Lights, Cameras, and Assemblies!
Animating using Autodesk® Inventor® Studio

Mark Allen Flayler : ASCENT – Center for Technical Knowledge®

ML311-3   Autodesk Inventor Studio bridges the gap between engineering and marketing. This class presents methods to create an animation of an assembly using moving cameras and lights. Learn how to animate components in your assembly, animate lights, and animate cameras. Finally, you'll see how to combine animations using the new Video Producer feature. At the end of the class, you'll have an understanding of how to render a complete animation of your assembly. This class is intended for Inventor users interested in animating their assemblies using Inventor Studio.

About the Speaker:

Mark is an Application Engineer with the Ascent and IMAGINiT Division of Rand Worldwide, specializing in the Autodesk manufacturing products. He has implemented the Autodesk Manufacturing products with many industries including the blow and injection molding, automotive, and custom machinery markets. Inventor has been a profound augmentation in his abilities allowing him to bring 3D digital prototyping to the forefront of the industries with which he has interacted. He has extensive experience and a comprehensive understanding of the technical, practical, business, and human dimensions of implementation. He is an effective and skillful communicator, consulting with his clients to help achieve their business objectives. Mark is an ATC certified instructor and has been instrumental in the training of hundreds of users. Mark is certified in AutoCAD, AutoCAD Mechanical, AutoCAD Electrical, Autodesk Data Management, and Autodesk Inventor.

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Introduction

Engineering and marketing have a lot in common. Engineers need to leverage marketing in designs, and marketing needs to leverage designs from engineers. This is the essence of collaborative engineering. What most companies don't realize is that the engineer's data holds more power than it ever did before with Autodesk Inventor.

The Studio package that comes with all versions of Inventor utilizes the engineer's data to make high impact presentations, marketing collateral, manual/catalog documentation, and more. If this capability is not understood or realized, companies can end up spending a hefty sum of money in third party contracting, additional software, and longer lead time to market. Inevitably, smaller companies get left behind because their budgets cannot afford this luxury. With Studio companies can leverage all of these tasks within a single software; Autodesk Inventor.

Access to Studio

Studio can be accessed in any Part (.ipt) or Assembly file (.iam), as well as, Sheet Metal and Weldment files. Presentation and Drawing files have no access to Studio. To access, select **Applications > Inventor Studio** from the main menu.

Styling your Studio   Surface Styles , Scene Styles , Lighting Styles

Surface, Scene, and Lighting Styles all combine for the overall quality of the animation. These need to be set up prior to an animation for a rich Studio output. These styles can be set up in your templates, Styles Library, or created on the fly. Here is a brief recap of these styles:

- Surface Styles correspond to color styles found in the Styles Library. Material properties are assigned a color in the iProperties, and more properties for these colors are available in Surface Styles. Here we have the controls for various aspects of colors, reflections of the surface, opacity, diffusion, and bump map settings.
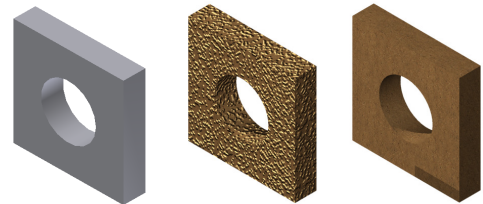
  Use to get and assign different styles to faces (in part mode) or components (in assembly mode) to change their effects. The applied color and bump map may not appear correctly on the Inventor model, but the rendered image will show the correct color.

- Scene Styles are essentially how the background or environment is set up. It controls background for single and gradient colors, reflective planes, images, and spherical images. Consider using real life image backgrounds for your backdrop in your renderings.
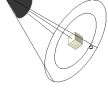
- Lighting Styles contain one or more light objects that define the overall lighting for a model. Blue Hue Lighting, as shown, is an example of a lighting style that contains four lighting objects. A lighting object is a source of light that can be one of three types: *Directional*, *Point*, or *Spot* which all have their own setting tabs for General, Illumination, Shadows, and a light specific tab.

Unlike Scene and Surface styles, Lighting styles are not inherently active on a new Studio Animation so you must set one active (right click on it) to work with it in the animation.

To create a new light within a selected lighting style, click [icon] above the listed Lighting styles.

Type	Description	Symbol
Directional	Simulates distant light sources, such as the sun. It has a direction, but no position.	
Point	Simulates a point source. It has a position and it radiates light in every direction.	
Spot	Simulates a spot light. It has a position and direction. A Spot light emits light in the shape of a cone with two degrees of intensity. The most intense area is located within the inner area of the cone of light and the less intense area is located within the outer area of the cone of light.	
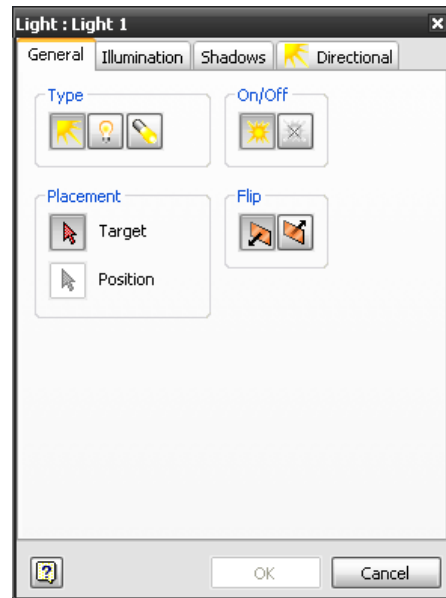
Wrapper Assemblies

When you have a typical piece of equipment or product, it is beneficial to create a standard room/scene to render these objects. For example, if you make staplers you may want a scene with other office supplies for all your marketing or presentations. To work efficiently, create an assembly that contains all the props and set up their lighting, scene, and surface styles so that the only work that needs to be done is the work on the new product. The props can be used over and over again, as needed Wrapper Assemblies can be as simple as a floor and two walls, or as elaborate as an entire furnished room or industrial backdrop, as shown below.
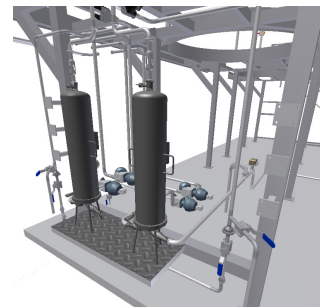
Local Lights   💡 Local Lights

Local lights differ from lighting styles in that they are discrete lights (Point and Spot only) that exist in the scene but not in a predefined lighting style. Local lights have the same controls as discrete lights. They are great to show LEDs, panel lights, illuminations, switches, and much more. They also have the unique advantage of traveling with their components if moved in an animation. Local lights can only be altered through an animation when the light is at the top level assembly.

