



DI-Guy Motion Editor 12.5

USER GUIDE

DI-Guy Motion Editor 12.0

User Guide

Copyright © 1999-2012, Boston Dynamics

Boston Dynamics
78 Fourth Avenue
Waltham Massachusetts 02451

For questions regarding *DI-Guy Motion Editor*,
send email to diguy@diguy.com

The software described in this document is furnished under a license agreement. The software may be used or copied only in accordance with the terms of the agreement. It is against the law to copy this software in any fashion or on any medium except as specifically allowed in the license or nondisclosure agreement. No part of this document may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without prior written consent of Boston Dynamics. Information in this document is subject to change without notice and does not represent a commitment on the part of Boston Dynamics.

DI-Guy, *DI-Guy SDK*, *DI-Guy Scenario* and *DI-Guy AI* are trademarks of Boston Dynamics
OpenGL is a registered trademarks of Silicon Graphics.

OpenFlight is a registered trademark of Presagis.

Visual C++, *Windows2000/XP*, and *Direct3D* are registered trademarks of Microsoft Corp.

FLEXlm is the registered trademark of GLOBEtrötter Inc and/or Macrovision.

Certain models were provided by CG², Presagis, Antycip, Engineering and Computer Simulations, Inc., and Viewpoint DataLabs International.

VR-Link is the registered trademark of MÄK Technologies © 1997-2009 www.mak.com

E-Town™ Building Library models are from CGSD Corporation, © 1999.

Haptik www.haptik.com

libjpeg – this software is based in part on the work of the Independent JPEG Group

libtiff © 1988-1997 Sam Leffler, Silicon Graphics, Inc. www.libtiff.org

Ogg Vorbis © 2002 Xiph.org Foundation www.xiph.org

OpenAL is a trademark of Creative Labs, Inc.

Perl – © 1989-1999, Larry Wall www.perl.org, www.activestate.com

Qt © 2005-2007 Trolltech ASA www.trolltech.com

zlib © 1995-2005 Jean-loup Gailly and Mark Adler www.zlib.net

Lua © 1994-2008 Lua.org, PUC-Rio www.lua.org

pthreads sourceware.org/pthreads-win32

Qscintilla © 2008 Riverbank Computing Limited www.riverbankcomputing.co.uk

Part No. DI-Guy Motion Editor 12.0 User Guide

DI-Guy Motion Editor Software License Agreement

This is a legally binding agreement between you (“LICENSEE”) and Boston Dynamics, with its principal place of business at 78 Fourth Avenue Waltham, MA USA (“Boston Dynamics”). By breaking the seal on the package containing the DI-Guy products (DI-Guy SDK, DI-Guy Scenario, DI-Guy AI and DI-Guy Motion Editor), and/or by installing and/or using the enclosed software, data, models, documentation, or related recorded information, regardless of its form or the method of the recording (the “SOFTWARE”), LICENSEE is agreeing to be bound by the terms and conditions of this agreement, including the software license and disclaimer of software warranty below. Please read this document carefully before opening the package and using the SOFTWARE. If LICENSEE does not agree with the terms and conditions of this agreement, LICENSEE should promptly return the unopened package and the SOFTWARE to the place where it was obtained, and LICENSEE will be given a full refund of any license fee that LICENSEE paid.

1. Grant of License: Subject to the terms and conditions of this Agreement, Boston Dynamics hereby grants to LICENSEE a non-transferable and non-exclusive right to use and execute the SOFTWARE on a single computer system at one time. LICENSEE agrees that it will not reverse engineer, decompile or disassemble any portion of the SOFTWARE, nor extract data of any kind from the SOFTWARE, including but not limited to motion data, 3D models, textures, texture movies, image sequences, terrain databases and the like. If LICENSEE disposes of any media or apparatus containing SOFTWARE, LICENSEE will ensure that it has completely erased or otherwise destroyed any SOFTWARE contained on such media or stored in such apparatus. LICENSEE may not distribute, lease, transfer, export, loan or otherwise convey the SOFTWARE or any portion thereof to anyone.

2. Copying Restrictions: In order to affect LICENSEE's license rights hereunder, it may install the SOFTWARE by copying it onto the hard disk drive or into the CPU memory of a computer system for use thereon, and may make full or partial copies of the SOFTWARE, but only as necessary for backup or archival purposes. LICENSEE agrees that (i) LICENSEE's use and possession of such copies shall be solely under the terms and conditions of this Agreement, and (ii) LICENSEE shall place the same proprietary and copyright notices and legends on all such copies as included by Boston Dynamics on the media containing the authorized copy of the SOFTWARE originally provided by Boston Dynamics.

3. Ownership: LICENSEE agrees and acknowledges that Boston Dynamics transfers no ownership interest in the SOFTWARE, in the intellectual property in SOFTWARE, nor in any SOFTWARE copy to LICENSEE under this Agreement or otherwise, and that Boston Dynamics and its licensors reserve all rights not expressly granted hereunder. After LICENSEE pays any applicable license fees, LICENSEE will own the media on which the SOFTWARE was originally provided hereunder and on which LICENSEE subsequently copies the SOFTWARE, but Boston Dynamics and its licensors shall retain ownership of all SOFTWARE and copies of the SOFTWARE or portions thereof embodied in or on any media.

4. Transfer Restrictions: LICENSEE may not sublicense, transfer, or assign this Agreement or any rights or obligations under this Agreement, in whole or in part.

5. Export Restrictions: LICENSEE agrees not to export or re-export, directly or indirectly, from the United States through any

country or to any country of ultimate destination defined by the United States Government or any agency thereof as an “Excluded Territory”. LICENSEE will not export, directly or indirectly, the Licensed Programs or Documentation to any country from which the United States Government or any agency thereof requires an export license or other governmental approval at the time of export without first obtaining such license or approval. The U.S. Government's list of “Excluded Territories” is subject to change without notice and is therefore not included herein.

6. Confidentiality: By accepting this license, you acknowledge that the SOFTWARE and accompanying materials, and any proprietary information contained in the media, are proprietary in nature and contain valuable confidential information developed or acquired at great expense. You agree not to disclose to others or utilize such trade secrets or proprietary information except as provide herein.

7. Enforcement of Terms: If LICENSEE fails to fulfill any of its obligations under this Agreement, Boston Dynamics and/or its licensors may pursue all available legal remedies to enforce this Agreement, and Boston Dynamics may, at any time after LICENSEE's default of this Agreement, terminate this Agreement and all licenses and rights granted under this Agreement. LICENSEE agrees that Boston Dynamics' licensors referenced in the SOFTWARE are third-party beneficiaries of this Agreement, and may enforce this Agreement as it relates to their intellectual property. LICENSEE further agrees that, if Boston Dynamics terminates this Agreement for default, LICENSEE will, within ten (10) days after any such termination, deliver to Boston Dynamics or render unusable all SOFTWARE originally provided hereunder and any copies thereof embodied in any medium.

8. Governing Law: This Agreement shall be governed by and interpreted in accordance with the laws of the Commonwealth of Massachusetts, excluding its choice of law rules.

9. U.S. GOVERNMENT PURCHASES: If SOFTWARE is acquired for or on behalf of the U.S. Government, then:

- a. It is recognized and agreed that the SOFTWARE: (i) was developed at private expense; (ii) was not required to be originated or developed under a Government contract; (iii) was not generated as a necessary part of performing a Government contract; and (iv) was not accomplished during and necessary for the performance of a Government contract.
- b. It is recognized and agreed that SOFTWARE is commercial computer software, as that term is used in FAR Parts 12 and 27.4 (and any applicable agency supplements thereto), and DFARS Parts 211.70, 227.4 (OCT 1988), 227.71 (JUN 1995) and 227.72 (JUN 1995).
- c. If this purchase is subject to FAR Part 27, and FAR 52.227-19 has been incorporated into the terms of this purchase, the Government's rights in the SOFTWARE are no greater than RESTRICTED RIGHTS as specified in FAR 52.227-19.
- d. If this purchase is subject to DFARS Part 227 (OCT 1988), the Government's rights in the SOFTWARE are no greater than RESTRICTED RIGHTS as specified in DFARS 252.227-7013(c)(1)(i).
- e. The Government's rights in the SOFTWARE are no greater than the rights expressly stated in the body of this Standard Licensing Agreement, if this purchase is subject to (i) FAR Part 12; (ii) FAR Part 27, and FAR 52.227-19 has not been incorporated into the terms of this purchase; (iii) DFARS Part 211.70; (iv) DFARS Parts 227.71 and 227.72 (JUN 1995); or (v) any other regulation or clause permitting the contractor to deliver commercial computer software under the contractor's standard commercial license.
- f. Any related technical data shall be delivered to the Government with no more than limited rights.

10. DISCLAIMER OF SOFTWARE WARRANTY: BOSTON DYNAMICS PROVIDES THE SOFTWARE TO LICENSEE "AS IS" AND WITHOUT WARRANTY OF ANY KIND, EXPRESS, IMPLIED OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR WITH RESPECT TO INTELLECTUAL PROPERTY OWNERSHIP, NO ORAL OR WRITTEN INFORMATION OR ADVICE GIVEN BY ANY BOSTON DYNAMICS EMPLOYEE, REPRESENTATIVE OR DISTRIBUTOR WILL CREATE A WARRANTY FOR THE SOFTWARE, AND LICENSEE MAY NOT RELY ON ANY SUCH INFORMATION OR ADVICE.

11. Limited Warranty on Media: Boston Dynamics warrants the media on which SOFTWARE is recorded and provided to LICENSEE under this Agreement to be free from defects in materials and workmanship under normal use for a period of ninety (90) days after the date of the original delivery of SOFTWARE to LICENSEE. Such warranty is solely for LICENSEE's benefit and LICENSEE has no authority to assign, pass through or transfer this warranty to any other person or entity. If LICENSEE returns any

defective media to Boston Dynamics or an authorized Boston Dynamics representative during the warranty period with proof of purchase, Boston Dynamics will, at its sole option, either replace such defective media or refund the purchase price for such media. This warranty will not apply to any media that has been damaged by abuse, accident or misuse. The foregoing warranty sets forth Boston Dynamics' entire liability and LICENSEE's exclusive remedy for any defects in any media and is in lieu of, and Boston Dynamics disclaims, all other warranties, express, implied, or otherwise, including without limitation any warranty of merchantability or fitness for a particular purpose.

12. LIMITATION OF LIABILITY: IN NO EVENT SHALL BOSTON DYNAMICS OR ITS LICENSORS BE LIABLE TO LICENSEE FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL OR INDIRECT DAMAGES OF ANY KIND (INCLUDING WITHOUT LIMITATION THE COST OF COVER, DAMAGES ARISING FROM LOSS OF DATA, USE, PROFITS OR GOODWILL, OR PROPERTY DAMAGE), WHETHER OR NOT BOSTON DYNAMICS HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY ARISING OUT OF THIS AGREEMENT. THESE LIMITATIONS SHALL APPLY NOTWITHSTANDING THE FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY. BOSTON DYNAMICS' LIABILITY ARISING OUT OF THIS SOFTWARE LICENSE AGREEMENT AND/OR LICENSEE'S USE OR POSSESSION OF THE SOFTWARE, INCLUDING WITHOUT LIMITATION ANY AND ALL CLAIMS COMBINED, WILL NOT EXCEED THE AMOUNT OF THE LICENSE FEE LICENSEE PAID FOR THE SOFTWARE PROVIDED UNDER THIS AGREEMENT.

13. Laws Governing Warranties and Liability: The law(s) of a jurisdiction may define the scope of warranty to be provided for products or the manner in which a supplier's liability may be limited, and such law(s) shall govern this Agreement only to the extent a party protected by such law(s) cannot waive the protection thereof by contract. In the U.S. and other countries, some states, territories or other principalities do not allow the limitation or exclusion of liability for incidental or consequential damages, or allow the exclusion of implied warranties, so the limitation and exclusion above may not apply to LICENSEE, and LICENSEE may have other rights that vary from state, territory or principality to state, territory or principality.



DI-Guy content is highly customizable. Geometry is specified in Collada or OpenFlight, textures are expressed in standard image formats in RGB, PNG, and JPEG, sounds use .wav files, and users can create new motions using the DI-Guy Motion Editor by hand, based on existing motions, or imported from BVH.

Table of Contents

1	DI-GUY MOTION EDITOR.....	7
1.1	INTRODUCING DI-GUY MOTION EDITOR.....	7
1.2	THE DI-GUY PRODUCT LINE.....	8
1.3	DOCUMENTATION	9
1.4	DIGITAL BIOMECHANICS.....	9
1.5	INSTALLING DI-GUY MOTION EDITOR.....	9
2	DI-GUY MOTION EDITOR WINDOWS OVERVIEW.....	10
2.2	COMMAND LINE.....	16
3	QUICK START TUTORIAL.....	17
3.1	REVIEW ACTION TABLE OF A CHARACTER	17
3.2	PLAYING A MOTION ON THE TIMELINE.....	18
3.3	BLENDING A POSE INTO THE MOTION	24
3.4	UNDO.....	31
3.5	EDIT FUNCTIONS: CUT, COPY, DELETE, PASTE, EDIT.....	31
3.6	EXPORT A MOTION FROM THE TIMELINE.....	31
4	MENUS	34
4.1	FILE MENU.....	34
4.2	EDIT MENU	37
4.3	WINDOW MENU	37
4.4	TOOLS MENU	38
4.5	HELP MENU	39
5	3D VIEW WINDOW.....	40
5.1	CAMERA MODE.....	41
5.2	PLAYBACK CONTROLLER.....	42
5.3	POSE EDIT MODE	43
5.4	INVERSE KINEMATICS MODE	48
6	PROJECT WINDOW.....	53
6.1	PREVIEWING ASSETS.....	53
7	TIMELINE	54
7.1	MOTION TRACKS.....	55
7.2	TIME.....	59
7.3	RANGE SELECTOR.....	59
7.4	STRETCH AND CROP.....	60
7.5	ZOOM IN/ZOOM OUT AND TIME INCREMENT COMBO BOX	60
7.6	TRACK MANIPULATION BUTTONS.....	60
7.7	EXTRACTION BUTTONS (OR “GRAB” BUTTONS).....	61
7.8	CHECKBOXES	61
7.9	TRANSITION TOOLBAR.....	62
7.10	JOINT LIMIT ERRORS TRACK.....	69
7.11	AUDIO TRACK.....	70

8	JOINT EDITOR.....	71
8.1	EDITING USING THE JOINT EDITOR.....	72
8.2	VELOCITY MODE.....	72
8.3	JOINTS AND LINKS.....	72
9	CAMERA WINDOW.....	74
9.1	DI-GUY SPACE.....	75
9.2	UNDERSTANDING THE CAMERA	75
9.3	USING THE CAMERA WINDOW	78
9.4	CHANGING THE CURRENT CAMERA SETTINGS	87
10	ACTION TABLE EDITOR.....	89
10.1	ACTIONS TAB.....	90
10.2	ACTION TABLE TAB	92
10.3	MOTION ARCS TAB	102
10.4	MOTION ARC EXTENDED INFO.....	103
10.5	ACTION TABLE CONFIGURATION FILES.....	111
11	GESTURE TABLE EDITOR.....	112
11.1	GESTURE TABLE SELECTOR	113
11.2	GESTURE PARAMETERS TAB	114
11.3	MOTION ARCS TAB, GESTURES TAB, GESTURE TABLE TAB	115
12	IMPORTING AND EXPORTING MOTIONS	116
12.1	IDEALIZED DATA.....	116
12.2	IDEALIZED DATA.....	117
12.3	IMPORTING BVH FILES	117
12.4	EXPORTING MOTIONS	117
12.5	GESTURES	120
13	HOTKEYS	122
14	GLOSSARY	125

1 DI-Guy Motion Editor

1.1 Introducing DI-Guy Motion Editor

DI-Guy Motion Editor is a graphical tool for creating, editing, and adding motions to the DI-Guy motion engine.

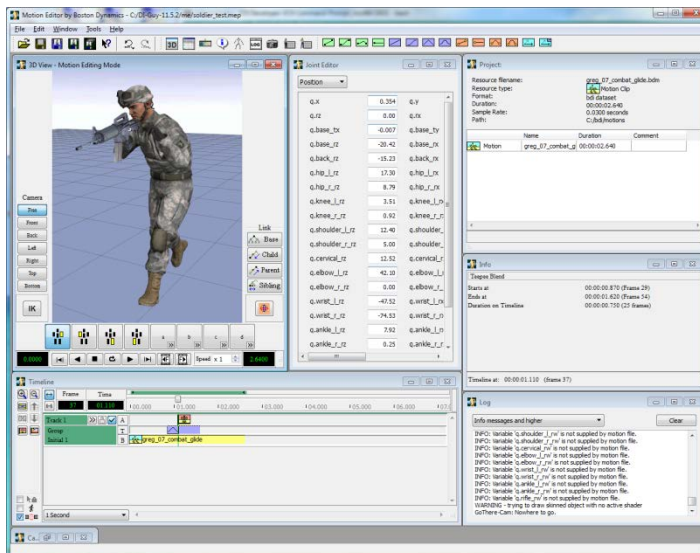
The tool allows users to

- load and edit motions from the *DI-Guy* motion library
- create entirely new motions from scratch
- import motions using the BVH format

The *DI-Guy Motion Editor* features a timeline-based editing tool for editing 3D human motion data and immediately reviewing the results. The editor features a number of blending and interpolation functions for rapid motion development.

Characters are displayed in a realtime 3D window and reflect the latest motion changes from the timeline. A forward kinematics and inverse kinematics based poser tool lets users directly manipulate the character to create new poses for the character to use for motion creation.

Using the Action Table Editor, users can integrate new motions into the DI-Guy motion engine and even create new actions. Once integrated, these new motions and actions are available throughout DI-Guy as if those motions were shipped with the product. All changes are stored in the custom directory, so custom motions can be easily propagated to other DI-Guy-enabled applications.



The *DI-Guy Motion Editor* including 3D Window and Timeline.

The Action Table Editor also lets you review the suite of actions used by the selected character in *DI-Guy* as well as the transitions between those actions. It is recommended that the DI-Guy Character Viewer is used as a final check on motion editing work.

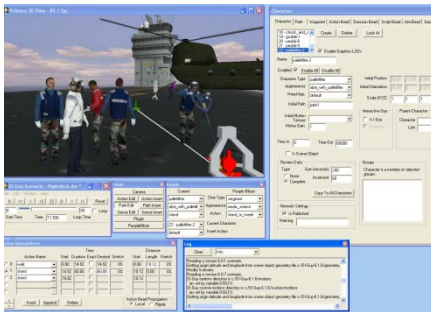
The *DI-Guy Motion Editor* is designed to customize motions for *DI-Guy SDK* and *DI-Guy Scenario*. Users of *Digital Biomechanics* can also use Motion Editor to create goal data.

1.2 The DI-Guy Product Line

DI-Guy Motion Editor is part of the DI-Guy Product Line, an integrated set of human simulation products. Members of the DI-Guy Product Line are designed to work together seamlessly:



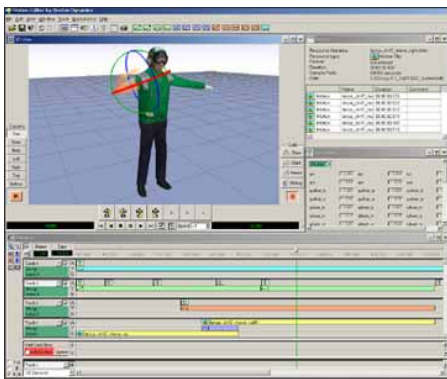
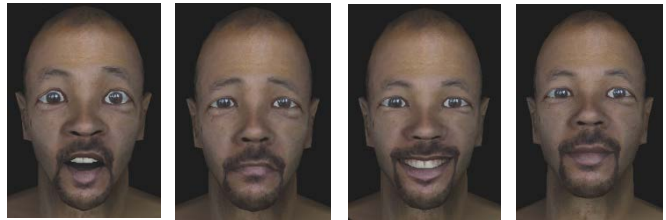
The DI-Guy SDK – embed the DI-Guy library in your real-time application and populate your world with lifelike human characters.



DI-Guy Scenario – author and visualize human performances in a rich, user-friendly graphical environment. Use DI-Guy Scenario as an end visualization application or save scenarios and load them into your DI-Guy SDK enabled application.

DI-Guy AI – generate crowds of autonomous characters to quickly populate your worlds with hundreds and thousands of terrain-aware, collision avoiding DI-Guys. Used as a module on top of DI-Guy Scenario and DI-Guy SDK.

Expressive Faces Module – enable DI-Guy characters to have faces that display emotion, eyes that look in directions and blink, and lips that sync to sound files. Not available on all SDK platforms. @@



DI-Guy Motion Editor – create or customize motions to your particular needs in an easy-to-use graphical application.

Networking Module – broadcast and receive DI-Guy characters using DIS or HLA. (DI-Guy Scenario only – note that DI-Guy SDK is also routinely networked, see the DI-Guy SDK User Guide on networking to find out how)

Special Effects – use an extremely versatile and customizable particle-based system to create smoke, fire, water, weather, explosions, dust trails, and other special effects. (DI-Guy Scenario only)

For more information about the DI-Guy Product Line, go to www.diguy.com or email us at diguy@diguy.com or sales@diguy.com.

1.3 Documentation

DI-Guy ships with multiple manuals explaining in detail the workings of the various parts of the product line.

- ***DI-Guy SDK User Guide*** – How to program using the DI-Guy SDK
- ***DI-Guy SDK Reference Manual*** – All the functions and classes of DI-Guy SDK
- ***DI-Guy Scenario User Guide*** – How to use DI-Guy Scenario
- ***DI-Guy Content Guide*** – How to customize DI-Guy models.
- ***DI-Guy AI User Guide*** – How to use DI-Guy AI.
- ***DI-Guy Motion Editor User Guide*** – How to customize DI-Guy motions
- ***DI-Guy for Vega Prime*** – How to use DI-Guy with Vega Prime
- ***DI-Guy Digest*** – XML-based file that explains DI-Guy content to non-DI-Guy applications

1.4 Digital Biomechanics

Digital Biomechanics is Boston Dynamics' physics-based simulation package designed to study human and robotic motion, control systems, and interactivity between humans and equipment using dynamic simulation.

For more information about *DI-Guy*, *DI-Guy Scenario*, or *Digital Biomechanics* visit our website at www.BostonDynamics.com.

1.5 Installing DI-Guy Motion Editor

DI-Guy Motion Editor is installed automatically as part of the DI-Guy product suite, along with *DI-Guy SDK* and *DI-Guy Scenario*, etc.

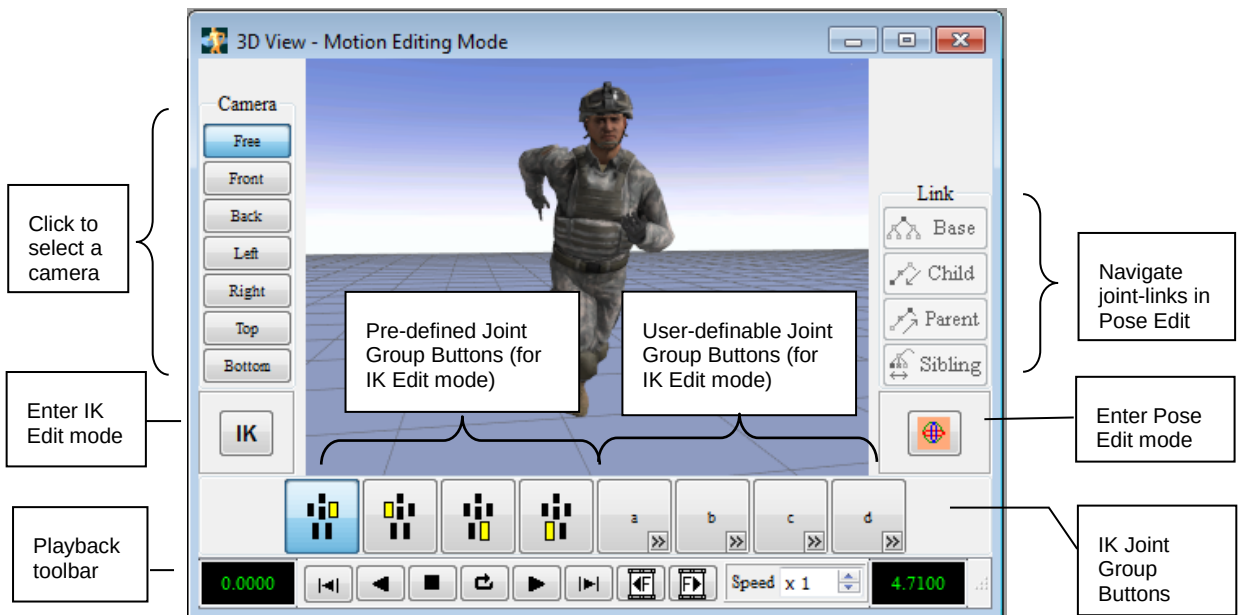
2 DI-Guy Motion Editor Windows Overview

DI-Guy Motion Editor uses a set of windows, each with a dedicated purpose, to provide an integrated environment for editing motions and actions. This section describes the *DI-Guy Motion Editor*'s menus and windows.

2.1.1 3D View

The 3D View shows the 3D display of the character. In this window users can work in several modes:

Camera mode	– to change to a different camera or view using the either the camera buttons or the camera-move, via mouse manipulation
Pose edit mode	– to edit a pose by moving a joint's DOF
IK edit mode	– to edit a pose by selecting a series of joints and links.
Playback controller	– to control playback of a motion on the Timeline



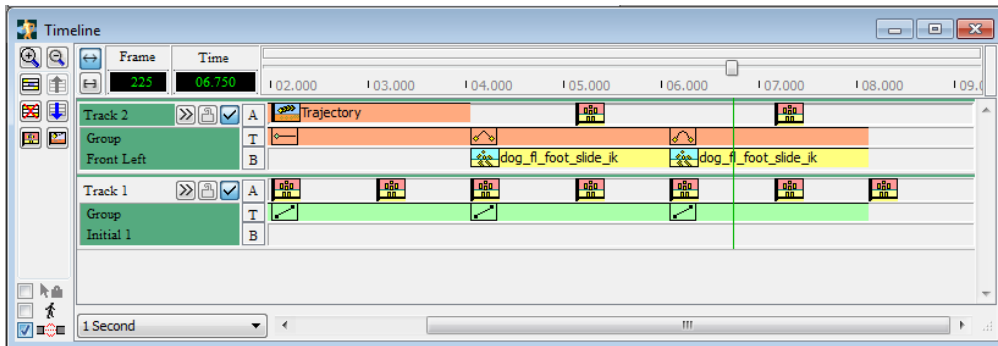
The 3D View Window

2.1.2 Timeline Window

The Timeline window shows graphically the current state of the motion being generated. To construct a motion, users organize motions, poses, trajectories, and transitions on one or more *Motion Tracks*. Motions for different parts of the body can be organized by using separate tracks.

Each Motion Track contains an A, B, and T channel. The A and B channels typically hold raw motion or pose information, while the T channel is used for transition information (e.g. – blend, interpolation, etc). There is no difference between the A and B channels, other than if data exists on both channels, the A channel data will be used in the absence of transition data.

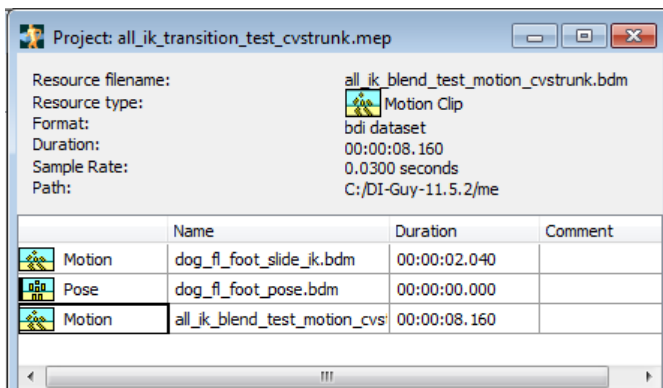
In the image below, seven poses are distributed on the A and B channels of Track 2. On the T channel, a cubic spline interpolation smoothly connects them together into one continuous motion. Clicking the play button on the 3D View window's playback controller starts the motion on the timeline.



Two motion tracks are being edited in the Timeline Window.

2.1.3 Project Window

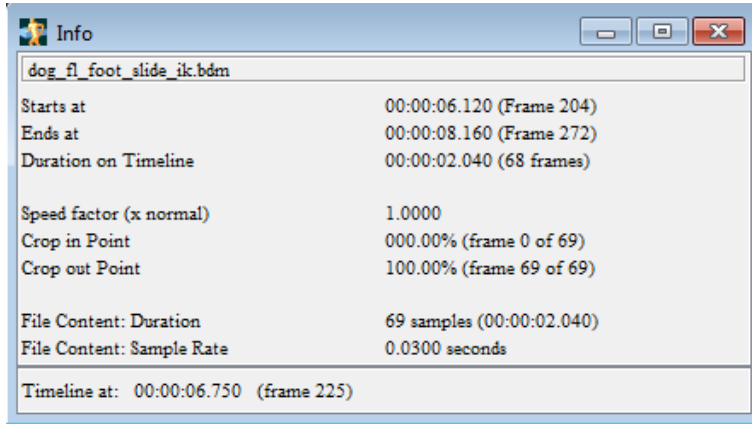
The Project window lists the *assets* currently loaded in the current project. Examples of assets include *motion clips*, *poses*, and *audio clips*. These assets are available to be dragged into the timeline.



Two motions and a pose are loaded in the Project Window.

