suit_1_g_diffuse.png`.
4. Click Open.
5. In the State Editor, click OK. The *male_suit_1.dae* is highlighted and has an asterisk.
6. Click Save Mtl File. You are prompted to save to the custom directory.
7. Click Yes.
8. Create a new appearance configuration entry for your character:
 - a. In a text editor, open `./config/diguy/appearances_skinned.cfg`.
 - b. Copy the entire multi-line entry for appearance `sk_male_suit_3` to a new file.
 - c. Save the new file as `./custom/config/autoload_my_custom_appearances.cfg`.
 - d. Change the name of that entry to `sk_male_suit_1_g`.
 - e. Change the head to `sk_male_w1_head` (or leave it as is, if you like).
 - f. Change the `graphics_state_switch_map1` line to use `male_suit_1_g`.
 - g. Delete the `graphics_state_switch_map2` line.
9. Restart the Character Viewer. The new appearance should now be available with a beautiful new tie (Figure 7). Compare it to Figure 2 on page 27.

Figure 7. Character with modified tie



2.2. Customizing Appearances by Modifying Geometry

Swapping textures is an easy way to customize DI-Guy characters. However, you often need to change geometry to create the exact new appearance you want. The following three examples show, in increasing complexity, how to customize the geometry files of a prop, a vehicle, and a human. All the examples are done in the same basic way. Since they build in complexity, it is important to read how to customize a prop and vehicle if you want to customize a human.

The key to customizing is to find the declarations for a character's appearance that are closest to the new appearance you want to implement and then copy the form and structure for your custom declaration.

i To complete this tutorial, you must have an application that can edit OpenFlight and MAX files and be familiar with editing them.

2.2.1 Creating a Custom Prop

A prop is defined as a DI-Guy character that cannot move. Prop appearances include:

- Road barrier
- Barbed wire fence
- Sofa
- Vending machine
- House

Props in DI-Guy are built using OpenFlight or Collada (DAE) geometry. (DI-Guy developers use DAE for all new models.) This example assumes OpenFlight geometry.

Prepare Your Geometry File

An OpenFlight model defines each prop's geometry.

► To add a new prop model to the prop library:

1. If necessary, convert your model from its existing format into the OpenFlight format. (Meshlab, <http://meshlab.sourceforge.net/>, is a good tool for doing this.)
2. Write out each LOD (up to 7) as a separate FLT file.
3. Edit your model so that there is a group at the root of the model hierarchy named "base".
4. Edit your model so that the positive Z axis points up and the positive X axis points forward. (Your prop should "look" down the X axis.)
5. Make sure your OpenFlight model specifies its texture files using relative addressing. Specify the location of the texture files as `../rgb/<texture_name>.rgb`.
6. Make sure the units in the OpenFlight model are correctly specified. (DI-Guy reads the OpenFlight units label to scale the props correctly. The preferred unit is meters.)
7. Set the OpenFlight LOD switch settings to: switch in = 1000, switch out = 0.
8. Save the file in `./custom/geometry/flt/`.
9. Save the texture files (.rgb, .rgba, .rgb.attr, .rgba.attr, .int) in: `./custom/geometry/rgb/`.

Customize the Configuration Entry

Now that the geometry is ready, it is time to customize the configuration entries so that DI-Guy knows about the new prop appearance. The system requires a configuration file that points to the geometry that defines the new prop at each level of detail.

1. Specify this file name as `./custom/config/autoload_actor_still_shapesets.cfg`.

If this file already exists, modify it to add a `shape_set` entry for the new prop appearance. If the file does not exist, create a new one, using `./config/diguy/actor_still_shapesets.cfg` as a model of what to include.

For example, to add a prop called "pink_flamingo" to the system, place the following block of text in the configuration file:

```
shape_set pink_flamingo
  actor = still
  is_base_shape = 1
  filename = pink_flamingo_most_detailed_LOD1.flt
  filename = pink_flamingo_LOD2.flt
  filename = pink_flamingo_LOD3.flt
  filename = pink_flamingo_LOD4.flt
  filename = pink_flamingo_LOD5.flt
  filename = pink_flamingo_LOD6.flt
  filename = pink_flamingo_least_detailed_LOD7.flt
  shape_and_joint = base position
```

① DI-Guy expects an OpenFlight or Collada (DAE) file designation for each LOD. If you have fewer than seven LODs for your model, just use the same file for multiple LODS. LOD1 is the most detailed.

2. Add or edit `./custom/config/autoload_custom_appearances.cfg`.
3. Add an appearance entry for the new prop. If this file already exists, modify it to add an appearance entry for the new appearance. If the file does not exist, create a new one, using `./config/diguy/appearances_base.cfg` as a model of what to include:

```
appearance pink_flamingo
item = pink_flamingo
preload = false
character_type = prop
```

Your customization should now work.

1. In DI-Guy Character Viewer, select the character prop. Your new appearance should appear as a choice.
2. Select it and you should see your new prop appearance.

2.2.2 Creating a Custom Vehicle

DI-Guy comes with a variety of vehicle appearances that you can use in the scenarios you create. You can create custom vehicles using OpenFlight files or Collada DAE files. The preferred method, and the one used by DI-Guy for new models is to use DAE files. Each vehicle appearance is defined by a DAE file.

► **To add a new skinned vehicle appearance to DI-Guy:**

1. Import/Merge the skinned model (*chevy_caprice_rigged.max*) into your new vehicle model.
2. Move/Scale/Rotate the new model into place. Be sure to Reset X Form so the model will not be offset when you export.
3. Add Skin Wrap Modifier to the new model.
4. Click Add.
5. Click the previously skinned model.
6. Click Convert To Skin.
7. Move bones into proper locations. DI-Guy vehicle skeletons support four doors and four wheels.
8. Use Skin/Parameters/Edit Envelopes to skin wheels and doors.
9. Create LODs.
10. Export the model as a DAE.
11. Do appropriate configuration editing.
12. Load the new model in DI-Guy.

Creating a Custom Vehicle Using an OpenFlight Model

Each vehicle appearance is defined by an OpenFlight model or an encrypted OpenFlight model.

► **To add a new vehicle appearance to DI-Guy, perform the same steps as the prop example, and do the following:**

1. Edit your model so that the positive Z axis points up and positive X points toward the front of the vehicle.
2. Place the origin of the vehicle at ground level in the center of all the wheels.

❗ If you have a pre-existing model that faces in the y-forward direction, you can use that model "as is" by:

- Having your `shape_and_joint` entry in the shapeset definition use `y_forward` instead of `position`.
- Adding the entry `item = invisible_vehicle` as an additional item in your appearance definition.

3. Put your custom shapeset in `./custom/config/autoload_custom_vehicle_shapesets.cfg`.

If this file already exists, modify it to add a `shape_set` entry for the new vehicle. If the file does not exist, create a new one, using `./config/diguy/actor_vehicle_shapesets.cfg` as a model of what to include. For example, to add a vehicle called "my_bmw" to the system, place the following block of text in the configuration file:

```
shape_set my_bmw
  actor = vehicle
  is_base_shape = 1
  filename = my_bmw_LOD1.flr
  filename = my_bmw_LOD2.flr
  filename = my_bmw_LOD3.flr
  filename = my_bmw_LOD4.flr
  filename = my_bmw_LOD5.flr
  filename = my_bmw_LOD6.flr
  filename = my_bmw_LOD7.flr
  shape_and_joint = base position
```

4. Create a custom appearance entry in `./custom/config/autoload_custom_appearances.cfg` as follows:

```
appearance my_bmw
  item = my_bmw
  preload = false
  character_type = vehicle
```

Your customization should now work. You can test it in DI-Guy Character Viewer.

1. In DI-Guy Character Viewer, select the character vehicle. Your new appearance should appear as a choice.
2. Select it and you should see your new prop appearance.

i Any skeleton embedded in your OpenFlight character model is ignored by DI-Guy. DI-Guy uses the skeleton of the associated actor to piece together the model at runtime. So do not be confused if the character you view in Creator or another OpenFlight editing tool looks different from the assembled character shown by DI-Guy.

2.2.3 Creating a Custom Human: Skinned Characters Using Collada

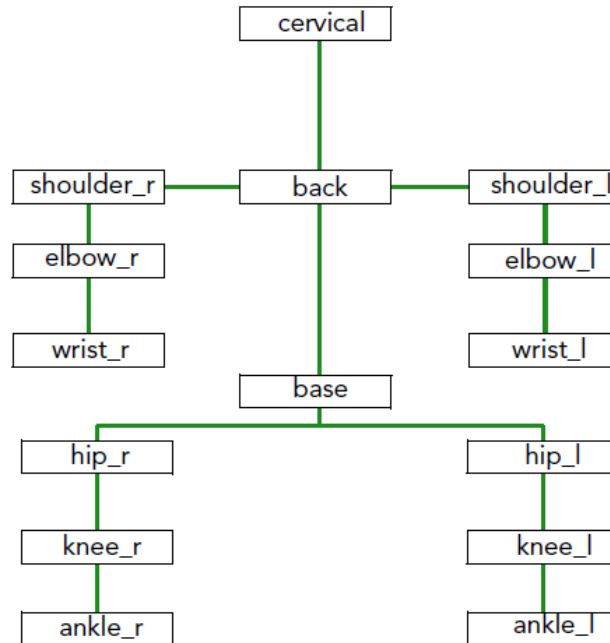
DI-Guy's best looking and fastest performing characters are skinned. These characters have a flexible mesh, eliminating the seams seen in segmented characters while also reducing draw calls to the CPU. The following sections describe the process we recommend for creating a skinned custom character in DI-Guy. (However, it is not the only way to add skinned models to DI-Guy.)

Create or Copy a Model that has a DI-Guy Compatible Skeleton

All DI-Guy actors are built Z up and X forward. Because the standard bones and biped in 3D Studio Max do not follow this convention, you need to be careful that your model uses a DI-Guy compatible skeleton. A sample skeleton is provided in *./geometry/max/greg_object_bones_skeleton.max*. Further information on the skeleton is provided in the next few sections to explain what is found in the MAX file. Copying a model similar to the one you want is usually the quickest and easiest way to create a new model.

Defining Links for a DI-Guy Compatible Skeleton

Links for a DI-Guy compatible skeleton should be positioned in world space based on the offsets listed in *./geometry/config/diguy/actor_greg_links.cfg*, except that all shapes are positioned directly from the origin (in other words, in world space) rather than starting from their parents' local coordinate systems. Figure 8 shows how the shapes should look in 3D Studio Max or another 3D editing program prior to setting up the hierarchy and locally rotating the arms and legs.

Figure 8. Shapes in 3D Studio Max

Actor Greg Skeleton in world Offset XYZ

base	0, 0, 0
back	0,0, 0.2254250
cervical	0, 0, 0.650875
shoulder_l	0, 0.1619250, 0.504825
shoulder_r	0, -0.1619250, 0.504825
elbow_l	0, 0.1619250, 0.2032
elbow_r	0, -0.1619250, 0.2032
wrist_l	0, 0.1619250, -0.053975
wrist_r	0, 0, -0.1619250, -0.053975
hip_l	0, 0.085725, 0
hip_r	0, -0.085725, 0
knee_l	0, 0.085725, -0.454025
knee_r	0, -0.085725, -0.454025
ankle_l	0, 0.085725, -0.885825
ankle_r	0, -0.085725, -0.885825

Setting Up the Hierarchy of a DI-Guy Compatible Skeleton

The hierarchy links are set up in the Schematic View. Make sure the links are set starting from the child to the parent. DI-Guy requires the object names to match exactly the joint name convention listed in the previous section, so be sure to use those names and double-check your spelling.

Skin the Model in 3D Editing Software

Skinning refers to the process of associating polygonal vertices with one or more bones. DI-Guy characters are driven almost entirely by motion capture, so a full animation rig is not necessary. Skin your new character using the same bones from the DI-Guy skeleton (preferably copied from an existing model.)

LODs

1. To optimize performance, decimate all models to four levels-of-detail. Table 1 lists an estimate of the polygon count per LOD.

Table 1. Polygon count per LOD for a typical body

LOD #	Polygon Count:
LOD1	5000
LOD2	2500
LOD3	800
LOD4	200

i Be sure to name material using DI-Guy naming conventions. Remember the material will be looked up later in DI-Guy configuration files. DI-Guy supports geometry with one material which may mean that the *head.max* file needs to be cleaned of any multi-materials.

A Note on Files

A typical set of output files looks like:

- *head.dae*
- *body.dae*
- *hands.dae*
- *head_mtl.cfg*
- *body_mtl.cfg*
- *hands_mtl.cfg*
- *head_diffuse.png*
- *head_normal.png*
- *head_specular.png*
- *body_diffuse.png*
- *body_normal.png*
- *body_specular.png*.

The skinned head requires LOD1 and LOD2. For LOD2, decimate the model by 50% of its polygons. The names of the LODs should be "head_lod1" and "head_lod2" respectively. The skinned hands have the same requirements as the head, but with the LOD names "hands_lod1" and "hands_lod2".

Copy the Collada (.dae) File into the DI-Guy Custom Directory

1. Copy the new Collada model into `./custom/geometry/dae`.
2. Copy the RGBs and PNGs this model uses into `./custom/geometry/rgb` and `./custom/geometry/png`.

Create a New DI-Guy Shape Set and Appearance

A Collada model is loaded into DI-Guy the same way an OpenFlight file is loaded. After exporting and processing the Collada file you must create the proper DI-Guy configuration entries to load it. You must create or edit `autoload_appearance.cfg` and `autoload_shape_set.cfg` and place them in `./custom/config`.

The file `autoload_appearance.cfg` designates a new DI-Guy appearance that uses the shape set and makes it available to a DI-Guy character type. In the following example code, the new appearance `sk_arab_male_1` is defined, and will now be available to the `mideast_mped_07` character_type.

```
appearance sk_arab_male_1
    actor = greg
    item = no_body
    item = sk_arab_male_1
    character_type = mideast_mped_07
```

The file `autoload_shape_set.cfg` loads the shape set that stores the Collada `.dae` file and assigns it to an actor. In the following example code, a new shape set `sk_arab_male_1` (our convention for all skinned characters is to preface them with `sk_`) is defined that uses "greg" as its actor and assigns the `.dae` file to all seven LODs.

```
shape_set sk_arab_male_1
    actor = greg
    is_base_shape = 1
    multi_lod_filename = arab_male_1.dae
    shape_attachment_data = body position
    shape_suffix_lod1 = _lod1Mesh
    shape_suffix_lod2 = _lod1Mesh
    shape_suffix_lod3 = _lod2Mesh
    shape_suffix_lod4 = _lod2Mesh
    shape_suffix_lod5 = _lod3Mesh
    shape_suffix_lod6 = _lod3Mesh
    shape_suffix_lod7 = _lod4Mesh
    shader_program = diguy_skin
```

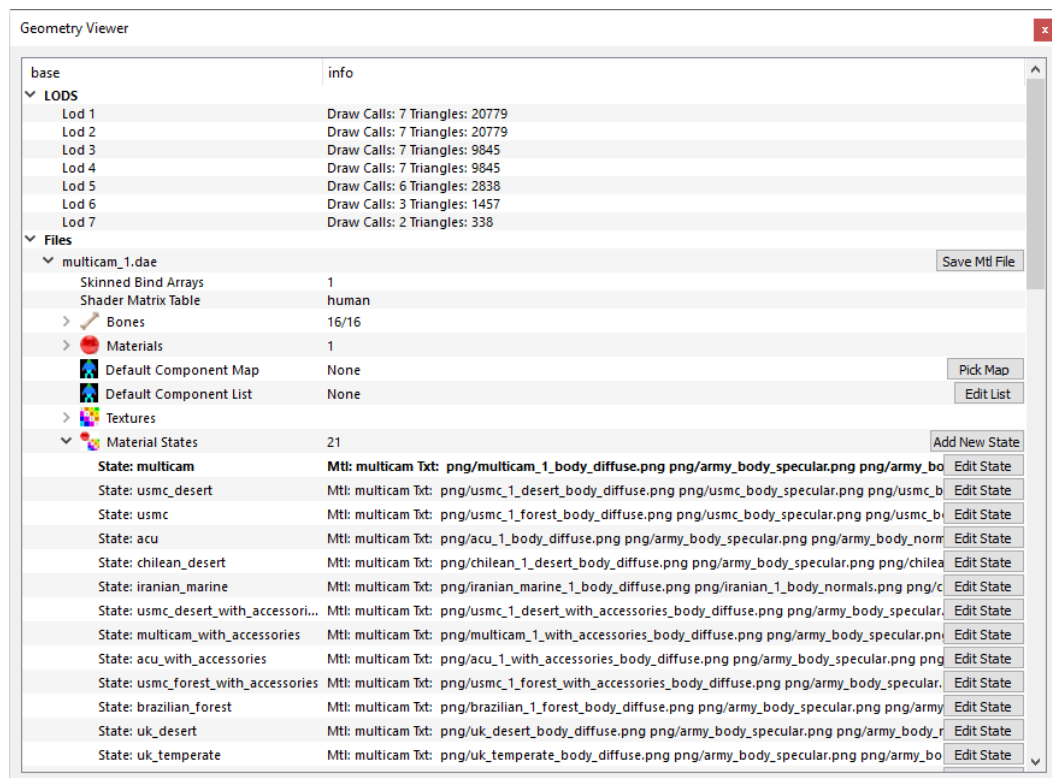
Test New Content and Create Material Files in DI-Guy Character Viewer

In this step, you create the `mtl.cfg` file that points the `.dae` files to their respective `.png` files.