Camera Creation   📷 Camera

Use the camera command to create user cameras for different viewing control options. With the dialog box open, select a Target for the Camera and a preview displays for the camera direction. This positioning is normal to the Target. For the Position, choose a point on the normal vector. Clicking on the Position or Camera graphic elements brings up 3D Move/Rotate tools to more precisely place them. Zoom is controlled by the extents of the camera shot or using the slider or input section. Roll angle is the tilt of the camera in its position. You must also choose either the Orthographic or Perspective (converging lines) Projection types. Depth of Field is used to control focus limits on the camera in the form of f-Stops and Focus Limits. This is only available on Perspective projections.
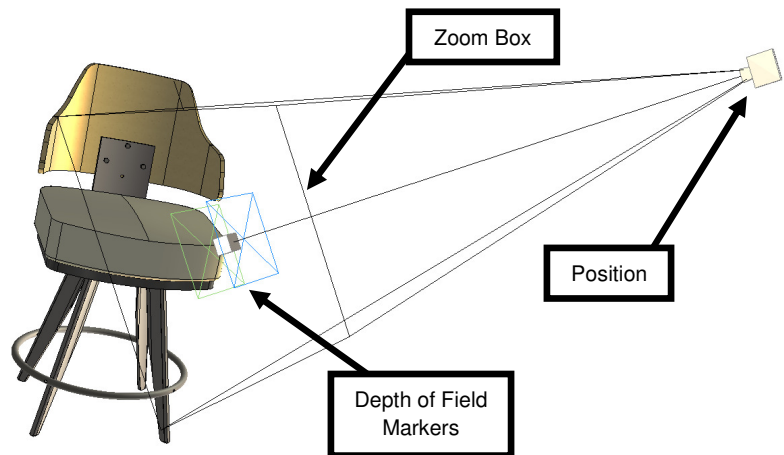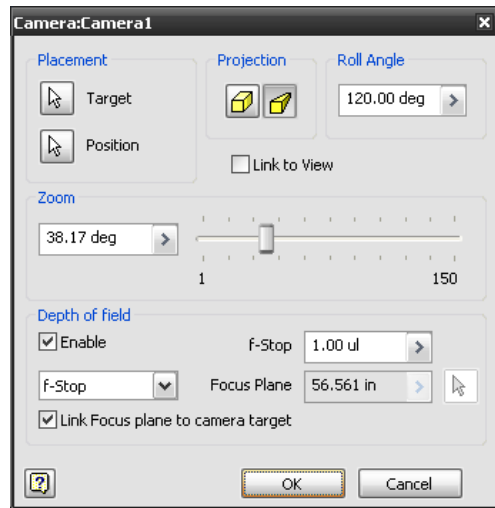
Depth of Field Options	Description
Focus Limits	Near – specifies the distance at which objects are clear (green plane) Far – specifies the distance at which objects are out of focus (blue plane)
f-Stop	f-Stop – value for depth of field; lower the number the narrower the depth Focus Plane – pick a known planar surface to set the f-stop
Link Focus Plane to camera target	When linked, moving the camera target also modifies the focal plane location.

Understanding the Animation Environment

Inventor Studio is designed to use intelligence from the assembly to grant movement within your animation. The biggest key factors here are constraints, position, and the assembly state before entering Studio. Consider using Design Views and Representations to control your assembly's positioning and component visibilities. Many users use the Master views as the start point.

Because Studio animates constraints, you work with existing constraints in the environment based on the degrees of freedom in the components. Animation commands are directly related to components and their constraints. If they are constrained together then they will move together, if they are not they will move individually. Studio also gives you the power to control suppression of constraints to grant movement and not affect the Assembly environment's constraints.

In general, large assemblies do not respond well to all or most of their constraints being turned off so use suppression sparingly. Consider, grounding all or some of the components to essentially eliminate the intelligence of the constraints. In this case the components work like the Presentation files. This can mean more or less work depending on your design intent and how well you know your assembly.

Storyboards are helpful to set up a plan for the animation before beginning work in Studio. Take some time to create either paper or electronic storyboards.
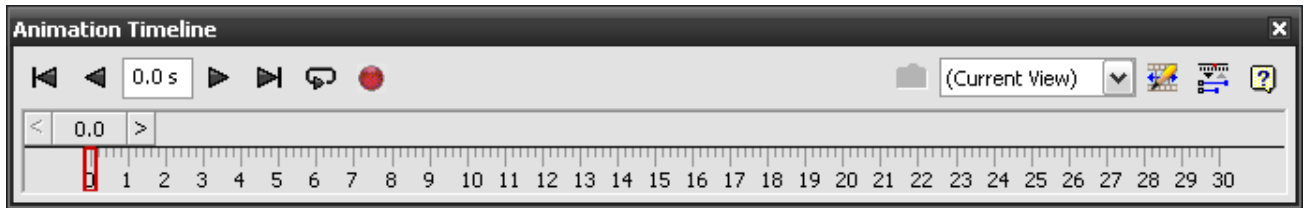

StoryBoardPro screenshot (http://movies.atomiclearning.com/k12/storyboardpro)
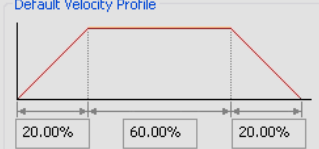
Consider camera movement, component movement, component opacity and fades, lighting elements, animation length, production effects such as gradient wipes and shot fades. Begin thinking about your Studio animation during the engineering design process. Use the Save Copy As… command to save a JPG or a BMP as a visual reference for storyboarding.

Animation Timeline   Animation Timeline

When working with any animation dialog box, the Animation Timeline dialog box appears.

| Icon	Description
	Sets the current time to the beginning (0 seconds) or end of the animation
	Plays the animation in forward or reverse
	Toggles between repeating and not repeating the animation
	Opens the Render Animation dialog box
	Creates a camera action that ends at the current time
	Opens the Animation Options dialog box and allows you to specify the duration of the animation in minutes and seconds. Click to equate the total duration to the sum of the durations of all the specified actions. You can also change the default Velocity Profile for Animation commands Specify the Velocity in Percentage or Time and their default values. Smallest increment for time is 1/10 of a second.
	Expands the actions editor. Actions are listed on the left side, while their start, duration, and end times are represented on the right side. Use this dialog box to view, edit, and delete existing actions. Modify an action by right-clicking on the desired action duration bar and selecting **Edit**, **Delete**, **Mirror**, or **Copy Action**. You can also adjust the durations of actions directly by dragging the duration bars.

When the Studio environment is activated, the state at which activation occurs is Frame 0 in the animation timeline. Studio can have more than one animation. For instance Block A is Mated to Block B in animation1, but in animation2 Block A is Mated and animated away 5 units to Block B. Animation1 is not affected by this since they are two different animations. Now if Block A and Block B are modified in the Assembly itself and not Studio, they would both change.

Common Animation Command Controls

Each animation command dialog box varies, but here are the common icons and their uses.

