Dreamteck Splines – User Manual

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1. Introduction

Dreamteck Splines is a Spline system and extension for Unity which comes with a collection of tools and components for mesh generation, particle control, object spawning and much more. For a full list of features, refer to Spline Users and Editor Tools. The tool was initially created to aid our company's developers (Dreamteck Ltd.) in the process of level editing and creating game mechanics. The tool has been growing ever since it was first created in 2013. Over the years it has been used for many different purposes in many different projects (action games, TCG games, racing games, children's games and more).

1.1. Key Features

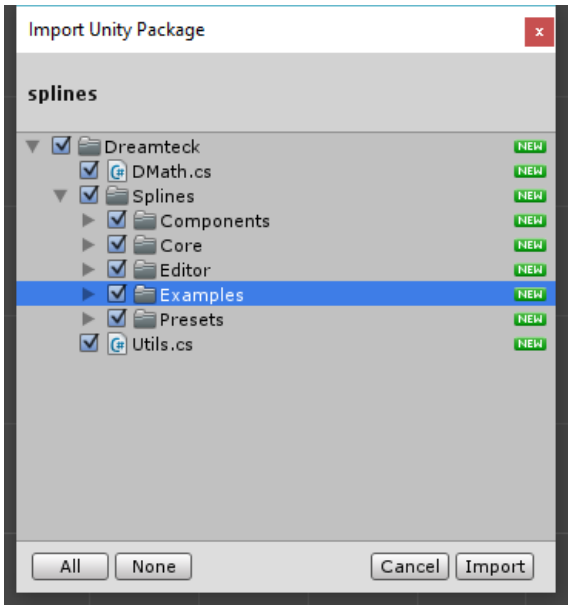
- Rapid spline creation and editing via custom editor in Unity.
- Four types of spline: Hermite, Bezier, B-Spline and Linear
- Procedural primitives and saving presets for later use
- Junctions
- Morph states
- On-the-fly mesh generation
- Multithreading
- Open source
- Easily expandable functionality

2. Getting Started

This chapter will guide the user through the installation, configuration and usage of the Dreamteck Splines system.

2.1. First time install

Dreamteck Splines comes packed in a .unitypackage file. Upon import, all the files and directories of the Dreamteck Spline system will be listed.



The "Examples" folder is optional. It contains example scenes which demonstrate the features of the system. It can be safely excluded from the import or deleted later if it isn't wanted.

The "Presets" folder contains an example preset file, saved with the preset manager. This folder can also be deleted but it will be automatically created as soon as a new preset is saved.

Clicking "Import" will decompress and import all of the selected files in the current Unity Project.

Dreamteck Splines 1.0.8 comes with an additional PlaymakerActions.unitypackage file found inside the Dreamteck/Splines folder. Importing this package will add Playmaker actions that work with Dreamteck Splines components.

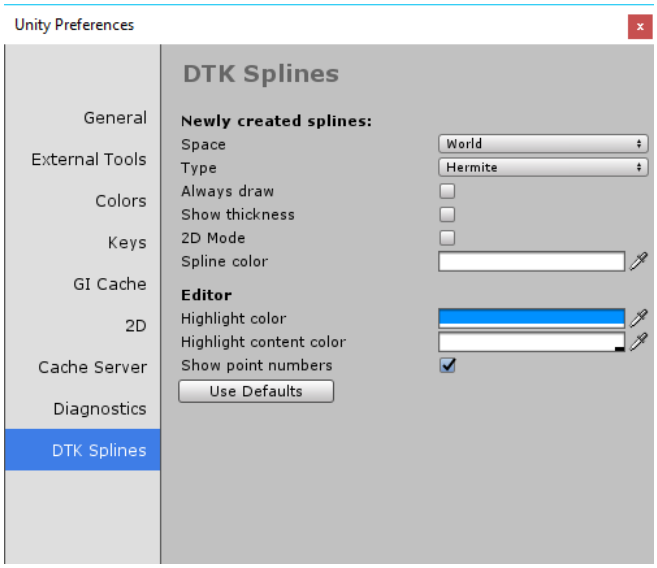
2.2. Updating Dreamteck Splines

If you already have Dreamteck Splines installed and have downloaded a newer version from the Asset Store, it is recommended that you delete the entire Dreamteck/Splines folder before importing the new version.

2.3. Preferences configuration

Since version 1.0.8 Dreamteck Splines comes with its own preferences screen that lets the user configure how the system behaves. These are all editor configurations and do not affect builds in any way.

To access the preferences screen go to Edit->Preferences->DTK Splines. This will open the following screen:



The options under “Newly created splines” allow the user to configure the default settings for each newly created spline. For example, if the game scene is full of light colors, then the default spline color could be set to black and that way each newly created spline will be black upon creation without the need of setting the color every time.

The options under the “Editor” section let the user customize the UI and scene view of the editor.

2.4. Creating a new Spline

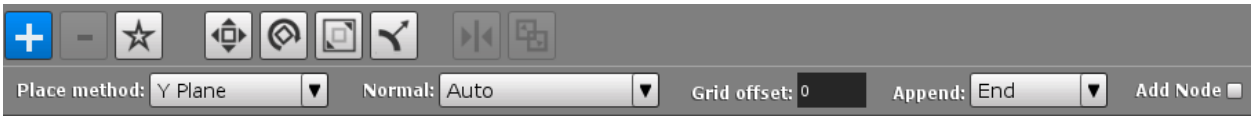
To create a new spline, select GameObject in the toolbar and navigate to Dreamteck->Spline->Computer

This will create a new Game Object called “Spline” with an empty **Spline Computer** component.

Once created, the object will be automatically selected and the currently selected editor tool for movement, rotation or scaling will be turned off. A new toolbar will appear in the scene view.

2.4.1. Adding control points

A spline needs at least two control points to exist. To add control points click the Plus button on the left of the toolbar. This will enter point creation mode and the button will get highlighted in blue. An additional toolbar will appear with the following options: Place method, Normal orientation and Far plane.



To create a new point, simply left click with the mouse somewhere in the scene. Where the point is created is defined by the place method. By default, the place method is set to Camera plane with far plane set to 0. This will create points in the position of the editor camera. The normal orientation option defines the direction of the normal of each new point upon creation. “Auto” will automatically pick a direction, appropriate for the selected placement method.

To exit point creation mode either press the Plus button again or click the right mouse button and without releasing it click the left mouse button too, then release both buttons – this is a shortcut for exiting point creation mode.

Version 1.0.5 introduces the append dropdown menu which lets the user select which end of the splines will the newly created points be appended to.

- End: Adds the new point to end of the spline
- Beginning: Adds the new point in the beginning of the spline, before the first point

Dreamteck Splines offers six placement methods to accommodate a big range of developer needs related to point creation. To choose a different method, click on the Place method dropdown menu and select a different method.

Version 1.0.7 introduces the Add Node option which will automatically create a new Node object and link it to the newly created point.

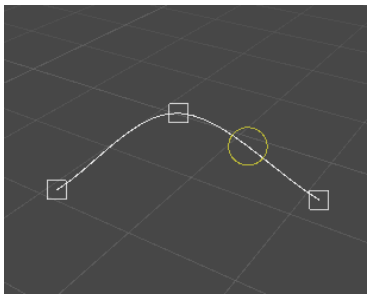
2.4.1.1. Camera plane

The camera plane placement method places points on a plane, perpendicular to the scene camera. Far plane controls how far from the camera is the plane on which the points are created.

The further the plane is, the bigger it becomes. If Far plane is set to 0, then the points will be created at exact position of the scene camera.

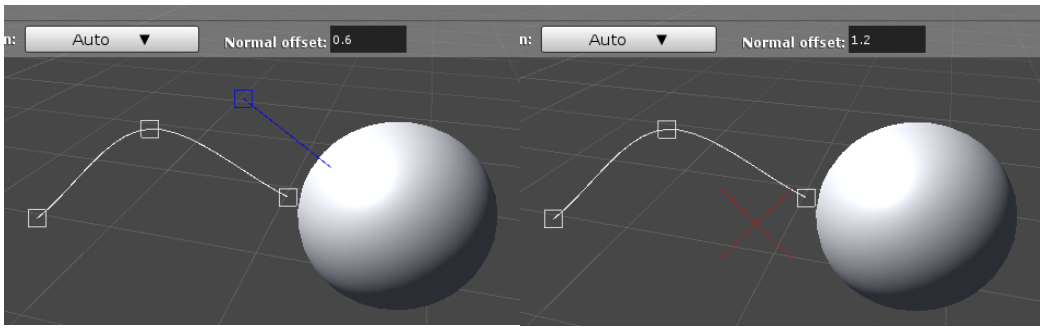
2.4.1.2. Insert

Insert inserts a new point between two points of the spline. When this method is selected, a circular button will appear in the scene. Moving the mouse around will move the button along the spline. Clicking the button will insert the point in the spline.



2.4.1.3. Surface

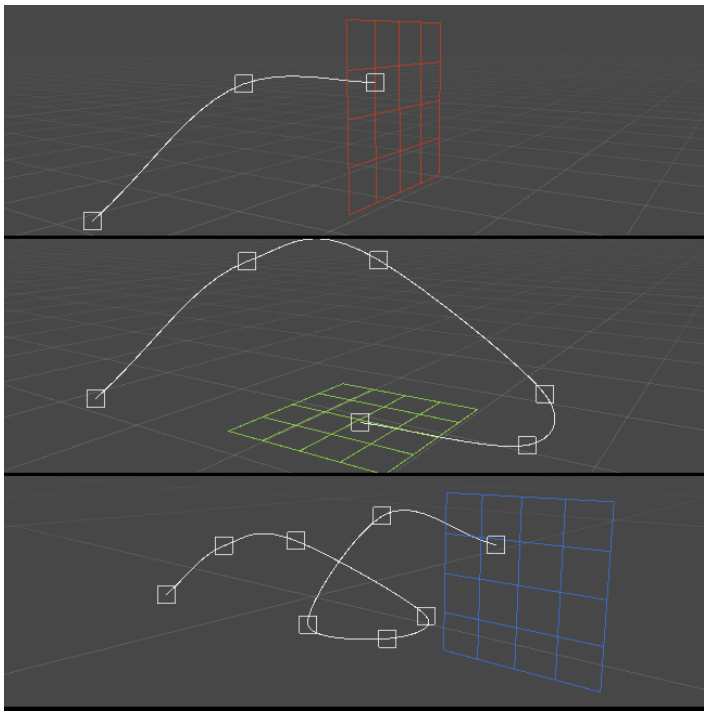
The surface method requires the scene to have at least one object with a collider. It will place the new point on the surface of the collider under the mouse upon left clicking. Normal offset controls the offset along the surface normal where the point will be created. If normal offset is 0, then the point will be created exactly on the surface of the collider. If the mouse does not hover over an object with a collider, a red cross will be displayed at the mouse position indicating that a point cannot be created.



Version 1.0.8 introduces the LayerMask button which opens a window with a layer mask field. This field lets the user set the layer mask of the surface raycast so that certain layers may be excluded from raycastig.

2.4.1.4. Plane-X, Y and Z

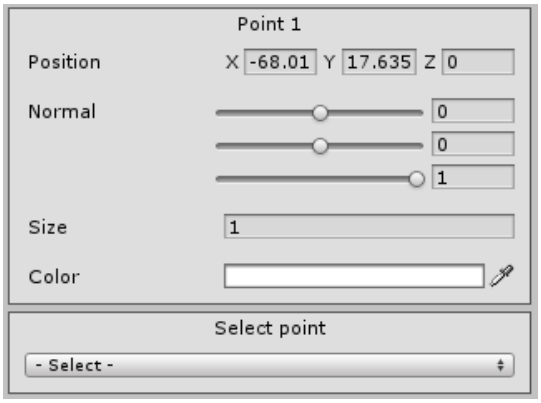
This placement method will project the mouse position onto infinite planes positioned at (0,0,0) world coordinates. This method is useful when the splines should be aligned to one of the three axes. In order to create a point the mouse must hover over the selected plane. If the mouse doesn't hover over the plane, a red cross will be drawn indicating that a point cannot be created. Plane offset controls the offset along the plane axis.



2.5. Selecting points

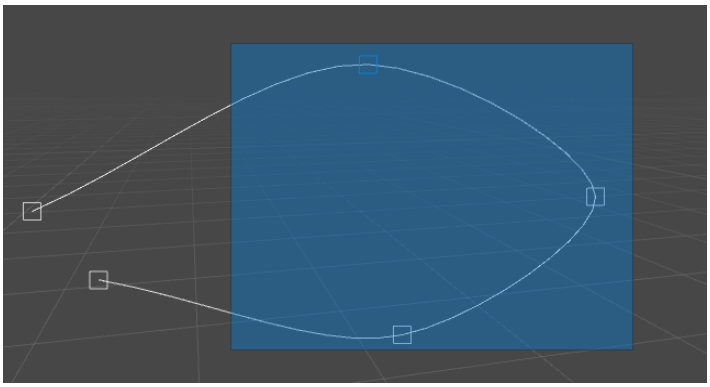
To select a point either click on it in the scene view or select it from the inspector using the point selection drop down menu.

When a point is selected, its parameters will be displayed in the inspector:



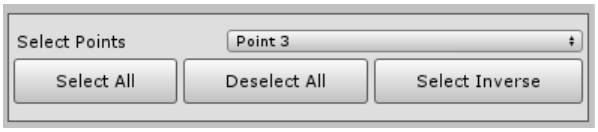
2.5.1. Selecting multiple points

To select multiple points either drag-select them in the scene view or select them one-by-one while holding Ctrl on the keyboard.



2.5.2. More selection options

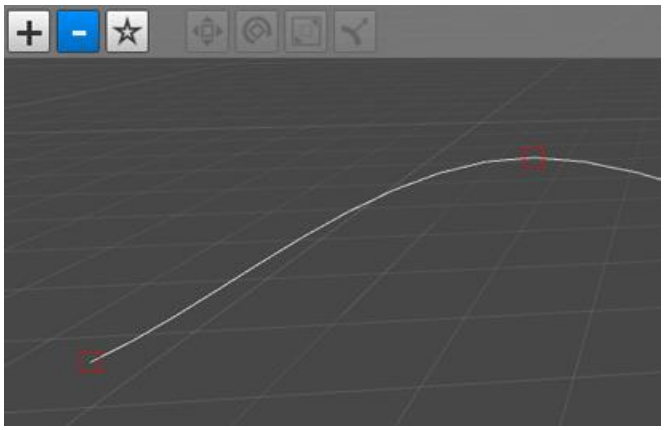
In version 1.0.8 three new buttons are introduced along with the Select point dropdown menu:



- Select All – Selects all points of the spline
- Deselect All – Deselects all points of the spline
- Select Inverse – Inverses the selection so that the selected points become unselected and vice versa

2.6. Deleting points

Points can be deleted by selecting them and pressing Delete on the keyboard or by entering Delete point mode.



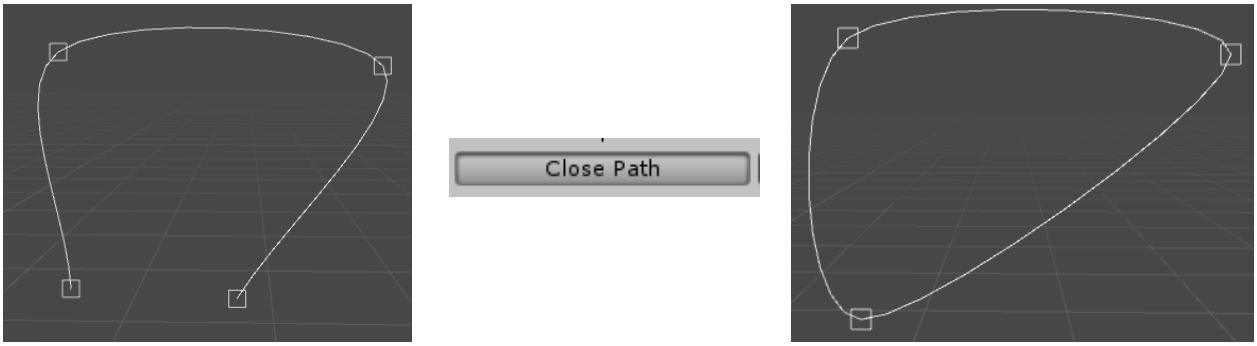
To enter Delete point mode, click on the Minus button in the scene toolbar. The button will get highlighted in blue and the control points will turn red. Clicking on a point in delete mode will delete the point.

2.7. Closing and breaking a spline

A spline path consisting of four or more points can be closed. This will connect the first and the last points of the spline.

2.7.1. Closing

To close a spline, first ensure that there are at least four control points present, go to the inspector and click the “Close spline” button. The button will get replaced with a “Break path” button and the path will get closed.



2.7.1.1. Close spline during point creation

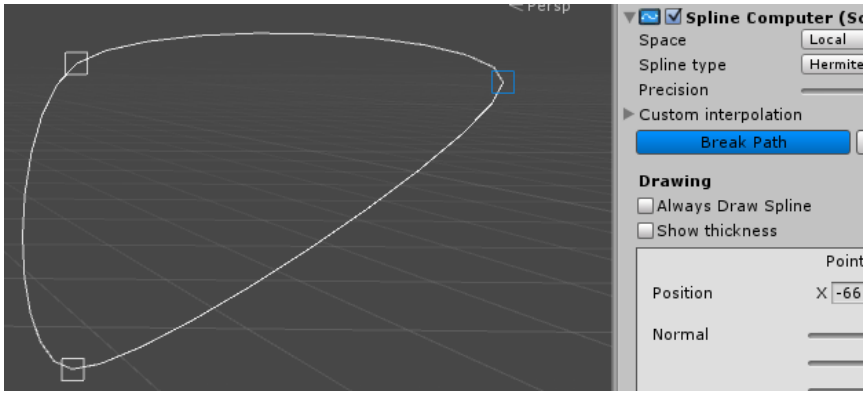
If a spline consists of three or more control points, it can be closed in point creation mode if the first point of the spline is clicked. Doing so will open a dialog asking whether or not the spline should be closed. This is convenient when the intention is to start off with a closed spline.

2.7.2. Breaking

To break a closed spline path press the “Break path button”. The two end points at which the path was closed will be able to move separately once again.