► **To test your new appearance:**

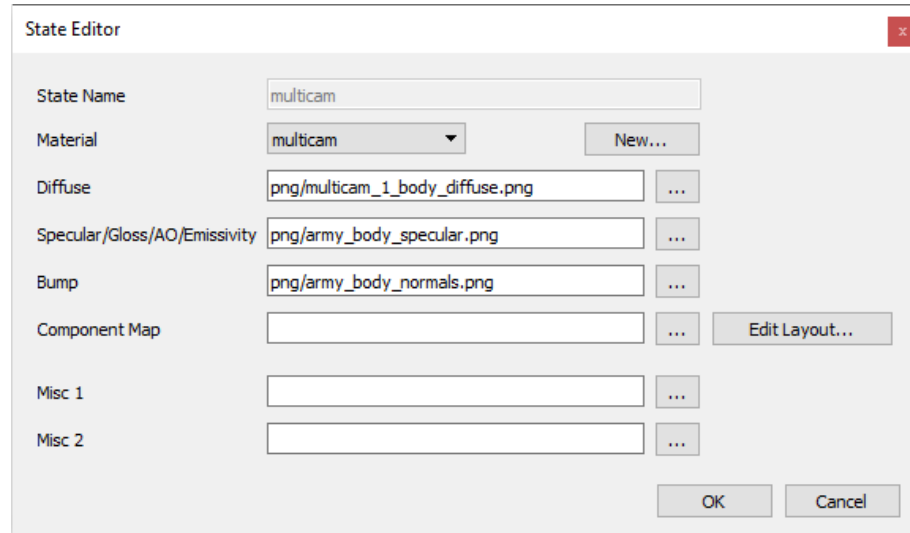
1. Open the DI-Guy Character Viewer.
2. Select the character type and appearance corresponding to your new model. You should be able to see your new model, and you can see how it looks when performing actions.
3. Choose **Window > Geometry Viewer**. The Geometry Viewer window opens (Figure 3 on page 28).
4. Expand the Files section.
5. Expand the DAE file that you want to edit.
6. Expand Material States (Figure 9).

Figure 9. Material States



7. For the bolded state, click Edit State. The State Editor opens (Figure 10).

Figure 10. State Editor



8. Specify files for Specular/Gloss/AO/Emissivity, Bump, and Component Map entries.
9. Click Save Mtl File (next to the file name) to save the *mtl.cfg* file. It is created in *./geometry/dae*.

2.2.4 Creating New Weapon/Equipment Combinations

It is easy to create new appearances from existing characters and weapons. For example, the weapon `pk_machine_gun`, is used by appearance `taliban_2`. What if you want a soldier to have an appearance in which he wears a BDU (battle dress uniform) and is holding a machine gun?

To make that appearance available, create or append the following appearance to *./custom/config/autoload_custom_appearances.cfg*:

```
appearance bdu_pk
  actor = greg
  item = bdu
  item = pk_machine_gun
  item = pk_machine_gun_flash
  item = ak47_ammo_pack
  item = bdu_trigger_hands
  parameters
    weapon_supplemental_data = pk_machine_gun
    character_type = afghan_fighter
    character_type = soldier_07
    quality_bias = 5
    appearance_map = male/adult/white / usa/army/pk74
```

The file *./config/diguy/appearances_human_military_soldier.cfg* contains the `taliban_2` appearance. To create the `pdu_bk` appearance, we copy the `taliban_2` appearance and replace the first item, `taliban_2`, with `bdu`.

If you want to add your own weapon model into DI-Guy:

1. Create a shaperset that points to your geometry based on the `pk_machine_gun` and `pk_machine_gun_flash` entries in `./config/diguy/actor_greg_shapesets.cfg`.
2. List your shaperset as an item in your new appearance.

You can also base a new appearance on an existing appearance with the `base_appearance` line. Many soldiers have a base appearance with no weapon so a new appearance can be made to inherit from an existing one:

```
appearance sk_acu_1_SMAW
  base_appearance = sk_acu_1_no_weapon
  item = SMAW_rocket_launcher
  item = SMAW_flash
  character_type = usmc_smaw
  appearance_map = male/adult/white/usa/army/smaw
  is_skinned_appearance = 1
  parameters
    weapon_supplemental_data = m240_cctt
```



3. Creating a Custom Character Type

This chapter explains how to create a new character type.

3.1. Creating a Custom Character Type	44
3.1.1 A Custom Character Type Example: Vehicle with Turret	44

3.1. Creating a Custom Character Type

If you want to animate a joint hierarchy that does not match any of the existing DI-Guy characters, you must create a custom character type.

3.1.1 A Custom Character Type Example: Vehicle with Turret

In this section, we will create a new character_type for use in DI-Guy called vehicle_turret. It will use the vehicle character_type as a template, but include an extra 3 DOF link to allow a turret to be animated.

Do not create a new character_type if you can find a joint hierarchy match in an existing DI-Guy character. It is much easier to create a new appearance for an existing character_type than it is to create a new character_type.

The basic steps for creating a character_type are:

1. Create the configuration files that define the character_type.
2. Test it using the DI-Guy Character Viewer. Keep refining it until all load errors disappear and you see your character in the viewer.
3. Verify that your new joints work by modifying the OpenGL pose example in *./programming_examples*.

Remember that a secondary goal when customizing DI-Guy configuration files is to avoid masking future changes to DI-Guy data. Always copy a standard DI-Guy configuration file into your custom directory, add more content, and then save it with the same name.

Creating the Configuration Files

These files are created in the custom directory to define the vehicle_turret character:

```
./custom/config/autoload_vehicle_turret.cfg  
./custom/config/autoload_vehicle_turret_appearances.cfg  
./custom/config/autoload_vehicle_turret_loader.cfg  
./custom/config/common/variables_vehicle_turret.cfg  
./custom/config/diguy/char_vehicle_turret.cfg  
./custom/config/diguy/actor_vehicle_turret.cfg  
./custom/config/diguy/actor_vehicle_turret_shapesets.cfg  
./custom/config/diguy/actor_vehicle_turret_links.cfg
```

The following sections examine each file separately.

autoload_vehicle_turret.cfg

This is the top level file for the vehicle turret. It tells DI-Guy to load the associated actor and vehicle.

```
include_optional_once diguy/actor_vehicle_turret.cfg  
include_optional_once diguy/char_vehicle_turret.cfg
```

autoload_vehicle_turret_appearances.cfg

This file defines a new appearance for our vehicle_turret, called silly_test_vehicle_turret. The item it references is the silly_test_vehicle_turret shapeset. A good example of an appearance file that was used as a template for this file is *./config/common/appearances_base.cfg*.

```
appearance silly_test_vehicle_turret
    item = silly_test_vehicle_turret
    preload = false
    character_type = vehicle_turret
```

autoload_vehicle_turret_loader.cfg

This file defines the new data loader required to load the new vehicle_turret. Remember, this vehicle has a new joint never loaded by DI-Guy before. A good example of a loader file that was used as a template for this file is *./config/common/loaders.cfg*.

```
data_loader ideal_and_turret
    include common/variables_ideal.cfg
    include common/variables_offset.cfg
    motion_lod_break = here
    include common/variables_vehicle_turret.cfg
    motion_lod_break = here
```

variables_vehicle_turret.cfg

This file references the three new variables for our turret. A good example of a variables file that was used as a template for this file is *./config/common/variables_vehicle_wheels.cfg*.

```
variable = q.turret_rz
variable = q.turret_rx
variable = q.turret_ry
```

char_vehicle_turret.cfg

This file defines the vehicle_turret character. The file *./config/diguy/char_vehicle.cfg* was used as the template for this file. We will use the standard DI-Guy vehicle's action table (we will drive the turret programmatically in "Modify the Pose Programming Example to Exercise Your New Joint" on page 47).

```
include_once diguy/char_vehicle_action_table.cfg

character_definition vehicle_turret

    abbreviation = vehicle_turret
    actor = vehicle_turret
    default_appearance = silly_test_vehicle_turret

#    data_loader = ideal_only
    data_loader = ideal_and_turret

    action_table = vehicle
```

actor_vehicle_turret.cfg

This file defines the vehicle_turret actor. It references the new shapeset and link file, as well as adding a link called "turret". The file `./config/diguy/actor_vehicle.cfg` was used as the template for this file.

```
include_once diguy/actor_vehicle_turret_shapesets.cfg
include_once diguy/actor_vehicle_turret_links.cfg

actor_definition vehicle_turret
#
#  standing_hip_height measurement not needed
#

include common/links_ideal.cfg
include common/links_y_forward.cfg
link = turret
```

actor_vehicle_turret_shapesets.cfg

We define a single shapeset for our vehicle_turret in this file. To avoid the issue of geometry file creation, we are using a human firefighter as our geometry model. That is why we have named the shapeset `silly_test`. The shapeset references the firefighter OpenFlight files. The group base will be associated with the joint position, while the group head will be associated with the joint turret. See various subsections in "2.2. Customizing Appearances by Modifying Geometry" on page 32 for information about shapeset files.

```
shape_set silly_test_vehicle_turret
actor = vehicle_turret
is_base_shape = 1
filename = firefighter_LOD1.flr
filename = firefighter_LOD2.flr
filename = firefighter_LOD3.flr
filename = firefighter_LOD4.flr
filename = firefighter_LOD5.flr
filename = firefighter_LOD5.flr
filename = firefighter_LOD5.flr
shape_and_joint = base position
shape_and_joint = head turret
```

actor_vehicle_turret_links.cfg

This file defines the link/joint hierarchy of vehicle_turret. The file is the same as `./config/diguy/actor_vehicle_links.cfg`, except that it appends an extra link called "vehicle_turret_turret". This link is placed one meter above the position link.

```
link vehicle_turret_parent
name = parent
parent = position
type = BDI_JOINT_TYPE_6DOF
name_tx = constant
name_ty = constant
name_tz = constant
name_rz = constant
```

```
name_rx = constant
name_ry = constant

link vehicle_turret_y_forward
  name = y_forward
  parent = position
  type = BDI_JOINT_TYPE_FROZEN
  offset_rz = -1.5707
  name_tx = constant
  name_ty = constant
  name_tz = constant
  name_rz = constant
  name_rx = constant
  name_ry = constant

link vehicle_turret_turret
  name = turret
  parent = base
  type = BDI_JOINT_TYPE_BALL
  offset_tx = 0
  offset_ty = 0
  offset_tz = 1.0
  name_tx = constant
  name_ty = constant
  name_tz = constant
  name_rz = default
  name_rx = default
  name_ry = default
```

Try to view your new custom character in the DI-Guy Character Viewer. Look at its log to make sure that no unusual warnings or errors were caused by your changes. Most of the messages are quite helpful and a little debugging can often quickly locate the typo that caused your problem.

Modify the Pose Programming Example to Exercise Your New Joint

Edit `./programming_example/diguy_ogl/pose/pose.cpp`. Make these changes:

1. Change the three static back index variables to be turret index variables.
2. Change the `bdi_log_stdout_enable` setting to `BDI_LOG_INFO`.
3. Change the character type in the `create_character` call from **soldier** to **vehicle_turret**.
4. Change the action in the `force_action` call from **stand_ready** to **still**.
5. Change the three `get_var_index` calls to retrieve your turret variables instead of back variables.
6. Initialize the three turret variables to zero.
7. Change the three weight variable indices from back indices to turret indices.

8. In the `glut_idle_callback()` function, set all three turret variables equal to `sin(t)`. Remove any reference to the back variables.

Recompile and run the example. You should see a fireman with an extra head that rotates in an unusual fashion. If you have problems, check that during initialization it successfully lists the three turret variables, and that your indices are not -1.



4. DI-Guy Expressive Faces

This chapter explains how to use the DI-Guy Expressive Faces plug-in.

4.1. Introduction to Expressive Faces	50
4.2. How to Work with DI-Guy	51
4.2.1 Create a Script	52
4.2.2 Select an Avatar	54
4.2.3 Prepare a Base Scenario	55
4.2.4 Record Voice Performances	55
4.2.5 Create Lip-Synching Animations in FaceFX Studio Professional	56
4.2.6 Create a Simple Local Path for Each Response (Animation)	61
4.3. Creating a FaceFX Head Appearance	63
4.3.1 Creating and Exporting Data from 3ds Max	63
4.3.2 Setting Up and Publishing a New FaceFX Actor	65
4.3.3 Setting Up a Head for Use in DI-Guy	65
4.4. Considerations for Using Expressive Faces	66

4.1. Introduction to Expressive Faces

Standard DI-Guy characters have static faces and are often viewed from far enough away that this is a satisfactory visual result (and a win for high performance visualization). The DI-Guy Expressive Faces module enables you to enhance DI-Guy characters with expressive face geometry to create a more intimate performance with their characters including:

- Faces that emote.
- Lips that synchronize to audio.
- Eyes that blink and gaze.

DI-Guy Expressive Faces users also tend to make heavier use of some standard features of DI-Guy such as gesturing, pointing, and gazing.

DI-Guy Expressive Faces is the perfect solution for simulations where communicating with other human characters is critical and characters are close to the camera. DI-Guy have been used for:

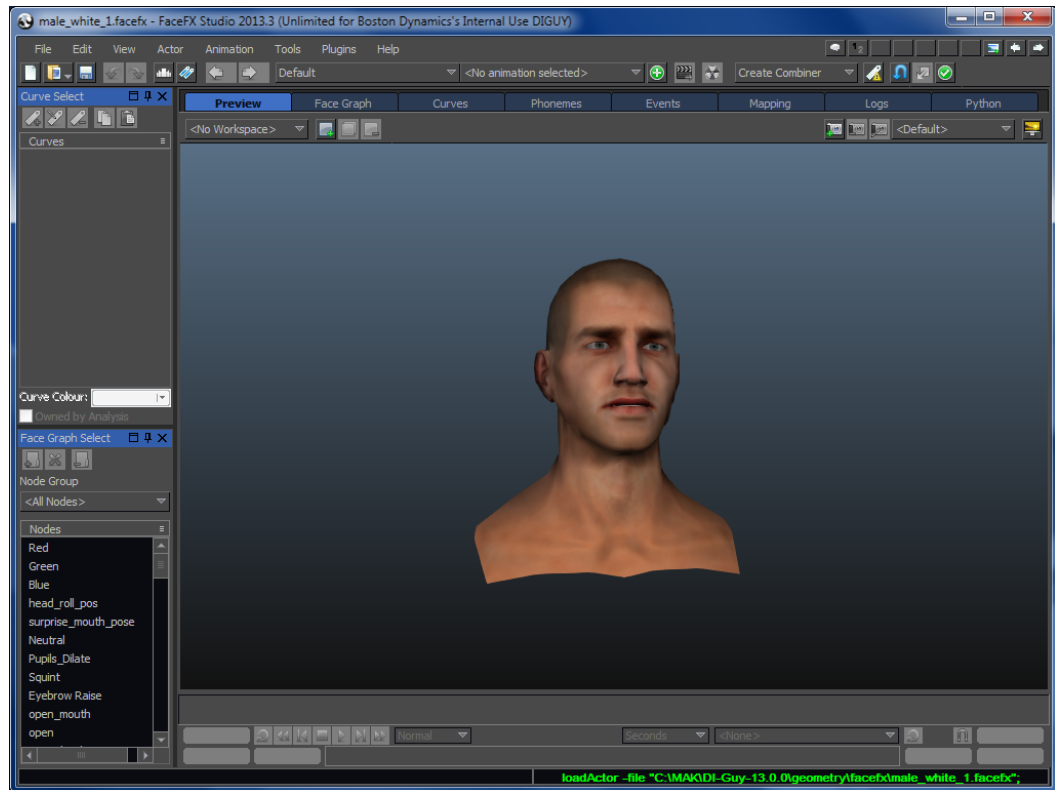
- Interrogation training for criminal investigators.
- Cultural training.
- Use-of-force training.