Option	Description
	Starts the action at the time the previous action ended
	Specifies the time to begin the action
	Performs the action instantaneously (in one frame)
	Start time of action
	Duration of action
	End time of action
	Ends the current action definition, advances the timeline by the New Action Increment value, and begins a new action of the same type.

The Acceleration tab, as shown below, is common among all animation command dialog boxes. This tab controls the speed of an action as it reaches its target. You can define the percentage of time or actual time for an action to reach its speed and wind down. (Not available with the ⊞ option.)
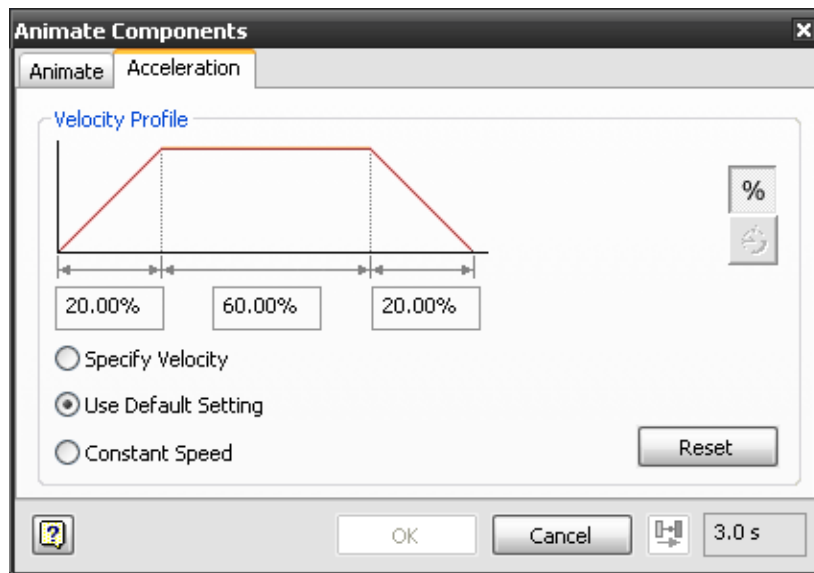
Animation Commands

There are a number of animation commands that can be used in Studio to create animations. These enable you to animate components, constraints, fading, parameters, positional representations, cameras, and lights. To access these animation commands, use the commands in the Inventor Studio Panel or right-click on an object in the browser bar and select its corresponding animation option. The animation commands will differ depending on the type of object you are right-clicking on. For example, a component provides the **Animate Components** and **Animate Fade** options, while a constraint provides **Animate Constraint**, and an animation favorite provides **Animate Parameters**, as shown below.
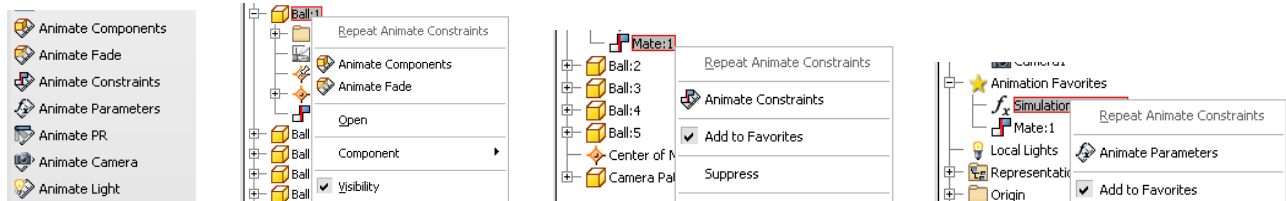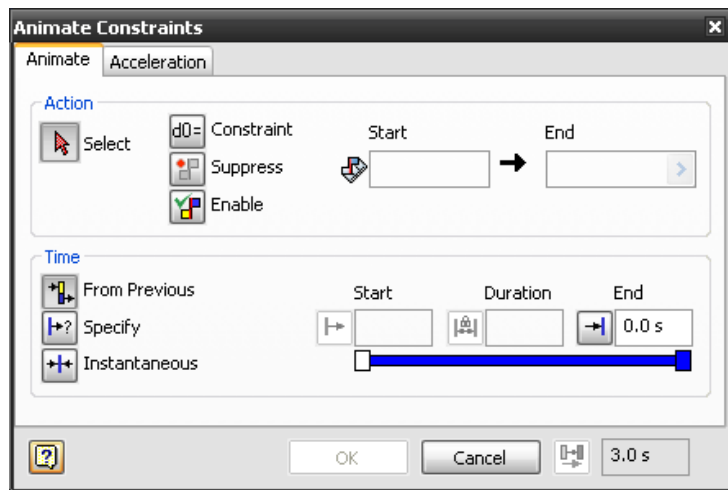

Animate Constraints

With (Select) toggled on, select one or more constraints from the browser bar to animate. Essentially Animate Constraints is used to drive offset values for constraints from start to end values. This relies on the intelligence of your assembly and how that intelligence is applied to the mechanical movement.

When a **Constraint** is selected a start value is automatically populated and an end value is required to drive the animation. Use the **Suppress** and **Enable** options as instantaneous actions to turn on and off constraints throughout the animation.

Option	Description
d0=	Animates a change in a linear or angular constraint value. Enter a value. The initial value for the constraint is shown by default.
(suppress icon)	Suppresses a constraint that may prevent movement for an action.
(enable icon)	Enables a constraint

Animate Components   Animate Components

With the (Components) option toggled on, select one or more components to move or rotate. Some newer users to Studio confuse Animate Constraints with Animate Components. Essentially it is the opposite of Animate Constraints. With Animate Components you use unconstrained degrees of freedom to move components, while Animate Constraints uses existing constraints to drive constraint values.
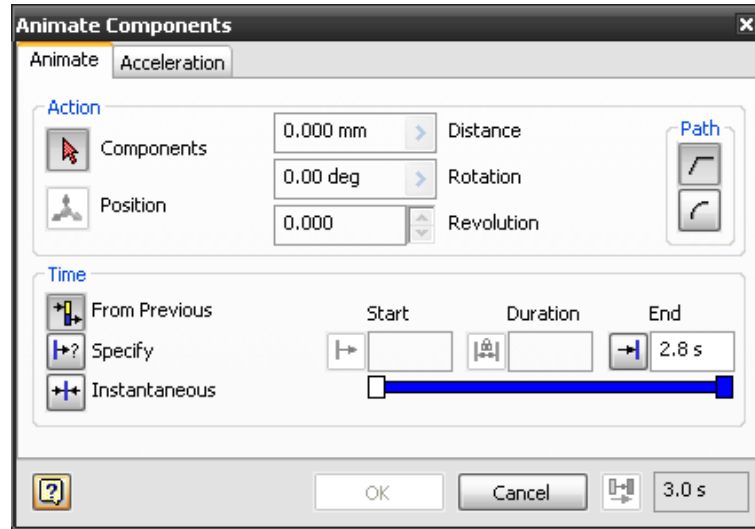
Click (Position) to access the 3D Move/Rotate dialog box. This dialog box allows you to move or rotate the selected component(s) in any direction of an unconstrained degree of freedom (or any direction if it is grounded). Enter Distance and Rotation values, as necessary. Click on the head of an arrow to change the linear movement and click on the shaft to change the rotation around the selected piece of the triad. Use Revolution as an alternative to Rotation angle.
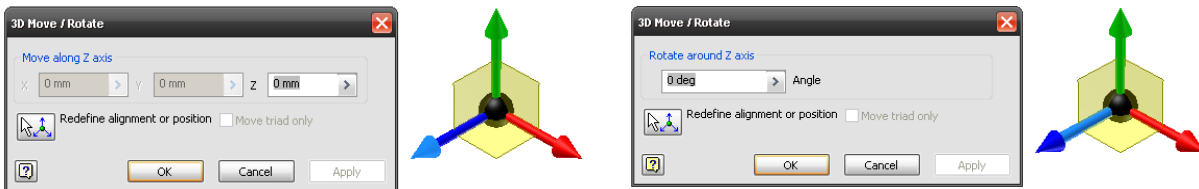
(Note: If you compound your movements such as rotating two or three times, or moving in different linear directions, the input fields in the command dialog box will combine the movements), as shown below.