2.1.4 Info Window

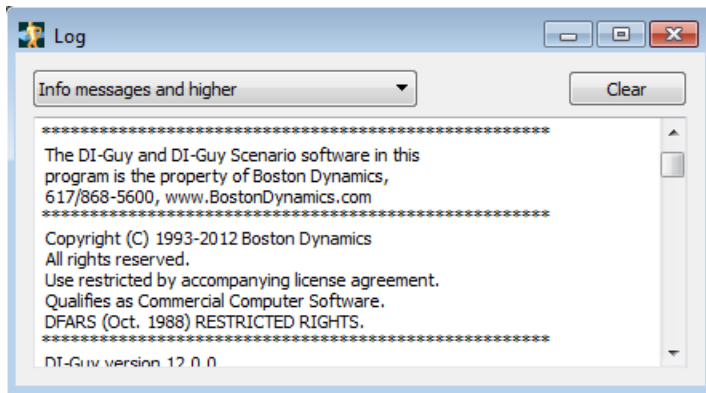
The Info window provides summary-level information about the selected motion, pose, or transition on the TimeLine. The example below shows data for a selected motion.



The motion file “dog_fl_foot_slide_ik.bdm” is detailed in the Info window.

2.1.5 Log Window

The Log window contains important messages, information, warnings, and errors about the current motion editing session. We recommend that users monitor the log window for messages that may indicate problems.

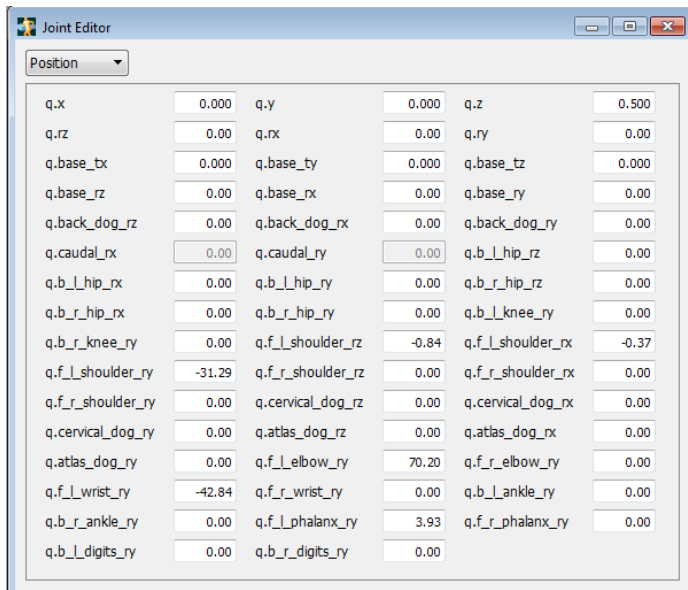


The Log Window

2.1.6 Joint Editor

The Joint Editor window allows users to see and (depending on the state of the Timeline) modify the current value (distance or angle) of each DOF (degree-of-freedom) of the character. In addition users can change the review mode from Position to Velocity to see the velocities of each DOF.

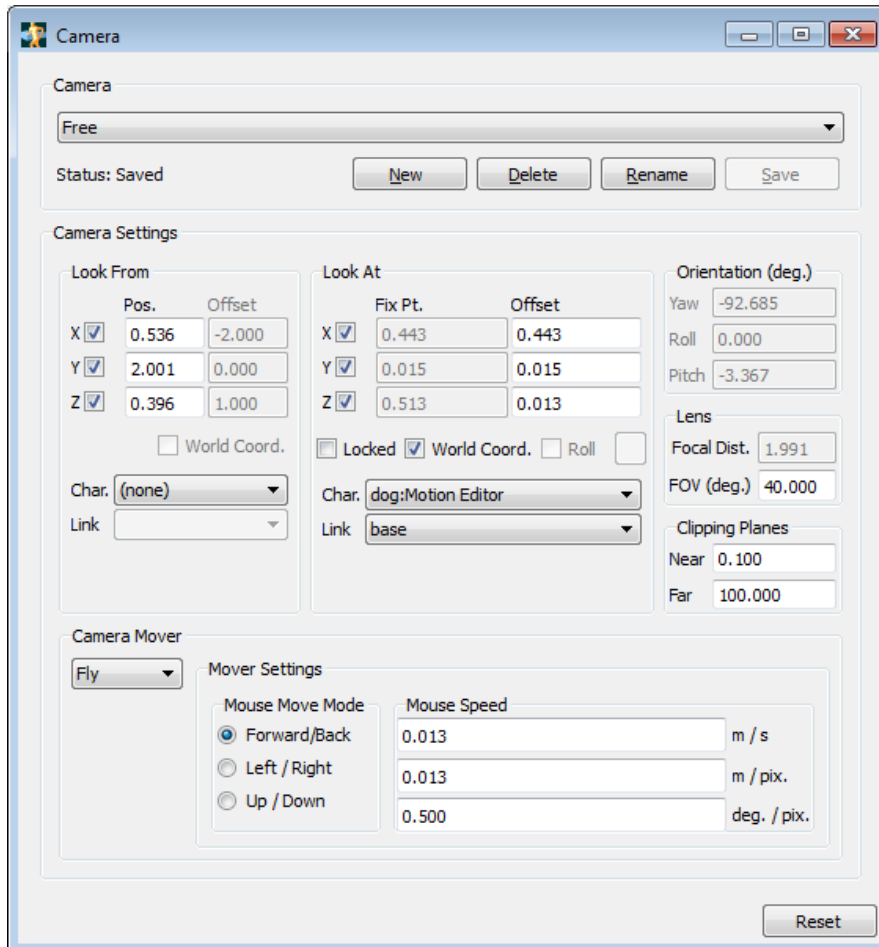
Review Mode	See values of each joint (in deg.) for the selected track at the selected time, when in Position mode. When in Velocity mode, one sees values for the joint's velocity (in deg. /sec.). Items shown in Red will be those that exceed set joint limits. In this mode, one also sees which joints are enabled or disabled for the currently selected track. Disabled joints are shown in Gray.
Pose Edit/Create Mode	to create or edit a pose, make sure the time cursor is at the desired frame and be sure to select the desired timeline Track, then type in a joint's value (users cannot edit Velocity, only Position) or use the Poser. A new pose will be created if none exist, otherwise, the existing pose will be modified.
'Offset Pose' Edit Mode	to edit an 'offset pose', which is a pose used by an Offset Effect or Offset Effect Linear, first deactivate all of the tracks except for the one containing the offset pose. Make sure it is the selected track before typing in the offset values.



The Joint Editor Window displays the current state of the DOFs of a character

2.1.7 Camera Window

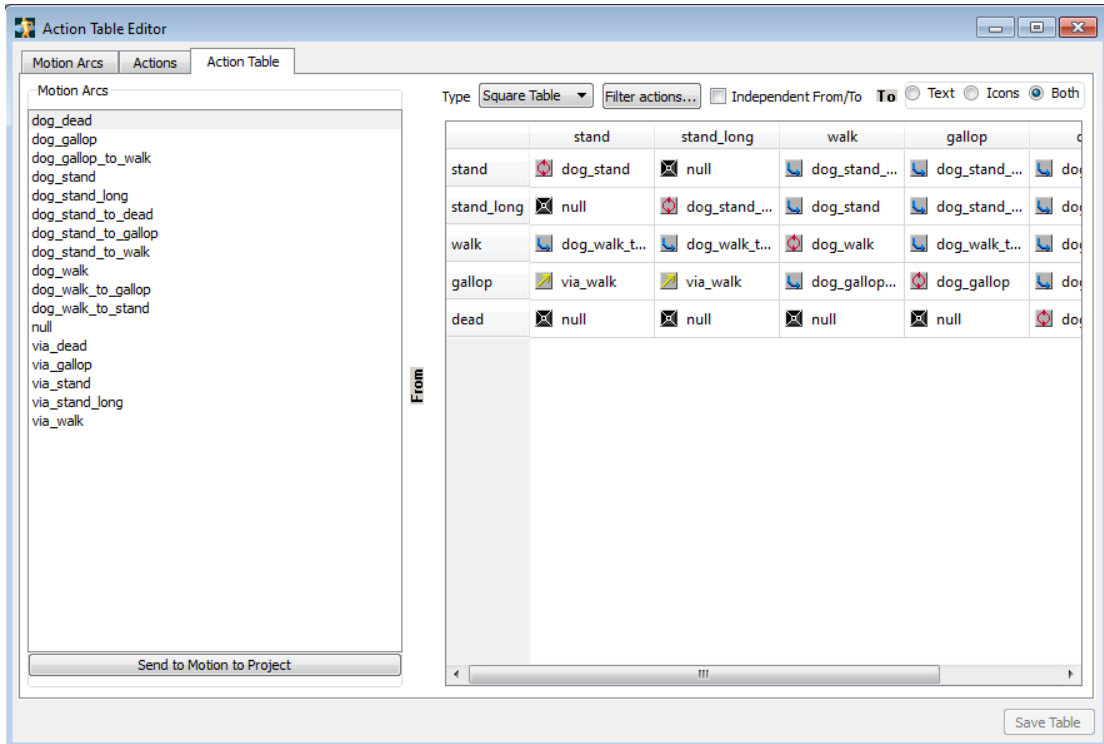
The Camera window allows users to manipulate, create, and view the cameras used in the Motion Editor. Cameras can both be set up and controlled in a number of ways.



The Camera window lets users view and set camera parameters

2.1.8 Action Table Editor

The Action Table Editor is used to create, modify, and review the actions and motions arcs used by DI-Guy characters. When the Action Table has focus, it takes over control of the character displayed in the 3-D window which is normally controlled by the Timeline.



The Action Table Editor with the “Action Table” tab selected

2.2 Command Line

Most users will start the Motion Editor directly from Start Menu→DI-Guy→DI-Guy Motion Editor. Motion Editor can be started from the command line as well. The command line arguments for starting DI-Guy Motion Editor are:

```
DIGuyMotionEditor -c character -a appearance -C filename.cfg -g -v filename.csv -p filename.mep -t ss -i filename.mec
```

- c *character*** Specify the character (e.g. -c soldier). Note that if -c is omitted, the motion editor will prompt with a list of characters and appearances from which to choose.
- a *appearance*** Specify a particular graphic appearance of the character. If you want to know what appearances are available, do not enter a character and the Motion Editor will prompt for a character and appearance. Select the character you want, and you will then see all of its available appearances.
- C *filename.cfg*** Specify the configuration file to be used. (e.g. -C me\btime.cfg). If not specified, diguy.cfg is used. Configuration files specify the available characters, appearances, and skeletal information.
- v *filename.csv*** Specify a .csv filename to be used for motion export. (e.g. -v output.csv)
- p *filename.mep*** Specify a project file to be loaded (e.g. -p projects\myproject.mep)
- t *ss*** Specify dt for the motion editor in seconds (e.g. -t 0.03). All output motions will use this dt between frames (so it determines the data frame-rate)
- i *filename.mec*** Specify a camera/IK settings file (e.g. -i mycamerasettings.mec)
- g** Specify generic character (-nodiguy automatically implies this)
- nodiguy** Specify a non-DI-Guy character (usually a Digital Biomechanics character). Non-DI-Guy characters do not have action tables associated with them.
- notools** Specify that the “Menu→Tools” options are not presented.
- noaudio** Specify that the Audio Track and audio-related features are not displayed
- nojointlimit** Specify that the Joint Limit Track is not displayed
- noik** Specify that IK-related features are not displayed

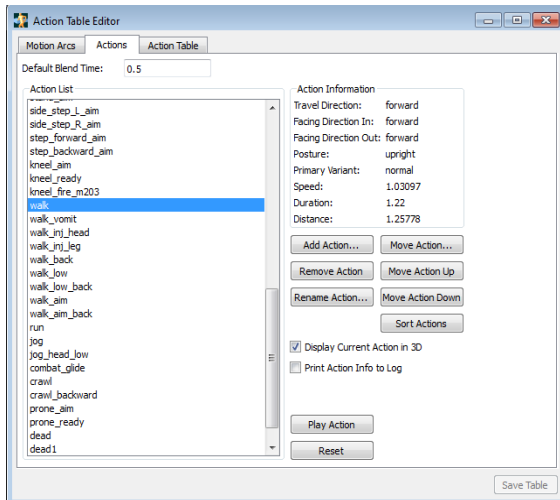
3 Quick Start Tutorial

This section demonstrates a typical session using DI-Guy Motion Editor. Details on features are in later sections of this manual.

3.1 Review Action Table of a character

Start the motion editor and select soldier_07 as the character type. If the Action Table Editor is not visible, use the “Window→Action Table ...” menu option to show it.

NOTE: Non *DI-Guy* users who use characters without action tables should go to step 2.2 to continue the tutorial.

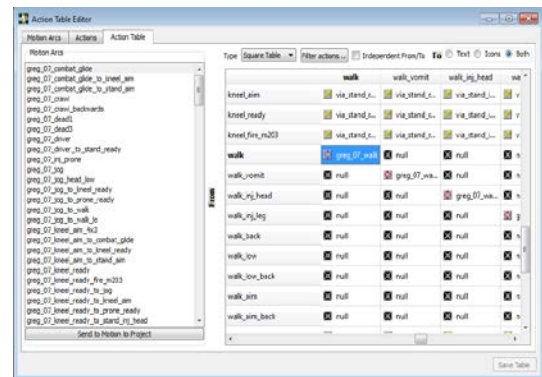


In the *Action Table* tab, most DI-Guy character types will display a “square table”. The square table describes which motions are played when moving from one action to another. The “from” action is described horizontally while the “to” action is described vertically. Note that the cells along the diagonal from upper left to lower right are addressed by the same action name both vertically and horizontally (e.g. – *From walk To walk*) and indicate the looping motion used by that motion. The contents of the action table, including the table size and the names of the motions shown, are specific to each character type.

In the *Actions* tab, double-click “walk” in the Action List. The soldier will start walking in the 3D View window. Click the “Reset” button to put the character back at the 3D origin. Double-click on other actions to see them play. Note that using this method one can not only review the looping motions that make up the action, but also the transition motions that get played when going from one action to a different action.

The Action tab is highlighted in the Action Table Editor.

Below, the Action Table tab is selected.



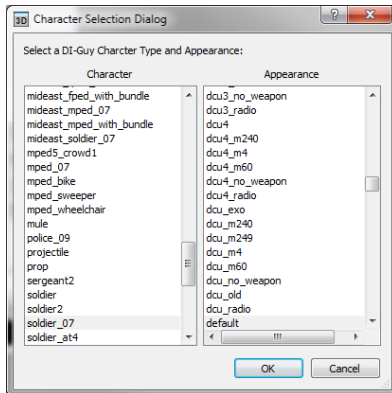
3.2 Playing a Motion on the Timeline

This section of the tutorial shows how to load a motion into a project and play it on the timeline.

3.2.1 Create a New Project

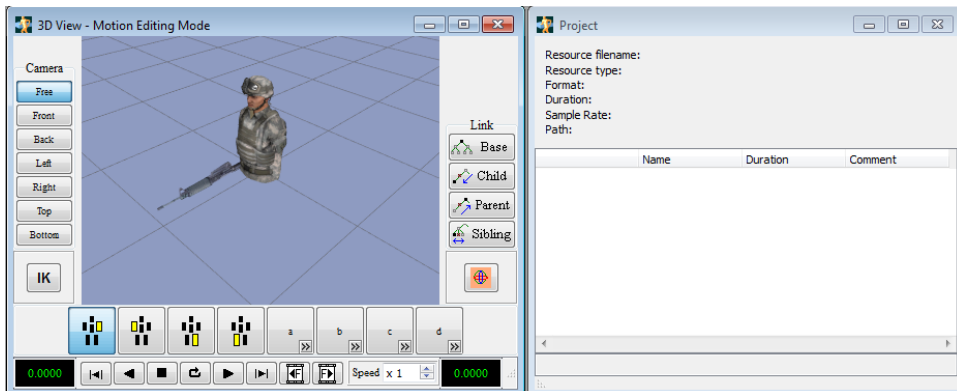
When DI-Guy Motion Editor is first opened, by default, the software asks to select a character and appearance, and then it opens a new project with that character and appearance as the working actor.

For this exercise, use the default character and appearance.



The “Character Selection Dialog” with defaults selected.

In a new project, the character’s zero pose is derived from the configuration file (diguy.cfg) and the Project window is empty.



The 3D View & Project Window of a new project with defaults accepted

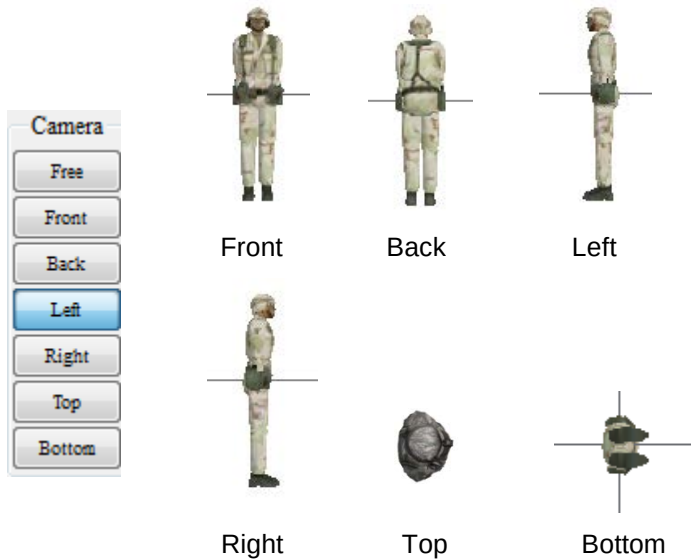
By default, a new character's origin is (0,0,0). The XY grid penetrates the character at the origin of its base joint (center of the hips) (See more information on this in Pose Edit Mode.)

Please note that the 3D View receives its input for how the character is posed from one of three sources: The Timeline, the Action Table Editor, or Motion Preview. Whichever of these widgets last had mouse focus controls the 3D View.

In this section's tutorial, the Timeline should have control of the 3D View, so please select the Timeline window to give it control.

3.2.2 Using the Default Camera Buttons

1. Click each camera button to see the default cameras provided. The character will be seen from the front, back, left side, right side, top, and bottom respectively.
2. Click on the Free camera button again to return to the first position.



3.2.3 Zoom and Rotate the Camera with the Mouse

Mouse clicks, presses, and drags can work differently based on the settings of the camera being used, as specified in the Camera Window. See the Camera Movers Section for specifics. The descriptions below presume that a “Fly” camera mover with the “Free” camera selected.

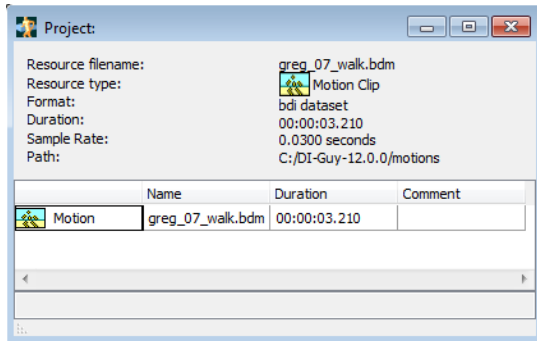
1. With the Free button still selected, position the cursor in the 3D View window and press the left mouse button. The camera zooms in.
2. Press the right mouse button to zoom out.
3. Press and hold both buttons and drag to rotate the camera around the character. The camera tracks the character so you can't get lost.

3.2.4 Load a Motion into the Project

1. Select File → Import → Motion/Pose ...
2. Navigate to the DI-Guy\motions directory. (the default start place)

3. Set file type to DI-Guy Motion to see all the files in this directory with the file extension .bdm.
(This should already be set by default)
4. Select the motion greg_07_walk.bdm.

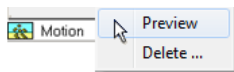
The motion file is placed in the list of assets in the Project window and a preview of the motion is offered. An asset can be a motion, a pose, or an audio clip. An asset can be dragged into the timeline.



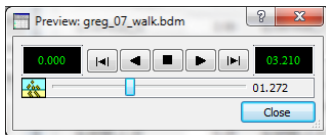
The Project window after motion “greg_07_walk.bdm” is imported

3.2.5 Preview the Motion

1. Right-click the motion and click Preview.



2. Click the play button on the Preview player.

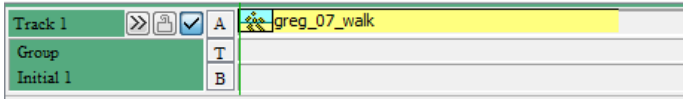


3. The motion is played in the 3D View window.



3.2.6 Drag-and-Drop the Motion onto the Timeline

1. Click and drag the motion into the left end of Channel A in track 1 in the timeline. Note that channels A and B are designed to hold motions and poses, while the T channel is for transitions (discussed later). The A and B channels lets overlapping motions be used as input. Without transition information, data in the A channel will override data in the B channel.



Screen-grab of an enabled track holding “greg_07_walk” motion in the Timeline Window in the A track channel

2. Use the magnifying glasses button (found on the Timeline) to zoom in (+) and out (-)



3. Zooming in decreases (+) and zooming out increases (-) the interval between the tick marks on the timeline.

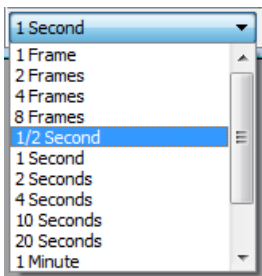


Zoomed in (+), decreased



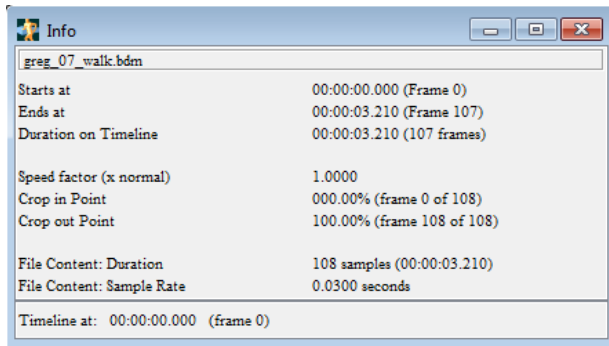
Zoomed out (-), increased

4. Click the interval pull-down to see possible intervals between tick marks.



A *pose* is defined as a single frame while a *motion* is defined as one or more frames. The amount of time between each frame is equal to DT (delta time). The DT is set in File → Preferences → Motion Editor DT.

5. With the motion selected, click windows → Info to see the Info window if it's not already visible. (If the window is minimized, clicking windows → Info twice displays it.)



The Info Window with motion “greg_07_walk.bdm” selected

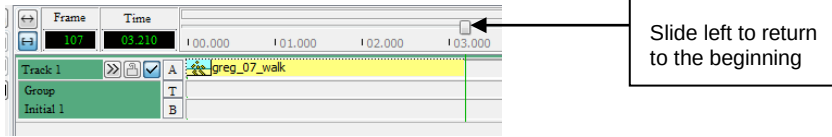
The Info window details the position of the selected motion is in the timeline (in this case, it starts at frame 0), whether it is scaled or cropped, and the original file-content duration (3.210 seconds) and sampling frequency (0.03 seconds/sample = 33.3 Hz). The last line tells where the Time Cursor is currently set in the timeline (frame 0).

3.2.7 Play the Timeline

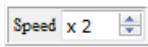
1. Click the play button on the 3D View window (the button that looks like “▶”)



2. Watch the soldier perform the motion. Notice that the joint values change in the Joint Editor window as the motion is played
3. Rest the cursor for a second on each button and read each tool tip.
4. Experiment with the playback controllers:
 - Click Home  to go back to the beginning of the motion.
 - Click Play  again and, before the motion ends, click Stop  to stop the motion.
 - Click Play Reverse  to play the motion backwards.
 - Click Forward One Frame  to advance the motion by a single frame and Back One Frame  to reverse by a single frame.
 - Click End  to skip to the end.
5. Drag the timeline slider back to the left and watch the motion reverse.



6. Click Cycle  to have playback loop repeatedly over the time range.
7. While the motion is replaying, press both mouse buttons and circle the mouse to move the camera around.
8. Click each camera button in turn to see the motion from different cameras.
9. Press the right and left buttons to zoom in and out.
10. Click the up/down arrows on the Speed control to speed up or slow down the motion.



3.2.8 Save the Project

1. Click File → Save Project.
2. Enter the name Tutorial and click Ok.

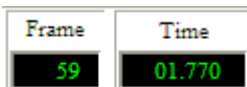
3.3 Blending a Pose into the Motion

One way to create a new motion is to modify an existing motion. A common technique is to modify the pose of the character somewhere during the motion and then blend that pose change with the original motion to create a final smooth motion. The new motion will look like the old motion except for the region that was blended. This tutorial steps through this procedure.

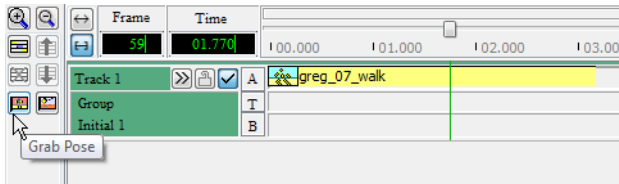
3.3.1 Extract a Pose

We are going to extract a pose from a motion and modify it so that the soldier is waving.

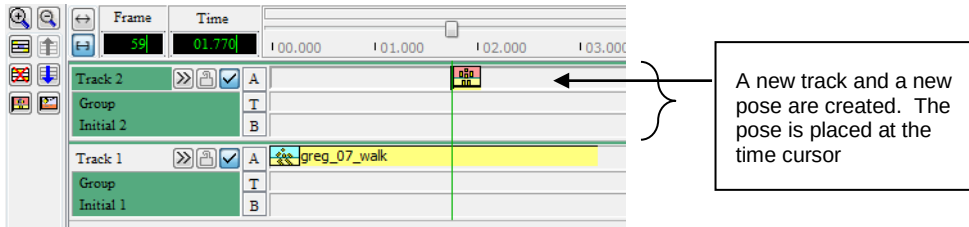
1. Drag the timeline slider till you find a place where you want to create the modified pose. For this tutorial, we will put the wave at frame 59. The current frame is shown both on the Timeline (see below) and on the bottom line in the Info Window.



2. Click the Grab Pose button on the timeline. 



In this case, a new motion track (Track 2) is automatically added, and then the character's current pose is grabbed and displayed at frame 59 on the new track.



By default, any newly created track will have all of the joints enabled. Selecting and de-selecting joints is described in the Joint Group Asset section later in this document. The track's Joint Group Asset determines which joints are controlled (enabled) by a track.

Tracks can be created and deleted by users as needed.

The newly created pose is not a project “asset” in this case (notice that it's not shown in the Project Window) because it exists only internally to the project that is currently being working on. It's called a “runtime” pose because of this.

Poses contain a single, constant, snap-shot of every joint value (the position of a joint) for all joints of the current Motion Editor character.

3.3.2 Use three different methods to modify the pose (IK, Poser, Joint Editor)

This section presents three different methods that users can employ to modify the pose of a Motion Editor character for any given frame on the timeline.

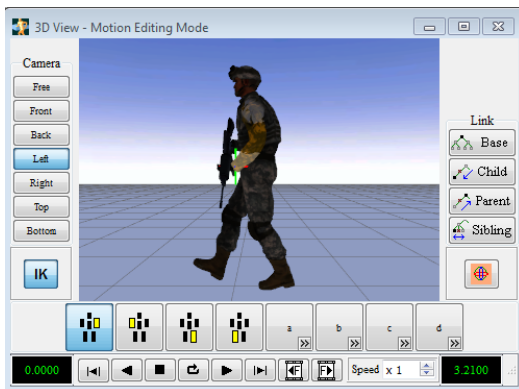
Modify a Pose using Inverse Kinematics (IK)

Inverse kinematics use kinematic equations to determine possible joint values that satisfy a resultant desired position and orientation for the “end effector” (or the last link) of a joint-link assembly.

1. Click the Left camera so that the soldier’s left arm is accessible. If necessary center the character on the screen (using the mouse in the 3D View window).

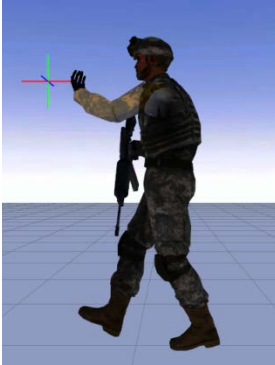


2. Click the IK button.  Also click the left arm IK button.  Both buttons are shown selected below. The character’s left arm should highlight and an IK cursor (green and red cross marks) should display. Other IK buttons activate other pre-defined body limbs of the character.



The 3D View when the Left camera is selected and IK is editing the left arm.

- Click and drag the mouse so that the left hand (which tugs on the left arm) is in an up position. Several of the values in the pose being edited will change. Notice that the corresponding values for those joints in the Joint Editor Window also change as the mouse is moved. These values are being stored in the pose on the timeline each time the mouse moves.

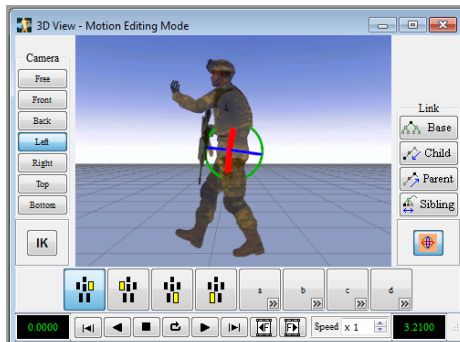


3D View during IK edit of the left arm.

You have now used inverse kinematics to alter the pose of a character. In this example, the hand was the end effector and the joint-link assembly (or chain) was the left arm. We will show you how to blend a pose with a motion in an upcoming section. You can exit IK edit mode by toggling the IK button between the on and the off state.

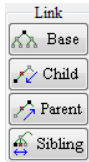
Modify the pose using the Pose Tool

- Click the Pose Edit button.  Notice that the entire character is highlighted with the “*posing gizmo*” located at the character’s base.

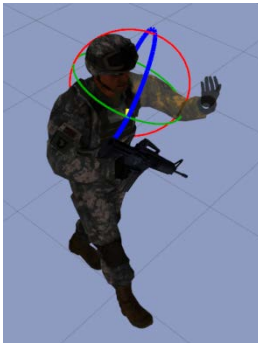


3D View when the Pose Tool is activated. The base is selected.