Developers will often couple speech recognition technology with DI-Guy characters to communicate naturally and have conversations with their lifelike Expressive Faces avatars. The avatars in turn often have sophisticated branching logic and performances that allow the avatar to react intelligently to questions, building on previous questions, and so on.

OC3's FaceFX software underpins DI-Guy. The benefits of FaceFX are:

- The FaceFX Studio Professional application. This software enables you to create lip-synching and other expressive performances. The user interface lets you edit parameters for facial animation, such as blink, eye brow raise, head tilt, and so on, and has a timeline-based editor that lets you tune the performance. FaceFX Studio Professional comes as part of the DI-Guy development license.

Figure 11. FaceFX



- FaceFX is a popular choice in the video game industry. Like DI-Guy, OC3 is investing in the continuous upgrade of FaceFX, so that users who choose DI-Guy can feel confident that their investment will keep pace with the ever-advancing changes in human and facial simulation.

4.2. How to Work with DI-Guy

There are many ways to work with DI-Guy, including:

- Using a DI-Guy AI hierarchical finite state machine (HFSM) to control logic.
- Have users (typically trainees) interact with an avatar
- Using speech.
- Using a button-pushing user interface.

This document does not try to address all possible modes of using DI-Guy. It describes a technique called the expressive local paths technique that has been successful with DI-Guy customers and DI-Guy developers. The goal is to quickly introduce you to using DI-Guy.

i We recommend that you use simple nomenclature for files and other assets. If possible, avoid using non-alphanumeric characters, dashes, spaces, and so on.

The expressive local paths technique assumes:

- The scenario to be created will be interactive between a user (referred to as the trainee) and one or more DI-Guy characters equipped with DI-Guy (referred to as avatars).
- The scenario follows a question and answer format between the trainee and the avatar. Occasionally actions performed by the trainee, such as drawing a weapon, will also influence avatar behavior.
- Responses to a particular question or action may be variable and will be affected by what questions or actions have previously occurred in the simulation.

These steps summarize the expressive local path technique:

1. Create a script.
2. Select an avatar.
3. Select a terrain, props, and background characters and prepare a base scenario.
4. Record voice performances.
5. Create lip-synching animations in FaceFX Studio Professional.
6. Create a simple path for each avatar response.
7. Create signals and a pushbutton interface for signaling questions to the avatar.
8. Create an expressive local path for each avatar response by adding gestures, gazes, and actions to the simple local path.
9. Build up logic for how the avatar chooses a response.
10. Create and train a vocabulary for accepting speech from the trainee and translating it into a signal.

In the following sections, we examine each step in detail.

4.2.1 Create a Script

The first step to creating your performance is to think about your goals for the simulation and how they can best be achieved. Consider these questions:

- Is your application training the trainee on how to ask certain questions, or perform a particular task?
- How can your scenario most effectively get at this core education?
- Is the scenario meant primarily to train, demonstrate, or test?
- How can you set boundaries on the simulation?

It will not be possible to have your avatar respond to every conceivable question. You will have to fit your development to the goals and the budget you have for authoring.

For this demonstration, we have created a simple interrogation scene. It tries to:

- Create a simulation likely to be useful to DI-Guy customers.
- Demonstrate a wide range of emotion for the avatar.
- Demonstrate logic that shows that previous questions affect future responses.

- Create a simulation that can be run in 2-3 minutes.
- Choose neutral subject matter.



- The initial script differs from the demonstration scenario included in the distribution of DI-Guy (Exface_Sales_Demo). Like all scripts, it undergoes changes as voice actors and developers acting as directors make modifications during the process of simulation creation.
- This is a purely fictitious scenario intended for demonstration purposes. It does not claim to follow real-world interrogation practices.
- There are two answers to most of the questions; this is because these questions can be asked twice.

Sample Interrogation Script

0? Can we ask you some questions? [Miranda rights]

No, it's OK, I've got nothing to hide. I don't even know what this is about. (friendly)

1? What is your name?

My name's Timothy Johnson, you can call me Tim. (smile)

I already told you, my name's Tim...

2? Where were you last night?

Last night I was with my buddy Johnny, you know, having a few beers. (laughs) We watched TV at his house all night. (happy)

Yea, like I was telling you, I was with my pal Johnny. That guy's the greatest. We watched the baseball game all night at his place.

3? Really? We arrested your friend Pete Kenny last night for burglary, and he said you were driving the car... [establishing witness]

I don't believe you. (disgust) *I was with Johnny last night.*

Why would Pete say that? (disgust)

4? Do you know that an officer was shot last night? [establishing guilt]

What? Really? (confusion) *I...I didn't know that.*

I understand, that's terrible. (sympathy, empathy)

5? Listen Tim, we're here to help, we just want to know what happened. [establishing trust]

I dunno...I was with Johnny last night. (confusion, weakness)

Listen, I didn't do it, but if I did, it would have been for the money, not to hurt anybody!

(Once 3,4,5 have been asked at least once, and perhaps forcing 2 or 3 of the questions to be asked twice, he then confesses.)

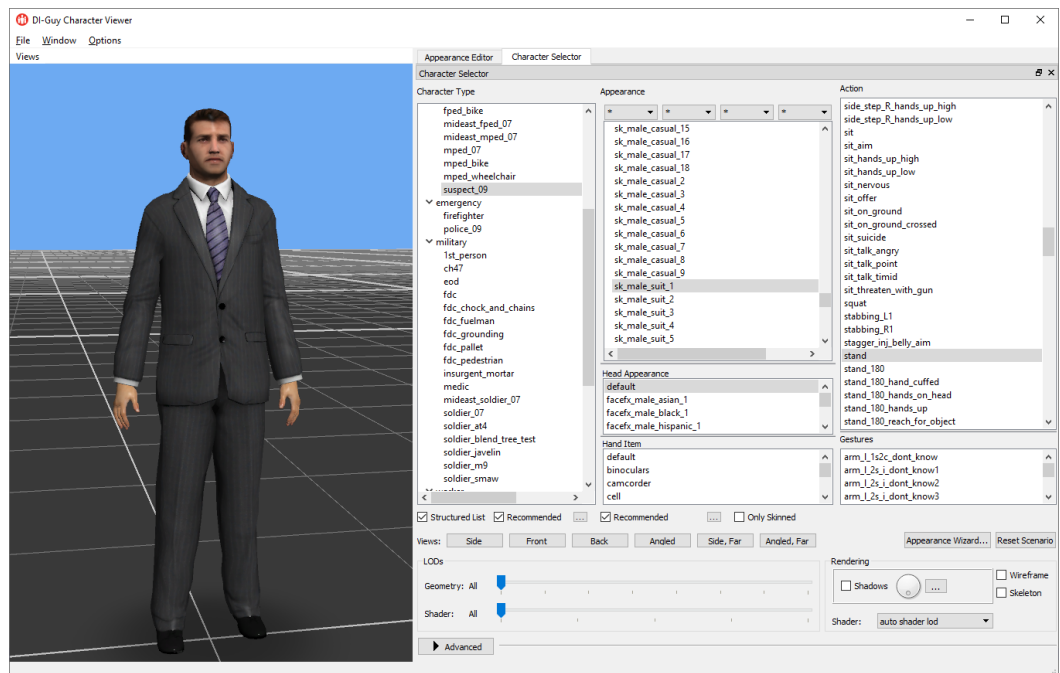
Alright, listen, I did it, it was a stupid idea. Pete put me up to it. I didn't want anyone to get hurt. That was Pete!....I think I should get a lawyer.

4.2.2 Select an Avatar

Selecting the best starting avatar involves three things:

- Selecting the best DI-Guy character type.
 - Selecting the best body appearance.
 - Selecting the best facial appearance.
1. Open the DI-Guy Character Viewer. DI-Guy Character Viewer lets you audition all of the content that comes with DI-Guy. (For details about the Character Viewer, see "Chapter 5. Using the Character Viewer" on page 69. If you have created any custom content, you can view it as well.)
 2. Choose the character type that has the most actions similar to what you are looking for in your performance. The "suspect_09" character type is a particularly rich character type that has many interesting actions relevant to simulations that might need facial animation.

Figure 12. suspect_09



3. Find the best appearance for the body and the facial appearance. Use the Appearances column to select different body appearances. Not all appearances have corresponding expressive face appearances. Those that do have a secondary appearance list under the main appearance list in which one or more expressive face appearances are listed.

i If you cannot find the right combination of character type, appearance, and facial appearance, please contact DI-Guy support at <https://www.mak.com/support> for assistance. Because FaceFX-style expressive faces were introduced in DI-Guy 12.0, there are only a small number of sample faces available for certain appearances. Let us work with you to get you the character type, appearance, and facial appearance that will let you be successful.

DI-Guy is fully customizable, so if there are additional motions, character appearances, or facial appearances required, these can be added by the developer. Contact support for assistance with facial customization. See "Chapter 5. Using the Character Viewer" on page 69 for customizing character appearances and *DI-Guy Motion Editor Users Guide* for instructions about customizing actions for DI-Guy.

You can also contract with MAK Technologies to create customizations, as well as building a starting scenario or other assistance.

4.2.3 Prepare a Base Scenario

1. Start DI-Guy Scenario¹.
2. Choose a scene object (terrain). It can be one provided by DI-Guy or one that you supply.
3. Determine where you would like your avatar(s) to be located, create a character of the character type and appearances decided in "4.2.2 Select an Avatar" on the previous page.
4. Choose one or more interesting camera angles to help bring the performance to life.
5. Place appropriate vehicles and props in your scene.
6. If there are any supporting characters, add them to the scenario.

4.2.4 Record Voice Performances

The quality of the voice recordings will be a major factor in the believability of your end performance.² Two factors are important:

- Technical quality. Use a quality microphone. Have post-processing tools that, at a minimum, allow you to crop audio recordings, reduce noise, and output .wav files.
- Performance quality. Choose a voice actor that has a voice that matches your avatar and is not a distraction. Be sure that the voice actor not only has a fine voice, but can emote and act convincingly. When producing the vocal performance, give strong direction to the actor to assure you have voice capture that will make your scenario successful.

¹The use of DI-Guy Scenario is recommended but not required for implementing Expressive Faces. Developers choosing not to use DI-Guy Scenario need to perform these operations using their own tools.

²Advanced Developers may consider using speech generation for their avatar. Contact support@mak.com for support and advice.

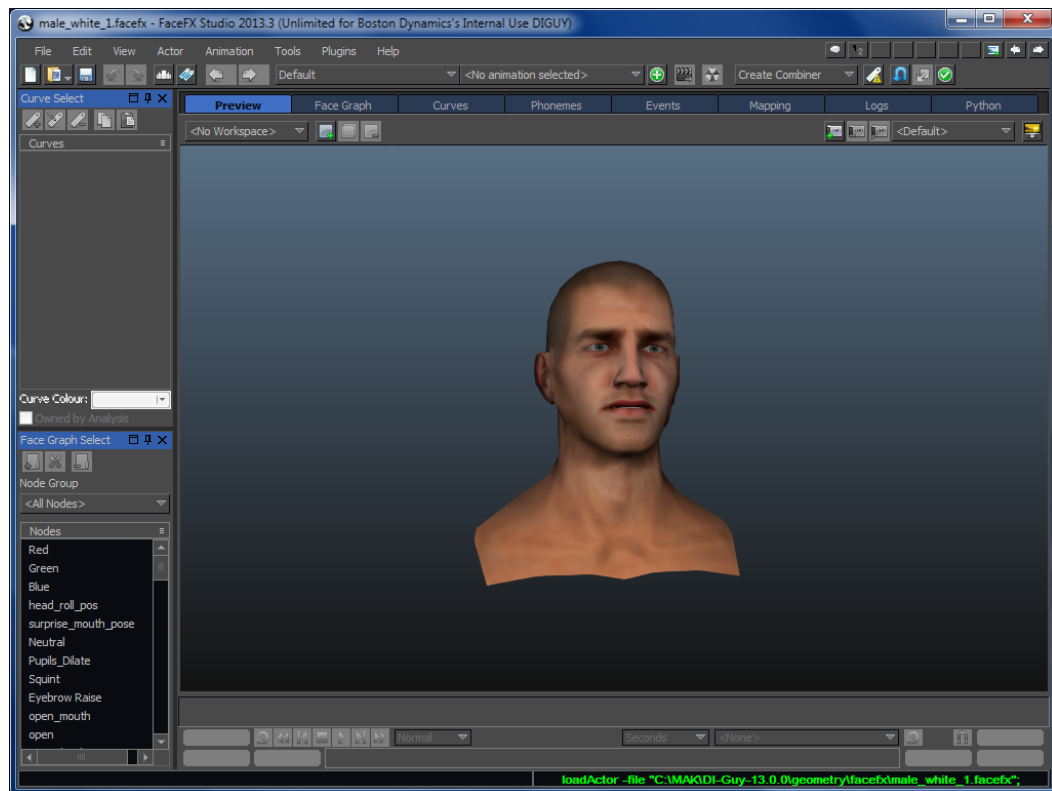
Consider video recording the performance to assist with later steps where the facial animation will be emotively tuned in FaceFX Studio Professional and DI-Guy Scenario to help bring the performance to life. Larger budget programs can even consider performing a motion capture session to capture skilled actor performances for reproduction in the simulation.

Final .wav files should be placed in `./custom/sfx/<recording session name>`. Consider using descriptive filenames and perhaps including the actor's name in the filename.

