Blotch3D Manual

Contents

Chapter 1

Blotch3D

Create real-time 3D graphics with just a few lines of C# code.

1.1 Quick start

1. Get the installer for the latest release of MonoGame from http://www.monogame.net/downloads/ and run it. (Do NOT get the current development version nor the NuGet package.)
2. Get the Blotch3D repository zip from https://github.com/Blotch3D/Blotch3D and unzip it.
3. Open the Visual Studio solution file (Blotch3D.sln).
4. Build and run the example projects. (For other platforms, you'll need the appropriate Visual Studio add-on and you will need to create a separate project for that platform.)
5. Use IntelliSense to see the reference documentation, or see "Blotch3DManual.pdf".

1.2 Introduction

Blotch3D is a C# library that vastly simplifies many of the tasks in developing 3D applications and games.

Examples are provided that show how with just a few lines of code you can...

- Load standard 3D model file types as "sprites", and display and move thousands of them in 3D at high frame rates.
- Set a sprite's material, texture, and lighting response.
- Load textures from standard image files, including textures with an alpha channel (with translucent pixels).
- Show 2D and in-world (as a texture) text in any font, size, color, etc. at any 2D or 3D position, and make text follow a sprite in 2D or 3D.
- Attach sprites to other sprites to create 'sprite trees' as large as you want. Child sprite orientation, position, scale, etc. are relative to the parent sprite, and can be changed dynamically (i.e. the sprite trees are dynamic scene graphs.)
- Override all steps in the drawing of each sprite.

- You can give the user easy control over all aspects of the camera (zoom, pan, truck, dolly, rotate, etc.).
- Easily control all aspects of the camera programmatically.
- Create billboard sprites.
- Connect sprites to the camera to implement HUD models and text.
- Connect the camera to a sprite to implement 'cockpit view', etc.
- Implement GUI controls (as dynamic 2D text or image rectangles, and with transparent pixels) in the 3D window.
- Implement a skybox sprite.
- Get a list of sprites touching a ray, to implement weapons fire, etc.
- Get a list of sprites under the mouse position, to implement mouse selection, tooltips, pop-up menus, etc.
- Implement levels-of-detail.
- Implement mipmaps.
- Create sprite models programmatically (custom vertices).
- Use with WPF and WinForms, on Microsoft Windows.
- Access and override many window features and functions using the provided WinForms Form object of the window (Microsoft Windows only).
- Detect collisions between sprites.
- Implement fog
- Define ambient lighting, and up to three point-light sources. (More lights can be defined if a custom shader is used.)
- Build for many platforms (currently supports all Microsoft Windows platforms, iOS, Android, MacOS, Linux, PS4, PSVita, Xbox One, and Switch).

Blotch3D sits on top of MonoGame. MonoGame is a widely used 3D library for C#. It is free, fast, cross platform, actively developed by a large community, and used in many professional games. There is a plethora of MonoGame documentation, tutorials, examples, and discussions on line.

Reference documentation of Blotch3D (classes, methods, fields, properties, etc.) is available through Visual Studio IntelliSense, and in "Blotch3DManual.pdf". (Note: To support Doxygen, links in the IntelliSense comments are preceded with '#'.)

See MonoGame.net for the official MonoGame documentation. When searching on-line for other MonoGame documentation and discussions, be sure to note the MonoGame version being discussed. Documentation of earlier versions may not be compatible with the latest.

MonoGame fully implements Microsoft's (no longer supported) XNA 4 engine, but for multiple platforms. It also implements features beyond XNA 4. Therefore XNA 4 documentation you come across may not show you the best way to do something, and documentation of earlier versions of XNA (versions 2 and 3) will often not be correct. For conversion of XNA 3 to XNA 4 see http://www.nelsonhurst.↩com/xna-3-1-to-xna-4-0-cheatsheet/.

Note that to support all the platforms, certain limitations were necessary. Currently you can only have one 3D window. Also, there is no official cross-platform way to specify an existing window to use as the 3D window—MonoGame must create it. See below for details and work-arounds.

1.3 Project structure

The provided Visual Studio solution file contains both the Blotch3D library project with source, and the example projects.

"BlotchExample01_Basic" is a bare-bones Blotch3D application, where Example.cs contains the example code. Other example projects also contain an Example.cs, which is similar to the one from the basic example but with a few additions to it to demonstrate a certain feature. In fact, you can do a diff between the basic Examples.cs file and another example's source file to see what extra code must be added to implement the features it demonstrates [TBD: the "full" example needs to be split to several simpler examples].

All the provided projects are configured to build for the Microsoft Windows x64 platform. See below for other platforms.

If you are copying the Blotch3D assembly (like Blotch3D.dll on Microsoft Windows) to a project or packages folder so you don't have to include the source code of the library in your solution, be sure to also copy Blotch3D.xml so you still get the IntelliSense. You shouldn't have to copy any other binary file from the Blotch3D output folder if you've installed MonoGame on the destination machine. Otherwise you should copy the entire project output folder. For example, you'd probably want to copy everything in the output folder when you are distributing your app.

To create a new project, you must first install MonoGame as described in the Quick start section, if you haven't already. You must also install the Visual Studio add-ons, etc. for the desired platform if different from Microsoft Windows. (For example, for Android you'd need the Xamarin for Android add-on.)

For Microsoft Windows, you can create a new project by either copying an existing Blotch3D example project and renaming it, or you can use the project wizard to create a MonoGame project and then add a reference to Blotch3D or the Blotch3D source.

For other platforms, you can look online for instructions on creating a MonoGame project/platform type you want and then add a reference to, or the source of, Blotch3D.

Or you can:

1. Create a new project with the project wizard that is close to the type you want or use online instructions for creating it.
2. Add a reference to MonoGame if it doesn't already have one. (typically found in \Program Files (x86)\Mono↩ Game\v3.0\Assemblies\...)
3. Include the Blotch3D source in the project, or a Blotch3D project in the solution, or add a reference to a build of it for that platform.
4. Follow the procedure in the 'Making 3D models' section to add a content folder and the pipeline manager so that you have a way to add content.
5. If available on the selected platform, while debugging you'll probably want to temporarily set the output type to a type that shows stdout messages (like 'Console Application' on Microsoft Windows) so you can see any debug messages.
6. You may need to copy various XML structures into your csproj file from other projects that have some of the attributes that you want.

To create a 3D window, follow the guidelines in the Development section.

1.4 Development

See the examples and their comments, starting with the basic example.

To make a 3D window, you must derive a class from BlWindow3D and override the Setup, FrameProc, and FrameDraw methods.

When it comes time to create the 3D window, you instantiate that class and call its "Run" method *from the same thread that instantiated it*. The Run method will call the Setup, FrameProc, and FrameDraw methods when appropriate (explained below), and not return until the window closes. (For this reason, you may want to create the BlWindow from within some other thread than the main thread so that the main thread can handle a GUI or whatever).

We will call the abovementioned thread the "3D thread".

All code that accesses 3D hardware resources must be done in the 3D thread, including code that creates and uses all Blotch3D and MonoGame objects. Note that this rule also applies to any code structure (Parallel, async, etc.) that may internally use other threads, as well. This is necessary because certain 3D subsystems (OpenGL, DirectX, etc.) generally require that 3D resources be accessed by a single thread. (There are some platform-specific exceptions, but MonoGame does not use them.)

This pattern and these rules are also used by MonoGame. In fact, the BlWindow3D class inherits from MonoGame's "Game" class. But instead of overriding certain "Game" class methods, you override BlWindow3D's Setup, FrameProc, and FrameDraw methods. Other "Game" class methods and events can still be overridden, if needed.

The Setup, FrameProc, and FrameDraw methods are called by the 3D thread as follows:

The Setup method is called by the 3D thread exactly once at the beginning of instantiation of the BlWindow3D-derived object. You might put time-consuming initialization of persistent things in there like the loading and initialization of persistent content (sprite models, fonts, BlSprites, etc.).

The FrameProc method is called by the 3D thread once every frame. For single-threaded applications this is typically where the bulk of application code resides, except the actual drawing code. For multi-threaded applications, this is typically where all application code resides that does anything with 3D resources. (Note: You can also pass a delegate to the BlSprite constructor, which will cause that delegate to be executed every time the BlWindow3D's FrameProc method is executed. The effect is the same as putting the code in FrameProc, but it better encapsulates sprite-specific code.)

The FrameDraw method is called by the 3D thread every frame, but only if there is enough CPU for that thread. Otherwise it is called less frequently. This is where you must put drawing code (BlSprite.Draw, BlGraphicsDeviceManager.DrawText, etc.). For apps that may suffer from severe CPU exhaustion (at least for the 3D thread), you may want to put your app code in this method so it is called less frequently (as long as that code can properly handle being called at variable rates).