2.7.2.1. Breaking a path at point

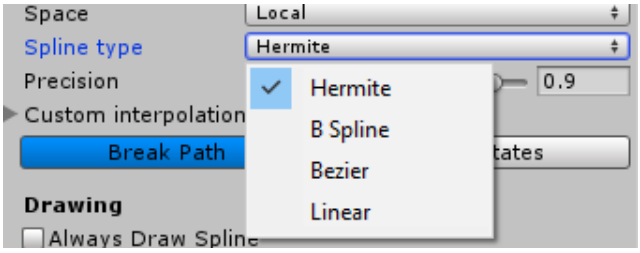
To break a spline path at a point simply select the point at which the path should be broken. The “Break Path” button in the inspector will get highlighted in blue. This indicates that the path will be broken at the selected point.



Make sure to select only one point, otherwise the path will break at the point it was previously connected.

2.8. Changing the spline type

Dreamteck Splines supports four types of interpolations: Hermite, Bezier, B-Spline and Linear. To change the spline type, navigate to the inspector and select a different type from the “Spline type” dropdown.



In version 1.0.8, a new dialog is introduced when changing the type from Hermite to Bezier, which offers to convert the Hermite spline to Bezier one. Clicking “Yes” will retain the spline’s shape after switching to Bezier. No extra points will be added but the tangents of the points will be recalculated.

2.9. Inversing the point order

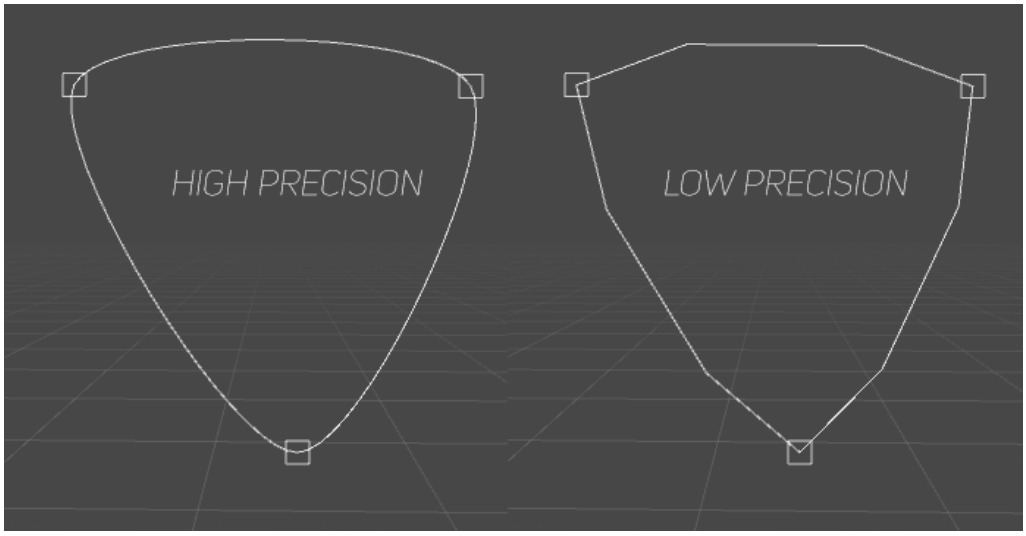
Sometimes it’s useful to be able to inverse the control point order without changing the spline’s shape. Doing so will inverse the spline’s direction. To inverse the point order, click the “Inverse Point Order” button in the SplineComputer inspector:

2.10. Spline precision

In computer graphics, splines aren’t endlessly smooth but are rather approximated at a certain rate. The higher the rate is the smoother the spline will be and the more computations it will require to approximate. It is usually a good idea to balance the precision so the spline looks visually smooth but it’s not too detailed.

To change the spline approximation rate, use the Precision slider in the inspector.

Note that precision should never be 1 (that would mean dividing by zero) and therefore the maximum precision that can be set is 0.9999



2.11. Framing control points

When a SplineComputer is selected and is in edit mode, the framing functionality of the Unity editor can be used to frame all or only the selected spline points. If the spline computer has one or more spline points, then going to Edit->Frame selected will frame the selected points or all points if none are selected. If the Spline Computer doesn’t have spline points, then the default command behavior is executed.

3. Editing splines

Dreamteck Splines are highly configurable and comes with a set of tools that aid the creation process. This chapter offers an in-depth look at those tools and explains how they work.

3.1. Point components

Each spline consists of a set of control points and each control point has a set of components that define it. These components get interpolated during spline evaluation.

3.1.1. Position

The position is a Vector3 point in space where the control point is located.

3.1.2. Normal

The normal is a Vector3 direction of the point normal. It is used to define object orientation along the spline.

3.1.3. Size

A float value defining the size of the point. It is used as a multiplier for scaling and offsetting.

3.1.4. Color

The color of the point.

3.1.5. Tangents

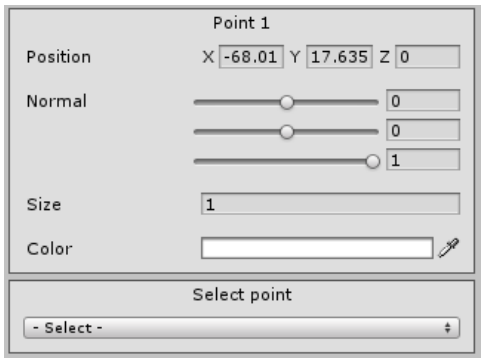
Each point has two additional Vector3 values for tangent position (tangent1 position and tangent2 position). The tangents are required by the Bezier algorithm otherwise do not have a function.

3.1.6. Type

The type of the point. Can be Smooth or Broken. This is used by the Bezier algorithm only to define whether or not the tangents will be free or locked.

3.2. Editing points

Selecting each point opens up the point menu in the inspector which exposes the point parameters. From there each point's position, normal, size, color and type can be edited. This menu is the only place where the point's size and color can be set however it isn't comfortable for setting the point's position and normal unless a precise value needs to be entered.



Dreamteck Splines comes with tools for movement, rotation scaling and editing normal. The buttons for those tools are located in the scene view toolbar and are unavailable by default. They become available once one or more points are selected.

3.2.1. Move tool

The move tool provides a standard move handle for each point. Clicking on the move tool button enables the move tool. Clicking on the button again, once it's highlighted disables the tool.

The move tool can be selected with by pressing "W" on the keyboard. This overrides Unity's built-in shortcut.

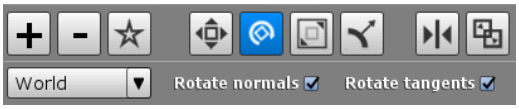
The Move tool has a Space dropdown menu which lets the user choose the space they want to move the point in. By default, "World" is selected which orients the move handle to align with the world axes. Local space will orient the handle to align with the local space of the SplineComputer's object and Spline space will orient the handle based on the spline direction.

- Grid snap enables automatic grid snapping. When grid snap is toggled, the size of the grid can be configured in the toolbar.

3.2.2. Rotate tool

The rotate tool provides a standard rotation handle for the selected points. Clicking on the rotate tool button enables the rotate tool. Clicking on the button again, once it's highlighted disables the tool.

The rotate tool can be selected with by pressing "E" on the keyboard. This overrides Unity's built-in shortcut.



This tool has two options which appear in the toolbar extension below.

- Rotate normal – whether or not the normal of the point should be rotated
- Rotate tangents – whether or not the tangents' positions should be rotated

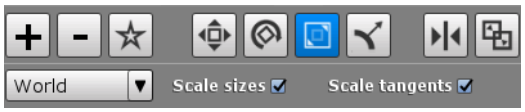
Rotating a single point will only result in rotating the normal and tangents IF the appropriate options are selected in the toolbar.

When multiple points are selected, the rotation handle is positioned in the center of both points. Points' positions are rotated around the position of the handle.

3.2.3. Scale tool

The scale tool provides a standard scale handle for the selected points. Clicking on the scale tool button enables the scale tool. Clicking on the button again, once it's highlighted disables the tool.

The scale tool can be selected with by pressing "R" on the keyboard. This overrides Unity's built-in shortcut.



This tool has two options which appear in the toolbar extension below.

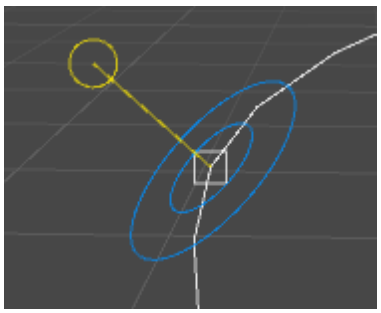
- Scale sizes – whether or not to scale the points' size parameters
- Scale tangents – whether or not to scale the points' tangents' positions

Scaling a single point will only result in scaling its size and tangents IF the appropriate options are selected in the toolbar.

When multiple points are selected, the scale handle is positioned in the center of both points. Points' positions are scaled away or towards the scale handle's position.

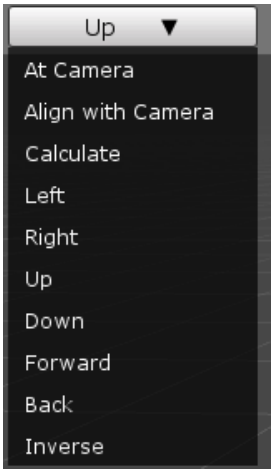
3.2.4. Normal tool

The move tool provides a special directional handle for each selected point. Clicking on the normal tool button enables the normal tool. Clicking on the button again, once it's highlighted disables the tool.



Dragging the yellow circular handle sets the normal's orientation.

The normal tool comes with a "Set Normals" function in the toolbar extension. This function sets the normal to automatically point at a certain direction. To choose where the normal should point, use the dropdown menu next to the "Set Normals" button. The available options are:



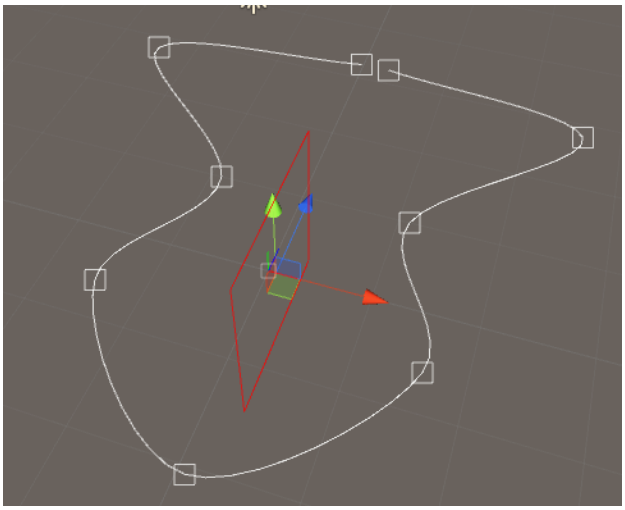
- At Camera – sets the normal to point at the editor camera position
- Align with camera – aligns the normal with the forward direction of the editor camera
- Calculate – Calculates the normal based on the point's neighbours
- Left – World left
- Right – World right
- Up – World up
- Down – World down
- Forward – World forward
- Back – World back
- Inverse – Inverses the normal's direction
- At Avg. Center – Orients the normal to look at the selected points' average position
- By Direction – Adjusts the normal so that it's perpendicular to the spline direction

Clicking on the button "Set normals" will set the normals of the selected points to the selected direction.

3.3. Symmetry editor

The symmetry editor is introduced in version 1.0.6 and its purpose is to help developers make symmetrical splines. To enter symmetry editing mode, click the symmetry editing button from the scene view toolbar. There needs to be at least at least one created spline point, otherwise the symmetry button will be disabled.

When in symmetry mode, the spline is reflected based on the symmetry center which by default matches the position of the SplineComputer's Transform. If the symmetry center isn't visible, make sure to look for it around the computer's transform position.



The symmetry center can be moved with the position handle attached to it or by modifying the center coordinates in the toolbar.

By default, the spline is reflected along the X axis, but this can be changed using the Axis dropdown menu. If flip is unchecked, the points to the left of the center will be reflected to the right, otherwise the

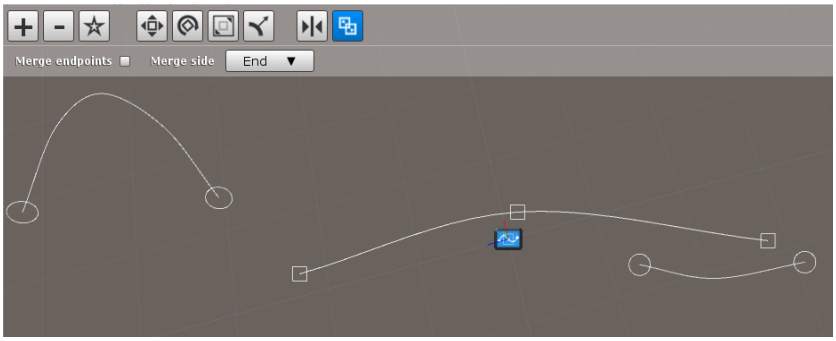
points on the right will be reflected to the left.

The “Weld Distance” setting defines at what distance from the symmetry plane two reflected points will be merged into one. If the spline is of Bezier type, the merged point will have broken tangents.

3.4. Merging Splines

A spline merging editor is introduced in version 1.0.6. Its purpose is to merge two or more spline computers into one. To toggle the merge editor, click the “Merge Spline Computers” button in the scene view toolbar. The spline needs to have at least two control points and must not be closed in order for the merge editor to work.

When the merge editor is selected, it will display all other available Spline Computers in the scene, each of them having a circular button at each endpoint.



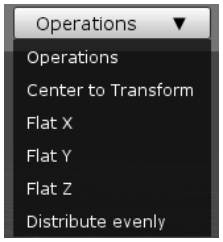
To merge the selected spline with another available spline, click one of the endpoints of the other splines. By default the merged spline will be appended to the end of the selected spline, but this can be changed by setting the “Merge Side” option to “Start” – then the merged spline will be appended to the beginning.

If the “Merge Endpoints” option is toggled, then the endpoint of the selected spline and the endpoint of the merged spline will be merged into one point. Basically, the endpoint of the merged spline will be removed.

When two splines are merged, all of the SplineUsers, subscribed to the merged spline get subscribed to the selected spline that “consumes” the merged spline. So for example, if the merged spline has a TubeGenerator attached to it, the TubeGenerator will get transferred to the selected spline.

After the merge, the above Tube Generator starts referencing the new spline.

3.5. Point operations

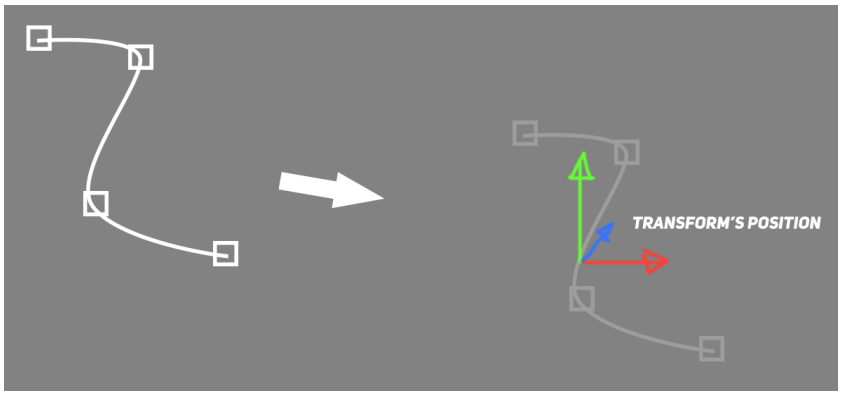


Dreamteck Splines provides a set of simple and handy operations for editing points. These operations can be found on the right side of the scene view toolbar and become available when at least one point is selected. Since most of the operations require two or more points to be selected, it's recommended to select at least three points when examining this feature for the first time.

When an operation is selected from the dropdown menu it is immediately executed.

3.5.1. Center To Transform

When splines are created, their points can be positioned very far from the position of the Spline Computer's Transform. Sometimes the control points need to be brought to the center of their transform so proper transformation can be applied. This operation brings all of the selected points to the center of the transform while maintaining their relative position.

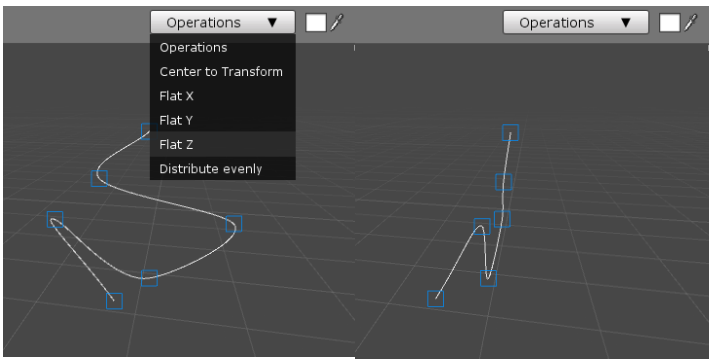


3.5.2. Move Transform To

This is the reverse equivalent of Center To Transform. This operation will move the position of the SplineComputer's transform to the average center of the selected points without moving any points.

3.5.3. Flat X, Y and Z

These operations flat the selected points' positions along the given axis.



If the spline type is Bezier, a dialog will appear upon selecting the flat operation giving the option to flat only the points' positions, only the points' tangents or everything.

3.5.4. Mirror X, Y and Z

Mirroring is introduced in version 1.0.3 and mirrors the selected spline points along the given axis.

3.5.5. Distribute evenly

As the name suggest, this operation will attempt to distribute the points at even distances from each other.

Before:

After:

3.6. Spline Computer settings

The Spline Computer component has several very important settings that can change the way it works. These settings can be found in the inspector.

3.6.1. Space

She Space of the Spline Computer can be either world or local and defines how the its spline is computed. Local space applies the transform's position, scale and rotation to the spline resulting in a transformed spline. Setting the space to World will cause the spline to ignore the object's transform much like the Space attribute of Unity's Built-in Line Renderer.

When changing the space of a Spline Computer, the spline's coordinates are preserved into the new coordinate system resulting in the spline staying the same.