← 10 in Z and 60 around Z	
10 in Z and Y and 60 around Z and 90 around Y →	
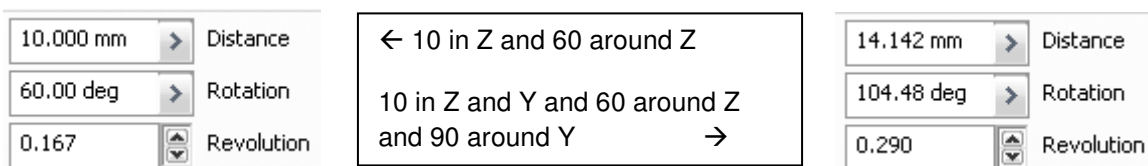
Finally, specify a smooth or straight path of motion. Smooth creates a continuous motion curve between the beginning, duration and end; Sharp generates more distinct movements.

**Animate Fade**   Animate Fade

As its name might suggest, **Animate Fade** does not relate to the visibility of components, rather it corresponds to the opacity (opposite of transparency) of a component. 0% opacity is completely non-visible and 100% is completely visible to the viewer. This command can be used for the following:

- Removing components from view completely and bringing them in later
- Showing interior movement with exterior components being less opaque
- Removing components completely from view amidst the duration of the animation
- Combining with Animate Constraint or Animate Components actions to Fade and move

To fade a component at Frame 0, create an **Instantaneous** ( ) Fade at the beginning of the animation with an initial start opacity value of 100% and an end value of 0%.

To display a component that initially does not appear at beginning of the animation, create another Fade with an initial start opacity value of 0% and an end value of 100%.
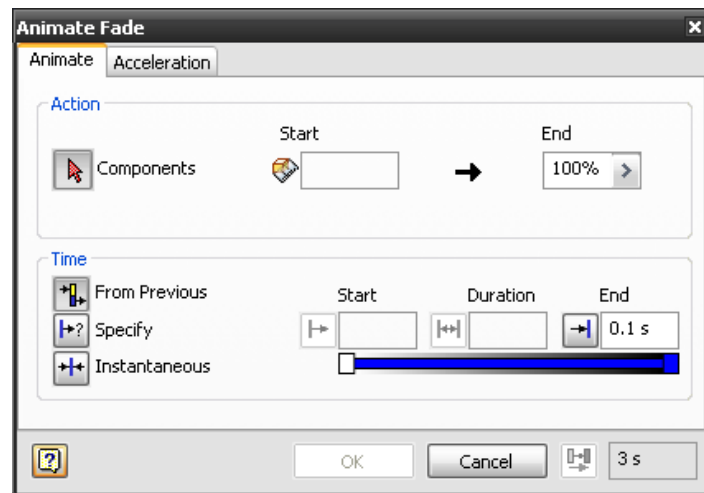
Animate Parameters   Animate Parameters

This animation command has endless possibilities for driving parameters in you models (assemblies and parts). For example, you can show dynamic section cuts, mimic fluid movement, show swelling and shrinking, emphasize a design variable, control a spring movement, and a host of other fantastic design intents.

To animate a parameter it must be either a modeling or a user parameter. In addition, the parameter must be nominated as an Animation Favorite for it to be available in the Inventor Studio browser bar. To nominate a parameter as an animation favorite, select and enable the **Favorite** option for the required parameters.
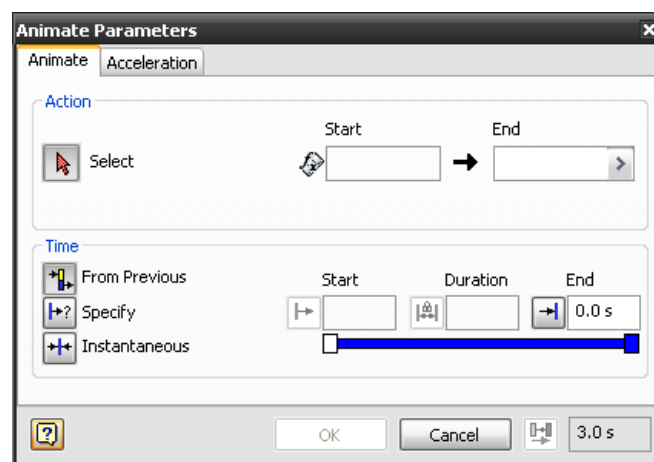
**Tip:** Dynamic Simulation has a Create Studio Animation command to bring over Simulations into Studio. The command is used after a Simulation is run but before you leave the run mode. It launches Studio and creates a Dynamic_Simulation animation and a parameter favorite called Simulation_timeline. This is indicative of the time steps in the Simulation and your end value here should match the time in Dynamic Simulation.