A single-threaded application would have all its code in those three overridden methods.

If you are developing a multithreaded app, then you would probably want to reserve the 3D thread only for tasks that access 3D resources. When other threads do need to create, change, or destroy 3D resources or otherwise do something in a thread-safe way with the 3D thread, they can pass a delegate to BlWindow3D.EnqueueCommand or BlWindow3D.EnqueueCommandBlocking.

Because multiple windows are not conducive to some of the supported platforms, MonoGame, and thus Blotch3D, do not support more than one 3D window. (You can create any number of other windows you like.) You *can* create multiple 3D windows, but they don't work correctly (input sometimes goes to the wrong window) and in certain situations will crash. If you want to be able to "close" and "re-open" a window, you can just hide and show the same window. (On Microsoft Windows, you can use the BlWindow3D.Form object for that.)

Officially, MonoGame must create the 3D window, and does not allow you to specify an existing window to use as the 3D window. There are some platform-specific ways to do it described online, but note that they may not work in later MonoGame releases. To properly make the MonoGame window be a child window of an existing GUI, you need to explicitly size, position, and convey Z order to the original MonoGame window so that it is overlaid over the child window.

All MonoGame features remain available and accessible in Blotch3D. For examples:

- The models you specify for a sprite object (see the BlSprite.LODs field) are MonoGame "Model" objects. So, you can, for example, specify custom shaders, etc., for those models.
- The BlWindow3D class derives from the MonoGame "Game" class.
- The BlGraphicsDeviceManager class derives from MonoGame's "GraphicsDeviceManager" class.
- You are welcome to draw MonoGame objects along with Blotch3D objects.
- All other MonoGame features are available, like audio, etc.

Remember that most Blotch3D objects must be Disposed when you are done with them and you are not otherwise terminating the program.

See the examples, reference documentation, and IntelliSense for more information.

1.5 Making 3D models

There are several primitive models available with Blotch3D. The easiest way to add them to your project is to...

1. Copy the Content folder from the Blotch3D project folder to your project folder
2. Add the "Content.mgcb" file in that folder to your project
3. Right-click it and select "Properties"
4. Set the "Build Action" to "MonoGameContentReference"

If the "MonoGameContentReference" build option is not available in the drop-down list because, for example, you have created a project from scratch (rather than copied an existing example), then try this:

(from http://www.infinitespace-studios.co.uk/general/monogame-content-pipeline-integration

1. Open your application .csproj in an Editor.
2. In the first <PropertyGroup> section add <MonoGamePlatform>$(Platform)</MonoGamePlatform>, where $(Platform) is the system you are targeting e.g Windows, iOS, Android. For example: <MonoGame↩ Platform>Windows</MonoGamePlatform>
3. Add the following lines right underneath the <MonoGamePlatform /> element: <MonoGameInstall↩ Directory Condition="\'$(OS)\' != \'Unix\' ">$(MSBuildProgramFiles32)</MonoGameInstallDirectory>

   <MonoGameInstallDirectory Condition="\'$(OS)\' == \'Unix\' ">$(MSBuildExtensionsPath)</MonoGame↩ InstallDirectory>
4. Find the <Import/> element for the CSharp (or FSharp) targets and underneath add:

   <Import Project="$(MSBuildExtensionsPath)\MonoGame\v3.0\MonoGame.Content.Builder.targets" />

You can get the names of the content files by starting the MonoGame pipeline manager (double-click Content/↩ Content.mgcb). You can also add more content via the pipeline manager (see http://rbwhitaker.↩ wikidot.com/monogame-managing-content). See the examples for details on how to load and display models, fonts, etc.

If no existing model meets your needs, you can either programmatically create a model by specifying the vertices and normals (see the example that uses custom Vertices), or create a model with, for example, the Blender 3D modeler and then add it to the project with the pipeline manager. The pipeline manager can import several model file types. You can also instruct Blender to include texture (UV) mapping by using one of the countless tutorials online, like https://www.youtube.com/watch?v=2xTzJIaKQFY or https://en.wikibooks.↩ org/wiki/Blender_3D:_Noob_to_Pro/UV_Map_Basics . Also, you may be able to import certain existing models from the web, but mind the copyright.

1.6 Translucency

Translucent pixels in text or textures drawn using the 2D Blotch3D drawing methods (BlGraphicsDevice↩ Manager#DrawText and BlGraphicsDeviceManager#DrawTexture) will always correctly show the things behind them. Just be sure to call those methods after all other 3D things are drawn.

However, a translucent texture applied to a sprite may require special handling.

If you simply apply the translucent texture to a sprite as if it's just like any other texture, there may be situations that you will see certain undesirable artifacts depending on whether a far surface with respect to the camera is drawn before or after a near surface. For some translucent textures the artifacts can be negligible, or your particular application may avoid the artifacts entirely because of camera constraints and drawing order. In those cases, you don't need any other special code. We do this in the "full" example because the draw order of the translucent sprites, and their positions, are such that you won't see the artifacts because you can't even see the sprites when viewed from underneath, which is when you would otherwise see the artifacts in that example.

One main reason such artifacts occur is because the default MonoGame "Effect" used to draw models (the "Basic↩ Effect" effect) provides a pixel shader that does not do "alpha testing". Alpha testing is the process of neglecting to draw texture pixels (and thus neglecting to update the depth buffer) if the texture pixel's alpha is below some threshold value (i.e. if it is translucent enough). Most typical textures with an alpha channel use an alpha value of pretty much zero or one, indicating absence or presence of texture. Alpha testing works well with those. For alpha values intended to show partial translucency, it doesn't work well. In those cases, at a minimum you will have to watch drawing order, and if translucent sprites intersect or a translucent surface occludes another surface of the same sprite, you will have to look online for more advanced solutions.

MonoGame does provide a separate "AlphaTestEffect" effect that supports it. But AlphaTestEffect does not support directional lights, as are supported in BasicEffect. So, don't bother with AlphaTestEffect unless you don't care about the directional lights.

For these reasons Blotch3D includes a custom effect called BlBasicEffectAlphaTest (to be held as a BlBasicEffect object) that provides everything that MonoGame's BasicEffect provides, but also provides alpha testing. See the SpriteAlphaTexture example to see how it is used. Essentially your program must do the following:

1. Copy the "BlBasicEffectAlphaTest.mgfxo" (or "BlBasicEffectAlphaTestOGL.mgfxo" for certain other platforms) from the Blotch3D source "Content/Effects" folder to, for example, your program execution folder.
2. Your program loads that file and creates a BlBasicEffect, like this:

   byte[] bytes = File.ReadAllBytes("BlBasicEffectAlphaTest.mgfxo"); // or 'BlBasicEffectAlphaTestOGL.mgfxo' for certain other platforms

   BlBasicEffectAlphaTest = new BlBasicEffect(Graphics.GraphicsDevice, bytes);
3. And it specifies the alpha threshold level that merits drawing the pixel, like this, for example (this could also be done in the delegate described below):

   BlBasicEffectAlphaTest.Parameters["AlphaTestThreshold"].SetValue(.5f);
4. And then for sprites that have translucent textures your program assigns a delegate to the BlSprite's SetEffect delegate field. The delegate does something like this:

   MyTranslucentSprite.SetEffect = (s,effect) =>

   {

   s.SetupBasicEffect(BlBasicEffectAlphaTest);

   return BlBasicEffectAlphaTest;

   };

Note that BlBasicEffectAlphaTest is slightly slower than the default (BasicEffect) effect, so only use BlBasicEffect↩ AlphaTest when needed.

The provided "BlBasicEffectAlphaTest.mgfxo" and "BlBasicEffectAlphaTestOGL.mgfxo" files are compiled. The shader source code (HLSL) can be found in the Blotch3D Content/Effects folder. It is just the original Mono↩ Game BasicEffect code with a few lines added for alpha test. The make_effects.bat file in the Blotch3D source folder builds them, but first be sure to add the path to 2MGFX.exe to the 'path' environment variable. Typically the path is something like "\\Program Files (x86)\\MSBuild\\MonoGame\\v3.0\\Tools".

1.7 Dynamically changing a sprite's orientation and position

Each sprite has a "Matrix" member that defines its orientation and position relative to its parent sprite, or to an unmodified coordinate system if there is no parent. There are many static and instance methods of the Matrix class that let you easily set and change the scaling, translation, rotation, etc. of a matrix.

When you change anything about a sprite's matrix, you also change the orientation and position of its child sprites, if any. That is, subsprites reside in the parent sprite's coordinate system. For example, if a child sprite's matrix scales it by 3, and its parent sprite's matrix scales by 4, then the child sprite will be scaled by 12 in world space. Likewise, rotation, shear, and translation are inherited, as well.