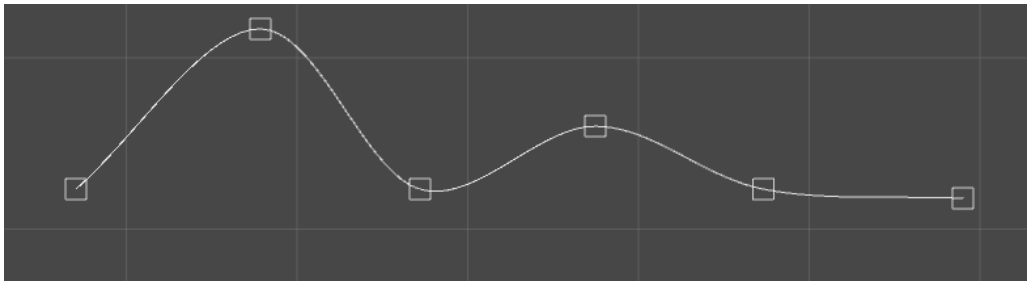
Example case:

A spline with five control points is created;
The Spline Computer's space is set to local;
The Spline Computer's scale is set to (2, 2, 2) (twice the initial). This results in a scaled spline;
The Spline Computer's space is set to world. The spline's size stays the same;
The Spline Computer's scale is set back to (1, 1, 1). The space is set to world so the spline's size stays the same;
The Spline Computer's space is set back to local; The spline's size stays the same.

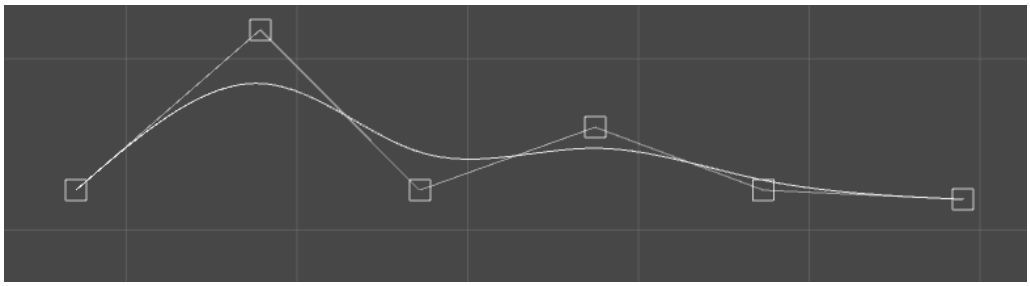
3.6.2. Spline type

The spline type defines which interpolation method should be used to calculate the spline.

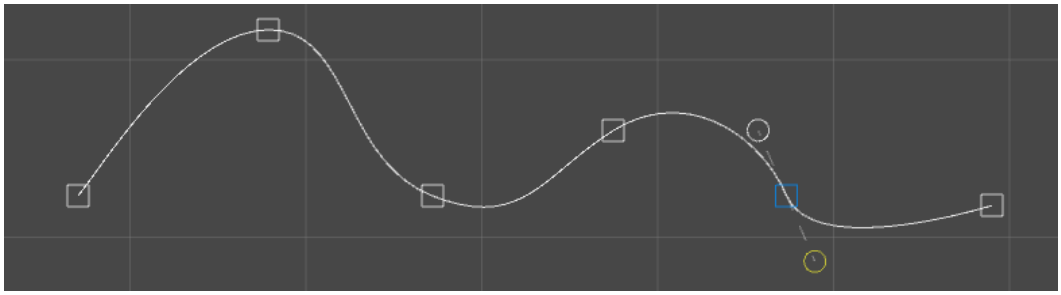
3.6.2.1. Hermite



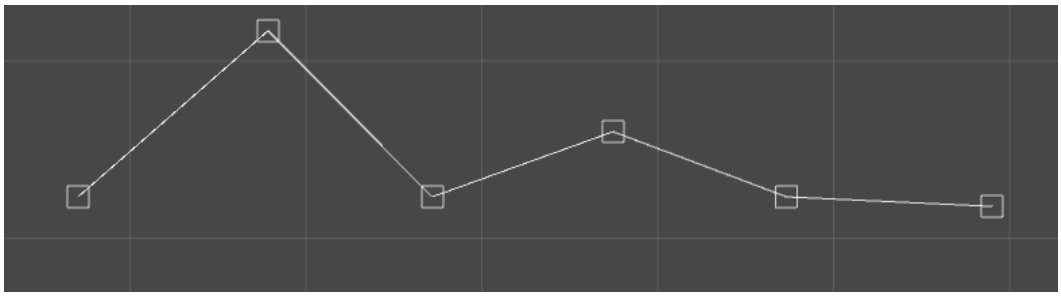
3.6.2.2. B-Spline



3.6.2.3. Bezier



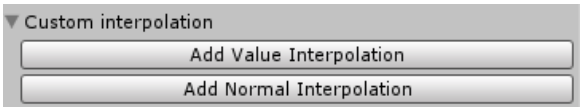
3.6.2.4. Linear



3.6.3. Custom interpolation

By default the points' colors, sizes and normals are linearly interpolated which may not be desired in some cases.

To set an interpolation curve, expand the "Custom interpolation" foldout in the inspector.

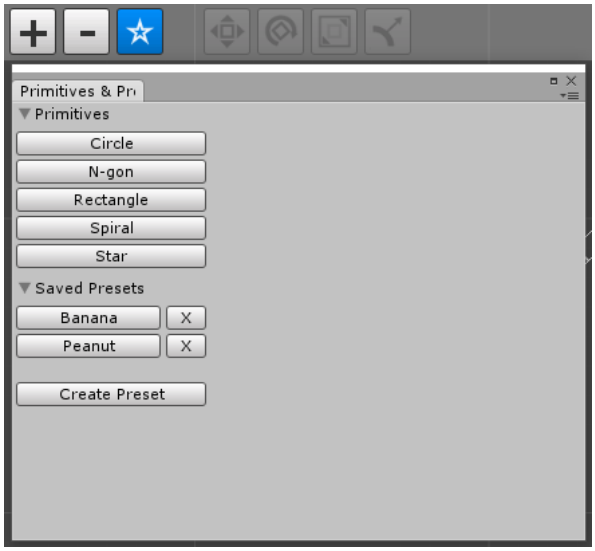


Then click on "Add Value Interpolation" to add a custom curve for the color and size interpolation or click "Add Normal Interpolation" to add a custom curve for the normal interpolation.

Doing so will create a default Ease-in, Ease-out curve which can then be edited to something else.

3.7. Primitives and presets

Dreamteck Splines provides a list of procedural primitives and a preset saving system. Both are located in the Primitives & Presets window which can be opened by clicking the Star button from the scene view toolbar.

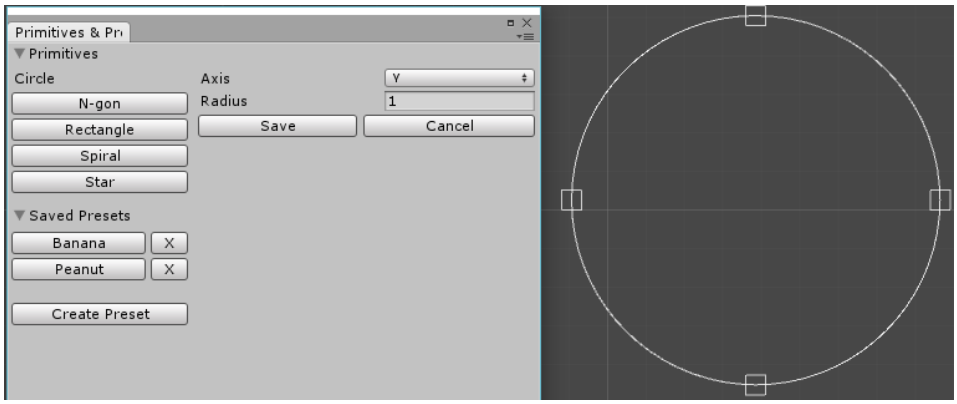


The primitives are listed first with buttons. Clicking on a primitive button will open the primitive preview and menu. The saved presets are listed second and like the primitives, clicking on a preset

button opens the preset preview and menu. Presets can be deleted by clicking on the button with a cross next to the preset button.

3.7.1. Using primitives

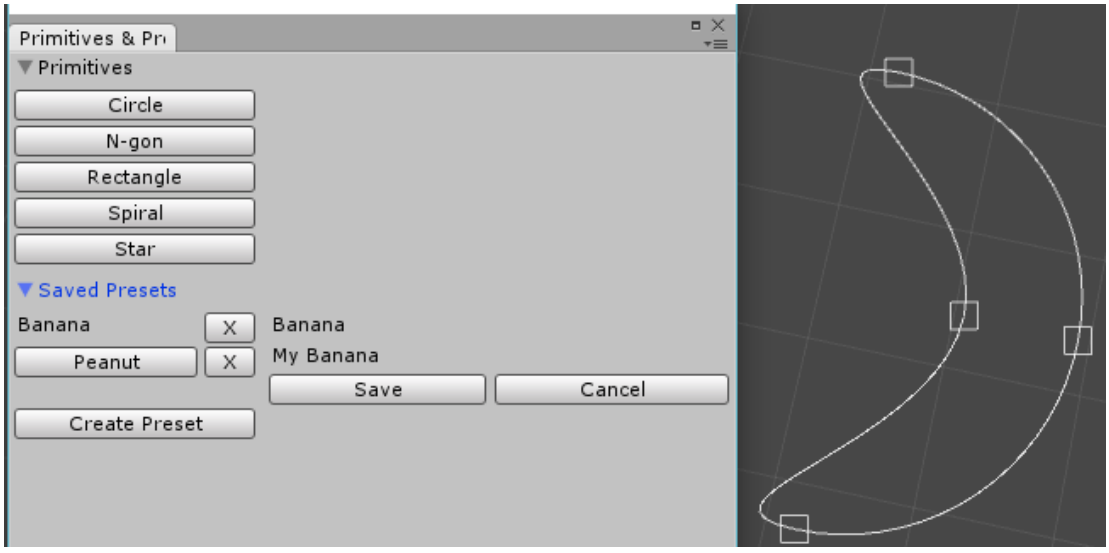
When a primitive is selected, its menu is displayed in the right side of the Primitives & Presets window. This menu features settings for the procedural primitive and a “Save” and “Cancel” button. In the scene view, the spline is set to display the primitive.



If “Save” is pressed, the spline shape and settings is set, if “Cancel” is pressed, the spline gets reverted to its previous state.

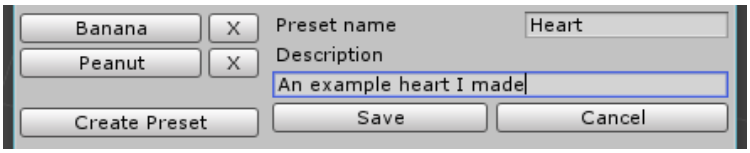
3.7.2. Using presets

When a preset is selected, it’s title and description as well as “Save” and “Cancel” buttons are displayed on the right side of the Primitives & Presets window. If “Save” is pressed, the preset is applied, if “Cancel” is pressed, the spline gets reverted to its previous state.



3.7.2.1. Creating a preset

To create a new preset, click the “Create preset” button. Fill the name and description fields that are displayed and click “Save”. This will create a new preset file in the presets folder.



If after saving, the file does not appear in the Presets folder, right click inside the folder and select “Refresh”.

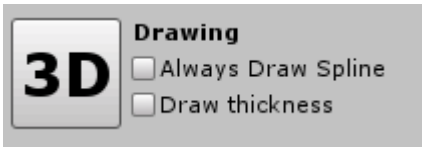
Presets can be transferred between projects.

3.8. Configuring the Spline Computer editor

The SplineComputer provides a set of settings which defined how the spline is drawn in the editor or how it behaves.

3.8.1. 2D and 3D Mode

Dreamteck Splines are 3D splines but version 1.0.8 introduces the 2D mode. It can be toggled by clicking the big button in the SplineComputer inspector saying “3D”.



Once clicked, the button will change its text to “2D”, the spline will be flattened and the normals will automatically be handled so that they point along the negative Z axis.

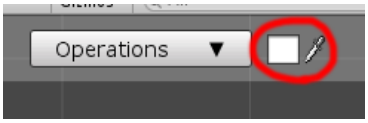
In 2D mode, the only available point creation modes are “Free” and “Insert”. The Free point creation mode is an analogue of the Z-plane creation mode.

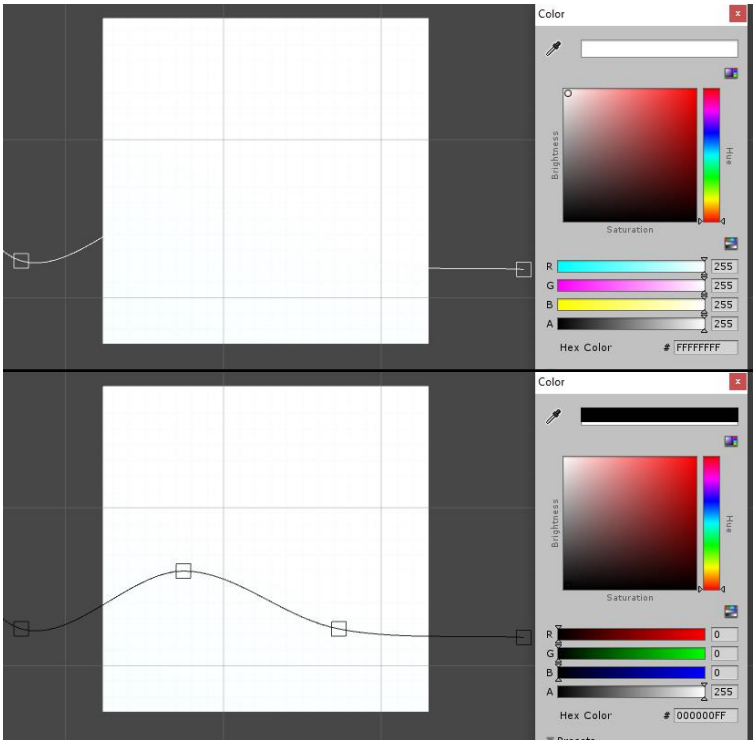
Note that the 2D mode only changes the behavior of the editor. The splines are still 3D and their control points can be displaced along the Z axis during runtime using code.

3.8.2. Custom Color

Custom colors can be used differentiating Spline Computers when several are drawn simultaneously or to prevent blending with the background.

To choose a color for the currently selected Spline Computer use the color picker located in the right side of the scene view toolbar.



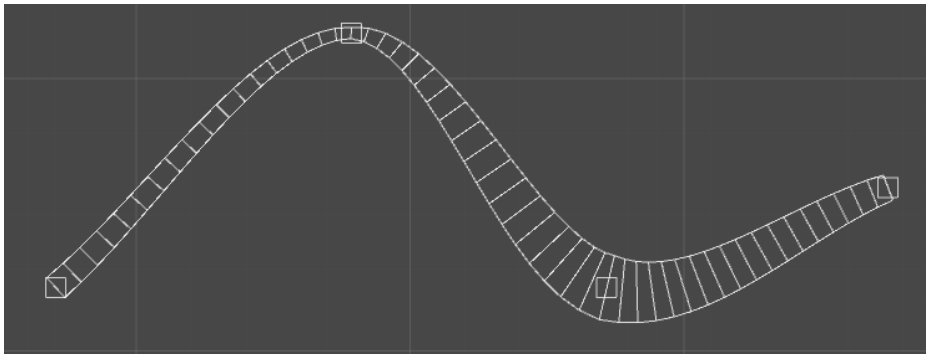


3.8.3. Always draw

Always draw can be toggled on or off from the Spline Computer's inspector. This option causes the spline to be drawn all the time even when the Spline Computer is not selected.

3.8.4. Draw thickness

Draw thickness is toggled on or off from the Spline Computer's inspector. This option causes the spline's thickness to visualize. The thickness is defined by the size of the points (which by default is 1).



4. Morph states

Each Spline Computer has a morph state module which allows adding channels that contain different spline shapes to the Spline Computer. These channels can then be blended using weights.

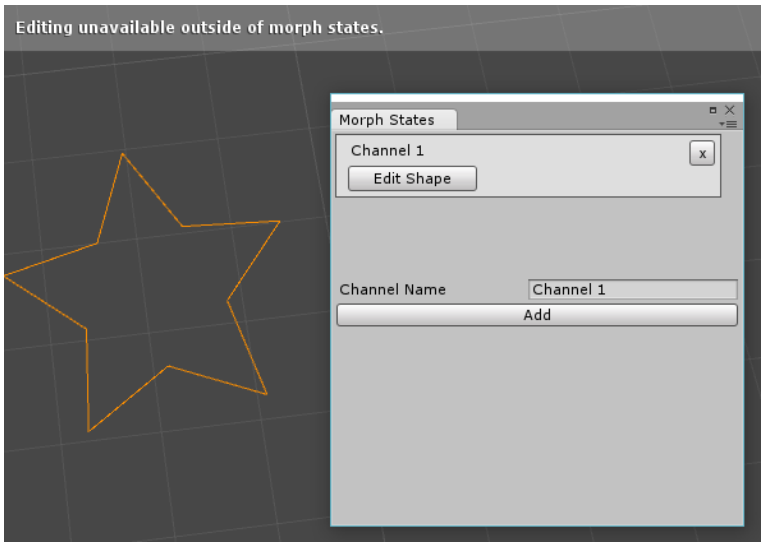
To open the Morph States window click the “Morph States” button in the Spline Computer inspector.

This will open a new empty window with the option to add a channel.