**Animate Positional Representations**   Animate PR

Animating Positional Representations (PosReps) in an assembly is one of the easiest ways to animate components because the design intent is already established in the assembly. All that is required is to have two valid representations and to know the time at which the assembly changes from one to the other. The nuances of Positional Representations are extensive (and would exceed allotted time). The following are a few highlights:

- PosReps control constraint suppression and offset modification; rectangular and circular pattern row and column offsets; component offsetting, grounding, PosReps and Flexibility.
- PosReps can be "deep". Meaning the Top Level Assembly can control which PosRep is active in lower subassemblies.
- PosReps that are deeper than the assembly being animated need to be set with a Flexible status, to allow subassemblies to flex with the movement of the larger assembly.
- Editing the PosRep after it is in the animation timeline allows individual control of the overrides that reside in the representation. Initially all members occupy the full span.
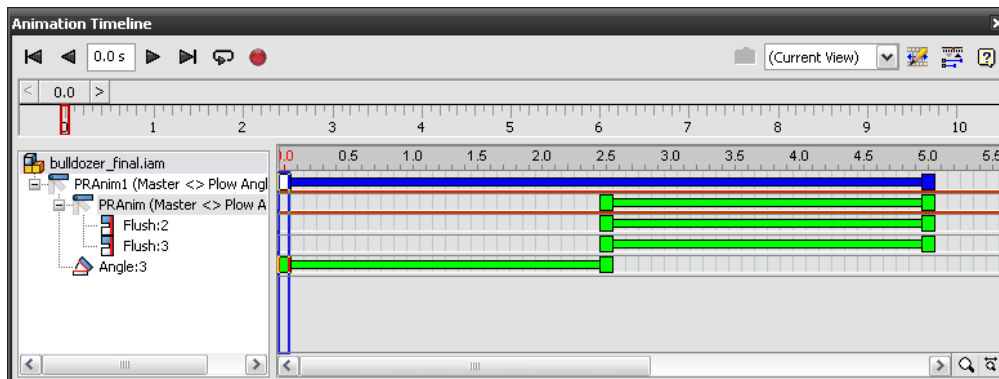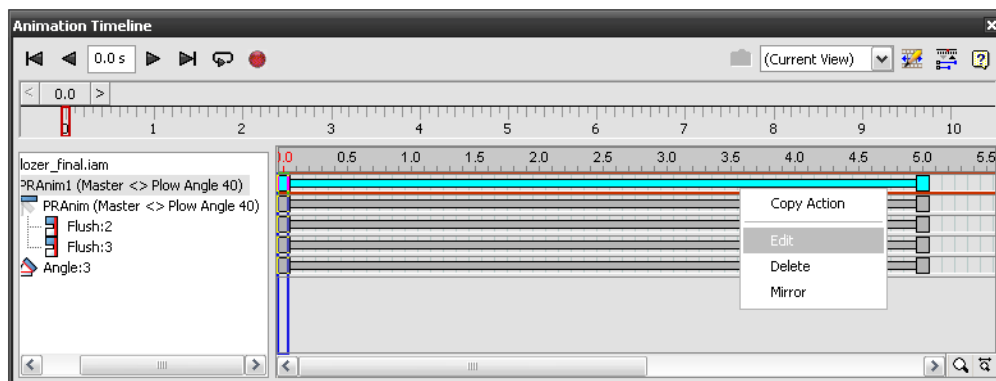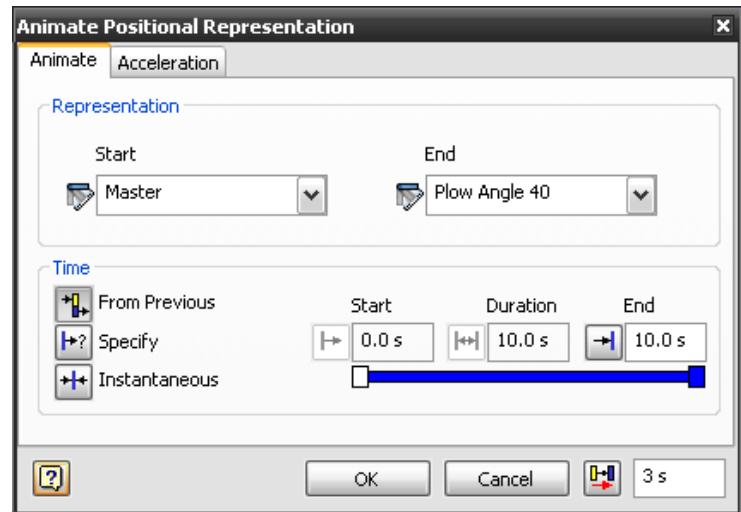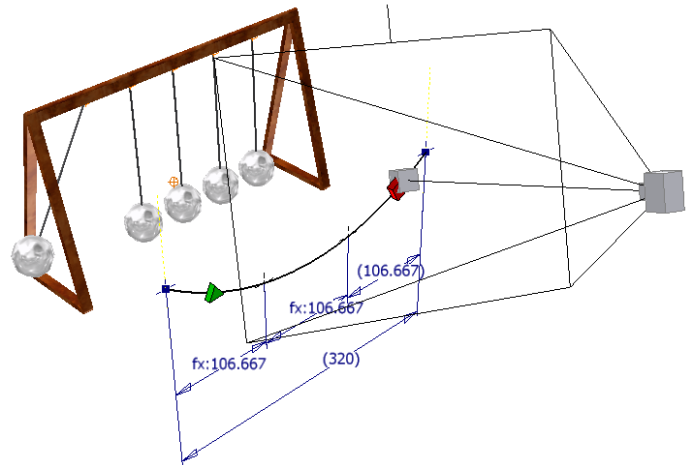
Animate Camera   Animate Camera

The majority of work in animating a camera is in the camera's initial setup. Once you have one established and in position this command creates some really fantastic visual movements. Use the Definition command to specify the target and positioning of the camera movement, as shown below.
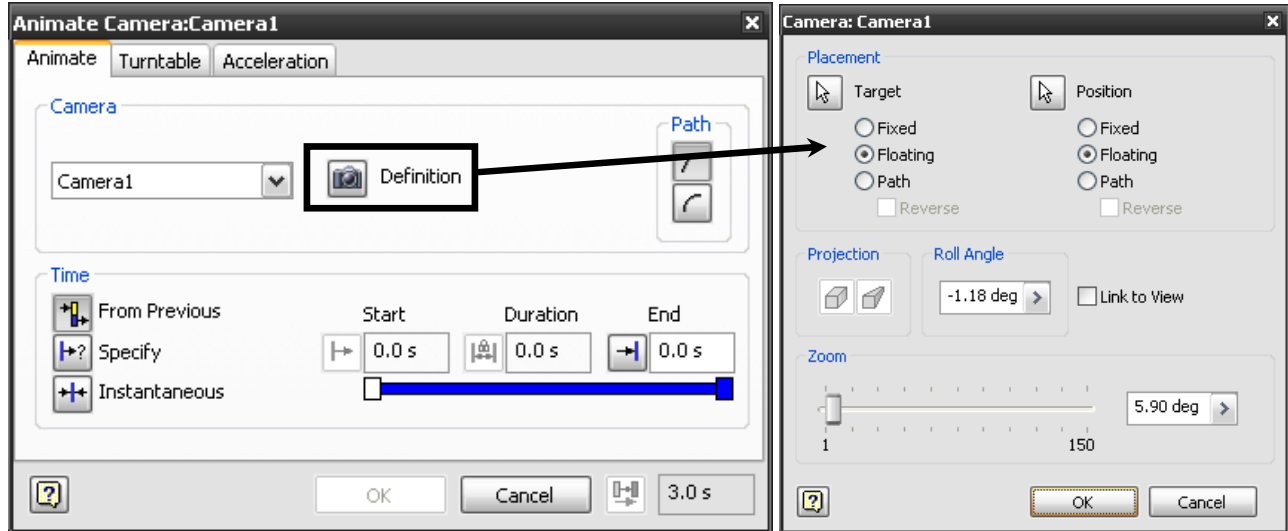
An animated camera definition is shown below that involves a reference part created on a 2D path. If **Reverse** is selected for the position, the red square and green triangle are reversed on the ends of the path.