4.2.5 Create Lip-Synching Animations in FaceFX Studio Professional

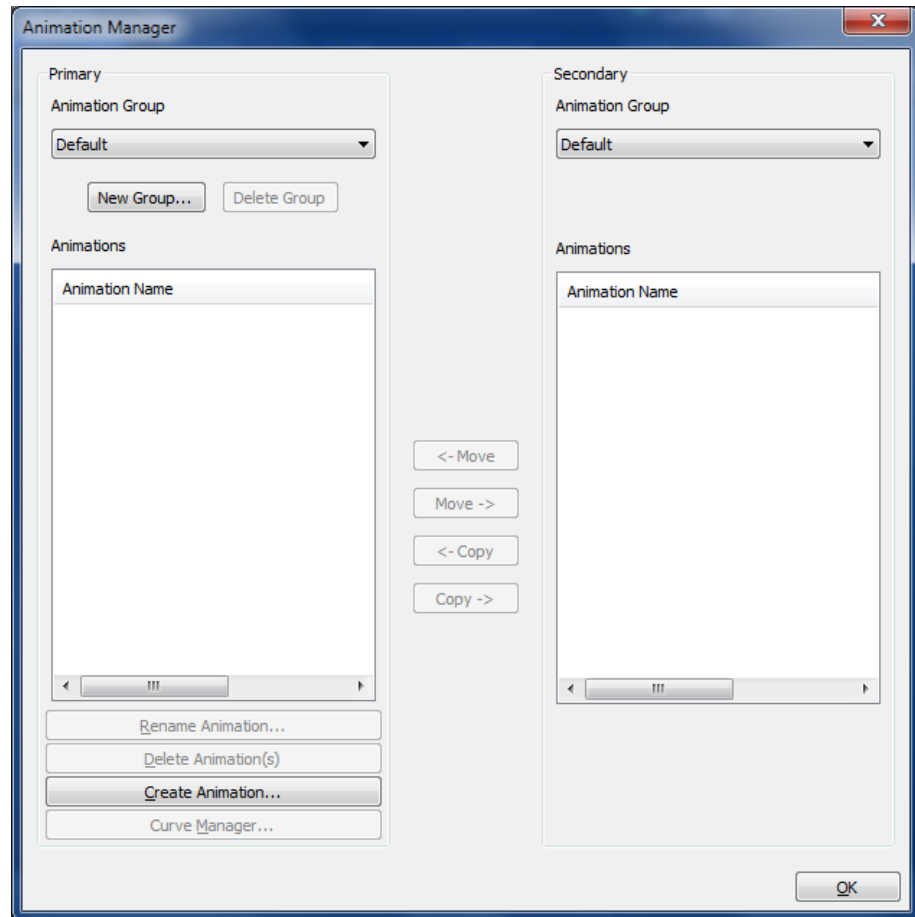
1. Start FaceFX Studio Professional.
2. Choose **File > Open Actor**. Available actors are in `./geometry/facefx`. These files have a `.facefx` suffix. You do not need to create a custom file. The face is displayed in the window
3. Press **Alt** and move the mouse to rotate the face to a frontal view (Figure 13).

Figure 13. FaceFX Studio Professional

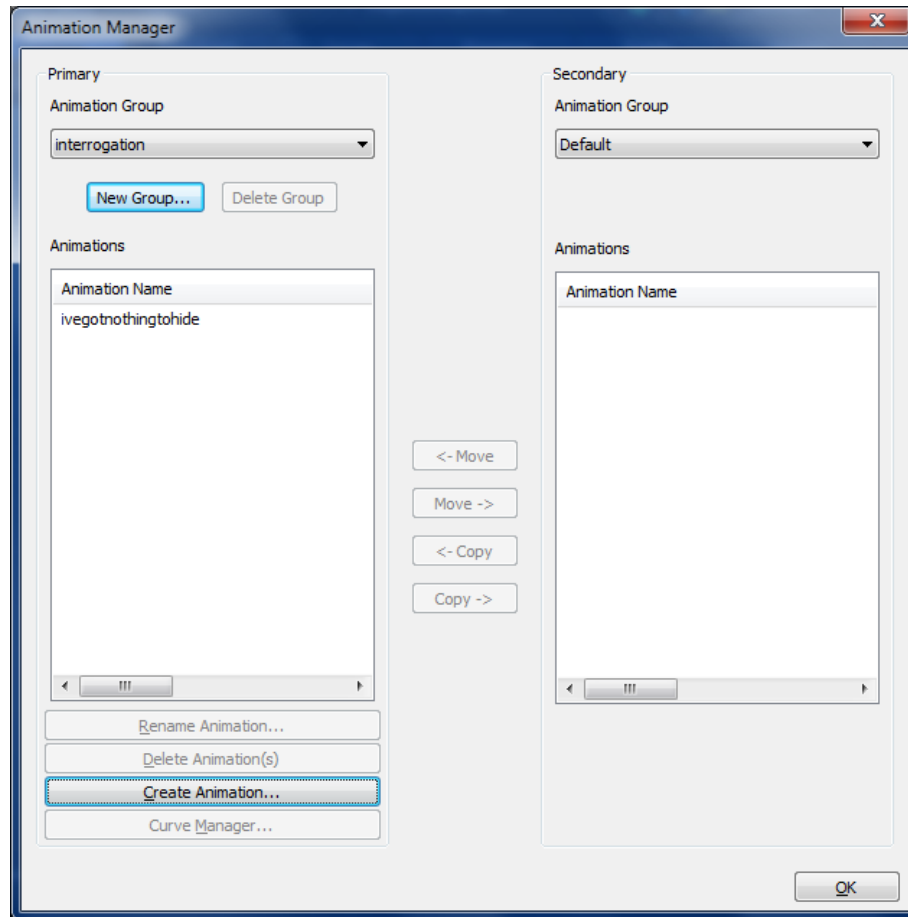


4. Generate a new animation group for the actor. Choose **Actor > Animation Manager**. The Animation Manager opens (Figure 14).

Figure 14. Animation Manager



5. Click **New Group**. The Create Animation Group dialog box opens.
6. Enter a name for your animation group. We will use "interrogation".
7. Click OK.
8. Click Create Animation. The Create Animation wizard opens.
9. Select Create an Animation from an Audio File and click Next.
10. Select a .wav file and choose Next. The wizard prompts you for the text of the sound file. (If you do not have your own wave file and just want to try this out, select `./sfx/exface_sales_demo/bob_now_were_talkin.wav`. The dialog text is "Now we're talking.")
11. Enter the dialog text and select Next.
12. Click Next to accept the language and default analysis actor file. The wizard prompts you with an animation name derived from the wave file name.
13. Click Finish. The animation name is added to the list (Figure 15).

Figure 15. Animation Manager with new animation

14. Click OK.
15. In the main window, click Play (Figure 13). You should see the character speak the text you have entered.

The character will not only perform the lip-synching, but other facial animation will be created by the system, attempting to get you started on a convincing performance. These may include various head tilts, eye brow motions, and blinks. If you are lucky, the performance will be satisfactory and you can consider publishing the animation and testing it in DI-Guy.

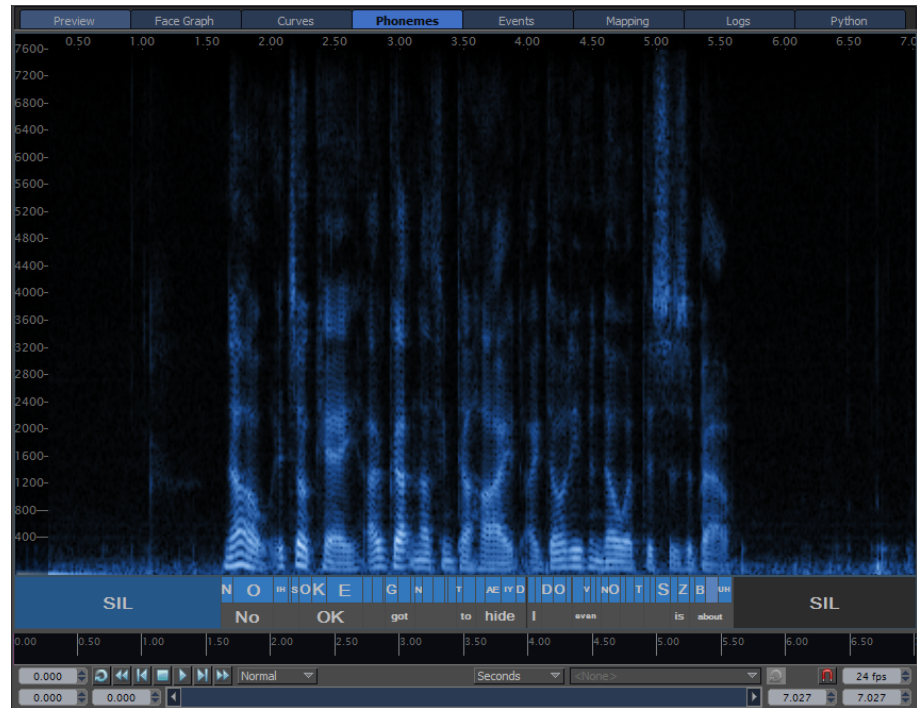
However, you will usually want to improve the performance. FaceFX Studio Professional has a wealth of features for directly editing the performance. The following sections demonstrate some basic tools you can use to refine the performance. See FaceFX Studio documentation for more details.

Refine the Lip-Synching

Examine the lip-synching in detail. If you do not believe that the character's mouth is truly speaking the phonemes you hear, then the quality of the rest of the performance does not matter.

1. Select the Phonemes tab. Figure 16 illustrates the phoneme tab for the text, "No. OK. I've got nothing to hide."

Figure 16. Phonemes tab



The display shows the audio wave. Beneath it is the phoneme breakdown of the sentence as matched to the actual audio wave. Beneath the phoneme breakdown is the exact text that you entered when you created the animation. Timing, in seconds, is shown along the top and bottom of the screen.

2. Adjust the location and width of the phonemes to match the lip movements.
3. Go back and forth between this window and the Preview window. Try playing the performance at quarter time by changing the Normal pulldown on the playback controller to Very Slow. While the voice will be much deeper, it is much easier at this speed to see and correct lip-synching timing issues.

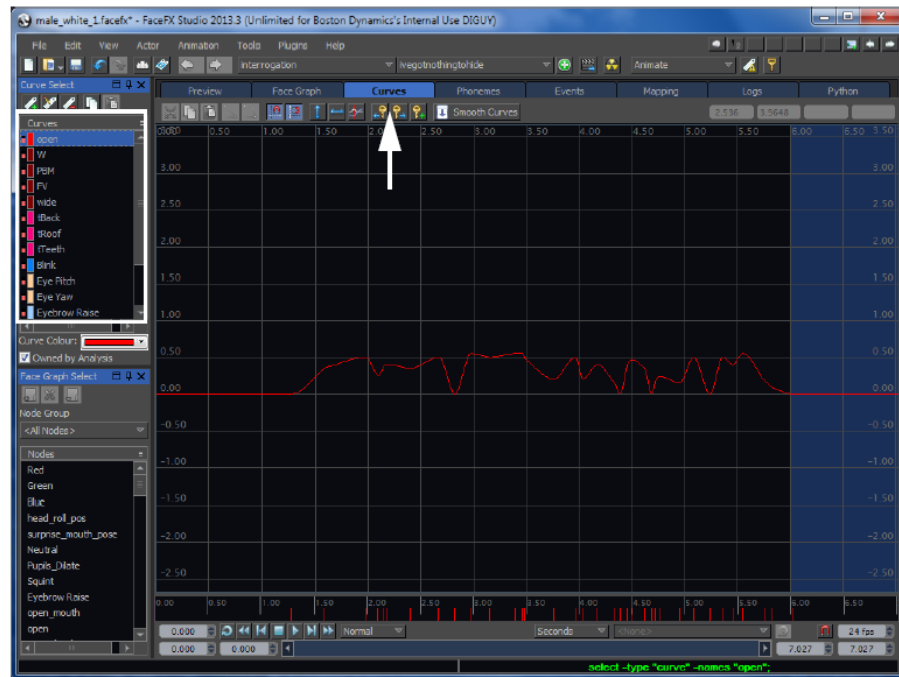
Besides editing the phonemes, you can insert or delete them. One thing you might want to do is close the mouth during pauses. We will see how to do this in the next section.

Curve Editing

One way to edit an animation is to edit curves for the different facial movements, such as opening and closing the mouth, blinking, head movement, and so on.

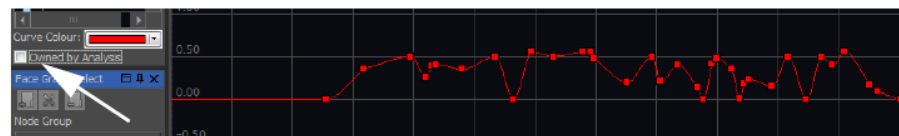
1. Select the Curves tab (Figure 17).

Figure 17. Curve editing



2. On the Curves palette, select open. Open controls how far open the mouth is.
3. To edit the curve, clear the Owned by Analysis check box. Points are added to the curve (Figure 18). You can move the control points up, down, or laterally in the curve editor. You can add new control points.

Figure 18. Curve points



4. Try editing other curves. Look at some of the other curve types, such as Blink, Squint, and Head Roll.

i FaceFX adds head movements based on its analysis of the sound file and text. If the voice recording is fairly short, such as "Now we're talking," it may not add many of the possible types of curves. You might want to add curves that it did not insert or try a longer recording to see if you get more movement added automatically.

► **To add a new curve type:**

1. On the Curve Select palette, click the Add button (). The Select Node to Drive or Type New Curve Name dialog box opens.

2. Select a curve in the list.
3. Click OK. The curve is added to the list. In the window it is a straight line.
4. Edit the curve to add the motion you want.

Working with these parameters in FaceFX is where technology meets art. The variation you can add to your performance is infinite. If you have made video recordings of your actor, you can watch those videos and duplicate the facial animations you liked the best.

Saving and Publishing Your Work

When you are satisfied with the new animation, save your actor and animation set. If this is the first time you are saving the animation set, you also need to save (export) it.

1. Choose **Actor > Export Animation Set**. A file browser opens.
2. Save the Animation set to `./custom/sfx/<your project name>/<character name>`. For this demo we called the project name *interrogation* and the character name *suspect*. Once you have done this, the Export Animation Set will be unavailable and the update of the animation set happens automatically during actor save or game publishing.
3. Select **File > Publish to Game**. The Publishing Options dialog box opens.
4. Set the Output directory to `./custom/sfx/<your project_name>` and accept the default checkboxes.

Reopening Your Work

When you want to do some more work:

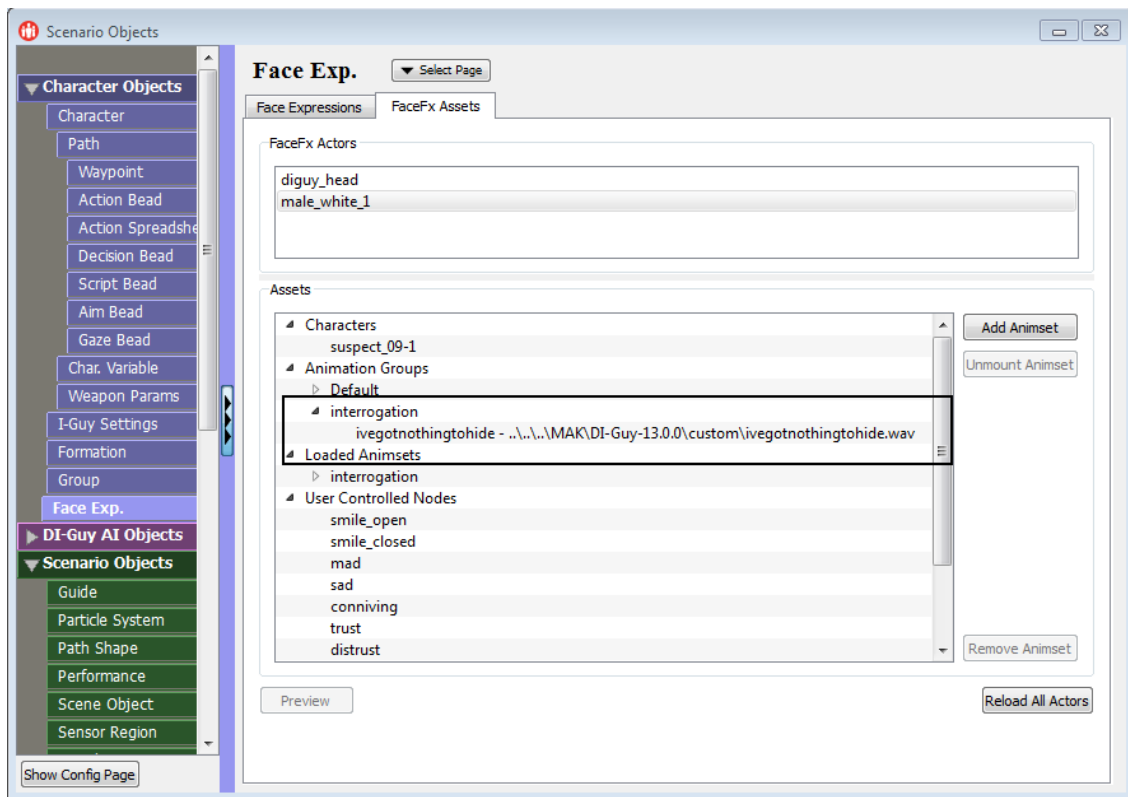
1. Start FaceFX Studio Professional.
2. Choose **File > Open Actor** and select the same actor as before.
3. Choose **Actor > Mount Animset** to retrieve your older animations.