4.1. Creating morph channels

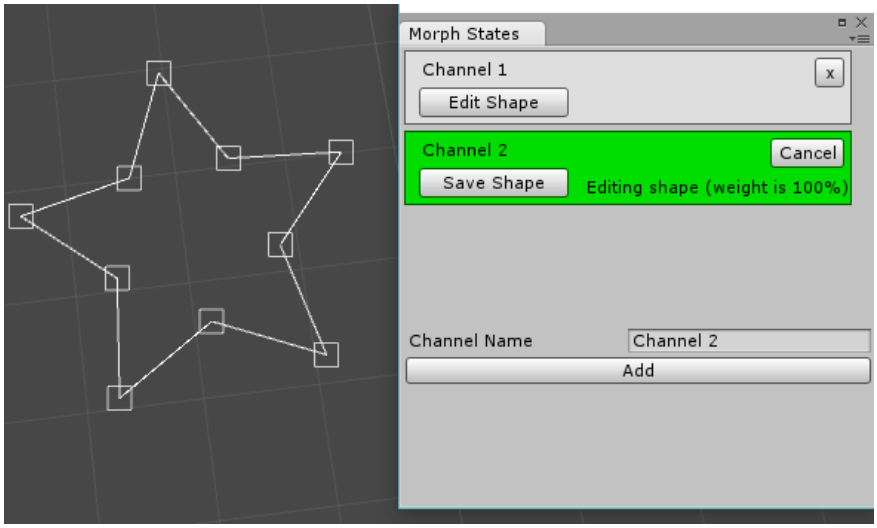
Clicking on the “Add” button in the Morph States window will create a new base channel which has 100% weight.

After the first channel is created, it will appear in the window above the “Add” button. The spline will turn orange and editing will be disabled. From this moment on, editing will be only enabled inside channels.



4.2. Editing morph channels

To edit the shape of a morph channel, go to the Morph States menu and click the “Edit Shape” button of the morph channel which shape must be edited. This will highlight the morph channel in green. It will also enable the spline points and editing tools.

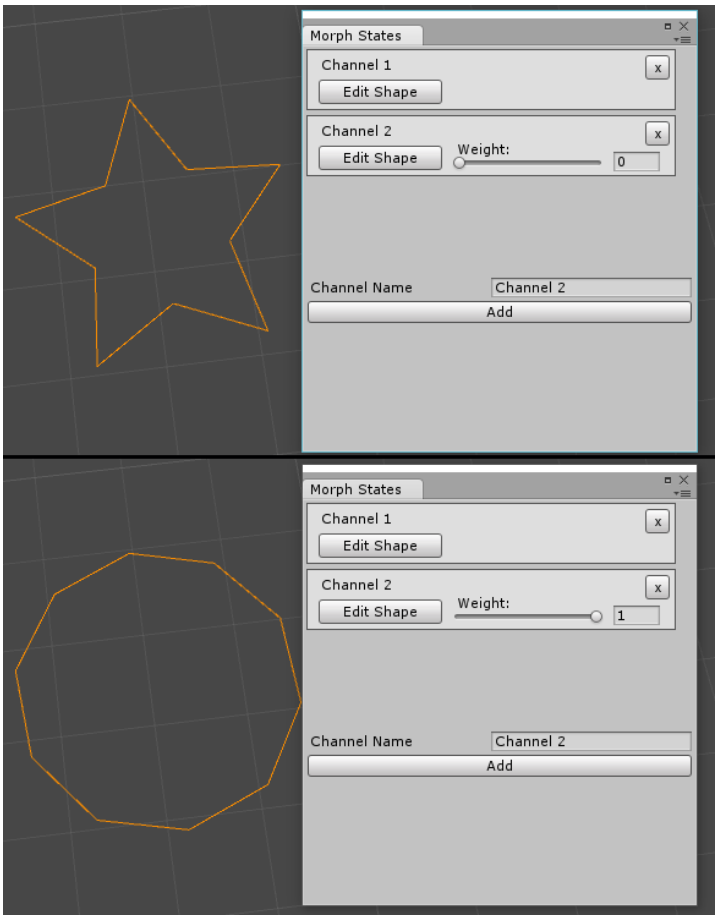


When editing the shape of a morph channel, the morph channel is weighted at 100%. After editing is complete, “Save Shape” should be pressed. This will write the edited shape to the channel and exit edit mode.

IMPORTANT! Each channel must contain exactly the same amount of points as the other channels. Therefore deleting and creation of points is disabled.

4.3. Blending between shapes

Once there are two channels with different shapes they can be blended. To blend a channel, drag its weight slider to the right.



During runtime, channel weights are set via code or UnityEvents. Look at the API reference to see examples of how to do this.

5. Spline Users

The Spline Computer all by itself cannot do much more than to provide sample data from its spline. To make use of the Spline Computer, Dreamteck Splines implements the Spline User. This is a base class, derived from MonoBeaviour. Its purpose is to sample the Spline Computer and use the sampled data for various purposes.

When a Spline User is selected in the editor, its Spline Computer is automatically drawn.

The Spline Users only sample Spline Computers when there has been a change in the spline, therefore do not have a constant overhead if no changes are made.

The Spline User class supports multithreading so sampling and calculations can be done in a separate thread, not affecting the game performance.

5.1. Basic SplineUser properties

As of version 1.0.5 the SplineUser components have two Sample modes that can be toggled in the SplineUser inspector:

- Computer
- User

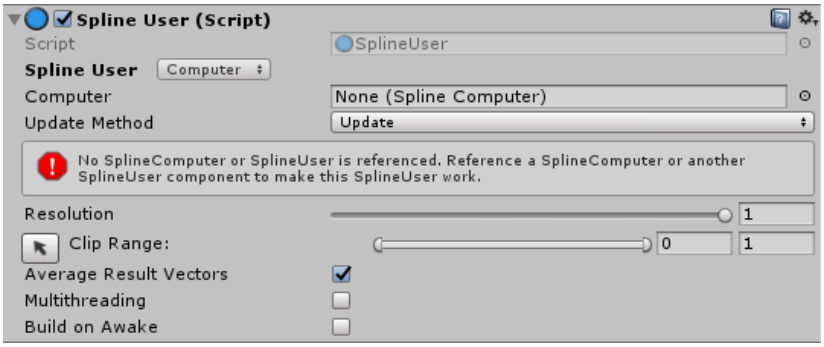
The sample mode defines the type of the sample target of the specific SplineUser.

5.1.1. Sample Target – Computer

When the sample mode is set to Computer, the SplineUser requires a SplineComputer reference to be set. The SplineUser then samples the referenced SplineComputer when there are changes in the spline.

When a SplineUser is set to sample a SplineComputer, the following properties are exposed:

- UpdateMethod: When is the user updated? Update/FixedUpdate/LateUpdate
- Resolution: (0-1) acts like a multiplier to the Spline Computer's precision
- Clip Range: Two values – clipFrom and clipTo which define the range of the spline that will be used
- Average result vectors: Whether or not to average each samples' directions and normals (in overall gives a good result when turned on)



When many SplineUsers are set to sample the same SplineComputer, each user will sample the computer individually when there is a change in the spline. This can cause a big performance drop due to the multiple sampling and in cases like this, it's recommended to use the User sample method.

5.1.1.1. The Clip Range

The clip range is defined by the Clip From and Clip To values. By default, the editor displays the range with a MinMax slider:

This type of control prevents the "clipFrom" value from being bigger than the "clipTo" value. In version 1.0.8. the clip range looping is introduced. If the sampled spline is closed, the clip range is controlled with two separate slider:

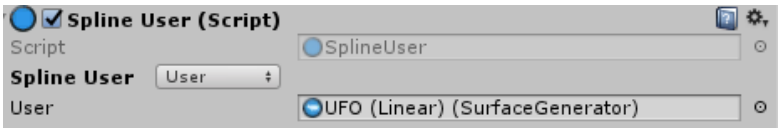
This allows for the "clipFrom" value to be bigger than the "clipTo" value. If clipFrom is bigger than clipTo, then the clipped range becomes looped, meaning that the sampled splines become [clipFrom;1.0] and [0.0;clipTo]

5.1.2. Sample Target – User

This sample mode requires a reference to another SplineUser. The referenced SplineUser must either be referencing a SplineComputer or a SplineUser which is referencing a SplineComputer.

This sample mode does not use the "resolution", "update method" and "average result vectors" properties. Instead it gets them from the referenced SplineUser.

When referenced SplineUsers get updated, all other SplineUsers which are referencing them also get updated.



5.2. Spline Tracer

The Spline Tracer is a new base component, introduced in version 1.0.8. It serves as a parent class to the SplineFollower, SplinePositioner and SplineProjector components. Its purpose is to provide base functionality for evaluation and positioning of objects along splines. By itself, the SplineTracer doesn't do anything but it comes with several key modules and properties which are inherited by the aforementioned components.

5.2.1. Transform Module

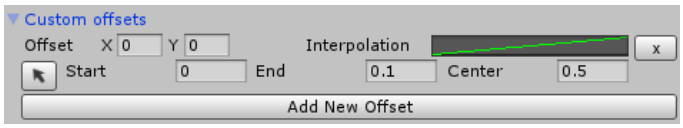
The transform module defines how the transformation from evaluating the spline is applied to the object. There are three axes for each position, rotation and scale. When an axis is toggled, transformation will be applied along it. The position and rotation components use world axes while the scale axes are local to the object.

Applying scale is disabled by default meaning that all axes are unchecked. When applying scale is enabled, an additional "Base Scale" Vector3 field is presented. The base scale is the scale that is going to be applied to the object. If the spline has various sizes, the base scale will be multiplied by the size value of the current spline evaluation.

Offsets can be applied to both the position and rotation. These offsets are local to the evaluation result's directions and are used constantly.

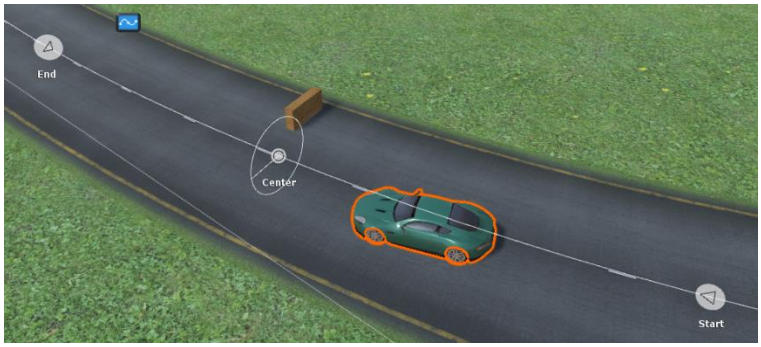
5.2.2. Custom Offset Module

The custom offset module adds a custom position offset to a specific area of the spline, defined by the user. This module comes empty since by default no custom offsets are assigned. Clicking the "Add New Offset" button will add a new area with a zero offset. The offset area will be immediately listed in the inspector:

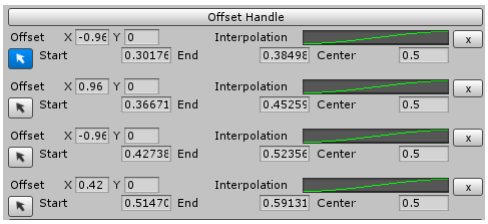


Each offset area is defined by a start percent along the spline [0-1], an end percent along the spline [0-1] and a center percent [0-1] to define where the offset's effect will be strongest. The center percent is local to the start-end range. An interpolation curve is provided to define motion easing.

Clicking the little black cursor at the left of the custom offset row will enable the scene view editor for the offset area:



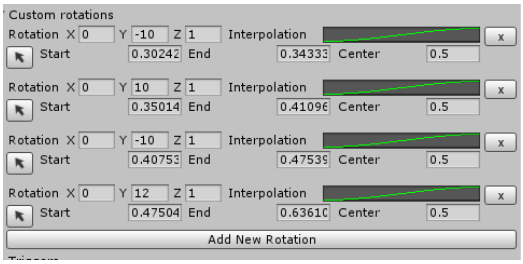
The scene view editor provides handles that can be used to visually set up the offset area. Dragging the "Start", "End" and "Center" handles along the spline will result in changes in the inspector. The target offset itself is visualized with a circle with a line going from its center to the edge.



When in scene edit mode, a button appears in the inspector with the text "Offset Handle". Clicking it toggles editing of the offset directly in the scene.

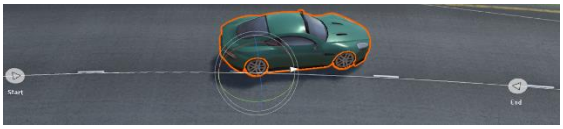
5.2.3. Custom Rotation Module

Similarly to the Custom Offset Module, the Custom Rotation module is used to apply a custom rotation offset to a specific region of the spline. Clicking the "Add New Rotation" button will add a new area with a zero rotation offset.



Just like the custom offset module, each custom rotation area is defined by a Start, End and Center percent and an interpolation curve is provided to define the easing of the motion.

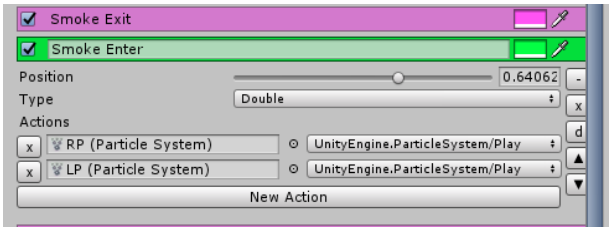
Clicking the black cursor on the side opens the scene editor which allows values to be set directly through the scene. The difference between this module and the custom offset module is that here a rotation handle is used.



5.2.4. Triggers

The SplineFollower, SplineProjector and LengthCalculator components can call events when a certain point of the spline has been reached or a certain length has been passed. These events are configured through triggers. To add a new trigger, expand the “Triggers” foldout and click the “Add new” button.

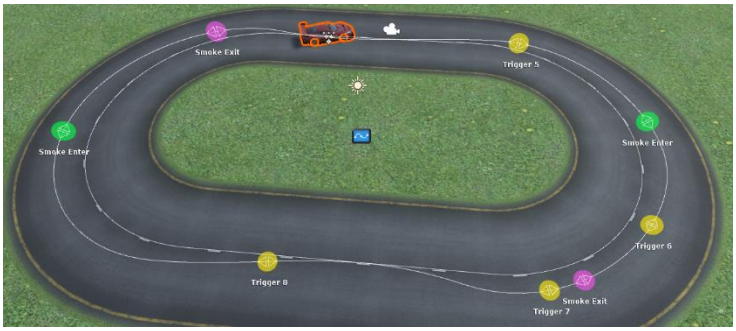
Each trigger can have a custom color and name and can raise multiple events. To configure a trigger, click on its name in the trigger list.



The position parameter of the trigger defines the place along the spline where the trigger will be located. Triggers can be three types: Double, Forward and Backward. The type defines the movement direction along the spline which activates the trigger. For example if a car is moving along the spline backwards and passes a Forward-type trigger, the trigger will not be activated.

To add a new event, click the “New Action” button, then select the object, script and function name to be called.

All triggers’ positions can also be edited directly in the scene.



5.2.5. Physics mode

The Physics mode of a SplineTracer can be either Transform, Rigidbody and Rigidbody2D. By default the Physics mode is set to Transform which modifies the property of the Transform directly. Using Rigidbody or Rigidbody2D will modify the rotation and

position of a Rigidbody component instead of the Transform. Rigidbody mode is preferred when physical interactions are needed.

Using PhysicsMode Rigidbody with a combination of the proper motion application settings can create realistically behaving followers.

5.2.6. Direction

The direction of the SplineTracer defines the direction that the object will be facing along the spline. In the SplineFollower component, the direction is also used to define the direction of movement.

5.3. Spline Follower : SplineTracer

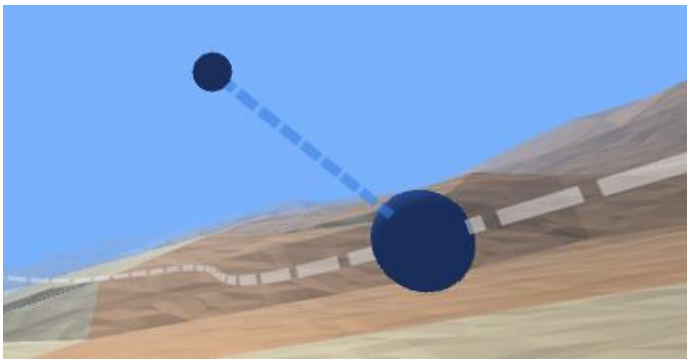
The Spline Follower component makes the object it's attached to follow a spline with a uniform speed. If autoFollow is enabled, the follower will automatically follow the spline with the follow speed during runtime. If autoFollow is disabled, the follower can be caused to follow by calling it's public method **Move(float distance).**

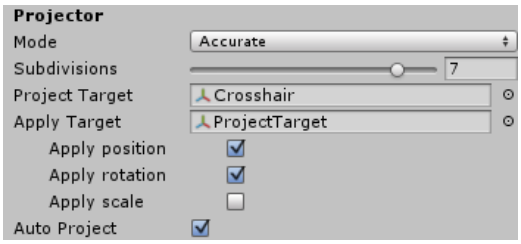
The Spline Follower has three wrap modes:

- Default – when the end of the spline is reached, the follower will stop
- Loop – When the end of the spline is reached, the follower will start again from the beginning.
- PingPong – When the end of the spline is reached, the follower will change its direction

5.4. Spline Projector : SplineTracer

The Spline Projector projects a Game Object from the scene on a spline. It will find the closest point of the spline to the object's position.





The Spline Projector needs two Transform components as targets – The target that is projected on the spline (Project Target) and the target that is positioned at the Project Target's projection. If Project Target is not set, then the Spline Projector's Transform is used by default. If Apply Target is not set, then Transform is set to the projection's result. The projection result can be accessed via code using the **projectResult** property.

The Spline Projector has two modes: Accurate and Cached.

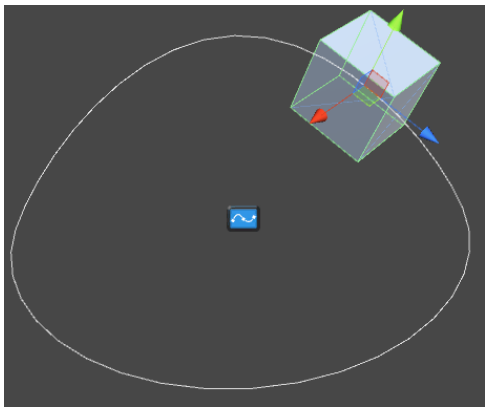
In accurate mode, the resolution slider of the Spline User is disabled. This tries to project the point on the spline as accurately as possible using subdivisions. The subdivisions are set to 4 by default. This in overall is a good value to produce an accurate result but there might be cases when it isn't enough.