2. Switch the camera to the Free camera (). Note that when in the Pose Tool, one must hold the Alt key down in order to engage the Camera mover. Hold the Alt key down and practice moving the camera while in Pose mode.
3. Next, we want to locate the Pose Tool's gizmo on the left shoulder. Either shift + left-clicking on the left arm (which is quick) or using the poser navigator buttons to move the gizmo through the character's joint space (which can be slow, but more precise).



The poser navigation buttons, which can be used to move the poser gizmo through the character's skeletal hierarchy. The buttons will grayed out when they are not applicable. The 'Base' button is always applicable.



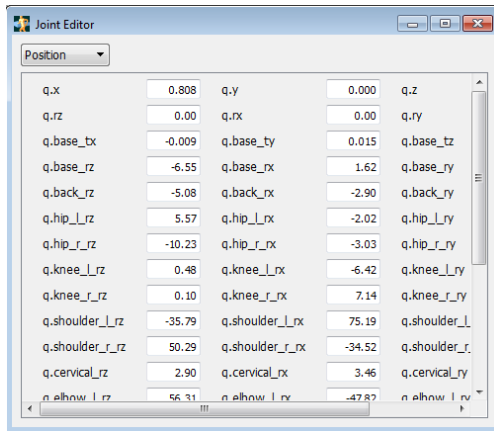
The 3D View when the left shoulder is selected. In this image, the blue DOF is selected.

4. When the poser gizmo is located at the joint that for editing, refine the selection of the joint's DOF. Cycle through the available DOFs using the space bar or alternatively shift + left-click to select via the mouse the different circles (representing the joint's *degrees of freedom*, or DOF) of the poser gizmo. Note that in the Motion Editor the x-axis DOF is rendered red, y-axis DOF is shown in green, and the z-axis DOF is displayed in blue.
5. Now grab the highlighted circle and mouse-drag it to change the joint's value. This action changes the value of the joint and stores the new values inside the pose being edited. Alternatively, use the "+" and "-" keys to change the value of a DOF without moving the mouse. Further, holding down the shift key while using the "+" and "-" keys increases the amount of change for each key presses. You have now successfully altered the character's pose using the Pose Tool. How to blend a pose with a motion is described in an upcoming section.

Modify the pose using the Joint Editor

1. Change the numeric value of any degree-of-freedom (DOF) by activating the Joint Editor Window and entering in a new value for the DOF. Remember to press the Enter or Tab key after typing in the new value to have the change take effect. Changes to DOFs in the Joint Editor will be stored in the active pose, so it's important to notice which motion track is active and where the time cursor is, as that determines which pose will be changed.

The “Position” combo-box in the upper left corner of the Joint Editor window indicates that the joint values are displayed. Joint variable names that end with “tx”, “ty”, or “tz” indicate translation in meters along the local x, y, and z axes. The base joint of all characters contain these variables. Joint variable names ending with “rx”, “ry”, and “rz” indicate rotation in degrees about the x, y, and z axes.



The Joint Editor window in Position view/edit mode.

3.3.3 Blend the Pose into the Motion

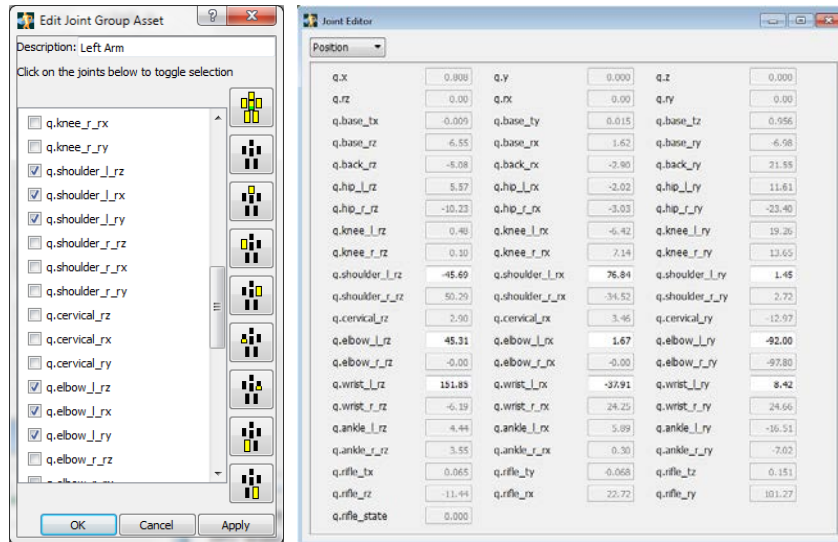
When a motion is played on the timeline, notice that the new pose we’ve created has no effect, except on frame 59. That is because for every frame, the timeline gets the data from the greg_07_walk motion, except on frame 59 where it gets the data from the new pose.

The following steps will allow us to blend our new pose into the walk motion. After the blend, the effects of the pose will be spread out across several frames, resulting in a smooth, natural appearing motion.

1. Let’s have Track 1 control all the joints and have track 2 control only the left arm. Track 1 already controls all joints, so there’s nothing to change on Track 1.

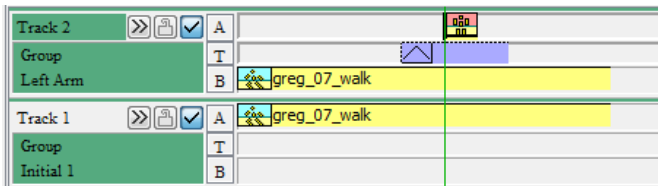
To access the joint group asset for Track 2, either click the  button on Track 2 or right-click on the larger green square of Track 2. Select “Joint Group Asset ...” and the Joint Group Asset editor dialog will appear. Use the editor to make this track affect only the left arm by first turning all the DOFs off (see description of buttons below) and then selecting the left arm joints. The buttons on the right-hand side of the dialog allow for pre-defined DOF groups to be toggled on and off.

2. While editing the joint group, change the *Description* field of the joint group, setting it to be “Left Arm” (as shown below) to help remember Track 2’s DOF responsibilities. Exit the dialog box by clicking OK. Notice that the Joint Edit window now has several gray joints values.



The Joint Group Asset (JGA) dialog (left) and Joint Editor window (right). The JGA Description text has been changed to “Left Arm” and only the left shoulder variables are selected (see checkboxes). The Joint Editor has most variables grayed out because Track 2 now only controls the left arm.

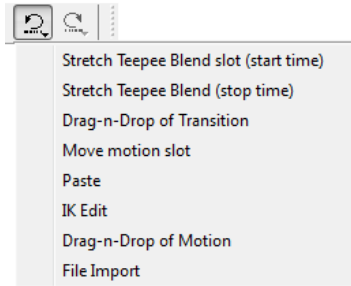
- Copy and then Paste greg_07_walk from the A channel of Track 1 to the B channel of Track 2 by right-clicking on greg_07_walk and using the Copy pull-down menu. Next, drag a Teepee Blend  from the Transition toolbar into channel T (Transition) of Track 2. Place it in a position where it is centered directly underneath the pose.



- One can move or stretch the ends of the purple transition rectangle using the mouse. Explore moving and resizing the transition and observe the results in the 3D View when the timeline is played. You have now successfully created a waving motion built on top of the original greg_07_walk. Later, you’ll learn how to save this motion and incorporate it into the Action Table.
- If Track 2 is deactivated (unchecked), the old motion can be reviewed to see the difference.
- Reactivate track 2 and click File → Save Project to save the project.

3.4 Undo

The Motion Editor includes undo and redo functions. Most functions including loading, moving, and editing can be undone and redone. Ctrl + Z and Ctrl + Y will undo or redo the most recent change. A menu of undo and redo items is available on the Main Menu Bar (see below)



In the undo menu shown above, clicking the topmost item undoes the last motion, a Stretch Teepee Blend slot (start time). Clicking File Import, the oldest motion in the list, also sequentially undoes the other activities in the list. When an item is selected, the Motion Editor will briefly redraw itself after completing the undo/redo.

3.5 Edit Functions: Cut, Copy, Delete, Paste, Edit

Cut/paste, copy/paste, delete, and edit functions are generally available for any asset placed in the timeline. To access them, right-click on any asset.

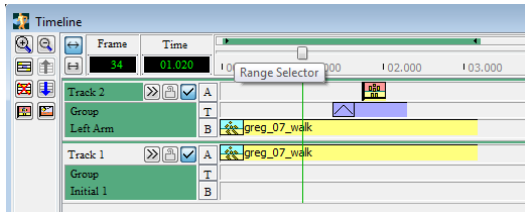
To paste a motion, pose, trajectory, or transition once it has been cut or copied, right-click the track and destination channel for the paste.

Selecting Edit brings up a dialog box that allows direct modification of values.

3.6 Export a Motion from the Timeline

3.6.1 The Range Selector

We will now export the motion from the Timeline. DI-Guy uses a convention for a cycle of walking that starts and ends the loop when the right foot passes the left. For our motion, the walk loop starts at frame 34 and ends at frame 86. The Range Selector at the top of the Timeline is used to define non-default start and stop times for a motion. Double-click in the range selector area to switch it from default mode to input mode (it will change from gray to green with arrows at each end).

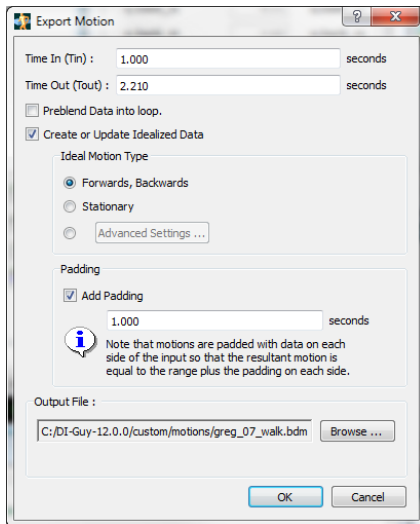


The Range Selector is shown as a green bar with arrows at each end

Drag each end of the range selector: one to frame 34 and one to frame 86. Play the motion in the 3D View; it will now play the range selected region of the timeline only.

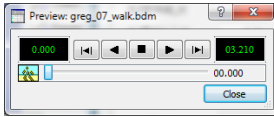
3.6.2 Export

1. Use the File→Export→Motion command to export the motion. It launches the “Export Motion” dialog. Use the defaults that the system calculates for Time In, Time Out, and Idealized data. Use the Browse... button to output to the %DIGUY%/custom/motions directory as shown below. Note that by outputting the file in a custom directory there is no risk of overwriting the original motion data file, while also making the changes more portable to other systems.



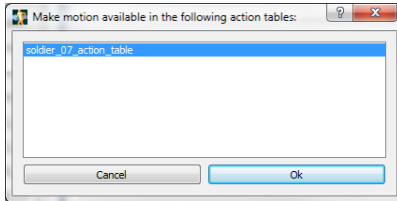
Export Motion dialog with defaults.

Press OK to export the motion. You should now see an option to preview the motion that was exported, if you press the play button (▶) it will show the motion in the 3D view. Close the dialog when you are done to continue with the motion export process.

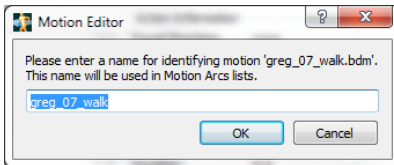


The preview pop-up dialog

After export, Motion Editor offers the option to place the motion in an Action Table. Press OK. Canceling will leave the exported motion as file in the directory previously selected, but it will not store it in an action table.



If Ok was selected in the above dialog, the new motion should now be part of the Action Table. If the Motion Editor asks to update **t-in** and **t-out** for motion arc greg_07_walk, answer “Yes.” The Motion Editor will ask for the name of the motion arc using this motion. Please take the default for this example, so that the file will be found and re-loaded. Motion arc “greg_07_walk” is used by the “walk” action in the Action Table.

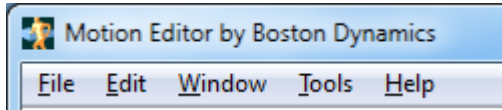


2. Open the Action Table Editor. In the Action Tab, double-click on “walk” in the table. The soldier will start walking, and you should see him wave. This allows the user to demo the new motion and motion transitions before exporting them to DI-Guy.

Note that this modified motion arc and action table will not be saved as part of *DI-Guy* unless the “File→Save Action Table” menu option is selected. Delete motions, such as greg_07_walk.bdm from the custom/motions directory in order to return to the default *DI-Guy* functionality

4 Menus

This section contains brief explanations of each menu item.



Screen-grab of the Menus of the Motion Editor

4.1 File Menu

File menu commands are described in the table below:

Item	Function
New Project...	Creates a new project. If a project is currently open, it is closed. A project stores all the information about the composite motion being constructed, such as tracks and assets.
Open Project...	Opens a project file. (If a project is already open, it is closed).
Close Project	Closes the current project. The timeline is cleared.
Save Project	Saves the current project.
Save Project As...	Saves the current project under a new filename, which has a .mep file extension.
Save Action Table	Saves all alterations made to the character's action table.
Save Current Gesture	Saves the alterations made to the gesture being edited (or last edited).
Save All Gestures	Saves all alterations made to the character's gesture table.
Import ►	(described in a following table)
Export ►	(described in a following table)
Exit	Exits DI-Guy Motion Editor.

Import and export options are described below:

Item	Function
------	----------

Import Motion or Pose...	Loads a motion file into the Project window. Motion files can have one of three file extensions: .dat (Boston Dynamics Data) or .csv (comma separated values) or .bdm (Boston Dynamics motion). A <i>pose</i> is a motion with only one frame of data. A motion or pose can be dragged from the Project window to the A or B channel of a timeline motion track. Note than when a motion is imported, it will be resampled to the DT used by the Motion Editor.
Import Audio ...	Loads an audio file in the .wav format into the Project window. An audio file can be dragged from the Project window to the audio track of the timeline. This option may be hidden if the Motion Editor was started with the <code>-noaudio</code> command line flag.
Import Project ...	An entire project can be imported into the current project. The tracks from the imported project are appended to the current tracks and any new assets are added into the Project window. The DT of the current project is maintained and all data is quantized to match the current project DT. Imported projects must match the character type of the existing project. (See also the “Open Project ...” menu command)
Export Pose ...	The pose as represented in the timeline at the current time is output. The output file format can be either .data or .csv.
Export Motion ...	The motion as represented in the Timeline is output. The start and end of the motion is designated by the Range Selector. The output format can be either .bdm, .data, or .csv. Exported motions use the Motion Editor frame rate (determined by DT). They also have idealized data that is very important to DI-Guy. See the chapter on Idealized Data in order to learn how to set these idealized data options properly.

Load and save IK settings are shown below:

Users often have particular camera and IK settings they want to reuse on different projects. The load/save camera/IK settings feature allows users to save and load these settings. The saved file has a .miss suffix. Note that the file is character-specific, therefore a different .miss file is required for each one.

Item	Function
Load Camera/IK Settings	Load a saved camera/IK settings file (.mec).
Save Camera/IK settings	Save the current camera and IK settings to a file. The file contains user-defined IK buttons (initially named “a”, “b”, “c”, and “d”) and any camera changes made.

Users preferences include:

Item	Function
Motion Editor DT	Set the DT for the Timeline. A frame in the Motion Editor is exactly one DT long. All motions, poses, and transitions start and end on the frame boundaries that are exact increments of DT.
Configure World ...	Customize the settings for sky, floor, grid, and the coordinate system as seen in the 3D View window.
Configure Transition Toolbar ...	Customize which transitions are visible in the Transition Toolbar by activating the dialog box from this selection.
Project Local	Enabling project local option will force all external assets associated with the project, including the project file itself, to all be copied into a single directory. This allows for easy copying of a project from one machine to another. Users are prompted when project local is enabled for the destination directory. Once project local is enabled, new external assets are automatically placed in the project local directory.
Augment Export with Velocities	This preference forces the output of velocity variables along with the state variables during an export. This is particularly useful when working with Boston Dynamics simulations that may use motions constructed with the Motion Editor as goal files.
Issue warnings for out-of-reach IK Trajectories	It is sometimes useful to know whether trajectory goals are reachable. This option shows warnings indicating whether a simple test has shown that the desired goal trajectory point is reachable. Note that the lack of an error does not mean that the desired goal trajectory is reachable, as the reachability test is limited and does not take into account joint limits and more complex aspects of inverse kinematics.
Output Text Datasets	Indicates whether .exported motion files will be ascii or binary. Binaries are much smaller. ASCII can be viewed in a text editor.
View Level Of Detail	Automatic adjustment to the level of detail shown of a character may depend on its distance to the observer. This feature is enabled/disabled using this option. More distant objects will appear with fewer details than closer objects.
Automatically preview exported motions	Verify output visually. This uses a pop-up preview dialog that allows control of the preview.
Exit	Exits DI-Guy Motion Editor.

4.2 Edit Menu

Edit menu commands are described in the table below:

Item	Function
Undo 	Undoes the previous action. Almost all Motion Editor functions can be undone. Multiple undos can be performed in one operation as well.
Redo 	Redoes an action that was previously undone. Any undone action can be redone. Multiple redos can be performed in one operation as well.
Cut 	The active asset(s) on the Timeline is deleted from the timeline but copied to the clipboard.
Copy 	The active asset(s) on the Timeline is copied to the clipboard.
Paste 	The asset(s) on the clipboard are copied onto the Timeline.
Delete 	The active asset(s) on the Timeline are deleted.

4.3 Window Menu

The Window menu toggles the display of the following windows, and supports cascade and tile.

Toggles Display of the Window	Function of Window
3D (Ctrl+D) 	View and animate 3D images of the character performing motions.
Project (Ctrl+P) 	View the assets currently loaded into the Motion Editor
Timeline (Ctrl+T) 	View and arrange the assets on a user-friendly timeline.
Info (Ctrl+I) 	View information pertaining to the active asset.
Joint Editor (Ctrl+J) 	View and modify the current state of all the DOFs of the character.
Log (Ctrl+L) 	View messages from the Motion Editor
Camera window (Ctrl+K) 	View and modify camera settings.

Action Table Editor (Ctrl+A) 	Play and Edit Action Table.
Gesture Table Editor (Ctrl+G) 	Play and Edit the Gesture Table
Cascade	Arranges the windows into a cascade (descending and overlapping).
Tile	Tiles the windows on the Motion Editor main window so that they are all displayed.

4.4 Tools Menu

Tools menu commands are described in the table below. Note that this menu may be hidden with the “-notools” command line argument when the motion editor is started up.

Item	Function
Joint Limits...	This function activates a joint limit dialog. The joint limit dialog shows the start and end limit of each DOF as well as maximum velocity for the model. Joint limit files can be saved and loaded from this dialog box. Joint Limits are used in Inverse Kinematics and in Compliance Reports. Note that angles are expressed in degrees and velocities are expressed in degrees/second.
Joint Limit Error and Stream Update Report – File ...	The timeline results are tested for each frame to verify that: • All DOF velocity values are within velocity limits • All DOF positional values are within the joint position limits • All DOF values are specified on the timeline for every frame. The data is output to a file chosen by the user.
Joint Limit Error and Stream Update Report – Log Window	This command is the same as the above command except that the report is sent directly to the log window, instead of to a file.
Time Offset	Users can offset all of the assets in the active track or in all tracks, starting at a specified frame. The offset can be in either the negative or positive direction. There are some restrictions regarding the state of the assets on the tracks that might prevent a successful time offset, such as a starting time that is spanned by a motion, particularly if a negative time offset is requested. Helpful error messages should indicate what violations, if any, the system has detected when testing to see if the time offset can be performed. In addition to repositioning the affected assets, the system attempts to extend and shrink transitions (if needed)

	so as to maintain continuity.
--	-------------------------------

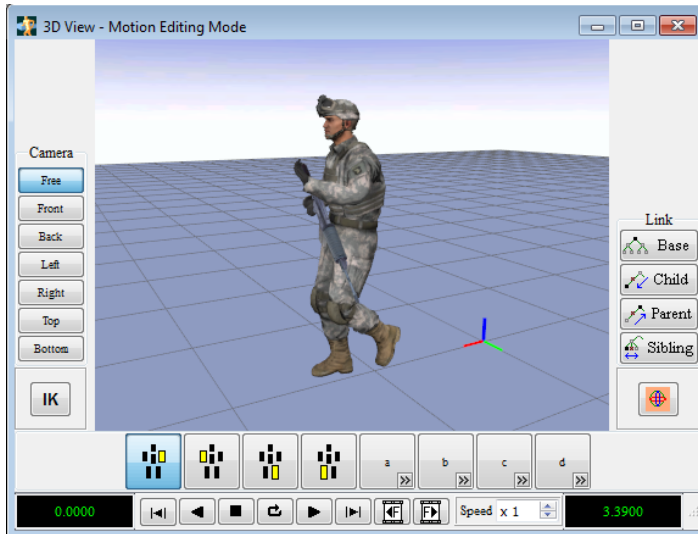
4.5 Help Menu

Help menu commands are described in the table below:

Item	Function
Help	View this document online.
About	Version information about the Motion Editor software.

5 3D View Window

The 3D View window provides a 3D display of the character.



In addition to this graphical display, the 3D View window accepts mouse clicks and drags that allow users to interact with the image. Users interact with the display in three modes:

1. Camera Mode
2. IK Mode
3. Pose Edit Mode

Users can also manipulate the camera view in three ways:

1. By using the buttons along the left
2. By using the Camera window
3. Or by dragging the mouse in the 3D image. The camera movements are determined by the settings in the Camera window.

Users can perform *Inverse Kinematics (IK)* by selecting the IK button on the left and then clicking one of the four IK pre-selection buttons or one of the four user-definable joint pre-selection buttons. Users can enter Pose Edit Mode by clicking the Pose Edit Mode button at the bottom right of the 3D View window.

Finally, users can control the playing of the data shown in the Timeline window by using the *playback controller* contained in the bottom section of the 3D-window.

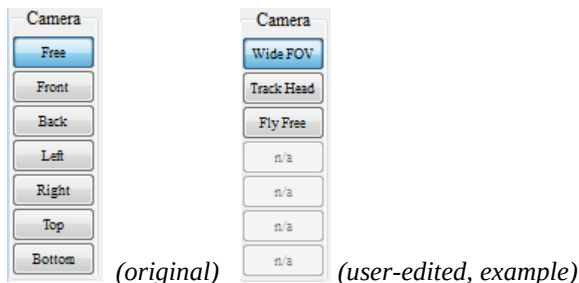
The action taken when users click and drag in the 3D View is determined by the mode that the 3D View window is currently in: Camera Mode, IK Mode, or Pose Edit Mode. Users can move between these three modes using the IK button at the lower left of the 3D View window and the Pose Edit Mode button at the lower right of the 3D View window.

- **Camera Mode.** In Camera mode, a mouse click-and-drag is interpreted based on the camera's mover mode. It is recommended that users consult the Camera window section for more details on working with cameras in the Motion Editor.
- **Inverse Kinematics (IK) Mode.** In IK mode, a mouse click-and-drag is interpreted as manipulating the end effector in space. See the Inverse Kinematics section below for more details.
- **Pose Edit Mode.** In Pose Edit Mode, a mouse click-and-drag is interpreted as incrementing or decrementing a DOF (degree-of-freedom). See the Pose Edit Mode section below for more details.

NOTE: When in either IK mode or Pose Mode, you must press and hold the ALT key to go into camera mode.

5.1 Camera Mode

Seven camera buttons located in the 3D View window allow users to quickly change the camera settings, and thus the view in the 3D View. Note that if users change the camera by rotating or translating the camera position using the mouse as described above, these new settings become associated with the active camera button. Thus the names “Front”, “Left”, etc. are descriptive of the original settings of these buttons only. Reset the view as desired using the Camera Window, or delete or rename any camera and change all of its settings. The names shown have “defaults” so that if one creates a camera with any of these names and press the “Reset” button, they will take on the “factory-preset” configuration values. The **set of all defined cameras** can also be quickly swapped out with a customized set of user-defined cameras by using the “File→Load Camera/IK Settings” menu command.



The original six pre-defined Cameras (left) and a user-edited set of Cameras, (right) where the user has deleted some cameras that were rarely used.

5.2 Playback Controller

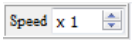
The Playback Controller, located in the 3D View, allows users to “play” the motion and see them in 3D in the 3D View window with many playback control options.



There are eight buttons that allow control of the playback, in order from left to right, are:

- Rewind to the beginning – Make the current time be the earliest time as specified by the Range Selector.
- Play backwards – Play the motion backwards in time.
- Stop – Stop the playing or reverse playing of a motion
- Cycle/Loop – Toggle the cycle state. When cycle is active, the playback controller continuously loops through the motion.
- Play – Play the motion
- End – Make the current time be the last time on the timeline with data, or the last time on the Range Selector (when it is displayed).
- Frame Backward – Move back one frame in time. Frame length is defined in File > Preferences > Motion Editor DT. Note that holding this button down automatically reactivates them.
- Frame Forward - Move forward one frame in time. Note that holding this button automatically reactivates another Frame Forward.

The playback area has the following features and functions:

Button	Function
 	The left counter shows time at the start of the simulation data file (usually zero). The right counter shows the time extent at the end of the timeline, regardless of the Range Selector. This is the last piece of data on any frame.
	This is the playback rate display, and specification tool. Increase or decrease speed of playback relative to real time by clicking on the tiny Up or Down arrows (▼, ▲)
	Rewind to the beginning – Make the current time be the earliest time as specified by the Range Selector.
	Play backwards – Play the motion backwards.
	Stop – Stop the playback.
	Cycle – Toggle cycling on or off. When cycle is active, the playback controller

	loops continuously through the simulation defined by the minimum and maximum.
	Play - Play the motion forwards.
	Fast Forward to the end.
	Frame Backward – Click to move back one whole frame in time; press and hold to move more continuously. One frame-duration in time is equal to the Motion Editor DT as defined in the File→Preferences→Motion Editor DT.
	Frame Forward – Click to move forward one frame in time; press and hold to move more continuously.

5.3 Pose Edit Mode

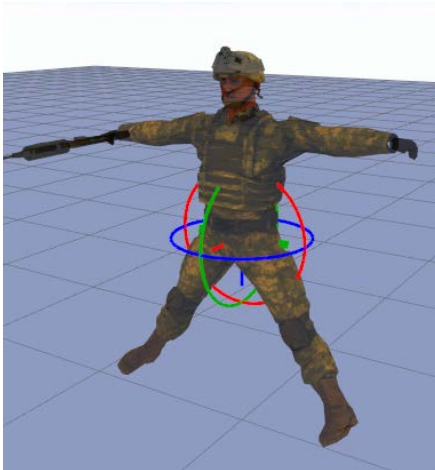
To edit a pose, start the posing tool () and use the mouse to select and adjust a joint and a DOF. This section describes how to select joints and DOFs. See the section Joints and Links for more detailed information on all joint names, link names, and DOF.



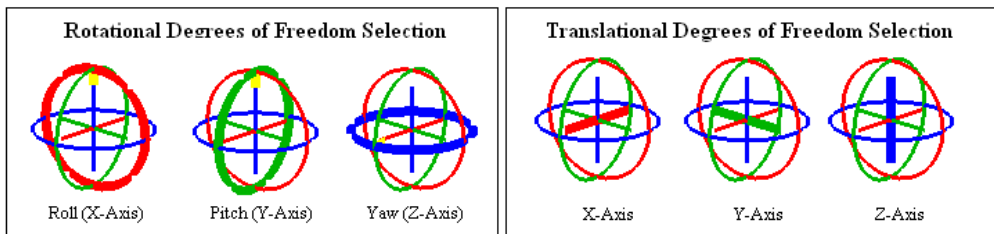
Screen-grabs from the 3D View showing two example poses

5.3.1 The Six Degrees-of-Freedom of the Poser Gizmo

By default, the posing tool selects the base joint of the character. The gizmo draws six graphic handles (3 translation posts and three rotation circles) associated with the 6 DOFs of the base. On a human, this base joint is at the hips. Adjust the values of the DOFs of the joint by clicking and dragging on a graphic handle, constrained by the DOF's range of motion.



Base Link selected for a soldier



The Poser Gizmo graphic handles for the 6 basic Degrees-of-Freedom (DOFS)

3 Translational posts allow the object to be moved linearly along an axis and use a length value:

- Front and Back, Red, adjusts along the X axis
- Side to Side, Green, adjusts along the Y axis
- Up and Down, Blue, adjusts along the Z axis

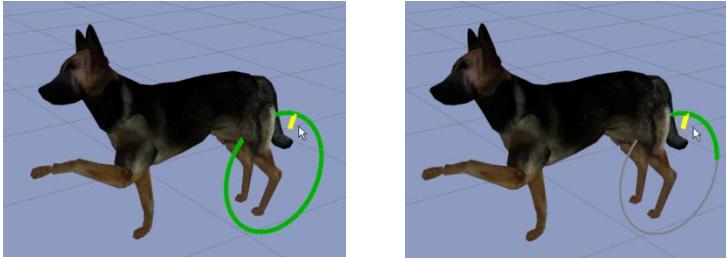
3 Rotational circles allow the joints to be adjusted rotationally and use an angular value:

- Blue circle adjusts the yaw (around the local Z axis)
- Red circle adjusts the roll (around the local X axis)
- Green circle adjusts the pitch (around the local Y axis)

DI-Guy uses a ZXY rotation order.

The Gizmo and non-6DOF joints.

The gizmo only draws graphic handles for DOFS available in a joint. The majority of joints in DI-Guy characters are 3DOF rotations so no post handles will be drawn. Pin joints will only have a single circle. For example, below is the poser widget for a dog's left ankle, which uses a pin joint. The name of the DOF being edited is "q.b_l_ankle_ry." Note that the "_ry" implies rotation about the local y axis, which is drawn as always, using a green circular handle. Also note that only the portion of the handle that is valid is drawn. The right image shows a "grayed-out" part of the handle that is off-limit.