4.2.6 Create a Simple Local Path for Each Response (Animation)

1. Start DI-Guy Scenario and load the scenario you created in "4.2.3 Prepare a Base Scenario" on page 55.
2. Open the Character Objects:Character page and select the character for which you made the animations.
3. In the Head Appearance list, select `facefx_male_white_1`. This gives the character the head appearance you created.
4. Select the Character Objects:Face Exp. page (Figure 19).
5. Select the FaceFx Assets tab.
6. Select your FaceFx Actor (`male_white_1`).
7. Click Add Animset. The Select Animset to Mount on Actor window opens.
8. Select the animset you saved (*interrogation*).

9. Click OK. The animation set is added to the Animation Groups section of the Assets list Figure 19.
10. Expand the interrogation section. It lists the wave files that you saved in FaceFX.
11. Double-click the ivegotnothingtohide line. The character executes the animation.

Figure 19. Face Expression page

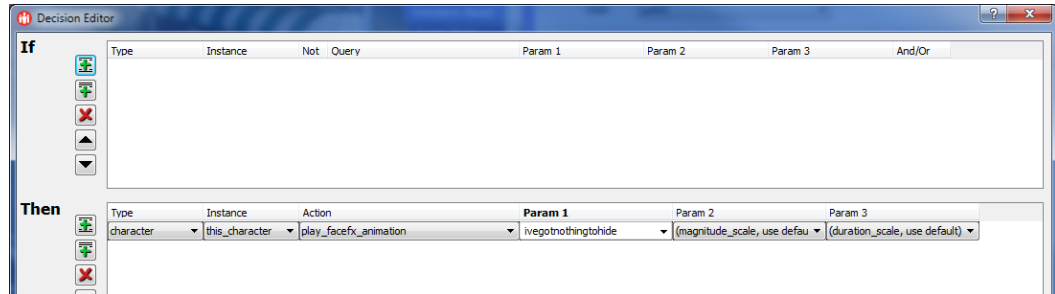


At the bottom of the FaceFx Assets tab there is the Reload All Actors button. This button is very useful. You can keep your FaceFX Studio Professional session running, and as you modify or add animations, once you have saved those changes, you do not need to restart DI-Guy Scenario to use those changes, just click the button.

Create a path for the animation.

1. Since the animation is called ivegotnothingtohide, select the Character Objects:Path page.
2. Add a path.
3. Change the name from path0 to ivegotnothingtohide.
4. Select the Character Objects:Decision Bead page.
5. Add a decision bead and logic to play your animation (Figure 20).

Figure 20. Animation setup



6. To audition the path, go to the Character Objects:Character page and make this path be the Initial Path.
7. Click Play. You may want to change the character's action to sit or stand, because the default is to walk.
8. On the Path page, click the Copy button for each animation you created. It is recommended that you set the "Path Paste Offset" to 0, 0, 0 in the Preferences dialog box so that each new copy is in the exact same place.
9. Update the new paths with better names and point the decision bead entries at the appropriate animation.

We now have one or more simple paths, but they are not local. Making these paths be local means that when the path starts, it will begin where the last path left off. This is useful when stringing paths together, the last thing you want is a discontinuity when a new path is activated.

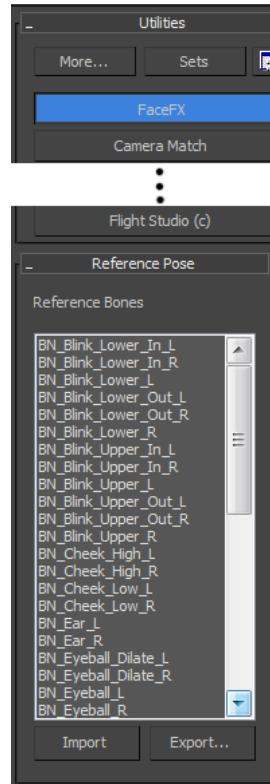
4.3. Creating a FaceFX Head Appearance

This section explains how to create and export data from 3ds Max and how to set up and publish a new FaceFX actor.

4.3.1 Creating and Exporting Data from 3ds Max

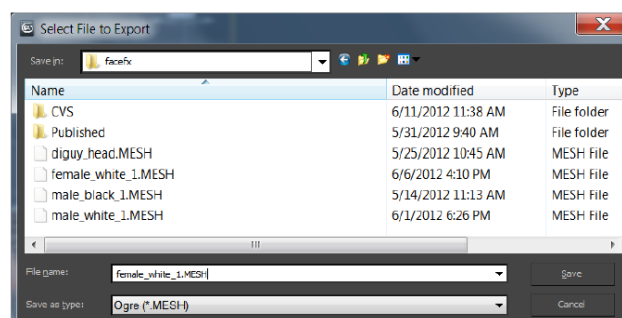
1. Open a sample FaceFX model from *./geometry/facefx*. There should be a number of *.max* files to use as a base.
2. Modify geometry, textures and so on. We recommend using the skin wrap modifier if you need to do any significant changes to vertex topology. The wrap modifier allows you to reference a second model and copy its weights by proximity.
3. Verify that the character can go through all the emotions and poses in the animation data.
4. Pick the FaceFX utility plug-in (Figure 21).

Figure 21. FaceFX plug-in



5. Click Create Actor and give the character a reasonable name that will match the associated head appearance.
6. On the Reference Bones panel, click Export and select all bones with the BN_ prefix.
7. On the Nodes Panel, click Batch Export.
8. Pick `./geometry/facefx/diguy_batch_export.txt`. This script has a list of poses and the keyframes they happen at.
9. Click Save Actor and place the new actor file in `./custom/geometry/facefx`.
10. Select the head of the character and execute the Export Selected command. The file should be exported as a Ogre `.Mesh` file. Give it the same name as the actor and save the file in `./custom/geometry/facefx/`.

Figure 22. Exporting a file



① Any change in the hierarchy of character bones or changes to the neutral pose will probably require that the actor is recreated. When in doubt go through the export process again. Select the various mesh LODs of the character and all of the BN_joints and export them as a collada DAE file in *./custom/geometry/dae*.

4.3.2 Setting Up and Publishing a New FaceFX Actor

1. Start FaceFX Studio.
2. Open the actor file that was saved in *./custom/geometry/facefx*. You should now see the face that was exported as an Ogre mesh file.
3. If you switch to the face graph view there will be a unstructured node graph that does not have constraints or connections.
4. Choose **Actor > Sync to Template** and import *./geometry/facefx/diguy_head_face_graph.fxt*. This should now give you a character that can animate and lip sync to audio.
5. See the FaceFX Studio documentation for the procedures to author animation and create animsets for use in DI-Guy.
6. Choose **File > Publish to Game** and publish the new actor in *./custom/geometry/facefx/published*.

4.3.3 Setting Up a Head for Use in DI-Guy

Example of a FaceFX shape set:

```
shape_set facefx_male_w1
  actor = greg
  is_base_shape = 0
  class_type = head
  multi_lod_filename = facefx_male_w1.dae
  shape_attachment_data = head position facefx
  shape_suffix_lod1 = _lod1Mesh
  shape_suffix_lod2 = _lod1Mesh
  shape_suffix_lod3 = _lod1Mesh
  shape_suffix_lod4 = _lod2Mesh
  shape_suffix_lod5 = _lod2Mesh
  shape_suffix_lod6 = _lod2Mesh
  shape_suffix_lod7 =
  parameters
    facefx_actor = male_white_1
```

Special flags for a FaceFX head shape set:

- `class_type = head`. Indicates that this shape replaces other items with class type of head, without this the character will have two heads.
- `shape_attachment_data = head position facefx`. Indicates that the head mesh should be attached to the position link and be initialized with the FaceFX module shape callbacks.

- `facefx_actor = male_white_1`. Indicates which FaceFX actor should be used when this shapeseet is loaded.

Example of a FaceFX head appearance:

```
head_appearance facefx_male_white_1
  item = facefx_male_w1
  parameters
    head_type = male_large
    graphics_state_switch_map1 = sk_male_w1_hands:male_w1_head
```

Special flags for a FaceFX head appearance:

- `head_type = male_large`. Indicates what body appearances this head is compatible with. Body appearances are also tagged with a `head_type` field to allow the user interface to only present the appropriate heads for a given appearance.
- `graphics_state_switch_map1 = sk_male_w1_hands:male_w1_head`. This state switch applies to the character's hand item and keeps the color of the hands synchronized with the color of the head. This is applied after any state switches in the body appearance.

 The head appearance functionality is not limited to FaceFX. Non-FaceFX heads can be made swappable as well. The `shape_attachment_data` should just not specify FaceFX.

4.4. Considerations for Using Expressive Faces

- DI-Guy uses a shader lookup table to establish a mapping between 3ds Max bones and DI-Guy links. The lookup table is specified in `./config/common/shader_matrix_index_tables.cfg`. If you plan to use a different naming convention for your face bones you must add a new `shader_matrix_index_table` entry to a custom version of `shader_matrix_index_tables.cfg`.
- Number of Joints. DI-Guy uses a maximum of 50 link matrixes in shaders. If you plan to build an expressive face with more than 50 joints, you must modify both the shaders and the `shader_matrix_index_tables`.
- Scale mismatch between DI-Guy and FaceFX. The animation data that FaceFX produces is scaled by `.0254` when mapped into DI-Guy's animation system. A few models have required a different value. It has been unclear where in a 3 application/2 file format export pipeline the problems arise. Figure 23 illustrates this problem.

Figure 23. Scale mismatch

To fix this, add the following metadata to `./custom/config/diguy/facefx.cfg`:

```
face_data female_white_1  
unit_conversion_factor = .01
```

- Scaling of heads in 3ds Max is also very tricky. It may require scaling the BN_Head node, disconnecting all children and scaling the bones back to a scale factor of <1.0,1.0,1.>, renormalizing all scale keyframe data on the joints, and then reconnecting the hierarchy. After a mesh is scaled, the mesh needs a Reset XForm modifier added above the mesh and below the skin and collapsed.

After changes to joint position, you typically must reset the skin by checking and unchecking Always Deform in the advanced section of the Skin Modifier.



5. Using the Character Viewer

This chapter explains how to use the Character Viewer to view characters, appearances, and actions.

5.1. Introduction to the DI-Guy Character Viewer	70
5.2. Viewing Characters, Appearances, Gestures, and Actions	71
5.2.1 Filtering the Character Type and Appearance Lists	72
5.2.2 Changing the Viewing Angle for a Character	73
5.2.3 Demonstrating a Character's Aim and Locomotion Capability	73
5.2.4 Viewing Different LOD Levels	74
5.2.5 Changing How a Character Is Rendered	75
5.2.6 Viewing Multiple Appearances at One Time (Army Mode)	77
5.2.7 Advanced Character Editing	80
5.2.8 Reloading Characters that Have Been Edited	82
5.2.9 Controlling Character Movement	82
5.2.10 Viewing Information About Character Movement and State	82
5.3. Improving Performance	83
5.3.1 Displaying the Performance Profiler	84
5.4. Running a Lua Script	84
5.5. Viewing Character Geometry Details	84
5.6. The Appearance Editor	85
5.6.1 Editing Configuration File Text	86
5.6.2 Editing Appearance Effects	87
5.7. Using the PBR Material Tester	87
5.7.1 Reloading Shaders	88
5.8. The Character Viewer Log Window	89
5.8.1 Setting the Notification Level	89
5.9. Broadcasting the Character Viewer over the Network	89
5.9.1 Joining a DIS Exercise	89
5.9.2 Joining an HLA Exercise	91

5.1. Introduction to the DI-Guy Character Viewer

The DI-Guy Character Viewer is a utility program that allows you to view and edit all of the characters provided with DI-Guy. It is also a testing tool for DI-Guy customers who create their own models. The windows in Character Viewer are:

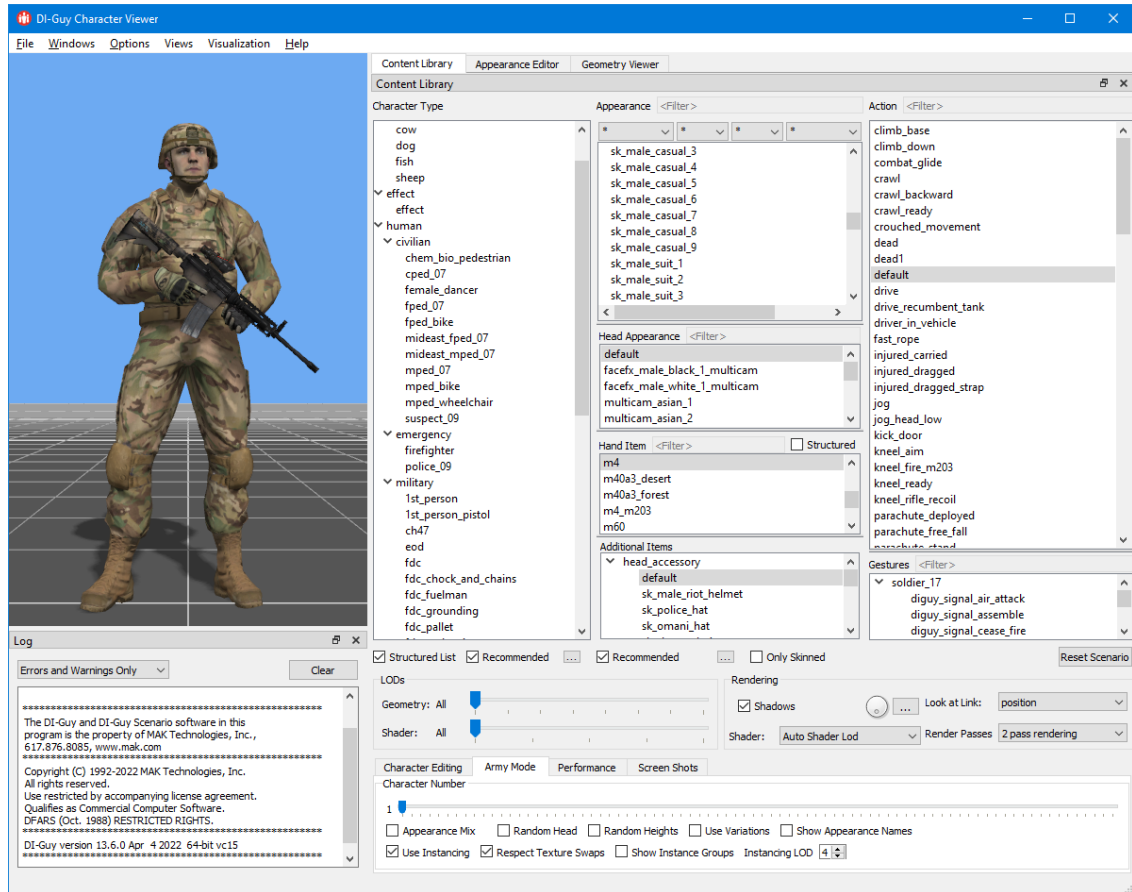
- 3D window. Displays the selected character, appearance, and action.
- Content Library. The Content Library lets you select the character appearances, gestures, and actions you want to view. It also has advanced features for experimenting with lighting and geometry.
- Appearance Editor. The Appearance Editor is a tool for advanced users who want to edit the parameters of character models.
- Geometry Viewer. The Geometry Viewer gathers all of the information for the selected character into one window so you can easily understand its details.
- Log. Displays errors, warning, and informational messages.

You can undock and resize the windows just as you would windows in other applications.

 The Character Viewer is a Windows-only application.

