Using a Real-Time Animation Pipeline: Autodesk® MotionBuilder®, Autodesk Maya®, and Autodesk 3ds Max®

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DG6341 - A key part of the production pipeline, Autodesk® MotionBuilder® 2012 software is used on high-profile film projects, such as Avatar and Lord of The Rings, and has also been widely adopted within the video game development and visual effects (VFX) markets. MotionBuilder® is used for live motion capture on-set as well as during post-shoot animation edit. Complex production pipelines require users to have a thorough understanding of how MotionBuilder® fits alongside the primary digital content creation packages: Autodesk® Maya 2012® and Autodesk® 3ds Max 2012®. This class will focus on technical challenges and best practices for developing a production pipeline that is effective, easy-to-use, and flexible and that harnesses the features and power of each application to create fluid and believable performance animation.

Learning Objectives -

At the end of this class, you will be able to:

- Define – Industry Application
- Understand – Software strengths and performance benefits
- Implement - Workflow – Animation Retargeting and edit.
- Implement - Interoperability – Understand how the products interact with one another through Autodesk® FBX® and enhanced interoperability in the 2012 releases

About the Speaker:

Lee has worked professionally within the 3D animation and VFX industry for over nine years. Prior to joining Autodesk, he worked as a senior animator and artist on a number of high-profile AAA video game titles for well-known studios. Notable titles he's contributed to include the hugely successful Grand Theft Auto and Manhunt video game series for Rockstar North. His background in production also includes experience in setting up mo-cap pipelines for gamecinematics from shoot to edit, and in-game implementation utilizing Vicon, Autodesk® MotionBuilder®, 3ds Max®, and Maya®.

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1. **Industry application and background –**

1.1 – **Product Background- Autodesk® MotionBuilder® / Kaydara® FiLMBOX®**

- Original developers Kaydara® founded in 1993 (Montreal)
  - Kaydara® FiLMBOX® Designed to capture motion data from Mocap devices
  - FiLMBOX 1.5® introduces the FBX® file format in 1996 (object-based)
  - Autodesk® FBX® interchange format now widely adopted both within 3D Animation industry and more broadly as 3D interchange format for Autodesk® products (Autodesk® Revit® FBX® / Autodesk® AutoCAD® FBX® etc.)
  - FiLMBOX® kernel used for camera control for the "Bullet Effect" for the Matrix® movie in 1998
- First MotionBuilder® release in 2002
  - FiLMBOX® 4.0® was renamed to MotionBuilder® 4.0 in 2002
  - Product focus expanded through MotionBuilder® to become overall animation and non-linear editing application. Broad industry adoption.
- Acquired by Alias® (Maya®) in 2004
  - Joined Autodesk® family with Alias® acquisition in 2006

**Key part of Autodesk® Entertainment Creation Suite®**

Autodesk® MotionBuilder® is currently included in all of the different flavors of the Autodesk® Entertainment Creation Suite®, alongside Autodesk® Maya®, 3ds Max® and Softimage®.

As a recognized key component of the suites, development is continuous for the product alongside the other ECS releases. Due to inclusion in the Suite, a major focus in development is in making sure that MotionBuilder interacts well with the other products through FBX and provides a consistent user experience. Major enhancements around FBX and product interaction have been seen in recent releases.

1.2 – **Industry Implementation**

With strengths in handling motion capture data, devices and animation editing, Autodesk® MotionBuilder® has been widely adopted in several industries. Usage of the software varies within each particular industry based on industry need and workflow:

**Game Development –**

Autodesk® MotionBuilder® is widely adopted within the Game Development sector. The majority of AAA studios working on games today use Autodesk® MotionBuilder® within their motion capture and animation pipelines. Key areas MotionBuilder® is used in Game development include:

- Motion Capture, Editing & Retarget
  - With a core built around device input and Motion Capture retargeting, MotionBuilder® is a key component in game development for data capture and edit.
- Character Animation (Gameplay)
  - With a strong suite of animation tools, the software is widely used in creating and editing hand-key animated move sets for gameplay animation.
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- Gameplay Cinematics
  With strong non-linear animation editing and camera shot layout tools, the software is widely utilized in assembly and finalization of narrative animated sequences for game. Real-Time performance allows animators and directors to edit and validate large complex scenes with multiple character setups and camera shots for cinematics.