In cached mode, the projector will find the two closest sampled results and project the target on the line between them. This is mode is designed to be a lot lighter than the Accurate mode but it will not give smooth results with low resolution samples.

This component has an additional module that control its behavior. Refer to Triggers and Modules for more information.

5.5. Spline Positioner : SplineTracer

This component positions a single Transform along a given path. This component is very similar to the Spline Follower but the difference is that it doesn't move the Transform along the spline. Its idea is to be used with animations, tweeners or other MonoBehaviour scripts. The way it works is it uses a position property which determines the object's position along the spline. Changing that property moves the object along the spline.



The positioner has two modes – Percent and Distance

- Percent maps the whole spline to the range [0-1]
- Distance positions the object at the given distance from the spline's start

This component has one additional module which controls its behavior. Refer to Triggers and Modules for more information.

5.6. Particle Controller

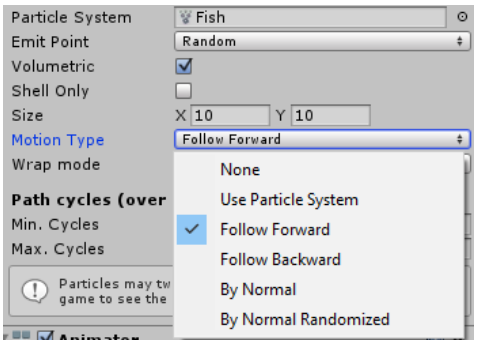
The Particle Controller uses a Shuriken particle system and places its particles along a spline.

This component offers a preview right in the editor if it's attached to the particle system that it controls.

The Particle Controller has an Emit point which controls where new particles will be spawned. The modes are:

- Beginning – Emits particles from the beginning of the spline
- Ending – Emits particles from the final point of the spline
- Ordered – Emits particles from the beginning of the spline towards it's end based on particle index
- Random – Emits particles between the beginning and the end of the spline on a random basis

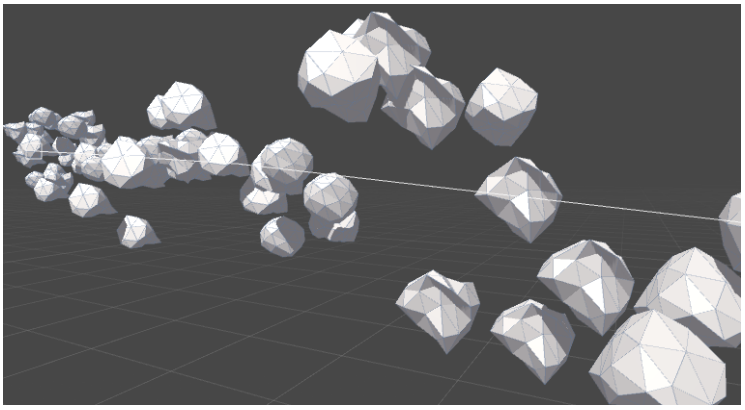
Another very important option of the Particle Controller is the Motion type. This controls the particle behavior over its lifetime. The available motion types are:



- Use Particle System – Uses the motion, defined by the Particle System component
- Follow Forward – Particles move forward along the spline based on their lifetime
- Follow Backward – Particles move backward along the spline based on their lifetime
- By Normal – Particles get their initial velocity set in the direction of the spline sample's normal
- By Normal Randomized – Same as above but the direction vector is randomized

5.7. Object Controller

The Object Controller component instantiates and positions Game Objects along a spline. This could be done both during runtime and in the editor.

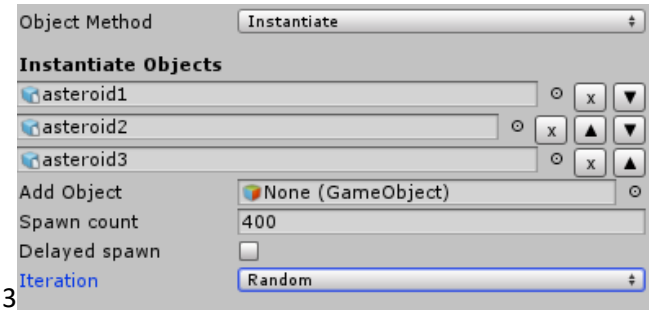


The Object Controller has two Object Methods which define how the objects it controls are created.

- Instantiate – This will instantiate new objects
- Get Children – This will not instantiate new objects but instead will take the existing children of the Object Controller's Transform and use them.

In Instantiate mode, a Game Object array is presented. For Instantiate to work there must be at least one added Game Object reference.

A Spawn Count property is presented. Modifying it will create or destroy objects.



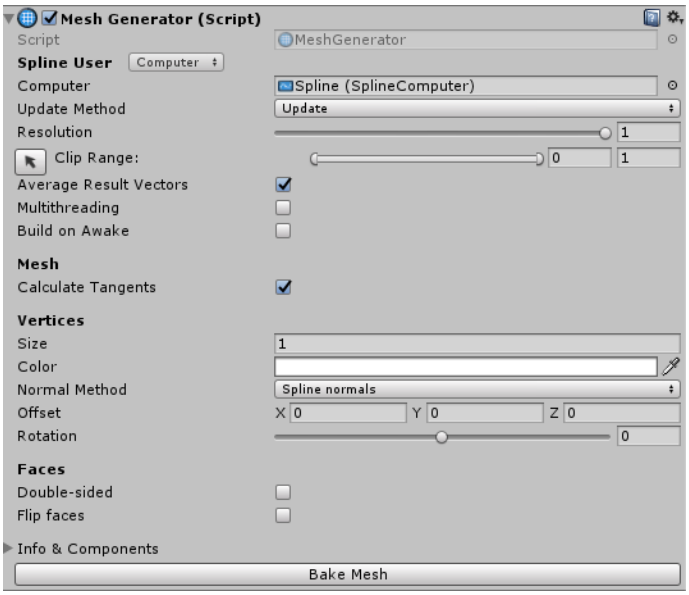
The Iteration dropdown defines in what order the Game Objects are instantiated. If Ordered is selected, the Game Objects will be spawned in the order they are added. To change this order, use the up and down arrows next to the objects. In Random mode, objects will be instantiated in a random order.

If Delayed spawn is turned on, the objects will spawn over a certain period of time. This is mostly used to prevent spike lags caused by spawning many objects at once. Delayed spawn does not work in the editor.

In Get Children mode, the child objects of the Object Controller's Transform will be used. Adding or removing objects from the hierarchy will include or exclude them from the controller.

5.8. Mesh Generators

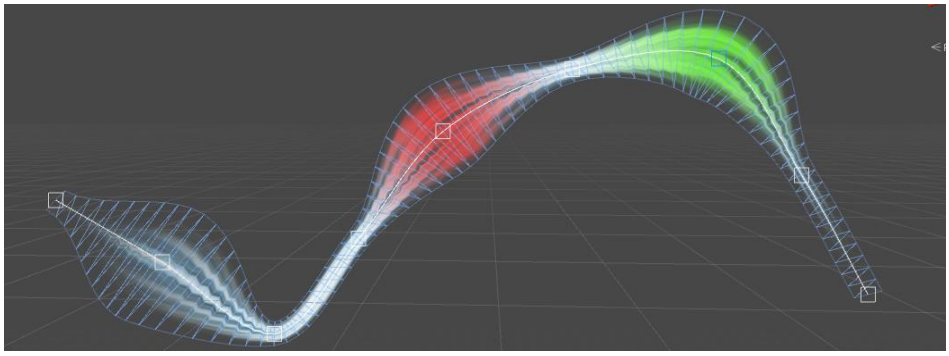
The Mesh Generators are a special kind of SplineUser class, dedicated to generating mesh geometry using a spline. The MeshGenerator component by itself doesn't do anything but is used as a base for creating other components. It provides basic properties, functionality and pipeline which are needed for the generation of meshes. It comes with its own custom editor which extends the SplineUser editor.



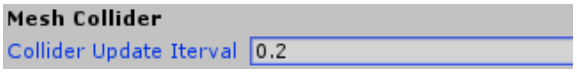
The MeshGeneration properties and functions are:

- Calc. Tangents: If checked, tangents will be calculated for normal mapping
- Size: The size of the generated geometry's circumference around the spline.
- Color: A color multiplier for the vertices
- Normal method: the method used for the vertex normal calculation
- Offset: A Vector3 offset direction local to the spline.
- Rotation: Rotation in degrees around the spline
- Double-sided: If checked, the generated mesh will be double-sided
- Flip faces: If checked, the generated mesh will have flipped faces
- Info & Components: a foldout with information about the mesh and the mesh components
- Bake mesh button: Button used for mesh baking (See Baking Mesh Generators)

Each MeshGenerator's behavior is affected by the spline points' colors and most of them are affected by the points' sizes.



If a MeshCollider component is present, the MeshGenerator will offer to update the MeshCollider when geometry is generated. Since updating mesh colliders is a heavy task, when a Mesh Collider is present an additional value will be exposed in the inspector. This value is called “Collider Update Interval” and defines how frequently the mesh collider will be updated.



Setting this value to 0 will cause the Mesh Collider to update as soon as there is a change in the mesh. Note that the Mesh Collider will not update if there aren’t changes in the mesh.

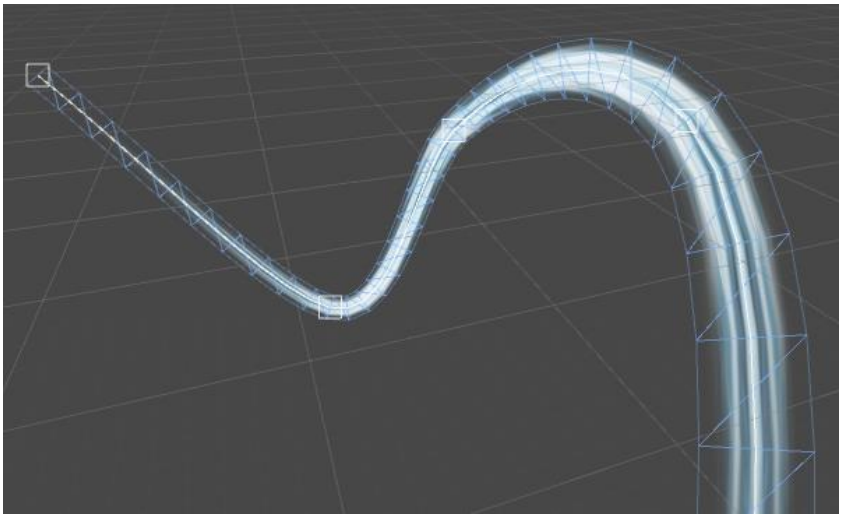
If multithreading is enabled, the mesh generation algorithm will be executed on another thread. However, due to the thread-unsafe nature Unity’s API, mesh writing, collider updates and optimization are done on the main thread.

Note: Optimizing the mesh and calculating tangents are heavy operations.

- Optimize should be used if the mesh isn’t updated frequently
- Calculate Tangents is toggled by default and must be toggled if the mesh uses a material with a normal map, otherwise, it is a good idea to uncheck it since tangents will not be used.

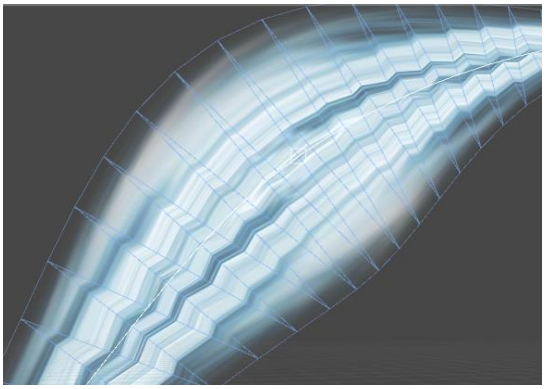
5.9. Spline Renderer : MeshGenerator

The Spline Renderer is an analogue of Unity’s Built-in Line renderer. It uses a spline to visualize instead of a set of points. It’s the first of a set of behaviors, derived from a special Spline User class called MeshGenerator. This class is used to provide basic functionality for creating procedural geometry using a spline.



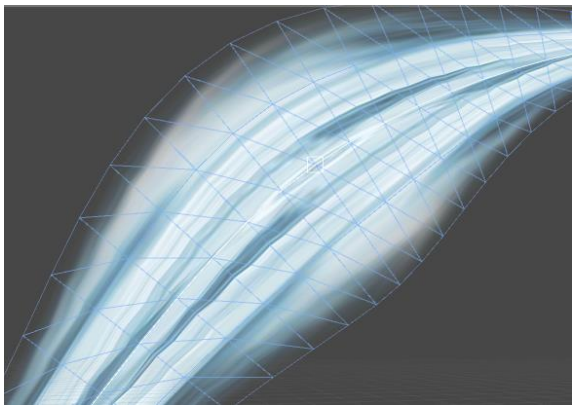
Editing the SplineRenderer and anything else, derived from MeshGenerator is as easy as editing the Spline Computer's spline.

Because of the triangular nature of the mesh, in some cases the texture coordinates of the Spline Renderer might appear jagged.



This is most often observed when there are spline points with different sizes and the solution to this is to add more edge loops. To do so go to the inspector and increase the number of Slices:

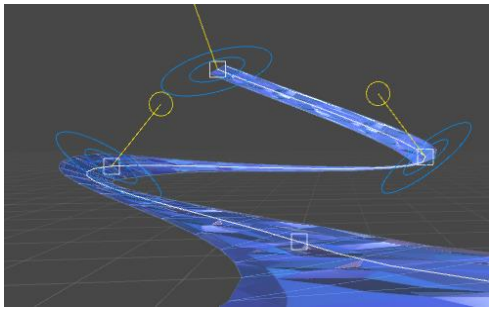
This will reduce the jagged artefacts. The same applies for the Path Generator component.



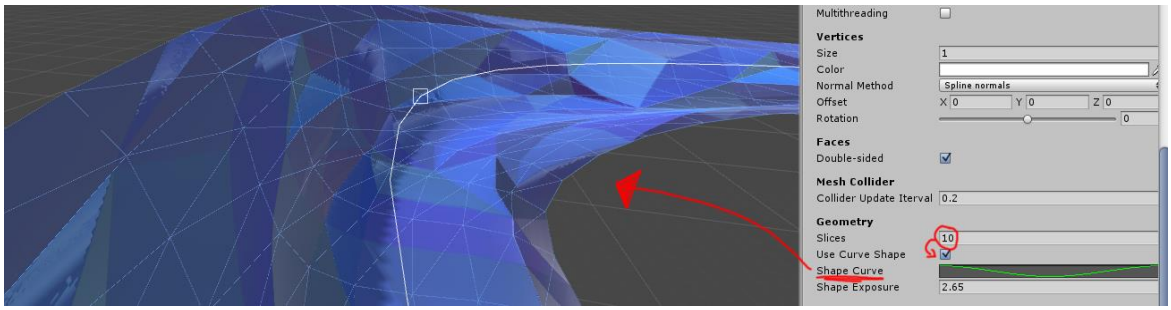
The SplineRenderer does not update Mesh Colliders.

5.10. Path Generator : MeshGenerator

The Path Generator is very similar to the Spline Renderer with a few exceptions. First, unlike the Spline Renderer, the Path Generator does not orientate the generated geometry to face the camera. Instead the geometry is orientated in the direction of the spline normal.

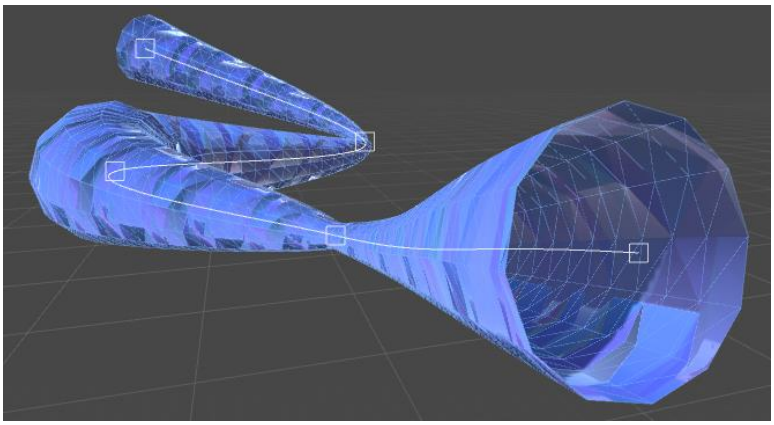


Like the Spline Renderer, the Path Generator has the option for multiple edge loops (called Slices) to prevent jagged texture coordinates. However, the Path Generator's slices also serve a function of deforming the generated path. Turning on the "Use Shape Curve" option will expose a curve editor. If the slices of the Path Generator are set to a value bigger than 1, then the path can be deformed using the curve editor.

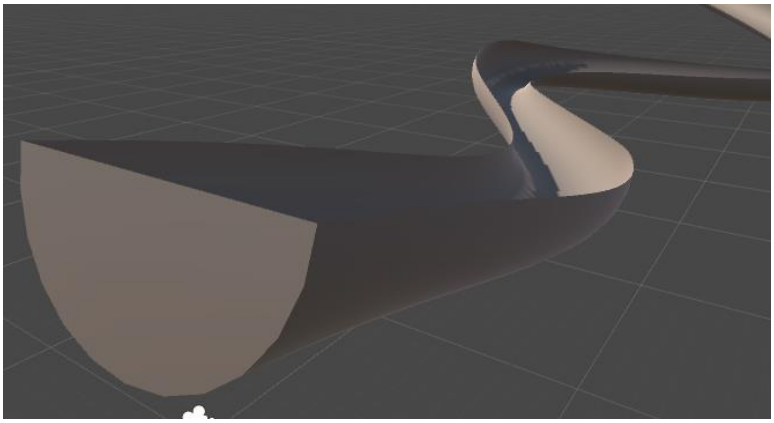


5.11. Tube Generator : MeshGenerator

The Tube Generator is another Mesh Generator, derived from the MeshGenerator class. It Creates a tube along a spline and is affected by the same things the Path Generator and the Spline Renderer are.