5.3.2 Screen-grabs of the poser widget for 1 DOF joints. *Left: without limits, Right: with limits* **Posing a Character**

1. Start by activate the posing tool by pressing the posing tool button.  By default the base joint is selected.
2. Select a DOF by shift-clicking a graphic handle or use the space bar to select DOFs sequentially.
3. Adjust the joint by dragging the mouse or using the “+” or “-” keys (optionally holding the Shift key down to increase the change)
4. Continue selecting joints and adjusting them until the imagined goal pose is achieved.

The table below summarizes the effects of actions aided by the Pose Tool.

To Achieve this Result	Perform this Action
To select a joint to adjust	Shift-click a link (body part). This activates the proximal (inbound, closer to the body) joint to the link. It highlights the link clicked and all distal (outbound, further from the body) links. One can also use the “Link” buttons to navigate through the character ( Base,  Child,  Parent,  Sibling). These buttons gray out when not applicable. One can also use the arrow keys too (→, ←, ↑, ↓).
To select a DOF to manipulate	Shift-click a graphic handle to highlight, or use the space bar to cycle through them all
To move a joint	With a joint highlighted, click and drag the mouse to change the value, or use the “+” or “-” keys. When using the keys instead of the mouse, holding the Shift key will increase the amount of movement.

5.3.3 To Change the Camera while using the Posing Tool, Press Alt

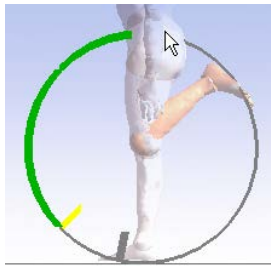
It is often useful to move rapidly between camera adjustments and posing tool adjustments.

- Press and holding the Alt key will temporarily turn off the posing tool and allow users to adjust the camera. With Alt pressed, use the standard mouse-clicks and mouse-movements as described in the section Camera Movers Section.

With the posing tool on, moving the mouse adjusts joints and does not affect the camera, unless users press Alt.

5.3.4 To Select a Joint

When users select a link, the link's proximal joint is activated for adjustment. The joint and all distal links are highlighted. Each of the available DOF is shown with a graphic handle.

Action	Result	Legend
Shift-click the calf to select the knee joint. Click and drag the mouse to adjust the knee joint.	 Note that joint limits are not specifically set in DI-Guy Motion Editor. Users can set joint rotational limits using Tools → Joint Limits.	The knee joint is activated for adjustment. The lower leg link and the foot link are highlighted. The knee joint has one DOF shown with a green graphic handle. The circle indicates that this is a rotational DOF. The green color shows that the pitch (around the X axis) is active. The highlighted arc (in green) shows the range of motion of the knee joint. The yellow marker shows the current angle of the calf. The gray marker shows the location of the cursor and that it is out of the knee's range of motion.

Sometimes, due to the graphic display or obstruction, one may have trouble clicking a desired body part to select a joint for pose adjustment. The joint navigation buttons allows one to navigate through the hierarchy of joints by ascending or descending chains of joints or by choosing parallel chains.

Users can select a joint in three different ways:

- Shift-click a link distal to the desired joint
- Click a joint navigation button (buttons are disabled when inapplicable):

Joint Navigation	Function
 Base	Selects the base joint.

 Child	Selects the first child joint of the current joint.
 Parent	Selects the parent joint of the current joint.
 Sibling	Cycles through sibling joints of the current joint.

- Press a posing tool hotkey:

Hotkey	Function
↑ Up arrow	Selects the parent joint of the current joint.
↓ Down arrow	Selects the child joint of the current joint.
→ Right arrow	Cycles through the sibling joint of the current joint, starting to the left and wrapping if needed.
← Left arrow	Cycles through the sibling joint of the current joint, starting to the right and wrapping if needed.

5.3.5 To Select a DOF

If a joint has a single DOF, it is automatically selected when the joint is selected. If a joint has more than a single DOF, one is selected by default.

To select a different DOF,

- Shift-click the graphic handle of another DOF, or
- Press the spacebar to cycle through the DOF on the selected joint.

5.3.6 To Adjust a Joint

Users can edit each joint by at least one DOF. With a joint and a DOF selected, users can adjust the joint in two ways:

- Drag the mouse, or
- Use posing tool Hotkeys.

Hotkey	Function in Posing Tool
+	Increase rotation or translation value. Holding the Shift key increases the movement.
-	Decrease rotation or translation value. Holding the Shift key increases the movement.

5.4 Inverse Kinematics Mode

Kinematics is the term used to describe the mathematical operations that allow one to determine the exact position and orientation of the end link of a multi-joint linkage from the start position and orientation of the base link and the state of each DOF in the linkage. Note that the mathematics of Kinematics, when used in this sense, is a *deterministic* operation, i.e. for a set of given input parameters, there is one and only one answer to the problem.

Inverse Kinematics is the term used to describe the opposite mathematical operation, when one knows the desired position and (possibly) orientation of the end link of a multi-joint-linkage, and one would like to determine the state of each DOF in the linkage that would allow the linkage to reach this desired goal. Unlike Kinematics as described above, this mathematical operation is *non-deterministic*, i.e. there may zero, one, or multiple different input parameters that would achieve the desired goal position and orientation. This is because the operation is inherently under-constrained – there will almost always be more than one solution to the mathematical equations.

What is important for users is that Inverse Kinematics allows users to grab the end of an arm or a leg of the character and drag it to a new position, and the Motion Editor will automatically try to guess all of the intermediate joint values.

IK NOTE 1: Because IK is inherently under-constrained, it can sometimes behave strangely. If the joints in a chain each have only a single degree of freedom (1DOF), it's easier to produce good results. Chains with joints having 2DOF, or 3DOF make IK very challenging. Users may see poor results in those cases. The Pose Tool or Joint Editor should be used instead.

5.4.1 Performing Inverse Kinematics

Inverse Kinematics is performed by first activating the IK Mode (pressing the IK Button) and selecting one of the eight IK buttons at the bottom of the 3D View window to be the IK chain. Then, click a point on or near the end effector of the joint assembly, and drag in the 3D View. When the mouse is released, the resulting pose is saved in the Timeline as a runtime pose. If there is a runtime pose in the active track on the Timeline at the current frame, the result overwrites the pose. If there is not a runtime pose in the active track, a runtime pose is automatically generated to receive the new settings.

IK NOTE 2: Unanticipated behavior can result if the active track does not have highest level control in the Timeline for all of the DOFs being modified by IK. This can occur if a track of higher priority also controls one or more of these DOFs. In addition, unexpected behavior can result if a runtime pose is masked by a transition.

IK NOTE 3: Press and hold the F1 key to reduce mouse-movement sensitivity.

NOTE 4: To enter camera mode while doing IK, press and hold the ALT Key

The eight buttons below the 3D view contain four pre-configured Joint Group Assets (with icons indicating the factory settings) and four (potentially blank) Joint Group Assets initially labeled “a” through “d”. The four buttons with icons will work for most human characters, but they don’t work well for animals or vehicles. Hence, the four user-editable Joint Group Asset buttons are provided. These buttons are described in the next section.



Screen-grab of default IK button appearance



Screen-grab of user-edited IK buttons

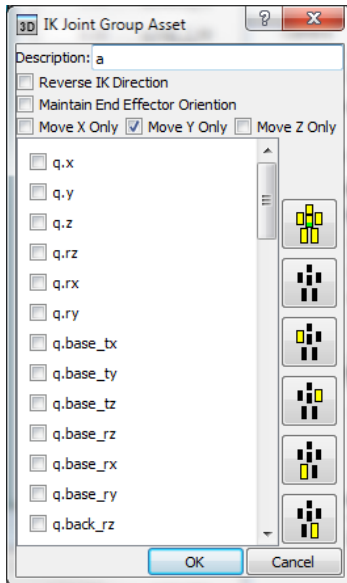
5.4.2 IK Configuration Buttons

The Motion Editor has four pre-defined IK configurations available in the first four buttons. The arm configurations (two left-most buttons) allow the orientation of the end effector (the hands) to vary, while the leg configurations (buttons 3 and 4 from the left) expressly preserve the orientation of the end effector (the feet).



5.4.3 User-Defined IK Buttons

Users can also specify their own IK configurations using the A, B, C, and D IK selection buttons, which can also be renamed to something more descriptive. Users can configure these four user-defined IK settings by clicking on the tiny '>>' button in the lower right corner of each IK button, or by right-clicking on the large IK button itself. A dialog box appears where users can specify many settings:

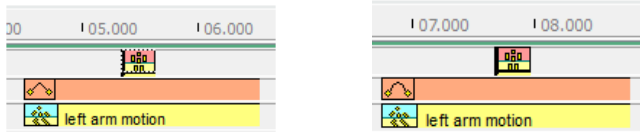


IK Joint Group Asset Dialog

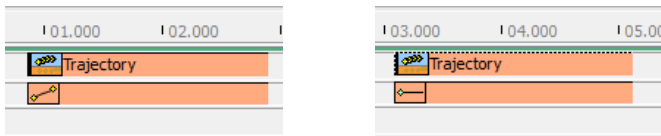
- Checkboxes - The active joints in the joint group can be specified using the check-boxes.
- Description - A description of the IK Joint Group Asset can be set. This text also gets placed in the button label.
- The Reverse IK Direction – Instead of a normal IK operation where the inbound part of the IK chain is fixed and the outbound end is to be manipulated, the outbound end is fixed and the inbound end and base joint are manipulated. “Reverse” inverse kinematics is particularly useful if users have a hand or foot positioned on a desirable location but would like the rest of the body to move during IK. A typical example is to set up a track that either controls the two legs (or the two arms), and where the two feet (or two hands) are already positioned at a desired position and orientation. Reverse IK mode will let users manipulate the body while preserving the feet (hands) position.
- Maintain End Effector Orientation – Specifies whether or not IK edits allow the orientation of the end-effector (the last joint in the chain) to vary.
- Move X Only/Move Y Only/Move Z Only – Specifies whether or not IK edits restrict the mouse-driven inputs to the IK solver to vary only in certain axial directions. These three checkboxes are exclusive (at most, only one can be selected at a time). For example, if Move Z Only is checkbox clicked, then when a user uses the mouse in the 3D View while in IK mode, the software will ignore both the X and Y axis related movements of the mouse, and only consider the Z axis related mouse movement. This could be useful if users are trying to raise the end of a chain without moving it in the left or right directions.

5.4.4 Trajectory and Trajectory Atoms

There are four different ways to perform IK on a Motion Track. When performed, it can use either the familiar **motions** and **poses** that other transitions use (say, when using the IK Tee-pee Blend  and IK Igloo Blend ) or in a less familiar way using **trajectories** and **atoms** (say, when using IK Linear Interpolation  and IK Hold  transitions are used). These latter two transition types will be described here since they use a unique object on the timeline called a **Trajectory**.



IK using motions and poses (left: IK Tee-pee Blend, right: IK Igloo Blend)



IK using trajectories (left: IK Linear Interpolation, right: IK Hold)

A Trajectory () is composed of one or more trajectory atoms (). Atoms act as IK goal data for IK and contain the three rotation values (rz, rx, and ry) and three position values (x, y, z).. For example, if the motion track has only the left arm enabled, then the end effector would be the tip of the left hand. In 3D space, the hand can be described using six values – its position (x, y, z) and its orientation (yaw = rz, roll = rx, and pitch = ry).

Users can create an atom using the “Grab Trajectory” button () located to the left of the Timeline. When an atom is grabbed, its six values are taken by inspecting the joint group asset of the active track, computing the location and orientation of the end effector in space, and storing these six values, plus the frame number, in the Trajectory.

These values can be inspected and hand-edited by right-clicking on the Trajectory. When the trajectory is edited, a Dialog appears that lists all of the trajectories atoms in a table.

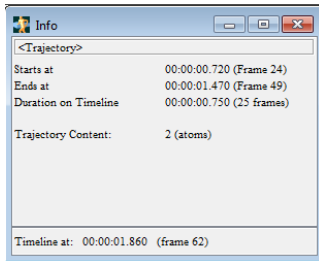
There are three different ways that users can tell how many atoms a trajectory contains.

The simplest way is to simply look at the trajectory on the timeline. When a trajectory has more than 2 atoms, users will see “atom ticks” lining the bottom of the trajectory () indicating what frame the atom occupies.

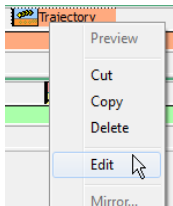


Trajectories containing 1, 2, 3, and 5 atoms

The second way to know how many atoms a trajectory has is to simply click on the trajectory in the timeline, and then inspect the Info Window.

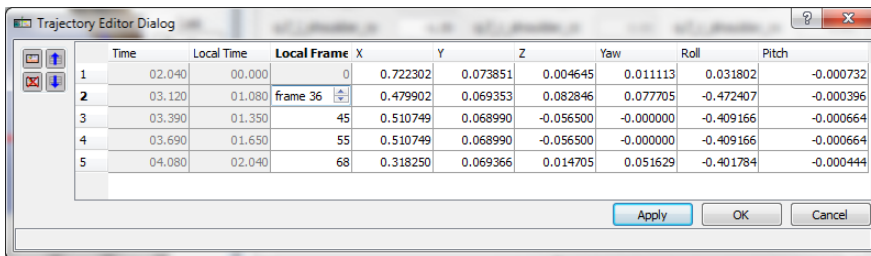


Info Window after selecting a trajectory – Note that the last line in the upper area reports that the trajectory atom count.



Right-click menu accesses the edit dialog

The third and last way to tell how many atoms a trajectory has is to manually edit the trajectory. Users can launch the Edit Dialog by right-clicking on a trajectory



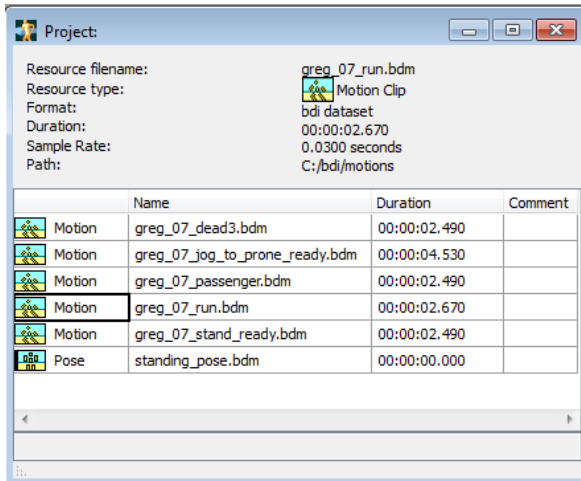
Screen-grab of the Trajectory Editor Widget – shown editing a trajectory with five atoms

The Trajectory Editor Dialog (above) allows atom-by-atom editing, as well as the creation of new atoms (📄), the destruction of existing atoms (✖), and the reordering of atoms (⬆ and ⬇). Each row holds the information for a single atom, starting with the first column (Time) through the last column (Pitch). For convenience, the time is shown both in global timeline-time and local trajectory-time, and the frame is shown in the local trajectory time-scope. The last six columns hold the six values for the end-effector of the motion track's joint group asset.

Project window.

6 Project Window

The Project window lists the *assets* currently loaded in the current project. An asset is a file that is available to add to a project, one of: a *motion clip*, a *pose*, or an *audio clip*. The list displays information about all the assets: their types (motion, pose, or audio), names, and lengths. The top section lists more information about the currently-selected asset, its sample rate, and the path.

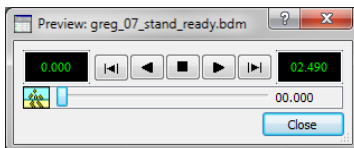


Screen-grab of the Project window, shown holding several motions and one pose

6.1 Previewing Assets

- Double-click an asset in the Project window to preview the asset.

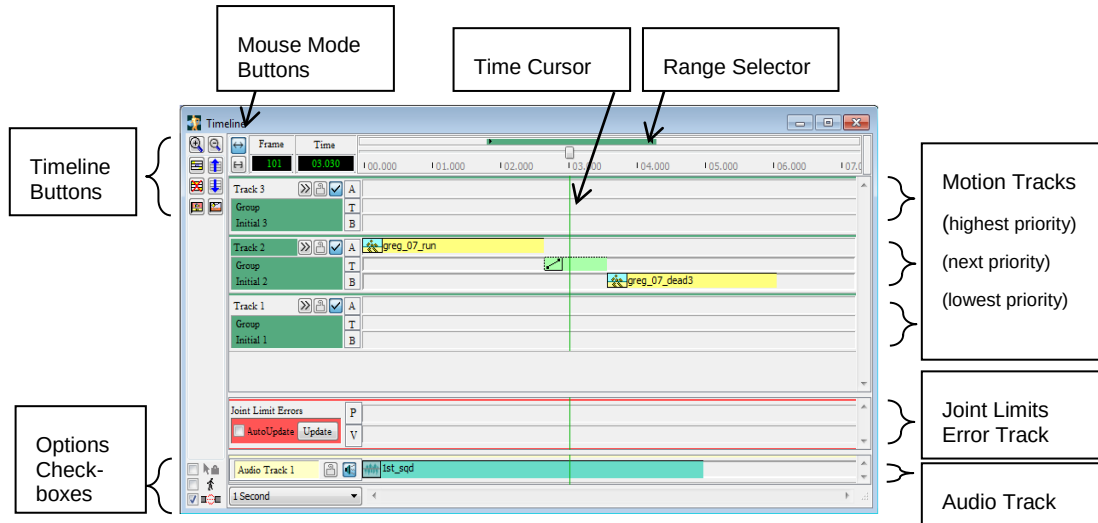
For a motion (or pose), a preview playback controller is displayed that allows users to view the motion in the 3D View window, independent of its placement or modification in the Timeline. For audio clips, a sound player is displayed that users can use to listen to the audio clip.



Screen-grab of the Preview Dialog shown when “greg_07_stand_ready.bdm” is being previewed

7 Timeline

The Timeline is the heart of the Motion Editing system.



The timeline uses a visual editing system to aid designers' creation of new motions from assets and transitions. The timeline is centered on the one or more *Motion Tracks* which organize motions, poses, trajectories and transitions in a temporal sequence. Motions for different parts of the body can be organized using different tracks that are arranged from top to bottom. Each track is usually associated with a different group of body joints. Note that in DI-Guy Motion Editor, the "top dog wins", so if a DOF is redundantly specified in two motion tracks, the higher track will win.

Running along the top of the timeline is a *Range Selector* for delimiting the start and end playback time. The current time is represented by the time cursor, which is a green line running vertically through the tracks. The text just beneath the *Range Selector* shows users the time as well as by the frame and time indicators located to the left. Time is shown in seconds and can zoomed into/out of by using either a subset of the *Timeline Buttons* in the top left corner or by selecting the large tick distance using the time increment combo box located at the bottom left of the timeline (it says 1 second in the following picture).

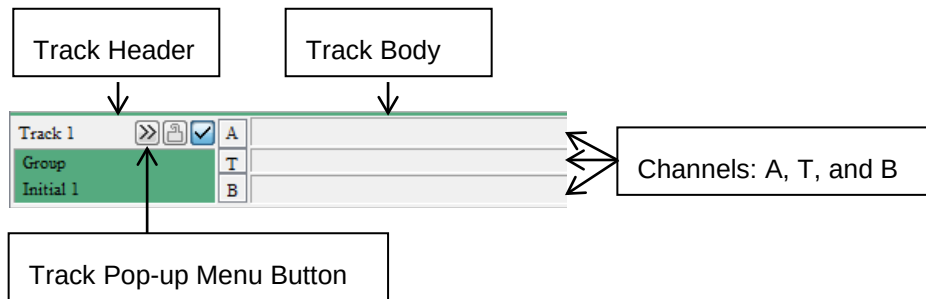
There are 6 track manipulation buttons (the bottom six *Timeline Buttons*) in addition to the top two *Timeline Buttons* which are the zoom buttons that allow users to perform track-level operations such as "add a motion track," "delete a motion track" and "move a motion track". The two buttons adjacent to the zoom buttons are the *Mouse Mode Buttons* and they allow users to select between "stretch" and "crop" mode when dragging the ends of motions or transition in the Timeline. Finally, there are some *Options Checkboxes* for turning on *locking*, *forward travel mode*, and *snap-to* functionality.

Finally, beneath the Motion Tracks, there is a single optional *Joint Limits Error Track* for detecting position and velocity errors for the DOFs of the model. Beneath the Joint Limit Error Track is a single optional *Audio Track* for loading audio clips.

7.1 Motion Tracks

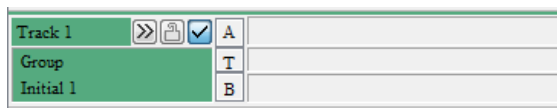
7.1.1 Motion Track = Track Header + Track Body

A Motion Track has two sections: the Track Header and the Track Body. These areas will be described in the sections that follow.



7.1.2 The Active Motion Track

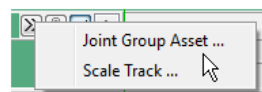
Only one Motion Track is considered the active Track and it's important to stay aware of which one it is because it affects many things. The active track's header contains additional color compared to the other tracks. The user can select a new active track by clicking the header of the desired track.



Extra green background designates this track as the active track

7.1.3 Motion Track Header

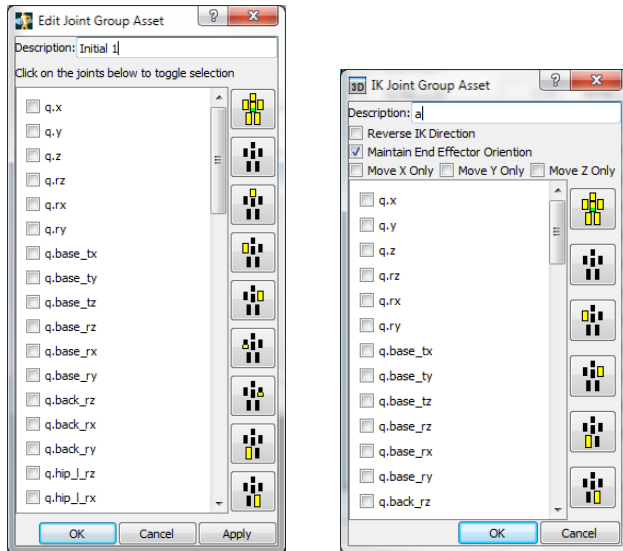
The Motion Track Header is comprised of an automatically computed track label (“Track 1” for example), a user-editable joint-group label (“Group”), a pop-up menu launching button , and two settings buttons: the Lock button  and the Enabled  button. Right-clicking the track's pop-up menu button  (or right-clicking on the green Joint Group Asset label) brings up a small popup menu from which users can activate the joint group asset editor or scale the track. The menu looks like this:



Pop-up menu on a Motion Track Header

7.1.3.1 Joint Group Asset

If users select “Joint Group Asset...” from the popup menu, a JGA Editor dialog will appear. Here users find a *Description* string where they can give their track’s joint group a useful name. The dialog allows them to select the JGA active degrees of freedom (DOF). By clicking on checkbox, one enables or disable the DOF. The large buttons along the right hand side allow users to quickly select and deselect entire sets of DOFs for most characters.



Screen-grab of the Joint Group Asset Editor for a Motion Track (left). For comparison, to the right is a screen-grab of the Joint Group Asset Editor for the IK Tool defining one of the IK user buttons.

Remember, the Joint Group Asset of a track determines which DOFs are affected by the data in the Track Channels. A DOF that is not highlighted is completely unaffected by the Motion Track.

Note that DOFs that are not enabled on the Active Track cause their corresponding textboxes in the Joint Editor to be disabled (see Joint Editor).

7.1.3.2 Scale Track

All the contents of a track can be scaled by using the pop-up menu of a motion track (⏏) and selecting “Scale Track ...” This displays a small popup menu from which you activate a Scale Track Dialog box. This can be used to scale the track such that all the assets in each channel of the track have their start times and their lengths adjusted. The scale can optionally be applied to all the tracks in the Timeline. Note that locked tracks are not be modified.

7.1.3.3 Track Lock

The Track Lock button indicates whether the data in the track can be modified. Users can toggle the lock on () to help protect finished work, or off () to allow edits.

7.1.3.4 Track Enabled Icon

The Track Enabled button indicates whether the Motion Track affects the motion being generated by the Timeline. It's a simple checkbox which looks like this () when it's enabled and this () when it is not. If the Motion Track is not enabled then the Timeline motion does not use its data, nor do exported motions use its data. The Track itself also can be inspected to see if it's enabled or not. A green line at the top of each track becomes gray when the track is disabled.



Screen-grab of disable track (left) and Enabled track (right)

7.1.4 Track Body

The Track Body is made up of three channels named A, T, and B channels. The A and B channels are Motion Channels that can hold motions or poses or trajectories while the T channel is the Transition Channel which can hold only transitions.

7.1.4.1 Motion Channels – A and B

Users can place motions, poses, runtime poses, and trajectories on the A and B channels. If at any given time there is motion data in the A and B channel (and nothing in the T channel), the A channel always has priority (Top Dog Wins) and the motion data in the B channel at that time is ignored. The reason that there are two motion channels instead of just one is so that Transition Blends can be performed (see the Transition Channel description below).

7.1.4.2 Transition Channel - T

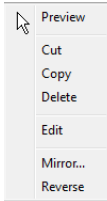
Users can place any of the transitions on the T channel. If at any given time there is a transition active, its data generation method overrides the data expressed in the A or B channel (although the Transition often makes use of this data). There are many different types of Transitions, a thorough discussion of the different Transition types offered can be found in the Transition Toolbar section of this document.

7.1.4.3 Manipulating Data in the Channels

Data in the channels can be manipulated many ways, including

- extracting character poses and end effector poses with the “grab pose” or “grab trajectory” buttons,
- using the right-click menus or shortcut keys for cutting, copying, pasting, or deleting,
- using mouse actions like dragging and dropping,

- menu options like mirroring, cropping, stretching, or launching the context-sensitive editors. (The items that are enabled when right-clicking are available can be considerable for some assets)



The right-click pop-up menu for a motion asset on a Motion Track

7.1.4.4 Adding Assets to the Timeline

- Motions and poses and audio assets are generally added to a channel by dragging them from the Project Window into the Motion Channel after they have been imported into the project.
- To add a transition, drag-and-drop a transition from the Transition Toolbar into the Transition Channel.
- Motions, poses, transitions, and trajectories can also be added by pasting these assets that were previously cut or copied: users just right-click in the Motion Channel and select paste from the pop-up menu.
- Runtime poses can be added by using the Grab Pose button on the Timeline, using the Joint Editor, or dragging in the 3D View window when it is in IK mode.
- IK Trajectories can be added by using the Grab Trajectory button.

7.1.4.5 Cut, Copy, Paste

Data can be cut, copy, and pasted by right-clicking an asset or item on the timeline and using the pop-up menu options Cut, Copy, or Paste. The same operations are also available via the Edit pull-down menu in the main menu. The destination for a paste is highlighted with a marching rectangle, as shown below:



Marching Rectangles are used by the Motion Editor to indicate areas of interest

7.1.4.6 Stretching (time scaling) and Cropping Motion Data

The start and end times of motions and transitions can be modified by simply clicking on the first or last frame of the item and moving the edge frames laterally along the timeline. Motion Data can be time-stretched (↔), or data cropped (⌂) by clicking and sliding the edges of the box representing the data. Note that the operation of time-stretch vs. data-crop is based on the cursor mode selected (see Timeline Modes later in this document), which is indicated by the cursors (shown earlier in this paragraph), and specified by toggling the suitable *Cursor Mode Button*. Transition data is easily stretchable in the same manner (but cropping has no meaning for a transition and is not supported).

Data can also be edited by right-clicking the data and selecting *Edit* from the popup-menu. An Edit dialog box is displayed which allows direct manipulation of the data.

7.1.4.7 Deleting Data

Data can be deleted by first selecting the data (single-mouse press, or a sweeping mouse-down, mouse-release action) and either hitting the Delete Key or by using the right pop-up menu or by the *Edit*→*Delete* pull-down menu in the Main Window. It will delete whatever items are surrounded by the marching rectangle that was just illustrated in 6.1.2.5.

7.1.4.8 Previewing Data

Data can be previewed by right-clicking the data and selecting *Preview* from the pop-up menu. Note that for motion data, unlike the preview described in the Project Window, the resultant motion displayed takes into account the modifications users may have done to the motion such as mirroring, stretch, cropping, or extending. Users cannot perform such edits directly on an asset that is in the Project Window.

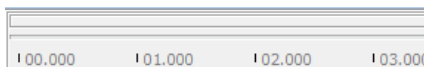
7.2 Time

As you may have noticed when you played data using the playback controller of the 3D View window, the time slider sweeps across the data in the Timeline showing graphically the passage of time. Note that to the left of the slider, the Frame and Time indicators also reflect the current time. The current time can be manipulated directly by 1) dragging the Time Slider, 2) single-clicking the time-labels area, 3) editing the current time in the Time Indicator or 4) double-clicking an asset in the timeline.

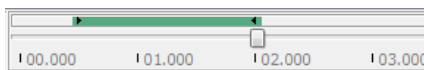
When enabled, *Snap-to* functionality () allows users also to easily find the beginning and ends of data. This functionality can be disabled if necessary.

7.3 Range Selector

The Range Selector controls the start and end time of the motion being created in the Timeline. By default, the range selector is hidden and the start time is 0.0 and the end time is simply the time in the Timeline past which no data has been inserted. To see and edit the Range Selector, double-click the range selector area. The active range is shown in green. The start and end can be slid using the mouse to trim or extend the start and end time. To hide the Range Selector, just right-click it and select “Default to All,” which causes the Timeline to take the defaults.



Before ...



and after double-clicking in the Range Selector

Note that the range selector affects both playback and motion export.

7.4 Stretch and Crop

These controls affect what happens to a motion when users drag its edge with the mouse cursor in a motion track channel. Stretch Mode alters the internal DT of the motion, causing time dilation, so that a motion that is stretched longer has an effectively larger internal DT (and seems to run in slow motion). Crop Mode preserves the DT of the original motion, but either trims or extends the starting and stopping time of the motion. The information about a slots stretch and crop edits can be seen in the Info window as well as in the Editors for each slot type.