- To open the Character Viewer, on the Start menu, choose **MAK Technologies > DI-Guy Character Viewer (64-bit)**. The Character Viewer opens (Figure 24).

Figure 24. Character Viewer



5.2. Viewing Characters, Appearances, Gestures, and Actions

The Character Viewer lists all of the characters available in DI-Guy. For each character, it lists all of the appearances, gestures, and actions that are available for that character. You can view any combination of character, appearance, gesture, and action. You can filter the Appearance list and you can change the perspective from which you view the characters.

► **To view a character and its appearances, actions, and gestures:**

1. Select the Content Library tab.
2. In the Character Type list, expand the list for the type of character you want to view.
3. Select the character that you want to view. It displays in the 3D window.
4. Optionally, to see only skinned characters in the Appearance list, select the Only Skinned check box (below the lists).
5. In the Appearance list, select the appearance that you want to see for this character.

If the selected character and appearance has head appearances, they are listed in the Head Appearance list. If the selected character and appearance has any items, they are listed in the Additional Items list.

6. Optionally, select a head appearance.
7. Optionally, select one or more items.
8. In the Action list, select the action that you want to view for this character. The character starts the action. If it is a traveling action, the character repeats it continuously.
9. In the Gestures list, select the gesture that you want the character to use.

5.2.1 Filtering the Character Type and Appearance Lists

You can filter the Character Type and Appearance Lists:

- Organize the Character Type list by type of character or alphabetically.
- Display character types and appearances at or above a specified level of quality.

i The quality of a character or appearance is specified in its **quality_bias** parameter. The quality is a somewhat arbitrary value, assigned by the model developer, based on their opinion of the quality of the character relative to other characters. The characters provided with DI-Guy have quality values ranging from 1 to 10.

- Display only skinned appearances.
 - Filter appearances by country, gender, age, and ethnicity. The filter options change based on the character type.
- To organize the Character Type list by category of character, select the Structured List check box. To organize it alphabetically, clear the check box.
- To display character types, appearances, or both that are at or above a specified quality level threshold, select the Recommended check box under the list.
- To filter the Appearance list by country, gender, age, or ethnicity, select an option from one of the drop-down lists at the top of the Appearance column.
- **To specify the quality level threshold to use when the Recommended check box is selected:**
1. Click the Browse button under the list for which you want to specify a recommended level of quality. A Quality Threshold dialog box opens for the list (Set Character Type Quality Threshold or Set Appearance Quality Threshold.)
 2. Set a quality threshold value. Higher values indicate a higher level of quality.
 3. Click OK.

i The Recommended check box and browse button for the Appearance list display on the same row of the GUI as those for the Character Type. As a result, it might not display immediately below the Appearance list. Those options do not affect the other lists (Head Appearance, Hand Item, or Additional Items).

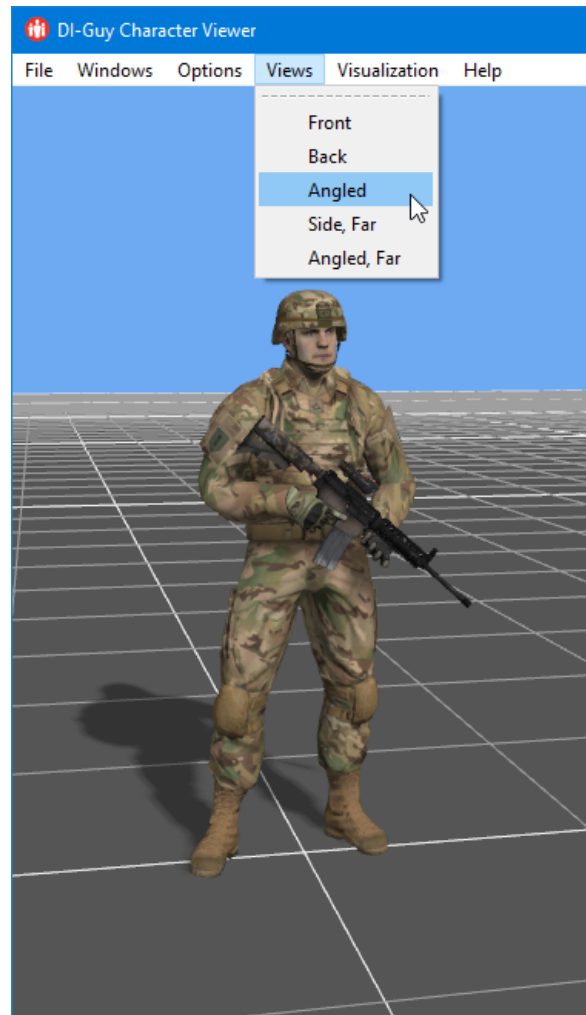
5.2.2 Changing the Viewing Angle for a Character

The default view of a character is from the front. You can quickly change to a predefined set of angles or move the character using your mouse or keyboard.

► To change the viewing angle of a character, do one or more of the following:

- Select an option from the View menu (Figure 25).

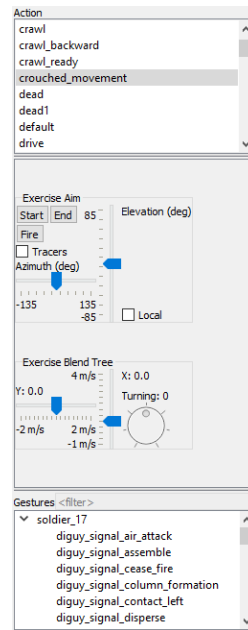
Figure 25. Views menu



- Zoom in and out using the left and right mouse buttons, or pressing **W** or **S**.
- Change the angle of view by holding down both mouse buttons and moving the mouse. You can also press **A**, **D**, or the arrow keys.

5.2.3 Demonstrating a Character's Aim and Locomotion Capability

When you select an action in the Action list, the Character Viewer displays the action in the 3D window. For some aim actions, the Character Viewer opens a panel where you can vary the aim azimuth and elevation (Figure 26). For some movement actions, you can vary the blend tree settings.

Figure 26. Exercise Aim panel

► **To demonstrate aim and locomotion capability:**

1. Select an aim action or an action that uses a blend tree. A panel is added to the Character Selector window between the Action list and the Gestures list. You may need to resize the window as a whole or the list windows to see all of the panel.
2. Adjust any of the sliders in the panel to see how they affect the character's movement and aiming.

5.2.4 Viewing Different LOD Levels

To optimize performance, DI-Guy characters have several quality levels. The closer a character is to the camera, the higher the quality that is used. If a character is farther away from the camera, it can be rendered at a lower quality, thereby improving performance. You can view characters at their various quality levels.

You can view a character at the different LOD levels available and you can view different quality of shaders.

► **To change the LOD level:**

- In the LODs group box, adjust the Geometry slider to see the different LODs for visual quality.
- In the LODs group box, adjust the Shader slider to see the different LODs for shaders.

► **To view all LOD levels for a character:**

1. Choose **Visualization > Show All LODs**. All LOD levels for the character display in the 3D viewer.
2. Adjust the camera to view the different LOD levels.

Figure 27. Showing all LOD levels

5.2.5 Changing How a Character Is Rendered

The Rendering group box has options for lighting, shadows, and shaders.

Changing Lighting and Shadows

You can quickly make simple changes to the lighting and shadows applied to the character. You can also make more advanced changes.

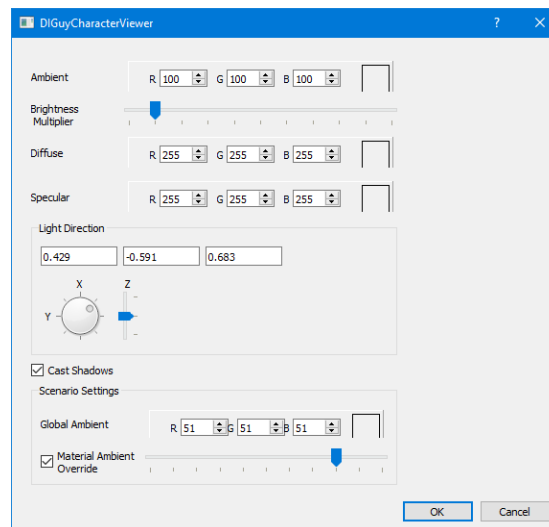
► **To change lighting direction and shadows:**

1. In the Rendering group box, select the Shadows check box to enable shadows.
2. Rotate the lighting widget (🕒) to change the direction from which light is applied to the character (and therefore, the direction of the shadow).

Configuring Advanced Lighting Options

► **To make advanced changes to the lighting:**

1. In the Rendering group box, click the Browse button next to the lighting widget. The Lighting dialog box opens (Figure 28).

Figure 28. Lighting dialog box

2. Change the color of ambient, diffuse, specular, or global ambient light by changing any of the RGB values or by clicking the color swatch and selecting a different color.
 - Ambient light is general background light in the entire scene.
 - Diffuse light is that which is reflected off of rough surfaces. It is reflected in many directions.
 - Global Ambient is the global amount of ambient light.
 - The Material Ambient Override slider adjusts the amount and color of ambient lighting values as they're applied to the DI-Guy character materials. This is in addition to the Ambient and Global Ambient settings and applies only to DI-Guy characters, whereas those other settings apply to the entire scene.
3. Adjust the Brightness Multiplier slider to increase the brightness of the diffuse and specular light.
4. In the Light Direction group, change both the direction and altitude of the light source.
5. To enable or disable shadows, select or clear the Cast Shadows check box. This check box is linked to the Shadows check box in the Rendering group box.
6. Click OK.

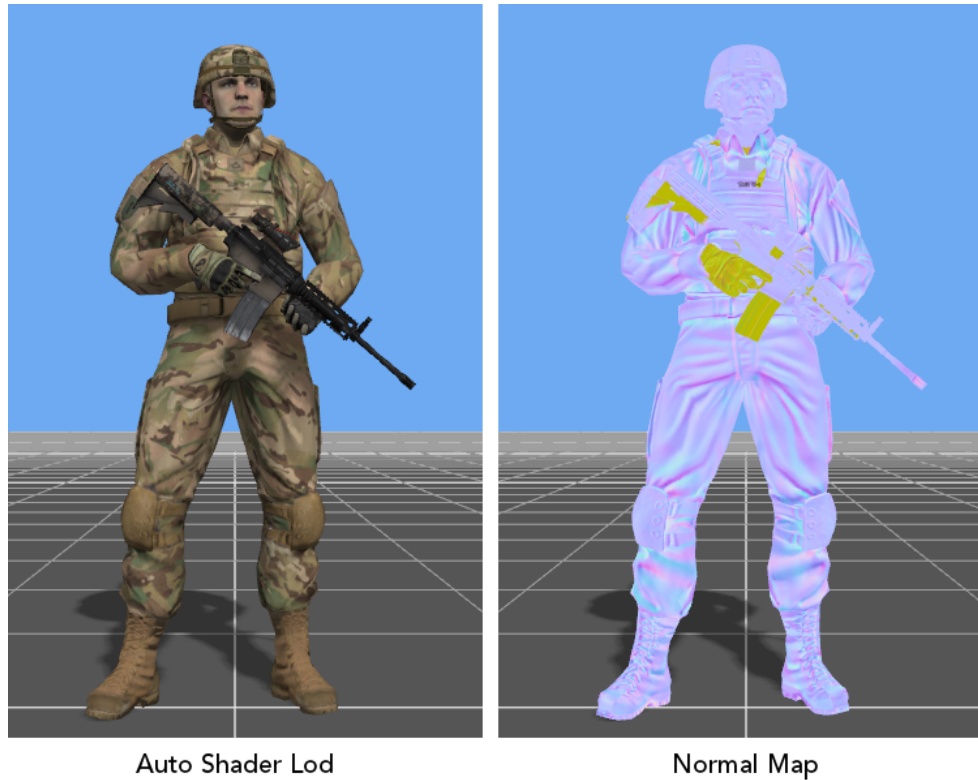
Viewing a Character's Structure

You can view a character's wireframe and skeleton.

- To view a character's wireframe, choose **Visualization > Wireframe**.
- To view a character's skeleton, choose **Visualization > Skeleton**.
- To view the link names, choose **Visualization > Link Names**.
- To view the connection names, choose **Visualization > Connection Names**.

Using the Shader Debugger

The shader debugger allows you to visualize the different texture maps that are used as source data. DI-Guy provides some shader debugging capabilities within its lighting shaders. The shaders are instrumented such that setting different flags (through uniforms) changes the behavior of the shader. Typically, it changes fragment colors based on some parameter or parameters. Figure 29 shows two different shader settings.

Figure 29. Shader debugging

i Shader debugging is also provided in DI-Guy Scenario on the Scenario Objects:Performance page.

- To change the shader being used, in the Rendering group box, select an option from the Shader list.

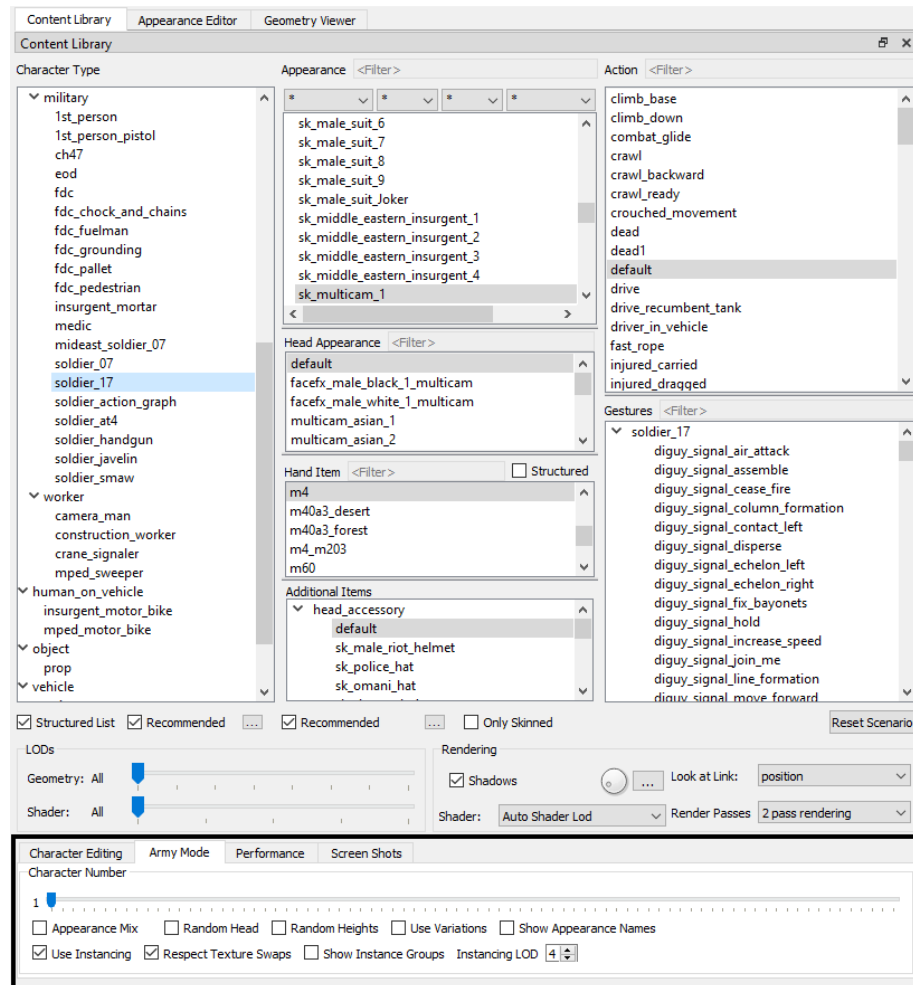
5.2.6 Viewing Multiple Appearances at One Time (Army Mode)

You can display many instances of a character at one time using different appearances.