| Option	Description
Target	Specifies the target of the camera. **Fixed** - The target does not change positions **Floating** - The target maintains position to the camera (target and camera move together) **Path** - The target follows a path made of a single continuous 2D or 3D sketch.
Position	Specifies the position of the camera. **Fixed** - The camera does not change positions **Floating** - The target maintains position to the camera (target and camera move together) **Path** - The target follows a path made of a single continuous 2D or 3D sketch. You can edit the Path location with the green triangle (start) or red square (end).
Roll Angle	Controls roll of camera for definition.
Zoom	Adjusts the Zoom of the camera with the slider or graphically with an on screen target box.

The following are some notes on Path animation:

- The 2D/3D sketches can be contained in a single file.
- You can turn on visibility of sketches from Part files for use as a Path as well.
- To exclude the path from the BOM make it a reference component.
- The 2D/3D sketch path must be one complete segment to use as a path. Even if multiple segments are contiguous you will have to create separate Camera Animations for each segment.

The Turntable tab is unique to camera animation and as its name implies it enables you to spin the camera around the model using a specified Axis (X, Y, Z, Camera-H, Camera-V), Direction (clockwise or counterclockwise), and Revolution, as shown below.

The **+/-** option is a literal revolution. So a revolution value of 1 will turn once around. The /**min** and /**sec** options use the Revolutions value/per unit of time in the animation.

Loop, exclusive to this dialog box for Time, enables you to continuously loop the turntable if it is the only camera action assigned for that camera. It can be adjusted to fit between other actions and will adjust automatically if it must fill the entire animation.
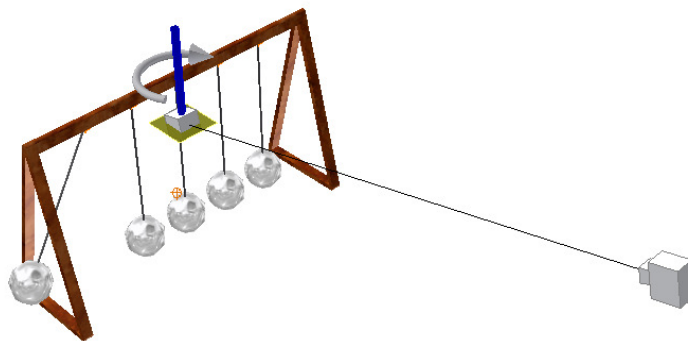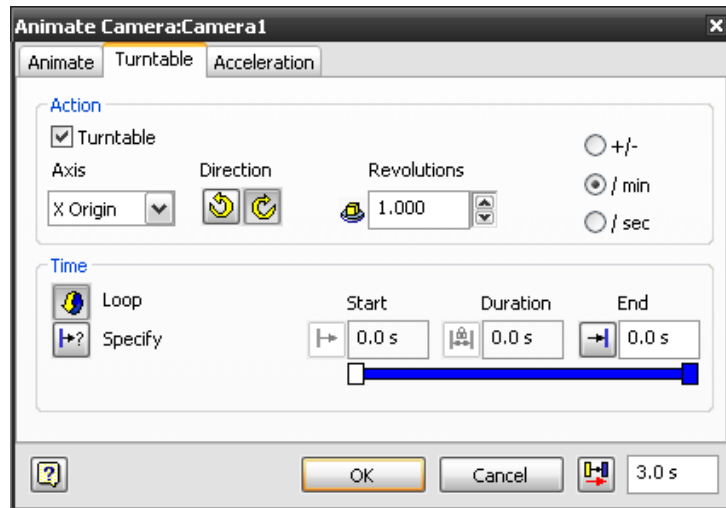
This image shows a camera positioned to perform a turntable action around the model's Z-axis in a clockwise rotation.

Animate Lights   Animate Light

Lights can be animated in a similar way to other animation commands. The key item to remember whenever you are animating an existing object is that you are choosing how you want to change the existing object. So if your light is on, you can animate it to be off, a different position, intensity, color, and light specific options.
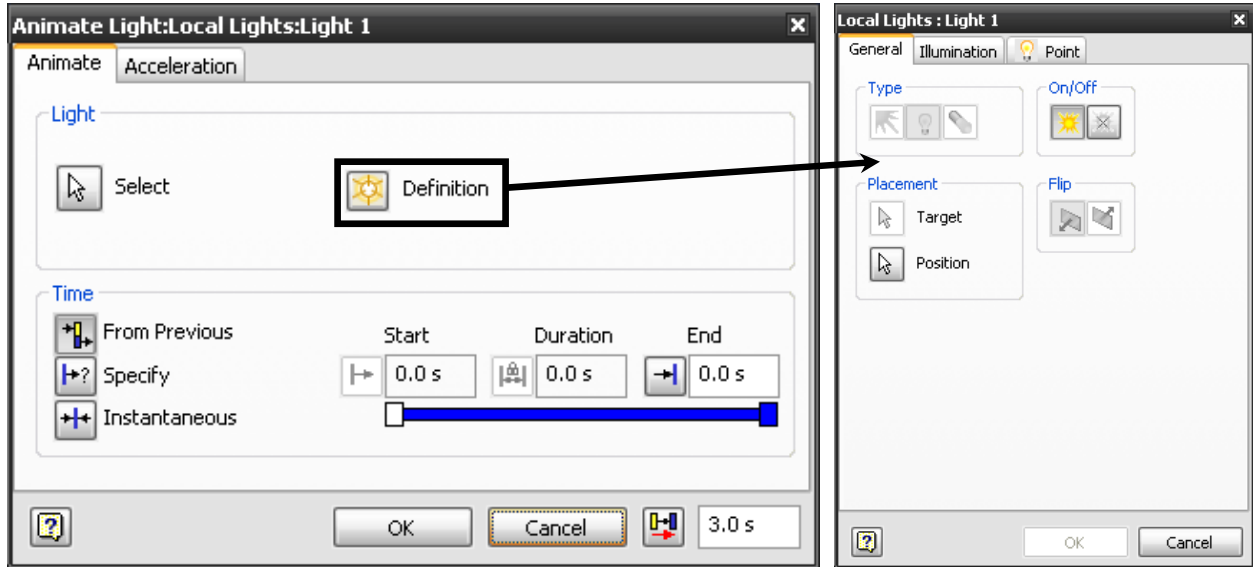
Studio allows animating of Lighting Styles, individual lights within styles, and local lights.