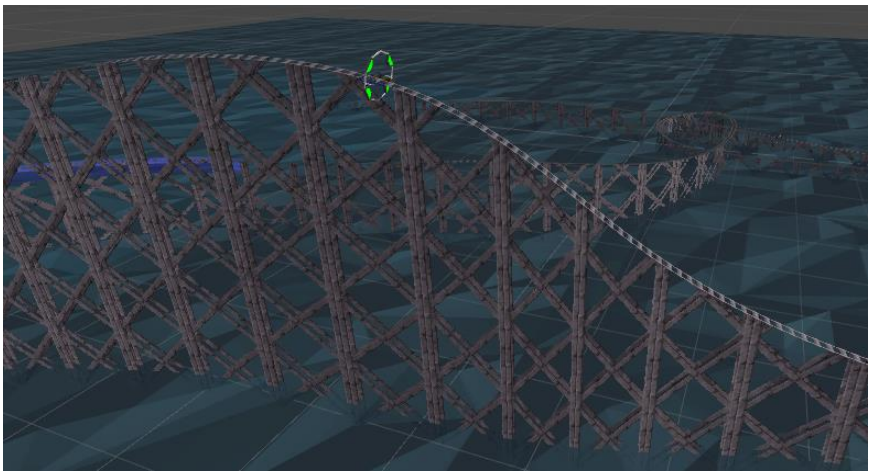


Its ends can have flat or round caps at its ends and the integrity value controls how much it revolves around the center.



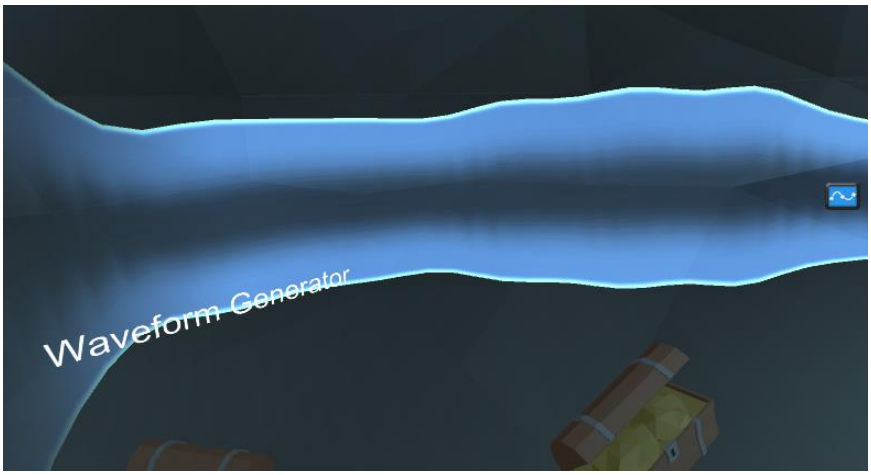
5.12. Waveform Generator : MeshGenerator

The Waveform Generator creates curved surfaces that resemble a waveform. It can be used for audio visualization, 2D terrains, fences and other structures. In the Roller Coaster example, Waveform Generators are used to make the railway supports.



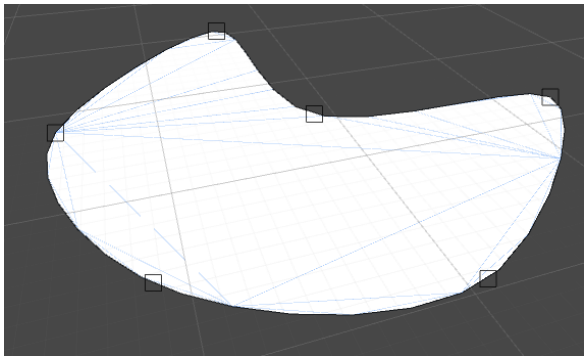
The Waveform Generator does not use the spline points' sizes for the mesh generation unlike the other three components described above.

There is a symmetry option which causes the waveform's shape to mirror along the axis it's created on.



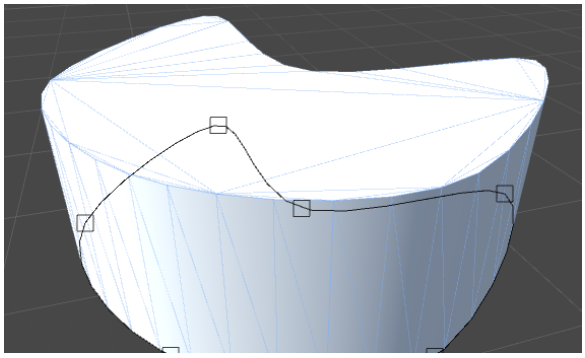
5.13. Surface Generator : MeshGenerator

The Surface Generator creates a 3D surface from a spline. These surfaces can be used for creating different kinds of platforms, natural water pools, shape animations etc. They don't require the spline to be closed to work.

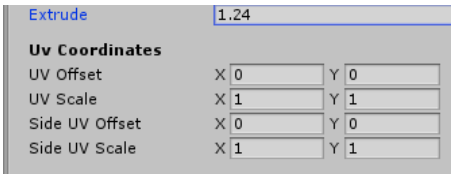


By default, the generated surfaces don't have

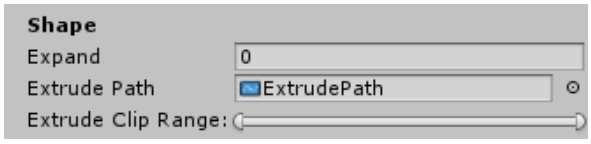
thickness which may not look good in some situations. To add thickness to the surface, increase the “Extrude” value in the inspector.



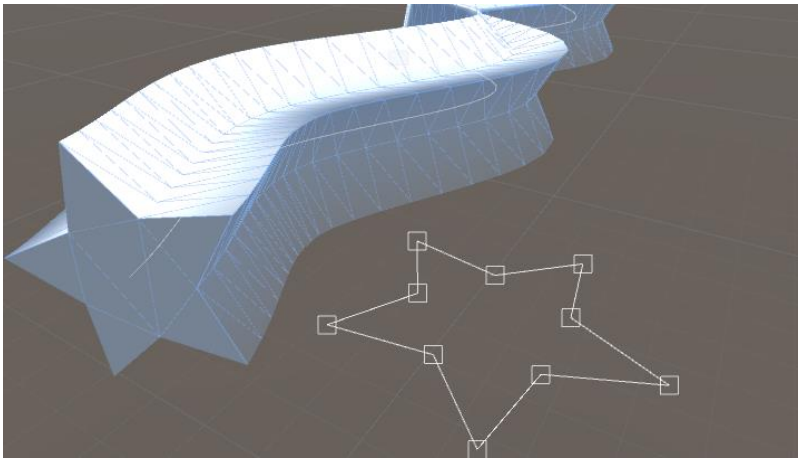
If Extrude is different than zero, a secondary set of UV coordinates which control the side UVs will be exposed in the inspector.



Version 1.0.3 introduces extrusion along another Spline. To extrude the surface along a spline, drag the SplineComputer component of the extrusion spline in the “Extrude Path” field in the Inspector:

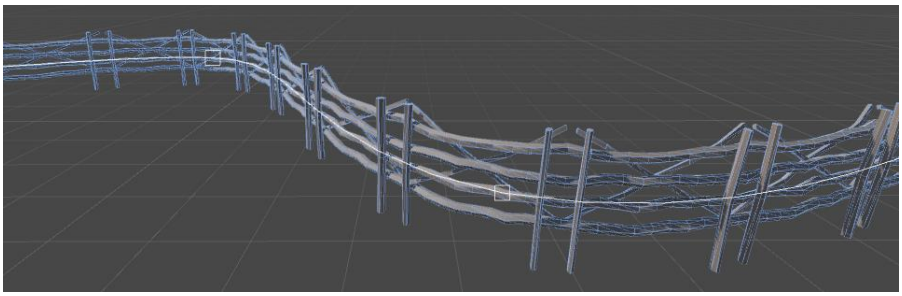


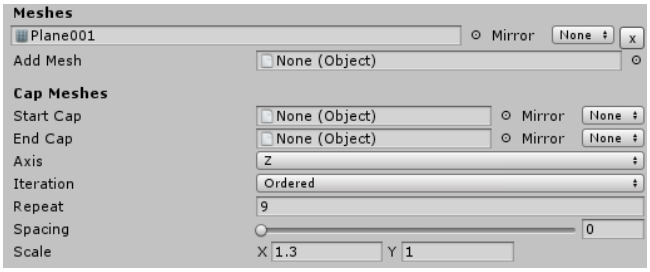
Doing so will automatically extrude the generated shape along the extrusion path.



5.14. Extrude Mesh : MeshGenerator

The Extrude Mesh component extrudes a mesh along a spline.





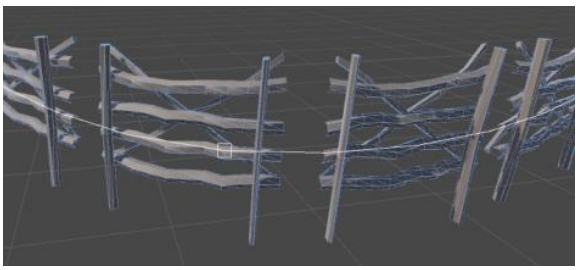
When an Extrude Mesh component is added it will require at least one input mesh. Input meshes can be added using the Add Mesh object field. This object field accepts Game Objects and Renderers too. If a Game Objects is passed, it will try to find a Mesh Renderer in the object. If a Mesh Renderer is found, then the Mesh Renderer's mesh and materials will be used for the Extrude Mesh object. After the first mesh is added it will appear in the inspector and will get extruded in the scene.

Since 1.0.7 the ExtrudeMesh component can work with more than one mesh and can have cap meshes. Each mesh can be mirrored so when cap meshes are needed only one mesh can be modeled for one of the caps and then mirrored for the other cap.

When multiple meshes are added, the ExtrudeMesh component will iterate through them in the order they are added but this can be changed by setting the Iteration property to "Random".

Once a mesh is set, it will automatically get extruded along the spline. The Axis dropdown menu changes the axis along which the mesh will be extruded. Repeat controls how many times the mesh will be repeated.

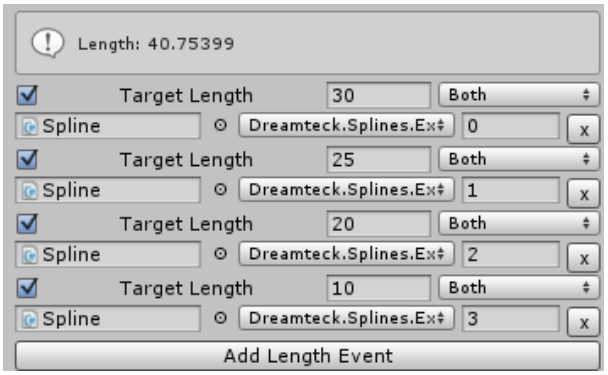
Increasing the Spacing will add space between each repeat. The Spacing actually shrinks the mesh along the extrude axis. A spacing of 1 will result in an infinitely thin mesh while a spacing of 0 will result in stretched meshes without space in between.



5.15. Length Calculator

A basic component which calculates the length of the spline using the approximation rate defined by the Spline Computer's precision and the Resolution of the Length Calculator component.

The Length Calculator can have length events added to it which fire when the spline has reached a certain length.



To add an event, click the "Add Length Event" button. This will create a new empty event. Set the "target length" value to the value that should be listened for, select the target object (an object with a certain behavior), select the method and assign the argument's value. The Dropdown menu tells the Length Calculator when to listen for the specific event.

- Growing: will invoke the event when the target length has been reached by growing
- Shrinking: will invoke the event when the target length has been reached by shrinking
- Both: will invoke the event when this value has been reached or passed in both directions

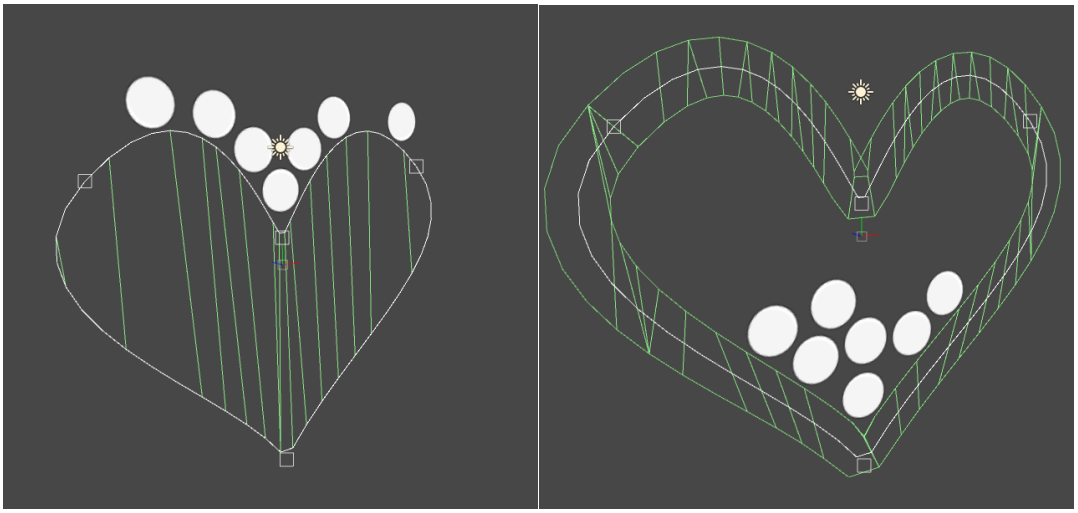
This component has one additional module that controls its behavior. Refer to Triggers and Modules for more information.

5.16. Polygon Collider Generator

As the name suggests, this component generates a 2D Polygon Collider to be used with 2D physics. The collider is immediately updated on change in the editor and has an update interval property used to restrict the number of updates during runtime.

The Polygon Collider Generator has two modes:

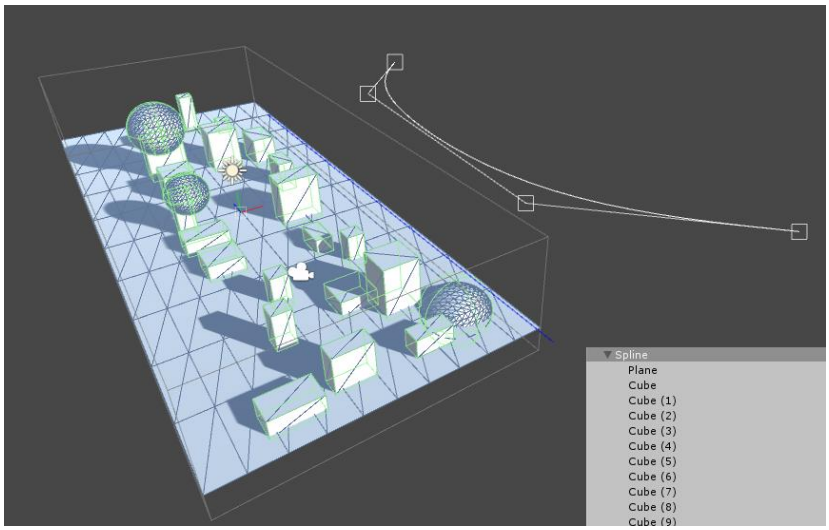
- Path: creates a path along the spline, much like the Path Generator
- Surface: creates a solid shape, much like the surface generator



5.17. Object Bender

The purpose of the Object Bender is to bend a game object and all of its children along a spline. The Object Bender will position and orient all of the objects in the hierarchy along the spline. The difference between the Object Bender and the Object Controller however is that the Object Bender will also bend any Meshes, MeshColliders and SplineComputers in the hierarchy.

When an Object Bender is added in the editor or in runtime, it will be in edit mode by default. This means that the object bender will not work. The edit mode allows the developer to edit the children in the hierarchy.

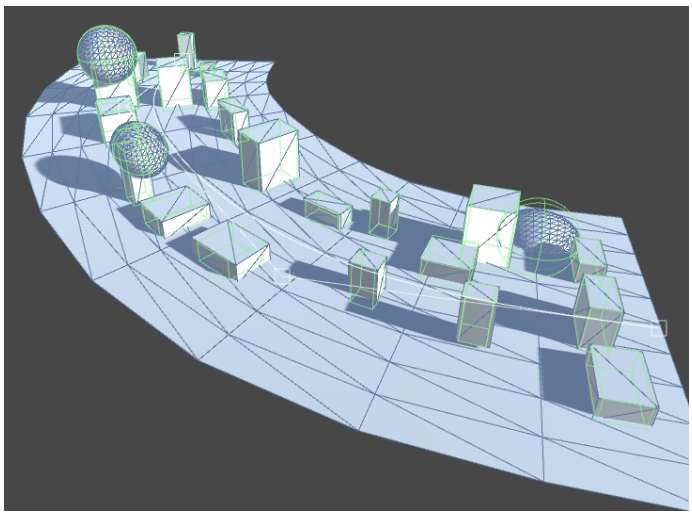


In edit mode, the ObjectBender editor will visualize the bounds of the parent object and all of the children in the hierarchy. These bounds include the Transform components, meshes, colliders and SplineComputers.

When in edit mode, there is a “Bend” button at the bottom of the ObjectBender’s inspector. Clicking it will exit edit mode and will start bending the objects along the spline.

When in Bend mode, all objects will be controlled by the spline. Each object from the hierarchy will be editable after it has been bent but if the spline updates, it will get recalculated and repositioned.

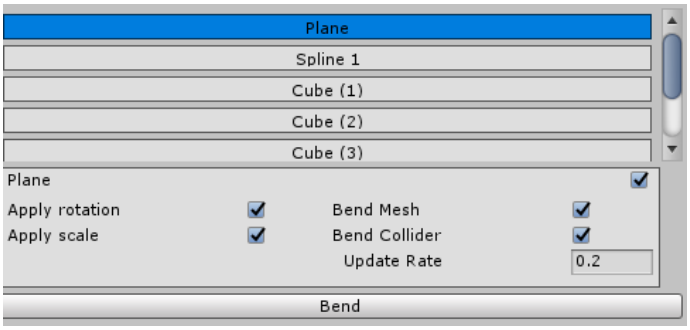
In Bend mode, the “Bend” button will be replaced with an “Enter edit mode” button which will revert the bend and enable editing.



The ObjectBender bends all the objects along one of the three local axes. The axes are local to the parent object. The bend axis can be selected through the ObjectBender’s inspector and will be applied immediately even if the ObjectBender is in edit mode.