► To view multiple appearances for a character:

1. At the bottom of the Content Library, select the Army Mode tab (Figure 30).

Figure 30. Army mode



2. Drag the Character Number slider to increase the number of characters displayed in the viewer window (Figure 31).

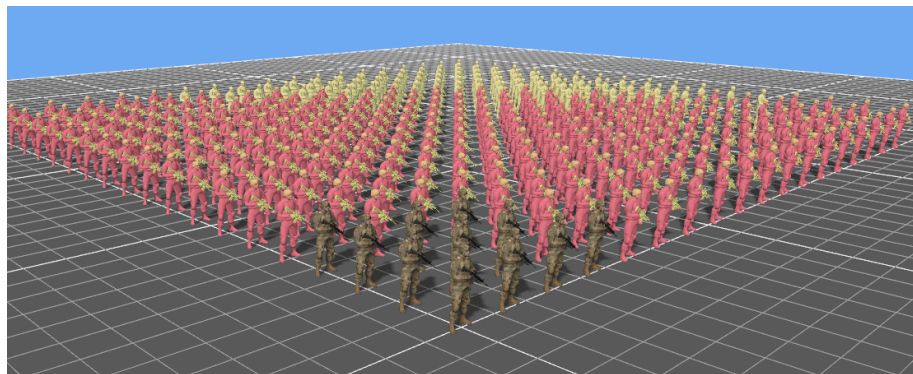
Figure 31. Multiple character instances (army mode)

3. Select the desired check boxes to change the variations in appearance of the characters in the viewer.

Instancing Options in Army Mode

The Army Mode tab has several options for testing instancing. When you use instancing, characters are lower quality, but display more quickly and use less memory. You can see the result of using instancing by turning on the profiler. (For information about the profiler, see "5.3.1 Displaying the Performance Profiler" on page 84.) This option is useful only if you are viewing multiple characters in army mode. When the Use Instancing check box is selected, additional check boxes are enabled:

- **Respect Texture Swaps.** Models have a base mesh that has different texture maps applied to it to create the different appearances for a character. For example, a character that wears a suit, might have several different color suits. Replacing the base texture for different appearances is called a texture swap. If this option is selected, the Character Viewer displays the different textures. However, texture swaps affect performance. You can choose to not use texture swaps.
- **Show Instance Groups.** When you enable instance groups, the characters are colored to show the distance at which LOD changes take effect (Figure 32).

Figure 32. Instance groups with Instancing LOD set to 4

- **Instancing LOD.** Specifies the LOD at which instancing turns on.

► **To enable instancing:**

1. Select the Army Mode tab.
2. Select Use Instancing.

5.2.7 Advanced Character Editing

The 3D window can display the character bounds (Figure 33 and Figure 34), inverse kinematics (Figure 35), aim vectors (Figure 36), LODs, and more. You can also see how a character looks with different rendering approaches.

- To view a character's bounds or bounding box, choose **Visualization > Character Bounds**, **Local Bounding Box**, or **Link Bounding Box**.
- To see inverse kinematics, choose **Visualization > Inverse Kinematics**. Not all characters display inverse kinematics. This depends on the hand item selected.
- To see aim vectors, choose **Visualization > Aim Vectors**. This displays the vectors only for characters that have a weapon that is configured for aim vectors and an action that involves aiming.

Figure 33. Character bounds

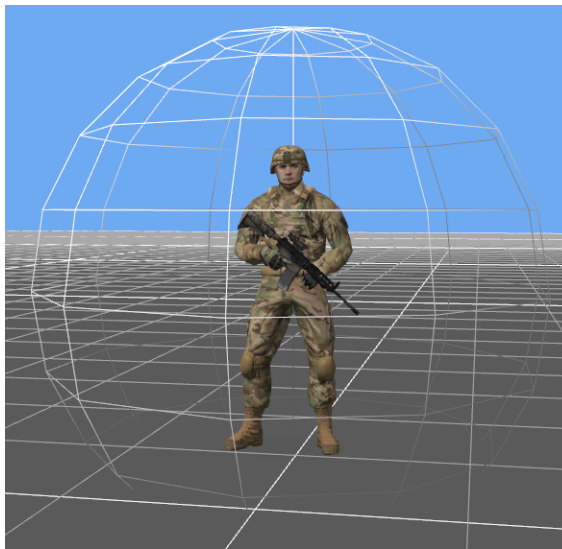


Figure 34. Local bounding box and Link bounding box

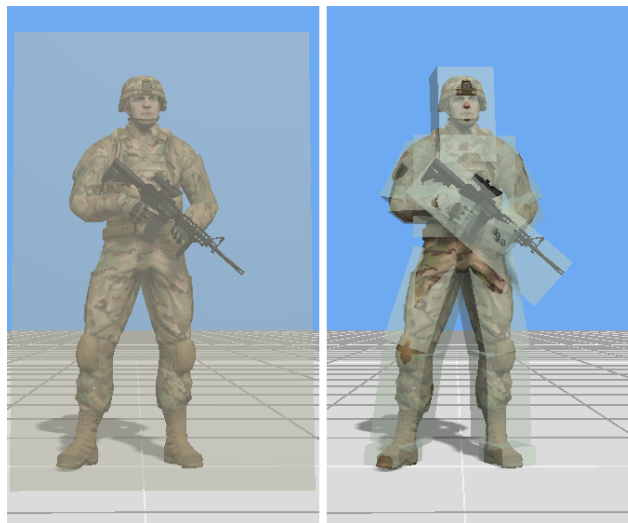


Figure 35. Inverse kinematics



Figure 36. Aim vector



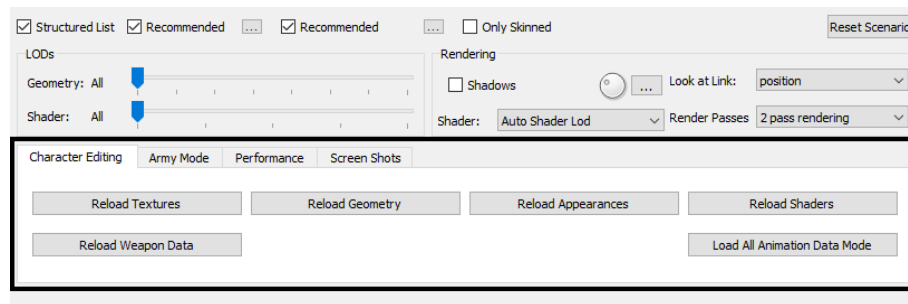
5.2.8 Reloading Characters that Have Been Edited

If you are editing some aspect of a character in another application, such as Photoshop, you can load the updated files without exiting the Character Viewer. You can reload textures, geometry, appearances, shaders, weapon data, and all animation data.

► **To reload the files for a character:**

1. At the bottom of the Content Library, select the Character Editing tab (Figure 37).

Figure 37. Character Editing Tab



2. Click the button for the type of data that you want to reload.

5.2.9 Controlling Character Movement

If you select a character action that involves movement, such as walking, or firing, the character in the viewing window displays that action. You can start and stop the action with the playback controls.

i The Playback Controls button bar has a full set of playback controls. Only the Start, Fast Forward, and Stop buttons are used.

► **To use the playback controls:**

1. Choose **Windows > Playback Control**. The Playback Controls are added to the Character Viewer.
2. Click the Forward button to make the character move.
3. Click the Fast Forward button to make the character move faster.
4. Click the Stop button to stop movement.

5.2.10 Viewing Information About Character Movement and State

You can view information about the Action the character is currently performing using the Movement Info and State Info options in the Visualization menu.

- **Movement Info.** Displays arrows that show the character's movements.
- **State Info.** Displays a label over the character's head with detailed information.

Figure 38. Soldier 17 displaying Movement and State Info

5.3. Improving Performance

The Character Viewer has some settings that can improve performance. They are:

- Use Multithreaded Pipeline. Use multithreading for the general animation system.
- Use Asynchronous Texture Loader. Load textures in the background.
- Use Delayed Motion Loading. Does not load motions until the first time they are played.
- Freeze Characters. Characters cannot move.
- Animation Load Management. Grants access to the Load Manager Settings in the ImGui Debug overlay.
- Visualize Load Management. Enables debug visuals in the 3D viewer when you make changes to the Load Manager Settings in the ImGui Debug overlay. These visuals reflect the size of the load management zones for the different update rates.
- Activate Tracy Trace. Allows the Tracy diagnostic tool to connect to the Character Viewer.
- Tracy Capture CPU/Stack. Enables Tracy's "Call Stack Sampling" option. Sampling is performed at 8 kHz on Windows and 10 kHz on Linux.



For information about Tracy and MAK ONE products, please see the *VR-Vantage Users Guide* or *VR-Forces Users Guide*. To learn more about the Tracy Client, read the documentation at <https://bitbucket.org/wolfpld/tracy/downloads>.

► **To enable or disable performance options:**

1. At the bottom of the Content Library, select the Performance tab.
2. Select or clear the check boxes to enable or disable performance options.

5.3.1 Displaying the Performance Profiler

The Character Viewer can display performance statistics for the characters that you are viewing. It displays frame rate statistics, a histogram, and geometry statistics.

► **To display the performance profiler:**

1. Click the character display window to make it active.
2. Press **Ctrl+P**. Continue pressing **Ctrl+P** to cycle through the performance displays.

5.4. Running a Lua Script

You can run Lua scripts to debug characters. You can access most of the *diguyCharacter* API as well as *diguyScenario* and *diguyApp* functions. You can also load and save scripts.

► **To run a Lua script:**

1. Choose **Windows > Script Editor**. The Code Editor dialog box opens.
2. Enter the code you want to run.
3. Click Trigger.

► **To load a Lua script:**

1. In the Code Editor, click Load. The Load Script window opens.
2. Navigate to the file that you want to load.
3. Click Open.

► **To save a Lua script:**

1. Click the Save button. The Save Script window opens.
2. Navigate to the folder where you want to save the file.
3. Click Save.

5.5. Viewing Character Geometry Details

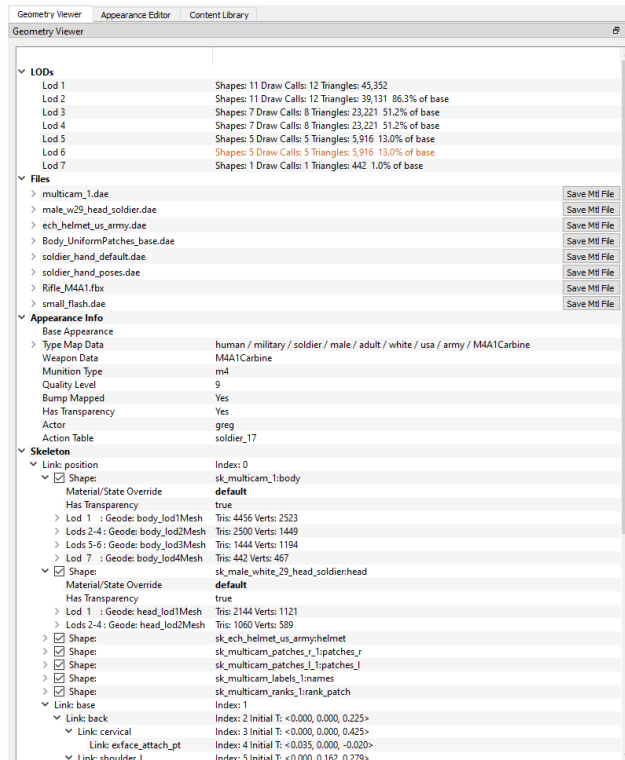
DI-Guy characters are rendered based on information in many different configuration files. Trying to understand a character's structure and functioning by examining all these files can be a tedious process. The Geometry Overview window gathers all of the information for the selected character into one window, helping you easily understand its details.

i The Geometry Viewer is also provided in DI-Guy Scenario. It is accessible as the Geometry tab on the Character Objects:Character page and the Scenario Objects:Scene Object page.

If you select a node in the Geometry Viewer in DI-Guy Scenario, the node is highlighted in the 3D View.

► To display the Geometry Viewer, select the Geometry Viewer tab (Figure 39).

Figure 39. Geometry Overview



5.6. The Appearance Editor

The Appearance Editor is a graphical user interface that lets you edit the character appearance files. By using the Appearance Editor rather than editing the files in a text editor, you can avoid syntax errors and invalid information. And since the Appearance Editor shows the configuration for the character selected in the Character Selector, you do not have to figure out which configuration file to edit for that character.

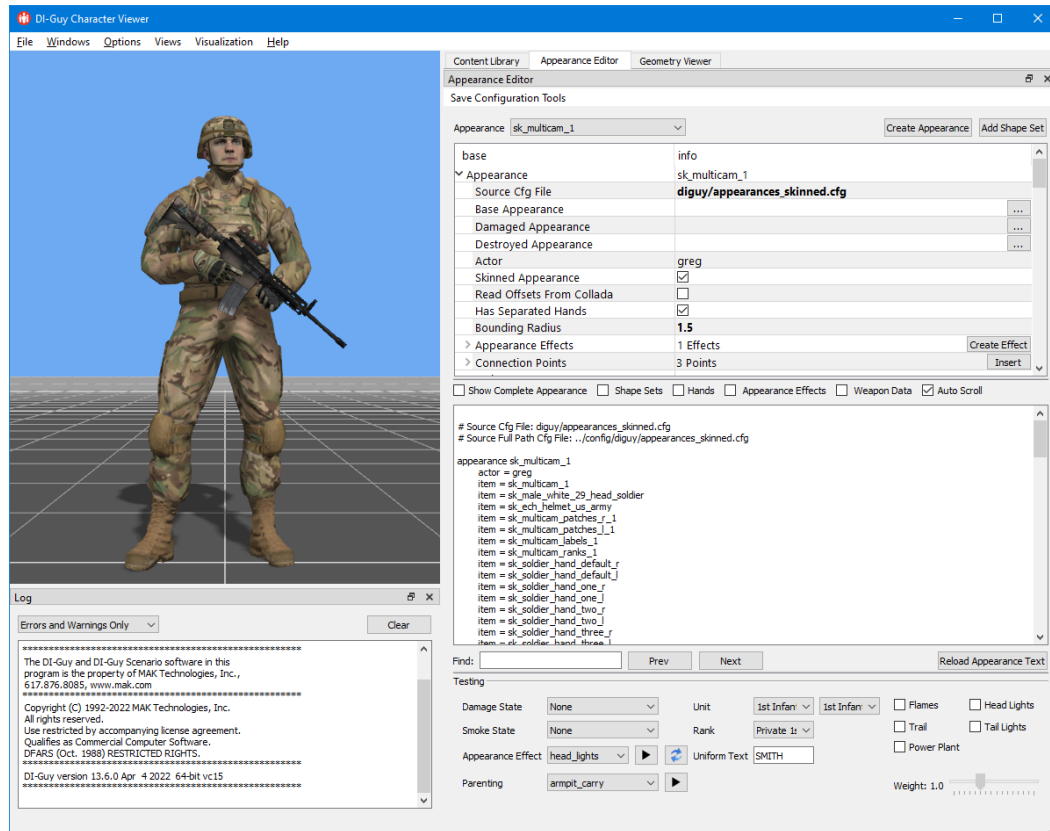
Although the Appearance Editor allows you to edit configuration files without touching the actual files, it also displays the contents of the configuration files, so that you can edit them directly if you want to. Sometimes it is quicker to edit the file, particularly when you want to delete a large section of text.

i The Appearance Editor is a tool for experienced modelers. It is beyond the scope of this manual to teach all the aspects of modeling needed to use it effectively.

► **To use the Appearance Editor:**

1. In the Content Library window, select the character whose appearance you want to edit.
2. Select the Appearance Editor tab (Figure 40).

Figure 40. Appearance Editor



3. In the Appearance list, select the appearance that you want to edit.
4. In the list of parameters, edit the parameters as desired. You edit parameters by:
 - Choosing options from a list.
 - Select or clearing check boxes.
 - Typing new values.
 - Clicking buttons to add, insert, and delete new parameters.

5.6.1 Editing Configuration File Text

The Appearance Editor displays the text of the configuration file that is being edited in the editor. You can edit the configuration file text directly. If you do so, you can refresh the editing GUI.