Tab	Options/Description
General	**On/Off** – Defines the state of the light at the end of the action **Placement** – Defines the placement of the light at the end of the animation
Illumination	**Intensity** – Defines the amount of color in the light **Color** – Defines the color of the light
Light Specific	**Directional** - Adjusts longitude and latitude **Spot** - Adjusts hotspot and falloff, numerical adjustment of target and position **Point** – Adjusts numerical position

Tip: In the Illumination tab, you can turn on a brighter light such as white and turn it to another color (i.e., blue) through the animation which will give the animation the appearance that the light is off, but stills provides light to the scene.

Video Producer

The Video Producer tool (Video Producer) creates Productions from one or more animations. The production is populated with cameras (animated or not) and transitions between those cameras. Ideally a user will have at least one animation and multiple cameras set up to take full advantage of the Video Producer.
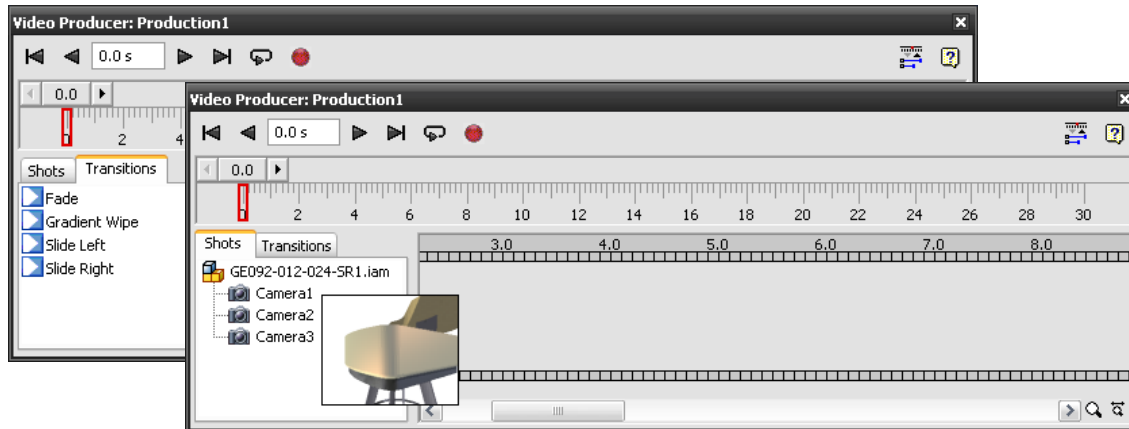
The Shots tab in the Video Producer represents your cameras. When Video Producer is active it automatically collects all the cameras and attaches their image representations. To see the camera image, pause your mouse over the camera in the Shots tab.

Access the Shots dialog box by right clicking on a placed shot in the timeline.

- Specify from which animation the shot is taken.
- Specify the starting point in the footage.
- Specify which camera to get footage from.
- Specify the timeframe in which to use the Camera.
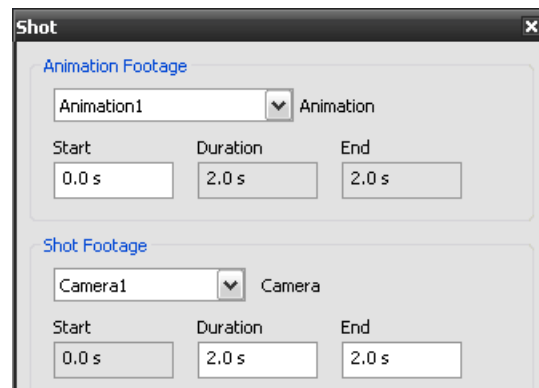
The Transitions tab lists the affected movements from one shot to the next. They are not spliced between the shots but rather overlap the shots in one or both directions. Color, type and duration can be edited. From Shot/To Shot is determined by the transition's placement on the timeline.

Access the Effects dialog box by right clicking on a placed transition in the timeline.

- **Fade**: From color to shot, shot to shot, shot to color
- **Gradient Wipe**: From left to right
- **Swipe Left**: Moves from left to right
- **Swipe Right**: Moves from right to left

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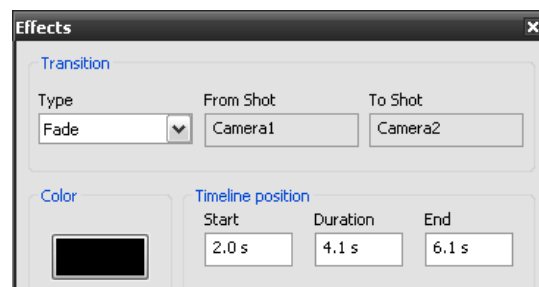
To populate the timeline of the Production, you can drag and drop shots and transitions into the timeline or right click on the shot or transition in the appropriate tab and select **Add to timeline**, as shown below.
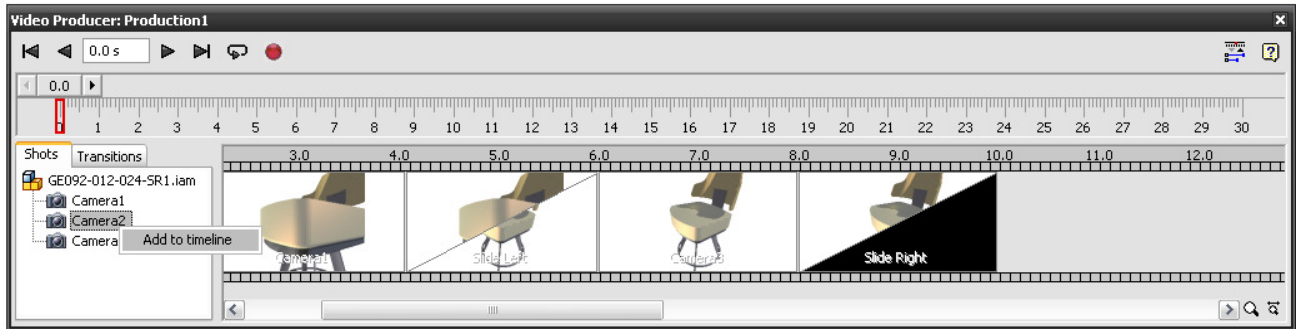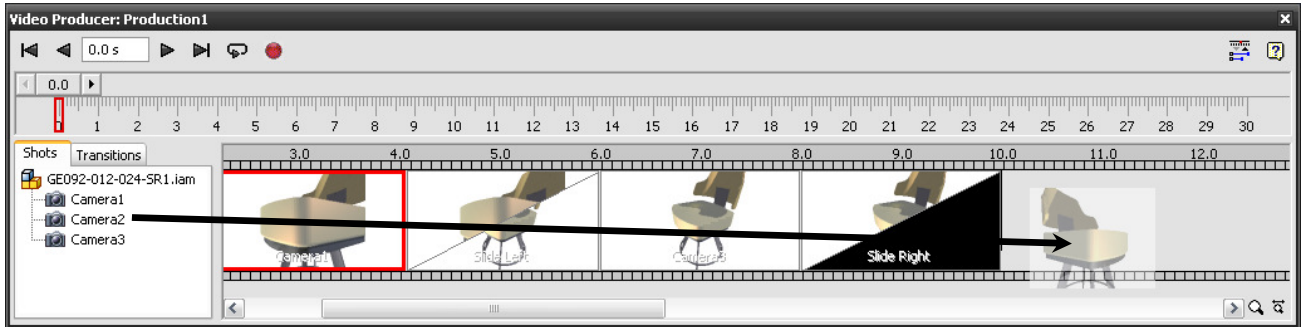