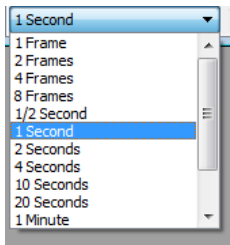
← Stretch Mode (above) and Crop Mode (below)

7.5 Zoom In/Zoom Out and Time Increment Combo Box

The Zoom In and Zoom Out buttons expand or contract the amount of time represented in the Timeline. This is purely a GUI feature and affects in no way the motion being generated. The Time Increment Combo Box reflects with the zoom setting, indicating the time interval between the large tick marks on the Time Slider, and it can also specify the setting with a single edit.



← Zoom In (left) and Zoom Out (right)



Time Increment Combo Box

7.6 Track Manipulation Buttons

The 4 buttons “Create New Track”, “Delete Active Track”, “Move Active Track Up”, and “Move Active Track Down” (some of which may be disabled when a viable target track is not highlighted) allow users to create, delete, and rearrange Motion Tracks on the Timeline.



← New Motion Track (top left), Delete Motion Track (bottom left),
Move Motion Track up (top right), and Move Motion Track down (bottom right)

7.7 Extraction Buttons (or “Grab” Buttons)

7.7.1 Extract Pose

When this button () is pressed, the state of the character, called its pose, at the current frame is captured and placed in a Runtime Pose on the active motion track on the Timeline. If there is no room on the active track, a new motion track will automatically be created.

7.7.2 Extract Trajectory

When this button () is pressed, presuming that a well-defined single chain has been specified for the JGA of the active motion track, then the position and orientation of the end effector (i.e. of the last joint) of the chain is extracted and placed in a trajectory atom. If an atom already exists, it is re-populated with the current values, but if no atom exist, then a new one is created. Note that if an existing Trajectory exists to the left or right of the time cursor, it will be extended to include the newest atom. See the sections on IK and Trajectories.

7.8 Checkboxes

7.8.1 Lock Timeline

This checkbox () prohibits editing of the contents of the Timeline. It essentially puts the Timeline in “read only” mode when it is activated (). Motion designers may want to lock a motion track to safeguard its contents.

7.8.2 Forward Travel Mode

This checkbox () enables or disables “forward travel mode” for the timeline. When enabled () , character changes in the x, and y position plus the character’s yaw rotation changes for the base joint between motions are preserved. For example, imagine a motion placed on a motion track where the character walked one meter forward and then turned 90 degrees to the right. Now imagine that two such instances of that motion were loaded into the timeline consecutively. With Forward Travel Mode turned off, users would see the motion repeated twice identically. If Forward Travel Mode is turned on, the character would perform the first motion, but then now it would perform the second motion from where the first motion terminated, thus at the end of the entire motion the character would have now turned 180 degrees and marched in an “L” pattern.

When this is combined with Blend Transitions, this can be a powerful tool for successfully linking together many motions into a larger single motion. Without this feature, users would have to use the Offset Effect transition and Offset Poses to produce the same kind of results.

7.8.3 Snap-to Mode

This checkbox () enables or disables the “Snap-to” edit mode for the timeline. When the checkbox is enabled (, it affects the sliding of data in the Motion and Audio Tracks on the Timeline, as well as the sliding of the time cursor. With it is enabled, the system can help users exactly lineup data along various time boundaries without requiring users to zoom in heavily to the time of interests or constantly monitoring the Info window or Time Frame indicator. For example, a Cubic Spline Interpolation Transitions can be stretched to exactly reach the poses that start and end the spline. This feature is defaulted to be switched on as it is very useful. Turning this feature off temporarily may be useful when manipulating data when the zoomed in level is high, or users want to place a resource near something else, but not align it exactly at the same frame.

7.9 Transition Toolbar

Transitions combine motions, poses, and trajectories in ways that result in new motions. The Transition toolbar contains a range of transitions that can be dragged to the transition channel (channel T) of a motion track. The transitions are grouped into four categories, identified by color:

- Interpolation transitions are **light green**
- Blend transitions are **plum**
- IK Interpolation transitions are **orange**
- Offset Effects are **cyan**



The transition icons of the Transition Toolbar

Note that the transitions can be confusing because they each have distinct personalities and conditions in which they can operate. To facilitate quick use, the “What’s This” text (triggered by first pressing the What’s This button () and then clicking on an item of interests) for each transition in the toolbar should provide users with a succinct summary of transition’s uses and conditions.

7.9.1 Interpolation Transitions – Light Green

Interpolation transitions fill in spaces on the timeline (either channel A or B) where motion data has not been defined, typically between two non-consecutive poses. The Interpolation transition then generates motion for all the frames between the poses that would otherwise be undefined.



Left: Example of a Cubic Spline Interpolation



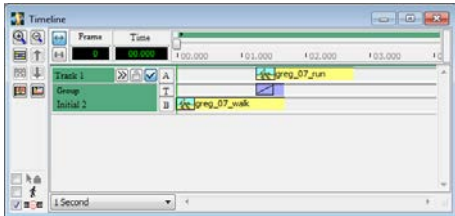
Right: Example of Hold Interpolation (Track 2) and Linear Interpolation (Track 1)

Note that in the examples above, as is the case for all Interpolations, the elements shown here in the B channel could be moved up at the same frame to the A channel, or vice versa, without altering the results. Moreover, because interpolations will only consider the first or last frame of a motion, interpolations are basically “frame oriented” operators. This is unlike Blends, which can consider and operate upon an entire motion.

Interpolation Transition	Function
Linear Interpolation 	Data for each DOF is interpolated linearly (in a straight line) between any two positions.
Polynomial Interpolation 	Data for each DOF is interpolated using a polynomial function.
Cubic Spline Interpolation 	Data for each DOF is interpolated using a cubic spline formula that guarantees smooth velocities. Velocity is zero at both endpoints.
Hold Interpolation 	Perhaps the simplest of the interpolations, this transition simply holds the last pose during a gap. More specifically, it fills in the gaps in the data with the first valid data value found earlier in the transition.

7.9.2 Blend Transitions - Plum

Blend Transitions (, ) are capable of blending either A) two motions together or B) blending one pose while motion. Please note that Blend transitions use different techniques to resolve situations where overlapping motion data exists.



Left: Example of a Linear Blend (which is similar to the Polynomial Blend)



Right: Example of Tee-Pee Blend (Track 2) and Igloo Blend (Track1)

Note that in the examples above, as is the case for all blends, the elements in channel A and B could be swapped without altering the resulting motion produced by the blend. Unlike interpolations, blends consider all data found within their transition width, and so they are basically are “motion oriented” operators.

Blend Transition	Function
Linear Blend 	A linear blend uses a linearly increasing or decreasing ratio to combine the overlap between two motions. In the example above, the left edge of the transition takes 100% of its data from channel B and 0% of its data from channel A. Half way into the transition 50% of the blend's data comes from channel A and 50% of the data comes from channel B. At the end of the transition, all of the data is from channel A. Functions with two motions (it will ignore poses).
Polynomial Blend 	A polynomial blend uses a sinusoidal ratio to combine the overlap between two motions. It is similar to the Linear Blend, except that it more smoothly ramps into/out of the blend. Functions with two motions (it will ignore poses).
Teepee Blend 	A teepee blend blends a motion and a pose or two motions. At the time of the pose, 100% of the data comes from the pose. The ratio of pose to motion data tapers off linearly to zero on each side of the transition (hence the word <i>teepee</i>). Functions with either two motions or a motion and a pose.

Igloo Blend 	An igloo blend blends a motion and a pose. At the time of the pose, 100% of the data comes from the pose. The ratio of pose to motion data tapers off in a rounded manner so that there is no velocity discontinuity at the pose or at either end of the transition (hence the word Igloo). Functions with either two motions or a motion and a pose.
---	---

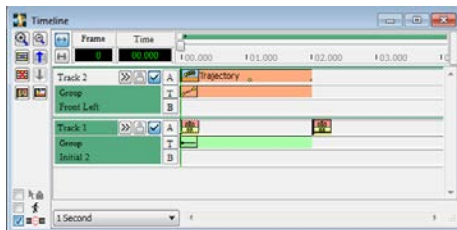
7.9.3 IK Interpolation Transitions - Orange

Use of IK Interpolation transitions is recommended for advanced users only.

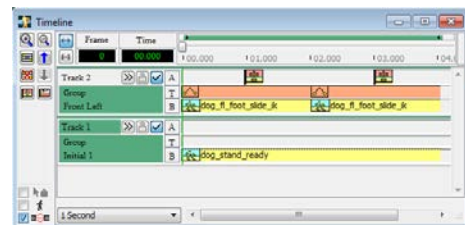
The igloo and teepee IK Transitions (, ) work with one motion and one pose, while the linear interpolation and hold IK Transitions (, ) work with one or more Trajectory atoms. Please note that IK transitions use different techniques to resolve situations where overlapping motion data exists.

IK functions all use Inverse Kinematics to fill in the empty spaces on the timeline. It is critical to select an appropriate Joint Group Asset for the Motion Track that is using IK Interpolations. The Joint Group Asset should show a single chain of joints with no branching, for example, a single arm or leg.

Because IK almost always deals with a subset of a Character's DOF, it is almost always necessary to have more than one enabled motion track in order to get IK to work. Furthermore, be aware that because the Trajectory information is stored in absolute space coordinates, the lower-level tracks should remain enabled when performing IK Edits if the lower tracks control the base position of the character (presuming that the IK motion track does not).



Left: Example of a Linear Trajectory (which is similar to the Hold Trajectory)



Right: Example of Tee-Pee IK Blend and Igloo IK Blend (both on Track2)

Note that in the examples above, both Track 1 and Track 2 are enabled. Track 1 determines the position of the character's base joint while Track 2 is operating on only a single chain of joints.

The IK is calculated as follows:

- The base position of the IK chain is determined by examining the Joint Group Asset and using the information calculated in the Timeline (including enabled lower-priority tracks) to determine its position and orientation. For example, if the right arm is chosen, the position and orientation of the right shoulder would be the base and its position would be determined by lower priority tracks in the Timeline. Thus, a lower track might define the base and trunk positions that would then be used by this transition.
- The end effector of the chain is determined by examining the Joint Group Asset.
- The goal position and orientation for the Inverse Kinematics, i.e. the position and orientation that the end effector tries to get within a certain tolerance of, is then calculated from the Trajectory found in the Motion Channels of the track.

The various IK Interpolation Functions below vary only in how the goal position and orientation are derived from the Trajectory found in the track.

Performance Note: IK Interpolation Transitions can be expensive to calculate. Try to minimize the situations where recalculation is required. In particular, we recommend that you place only tracks that modify the base position of the IK chain defined in the JGA below the track containing the IK transition. For example, if you are specifying walking motions for the legs using IK interpolation, place upper body tracks in tracks above the leg tracks. Then, every time the upper body is modified, the leg IK transitions are not recalculated. On the other hand, if you want to modify the Z height of the hips, place that track below the leg IK transitions so that the changes in the hip height do force recalculation of the leg IK transitions.



Blend Transition	Function
IK Linear Interpolation 	Linear Interpolation is used to fill the gaps within the Trajectory. Functions with Trajectories (it will ignore motions and poses).
IK Hold 	A simple fill technique is used to fill the gaps within the Trajectory. Functions with Trajectories (it will ignore motions and poses).
IK Teepee Blend 	A teepee blend (on the computed end effector) is used to fill the gaps within the Trajectory. Functions with a pose in the A channel and a motion in the B channel.
IK Igloo Blend 	An igloo blend (on the computed end effector) is used to fill the gaps within the Trajectory. Functions with a pose in the A channel and a motion in the B channel.

7.9.4 Offset Effect Transitions - Cyan

Offset effects apply data in their tracks to data already generated by lower motion tracks in the timeline. The Offset Effect () uses a single pose in its track, whereas the Offset Effect Linear () uses two or more poses.



Left: Example of Offset Effect



Right: Example of Offset Effect Linear

Note that in the examples above, both Track 1 and Track 2 are enabled. Typically, the track with an effect on it (in this case, that's Track 2) has only a few DOF enabled – only the DOF that need to be offset are enabled, while the other track has many DOF enabled (or all of them). It's important to remember that in order to edit an Offset pose (those that are in Track 2 in this example), users should first disable all other tracks, and then select the track with the offset pose on it before using the editor.

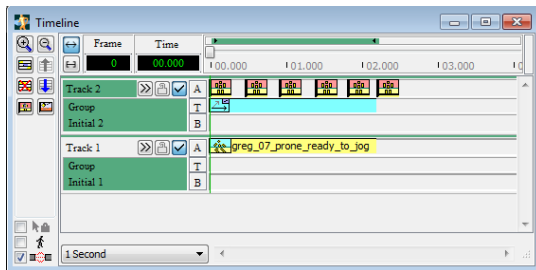
7.9.5 Offset Effect

For the Offset Effect () , the offset values of a pose are applied as an added adjustment to data that is already being generated by the Timeline, coming from lower priority tracks. For example, imagine that

one has created a walking motion, but that the motion needs to be offset in the z direction to get the feet to properly contact the floor. One can simply create a pose with the desired offset to be applied (so if the feet were 0.17 meters above the floor, one would create a pose with a z value of -0.17), put that in the A Channel at time 0.0 of a motion track having higher priority than the motion to be modified, and then place a Offset Effect in the T Channel. For the length of the new transition, the z value is decremented by -0.17 . Note that it is often advisable to set the JGA to affect only the z value.

7.9.6 Offset Effect Blend

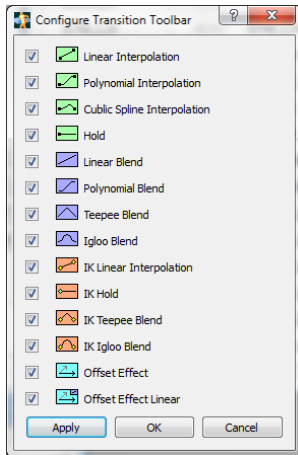
The Offset Effect Blend () is exactly like the Offset Effect, with one rather important difference. Unlike the Offset Effect, the Offset Blend does not ignore other Poses that span its width in the same Motion Track. It will linearly interpolate between each present pose to compute the offset values that will be applied as adjustments to the data that is already being generated by the Timeline coming from lower priority tracks. So, if adding a constant z value of -0.17 in the previous example isn't good enough because the character is not walking at the same height all the time, users can construct an offset effect having many poses – each with a different offset – and the effect will linearly interpolate between those values to compute the offset to apply.



Screen-grab of an Offset Effect Blend making multiple offset adjustments

7.9.7 Customizing the Transition Toolbar

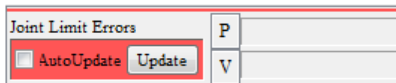
By default, all possible transitions are displayed in the toolbar. Users can hide particular transitions by using the dialog box accessible from the File → Preferences → Transition Toolbar pull-down. Use the checkboxes there to enable/disable showing of the transition in the toolbar.



The Transition Toolbar Configuration Dialog

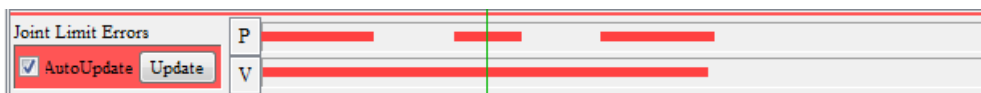
7.10 Joint Limit Errors Track

Motion designers may want to understand whether the motion currently represented in the timeline is violating joint limits, or if the joints are moving faster than a maximum threshold. The Joint Error Track provides a quick and easy way to determine this information. Two channels are presented, the “P” channel for Position, and the “V” Channel for Velocity. The Joint Limit Errors track may be minimized by collapsing its “splitter” or, it may be hidden entirely using the “-nojointlimit” start-up command line flag.



The optional Joint Limit Errors Track

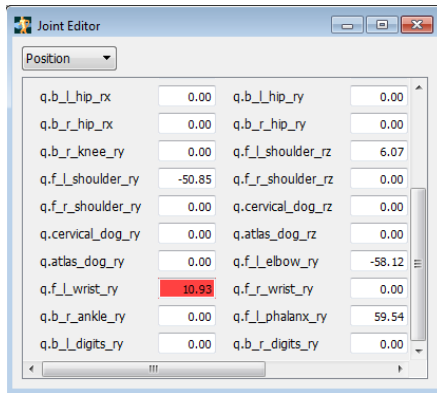
By clicking the update button, users can immediately request the two channels to be updated. The Auto update forces a joint limit error track recalculation every time the timeline is altered. It may be necessary to alter the track to force an update. When a limit violation is detected, the appropriate channel (P or V) will display a red bar for the frames in which a limit is detected. Additionally, the Joint Editor will display the DOF background in red when the frame is being displayed.



Detected violations to both Joint Limits and Position Limits

Note that joint error information is also available from the Joint Editor Window. The two can work together to help debug joint limit problems. For example, the joint limit track might show that some position errors occurred on a particular frame, by advancing the time cursor to that frame, users can

determine exactly which DOFs are causing errors by examining the values represented in the Joint Editor and noticing which values are colored red, indicating a violation. Joint Limits (both positional and velocity) are set using the Tools→Joint Limits menu.



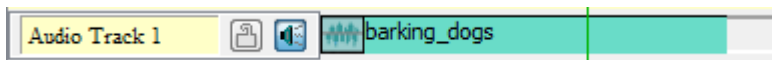
Joint Editor showing a position limit violation

7.11 Audio Track

The Audio Track functions very similarly to the Motion Track. Like the Motion Track, it contains Lock and Enable buttons with identical functions. When the Enable button for an Audio track is on, it looks like (🔊) and the top of the track is yellow. When it is disabled, the button looks like (🔇) and the track is shown with the top grayed out. There is only 1 channel in which to place audio clips, which can be imported into the Project Window using the “File→Import→Audio...” and then dragged onto the audio track. The operations of Cut, Copy, Paste, Delete, and Preview all behave the same for audio data as they did for Motion Data, and the audio data can be manipulated by sliding it laterally in the Audio Track.

7.11.1 Beat indicators for dance design

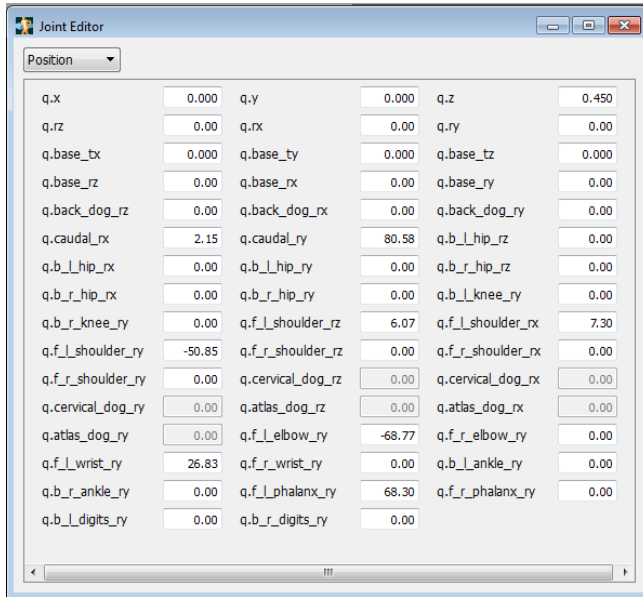
The Edit Dialog for an audio clip allows musical beat indicators to be created to allow users to more easily sync motions with music. Beat indicators are drawn as tiny red tick-marks below the audio asset. The tick mark is drawn for every beat per minute and the set of ticks can be offset from the beginning of the audio track by a phase angle. See the Edit dialog for audio slots.



An enabled audio track containing a sound slot

8 Joint Editor

The Joint Editor allows users to directly review of the values of all the DOF of the character as specified by the timeline at the current time. When position limits are defined (see Tools→Joint Limits ...), limit violations are shown in red. Editing these values results in the modification (and possible creation) of a runtime pose on the timeline. Note: For Offset Effects, users should disable all other tracks to see the values of the track containing the offset runtime pose.

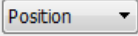


The Joint Editor displaying DOF information for a dog character type

DOFs that are inactive in the current track are shown disabled in the Joint Editor window (see Joint Group Asset for more information).

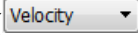
Performance Note: The Joint Editor is updated regularly. On slower systems, its update may detract from the performance of the 3D View window. Thus, we recommend that you close the Joint Editor Window on slower systems when 3D View window performance is important or when you are not using the Joint Editor Window to monitor or modify DOF data.

8.1 Editing Using the Joint Editor

To edit DOF data directly, put the Joint Editor in Position mode () and type values into the text boxes. If a text box has cursor focus, it does not update normally like the other text boxes, as it might interfere with the attempt to directly enter in a new value.

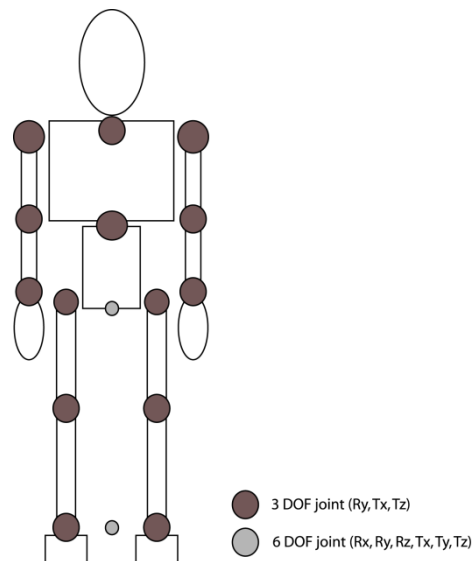
Any time a user changes a value in the Joint Editor, the new value is stored in a runtime pose. The Motion Editor attempts to locate a runtime pose in the active track at the current time to modify, if it cannot find such a runtime pose, it attempts to create a runtime pose at that location. If that location is unavailable, a new track is added to the timeline and the runtime pose is created there.

8.2 Velocity Mode

In addition to position mode the Joint Editor supports displaying velocity mode () which is read-only. Velocity is defined as 0.0 for Frame 0. For frame n , it's defined as $(P_n - P_{n-1})/(DT)$. When velocity limits are defined (see Tools→Joint Limits ...), limit violations are shown in red.

8.3 Joints and Links

A typical DI-Guy character has 15 joints and 48 DOF. In addition, it includes an idealized base joint with 6 DOF. Sometimes a character might have a piece of equipment, such as a rifle that also has a base joint with 6 DOF. The figure below shows a schematic representation of the joints and their DOF.



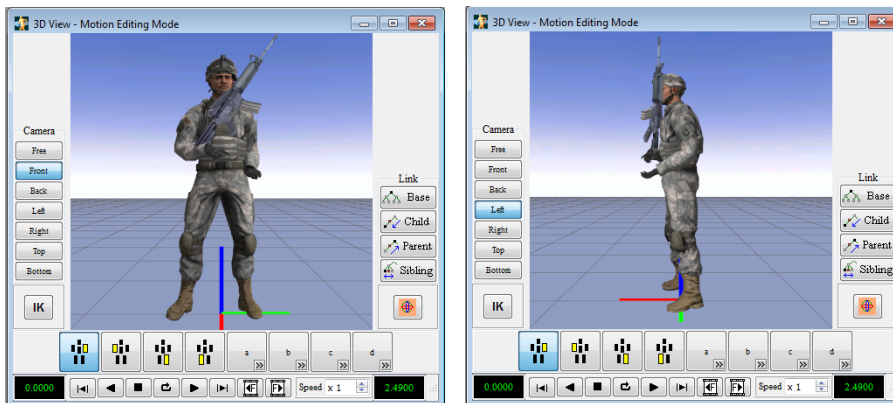
Standard DI-Guy Link, Joints, and DOF names

Joint (DOF) Name	Outbound Body Link
{x,y,z}	idealized joint
r{x,y,z}	idealized joint
offset*	Internal use only
base_t{x,y,z}	pelvis
base_r{x,y,z}	pelvis
back_r{x,y,z}	torso
C7_r(x,y,z)	neck
shoulder_{r,l}_r{x,y,z}	uarm_{r,l} (upper arm)
elbow_{r,l}_r{x,y,z}	larm_{r,l} (lower arm)
wrist_{r,l}_r{x,y,z}	hand_{r,l}
hip_{r,l}_r{x,y,z}	uleg_{r,l} (lower leg)
knee_{r,l}_r(x,y,z)	lleg_{r,l} (lower leg)
ankle_{r,l}_r(x,y,z)	foot_{r,l}

9 Camera Window

This 3D View window provides the 3D graphic display of a motion. In any mode, users can:

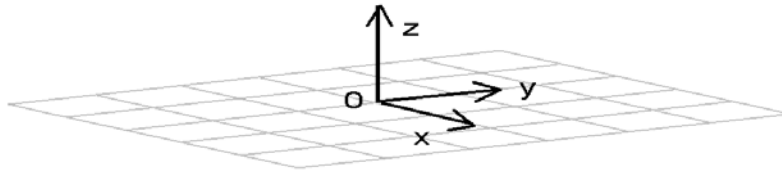
- Change the camera view, location, motion, and object tracking using mouse clicks and movements.
- Set the camera to follow the action by tracking a character (Looking At) or dollying with a character (Looking From).
- Define and save a camera that includes its view, location, motion, and what objects it tracks.
- Access saved cameras with the default camera menu or hotkeys.



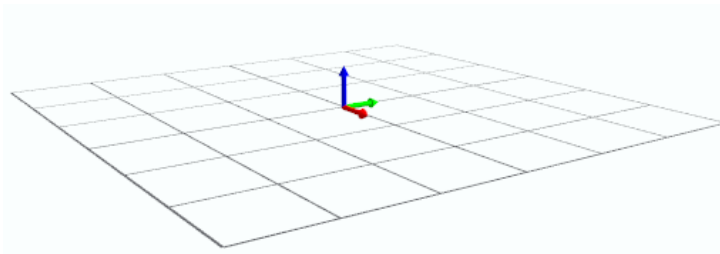
Screen-grabs of the Front and Left Views of a character (with coordinate system drawn)

9.1 DI-Guy Space

DI-Guy and its Motion Editor exist in Cartesian space with an X-forward, Y-left, and Z-up coordinate system. The 3D View of a scenario displays a grid as a visual aid to show the XY plane. The origin of the world is in the middle of the grid. All distances reported or entered in DI-Guy are measured relative to the origin. DI-Guy characters walk forward along the X-axis by default.



DI-Guy Space

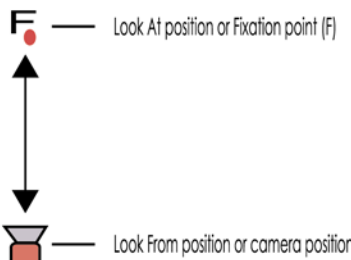


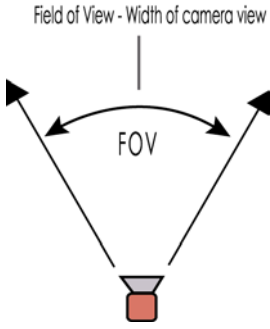
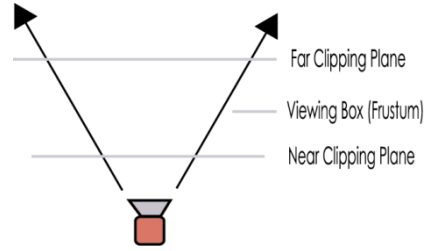
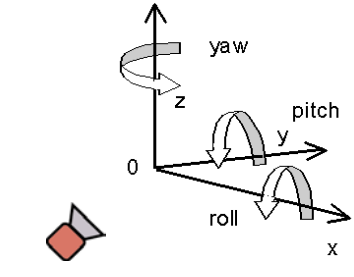
Motion Editor with File→Preferences→Configure World showing the coordinate system orientation

9.2 Understanding the Camera

The 3D View window renders the character based on modifiable camera settings which can be saved. The seven buttons on the left of the 3D View window are default Cameras. Users can change the settings of the default cameras and/or rename the default cameras.

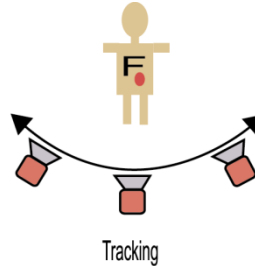
This section defines the terms used in the Camera window to change the camera.

Term Definition	Figure
Look At (Fixation Point), Look From (Camera Position) A camera <i>Looks At</i> a fixation point, and <i>Looks From</i> a camera position. Look At and Look From can be defined with X,Y,Z coordinates or with objects.	

Focal Distance The distance from the Look At point and the Look From point is the <i>Focal Distance</i>; units are meters.	 The diagram shows a red cube representing the camera at the bottom and a red dot labeled 'F' representing the Look At point at the top. A vertical double-headed arrow connects them. A legend line points to the arrow with the text: "Focal Distance - Distance from the Look From position or camera position to the Look At position or Fixation point (F)".
Field of View The <i>Field of View</i> is the width of the camera view; units are degrees.	 The diagram shows a red cube at the bottom with two lines extending upwards and outwards to form a viewing frustum. An arc between the two lines is labeled "FOV". A legend line points to the arc with the text: "Field of View - Width of camera view".
Clipping Planes <i>Near and Far Clipping Planes</i> define the near and far limits of the viewing frustum; units are in meters from the Look From point.	 The diagram shows a red cube at the bottom with a viewing frustum. Two horizontal lines intersect the frustum: the lower one is labeled "Near Clipping Plane" and the upper one is labeled "Far Clipping Plane". A legend line points to the frustum with the text: "Viewing Box (Frustum)".
Orientation The camera orientation defines where the camera is pointed. It is set in degrees for yaw, roll, and pitch.	 The diagram shows a 3D coordinate system with x, y, and z axes. A red cube is at the origin. Curved arrows indicate rotations: "yaw" around the z-axis, "pitch" around the x-axis, and "roll" around the y-axis. The origin is labeled "0".