There are also static and instance Matrix methods and operator overloads to "multiply" matrices to form a single matrix which combines the effects of multiple matrices. For example, a rotate matrix and a scale matrix can be multiplied to form a single rotate-scale matrix. But mind the multiplication order because matrix multiplication is not commutative. See below for details, but novices can simply try the operation one way (like A times B) and if it doesn't work the way you wanted, do it the other way (B times A).

For a good introduction (without the math), see http://rbwhitaker.wikidot.com/monogame-basic-matrices.

The Matrix internals section should be studied only when you need a deeper knowledge.

1.8 Matrix internals

Here we'll introduce the internals of 2D matrices. 3D matrices simply have one more dimension.

Let's imagine a model that has one vertex at (4,1) and another vertex at (3,3). (This is a very simple model comprised of only two vertices!)

You can move the model by moving each of those vertices by the same amount, and without regard to where each is relative to the origin. To do that, just add an offset vector to each vertex. For example, we could add the vector (2,1) to each of those original vertices, which would result in final model vertices of (6,2) and (5,4). In that case we have *translated* (moved) the model.

Matrices certainly support translation. But first let's talk about moving a vertex *relative to its current position from the origin,* because that's what gives matrices the power to shear, rotate, and scale a model about the origin. This is because those operations affect each vertex differently depending on its relationship to the origin.

If we want to scale (stretch) the X relative to the origin, we can multiply the X of each vertex by 2.

For example,

X' = 2X (where X is the initial value, and X' is the final value)

... which, when applied to each vertex, would change the above vertices from (4,1) and (3,3) to (8,1) and (6,3).

We might want to define how to change each X according to the original X value of each vertex *and also according to the original Y value*, like this:

X' = aX + bY

For example, if a=0 and b=1, then this would set the new X of each vertex to its original Y value.

Finally, we might also want to define how to create a new Y for each vertex according to its original X and original Y. So, the equations for both the new X and new Y are:

X' = aX + bY

Y' = cX + dY

(Remember, the idea is to apply this to every vertex.)

By convention we might write the four matrix elements (a, b, c, and d) in a 2x2 matrix, like this:

a b

c d

This should all be very easy to understand.

But why are we even talking about it? Because now we can define the elements of a matrix that, if applied to each vertex of a model, define any type of *transform* in the position and orientation of that model.

For example, if we apply the following matrix to each of the model's vertices:

1 0

0 1

...then the vertices are unchanged, because...

X' = 1X + 0Y

Y' = 0X + 1Y

...sets X' to X and Y' to Y.

This matrix is called the *identity* matrix because the output (X',Y') is the same as the input (X,Y).

We can create matrices that scale, shear, and even rotate points. To make a model three times as large (relative to the origin), use the matrix:

3 0

0 3

To scale only X by 3 (stretch a model in the X direction about the origin), then use the matrix:

3 0

0 1

The following matrix flips (mirrors) the model vertically about the origin:

1 0

0 -1

Below is a matrix to rotate a model counterclockwise by 90 degrees about the origin:

0 -1

1 0

Here is a matrix that rotates a model counterclockwise by 45 degrees about the origin:

0.707 -0.707

0.707 0. 707

Note that '0.707' is the sine of 45 degrees.

A matrix can be created to rotate any amount about any axis.

(The Matrix class provides functions that make it easy to create a rotation matrix from a rotation axis and angle, or pitch and yaw and roll, or something called a quaternion, since otherwise we'd have to call sine and cosine functions, ourselves, to create the matrix elements.)

Since we often also want to translate (move) points *without* regard to their current distances from the origin as we did at the beginning of this section, we add more numbers to the matrix just for that purpose. And since many mathematical operations on matrices work only if the matrix has the same number of rows as columns, we add more elements simply to make the rows and columns the same size. And since Blotch3D/MonoGame works in 3-space, we add even more numbers to handle the Z dimension. So, the final matrix size in 3D graphics is 4x4.

Specifically:

X' = aX + bY + cZ + d

Y' = eX + fY + gZ + h

Z' = iX + jY + kZ + l

W = mX + nY + oZ + p

(Consider the W as unused, for now.)

Notice that the d, h, and l are the translation vector.

Rather than using the above 16 letters ('a' through 'p') for the matrix elements, the Matrix class in MonoGame uses the following field names:

M11 M12 M13 M14

M21 M22 M23 M24

M31 M32 M33 M34

M41 M42 M43 M44

Besides the ability to multiply entire matrices (as mentioned at the beginning of this section), you can also divide (i.e. multiply by a matrix inverse) matrices to, for example, solve for a matrix that was used in a previous matrix multiply, or otherwise isolate one operation from another. Welcome to linear algebra! The Matrix class provides matrix multiply, inversion, etc. methods. If you are interested in how the individual matrix elements are processed to perform matrix arithmetic, please look it up online.

As was previously mentioned, each sprite has a matrix describing how that sprite and its children are transformed from the parent sprite's coordinate system. Specifically, Blotch3D does a matrix-multiply of the parent's matrix with the child's matrix to create the final ("absolute") matrix used to draw that child, and that matrix is also used as the parent matrix for the subsprites of that child.

1.9 A Short Glossary of 3D Graphics Terms

Polygon

A visible surface described by a set of vertices that define its corners. A triangle is a polygon with three vertices, a quad is a polygon with four. One side of a polygon is a "face".

Vertex

A point in space. Typically, a point at which the line segments of a polygon meet. That is, a corner of a polygon. A corner of a model. Most visible models are described as a set of vertices. Each vertex can have a color, texture coordinate, and normal. Pixels across the face of a polygon are (typically) interpolated from the vertex color, texture, and normal values.

Ambient lighting

A 3D scene has one ambient light setting. The intensity of ambient lighting on the surface of a polygon is unrelated to the orientation of the polygon or the camera.

Diffuse lighting

Directional or point source lighting. You can have multiple directional or point light sources. Its intensity depends on the orientation of the polygon relative to the light.

Texture

A 2D image applied to the surface of a model. For this to work, each vertex of the model must have a texture coordinate associated with it, which is an X,Y coordinate of the 2D bitmap image that should be aligned with that vertex. Pixels across the surface of a polygon are interpolated from the texture coordinates specified for each vertex.

Normal

In mathematics, the word "normal" means a vector that is perpendicular to a surface. In 3D graphics, "normal" means a vector that indicates from what direction light will cause a surface to be brightest. Normally they would mean the same thing. However, by defining a normal at some angle other than perpendicular, you can somewhat cause the illusion that a surface lies at a different angle. Each vertex of a polygon has a normal vector associated with it and the brightness across the surface of a polygon is interpolated from the normals of its vertices. So, a single flat polygon can have a gradient of brightness across it giving the illusion of curvature. In this way a model composed of fewer polygons can still be made to look quite smooth.

X-axis

The axis that extends right from the origin.

Y-axis

The axis that extends forward from the origin.

Z-axis

The axis that extends up from the origin.

Origin

The center of a coordinate system. The point in the coordinate system that is, by definition, at (0,0).

Translation

Movement. The placing of something at a different location from its original location.

Rotation

The circular movement of each vertex of a model about the same axis.

Scale

A change in the width, height, and/or depth of a model.

Shear (skew)

A pulling of one side of a model in one direction, and the opposite side in the opposite direction, without rotation, such that the model is distorted rather than rotated. A parallelogram is a rectangle that has experienced shear. If you apply another shear along an orthogonal axis of the first shear, you rotate the model.

Yaw

Rotation about the Y-axis

Pitch

Rotation about the X-axis, after any Yaw has been applied.

Roll

Rotation about the Z-axis, after any Pitch has been applied.

Euler angles

The yaw, pitch, and roll of a model, applied in that order.

Matrix

An array of numbers that can describe a difference, or transform, in one coordinate system from another. Each sprite has a matrix that defines its location, rotation, scale, shear etc. within the coordinate system of its parent sprite, or within an untransformed coordinate system if there is no parent. See `Dynamically changing a sprite's orientation and position`.

Frame

In this document, \'frame\' is analogous to a movie frame. A moving 3D scene is created by drawing successive frames.

Depth buffer

3D systems typically keep track of the depth of the polygon surface (if any) at each 2D window pixel so that they know to draw the nearer pixel over the farther pixel in the 2D display. The depth buffer is an array with one element per 2D window pixel, where each element is (typically) a 32-bit floating point value indicating the nearest (to the camera) depth of that point. In that way pixels that are farther away need not be drawn. You can override this behavior for special cases. See BlGraphicsDeviceManager.NearClip, BlGraphicsDeviceManager.FarClip. and search the web for MonoGame depth information.

Near clipping plane (NearClip)

The distance from the camera at which a depth buffer element is equal to zero. Nearer surfaces are not drawn.