Film –

Autodesk® MotionBuilder® is also widely utilized within the Film animation sector. Usage is slightly more focused within film, due to the nature and specialization of the media and project teams-

- On Set Pre-Visualization (Real-Time Retargeting)
  The software is widely utilized on film projects as a tool to aid in pre-visualization and validation of both motion capture performance, shot framing and art asset assembly. With strong device connections through plugins and industry leading performance, directors can work in real-time validating scenes with CGI and live action elements as never before.

- Motion Capture, Editing & Retarget
  Alongside live device capture and real-time retargeting, the software is also utilized within film projects as a motion editing tool to refine performance before finalization in Autodesk® Maya, 3ds Max® or Softimage®

Design Visualization

The software is also increasingly being utilized as a real-time design visualization tool within the manufacturing sector.

- Motion Capture and visualization
  With core tools built around handling motion capture data and character animation, the software can be utilized easily with design visualization to validate design concepts with live characters.

- Device Control
  The software is also being utilized as device control in design visualization due to the core strengths in device input and relation connection. Generic device inputs such as joystick, keyboard or custom devices can be used to control animation motion triggering and effects. This can be used to aid in simulation or validation within the manufacturing industry. Recent proof of concept work in implementing MotionBuilder's® device control within Autodesk® Showcase® have shown that simplified commercial solutions incorporating elements of the MotionBuilder® device core may be possible in future.

- Real-Time Visualization & Stereoscopic Support
  With support for real-time shaders, device and animation playback- the software is an ideal tool for design visualization. Industry standard support for Stereoscopic 3D, using the same implementation as Autodesk® Maya® allows studios working in design visualization to validate designs in Stereoscopic 3D using compatible display.
2. Software strengths and performance benefits

2.1 - Performance Capture – Real-Time device input (Mo-Cap)

Performance Capture and Virtual Cinematography have recently become buzz words within the 3D animation community. The methodologies employed in recent productions such as Avatar® have raised public awareness of motion capture and virtual cinematography as a means to tell richer more believable stories through the medium of virtual storytelling.

Autodesk® MotionBuilder® is at the core of many modern pipelines used within virtual cinematography due to the strength and flexibilities it offers in real-time device capture, animation retargeting & editing and playback performance-

Device Input

Autodesk® MotionBuilder® supports a wide variety of capture devices through device plugins. With an open SDK architecture and application core which provides performance for device streaming, the software is at the center of performance capture and virtual cinematography pipelines.

Motion Capture Device Input (Body Capture) – Hardware vendors

For full body capture, a range of devices and plugins are available for the software which support live on-set device input streaming. Although not an exhaustive list, the links below highlight the range of hardware devices available for optical, suit based and markerless capture. Hardware solutions range in price and offer flexibility for both large and small studios working with mo-cap-

VICON- http://www.vicon.com/


OptiTrack- http://www.naturalpoint.com/optitrack/


ShapeWrap 3 http://www.shapewrap.com/shapewrap.html

Xsens MVN – Inertial Motion Capture http://www.xsens.com/en/general/mvn

2.2 - Virtual Camera Device Input

On-Set Pre-visualization of animated sequences incorporating preview of 3D Animated elements alongside live set elements and actor performance has reached a new level thanks to innovations in camera device capture. Many of these innovations have led to commercial hardware solutions available for Autodesk® MotionBuilder®-

“I can’t operate a camera with a ... mouse. It’s ridiculous. It’s why CG camera movements look computer-generated.” - James Cameron, Wired Magazine Interview

SimulCam-

The term SimulCam was created recently to describe the camera device setup used on Avatar®. The custom systems that are available use a mixture of the technologies in the commercial solutions outlined below alongside hardware to mix the live action from set with virtual environment for preview-