Tracking — Always Look At Character

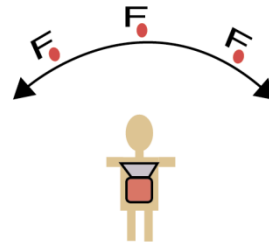
The camera is *tracking* a character if the Look At point follows a character. The Look At character can be further defined to be Look At a specific joint and an optional offset in meters. Use tracking to keep a character centered in the 3D View when either the camera or character is moving.



Always Look At character; camera location changes.

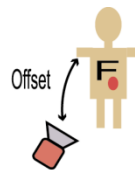
Dolly — Always Looks From Character

The camera is *dolly*ing with a character if the Look From point follows a character. Use dollying if users want the camera to move with a character.



Camera Looks From a character; fixation point changes.

Tracking a Character and Dollying to the Same Character with an Offset This is a particularly useful mode; the camera keeps a character centered in the 3D view as it moves with the character.

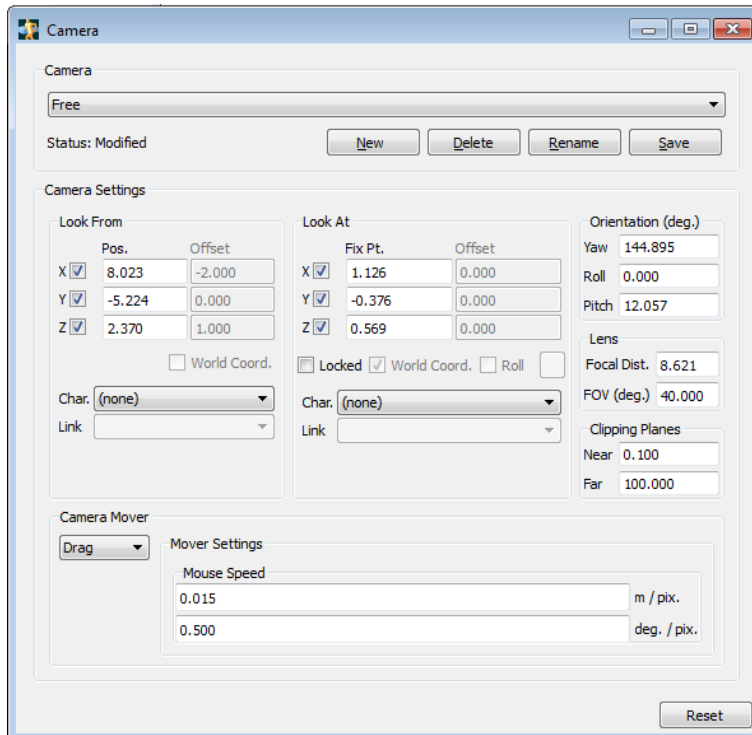


Tracking and Dollying at an Offset

Always Look At character; character stays centered.

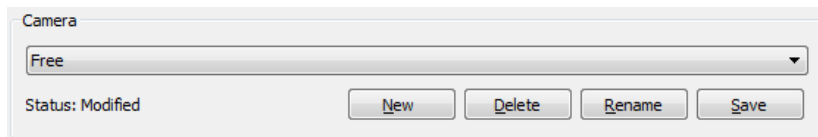
9.3 Using the Camera Window

Users can precisely control views and define cameras with the Camera window.



Camera window

9.3.1 Camera Section



“Camera” selection section of the Camera window



This Reset button resets cameras to their “factory” setting

The Camera section has the following controls:

Window Item	Function
Camera Drop-down menu	Specifies the name of the current camera.
New	Click to create a new camera.
Delete	Click to delete a camera.
Rename	Click to rename the current camera.
Save	Click to save the current camera window settings with the named camera.
Status	Saved if the current settings have been saved. Modified if users have made changes, but not yet clicked Save.
Reset	Click to return to default camera settings.

9.3.2 Camera Settings Section

Change where the camera is located and what it is viewing in the Camera Settings section of the Camera window.

Some settings or camera movers (discussed in the section *Camera Movers*) disable some camera settings.

Similarly, certain settings in the Camera window enable and disable other settings.

The screenshot shows the 'Camera Settings' window with the following sections:

- Look From:**
 - Pos. X: 8.023, Y: -5.224, Z: 2.370
 - Offset X: -2.000, Y: 0.000, Z: 1.000
 - ☐ World Coord.
 - Char: (none)
 - Link: (none)
- Look At:**
 - Fix Pt. X: 1.126, Y: -0.376, Z: 0.569
 - Offset X: 0.000, Y: 0.000, Z: 0.000
 - ☒ Locked
 - ☒ World Coord.
 - ☐ Roll
 - Char: (none)
 - Link: (none)
- Orientation (deg.):**
 - Yaw: 144.895
 - Roll: 0.000
 - Pitch: 12.057
- Lens:**
 - Focal Dist.: 8.621
 - FOV (deg.): 40.000
- Clipping Planes:**
 - Near: 0.100
 - Far: 100.000

The “Camera Settings” section of the Camera window

Frequently-Adjusted Camera Settings

The following settings are frequently adjusted, either by users directly or by the software as they move the mouse.

Window Item	Function
Look From	Sets where the camera is looking from.
Position X,Y,Z	Location of the camera. If the camera is dollying with a character, then the character determines the camera position.
Offset X,Y,Z	If a dolly character is selected, locate the camera at an offset to the character's selected joint. Disabled if no character selected.
World Coord	If checked, the offset uses world coordinates. If not checked, the offset uses local coordinates.
Char	Select a character with which the camera will dolly.
Link	If a dolly character is selected, the link of that character can also be selected. If unspecified, the base joint is used.
x, y, z Checkboxes	Enables or disables the constraint of where to look from when a look from character is selected
Look At	Sets what the camera is looking at.
Fix Pt X,Y,Z	A fixation point at which the camera is looking.
Offset X,Y,Z	If a track character is selected, the offset will be applied. Disabled if no character is tracked.
Locked	Sets the camera to track a fixed point in space (useful when there is no look-at character selected)
World Coord	If checked, the offset uses world coordinates. If not checked, the offset uses local coordinates.
Roll	This checkbox enables the camera to roll away from the Z-up vector. Users can then use the vector selection tool (the button to the right) to specify the "up" vector. This is only available when both look-from and look-at characters are selected.
Char	Select a character for the camera to look at. The camera then <i>tracks</i> this character.
Link	If a track character is selected, the link of the character to track can also be specified. If no link is selected, the base link is assumed.
x, y, z Checkboxes	Enables or disables the constraint of where to look at when a look at character is selected

Rarely-Adjusted Camera Settings

The following settings are usually automatically updated as the user moves the mouse, or they are infrequently edited.

Window Item	Function
Orientation	Defines the direction in which the camera is looking. Active only if the camera is not tracking a character.
Yaw, Roll, Pitch	Degrees around the Z, X, and Y axes respectively.
Lens	
Focal Dist	Shows the distance between the camera Look-From point and the camera Look-At point. As the mouse is moved to change the camera, this figure changes. This value rarely needs to be set manually.
FOV (deg.)	Shows the field-of-view of the frustum of the camera. This changes infrequently.
Clipping Planes	Determines the amount of culling done.
Near Clip	The camera sees nothing closer than the Near Clip. (Everything closer is clipped.)
Far Clip	The camera sees nothing further than the Far Clip. (Everything further is clipped.)

9.3.3 Camera Movers Section

A camera mover specifies how mouse clicks and mouse-drags modify the camera's position, fixation points, and how and when it zooms. There are four different camera mover types. Movers chiefly affect camera position, camera fixation, camera offsets, and zooming in and out. The table below briefly describes the movers. Detailed descriptions follow.

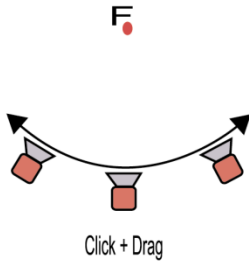
Mover Type	Description
Drag	1) Click either mouse button + Drag to rotate the camera position, 2) Shift-click + Drag up or down to change focal distance, and 3) Ctrl-click + Drag to pan (camera keeps position, but changes what it is looking at by swinging view left and right, up and down). Pros: Precise camera control. Con: Requires repeated mouse strokes.
Fly	1) Press a mouse button to make the camera move quickly (i.e.: fly) though 3D space. 2) Press both buttons + Drag to pan or rotate cameras.

	Pros: Little mouse movement required. Can fly through large spaces quickly. Con: Difficult to use for precise positioning.
Plan View	1) Press a mouse button to make the camera fly through space constrained along an axis. 2) Press both buttons to move the camera perpendicular to the viewing axis. Pros: Provides for easy orientation-constrained movement of cameras by limiting camera movement and orientation to the world axes (x,y,z). Con: Camera is restricted to axes. Difficult to use for precise positioning.
None	Camera ignores mouse movements and buttons.

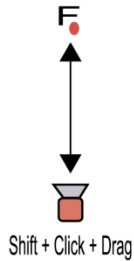
9.3.3.1 Drag

If the Camera Mover is set to Drag, dragging the mouse changes the camera. The three figures below show how mouse motions work when the Drag Camera Mover is set to Drag and tracking is on, tracking is off, and dollying is on, respectively.

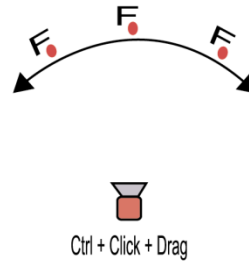
Drag Camera Mover with Tracking - If the Drag camera mover is selected and one has selected an object to track, the mouse works as follows:



Fixation point stays fixed; camera location changes.

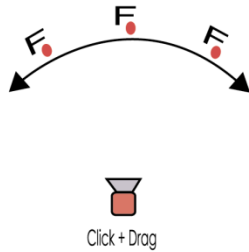


Camera position changes.

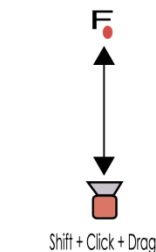


Same camera location, camera swivels to change fixation point.

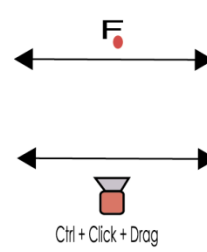
Drag Camera Mover without Tracking - If the Drag camera mover is selected and one has not selected to track an object (in the Look At section), the mouse works as follows:



Same camera location, camera swivels to change fixation point.

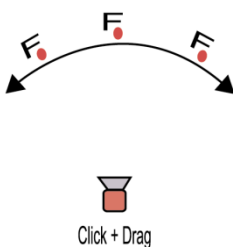


Camera position changes.

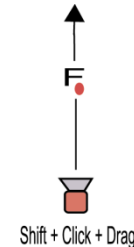


Camera and fixation point pan together through space.

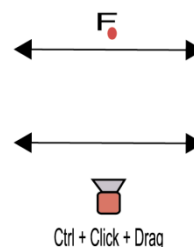
Drag Camera Mover with Dolly - If the Drag camera mover is selected and one has selected a character with which the camera will dolly (in the Look From section), the mouse works as follows:



Same camera location, camera swivels to change fixation point.



Focal distance stays fixed.



Camera and fixation point pan together through space.

Speed Settings

The Drag camera mover has two speed settings, defined in the table below.

Camera Mover

Mover: Drag

Mover Settings

Mouse Speed

0.015 m / pix.

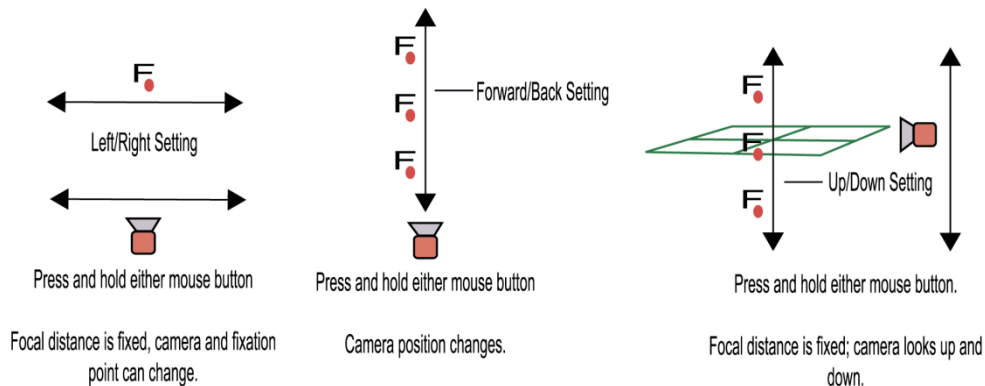
0.500 deg. / pix.

Property	Function
m / pix.	Meters per pixel determine how rapidly the camera pans, zooms, or rotates with respect to how far the mouse has been moved.
deg. / pix.	Degrees per pixel determine how rapidly the camera pans, zooms, or rotates with respect to pixel movements of the mouse on the screen (that is, how much a mouse drag affects the camera settings).

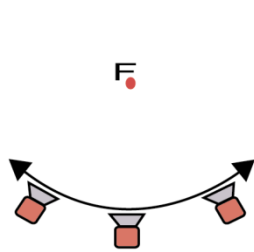
9.3.3.2 Fly

The Fly camera mover lets the camera *fly* through 3D space, covering great distances with small movements. The figures below show how mouse movements affect the camera when the Flyer camera mover is selected.

Fly Camera Mover without Tracking - If the Fly camera mover is selected and one has not selected to track an object (in the Look At section), the mouse works as follows with the Left/Right mover setting, the Forward/Back mover setting, and the Up/Down mover setting:



Fly Camera Mover with Tracking If the Fly camera mover is selected and one has selected an object to track, the mouse works as follows:



With tracking, press and hold both mouse buttons + Drag

Fixation point stays fixed; camera location changes.



Press and hold either mouse button

Camera position changes.

Speed Settings

The fly camera mover has three speed settings defined in the table below:

Camera Mover

Fly

Mover Settings

Mouse Move Mode

☐ Forward/Back
☐ Left / Right
☒ Up / Down

Mouse Speed

0.015 m / s

0.015 m / pix.

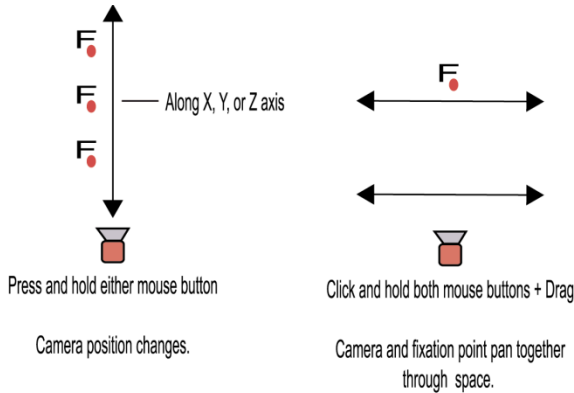
0.500 deg. / pix.

Property	Function
m / s	Meters-per-second determines how rapidly the camera zooms or pans with respect to how long the mouse has been pressed.
m / pix.	Meters-per-pixel determines how rapidly the camera zooms or pans with respect to pixel movements of the mouse on the screen (that is, how much mouse dragging affects the camera settings).
deg. / pix.	Degrees-per-pixel determines how rapidly the camera zooms or pans with respect to pixel movements of the mouse on the screen (that is, how much mouse dragging affects the camera settings).

9.3.3.3 Plan View

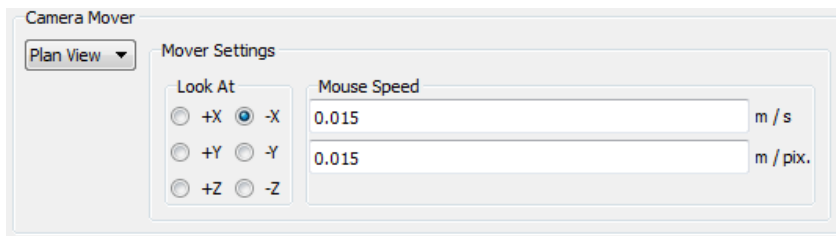
With the Plan View camera mover on, one cannot reorient the camera. The camera always looks in the direction specified by the Look At Setting.

Plan View with Either Mouse Button or with Both Mouse Buttons



Mover Settings

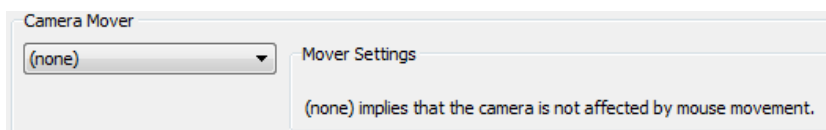
The Plan View camera mover has 3 mover settings, described in the table below.



Property	Function
m / s	Meters per second determine how rapidly the camera zooms or pans with respect to how long the mouse has been pressed.
m / pix.	Meters per pixel determine how rapidly the camera zooms or pans with respect to pixel movements of the mouse on the screen (that is, how much a mouse drag affects the camera settings).
Look At X,Y, Z grid	Specifies the Look At direction of the camera – specifically, along which axis and in which direction the camera should look at.

9.3.3.4 Camera Mover None

If None is selected, all camera settings remain fixed and moving the mouse has no effect on the camera.



9.4 Changing the Current Camera Settings

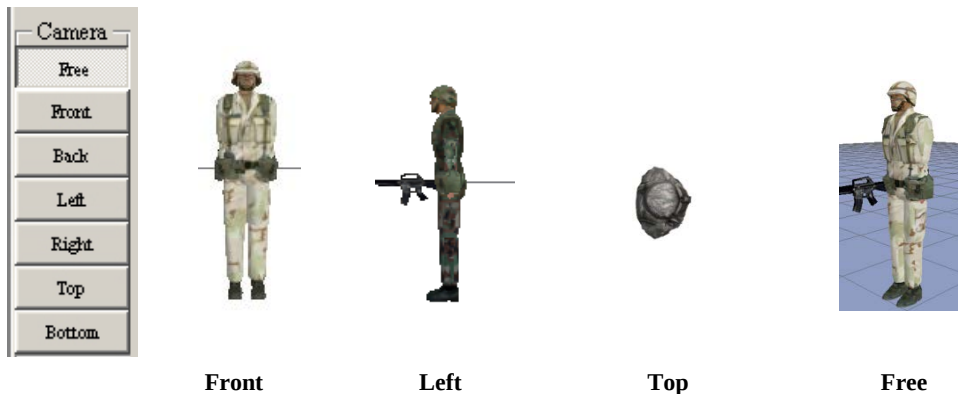
In every camera mode, clicking mouse buttons and moving the mouse changes the camera. In addition, one can change the current camera using one of the following procedures.

9.4.1 To Change to a Default Camera

- Click a default camera on the menu on the 3D View window.

The camera changes to the selected camera. The view and the mouse motion change accordingly.

The 3D View window contains seven buttons that activate default cameras. A *camera* consists of the camera location, what it is looking at, how it can move, and other viewing parameters. The default cameras are named according to what the camera is looking at.



Hotkeys: Users can also access the default cameras using keys 1-7 on the keyboard. The first three new cameras that users create can be accessed with 8, 9, and 0 respectively.

9.4.2 To Rename a Default Camera

The cameras on the default camera menu can be renamed without changing their settings

1. Select the camera to rename from the Camera combo-box (or click on its button in the 3D View)
2. Click the **Rename** button in the Camera window, enter a new name, and click **OK**.

The renamed camera is now on the list of default cameras in place of the old one and it will show up in the 3D View window Camera buttons too.

9.4.3 To Change a Camera to Reuse in this Session

In addition to being renamed, cameras on the default camera menu can also be modified for the current session without changing their permanent settings for other sessions.

1. Select the camera to edit and change any settings in the Cameras window.

2. Press Tab after each setting to see the change applied immediately.

The status label changes from *Saved* to *Modified*, signals that changes have not yet been saved.

Status: Modified

3. Click Save.

The status message changes to Saved. Changes are saved to the current camera.

Status: Saved

The current camera retains these settings unless the current project is closed or a new project is opened. Importing a project will not change the settings.

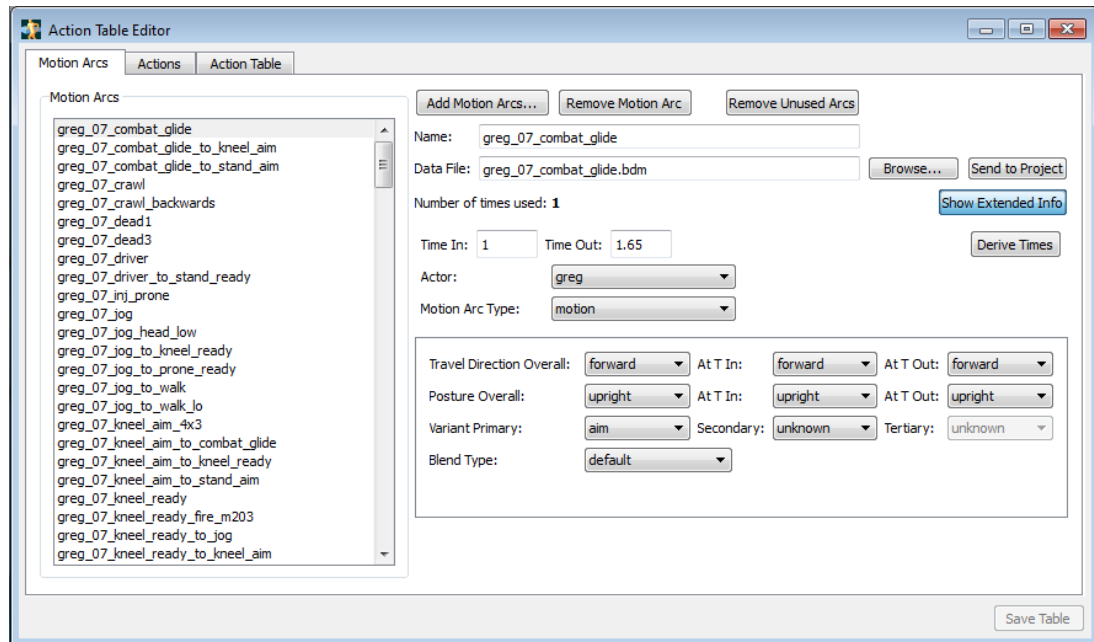
9.4.4 To Save and Reuse Your Cameras for the Next Session

During your use of the Motion Editor, users may create certain cameras that work particularly well for them. If so, they may want to be able to save them for future DI-Guy Motion Editor sessions.

1. Change and save settings for each Camera in the Camera window, as described in the preceding section. Note that one can have more than seven cameras defined, or less than seven, and they can have any name.
2. Before exiting DI-Guy Motion Editor, select **File → Save Camera/IK Settings**. This saves the cameras, as well as the user-defined IK buttons (which are named “a”, “b”, “c” and “d” by default).
3. Choose a memorable camera file-name, such as SueCameras.
4. The next time DI-Guy Motion Editor is opened, reuse the saved cameras by selecting **File → Load Camera/IK Settings** and selecting the saved settings file in the Open window. The saved cameras are reloaded and available for the current DI-Guy Motion Editor session.

Note also that if these camera settings are desired when opening the motion editor, modify the command-line arguments that are used to launch the DI-Guy Motion Editor to include **-i SueCamera.mec** (the file-path will need to be included too). As a result, this camera/IK file will get loaded automatically on start-up. One potential problem with this is that different characters have different “Dollying” and “Tracking” names, so if the defined cameras track or dolly to a character, only that character-type will work for the settings.

10 Action Table Editor



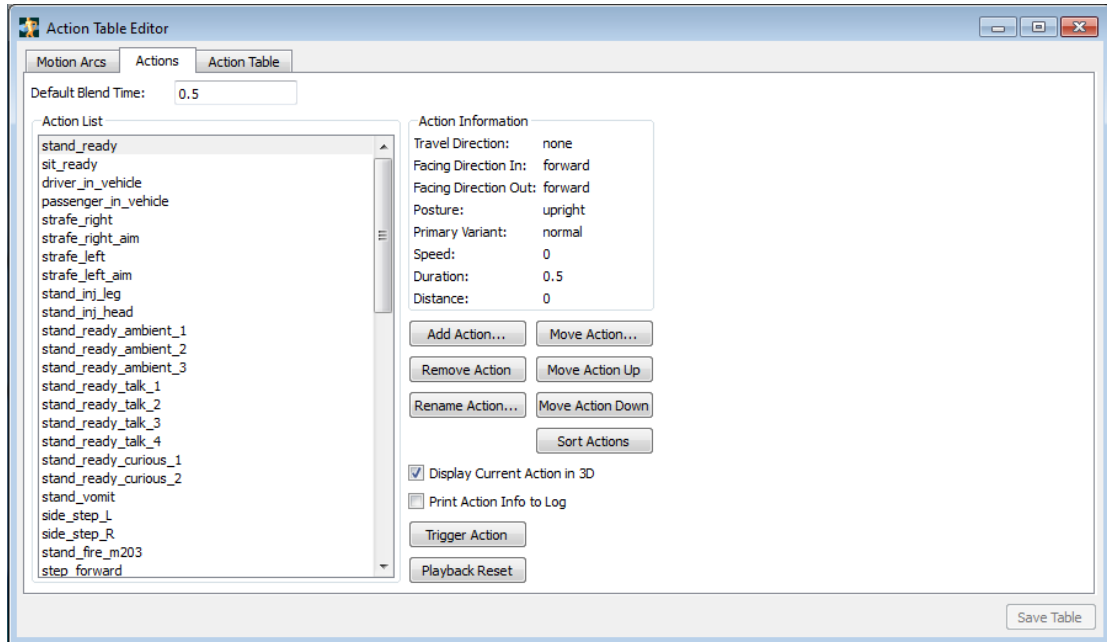
The Action Table Editor with the “Motion Arcs” tab selected for soldier_07

The Action Table Editor window lets users integrate new motions into the character’s motion engine. Every *DI-Guy* Character has an action table of a certain type (square, three-column, or one-column). The action table defines the actions that the *DI-Guy* Character can perform, the underlying motions that are used to perform those actions, as well as the transitional motions used to transition from one action to another action.

When the Action Table Editor or the Gesture Table Editor windows are active, they take control of the 3D View window; otherwise, the Timeline window has control.

After edits have been completed on an action table, it is important to save the table (first by using the button on bottom right of window) and then by using File→Save Action Table.

10.1 Actions Tab



The Action table Editor with the “Actions” tab selected for soldier_07

The Action tab defines the actions a DI-Guy character can perform. The actions listed in the *Action List* are the same actions seen in DI-Guy Character Viewer and the DI-Guy Data Reference documentation. The details of each action appear in the *Action Information* area to the right, including the overall direction, facing direction in and out, the overall DI-Guy posture type (see the Motion Arcs tab for details and specifications), the average speed (distance divided by duration), duration, and distance.

When active, the Action Table controls the character in the 3D Window. For example, trigger a new action in the list by double clicking on it, or by using the “**Trigger Action**” button. Triggering the action will not only play the action, but also perform the transition between the current action and the triggered action. This is an excellent way to test any or all of the transition specifications that are configured in the Action Table (see next section).

The buttons on the Action’s Parameters tab work as follows:

Button	Function
Add Action ...	Adds a new action to the Action Table. A new action will show up in the list on this Tab. New rows and/or columns are created in the table as needed, and initialized. To see the effect, inspect the Action Table tab too.
Move Action ...	This button repositions an action relative to any other. More convenient than using “Move Action Up” or “Move Action Down” when the list is large. See notes on the order of actions immediately below.
Remove Action	Deletes selected action from the action table.
Move Action Up	Moves an action up in the list.
Rename Action ...	Changes the name of an action in the action list
Move Action Down	Moves an action down in the list.
Sort Actions	Resorts the action list (useful after adding or renaming actions) except for the first action, which is the <i>Default</i> action for the character (which should be a roughly stationary action).
Trigger Action	Same as double-clicking on an action in the Action List. Transitions to the selected action, making it the current action.
Playback Reset	Moves the character to (0,0,0) in space, and to time 0 for the <i>Default</i> action. This does not undo any edits or changes (the undo/redo buttons perform that function) - only the playback is affected.

The order of actions in the Action Table is, for the most part, irrelevant to DI-Guy. However, the first action is the “default” action for a character, choose an action that is “still”, such as standing (for human characters). Users are encouraged to group actions logically or alphabetically.

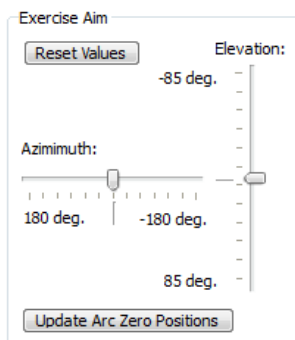
The labels to the right of the Action Parameters tab describe the current action. These fields come from the primary motion arc used to define the action, the details of which can be found in the “**Extended Info**” section of the Action Table Editor (see section *Motion Arcs* that follows).

Label	Definition
Travel Direction	The overall travel direction for the action. E.g. forward, backward, right, left.
Facing Direction In	At tin, the character faces this direction. E.g. forward, backward, right, left.

Facing Direction Out	At tout, the character faces this direction. E.g. forward, backward, right, left.
Posture	The “Overall Posture” as defined by the motion arc. ... E.g. upright, sitting, crouched, prone.
Primary Variant:	Which of the variants this action best applies to. E.g. normal, socializing, prone, aim, assault, curios, injured, sick, dead.
Speed	The average velocity of the action, in meters per second. (Distance / Duration)
Duration	The length of time in seconds that the action plays (Tout – Tin) when it transitions to itself.
Distance	The length in meters that the action translates in the x-y plane when it transitions to itself once.

10.1.1 Aim Primary Variet

When the user selects an Action from the Action List having it's Primary Variant (as defined in the table above) set to **aim** (as can be seen in the Action Information group-box), then the "Exercise Aim" group-box user interface (see image below) will be shown to the right of the Action Information.



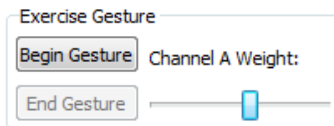
Exercise Aim settings for an action with Primary Variant set to "aim"

The Azimuth and Elevation sliders allow you to test the two degrees of freedom of the aim. The "Reset Values" button sets both values to zero whereas the "Update Arc Zero Positions"

button set the current 2-Axis Motion Arc's zero_angle_position (for both axes) to the current values of both sliders.