Far clipping plane (FarClip)

The distance from the camera at which a depth buffer element is equal to the maximum possible floating-point value. Farther surfaces are not drawn.

Model space

The untransformed three-dimensional space that models are initially created/defined in. Typically, a model is centered on the origin of model space.

World space

The three-dimensional space that you see through the two-dimensional view of the window. A model is transformed from model space to world space by its final matrix (that is, the matrix we get *after* a sprite's matrix is multiplied by its parent sprite matrices, if any).

View space

The two-dimensional space of the window on the screen. Objects in world space are transformed by the view matrix and projection matrix to produce the contents of the window. You don't have to understand the view and projection matrices, though, because there are higher-level functions that control them—like Zoom, aspect ratio, and camera position and orientation functions.

1.10 Troubleshooting

Q: When I set a billboard attribute of a flat sprite (like a plane), I can no longer see it.

A: Perhaps the billboard orientation is such that you are looking at the plane from the side or back. Try setting a rotation in the sprite's matrix (and make sure it doesn't just rotate it on the axis intersecting your eye point).

Q: When I'm inside a sprite, I can't see it.

A: By default, Blotch3D draws only the outside of a sprite. Try doing a "Graphics.GraphicsDevice.RasterizerState = RasterizerState.CullClockwise" (or set it to CullNone to see both the inside and outside) in the BlSprite.PreDraw delegate, and set it back to CullCounterClockwise in the BlSprite.DrawCleanup delegate.

Q: I set a sprite's matrix so that one of the dimensions has a scale of zero, but then the sprite becomes black.

A: A sprite's matrix also affects its normals. By setting a dimension's scale to zero, you may have caused some of the normals to be zero'd-out as well.

Q: When I am zoomed-in a large amount, sprite and camera movement jumps as the sprite or camera move.

A: You are experiencing floating point precision errors in the positioning algorithms. About all you can do is "fake" being that zoomed in by, instead, moving the camera forward temporarily. Or simply don't allow zoom to go to that extreme.

Q: Sometimes I see slightly farther polygons and parts polygons of sprites appear in front of nearer ones, and it varies as the camera or sprite moves.

A: The floating-point precision limitation of the depth buffer can cause this. Try increasing your near clip and/or decreasing your far clip so the depth buffer doesn't have to cover so much dynamic range.

Q: I have a sprite that I want always to be visible, but I think its invisible because its outside the depth buffer, but I don't want to change the depth buffer.

A: Try doing a "Graphics.GraphicsDevice.DepthStencilState = Graphics.DepthStencilStateDisabled" in the BlSprite.PreDraw delegate, and set it back to DepthStencilStateEnabled in the BlSprite.DrawCleanup delegate.

Q: I'm moving or rotating a sprite regularly over many frames by multiplying its matrix with a matrix that represents the change per frame, but after a while the sprite gets distorted or drifts from its predicted position, location, rotation, etc.

A: When you multiply two matrices, you introduce a very slight floating-point inaccuracy in the resulting matrix because floating-point values have a limited number of bits. Normally the inaccuracy is too small to matter. But if you repeatedly do it to the same matrix, it will eventually become noticeable. Try changing your math so that a new matrix is created from scratch each frame, or at least created every several hundred frames. For example, let's say you want to slightly rotate a sprite every frame by the same amount. You can either create a new rotation matrix from scratch every frame from a simple float scalar angle value you are regularly updating, or you can multiply the existing matrix by a persistent rotation matrix you created initially. The former method is more precise, but the latter is less CPU intensive because creating a rotation matrix from a floating-point angle value requires that transcendental functions be called, but multiplying matrices does not. A good compromise is to use a combination of both, if possible. Specifically, multiply by a rotation matrix for a time, but somewhat periodically recreate the sprite's matrix directly from the scalar angle value.

1.11 Rights

Chapter 2

Namespace Index

2.1 Packages

Here are the packages with brief descriptions (if available):

Chapter 3

Hierarchical Index

3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 4

Class Index

4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 5

Namespace Documentation

5.1 Blotch Namespace Reference

Classes

- class BlBasicEffect

  Built-in effect that supports optional texturing, vertex coloring, fog, and lighting.
- class **BlDebug**

  This static class holds the debug flags. Many flags are initialized according to whether its a Debug build or Release build. Some flags enable exceptions for probable errors, and many flags cause warning messages to be sent to the console window, if it exist. For this reason you should first test your app as a debug build console app.
- class BlGraphicsDeviceManager

  This holds everything having to do with an output device. BlWindow3D creates one of these for itself.
- class BlGuiControl

  A 2D GUI control. To create a GUI control: instantiate one of these, set its initial Texture (remember to create it in the 3D thread context), window position, and delegate, and then add it to BlWindow3D::GuiControls. (Any member can be dynamically changed.) The texture will be displayed, and then each frame the mouse is over it the delegate will be called. The delegate typically would examine the current mouse state (Mouse.GetState()) and the PrevMouseState member to detect button changes, etc. and perform an action. The delegate is called in the context of the window's 3D thread after the BlWindow3D::FrameProc method. You can use BlGraphicsDeviceManager::TextToTexture to create a textual textures, or just load a texture from a content file. Remember to Dispose textures when you are done with them.
- class BlMipmap

  A mipmap of textures for a given BlSprite. You could load this from an image file and then assign it to a BlSprite::Mipmap. Note that this is a software mipmap (i.e. it isn't implemented in the 3D hardware). That is, only one resolution texture is used at time.
- class BlSprite

  A BlSprite is a single 3D object. Each sprite can also hold any number of subsprites, so you can make a sprite tree (a scene graph). In that case the child sprites 'follow' the orientation and position of the parent sprite. That is, they exist in the coordinate system of the parent sprite. The location and orientation of a sprite in its parent's coordinate system is defined by the sprite's Matrix member. Subsprites, LODs, and Mipmap are NOT disposed when the sprite is disposed, so you can assign the same one to multiple sprites.
- class BlWindow3D

  To make a 3D window, you must derive a class from BlWindow3D and override the Setup, FrameProc, and FrameDraw methods. When it comes time to open the 3D window, you instantiate that class and call its "Run" method from the same thread that instantiated it. The Run method will call the Setup, FrameProc, and FrameDraw methods when appropriate, and not return until the window closes. All code that accesses 3D resources must be done in that thread, including code that creates and uses all Blotch3D and MonoGame objects. Note that this rule also applies to any code structure that may internally use other threads, as well. Do not use Parallel, async, etc. code structures that access 3D resources. Other threads that need to access 3D resources can do so by passing a delegate to EnqueueCommand and EnqueueCommandBlocking.

5.2 Botch Namespace Reference

Classes

- class **BlEffectHelpers**

  Helper code shared between the various built-in effects.

Enumerations

- enum BlEffectDirtyFlags {
  WorldViewProj = 1, **World** = 2, **EyePosition** = 4, **MaterialColor** = 8,
  Fog = 16, **FogEnable** = 32, **AlphaTest** = 64, **ShaderIndex** = 128,
  All = -1 }

  Track which effect parameters need to be recomputed during the next OnApply.

5.2.1 Enumeration Type Documentation

5.2.1.1 BlEffectDirtyFlags

```
enum Botch.BlEffectDirtyFlags  [strong]
```

Track which effect parameters need to be recomputed during the next OnApply.

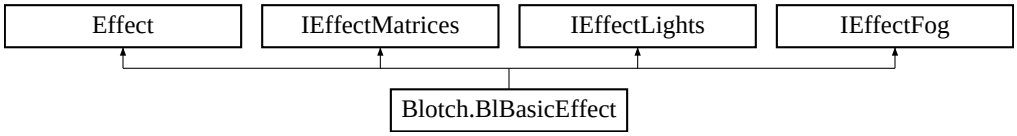
Chapter 6

Class Documentation

6.1 Blotch.BlBasicEffect Class Reference

Built-in effect that supports optional texturing, vertex coloring, fog, and lighting.

Inheritance diagram for Blotch.BlBasicEffect:



Public Member Functions

- BlBasicEffect (GraphicsDevice device, byte[ ] bytes)

  Creates a new BasicEffectWithAlphaTest with default parameter settings.
- override Effect Clone ()

  Creates a clone of the current BasicEffectWithAlphaTest instance.
- void EnableDefaultLighting ()

Protected Member Functions

- BlBasicEffect (BlBasicEffect cloneSource)

  Creates a new BasicEffectWithAlphaTest by cloning parameter settings from an existing instance.
- override void OnApply ()

  Lazily computes derived parameter values immediately before applying the effect.