Avatar: Creating The World of Pandora - Simul-Cam
CgSociety :: Production Focus – Real Steal SimulCam
http://www.cgsociety.org/index.php/CGSFeatures/CGSFeatureSpecial/real_steel1

Commercial solutions (With MotionBuilder device plugins)

Listed below is a non-exhaustive list of the commercial solutions currently available or in development. The solutions are typically based on a mixture of technologies to mimic how a director would interact with a real camera on set. Systems typically use a mixture of hardware motion tracking (optical / inertial) alongside device controls such as joystick / lens controls to place the camera within scene and control DOF / Focus. Systems such as the Intersense Vcam mimic the appearance of a real film camera whilst other systems use a tablet style LCD display panel for previz-

Intersense - Vcam-
http://www.intersense.com/pages/14/29
http://www.intersense.com/pages/19/28

OptiTrack – Insight VCS

PhaseSpace / HP TouchSmart
http://eeepec.net/hp-touchsmart-tm2-makes-animated-motion-capture-a-cinch/
2. Software strengths and performance benefits

2.3 - Animation Retargeting

Alongside supporting real-time Mo-Cap device input, MotionBuilder® includes a range of tools to map the motion from the source data to character in real-time. This allows pre-visualization of the motion capture data on character asset in scene in real-time which can be close to the final look for film game.

In MotionBuilder® optical motion capture data (typically C3D format) and other body capture formats can be linked to an actor asset which acts as intermediary to map motion to the character asset (see Figure 2.3.1) The system allows live device input to drive the 3D character in real-time.

The character solving in MotionBuilder® maps the data between source (mo-cap) and character asset intelligently. The solving can map between different proportioned characters realistically with the foot plants and hip position being maintained through the reach on the character- Reach acts similarly to Inverse Kinematics with the feet/hips following the source Mo-cap data (see Figure 2.3.2 – left)
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When mapping data to character with different proportions to source Mo-Cap Actor, offset such as Hip Height Y can be used to more realistically interpret the motion (see Figure 2.3.2 – right)

**Keying Reach / Hand Placement –**

When working with data where the mo-cap actor is interacting with real world objects or other actors (such as shaking hands, picking up objects) – It can be necessary to match hand placement from the source data to the character. This can be achieved by setting or keying the character’s reach on the hands or other body parts through the Character Controls window in MotionBuilder® (see Figure 2.3.3 – right screenshot)

![Figure 2.3.3 – Motion Retargeting – Hand Reach = 100% (right screen)](image)

**2.4 - Animation Editing 1 – Clean-up Layers**

In addition to high level controls for retargeting motion capture data, MotionBuilder® includes industry standard animation editing tools to further clean and refine retargeted mo-cap data.

For example:
- **Shoulder posing**
  Typically issues can be seen with shoulder posing after retarget, these types of issues can be due to differences between the joint placement or proportions on the character you’re mapping the data to. This type of problem can be resolved by using MotionBuilder’s® Animation Layers alongside IK Pinning to adjust the shoulder angle whilst maintaining the hand IK position (see Figure 2.4.1 – left screenshot)
- **Mesh interpenetration**
  Interpenetration issues due to difference in the character mesh proportions may also be seen on the limbs. Similarly, these types of problems can be resolved by using Animation Layers. Zero key from Key Controls can be used to lock position to the base layer before and after edit to maintain motion from source (see Figure 2.4.1 – right screenshot)

![Figure 2.4.1 – Animation Layers – Shoulder pose fixing and refinement](image)
2.5 - Animation Editing 2 – Performance Edit

The animation editing tools in the software are also typically used to modify a performance from retarget. For example, the source Mo-cap data may not have sufficiently exaggerated timing pacing or posing. For example, let’s say you want a character kick to be more exaggerated, with the legs more extended on the kick or character jumping further from ground if leaping.