The ObjectBender component gives complete control over what is bent and how it’s bent. A bend property is created for each object from the hierarchy. Each bend property allows the developer to toggle certain aspects of the bending process on and off for each object individually or toggle off bending for the object completely.

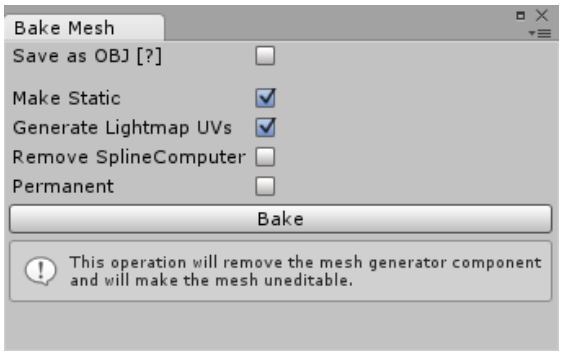
All bend properties are automatically exposed in the inspector. Clicking on a property will highlight it in blue and will open the property editor. Several properties can be edited simultaneously. To select multiple properties, hold down Ctrl and click on properties to add them to the selection. Shift + click will select multiple properties in a row.



6. Baking Mesh Generators

Starting with version 1.0.4, each MeshGenerator component can be baked into a static mesh with lightmap UVs. To do that, click the “Bake Mesh” button at the bottom of the MeshGenerator’s inspector. This will open the Bake Mesh window.

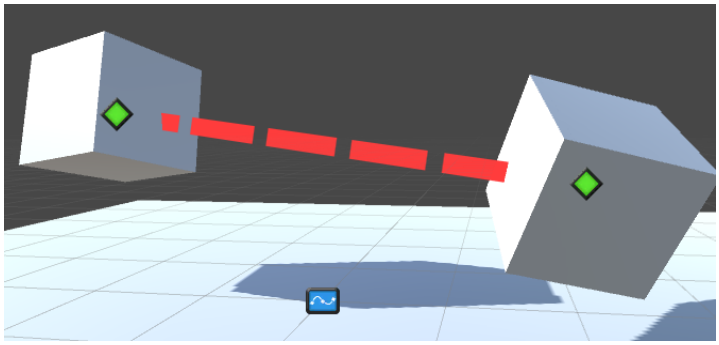
The Bake Mesh window provides a range of settings for baking and a Bake button.



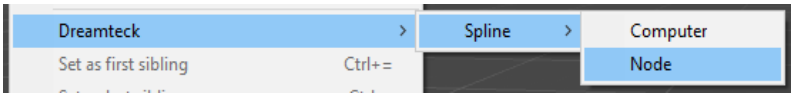
- Save as OBJ will save the baked mesh as an OBJ file in the Assets folder so it can be used later again in another scene or in a prefab.
- Make static will make the object static when bake is finished.
- Generate Lightmap UVs will generate lightmap UVs for the baked mesh so it can be properly lightmapped.
- Remove computer will remove the SplineComputer component that is referenced by the Mesh Generator
- Permanent will remove the Mesh Generator component making the bake permanent. Otherwise the Mesh Generator will be left and be disabled so it could be re-enabled later.

7. Nodes

Nodes are a key feature and serve two very important purposes - to bind points of Spline Computers to other scene objects and to create junctions.

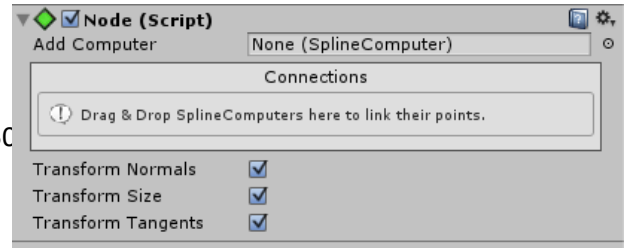


To create a Node, go to Game Object->Dreamteck->Spline->Node. This will create a new Game Object with a Node component in the scene.



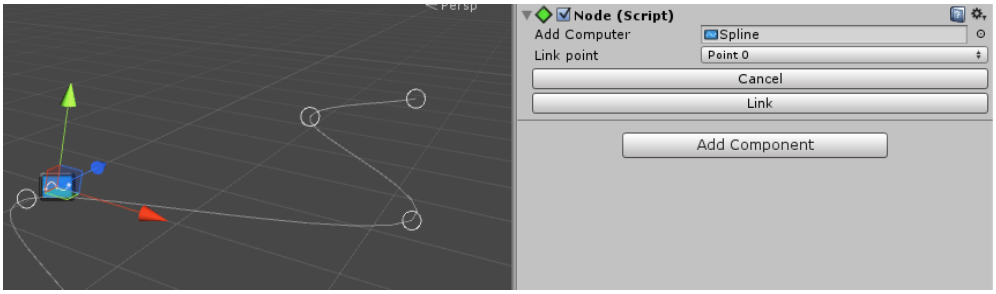
Another way to create a Node is just by adding a Node component to an existing object.

The newly created node will be empty and will require a connection to be added. To add a

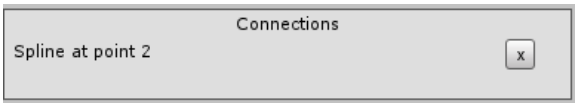


connection, drag a Game Object with a Spline Computer from the scene into the Connections box or select it through the object field above the connections box.

When a Spline Computer is added, its points will visualize as circles and a point dropdown menu will be shown in the inspector.

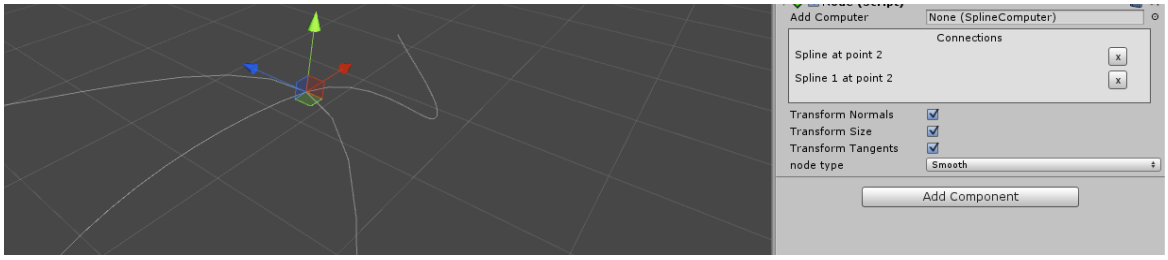


The Node will now require a point from the Spline Computer to be selected. To select a point either select it from the dropdown menu and click “Link” or click on a point in the scene view. After a point is selected, a new connection will be added in the Node. The new connection will be listed in the Connections box.



After a connection is added, the spline point of the added Spline Computer will snap to the Node’s transform. The Node’s Transform can then be animated or a Rigidbody can be attached and when the Node moves, the connected point will also be updated.

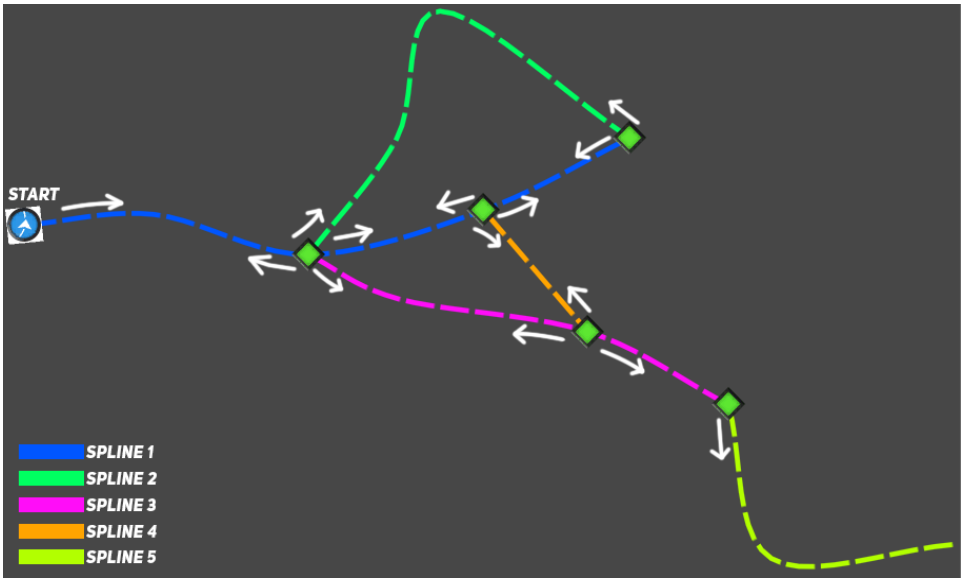
A Node can have more than one Spline Computer connected to it. Repeat the procedure with another Spline Computer to add a new connection.



When editing a point that is connected to a Node in the Spline Editor, the node’s position will also be updated and therefore all the other Spline Computers connected to it.

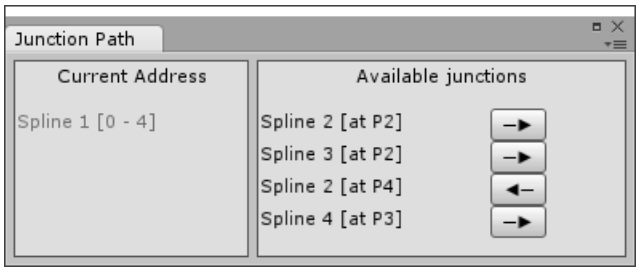
7.1. Junctions

When two Spline Computers are connected to the same Node, this is considered a junction. Each Spline User has its own junction address that defines which parts of the connected splines are being traversed.



A user's junction address can be set up if its base computer has at least one junction. When this condition is met, an "Edit junction path" button will appear in the inspector of the Spline User.

Clicking this button will open up the Junction Path window. This window lets the developer pick the paths and directions through which the Spline User will traverse.



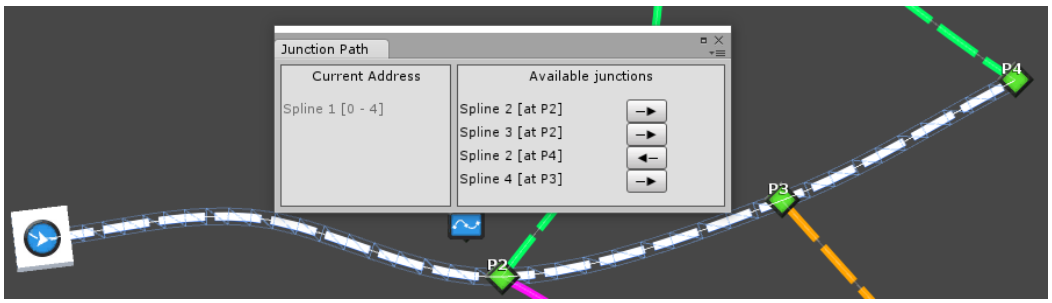
The Junction Path window consists of two panels: Current address and Available junctions.

The Current Address holds the current address of the Spline User. It shows all connections and directions. Each element in the Current Address can be exited using the "x" button.

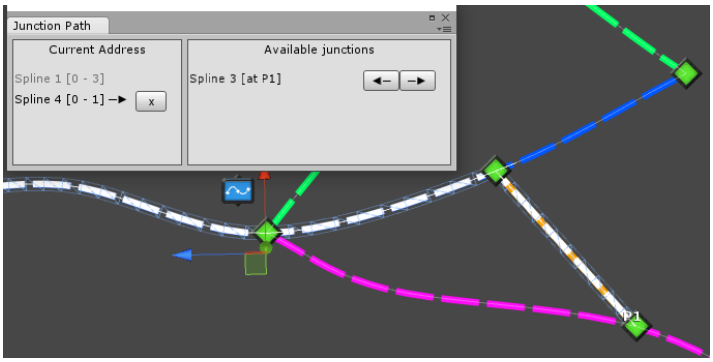
The Available Junctions panel shows the available junctions ahead of the last connection. In the above case, starting from point 0 of Spline 1 there are four available connections. Each connection has a button with an arrow next to it. Clicking the button will enter the given connection. If the arrow points to the left, the entered Spline Computer will be traversed backwards and if the arrow points to the right, the entered Spline Computer will be traversed forwards.

EXAMPLE:

Using the above setup, a new white Spline Renderer is added to the scene. Its computer reference is set to Spline 1. When opening the Junction Path window, the same options as above are displayed.

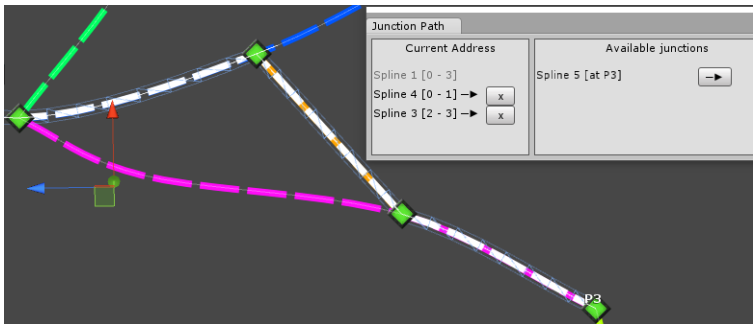


In this example, the connection with Spline 4 at point 3 is chosen and the arrow button next to it is clicked in the Available junctions. Right away, Spline 4 is added to the current address and the Spline Renderer takes on its new path.

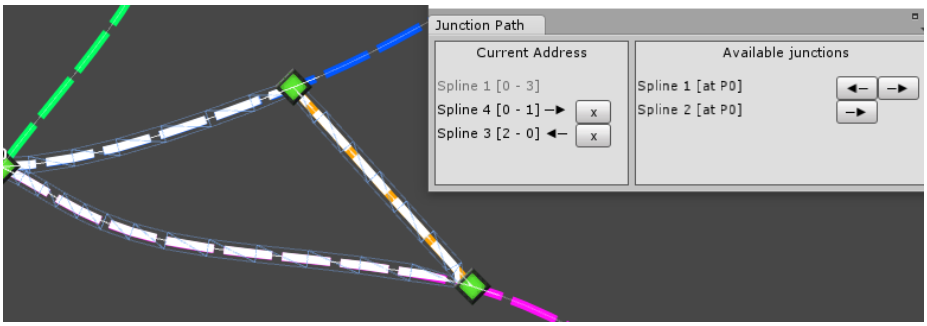


The newly entered Spline 4 has another junction ahead so it's immediately listed in the Available Junctions panel. This junction could be entered backwards or forwards and therefore there are both a left and a right arrow available.

Clicking the Right arrow will enter Spline 3 forwards:



And clicking the left arrow will enter Spline 3 backwards:



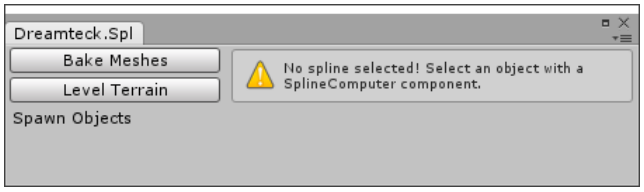
There is no limit to how long the Spline Address can be but when entering addresses at runtime (refer to the Scripting Reference document) it's usually a good practice not to go in circles and enter the same segments again and again.

8. Editor Tools

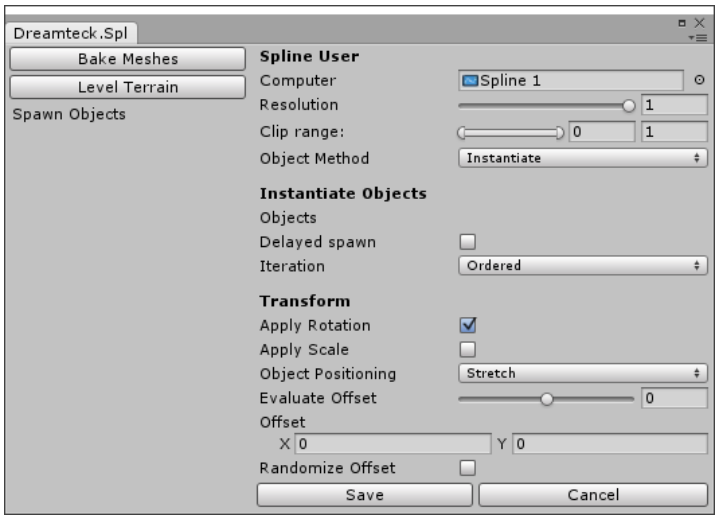
The Spline User is a component that is mostly meant to work in runtime although it can be configured in the editor. Sometimes, however, level designers just need a tool to help them in the work process. For pure level design purposes, Dreamteck Splines offers the Spline Tools window which is located in **Window->Dreamteck->Spline Tools**

This will open a window with a set of tools for level editing:

Each tool can be selected by clicking on its button. Some tools require an object with a Spline Computer to be selected in the editor in order to work. Otherwise a warning will be displayed:

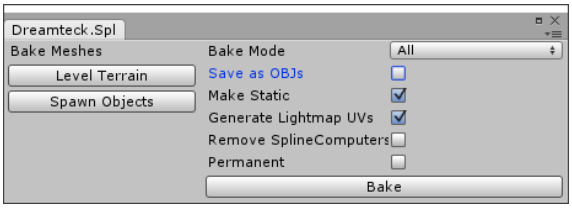


If this warning appears, go to the scene's hierarchy, select a Spline Computer and click on the tools window again. This will update it and the warning will disappear.



8.1. Mass Baking Spline-generated Meshes

If a lot of Mesh Generators need to be baked simultaneously, the Bake Meshes tool can help with that. It does not need a Spline Computer to be selected in order to work and can be opened right away.