10.1.2 Exercise Gesture

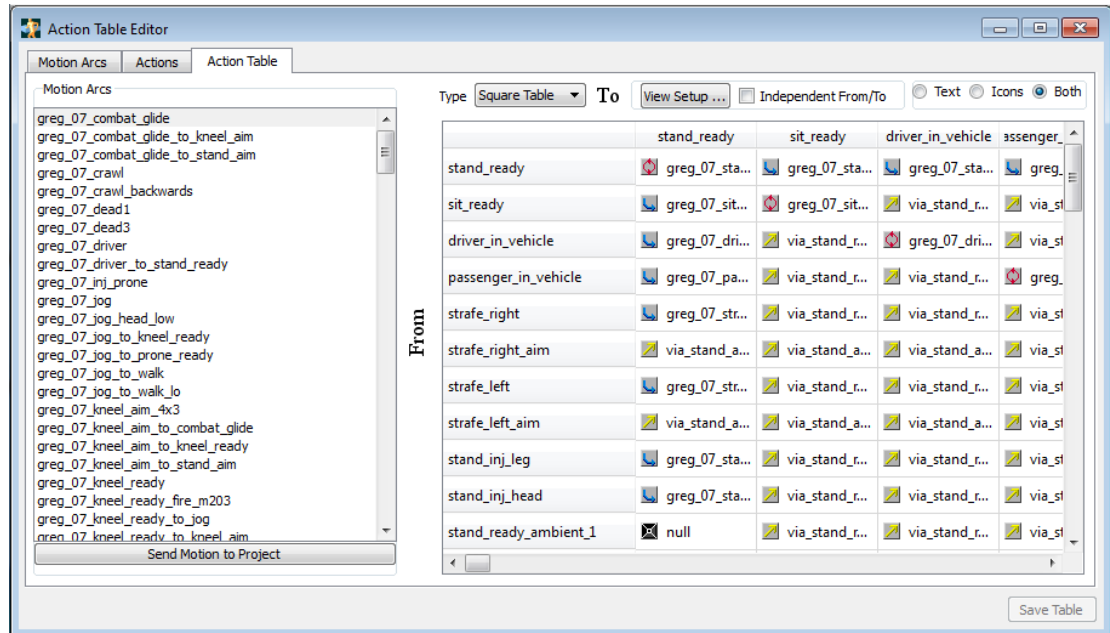
The Gesture Table Editor is analogous to the Action Table Editor in many ways. One exception was just given in 10.1.1, which discusses a GUI that only shows for the Action Table. Another GUI exception is given here for when the Gesture Table is showing the Gestures tab. The Gesture Tab GUI not only allows you to trigger a Gesture (just like you can trigger an Action) but it also allows you to test the effect of Channel A weight changes (the value of which can vary from 0.0 to 1.0). The following user interface is displayed for all selected Gestures:



Exercise Gesture group-box seen exclusively in the Gesture tab

The "Begin Gesture" button triggers the start of the gesture and lets it play until it reaches the "loop" part of the gesture (if the gesture loops), at which time the loop repeats indefinitely. If the gesture does not have a looping element, the "Begin Gesture" button will play the entire gesture once. The "End Gesture" button breaks the gesture out of its looping mode (if applicable) and allows the gesture to come to its natural end. The shown slider sets the Channel A weight of the gesture. This weight varies from 0.0 to 1.0 and determines how strongly the gesture overlays on top of an active motion arc.

10.2 Action Table Tab



The Action table Editor with the “Action Table” tab selected for soldier_07

The Action Table tab displays the contents of the DI-Guy Action Table for the character type. Each character type has only one action table. In this example, the table type is “Square Table”. Each row and column of an action table is labeled (left and top respectively) with the name of an action that the character can perform. Each cell in an action table contains either a *motion arc*, a null motion arc, or a “via” identifier that specifies the motion arch used to support the transition from the row action (**From**) to the column action (**To**). A motion arc may be dragged into the Action Table cell with the mouse while the left mouse button is depressed. If more than one cell in the Action Table is selected prior to the drop, then all selected cells in the Action Table are populated with the selected motion arc. Note also that items in the cells can be dragged into neighboring cells, replacing those cells contents with the dragged item.

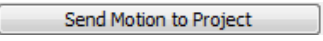
For a Square Table, the intersection of a row and a column contains the motion that will be used to perform the transition from the row action to the column action (note the “**From**” and “**To**” label to the left and on top of each table). Often the **From** → **To** transition is different than the **To** → **From** transition.

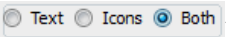
Square tables have the same number of rows as columns. A single-column table has many rows, but only one column. A three-column table has many rows, but only three columns. The various table types are described in detail in coming sections.

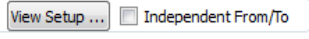
The Table Type () combo-box pull-down allows users to specify the kind of action table that the character uses. It is generally ok to increase the complexity of a table (say from single-column to three-column, or from single-column to square, or from three-column to square), but it's generally a bad idea to transfer from a more complicated table to a simpler one (say from square to three-column, or from square to single-column, or from three-column to single-column) because doing so loses information and may result in existing scenarios working differently. Changing the table type is ill-advised except for expert users.

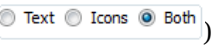
Note: Changing the Action Table Type will result in the DI-Guy Motion Editor automatically providing a newly populated table of the requested type with initial default values. Use the “undo/redo” features of the Motion Editor to prevent accidentally losing Action Table settings *if you change your mind* about the table

Double-clicking on a cell always selects that motion arc in the Motion Arcs section of the window and makes the Motions Arcs list-box scroll until it is ensured to be visible.

Clicking on the “Send Motion to Project” button () attempts to find the motion data file associated with the currently selected Motion Arc, and automatically imports the data and places it in the DI-Guy Motion Editor's Project window.

There are three different display settings options for the Action Table (). These are the “text view”, “icon view”, and “both”. These radio buttons are at the top right corner of the Action Table tab. They are used to select the display mode for this table. The display mode affects only how the Cells of the Action Table are presented to the user.

The View Setup ...” button and Independent From/To () checkbox work together to help users specify which rows and columns of the Action Table they want to see. The rows and columns that are not shown will still exist – they are just not displayed, which is useful if users want to focus their attention on a subset of the table. If the checkbox is selected before users press the *View Setup* button, then they'll get two pop-up dialogs instead of one (i.e., one dialog for rows, one dialog for columns, instead of one dialog to configure whether the action shows up at all on any row/column).

The Cell Display options combo-box () allow users to specify the content presentation for the action table cells.

The icons used in each Action Table cell have specific meanings, which are given here:

Icon	Meaning
Looped 	When the looped icon appears in a cell, it indicates that the motion arc in the cell should be capable of transitioning from and to itself; it should therefore be designed to look ok when doing so. This icon will automatically appear in certain tables when contextually correct.

Arc		When the arc icon appears in a cell, the motion is generally used a transition; it should look good when transitioning to and from the other motions it is associated with. This is the “generic” icon.
Null		When the null icon appears in a cell, it means that there is no motion arc in the cell, and that default motion interpolation may occur.
Via_<x>		The “via” motion arc icon indicates that this action should use the same transition as the via-action when transitioning to the destination action.

As will be described in the Motion Arcs section that soon follows, dragging a motion arc into an Action Table cell displays an appropriate icon in the dropped cell. For example, users should be able to find a “null” or “via” motion arc in the “Motion Arcs” list for any character type, and then use the mouse to drag that motion arc into a cell in the table.

10.2.1 Table Types

There are three types of tables supported by *DI-Guy*: square, three-column, and one-column. All types provide information on what motions, if any, should be used to transition from one action to another. For this reason, these tables are sometimes referred to as “transition tables”.



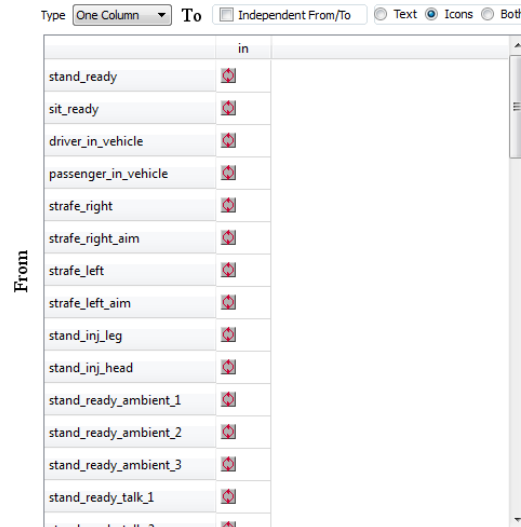
Table Type	Meaning
One-column	Each action transitions to another action directly, instead of through some intermediary motion arc. On-the-fly blending smooths the result.
Three-column	Each action transitions either to or from another action using the same motion arc. This generally works well when there is a “standard neutral” action (such as standing) that each action goes to before going to the next action.
Square	Each action can transition to and from any other action through an intermediary motion arc.

Details about the three *DI-Guy* Action Table types are provided in the sections that follow.



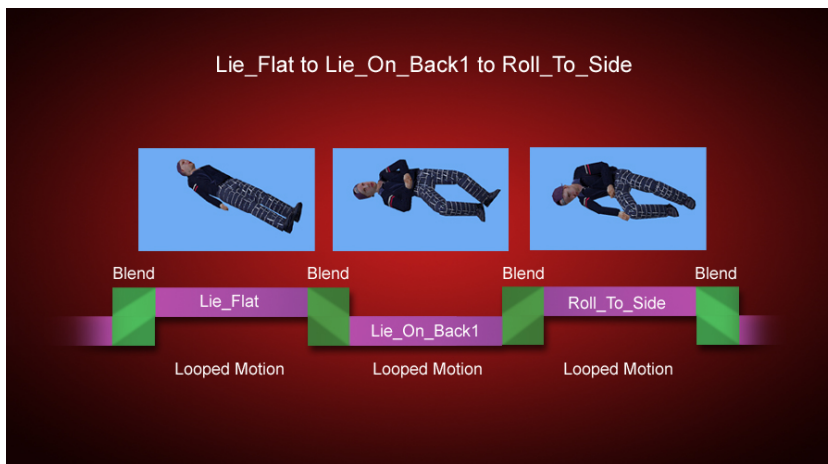
10.2.1.1 One-Column Table

A one-column action table (shown below) is the simplest table. Each action (i.e., row) corresponds to a single motion arc. Each motion arc in this table's cells should be designed to play well in a loop. DI-Guy blends the motions at runtime to transition from one action to another. None of the motion arcs in this table may be of type “via” or NULL.



One-Column Table (Icon View)

An example (unrelated to the screen-grab above) is given in the illustration below showing how a one-column table would transition from action *lie_flat* to action *lie_on_back1* to action *roll_to_side*. All three motions in this illustration are looped. DI-Guy does the blending work.



10.2.1.2 Three-Column Table

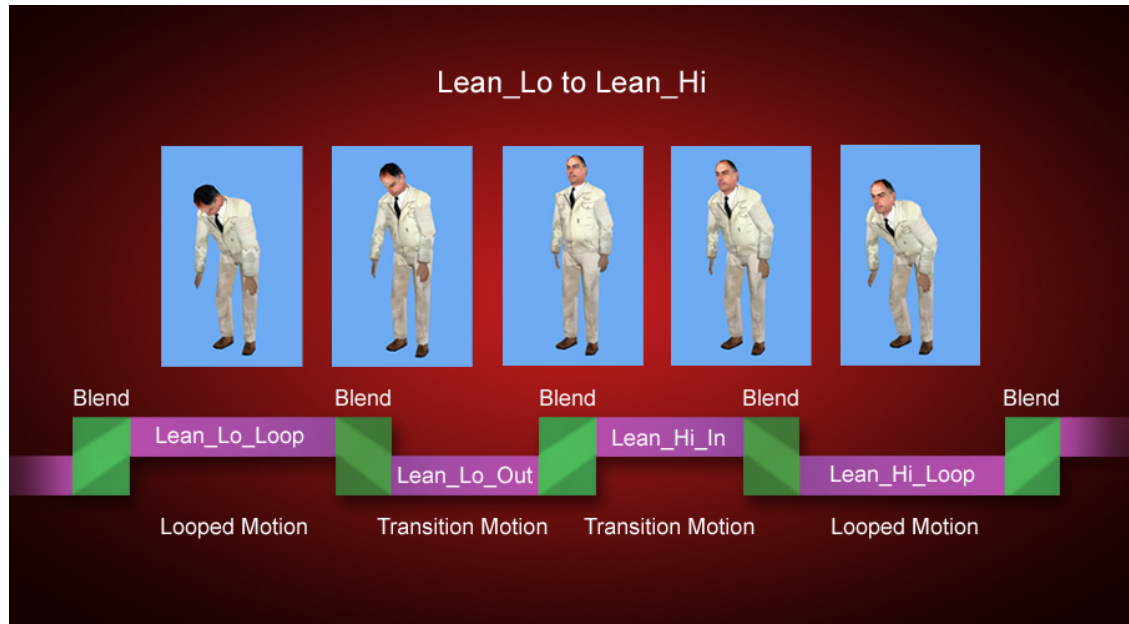
A three-column table (shown below) contains actions (i.e., each row) with three motion arcs to transition the action “in”, “loop”, and “out”. The looped column (in middle) should always contain a looped motion arc and it is usually the essential motion of the action. The “in” and “out” motion arcs may be NULL when there is no need to transition into the looped arc (in which case, that action behaves like a one-column action). None of the motion arcs in this table may be of type “via”. The center (looped) motion arc cannot be of type NULL. One common technique is to choose a common “neutral” posture (the same one may be used for all actions) from which the “in” and “out” motions blend well.

Type: **Three Column** To: ☐ Independent From/To ☐ Text ☒ Icons ☐ Both

	in	loop	out	
stand_ready				
sit_ready				
driver_in_vehicle				
passenger_in_vehicle				
strafe_right				
strafe_right_aim				
strafe_left				
strafe_left_aim				
stand_inj_leg				
stand_inj_head				
stand_ready_ambient_1				
stand_ready_ambient_2				
stand_ready_ambient_3				
stand_ready_talk_1				
stand_ready_talk_2				

Three-Column Table (Icon View)

An example (unrelated to the screen-grab above) is given in the illustration below showing how a three-column table might cause a transition between two (looped) motions to occur by using two intermediate (non-looping) motions. In this example, 1) motion *lean_lo_loop* passes through motion *lean_lo_out*, (the “out”) then 2) into motion *lean_hi_in* (the “in”) and finally 3) into motion *lean_hi_loop*, (the “loop”) where it can play repeatedly in a loop if needed. Switching between the two looping motions (*lean_lo_loop* and *lean_hi_loop*) gracefully uses two transition motion arcs. In this case, the “neutral” posture (as suggested in the table of icons earlier for a three column table) is “standing” (middle image).



10.2.1.3 Square Tables

A square action table (below) is the best solution for most characters because it offers the greatest flexibility. The down-side is that it takes longer to fill in. Every action can have a specific motion to transition it to every other action. Since every action in a square table can transition to itself, the diagonal of this table should always display looped motion arcs, which can be seen in the table below. Every time a new action is added, transitional motion arcs need to be specified to cover the “from” and “to” to every other action, therefore these table types can become large easily. None of the motions along the diagonal may be of type NULL or “via”.

Type **Square Table** To **View Setup ...** ☐ Independent From/To ☐ Text ☒ Icons ☐ Both

	stand	stand_long	walk	gallop	dead
stand					
stand_long					
walk					
gallop					
dead					

From

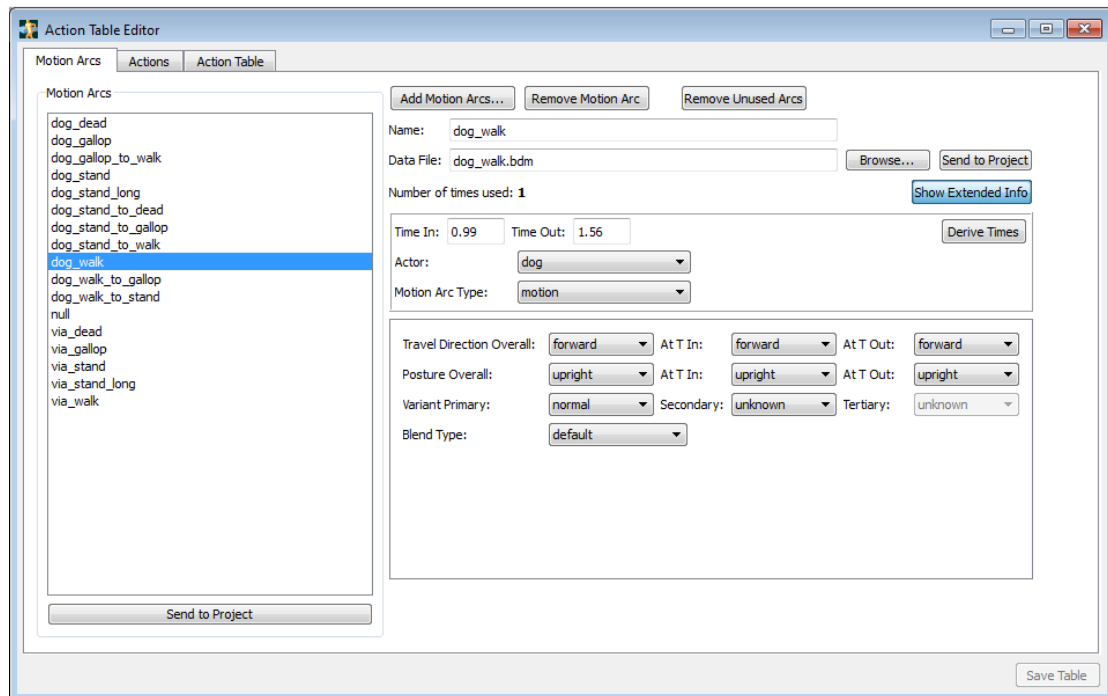
Simple Square Table (Icon View)

An example (unrelated to the screen-grab above) is given in the illustration below showing how a square table might cause a transition between two (looped) motions to occur by using one intermediate (non-looping) motion. In this example, 1) action *stand_ready* passes through *stand_ready_to_kneel_ready*, then 2) into *kneel_ready*, where it can play repeatedly in a loop if needed. Switching between the two looping motions takes only one transition motion arc.

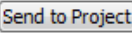
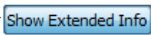


10.3 Motion Arcs Tab

This section of the document describes the Motion Arcs tab of the Action Table Editor window. The **Motion Arcs** portion of the tab (left-hand side) lists all available motion arcs that have been created for the current character. It also allows users to edit attributes of the motion arc, add new motion arcs, and delete existing motion arcs. Note, however, that a motion arc cannot be deleted if it is currently used in the action table – users must remove them from the table first. The graphic user interface is as shown below. All motion arcs must have unique names. It is particularly important to set the attributes of a motion arc correctly so that the transition machinery in DI-Guy can automatically preserve character orientation and translation continuity correctly when DI-Guy switches the character from one path to another. Users of this tool are strongly encouraged to test changes in DI-Guy concurrently.



Screen-grab of the Motion Arcs Tab of the Action table Editor, showing Extended Info

When a motion arc is selected (in the example above, *dog_walk* is selected), the information on the right hand of the window is updated. In particular, the name of the motion arc is shown again, the name of the data file containing the motion, and the number of times that the motion arc is used in the current action table. The user may select the “**Browse ...**” button () to change the data file associated with the selected motion and press the “**Send to Project**” button () to add the resource to the Project window. The number of times that the motion arc can be found in the current character’s action table is also shown. The “**Show Extended Info**” button () and area are described in the next section.

10.4 Motion Arc Extended Info

When the “**Show Extended Info**” button () in the Motion Arcs Tab of the Action Table Editor is depressed, additional information is shown that depends on the type of the motion arc currently selected. Null motion arcs and “via_*” motions have no extended information shown while more complicated types can have the type of information shown in the screen-grab below. There are several motion arc types to be aware of, as summarized in the next section, and then discussed in detailed in the sections that follow.



The screenshot shows a dialog box with the following elements:

- Time In: 0.99
- Time Out: 1.56
- Derive Times button
- Actor: dog (selected from a dropdown menu)
- Motion Arc Type: motion (selected from a dropdown menu)

The Extended Info data displayed for a particular motion arc

Time In	The motion arc “begin time” occurs at this time. Motion data proceeding the time in is considered padding data, and is used internally by DI-Guy to perform action transitioning. This is also called “tin”.
Time Out	Similar to the Time In, except this is where the motion arc ends. Motion data after this time is considered padding. This is also called “tout”.
Derive Times	If this button is pressed, then DI-Guy will: 1) attempt to derive reasonable time in and time out values for the currently selected motion arc, 2) replace them, 3) mark the motion arc (and therefore the action table) as edited, and 4) record a history of the event (so that undo/redo can be performed).
Actor	This refers to a particular person (for human characters) for which the motion was generated for or recorded from. It is important to select the correct actor so that different actors can play the motion data without it looking inappropriate on them. In particular, since the heights of different DI-Guy characters differ, DI-Guy must scale the motion arc data designed for other actors when playing motions on a different actor in such a way that the feet of any character will reach the floor. DI-Guy minimizes slippage of the feet that might occur during walking or running, for example.
Motion Arc Type	The type of motion, as described in the next section. The values can be one of: motion, pose, 1-axis pose, 2-axis pose, 2-channel pose, 2-channel motion, vehicle, unknown, null, and via_action.

10.4.1 Motion Arc Types

The type of a motion arc determines how DI-Guy will play the motion back, and also determines what kind of role the motion may serve for the character. Below is a list and description of the various types.

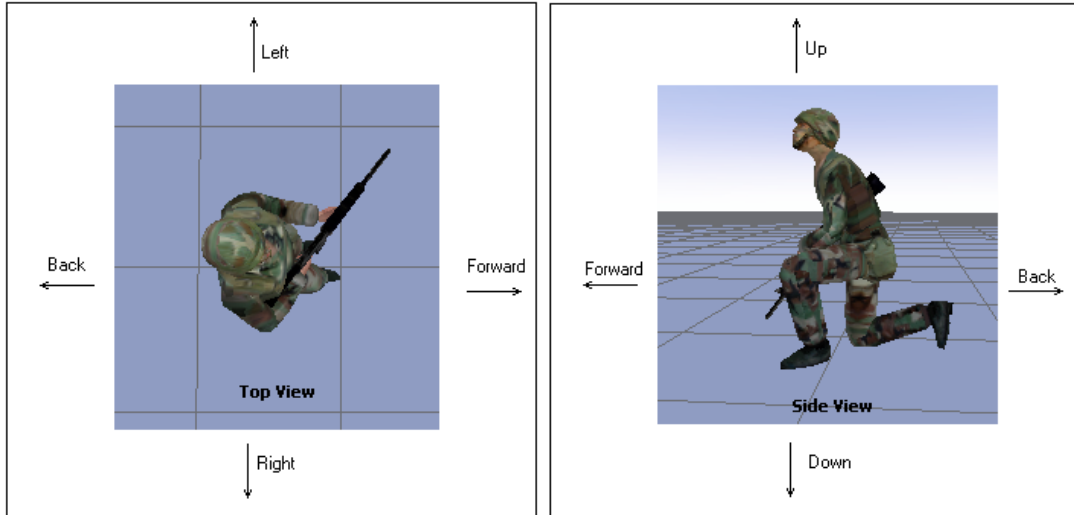
Motion Arc Type	Description
unknown	deprecated
null	The selected motion arc is NULL, meaning there is no motion arc in the selected table cell. This is not typically selected by users.
motion	More than four frames of data are required of this motion type. The motion should have padding, and time-in and time-out set appropriately. DI-Guy plays each frame of data except the padding, which is used to compute transitions between actions.
pose	One frame of motion data is required of the motion. Time is ignored, and so is the frame rate, time in, and time out, because they are not applicable.
2-channel pose	deprecated
1-axis pose	Two frames of motion data are required of the motion (time is ignored, so the frame rate, time in, and time out are considered not applicable). The motion describes the two postures that are to be transition between as a single axis value changes between two extremes. Useful with joystick-control.
2-axis pose	Four frames of data are required of the motion (time is ignored, so the frame rate, time in, and time out are considered not applicable). If the four 2-axis frames of data are thought of as corners of a rectangle, then the frames [0, 1, 2, 3] of the motion correspond to these corners of the rectangle: {lower left, upper left, lower right, upper right}. The motion describes the four postures that are to be transitioned between as the values of a two axes vary in a finite, rectangular region. Useful with joystick-control.
2-channel motion	2 channel motions are used by gestures.
vehicle	Designates a vehicle_09 motion
via_action	This type is actually a convenient shorthand way of indicating to the Action Table that a transition (say from action A to action B) should first transition to the via action, and then of course the via action transition to the destination action. For example, a character who can do pushups and for whom a user has built a new jumping jack motion. Instead of creating a jumping jack to pushup motion, the user could instead use via_action stand, which would have the character transition from jumping jack to stand, and then from stand to push ups.

10.4.2 Direction Types

The direction of a character is also referred to as it's facing. Knowing the direction of a motion at the beginning, looping-part, and ending of a motion can be important to DI-Guy since it must automatically manage the transitions between various actions, and this usually means keeping some amount of continuity in the facing of the various motion arcs that underlie each action. For this reason, users should become familiar with the following terms, and be diligent in selecting the correct direction type for motion edited. Users will see this terminology used in the extended info section of the Motion Arc graphic interface, under the labels: “**Travel Direction Overall**” labels, “**Facing Direction T-In**”, and “**Facing Direction T-Out**”.

Direction Type	Description
none	A stationary motion, such as stand. Most motions are either “none” or “forward”. “None” motions mean that the loop will have no change in <i>translation</i> and <i>rotation</i> .
forward	Along with “none”, the most common motion type. Character moves forward down the x-axis.
backward	Backward movement. ADVANCED USERS ONLY.
left	Leftward movement (usually a side-step). ADVANCED USERS ONLY.
right	Rightward movement (usually a side-step). ADVANCED USERS ONLY.
up	Rising movement (say, rise from sitting). ADVANCED USERS ONLY.
down	Downward movement (say, sitting down). ADVANCED USERS ONLY.
turn left	If the character starts facing “forward” but during the motion rotates to the left 90 degrees, then the overall travel direction should be “turn left” while the t-in direction would be “forward” and the t-out direction would be “left”. ADVANCED USERS ONLY.
turn right	If the character starts facing “forward” but during the motion rotates to the right 90 degrees, then the overall travel direction should be “turn right” while the t-in direction would be “forward” and the t-out direction would be “right”. ADVANCED USERS ONLY.
nonlinear	The motion doesn't move along any particular axis in a regular manner. ADVANCED USERS ONLY.
linear off-axis	The motion moves along an axis, but not the x, y, or z axis. For example, if the character starts facing “forward” but during the motion rotates to the left only 30 degrees (say), then the overall travel direction should be “turn left”, while the t-in direction would be “forward” and the t-out direction would be “linear off-axis” THIS SETTING IS STRONGLY DISCOURAGED. ADVANCED USERS ONLY.
inherit	The motion direction takes on the corresponding direction of the previous

	motion arc (that was used to transition into this motion arc). ADVANCED USERS ONLY.
unknown	This only means that the direction type has not yet been specified. THIS SETTING IS STRONGLY DISCOURAGED. ADVANCED USERS ONLY.



These illustrations show examples of the direction types. The above images assume that a motion arc moves the character's base joint in the direction of the arrows.

10.4.3 Posture Types

The posture type of a character (or motion arc) is important to DI-Guy for the many of the same reasons that the direction is, but it uniquely important for querying use such as the joystick manipulation (think DI-Guy Interactive-Guy) where buttons are assigned to control the posture of a character in a hopefully consistent and intuitive way. For this reason, users should become familiar with the following terms, and be diligent in selecting the correct posture type for each motion edited. Users will see this terminology used in the extended info section of the Motion Arc graphic interface, under the labels: “**Posture Overall**” labels, “**Posture T-In**”, and “**Posture T-Out**”.

Posture Type	Description
upright	The character is standing vertically, or nearly vertically.
crouched	The character is standing but bent forward significantly, or kneeling.
prone	The character is lying horizontally, or is very low.
sitting	The character is sitting.
any	The (looped) motion arc spans across multiple posture types.

unknown	This only means that the posture type has not yet been specified.
---------	---

10.4.4 Motion Arc Type: Motion

When the Motion Arc Type (shown when Extended Info is selected) is set to **Motion**, the following information is displayed in the GUI.

Travel Direction Overall:	forward	At T In:	forward	At T Out:	forward
Posture Overall:	upright	At T In:	upright	At T Out:	upright
Variant Primary:	normal	Secondary:	unknown	Tertiary:	unknown
Blend Type:	default				

Screen-grab of Motion Arc information for motion arc type “Motion”

“Motion” is the most commonly used motion arc type found in the Motion Arc list. The fields shown above have the following meaning given in the table below.

Field	Function and Meaning
Travel Direction Overall	Overall, the conceptual direction of the motion arc. See “direction types” earlier.
At T In	The direction that the motion starts at during tin. See “direction types” earlier.
At T Out	The direction that the motion ends at during tout. See “direction types” earlier.
Posture Overall	Overall, the conceptual direction of the motion arc. See “posture types” earlier.
At T In	The posture that the motion starts at during tin. See “posture types” earlier.
At T Out	The posture that the motion ends at during tout. See “posture types” earlier.
Variant Primary	normal, aim, dead, angry, assault, curious, exercise, funky, injured, ready, sick, socialize, other, misc0, misc1, ... misc9, unknown, any. By classifying a motion with a variant, DI-Guy can later be queried for an action and return the best fit. For example, a user may ask for a stationary action with variant angry, and the character will play a “protest” action.
Secondary	Some motions are best classified with multiple variants.
Tertiary	Some motions are best classified with multiple variants.
Blend Type	Exponential-5, Exponential-10, Half-Sine, Linear, Quarter-Sine, Step-Halfway, Waver

10.4.5 Motion Arc Type: Pose

When the Motion Arc Type (shown when Extended Info is selected) is set to **Pose**, the following information is displayed in the GUI.