You can control the amount of detail shown in the editing window:

- Display partial or complete appearance. By default, the window only shows the leaf-level parameters for the appearance. To show the parameters that the character inherits from the base appearance, show the complete appearance.
 - Shape sets. By default, shape sets are not displayed in the editing window.
- To show the complete appearance, select the Show Complete Appearance check box.
 - To show shape sets, select the Show Shape Sets check box.
 - To show hand items, select the Hands check box.
 - To show information about the weapon (if any), select the Weapon Data check box.
 - To refresh the editing GUI, click Reload Appearance Text.

5.6.2 Editing Appearance Effects

You can add effects to an appearance, such as dust, brake lights, flames, and rotor wash. The Appearance Editor lets you edit the supplied appearance effects and add more. You can then add them in the Appearance Effects line of the Appearance section of the editor.

➤ **To edit appearance effects:**

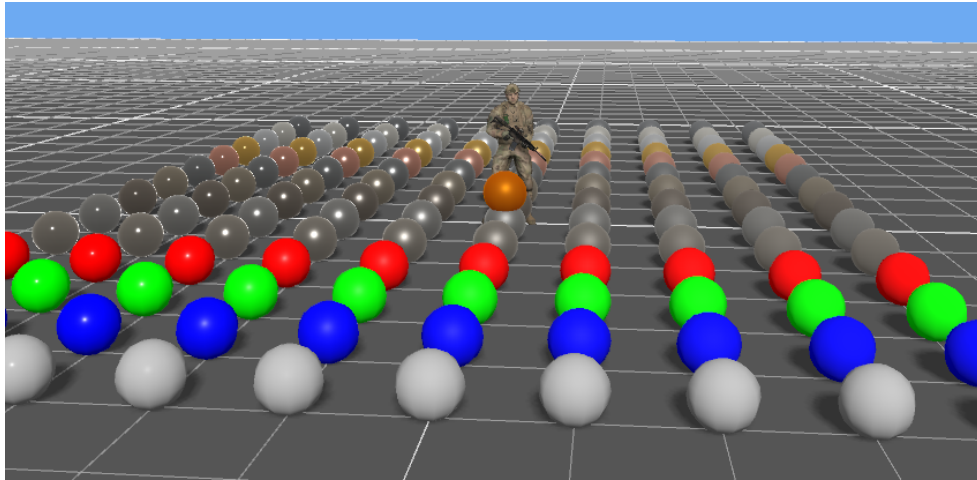
1. Select the Appearance Effects check box. The editor displays a list of shared appearance effects.
 2. Edit the effects. The GUI works the same way as it does for editing an appearance.
- To return to editing the appearance, clear the Appearance Effects check box.

5.7. Using the PBR Material Tester

The PBR Material Tester is an experimental tool for manipulating PBR shaders. (Experimental tools are not as fully tested as other features.) It adds a grid of cylindrical or spherical shapes to the Character Viewer window. You can adjust these shader characteristics:

- Color
- Metalness
- Specular reflection
- Reflectivity
- Diffuse
- Shininess
- Ambient
- Emission
- Alpha.

Figure 41. PBR Material Tester

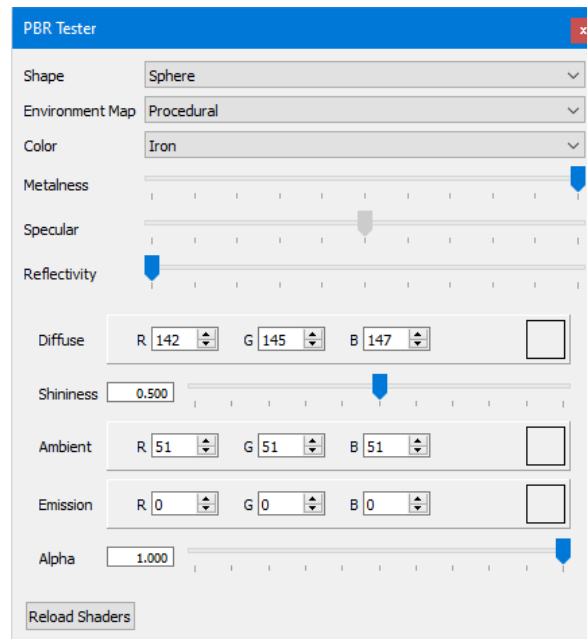


If you change shaders offline, you can reload them from the PBR Tester dialog box.

► **To use the PBR Material Tester:**

1. Choose **Windows > PBR Material Tester**. A grid of spheres is added to the window and the PBR Tester dialog box opens (Figure 42).

Figure 42. PBR Tester dialog box



2. Adjust settings as desired.

5.7.1 Reloading Shaders

If you edit shaders, you can reload them without restarting the Character Viewer.

► **To reload shaders.**

1. Choose **Window > PBR Material Tester**. A grid of spheres is added to the window and the PBR Tester dialog box opens (Figure 42 on the previous page).
2. Click Reload Shaders.

5.8. The Character Viewer Log Window

The Character Viewer has a log that records system messages while you are using it.

► **To open the Log window, choose **Windows > Log**.**

5.8.1 Setting the Notification Level

The Log window displays messages at the notification level that you specify. The levels are:

- Errors only.
- Errors and warnings.
- Informational messages and higher.
- Debug messages and higher.
- Everything.

► **To set the notification level, choose an option from the list in the Log window.**

5.9. Broadcasting the Character Viewer over the Network

You can broadcast the state of the character in the Character Viewer over DIS or HLA. This allows you to view the character within the context of the terrain in an image generator or similar 3D viewing application.

5.9.1 Joining a DIS Exercise

► **To join an exercise using DIS:**

1. Choose **Windows > Network Settings**. The Networking Settings dialog box opens.
2. In the Network Protocol group box, select DIS (Figure 43).

Figure 43. Networking Settings dialog box for DIS

Network Settings

Network Protocol
☒ DIS ☐ HLA 1.3 ☐ HLA 1516e

Join Exercise Leave Exercise

DIS Connection Settings

Network Interface: Automatic Port: 3000

Exercise ID: 1 Site ID: 0 Host ID: 0

Broadcast Address: 0.0.0.0

☒ Send DI-Guy State
☐ Send Custom PDUs
☒ Display Remote Characters
☐ Cull Entries Past World's Edge
☒ Publish Local Characters
☒ Publish Local Crowds

Ex. Location Ex. Time Interoperability Multiscreen Debugging

Coordinate Conversion: No Conversion

Offset Altitude (m): 0.000

Offset Orientation (YRP): 0.000 0.000 0.000

☐ DIS loopback
 Offset X: 0 Y: 0

Scenario Settings
☐ Create Network Crowds
☐ Join When Scenario Loads

Edit Model Map
 Reload Model Map
 Reload Munitions.cfg
 Reload Network.cfg

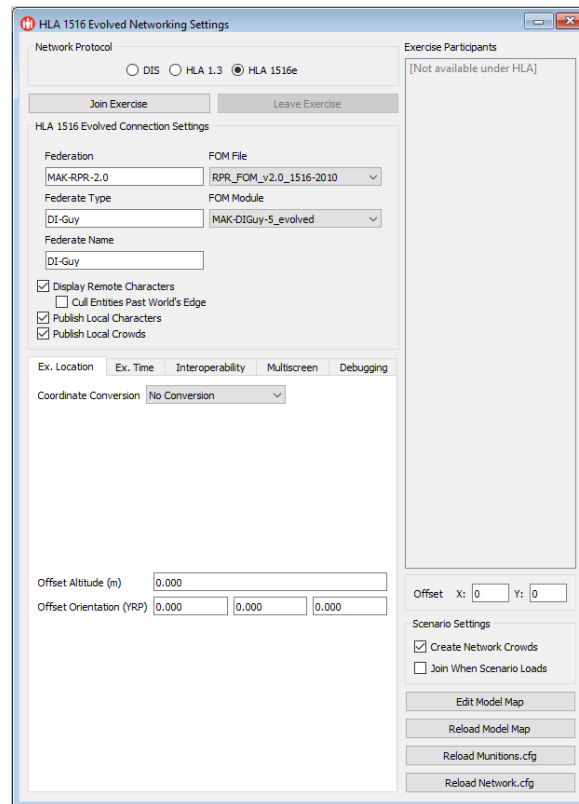
3. In the Network Interface list, select the network interface address that matches the one you are using for your IG's DIS connection.
4. In the Exercise ID box, enter the number of the exercise you want to join. Exercise 0 connects you to all DIS traffic on the network. Exercise 1 or above connects you to exercises that use the same exercise number.
5. In the Port box, set the port to match the port you are using for your IG.
6. Select the Publish Local Characters to Network check box.
7. Select the Ex. Location tab.
8. In the Coordinate Conversion list, select Flat Earth.
9. In the Coordinate Source group box, select User Specified.
10. Enter the latitude and longitude at which you want to view the character. (If you set latitude, longitude, and altitude to 0, the character stands in the ocean on the equator, just west of Africa.)
11. In the Offset Altitude box, specify an altitude for the character.
12. At the top of the dialog box, click Join Exercise.

5.9.2 Joining an HLA Exercise

► To join an exercise using HLA:

1. Choose **Windows > Network Settings**. The Networking Settings dialog box opens.
2. In the Network Protocol group box, select one of the HLA options (Figure 44).

Figure 44. Networking Settings dialog box for HLA Evolved



3. In the HLA Connection Settings group box, set the Federation to match the Federation value in the connection you are using in your IG.
4. In the FED File list, select that same FED file as the one you are using in your IG.
5. Select the Publish Local Characters to Network check box.
6. Select the Ex. Location tab.
7. In the Coordinate Conversion list, select Flat Earth.
8. In the Coordinate Source group box, select User Specified.
9. Enter the latitude and longitude at which you want to view the character. (If you set latitude, longitude, and altitude to 0, the character stands in the ocean on the equator, just west of Africa.)
10. In the Offset Altitude box, specify an altitude for the character.
11. At the top of the dialog box, click Join Exercise.



Index

#

3DS Max
exporting data from, 63

A

action
viewing, 71
actor, 21
appearance, 23
configuration file, 22-23
opening, 56, 61
publishing, 65
saving, 61
setting up, 65
skeletal hierarchy, 23
advanced lighting, 75
aim
vector, 80
animation
creating, 57
decision bead, 62
set
open, 61
save, 61
appearance, 21
actor, 23
categories, 23
creating new, 39
expressive face, 23
FaceFX, 63
filter, 72

list, 71
multiple for character type, 77
quality, 72
tutorial, 26
viewing, 71
appearances configuration file, 23
army mode, 77
audio
recording, 55
autoloading configuration files, 23
avatar, selecting, 54

B

bounding volume, 76
character, 80

C

category, appearance, 23
changing
geometry, 32
viewing angle, 73
character
appearance
quality, 72
bounds, 80
geometry, 84
gesture, viewing, 71
skinned, 22, 36
type, 21
quality, 72
sorting, 72
viewing, 71

- waypoint, 22
- character type, 54
 - quality, 72
 - sorting, 72
- Character Viewer, 70
- character_type
 - creating custom, 44
 - definitions, 22
- character_types_list configuration file, 23
- class
 - diguyApp, 84
 - diguyCharacter, 84
 - diguyScenario, 84
- Collada, 36
- command
 - diguyEncryptGeometryFile, 20
- common_actors configuration file, 22
- common_characters configuration file, 22
- common_links configuration file, 22
- compressing
 - geometry, 20
- configuration file
 - actor, 22-23
 - appearances.cfg, 23
 - autoloading, 23
 - character_types_list.cfg, 23
 - common_actors.cfg, 22
 - common_characters.cfg, 22
 - common_links.cfg, 22
 - default_appearance_effects.cfg, 23
 - default_particle_descriptions.cfg, 23
 - diguy.cfg, 21
 - diguy_actors.cfg, 22
 - diguy_character_type_maps.cfg, 22
 - diguy_characters.cfg, 22
 - exface_shapesets.cfg, 23
 - gestures.cfg, 23
 - including configuration files in, 21
 - loaders.cfg, 22
 - motex_arcs.cfg, 23
 - required_characters.cfg, 22
 - shader_matrix_index_tables.cfg, 22
 - shape_and_joint_data.cfg, 22
 - shapeset, 23
- creating
 - animation, 57
 - appearance, 39
 - character_type, 44
 - local path, 61
 - scenario, 55
 - script (dialogue), 52
 - shapeset, 39
 - weapon and equipment combination, 41

- curve
 - editing, 59
- custom
 - directory, 20
 - human, 36
 - scene object, 24
 - vehicle, 34
- customizing
 - sound, 24
 - texture, 24

D

- DAE file, 22
- data_version, 22
- debugging
 - shaders, 76
- decision bead
 - animation, 62
- default
 - particles, 23
- default_appearance_effects configuration file, 23
- default_particle_descriptions configuration file, 23
- definition
 - character_type, 22
- diguy configuration file, 21
- DI-Guy Motion Editor, 24
- diguy_actors configuration file, 22
- diguy_character_type_maps configuration file, 22
- diguy_characters configuration file, 22
- diguyApp class, 84
- diguyCharacter class, 84
- diguyEncryptGeometryFile command, 20
- diguyScenario class, 84
- directory
 - custom, 20
- documentation
 - help, 8

E

- editing
 - curves, 59
 - lip-synching, 58
- encrypting geometry, 20
- equipment, new, 41
- exface_shapesets configuration file, 23
- export
 - data from 3DS Max, 63
- expressive face, appearances, 23
- expressive local path technique, 52

F

- FaceFX, 50
 - appearance, 63
- FaceFX Studio Professional, 50
 - lip syncing, 56
- file
 - custom directory, 20
 - DAE, 22
- filtering Appearance list, 71
- finite state machine, 51

G

- geometry
 - changing, 32
 - character, 84
 - compressing, 20
 - encrypting, 20
 - processor, 20
- geometry_set_priority_list, 22
- gesture, 23
 - character, viewing, 71
- gestures configuration file, 23

H

- head
 - setting up for Expressive Faces, 65
- help
 - HTML5, 8
- hierarchical finite state machine, 51
- human, custom, 36

I

- inverse kinematics, 80

J

- joint, 21
 - number of, 66

K

- kinematics
 - inverse, 80

L

- lighting
 - advanced, 75
 - applying, 75
- link, 21
- lip syncing
 - editing, 58
 - FaceFX Studio Professional, 56
- loaders configuration file, 22
- local path
 - creating, 61
- LOD
 - level, viewing different, 74
- Lua
 - script
 - running, 84

M

- machine
 - finite state, 51
- mode
 - army, 77
- motex_arcs configuration file, 23
- motion, 24
 - textures, 23

N

- networking, 89, 91

O

- opening
 - actor, 56, 61
 - animation set, 61

P

- particle, default, 23
- path
 - local
 - creating, 61
- PBR Material Tester, 87
- playback control, 82
- publishing
 - actor, 65

Q

quality
 character, 72
 threshold, 72

R

recording
 voice, 55
required_characters configuration file, 22
required_sdk_version, 22

S

saving
 actor, 61
 animation set, 61
scale mismatch, 66
scenario
 creating, 55
scene object
 custom, 24
script
 creating dialogue, 52
 Lua
 running, 84
selecting
 avatar, 54
shader, 66
 debugging, 76
 PBR, 87
shader_matrix_index_table, 23
shader_matrix_index_tables configuration file, 22
shadow
 viewing, 75
shape, 21-22
shape_and_joint_data configuration file, 22
shapeset, 21
 configuration file, 23
 creating new, 39
skeletal hierarchy, 23
skeleton, 76
skinned character, 22, 36
sound
 customizing, 24
standing_hip_height, 23
state
 machine, 51

T

terrain, 24
texture
 customizing, 24
 motion, 23
 swap, tutorial, 26
tutorial
 appearance, 26
 texture swap, 26
type
 character, 21
 quality, 72
 sorting, 72

V

vehicle
 custom, 34
viewing angle, 73
voice recording, 55
volume
 bounding, character, 80

W

waypoint
 character, 22
weapon
 new, 41
wireframe, 76



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