Properties

- Matrix World [get, set]

  Gets or sets the world matrix.
- Matrix View [get, set]

  Gets or sets the view matrix.
- Matrix Projection [get, set]

  Gets or sets the projection matrix.
- Vector3 DiffuseColor [get, set]

  Gets or sets the material diffuse color (range 0 to 1).
- Vector3 EmissiveColor [get, set]

  Gets or sets the material emissive color (range 0 to 1).
- Vector3 SpecularColor [get, set]

  Gets or sets the material specular color (range 0 to 1).
- float SpecularPower [get, set]

  Gets or sets the material specular power.
- float Alpha [get, set]

  Gets or sets the material alpha.
- bool LightingEnabled [get, set]
- bool PreferPerPixelLighting [get, set]

  Gets or sets the per-pixel lighting prefer flag.
- Vector3 AmbientLightColor [get, set]
- DirectionalLight DirectionalLight0 [get]
- DirectionalLight DirectionalLight1 [get]
- DirectionalLight DirectionalLight2 [get]
- bool FogEnabled [get, set]
- float FogStart [get, set]
- float FogEnd [get, set]
- Vector3 FogColor [get, set]
- bool TextureEnabled [get, set]

  Gets or sets whether texturing is enabled.
- Texture2D Texture [get, set]

  Gets or sets the current texture.
- bool VertexColorEnabled [get, set]

  Gets or sets whether vertex color is enabled.

6.1.1 Detailed Description

Built-in effect that supports optional texturing, vertex coloring, fog, and lighting.

6.1.2 Constructor & Destructor Documentation

6.1.2.1 BlBasicEffect() [1/2]

```
Blotch.BlBasicEffect.BlBasicEffect (
            GraphicsDevice device,
            byte [] bytes )
```

Creates a new BasicEffectWithAlphaTest with default parameter settings.

6.1.2.2 BlBasicEffect() [2/2]

```
Blotch.BlBasicEffect.BlBasicEffect (
            BlBasicEffect cloneSource )  [protected]
```

Creates a new BasicEffectWithAlphaTest by cloning parameter settings from an existing instance.

6.1.3 Member Function Documentation

6.1.3.1 Clone()

```
override Effect Blotch.BlBasicEffect.Clone ( )
```

Creates a clone of the current BasicEffectWithAlphaTest instance.

6.1.3.2 OnApply()

```
override void Blotch.BlBasicEffect.OnApply ( )  [protected]
```

Lazily computes derived parameter values immediately before applying the effect.

6.1.4 Property Documentation

6.1.4.1 Alpha

```
float Blotch.BlBasicEffect.Alpha  [get], [set]
```

Gets or sets the material alpha.

6.1.4.2 DiffuseColor

```
Vector3 Blotch.BlBasicEffect.DiffuseColor  [get], [set]
```

Gets or sets the material diffuse color (range 0 to 1).

6.1.4.3 EmissiveColor

```
Vector3 Blotch.BlBasicEffect.EmissiveColor  [get], [set]
```

Gets or sets the material emissive color (range 0 to 1).

6.1.4.4 PreferPerPixelLighting

```
bool Blotch.BlBasicEffect.PreferPerPixelLighting  [get], [set]
```

Gets or sets the per-pixel lighting prefer flag.

6.1.4.5 Projection

```
Matrix Blotch.BlBasicEffect.Projection  [get], [set]
```

Gets or sets the projection matrix.

6.1.4.6 SpecularColor

```
Vector3 Blotch.BlBasicEffect.SpecularColor  [get], [set]
```

Gets or sets the material specular color (range 0 to 1).

6.1.4.7 SpecularPower

```
float Blotch.BlBasicEffect.SpecularPower  [get], [set]
```

Gets or sets the material specular power.

6.1.4.8 Texture

```
Texture2D Blotch.BlBasicEffect.Texture  [get], [set]
```

Gets or sets the current texture.

6.1.4.9 TextureEnabled

```
bool Blotch.BlBasicEffect.TextureEnabled  [get], [set]
```

Gets or sets whether texturing is enabled.

6.1.4.10 VertexColorEnabled

```
bool Blotch.BlBasicEffect.VertexColorEnabled  [get], [set]
```

Gets or sets whether vertex color is enabled.

6.1.4.11 View

```
Matrix Blotch.BlBasicEffect.View  [get], [set]
```

Gets or sets the view matrix.

6.1.4.12 World

```
Matrix Blotch.BlBasicEffect.World  [get], [set]
```

Gets or sets the world matrix.

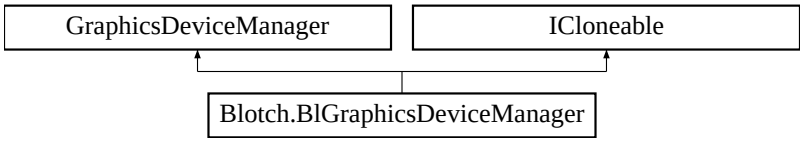
The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlBasicEffect.cs

6.2 Blotch.BlGraphicsDeviceManager Class Reference

This holds everything having to do with an output device. BlWindow3D creates one of these for itself.

Inheritance diagram for Blotch.BlGraphicsDeviceManager:



Classes

- class Light

  Defines a light. See the Lights field. The default BasicShader supports up to three lights.

Public Member Functions

- BlGraphicsDeviceManager (BlWindow3D window)
- void Initialize ()

  For internal use only. Apps should not normally call this. This initializes some values AFTER the BlWindow3D has been created.
- void ExtendClippingTo (BlSprite s)

  Informs the auto-clipping code of an object that should be included in the clipping region. This is mainly for internal use. Application code should control clipping with NearClip and FarClip.
- void SetSpriteToCamera (BlSprite sprite)

  Sets a sprite's BlSprite::Matrix to the current camera position and orientation. You could use this to implement a HUD, for example. Note: This only works correctly if the sprite has no parent (and is thus drawn directly) or it's parents are untransformed. If all you want is to set the sprite's position (but NOT orientation) to the camera, then set the sprite's Matrix.Translation = graphics.Eye
- void SetCameraToSprite (BlSprite sprite)

  Sets the camera position and orientation to the current position and orientation of a sprite. You could use for cockpit view, for example. Note that the camera will lag sprite movement unless the following is done: For every frame you must first calculate the sprite's position and orientation, call this function, and then draw everything.
- void AdjustCameraZoom (double dif)

  Sets the Zoom. If dif is zero, then there is no change in zoom. Normally one would set zoom with the Zoom field. This is mainly for internal use.
- void AdjustCameraDolly (double dif)

  Migrates the current camera dolly (distance from LookAt) according to dif. If dif is zero, then there is no change in dolly.
- void AdjustCameraTruck (double difX, double difY=0)

  Adjusts camera truck (movement relative to camera direction) according to difX and difY. if difX and difY are zero, then truck position isn't changed.
- void AdjustCameraRotation (double difX, double difY=0)

  Adjusts camera rotation about the LookAt point according to difX and difY. if difX and difY are zero, then rotation isn't changed.
- void AdjustCameraPan (double difX, double difY=0)

  Adjusts camera pan (changing direction of camera) according to difX and difY. if difX and difY are zero, then pan direction isn't changed.
- Ray DoDefaultGui ()

  Updates Eye, LookAt, etc. according to mouse and certain key input. Specifically: Wheel=Dolly, CTRL-wheel=Zoom, Left-drag=Truck, Right-drag=Rotate, CTRL-left-drag=Pan, Esc=Reset. Also, SHIFT causes all the previous controls to be fine rather than coarse. If CTRL is pressed and mouse left or right button is clicked, then returns a ray into window at mouse position.
- void ResetCamera ()

  Sets Eye. LookAt, etc. back to default starting position.
- void SetCameraRollToZero ()

  Sets the camera 'roll' to be level with the XY plane
- Ray CalculateRay (Vector2 windowPosition)

  Returns a ray that that goes from the near clipping plane to the far clipping plane, at the specified window position.
- Vector3 GetWindowCoordinates (BlSprite sprite)

  Returns the window coordinates of the specified sprite.
- Texture2D TextToTexture (string text, SpriteFont font, Microsoft.Xna.Framework.Color? color=null, Microsoft.Xna.Framework.Color? backColor=null)

Returns a Texture2D containing the specified text. It's up to the caller to Dispose the returned texture.