Select a Shot or Transition and dynamically pull on the left or right side of the extents to manipulate the timeline duration. Use the <Shift> or <Control> keys to grab two items at once and dynamically update their extents at the same time. This is more efficient than grabbing one at a time.
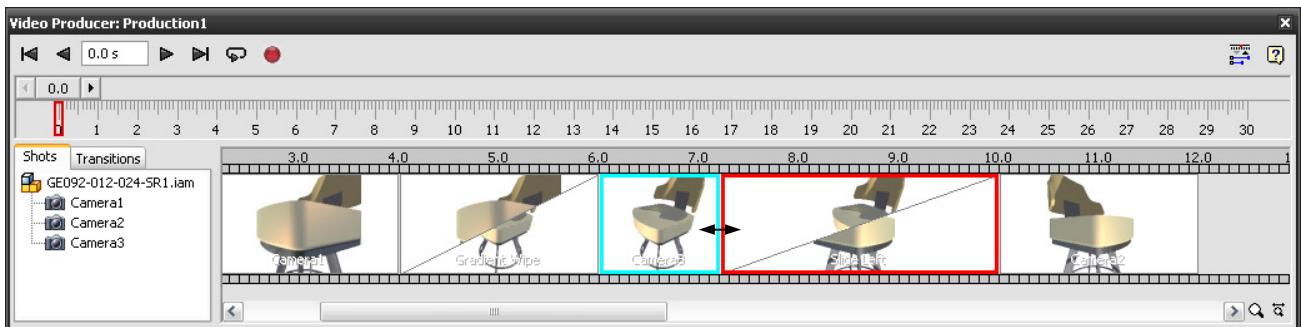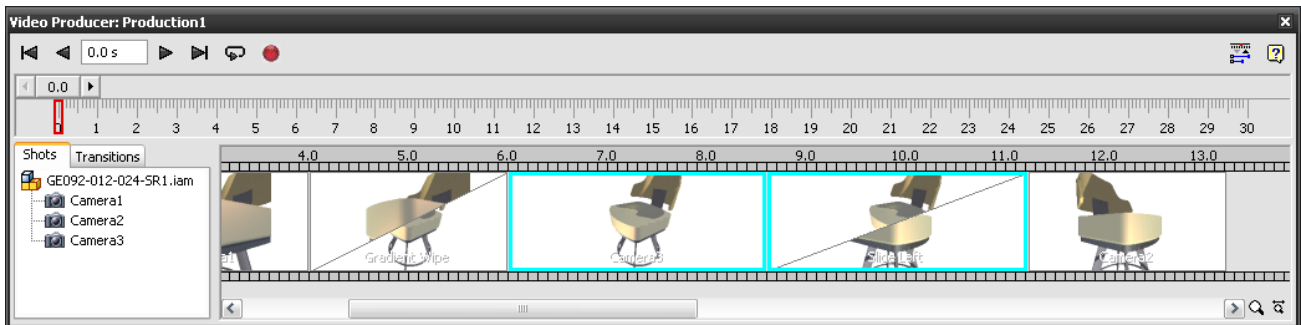
Rendering the Animation/Production

The Render Animation tool ( ) is similar to Render Image; however, has a few extra options on the Output tab. If you want to take advantage of your Production, make sure it is active before the animation is rendered.
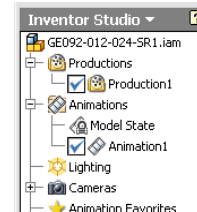
Option	Description
Output File	Specifies the file location and type: WMV or AVI
Time Range	Sets for the entire animation or specified interval with optional **Reverse** playback.
Antialiasing	Controls edge smoothness and affects rendering time. High suits most users, use Highest for Soft Shadow use.
Format	Sets video or image sequencing.
Preview:No Render	Creates quick render previews to check for any final adjustments.
Frame Rate	Sets the frame rate. A value of 24-30 is typical for TV, 15 still creates good quality output.
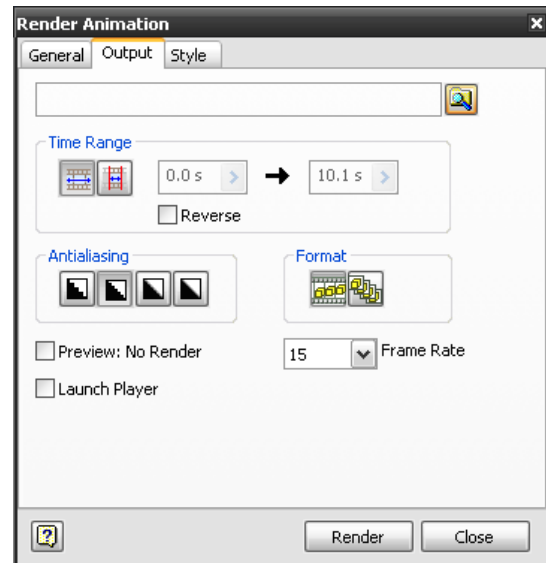
Significant time may be required to generate more realistic rendering. The following contribute to increased rendering times yet more realistic renderings:

• Higher frame rates
• Advanced Lighting settings such as Skylight, bounced light, Inverse and Inversed Squared Decays
• Shadow selections (Soft Shadows, etc)
• Higher antialiasing for edge smoothness
• Using True Reflection to show reflection of objects

The length of time required for rendering ultimately depends on your computer's specifications. Rendering in Inventor Studio uses multi-core processors; however, having a strong graphics card and increased RAM is also a benefit.

Class Summary: Inventor Studio provides users the tools to create high power presentations and animations for distribution within the company or to customers. By relying on predefined intelligence in your Inventor models, the required commands can be easily executed. The power to document and simulate the design remains with the design engineer who already intimately knows the model's design intent. Using Inventor Studio, companies save on outsourcing and reduce lead times to produce high quality productions. Consider using Inventor Studio in your company's concurrent engineering environment for everything from brainstorming to marketing and documenting the final product.