- Exaggerating posing or spacing on the animation can again easily be accomplished with Animation Layers (see Figure 2.5.1)

- Feet hand or IK effector pinning can be used to easily maintain existing poses where needed. For example, the foot position can largely be maintained whilst hips pulled to extend kick( see Figure 2.5.1 – third screen from left)

- ‘Zero Key’ in Full-Body mode can be used to maintain the pose ‘as is’ on the Base layer before and after edit (see Figure 2.5.1 – second screen from left)

![Figure 2.5.1 – Animation Layers – Exaggerated posing](image)

**Story mode layout**

The Story mode in MotionBuilder® allows animation directors to easily layout large scenes with multiple character’s and camera cuts for video game cinematics and film. The tools in Story mode also allow easy edit to character animation through Story Character Tracks where overall character placement and timing in scene can be edited for longer format sequences. From the non-linear editing environment of Story, character animation clips can be loaded externally and data plotted from Story back to the Character Control rig for further edit with the industry leading character animation tools.
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2.6 - Interoperability – Autodesk® FBX ®

The Autodesk® FBX ® Interchange format is used to transfer source character assets from Autodesk® Maya ®, Autodesk® 3ds Max ® and Autodesk® Softimage ® to Autodesk® MotionBuilder ® (see Figure 2.6.1)

![Image](image1.png)

FIG 2.6.1 – Autodesk® Maya ®   >>> Autodesk® FBX ® >> Autodesk® MotionBuilder ®

Source character model needs to be setup with base skeleton hierarchy and skin bind in the source application (see Figure 2.6.2) No animation controls or IK setup are necessary at this stage as this is created in Autodesk® MotionBuilder ®

![Image](image2.png)

FIG 2.6.2 – Autodesk® Maya ®  - Source character mesh, skeleton hierarchy and skin bind.

**Autodesk® FBX ® – Support and Documentation-**

The Autodesk® FBX ® interchange plugin ships with Autodesk® Maya ®, Autodesk® 3ds Max ® and Autodesk® Softimage ® and is updated regularly. The format supports a wide variety of scene elements, including light, cameras, meshes, skin binds etc. Support for advanced elements such as Constraints, Human IK and particle cache data varies between the products.

[www.autodesk.com/fbx](http://www.autodesk.com/fbx)
The Autodesk® FBX® product page includes compatibility chart listing supported elements carried via FBX® between each of the products (see Figure 2.6.3)

**Autodesk® MotionBuilder® - FBX Import and Characterization**

Typical workflow for character setup in MotionBuilder includes:

- Import character mesh with joint hierarchy and skin from source FBX® (see Figure 2.6.4 – left)
- Use Characterization Tool in MotionBuilder to define which skeletons on rig the controls will be associated with (see Figure 2.6.4 – 2nd screen from left)

Note: The new Characterization Tool was implemented in MotionBuilder® 2012 and provides an easy click assignment workflow to setup the definition. Valid definitions will show with green highlight with the tool whilst (minor issues in joint alignment which may not break setup) may show in orange highlight.

**FIG 2.6.4 – Autodesk® MotionBuilder® 2012 - Characterization Tool**
Note 2: As HumanIK® is also implemented in Maya®, character definitions and completed control rigs and animations can be transferred between both. Additionally, Maya® 2012 now includes the same Character Definition windows and workflows, meaning that the Character Definition and Control Rig setup phase can also be completed in Maya® 2012 prior to export to FBX® and import to MotionBuilder® 2012 for retargeting.

Although the HumanIK control rig and UI is not implemented in 3ds Max® or Softimage®, the initial mesh and skin setup can still be completed prior to export to MotionBuilder®. Completed character animation in MotionBuilder® can be plotted (or baked) to the source skeleton for import back into 3ds Max® or Softimage®.