- void DrawTexture (Texture2D texture, Rectangle windowRect, Microsoft.Xna.Framework.Color? color=null)

  Draws a texture in the window.
- void DrawText (string text, SpriteFont font, Vector2 windowPos, Microsoft.Xna.Framework.Color? color=null)

  Draws text on the window.
- Texture2D LoadFromImageFile (string fileName)

  Loads a texture directly from an image file.
- void PrepareDraw (bool firstCallInDraw=true)

  This is automatically called once at the beginning of your BlWindow3D::FrameDraw method. It calculates the latest View and Projection settings according to the current camera specifications (Zoom, Aspect, Eye, LookAt, etc.), and if firstCallInDraw is true it also may sleep in order to obey FramePeriod. It must also be called explicitly after any changes to the camera settings made later in the BlWindow3D::FrameDraw method. Only in the first call should firstCallInDraw be true, and in any subsequent calls it should be false.
- Texture2D CloneTexture2D (Texture2D tex)

  Returns a deepcopy of the texture
- object **Clone** ()
- new void Dispose ()

  When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug::EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

Public Attributes

- Microsoft.Xna.Framework.Matrix View

  This is the view matrix. Normally you would use the higher-level functions Eye, LookAt, CameraUp, SetCameraToSprite, and DoDefaultGui intead of changing this directly.
- Microsoft.Xna.Framework.Matrix Projection

  The Projection matrix. Normally you would use the higher-level functions Zoom, Aspect, NearClip, or FarClip intead of changing this directly.
- Vector3 CameraUp

  Camera Up vector. Initially set to +Z. ResetCamera and SetCameraToSprite updates this.
- double DefGuiMinLookZ = -1

  Causes DoDefaultGui to prevent the Z component of CameraForwardNormalized from falling below this value. For example, set this to zero so that DoDefaultGui won't allow the camera to look downward
- double DefGuiMaxLookZ = 1

  Caues DoDefaultGui to prevent the Z component of CameraForwardNormalized from rising above this value. For example, set this to zero so that DoDefaultGui won't allow the camera to look upward
- DepthStencilState DepthStencilStateEnabled

  Assign DepthStencilState to this to enable depth buffering
- DepthStencilState DepthStencilStateDisabled

  Assign DepthStencilState to this to disable depth buffering
- Vector3 TargetEye

  The point that Eye migrates to, according to CameraSpeed. See Eye for more information.
- Vector3 TargetLookAt

  The point that LookAt migrates to, according to CameraSpeed. See LookAt for more information.
- double CameraSpeed = .4

  The responsiveness of the camera position to changes in TargetEye and TargetLookAt. A value of 0 means it doesn't respond to changes, 1 means it immediately responds. See Eye and LookAt for more information.
- double Zoom =45

  The field of view, in degrees.
- double Aspect =2

The aspect ratio.

- double NearClip = 0

  The near clipping plane, or 0 = autoclip.

- double FarClip = 0

  The far clipping plane, or 0 = autoclip.

- Microsoft.Xna.Framework.Color ClearColor =new Microsoft.Xna.Framework.Color(0,0,.1f)

  The background color.

- double AutoRotate = 0

  How fast DoDefaultGui should auto-rotate the scene.

- double FramePeriod = 1/60.0

  How much time between consecutive frames.

- List< Light > Lights = new List<Light>()

  The directional lights. Note: The BasicEffect shader only supports the first three. To handle more lights, you'll need to write your own shader.

- Vector3 AmbientLightColor = new Vector3(.1f, .1f, .1f)

  The ambient light color. If null, no ambient light is enabled. Note: There is no ambient color for a BlSprite. Both diffuse and ambient light illuminates the model's Color. See the BlSprite::Color member.

- Vector3 FogColor = null

  If not null, color of fog.

- float fogStart = 1

  How far away fog starts. See FogColor.

- float fogEnd = 10

  How far away fog ends. See FogColor.

- BlWindow3D Window

  The BlWindow3D associated with this object.

- SpriteBatch SpriteBatch =null

  A SpriteBatch for use by certain text and teture drawing methods.

- bool IsDisposed = false

  Set when the object is Disposed.

Properties

- Vector3 CameraForward `[get]`

  The vector between Eye and LookAt. Writes to Eye and LookAt and calls to SetCameraToSprite cause this to be updated. Also see CameraForwardNormalized and CameraForwardMag.

- Vector3 CameraForwardNormalized `[get]`

  Normalized form of CameraForward. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated. Also see CameraForward and CameraForwardMag.

- float CameraForwardMag `[get]`

  The magnitude of CameraForward. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated. Also see CameraForward and CameraForwardNormalized.

- Vector3 CameraRight `[get]`

  Camera Right vector. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated.

- Vector3 Eye `[get]`

  The current camera position. Note: To change the camera position, set TargetEye. Also see CameraSpeed.

- Vector3 LookAt `[get]`

  The current camera LookAt position. Note: To change the camera LookAt, set TargetLookAt. Also see CameraSpeed.

- double CurrentAspect `[get]`

  Current aspect ratio. Same as Aspect unless Aspect==0.

- double CurrentNearClip `[get]`

  Current value of near clipping plane. See NearClip.

- double CurrentFarClip [get]

  Current value of far clipping plane. See FarClip.
- double MinCamDistance [get]

  Distance to the nearest sprite, less its radius. Note this is set to a very large number by PrepareDraw, and then as BlWindow3D::FrameDraw is called it is set more reasonably.
- double MaxCamDistance [get]

  Distance to the farthest sprite, plus its radius. Note this is set to a very small number by PrepareDraw, and then as BlWindow3D::FrameDraw is called it is set more reasonably.

6.2.1 Detailed Description

This holds everything having to do with an output device. BlWindow3D creates one of these for itself.

6.2.2 Constructor & Destructor Documentation

6.2.2.1 BlGraphicsDeviceManager()

```
Blotch.BlGraphicsDeviceManager.BlGraphicsDeviceManager (
            BlWindow3D window )
```

Parameters

window	The BlWindow3D object for which this is to be the BlGraphicsDeviceManager

6.2.3 Member Function Documentation

6.2.3.1 AdjustCameraDolly()

```
void Blotch.BlGraphicsDeviceManager.AdjustCameraDolly (
            double dif )
```

Migrates the current camera dolly (distance from LookAt) according to dif. If dif is zero, then there is no change in dolly.

Parameters

dif	How much to dolly camera (plus = toward LookAt, minus = away)

6.2.3.2 AdjustCameraPan()

```
void Blotch.BlGraphicsDeviceManager.AdjustCameraPan (
            double difX,
            double difY = 0 )
```

Adjusts camera pan (changing direction of camera) according to difX and difY. if difX and difY are zero, then pan direction isn't changed.

Parameters

difX	How much to pan horizontally
difY	How much to pan vertically

6.2.3.3 AdjustCameraRotation()

```
void Blotch.BlGraphicsDeviceManager.AdjustCameraRotation (
            double difX,
            double difY = 0 )
```

Adjusts camera rotation about the LookAt point according to difX and difY. if difX and difY are zero, then rotation isn't changed.

Parameters

difX	How much to rotate the camera horizontally
difY	How much to rotate the camera vertically

6.2.3.4 AdjustCameraTruck()

```
void Blotch.BlGraphicsDeviceManager.AdjustCameraTruck (
            double difX,
            double difY = 0 )
```

Adjusts camera truck (movement relative to camera direction) according to difX and difY. if difX and difY are zero, then truck position isn't changed.

Parameters

difX	How much to truck the camera horizontally
difY	How much to truck the camera vertically

6.2.3.5 AdjustCameraZoom()

```
void Blotch.BlGraphicsDeviceManager.AdjustCameraZoom (
            double dif )
```

Sets the Zoom. If dif is zero, then there is no change in zoom. Normally one would set zoom with the Zoom field. This is mainly for internal use.

Parameters

dif	How much to zoom camera (plus = magnify, minus = reduce)

6.2.3.6 CalculateRay()

```
Ray Blotch.BlGraphicsDeviceManager.CalculateRay (
            Vector2 windowPosition )
```

Returns a ray that that goes from the near clipping plane to the far clipping plane, at the specified window position.

Parameters

windowPosition	The window's pixel coordinates

Returns

The Ray into the window at the specified pixel coordinates

6.2.3.7 CloneTexture2D()

```
Texture2D Blotch.BlGraphicsDeviceManager.CloneTexture2D (
            Texture2D tex )
```

Returns a deepcopy of the texture

Parameters

tex	The texture to deepcopy

Returns

A deepcopy of tex

6.2.3.8 Dispose()

```
new void Blotch.BlGraphicsDeviceManager.Dispose ( )
```

When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug::EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

6.2.3.9 DoDefaultGui()

```
Ray Blotch.BlGraphicsDeviceManager.DoDefaultGui ( )
```

Updates Eye, LookAt, etc. according to mouse and certain key input. Specifically: Wheel=Dolly, CTR↩ L-wheel=Zoom, Left-drag=Truck, Right-drag=Rotate, CTRL-left-drag=Pan, Esc=Reset. Also, SHIFT causes all the previous controls to be fine rather than coarse. If CTRL is pressed and mouse left or right button is clicked, then returns a ray into window at mouse position.