There are three bake modes:

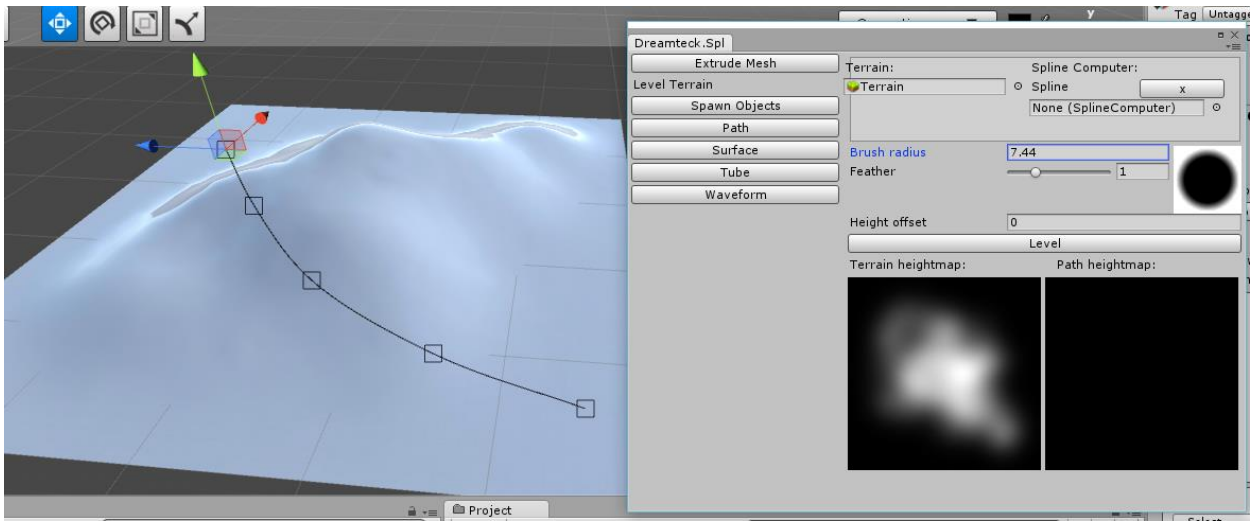
- All: Bakes all Mesh Generators in the scene
- Selected: Bakes only the selected Mesh Generators
- AllExcluding: Bakes all Mesh Generators except for the selected ones

When “Save OBJs” is checked the bake operation will save all meshes as OBJ files in the selected directory. Meshes with the same names will be renamed with a number to prevent overwriting.

8.2. Leveling terrain

The Level Terrain tool is an editor-only tool meant for sculpting terrains using splines.

For the Level Terrain tool to work, the scene needs to have at least one terrain and a Spline Computer needs to be selected. If the scene has more than one terrain, the terrain that should be leveled should also be selected along with the Spline Computer.

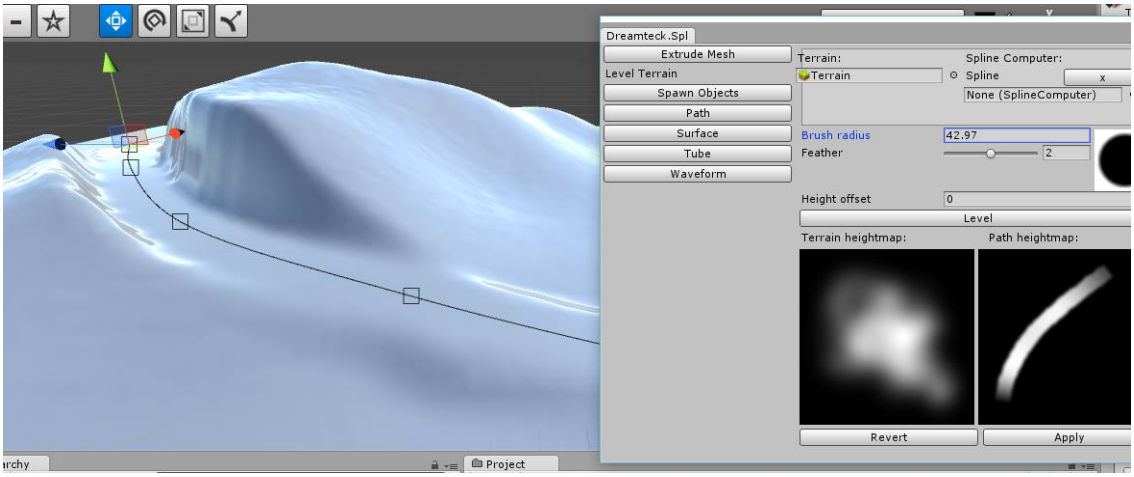


Once open, the Level Terrain tool will display a preview of the terrain’s heightmap, the path heightmap which will be black and a preview of the brush feather.

The tool has only three settings:

- Brush Radius – the radius of the brush in world units
- Feather – the feather of the brush
- Height Offset – height offset

To level the terrain using the selected spline(s), click the “Level” button. The path heightmap will be drawn and the terrain will be sculpted.

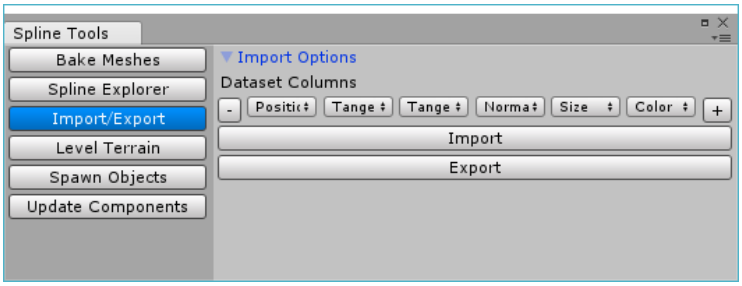


An “Apply” and “Revert” buttons will appear under the heightmap previews. If the result is not satisfying, edit the spline and the settings and click Level again – the previous level will get replaced with the new one. To save the terrain, click “Apply” – this will write the level data to the terrain permanently.

The brush radius is affected by the sizes of the points.

8.3. Import/Export

Version 1.0.8 introduces a new import and export tool which is capable of importing splines from external files and exporting splines to external files. The currently supported formats are SVG and CSV datasets.

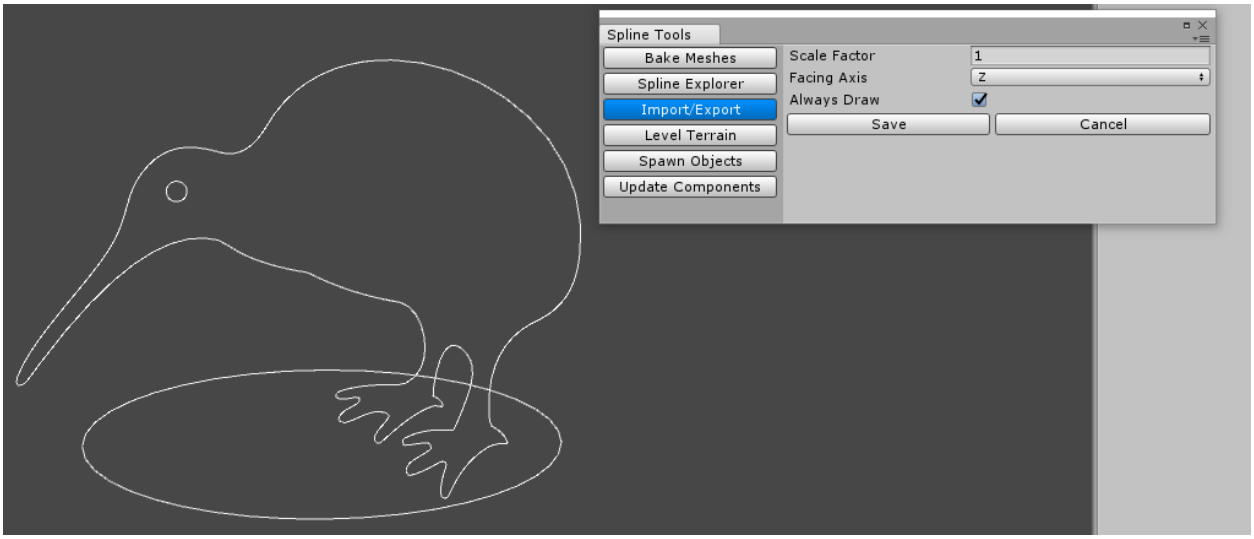


8.3.1. Importing

The import tool is pretty straightforward. To import an SVG or a CSV file click the “Import” button. This will open a new file browser. Navigating to the desired SVG or CSV file and clicking “Open” will instantly import the splines from the file in the Unity scene.

WARNING: Splines from SVG files are usually very big, about the size of a Canvas or even bigger. If the imported SVG spline isn't visible after import, make sure to zoom-out further in the scene.

After the spline has been imported, a new object with the name of the file will be created in the scene and the import tool's panel will display some importing options:



- Scale Factor – This is the scale factor of the imported graphic. A scale factor of 1 will retain the size of the graphic.
- Facing axis – The orientation of the imported graphic. By default it is Z which means no rotation
- Always draw – Should the splines be drawn in the scene constantly after closing the import tool?

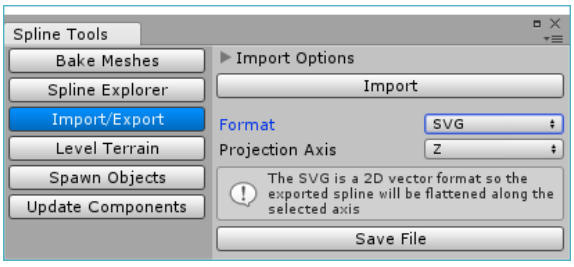
8.3.2. Exporting

To export one or more splines, the splines first have to be selected in the scene. If no splines are selected in the scene, the export button will be unavailable.

When the export mode is toggled, a Format dropdown menu will be available, allowing the user to select between SVG and CSV.

8.3.2.1. Exporting SVG

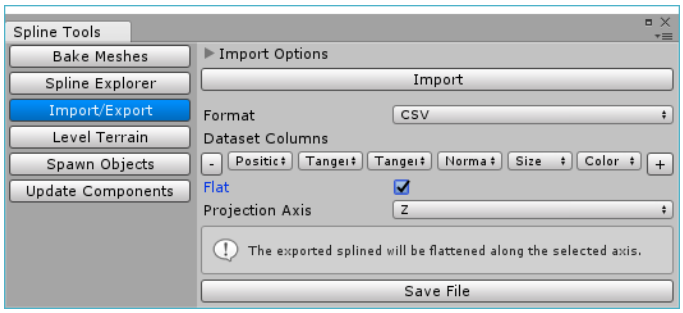
Since the SVG is a 2D vector format, when a spline is exported to SVG it is flattened.



The projection axis dropdown menu defines the axis along which the spline will be flattened and projected onto the SVG canvas.

8.3.2.2. Exporting CSV

The CSV export creates a new Excel file with each spline point's data written on each row.



The Dataset columns field allows for customization of the columns that will be written in the CSV file. For example if only the points' positions are needed, all columns except the position column should be removed.

CSV Export also supports flattening. If "Flat" is toggled, a projection axis dropdown menu is presented.

9. Performance, Oprimization and under the hood

Dreamteck Splines is optimized for speed and runs smoothly on all mobile devices, including older ones. This chapter will go over the main concepts behind the system's design and shed some light on how the main components – the SplineComputer and the SplineUser work.

9.1. What impacts performance and what doesn't?

A common question among the developers using Dreamteck Splines is "**How big a spline can be before there is a performance drop?**"

The short answer is:
There is no limit to the length of the spline and this doesn't impact the performance.

This is true, because when a SplineComputer is added to the scene, it doesn't do any calculations at all. Spline calculations are done when the following methods are called:

- SplineComputer.Evaluate
- SplineComputer.EvaluatePosition
- SplineComputer.Travel
- SplineComputer.Project
- SplineComputer.CalculateLength

Having a SplineComputer in the scene by itself doesn't cause any of the aforementioned methods to be called.

However, as soon as a SplineUser is added, things change. By design, the SplineUser component iterates over the referenced SplineComputer and caches all of the sample results in an array called "samples". This doesn't happen every frame – it only happens when there has been a change in the spline. This includes moving the SplineComputer's transform in Local space mode. So after the SplineUser samples the referenced computer, it does no further calculations until another change is present. This means that even if the spline is very big and the sampling process takes a long time, the framerate will be restored after the initial hiccup. But this concerns only very big splines with high precision. Usually a calculation hiccup is not present. If a very big spline needs to be re-sampled oftenly, consider toggling the multithreading option of the SplineUser component – this will take the spline calculation to another thread and will free up the performance of the main game thread.

9.1.1. What happens if multiple SplineUsers sample a single spline?

When multiple user sample a single spline, they all re-sample the spline on their own and a cached version of the spline is kept for each user. Sampling a spline twice is not an optimal solution and this is why the SplineUser sample mode has been introduced. This sampling mode lets the SplineUsers read from the samples of another SplineUser which samples the SplineComputer instead of re-sampling the SplineComputer by themselves.

9.1.2. Does having many SplineComputer components in the scene hurt performance?

As mentioned above, the SplineComputer by itself doesn't re-calculate the spline so there will be no Spline calculations. However, in order to ensure that the splines will be updated properly when the SplineComputer's transform changes, there will be a couple of if-checks during update. This means that having several thousand SplineComputers in the scene will indeed take up performance. However, having thousands of active monobehaviours is rarely the case in Unity .

9.1.2.1. How to optimize if a thousand SplineComputers are present?

The easiest way to optimize would be to disable all SplineComputer components. This will not disable the splines, but will disable the checks every frame. Then whenever you need a computer updated, either enable while its needed or call ResampleTransform() on it.

9.1.3. What happens when a scene, full of SplineComputers and SplineUsers loads?

The initial load time of a scene is important and so it's important to discuss what happens when a new scene full of spline objects is loaded.

When a SplineUser samples a SplineComputer and caches it into its memory, the samples get serialized, meaning that when a new scene is loaded, there is no need for the SplineUser to re-sample the computer it's referencing. So the short answer to this questions is:

There is no performance overhead when a new scene is loaded.

However, there is one exception. SplineUsers set to build on awake will re-sample the referenced spline on awake regardless of whether there is a change in the spline or not.

9.2. What each Evaluate method does

In Dreamteck Splines, a couple of methods with the same name can be found in several classes. These methods are:

- Evaluate
- EvaluatePosition
- Travel
- CalculateLength
- Project

They can be found in the Spline class, as well as in SplineComputer, SplineUser and SplineAddress. So what is the difference between all of them?

9.2.1. Methods in Spline

The Spline class represents a spline in world coordinates. It isn't transformed by any transform and it isn't used directly by any SplineUser component. Instead, it is wrapped by the SplineComputer class.

Creating a new Spline object and calling one of the listed above methods will call the internal spline calculation methods of the Spline class. This is considered expensive if done many times per frame.

9.2.2. Methods in SplineComputer

The SplineComputer class creates a Spline instance and then transforms it using its own Transform component.

Calling one of the methods listed above on SplineComputer will call them on Spline and then will transform the result using the Transform component. If the space is set to Local, this will be more expensive than calling the methods on Spline because of the additional transformation that takes place after the result is calculated.

9.2.3. Methods in SplineAddress

The SplineAddress is just a collection of SplineComputers and their connection points so calling any of the methods on a SplineAddress object, will call these methods on a single Computer from the listed ones in the SplineAddress object.

9.2.4. Methods in SplineUser

Since the SplineUser samples a SplineComputer and caches the result, calling one of the methods on a SplineUser object will not cause the spline to be recalculated. Instead, the cached results will be interpolated to find the best value that fits the arguments.

This is very fast since there are no spline calculations and no transformations.

9.3. Does the clip range of the SplineUser control the sample count?

The answer is no. When a SplineUser samples a SplineComputer, it samples the whole spline computer completely and stores the samples in the samples array. If the clip range is modified to be smaller than [0-1], the spline will not be re-evaluated. The clip range only defines what portion of the already evaluated results to use. This ensures that no spline calculations will be performed if a SplineUser's clip range is changed.

10. Writing a custom SplineUser class

Dreamteck Splines' functionality can be expanded easily by creating new SplineUser components. For a SplineUser class to be created it needs to derive from the SplineUser base class. Before deriving the class from SplineUser, the following using directive should be added to the new script:

```
using Dreamteck.Splines;
```

A basic SplineUser example is provided in the Components folder. It can be used as a template for creating SplineUsers.

10.1. Protected and virtual Methods

Each SplineUser class inherits a set of methods which are automatically called. These methods are automatically called and should be overridden in order to create custom functionality.

SplineUser classes are not supposed to have Update, FixedUpdate and LateUpdate methods. They can have a Start method and an Awake method through overriding:

```
protected override void Awake()
{
base.Awake();
//Code here
}
```

10.1.1. Protected virtual void Run()

Run is called automatically on Update, FixedUpdate or LateUpdate based on the Update Method setting of the SplineUser. It's mainly used for game logic that will run on each update cycle.

10.1.2. Protected virtual void Build()

Build is called when there has been a change in the spline user. For example if the spline has changed or a property of the SplineUser has been set. Build can either be called from the main thread or from a separate one if multithreading is enabled. Therefore it is advised that there should be only thread-safe code inside. Make call calculations inside Build and then apply them in PostBuild.

10.1.3. Protected virtual void PostBuild()

PostBuild is always called on the main thread after Build has finished even if multithreading is enabled. It's used to apply the results, calculated in Build(). For example if the custom SplineUser will

position objects along path. The objects' positions should be calculated in Build and then applied to the objects' transforms in PostBuild().

10.2. Rebuilding

The SplineUser class has the Rebuild(bool sampleComputer) method which forces the user to recalculate on the next update cycle.

SplineUsers rebuild automatically when their spline is modified or their properties are changed. That however does not happen when the properties of custom SplineUser classes are modified. In order to make the SplineUser class rebuild, custom setters should be implemented that call the Rebuild method. Example:

```
private bool _state = false;
public bool state
{
    get { return _state; }
    set
    {
        if (value != _state) //Only rebuild if the value is different
        {
            _state = value;
            Rebuild(false); //Rebuild but don't resample the spline
        }
    }
}
```

Rebuild is a public method so it can also be called from another object. Rebuilding happens once per update cycle no matter how many times it's called prior to that.

10.2.1. RebuildImmediate

Rebuild waits for the next update cycle so calling it will not yield any changes immediately. In some cases, however, rebuild should happen on demand and that's what RebuildImmediate(bool sampleComputer) is for. RebuildImmediate calls he rebuild sequence regardless of update cycles and will yield results immediately.

Calling RebuildImmediately multiple times per update cycle will cause the SplineUser to rebuild as many times as RebuildImmediately is called.