**Autodesk® Maya 2012 ® - Consistent Control Rig display and editing**

With full support implemented for HumanIK interoperability between Maya® 2012 and MotionBuilder® 2012, there are a number of additional benefits beyond consistent characterization Tool and transfer-

**Control Rig Look and interaction -**

- The HumanIK Control Rig viewport display is similar between both applications (see Figure 2.6.5)
- Options to toggle between the different Rig Looks are same (Wire/Stick/Box)
- Note: X-ray Joints Display mode in Maya will give similar results to MotionBuilder’s® X-Ray (Ctrl+A) Display mode, allowing ease of display and selection whilst animating.

**Autodesk® FBX ® Interoperability – Consistent FCurve Editor and data**

The products included in the different Autodesk® Entertainment Creation Suites 2012 alongside MotionBuilder® now include a consistent user interface for FCurve editing, with icons and terminology being standardized. This means that animators working in Maya®, 3ds Max® or Softimage® can enjoy a more consistent user experience when working with animation curve data (see Figure 2.6.6 – middle screen)
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Work ‘under the hood’ in the applications now means that default curve tangency types for Fcurves are also unified with Auto-tangency being the default. This ensures that the motion timing and spacing of the animation is consistent when transferred via FBX® between the products included in the Autodesk® Entertainment Creation Suites 2012 (see Figure 2.6.6)

**Autodesk® FBX® Interoperability – Animation Layers**

Animation Layers are also fully supported through FBX® in Maya® and MotionBuilder®. Since the 2011 release of both products, labeling of animation layers and animation data transferred through FBX is consistent. This means that the previously highlighted animation layer edits on the HumanIK control rig in MotionBuilder® can be transferred to Maya® and vice versa (see Figure 2.6.7)

Note: Although HumanIK Control Rig and definition is not supported in Softimage® or 3ds Max®, the data is still carried in FBX® format and can be interpreted on import through the FBX® plugin.
2. Software strengths and performance benefits

2.7 - Python® – Tools development

With support for the industry standard Python® programming language, technical directors and programmers can easily create custom tools which help to automate and streamline the animation process. Exposure of elements in the UI to Python® has expanded in recent releases, making it easier than ever to automate workflow. A number of Python® and SDK examples ship with the software, including the Batch Tool which allows batch processing of animation data through simplified UI scheme (see Figure 2.7.1).

FIG 2.7.1 – Batch Tool – batch processing of BVH animation data, retargeted to character.

2.8 - Performance – Multi-core / Profiling Centre

With core feature benefits in real-time performance and playback, development are focused on improving performance with every new release of the software. Recent enhancements around multi-threaded processor support for Story mode have been seen alongside support for GPU skinning and frustrum culling for render. All of which is pushing the software performance forwards.

The 2012 release of MotionBuilder® also includes a new Profiling Center (see Figure 2.8.1) The Profiling Center allows technical directors and animators to graphically visualize performance and make adjustments to scene evaluation to improve real-time playback.

FIG 2.8.1 – MotionBuilder® 2012 - Profiling Center UI
3. References and additional reading

Virtual Cinematography & Previsualization


Autodesk - Previsualization & Virtual Cinematography- http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=13386214


Previsualization Society http://www.previssociety.com/

A Previsualization Society is Born http://www.awn.com/articles/article/previsualization-society-born

David Morin, Autodesk Consultant and Virtual Production Chair @ VES Production Summit http://www.youtube.com/watch?v=nSWdqL2gv38

Autodesk® - Product Pages

Autodesk® MotionBuilder® - Product Page http://www.autodesk.com/motionbuilder

Autodesk® Entertainment Creation Suite® - Product Page http://www.autodesk.com/modernpipeline

Autodesk® MotionBuilder® - Training resources

Autodesk® MotionBuilder® Services & Support – Learning Path http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=13251539&linkID=9242336

Autodesk® MotionBuilder® Feature Videos http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=14367660&linkID=9242336

Foundation Learning Tool http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=13293201&linkID=9242336

Autodesk® AREA® - Tutorials http://area.autodesk.com/tutorials?word=&where=1&software=9&tutotips=&level=

Autodesk® AREA® – Forums http://area.autodesk.com/forum