Returns

If a mouse left or right click occurred, returns the Ray into the screen at that position. Otherwsie returns null

6.2.3.10 DrawText()

```
void Blotch.BlGraphicsDeviceManager.DrawText (
            string text,
            SpriteFont font,
            Vector2 windowPos,
            Microsoft.Xna.Framework.Color?  color = null )
```

Draws text on the window.

Parameters

text	The text to draw
font	The font to use (typically created from SpriteFont content with Content.Load<SpriteFont>(...))
windowPos	The X and Y window location, in pixels
color	Foreground color of the font

6.2.3.11 DrawTexture()

```
void Blotch.BlGraphicsDeviceManager.DrawTexture (
            Texture2D texture,
```

```
            Rectangle windowRect,
            Microsoft.Xna.Framework.Color?  color = null )
```

Draws a texture in the window.

Parameters

texture	The texture to draw
windowRect	The X and Y window location, in pixels
color	Foreground color of the font

6.2.3.12 ExtendClippingTo()

```
void Blotch.BlGraphicsDeviceManager.ExtendClippingTo (
            BlSprite s )
```

Informs the auto-clipping code of an object that should be included in the clipping region. This is mainly for internal use. Application code should control clipping with NearClip and FarClip.

Parameters

s	The sprite that should be included in the auto-clipping code

6.2.3.13 GetWindowCoordinates()

```
Vector3 Blotch.BlGraphicsDeviceManager.GetWindowCoordinates (
            BlSprite sprite )
```

Returns the window coordinates of the specified sprite.

Parameters

sprite	The sprite to get the window coordinates of

Returns

The window coordinates of the sprite, in pixels

6.2.3.14 Initialize()

```
void Blotch.BlGraphicsDeviceManager.Initialize ( )
```

For internal use only. Apps should not normally call this. This initializes some values AFTER the BlWindow3D has been created.

6.2.3.15 LoadFromImageFile()

```
Texture2D Blotch.BlGraphicsDeviceManager.LoadFromImageFile (
            string fileName )
```

Loads a texture directly from an image file.

Parameters

fileName	An image file of any standard type supported by MonoGame (jpg, png, etc.)

Returns

The texture that was loaded

6.2.3.16 PrepareDraw()

```
void Blotch.BlGraphicsDeviceManager.PrepareDraw (
            bool firstCallInDraw = true )
```

This is automatically called once at the beginning of your BlWindow3D::FrameDraw method. It calculates the latest View and Projection settings according to the current camera specifications (Zoom, Aspect, Eye, LookAt, etc.), and if firstCallInDraw is true it also may sleep in order to obey FramePeriod. It must also be called explicitly after any changes to the camera settings made later in the BlWindow3D::FrameDraw method. Only in the first call should firstCallInDraw be true, and in any subsequent calls it should be false.

Parameters

firstCallInDraw	True indicates this method should also sleep in order to obey FramePeriod.

6.2.3.17 ResetCamera()

```
void Blotch.BlGraphicsDeviceManager.ResetCamera ( )
```

Sets Eye. LookAt, etc. back to default starting position.

6.2.3.18 SetCameraRollToZero()

```
void Blotch.BlGraphicsDeviceManager.SetCameraRollToZero ( )
```

Sets the camera 'roll' to be level with the XY plane

6.2.3.19 SetCameraToSprite()

```
void Blotch.BlGraphicsDeviceManager.SetCameraToSprite (
            BlSprite sprite )
```

Sets the camera position and orientation to the current position and orientation of a sprite. You could use for cockpit view, for example. Note that the camera will lag sprite movement unless the following is done: For every frame you must first calculate the sprite's position and orientation, call this function, and then draw everything.

Parameters

sprite	The sprite that the camera should be connected to

6.2.3.20 SetSpriteToCamera()

```
void Blotch.BlGraphicsDeviceManager.SetSpriteToCamera (
            BlSprite sprite )
```

Sets a sprite's BlSprite::Matrix to the current camera position and orientation. You could use this to implement a HUD, for example. Note: This only works correctly if the sprite has no parent (and is thus drawn directly) or it's parents are untransformed. If all you want is to set the sprite's position (but NOT orientation) to the camera, then set the sprite's Matrix.Translation = graphics.Eye

Parameters

sprite	The sprite that should be connected to the camera

6.2.3.21 TextToTexture()

```
Texture2D Blotch.BlGraphicsDeviceManager.TextToTexture (
            string text,
            SpriteFont font,
            Microsoft.Xna.Framework.Color?  color = null,
            Microsoft.Xna.Framework.Color?  backColor = null )
```

Returns a Texture2D containing the specified text. It's up to the caller to Dispose the returned texture.

Parameters

text	The text to write to the texture
font	Font to use
color	If specified, color of the text. (Default is white)
backColor	If specified, background color, like Color.Transparent. If null, then do not clear the background)

Returns

The texture (as a RenderTarget2D). Caller is responsible for Disposing this!

6.2.4 Member Data Documentation

6.2.4.1 AmbientLightColor

```
Vector3 Blotch.BlGraphicsDeviceManager.AmbientLightColor = new Vector3(.1f, .1f, .1f)
```

The ambient light color. If null, no ambient light is enabled. Note: There is no ambient color for a BlSprite. Both diffuse and ambient light illuminates the model's Color. See the BlSprite::Color member.

6.2.4.2 Aspect

```
double Blotch.BlGraphicsDeviceManager.Aspect =2
```

The aspect ratio.

6.2.4.3 AutoRotate

```
double Blotch.BlGraphicsDeviceManager.AutoRotate = 0
```

How fast DoDefaultGui should auto-rotate the scene.

6.2.4.4 CameraSpeed

```
double Blotch.BlGraphicsDeviceManager.CameraSpeed = .4
```

The responsiveness of the camera position to changes in TargetEye and TargetLookAt. A value of 0 means it doesn't respond to changes, 1 means it immediately responds. See Eye and LookAt for more information.

6.2.4.5 CameraUp

```
Vector3 Blotch.BlGraphicsDeviceManager.CameraUp
```

Camera Up vector. Initially set to +Z. ResetCamera and SetCameraToSprite updates this.

6.2.4.6 ClearColor

```
Microsoft.Xna.Framework.Color Blotch.BlGraphicsDeviceManager.ClearColor =new Microsoft.Xna.↩
Framework.Color(0,0,.1f)
```

The background color.

6.2.4.7 DefGuiMaxLookZ

```
double Blotch.BlGraphicsDeviceManager.DefGuiMaxLookZ = 1
```

Caues DoDefaultGui to prevent the Z component of CameraForwardNormalized from rising above this value. For example, set this to zero so that DoDefaultGui won't allow the camera to look upward

6.2.4.8 DefGuiMinLookZ

```
double Blotch.BlGraphicsDeviceManager.DefGuiMinLookZ = -1
```

Causes DoDefaultGui to prevent the Z component of CameraForwardNormalized from falling below this value. For example, set this to zero so that DoDefaultGui won't allow the camera to look downward

6.2.4.9 DepthStencilStateDisabled

```
DepthStencilState Blotch.BlGraphicsDeviceManager.DepthStencilStateDisabled
```

Initial value:

```
= new DepthStencilState()
        {
            DepthBufferEnable = false,
            DepthBufferWriteEnable = false,
            DepthBufferFunction = CompareFunction.Always
        }
```

Assign DepthStencilState to this to disable depth buffering

6.2.4.10 DepthStencilStateEnabled

```
DepthStencilState Blotch.BlGraphicsDeviceManager.DepthStencilStateEnabled
```

Initial value:

```
= new DepthStencilState()
        {
            DepthBufferEnable = true,
            DepthBufferWriteEnable = true,
            DepthBufferFunction = CompareFunction.LessEqual
        }
```

Assign DepthStencilState to this to enable depth buffering

6.2.4.11 FarClip

```
double Blotch.BlGraphicsDeviceManager.FarClip = 0
```

The far clipping plane, or 0 = autoclip.

6.2.4.12 FogColor

```
Vector3 Blotch.BlGraphicsDeviceManager.FogColor = null
```

If not null, color of fog.

6.2.4.13 fogEnd

```
float Blotch.BlGraphicsDeviceManager.fogEnd = 10
```

How far away fog ends. See FogColor.

6.2.4.14 fogStart

```
float Blotch.BlGraphicsDeviceManager.fogStart = 1
```

How far away fog starts. See FogColor.

6.2.4.15 FramePeriod

```
double Blotch.BlGraphicsDeviceManager.FramePeriod = 1/60.0
```

How much time between consecutive frames.

6.2.4.16 IsDisposed

```
bool Blotch.BlGraphicsDeviceManager.IsDisposed = false
```

Set when the object is Disposed.

6.2.4.17 Lights

```
List<Light> Blotch.BlGraphicsDeviceManager.Lights = new List<Light>()
```

The directional lights. Note: The BasicEffect shader only supports the first three. To handle more lights, you'll need to write your own shader.