Facing Direction:	forward				
Posture:	upright				
Variant Primary:	normal	Secondary:	unknown	Tertiary:	unknown

The Pose motion arc time is a relatively rare motion arc type that is simple. It involves only one frame of data, only one facing, and only one posture description. Since it ignores time, there are no tin or tout qualifiers to populate. The fields here have roughly the same meaning given in the earlier “Motion” motion arc type example.

10.4.6 Motion Arc Type: NULL

When the Motion Arc Type (shown when Extended Info is selected) is set to **Null**, the following information is displayed in the GUI. For Motion Arc type “NULL” there is little to show.

Blend Duration:	-1
Blend Function:	Exponential5

The Blend fields here have roughly the same meaning given in the earlier “Motion” motion arc type example.

10.4.7 Motion Arc Type: Unknown

The Motion Arc Type (shown when Extended Info is selected) cannot be set directly to **Unknown**. However, if “unknown” motion arc is selected from the Motion Arcs list, the following information is displayed in the GUI.

Blend Duration:	-1
Blend Function:	Exponential5

This information is grayed out because DI-Guy does not process unknown motion arcs.

10.4.8 Motion Arc Type: Via action

The Motion Arc Type (shown when Extended Info is selected) cannot be directly set to **via_action** because it's forbidden. However, if one selects one of the via_* motion arcs listed in the Motions Arcs list, then only the name of the action will be seen that supplies the transition details of the via_action shown.

Action: walk

10.4.9 Motion Arc Type: 1-Axis Pose

One-axis poses are used for tasks like aiming where a parameter is used to index into a pose space defined by the motion arc. Two poses are then included at two different points along the axis, for example, a left-aiming pose and a right-aiming pose. The parameter is then used to index into a pose derived via interpolation from the two definition poses.

The motion-arc-specific graphic user interface for Motion Arc type “1-Axis Pose” is shown below. It involves only the two frames of data. Also, since it ignores time, only one facing and one posture description is necessary, and there are no tin or tout qualifiers. The “**Min Axis**” and “**Max Axis**” settings define the range of the parameterization (as if a positioning along the axis) usually associated with a DI-Guy bead (such as *aim bead*). See *DI-Guy* documentation for details. The other fields here have roughly the same meaning as those given in the “Motion” motion arc type example.

Facing Direction:	forward ▼		
Posture:	upright ▼		
Variant Primary:	normal ▼	Secondary:	unknown ▼
		Tertiary:	unknown ▼
Min Axis:	0	Max Axis:	1

10.4.10 Motion Arc Type: 2-Axis Pose

Two-axes poses are identical to 1-axis poses except they use four poses that define the 2D pose space (along two independent axes) that retrieve poses based on two parameters. See *DI-Guy* documentation for details. The other fields here have roughly the same meaning as those given in the “Motion” motion arc type example.

Facing Direction:	forward		
Posture:	upright		
Variant Primary:	normal	Secondary:	unknown
Tertiary:	unknown		
Min Axis 0:	0	Max Axis 0:	1
Min Axis 1:	0	Max Axis 1:	1

10.4.11 Motion Arc Type: 2-channel pose

2 channel poses are not recommended.

Facing Direction:	forward		
Posture:	upright		
Variant Primary:	normal	Secondary:	unknown
Tertiary:	unknown		
Channel B			
Data File:		Browse...	Send to Project

10.4.12 Motion Arc Type: 2-channel motion

Gestures can use 2 channel motions, often with different intensities of gestures. Users can then parameterize how much of each channel they want for the final gesture.

Travel Direction Overall:	forward	At T In:	forward	At T Out:	forward
Posture Overall:	upright	At T In:	upright	At T Out:	upright
Variant Primary:	normal	Secondary:	unknown	Tertiary:	unknown
Blend Type:	default				
Channel B					
Data File:		Browse...	Send to Project		
Time In:	0	Time Out:	0		

10.4.13 Motion Arc Type: Vehicle

Vehicle_09 motions only.



10.5 Action Table configuration files

Action Tables are stored in human-readable ASCII text configuration files. They are generated when the user saves the table and uses the File→Save Action Table menu. It's important for users to save these files in the correct directory location. In order to be useful, DI-Guy Scenario must be able to locate and load the tables during a DI-Guy session. This section describes the search technique that DI-Guy uses to locate Action Table configuration files. Specifically, let's give the search path for the action table for character type <foo> (e.g. <foo> is “dog”, “fireman”, “soldier”, “vehicle”, and so on). The files are first searched for in location:

`%DIGUY%\custom\config\diguy\char_<foo>_action_table.cfg`

If the file is not found there, then it is secondly looked for in:

`%DIGUY%\custom\config\diguy\char_<foo>_action_table.cfg`

Finally, if for whatever reason, you decide to hand-edit these files, be aware of the following rules:

1-column action tables have N actions and N action table entries.

=====

3-column action tables have N actions and 3*N action table entries. The entries are a series of 3 motions (pre, loop, post) for each action.

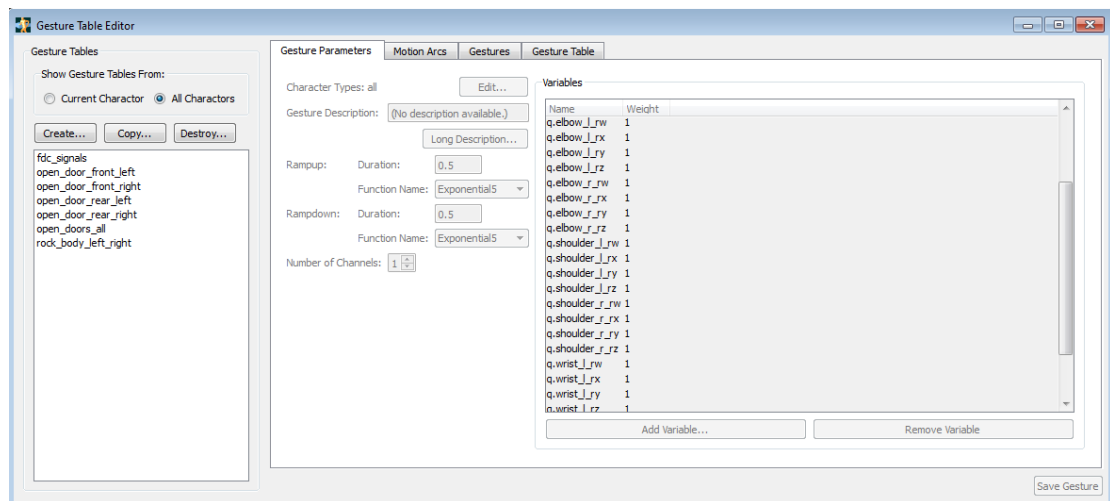
=====

Square action tables have N actions and N*N action table entries. Entry i,j defines the underlying blend motion from action i into action j, except when i equals j, when it instead defines the underlying looping motion of action i.

11 Gesture Table Editor

Gestures extend the behavior of a DI-Guy Character by piggy-backing extra body movement onto existing Actions for a suite of character types. The Gesture Table Editor allows review, creation, modification, and extension of gesture motions.

If a gesture table is suitable for a character, then all of the gestures are available to all of the actions defined by that character type. That is, the Gesture Table doesn't care about the Action Table at all (and vice versa). Rather, gesture compatibility requires only that the DOF names correspond for a motion and a character type. A character type's Action and Gesture table types are independent of each other.



The Gesture Table Editor, with the “Gesture Parameters” tab selected for gesture table “fcd_signals”

The Gesture Table Editor lets users discover all defined gestures (not only for the current character type, but for all character types if desired), edit or specify the gesture motion blend weights that each gesture DOF uses when a gesture is applied, specify which character DOFs the gesture will affect, and set up a gesture table that specifies the underlying motions that are used to perform each gesture as well as specifies the transitional motions used to transition from one gesture to another gesture.

When the Gesture Table Editor or the Action Table Editor windows are active, they take control of the 3D View window; otherwise, the Timeline window has control.

Not every DI-Guy Character type has a gesture table or can use gestures. Standard character types have gestures but unusual character types may not. Existing tables may be applicable to the active

character type; users should inspect the *Variables* (i.e. DOF names) listed in the Gesture Parameters tab of the Gesture Table Editor to see if they match the variable names of the character.

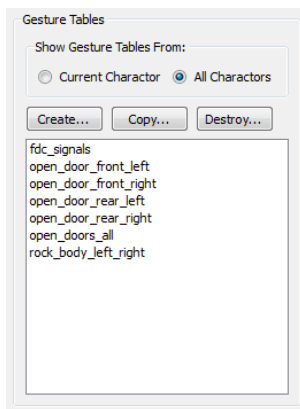
After edits have been completed on a gesture table, it is important to save the table (first by using the button on bottom right of window) and then by using File→Save Gesture Table.

11.1 Gesture Table Selector

A **gesture** is a motion that is applied to a sub-set of the DOF of a character during a particular action. Gesture definitions describe which DOFs they control and a weight value indicates how much the new DOF value should be blended with the existing DOF value. Weights set to zero have no effect, whereas weights of one will result in the gesture totally overriding the current value of a DOF. A typical example of a gesture would be a “hand-wave” where the weights of the motion are non-zero for the waving arm only, and perhaps part of the back, because waving a hand only requires DI-Guy algorithms to take over one arm of a character, leaving the rest of character’s action unedited.

The DOF weights of a Gesture Table are constant and will not be changed from gesture to gesture. If different gestures require different weights, another gesture table is required.

Below, we describe the Gesture Table selector.



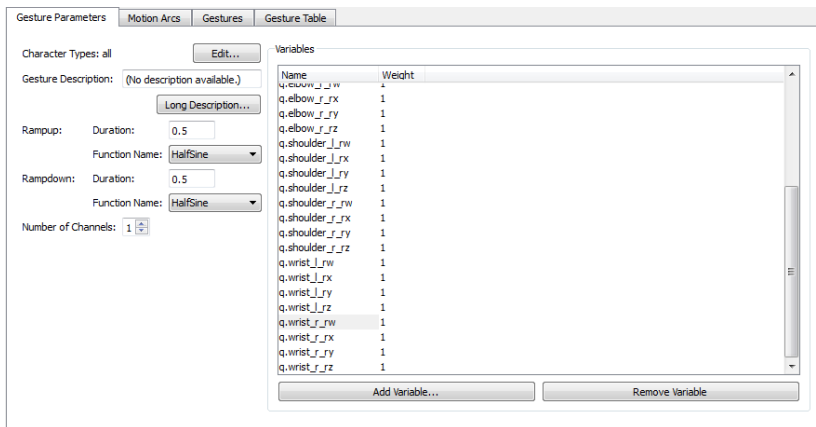
The Gesture Table Sector, showing gesture tables for all characters

- The “Show Gesture Tables From” combo-box (shown above) allows users to search for gesture tables for either the current character (which may have none), or for all DI-Guy characters. The names of the found gesture tables will show up in the gesture table list. Note that the gesture table “fdc_signals” (as shown first above) is a gesture table that works for most human *DI-Guy* character types.
- The Create button () will create a new gesture table. Users can set the gesture parameters for that table, set up the motion arcs, the gestures, and establish the contents of the gesture table using the other tabs of the Gesture Table Editor. By default, a new table is accessible to all Characters.

- The Copy button () will copy an existing table (the one selected) and create a new gesture table based off of it. A unique name is required for the new gesture table.
- Pressing the Destroy button () will delete the currently selected gesture table.

11.2 Gesture Parameters Tab

The Gesture Parameter Tab allow users to: specify which characters have access to the gesture table, provide a description of the table, and to specify many details regarding the nature of the blending that the gesture automatically performs.

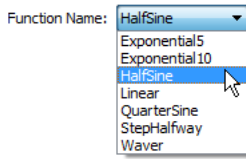


Screen-grab of the Gesture Tab from the Gesture Table Editor

The Left hand side of the Gesture Parameters Tab contains several pull-downs and editable boxes. They are described below.

- **Character Types:** This label shows users the characters that can use the gesture table. Using the Edit button (), users can change this with a **multi-selection** dialog (one or more character types). Also note that one of the options in the pop-up dialog is “All.” Users can, of course, make the table for just one character type by selecting only one character in the list. The effect of changing the character type is that the list of potential variables (DOF) that the gesture effects is culled to include only variable names useful to those characters.
- **Gesture Description:** This editable text-box contains a user-edible description of the Action table. For a longer description, enter the description using the Log Description dialog, which is launched by the “Long Description” button (). Or users can view the long description that is already provided using this button.
- **Rampup:** This setting determines the blend duration when the gesture is overlayed onto an action from the Action Table. The duration is in seconds. The type of blend is determined

from the function selected in the function-name combo-box. These are the same functions previously described in the Action Table Editor chapter.



Screen-grab of a mouse-click on the Function Name combo-box

- Rampdown: Just like ramp-up, a blend must be able to ramp out. These settings are analogous to the ramp-up settings.
- Number of Channels: Indicates whether a single (default) or dual channel gesture is being used.

Finally, the right-hand side of the Gesture Parameter's tab shows the list of variable names (DOF) and the gesture DOF weights. A weight of 0 means the gesture does not affect a particular DOF whereas a weight of 1 means the gesture completely overrides the current DOF value. These weights can be hand-edited by clicking on the text in the Weight column, and typing in a number. Additionally, variables can be added () or deleted (). Note that if the weight is zero, users might as well delete that variable.

11.3 Motion Arcs Tab, Gestures Tab, Gesture Table Tab

For these tabs, please see the Action Table Editor section.

The three right-most tabs on the right-hand side of the Gesture Table (labeled the *Motion Arcs* tab, *Gestures* tab, and the *Gesture Table* tab) are nearly identical in design and presentation to those tabs found in the Action Table Editor window (which are analogously labeled Motion Arcs tab, Actions tab, and Action Table tab). The difference is that the tabs in the Gesture Table Editor window serve to specify the Gesture Table data instead of Action Table data.

12 Importing and Exporting Motions

12.1 Idealized Data

DI-Guy uses a concept called *idealized data* to help distill basic information about a motion. *Idealized data* allows the software to gain a higher-level understanding of the motion. The concept is best explained by an example:

Let's imagine that we are creating a motion called `drunken_walk`. In this motion, our character advances forward 1 meter, but while he does this he staggers from side to side. It looks like this:

XY plot of base joint (center of hips)

XY plot of Idealized Data

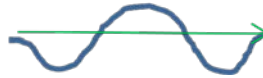


Illustration of the x and y translation of a drunken walk

The **idealized** motion of this character would be a straight line in the x direction that moves at constant velocity. Meanwhile, the **base** link of the character is moving side to side as the character staggers up the street.

- This *idealized* information is represented in the motion (.bdm) file by the variables:
[q.x, q.y, q.z, q.rz, q.rx, q.ry]
- The *base* information is represented in the same motion (.bdm) file by different variables specifying the transform from the idealized position to the final base (hip) position:

[q.base_tx, q.base_ty, q.base_tz, q.base_rz, q.base_rx, q.base_ry]

Thus the sum of the base transform and the idealized transform derives the true position of the hip in space. (Note: Studios users will note that there is a third transform called offset as well, but this transform is only used internally by DI-Guy: motion creators need not worry about these variables).

The sum of the *base* transform and the *idealized* transform derives the true position of the character in space.

12.2 Idealized Data

When playing a motion in the motion editor, the idealized variables $q.\{x, y, z\}$ and $q.r\{x, y, z\}$ can be found in the Joint Editor Window and can be edited and processed just like any other variable. Editing these values, however, is recommended for Advanced Users only. During motion export, DI-Guy will automatically calculate idealized data.

12.2.1 Importing Motions from a different Actor

If users choose to import a motion into the *Motion Editor* that was created by a different actor and then export a *DI-Guy* motion from the *Motion Editor* Timeline, the current DI-Guy Actor is now used to generate the idealized data, not the actor who actually performed the original motion, so users should let DI-Guy recompute idealized data during export, or otherwise edit it by hand. Visually inspect the motion in these circumstances, and use tools like the Offset Effect transition to repair any problems caused by actor mismatch.

12.3 Importing BVH files

In addition to being able to import other Boston Dynamics Motion (.bdm) files, DI-Guy Motion Editor also can import Bio-Vision Hierarchical (.bvh) files. These files are restricted to having skeletal hierarchies and joint names that match the current character of the Motion Editor.

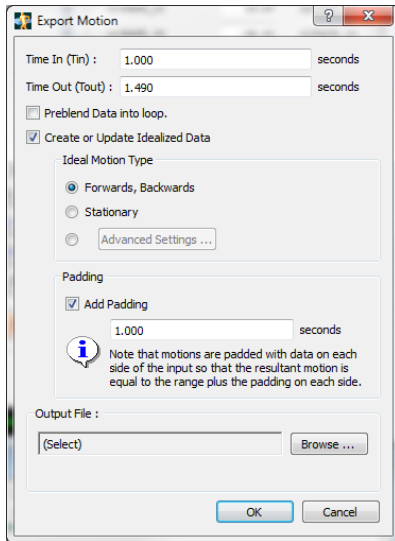
The bvh file %DIGUY%/motions/sample.bvh is included in the distribution to aid users with constructing compatible bvh files.

To import a bvh motion, select File→Import→Motion or Pose, just as is usual.

12.4 Exporting Motions

Motion exporting optionally allows the user to prepare the additional information that DI-Guy needs about the motion so that it can be used properly by the DI-Guy motion engine and the Action Table. To export the current contents of the Timeline as defined by the range selector (or all data, if the range selector is not shown), select File→Export→Motion. The Export Motion dialog will then appear to assist with correctly exporting the motion.

It is **STRONGLY RECOMMENDED** that exported motions allow for 1 second of padding on each side of the motion. For example, one might define a walk motion from a motion capture session of many steps. Instead of selecting a cycle starting at the first step, the user should start the selection at a point in the timeline where there is a second of natural walking data to the left, and end the selection where there is still a second of motion data to the right. Having natural motion padding on each end results in better motion blending in the DI-Guy motion engine.



The Export Motion Dialog

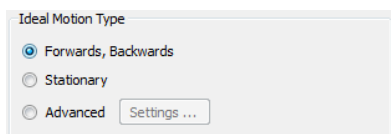
12.4.1 Pre-blended Data

When a motion is exported, it's possible to set it up so that the padding is pre-blended. Use the pre-blend data check-box (☐ **Preblend Data into loop.**) to specify this. Only advanced users should do this, and couple this selection with action table entries for the motion arc also designating that the blend would be “already blended”.

12.4.2 Creating or Updating Idealized Data

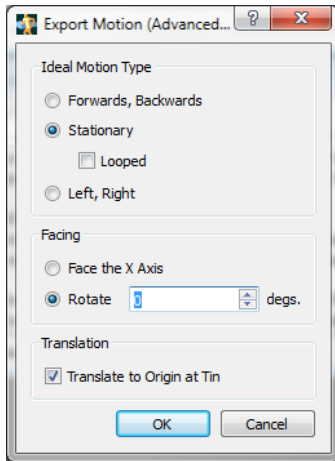
Users will almost always want to create or update the idealized data when they export a motion that is to be used with *DI-Guy*. The “Create or Update Idealized Data” check-box (☒ **Create or Update Idealized Data**) allows users to turn this feature on and off.

If users elect to update or create idealized data, then they'll need to classify the motion as a forwards/backwards motion, or as a stationary motion, or they may be creating a more advanced motion and need to select the “Advanced” option to specify the idealized data options. Remember that idealized data is an idealized notion of how a character is moving. A character that is dancing but ends up very near where the character started should be classified as a stationary motion. Forward and backwards motions should face in the positive X direction.



Idealized Motion settings

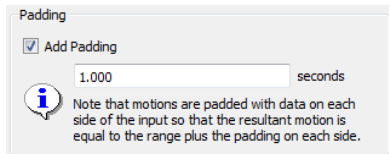
Advanced users can also use Advanced Settings to specify idealized data where the character moves left or right, and also specify the facing of the motion. Please see the Action Table documentation for further description of facing and motion direction.



The Advanced Ideal Motion Type settings pop-up dialog

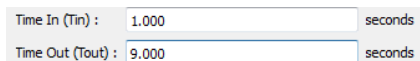
12.4.3 Padding

DI-Guy pads its motions, usually 1 second on each side, to enhance the appearance of motions as they are being blended into actions by the DI-Guy motion engine. It's recommended that padding should always be added to motions to achieve smooth action transitioning. A larger padding can be specified if the motion requires more time for the blend-in and blend-out to work well.



Screen-grab of the Padding options area

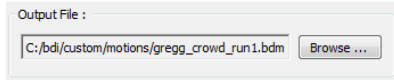
The motion export dialog will try to export as much data directly from the timeline as is possible to implement the padding. Extra padding data is generated automatically if the padding time extends past the end of data on the timeline. Notice that a 10 second motion on the timeline (imagine that the range selector spans from 0.000 to 10.000 seconds and with padding of 1 second), then the exporter will export seconds 0-10 as the motion (perhaps it's a looping motion) but auto-generate an extra second of data on each end. This is not optimal. Better would be to use a motion where there is real data on either side of the motion specified using the range selector.



Specification for Tin and Tout.

12.4.4 Output File

After all of the options have been selected for Motion Export, users still need to specify the output file name. Users should browse to select an appropriate output directory and filename.



Screen-grab of the output-file specification area

Boston Dynamics uses the file naming convention of: **<actor_name>_<motion_descriptor>** and recommends this convention to the user. For example, “gregg_run” would be the name of the output file if the actor is named Gregg and the motion being created is a running motion.

After pressing the OK button in this dialog, the user will 1) be offered a preview of the motion, 2) be asked which Action Tables the motion should be made available to, and 3) be prompted for a motion arc name that will be used by the Action Table(s) for the character type being used.

Boston Dynamics uses the motion arc naming convention of:

id_<actor_name>_<motion_descriptor> and recommends this convention to the user. Users can later change the motion arc name in the Action Table Editor. For more information on working with the new motion and motion arc, please consult the Action Table Editor chapter.

12.5 Gestures

The motion data for a gesture is just the same as the motion data for an action, except that it only needs data for the joints used by the gesture. For example, if the gesture uses just the upper body, data for the lower body (hips, knees, and ankles) is not needed.

Most gestures have three motion arcs, one to initiate the gesture, a second that can be repeated many times to extend the gesture, and a third to terminate the gesture. The three motion arcs can be from the same motion file or from separate motion files.

Once users have motion data for the gesture, create a DI-Guy configuration file to define the gesture. For examples of how to define a gesture, look at %DIGUY%\config\gestures_wave.cfg, which defines three different waving gestures. Name the file autoload_gesture_<mnemonic>.cfg and save it in folder %DIGUY%\custom\config.

For example, imagine a need for a gesture for stirring something. Create a motion file that has a character stirring, and save it as brooks_stir.bdm. Imagine that the data from 1.0 to 1.5 s brings the right hand up to begin stirring, from 1.5 to 2.5 s is one complete revolution of the whisk, and from 2.5 to 3.0 s withdraws the hand. Define the gesture as follows:

```
gesture stir_arm_r
  gesture_type = progression
  num_stages = 3
  num_channels = 1
  progression_stage1 = in
  progression_stage2 = loop
  progression_stage3 = out
```

```
include common/gesture_variables_back_50.cfg
include common/gesture_variables_head_50.cfg
include common/gesture_variables_arm_r.cfg
character_type = all

motion_arc in
    datafile = brooks_stir.bdm
    tin = 1.000
    tout = 1.500

motion_arc loop
    datafile = brooks_stir.bdm
    tin = 1.500
    tout = 2.500

motion_arc out
    datafile = brooks_stir.bdm
    tin = 2.500
    tout = 3.000
```

13 Hotkeys

This table describes the “Hotkey” functionality of the Motion Editor. It is important to note which window has focus when using a Hotkey, as Hotkeys are “caught” by particular windows of the Motion Editor. See the “window/scope” column of this table to learn which window must have focus in order for the hotkey to function.

Key	Window/Scope	Description
Ctrl + O	Any/All	Open Project
Ctrl + W	Any/All	Close Project
Ctrl + S	Any/All	Save Project
Ctrl + N	Any/All	Import Motion or Pose
Ctrl + E	Any/All	Export Pose
Ctrl + M	Any/All	Export Motion
Ctrl + Q	Any/All	Quit Motion Editor
Ctrl + Z	Any/All	Undo
Ctrl + Y	Any/All	Redo
Ctrl + X	Any/All	Cut
Ctrl + C	Any/All	Copy
Ctrl + V	Any/All	Paste
Delete	Any/All	Delete (deletes from the timeline)
Ctrl + D	Any/All	Open/Close 3D View window
Ctrl + P	Any/All	Open/Close Project window
Ctrl + T	Any/All	Open/Close Timeline window
Ctrl + I	Any/All	Open/Close Info window
Ctrl + J	Any/All	Open/Close Joint Editor window
Ctrl + L	Any/All	Open/Close Log window
Ctrl + K	Any/All	Open/Close Camera window
Ctrl + H	Any/All	Open a Help window
Ctrl + A	Any/All	Open/Close the Action window
Ctrl + G	Any/All	Open/Close the Gesture window

L	Any/All	Clears the Log window
Shift + L	Any/All	Run Limits report (to log window)
Ctrl + U	Any/All	Import Audio
Ctrl + R	Any/All	Launch the Joint Limits dialog
<	Any/All	Decreases the timeline playback speed (Slower)
>	Any/All	Increases the timeline playback speed (Faster)
Home or O	Any/All	Jump time to beginning of timeline
End or Shift + O	Any/All	Jump time to end of timeline
[or Page Up	Any/All	Move time left one frame
] or Page Down	Any/All	Move time right one frame
P	Any/All	Toggle forward playing of timeline (resume/pause)
Shift + P	Any/All	Toggles reverse playing of timeline (resume/pause)
A	Any/All	Toggle all audio tracks on/off
0 through 9	Any, Camera mode	Activate camera 1 through 10
Ctrl + 0 through 9	Any, Camera mode	Save the current camera settings to the index
+	3D, Pose Editor	Increase rotation, or translation value (single DOF only) (Hold the Shift Key down for even faster changes)
-	3D, Pose Editor	Decrease rotation or translation value (single DOF only) (Hold the Shift Key down for even faster changes)
↑	3D, Pose Editor	Parent Joint
↓	3D, Pose Editor	Child Joint
→	3D, Pose Editor	Left Sibling Joint
←	3D, Pose Editor	Right Sibling Joint
Space	3D, Pose Editor	Toggle DOF

F1	3D, IK mode	Increase mouse sensitivity for edits
+	3D, Camera mode	Increase translation time factor (faster movement)
-	3D, Camera mode	Decrease translation time factor (slower movement)
F	3D, Camera mode	Set camera to forward mode (if mover is FLY, and not focusing on a character)
S	3D, Camera mode	Set camera to sideways mode (if mover is FLY, and not focusing on a character)
D	3D, Camera mode	Set camera to vertical mode (if mover is FLY, and not focusing on a character)
+	Timeline	Zooms in (changes time scale)
-	Timeline	Zooms out (changes time scale)
Ctrl + ←	Timeline	Scroll timeline horizontally left
Ctrl + →	Timeline	Scroll timeline horizontally right
U	Timeline	Update the Joint Limit Compliance Track
Space	Timeline	Toggle Snap-to

14 Glossary

Chain: A chain is a set of continuous joint-link DOFs that do not branch. Thus, the set of the three DOFs of the left thigh of the character could be considered a single chain, while the set of DOFs for both thighs would have to be considered two chains. Chains are used by Inverse Kinematics

Channel: A Motion Track consists of three channels, the A, B, and T channels. The A and B channels can have motions, poses, and trajectories loaded into them while the T channel can have transitions.

Degree-of-Freedom (DOF) : Joints in the model of the character can be described by the number and type of DOFs of which they are composed. For example, a pin joint contains a single degree-of-freedom joint where the joint can rotate about one axis. The base joint is a 6DOF joint; it describes a position that requires 6 degrees-of-freedom to specify it (X, Y, Z, YAW, ROLL, and PITCH)

Joint Group Asset (JGA) : Every Motion Track contains a JGA. The JGA features a picture of the model with a Boolean value for every DOF in the model. These are used to indicate which DOFs are to be affected by the Motion Track

Motion: A motion is a set of one or more frames of data. Each frame of data specifies the value for every DOF (Degree of Freedom) in the model. Motions containing two or more frames of data also have a DT value that specifies the amount of time between two frames of consecutive data. A motion has a time duration of $(N-1) \times DT$ seconds, where N is the number of frames in the motion. A motion that has only one frame of data is also called a pose.

Motion Track: A Motion Track is a horizontal bar in the Timeline consisting of a head and a body into which motions, poses, and transitions can be loaded. Each Motion Track has a Joint Group Asset associated with it. Tracks can be combined easily in the Motion Editor to create complex motions.

Pose: A Pose is a motion that has only one frame of data is called a pose. A pose has duration of zero seconds.

Project: A project is the highest level of data organization in the Motion Editor. It describes the complete state of the Timeline and thus preserves all the information needed to fully describe the new motion being created. A project file (.mep file) is the text file that describes a project.

Runtime Pose: A runtime pose is a pose that does not have an independent external file representing it. Runtime pose information is stored in memory when a project is loaded or if a new project is being edited. They are stored directly in the Motion Editor Project File (.mep) when a project is saved. A runtime pose can be exported to create a Pose asset.

Trajectory: An asset that can be constructed on the timeline that holds a series of trajectory atoms.

Trajectory Atom: One of the repeated components of a Trajectory. The six values [X, Y, Z, Yaw, Roll, and Pitch] that completely specify the Position and Orientation of an object in space are held in each atom. The sequence of atoms determines the path of the end-effector of the link through time.