6.2.4.18 NearClip

```
double Blotch.BlGraphicsDeviceManager.NearClip = 0
```

The near clipping plane, or 0 = autoclip.

6.2.4.19 Projection

```
Microsoft.Xna.Framework.Matrix Blotch.BlGraphicsDeviceManager.Projection
```

The Projection matrix. Normally you would use the higher-level functions Zoom, Aspect, NearClip, or FarClip intead of changing this directly.

6.2.4.20 SpriteBatch

```
SpriteBatch Blotch.BlGraphicsDeviceManager.SpriteBatch =null
```

A SpriteBatch for use by certain text and teture drawing methods.

6.2.4.21 TargetEye

```
Vector3 Blotch.BlGraphicsDeviceManager.TargetEye
```

The point that Eye migrates to, according to CameraSpeed. See Eye for more information.

6.2.4.22 TargetLookAt

```
Vector3 Blotch.BlGraphicsDeviceManager.TargetLookAt
```

The point that LookAt migrates to, according to CameraSpeed. See LookAt for more information.

6.2.4.23 View

```
Microsoft.Xna.Framework.Matrix Blotch.BlGraphicsDeviceManager.View
```

This is the view matrix. Normally you would use the higher-level functions Eye, LookAt, CameraUp, SetCameraToSprite, and DoDefaultGui intead of changing this directly.

6.2.4.24 Window

```
BlWindow3D Blotch.BlGraphicsDeviceManager.Window
```

The BlWindow3D associated with this object.

6.2.4.25 Zoom

```
double Blotch.BlGraphicsDeviceManager.Zoom =45
```

The field of view, in degrees.

6.2.5 Property Documentation

6.2.5.1 CameraForward

```
Vector3 Blotch.BlGraphicsDeviceManager.CameraForward [get]
```

The vector between Eye and LookAt. Writes to Eye and LookAt and calls to SetCameraToSprite cause this to be updated. Also see CameraForwardNormalized and CameraForwardMag.

6.2.5.2 CameraForwardMag

```
float Blotch.BlGraphicsDeviceManager.CameraForwardMag [get]
```

The magnitude of CameraForward. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated. Also see CameraForward and CameraForwardNormalized.

6.2.5.3 CameraForwardNormalized

```
Vector3 Blotch.BlGraphicsDeviceManager.CameraForwardNormalized  [get]
```

Normalized form of CameraForward. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated. Also see CameraForward and CameraForwardMag.

6.2.5.4 CameraRight

```
Vector3 Blotch.BlGraphicsDeviceManager.CameraRight  [get]
```

Camera Right vector. Writes to Eye and LookAt, and calls to SetCameraToSprite cause this to be updated.

6.2.5.5 CurrentAspect

```
double Blotch.BlGraphicsDeviceManager.CurrentAspect  [get]
```

Current aspect ratio. Same as Aspect unless Aspect==0.

6.2.5.6 CurrentFarClip

```
double Blotch.BlGraphicsDeviceManager.CurrentFarClip  [get]
```

Current value of far clipping plane. See FarClip.

6.2.5.7 CurrentNearClip

```
double Blotch.BlGraphicsDeviceManager.CurrentNearClip  [get]
```

Current value of near clipping plane. See NearClip.

6.2.5.8 Eye

```
Vector3 Blotch.BlGraphicsDeviceManager.Eye  [get]
```

The current camera position. Note: To change the camera position, set TargetEye. Also see CameraSpeed.

6.2.5.9 LookAt

```
Vector3 Blotch.BlGraphicsDeviceManager.LookAt  [get]
```

The current camera LookAt position. Note: To change the camera LookAt, set TargetLookAt. Also see CameraSpeed.

6.2.5.10 MaxCamDistance

```
double Blotch.BlGraphicsDeviceManager.MaxCamDistance  [get]
```

Distance to the farthest sprite, plus its radius. Note this is set to a very small number by PrepareDraw, and then as BlWindow3D::FrameDraw is called it is set more reasonably.

6.2.5.11 MinCamDistance

```
double Blotch.BlGraphicsDeviceManager.MinCamDistance  [get]
```

Distance to the nearest sprite, less its radius. Note this is set to a very large number by PrepareDraw, and then as BlWindow3D::FrameDraw is called it is set more reasonably.

The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlGraphicsDeviceManager.cs

6.3 Blotch.BlGuiControl Class Reference

A 2D GUI control. To create a GUI control: instantiate one of these, set its initial Texture (remember to create it in the 3D thread context), window position, and delegate, and then add it to BlWindow3D::GuiControls. (Any member can be dynamically changed.) The texture will be displayed, and then each frame the mouse is over it the delegate will be called. The delegate typically would examine the current mouse state (Mouse.GetState()) and the PrevMouseState member to detect button changes, etc. and perform an action. The delegate is called in the context of the window's 3D thread after the BlWindow3D::FrameProc method. You can use BlGraphicsDeviceManager::TextToTexture to create a textual textures, or just load a texture from a content file. Remember to Dispose textures when you are done with them.

Public Member Functions

- delegate void OnMouseChangeDelegate (BlGuiControl guiCtrl)

  Delegates for a BlGuiControl are of this type
- **BlGuiControl** (BlWindow3D window)
- bool HandleInput ()

  Periodically called by BlWindow3D. You shouldn't need to call this.

Public Attributes

- Texture2D Texture = null

  The texture to display for this control. Don't forget to dispose it when done.
- Vector2 Position = Vector2.Zero

  The pixel position in the BlWindow3D of this control
- OnMouseChangeDelegate OnMouseOver = null

  The delegate to call each frame (from the 3D thread) when the mouse is over the control. A typical delegate would make a decision according to PrevMouseState and the current mouse state (Mouse.GetState).
- MouseState PrevMouseState = new MouseState()

  The previous mouse state. A delegate typically uses this along with the current mouse state to make a decision.
- BlWindow3D Window = null

  The window this BlGuiControl is in.

6.3.1 Detailed Description

A 2D GUI control. To create a GUI control: instantiate one of these, set its initial Texture (remember to create it in the 3D thread context), window position, and delegate, and then add it to BlWindow3D::GuiControls. (Any member can be dynamically changed.) The texture will be displayed, and then each frame the mouse is over it the delegate will be called. The delegate typically would examine the current mouse state (Mouse.GetState()) and the PrevMouseState member to detect button changes, etc. and perform an action. The delegate is called in the context of the window's 3D thread after the BlWindow3D::FrameProc method. You can use BlGraphicsDeviceManager::TextToTexture to create a textual textures, or just load a texture from a content file. Remember to Dispose textures when you are done with them.

6.3.2 Member Function Documentation

6.3.2.1 HandleInput()

```
bool Blotch.BlGuiControl.HandleInput ( )
```

Periodically called by BlWindow3D. You shouldn't need to call this.

Returns

True if mouse is over any control, false otherwise.

6.3.2.2 OnMouseChangeDelegate()

```
delegate void Blotch.BlGuiControl.OnMouseChangeDelegate (
            BlGuiControl guiCtrl )
```

Delegates for a BlGuiControl are of this type

Parameters

guiCtrl	

6.3.3 Member Data Documentation

6.3.3.1 OnMouseOver

```
OnMouseChangeDelegate Blotch.BlGuiControl.OnMouseOver = null
```

The delegate to call each frame (from the 3D thread) when the mouse is over the control. A typical delegate would make a decision according to PrevMouseState and the current mouse state (Mouse.GetState).

6.3.3.2 Position

```
Vector2 Blotch.BlGuiControl.Position = Vector2.Zero
```

The pixel position in the BlWindow3D of this control

6.3.3.3 PrevMouseState

```
MouseState Blotch.BlGuiControl.PrevMouseState = new MouseState()
```

The previous mouse state. A delegate typically uses this along with the current mouse state to make a decision.

6.3.3.4 Texture

```
Texture2D Blotch.BlGuiControl.Texture = null
```

The texture to display for this control. Don't forget to dispose it when done.

6.3.3.5 Window

```
BlWindow3D Blotch.BlGuiControl.Window = null
```

The window this BlGuiControl is in.

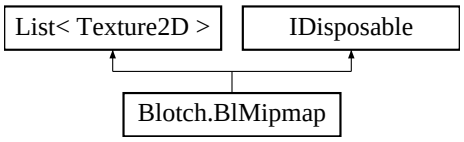
The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlGuiControl.cs

6.4 Blotch.BlMipmap Class Reference

A mipmap of textures for a given BlSprite. You could load this from an image file and then assign it to a BlSprite::Mipmap. Note that this is a software mipmap (i.e. it isn't implemented in the 3D hardware). That is, only one resolution texture is used at time.

Inheritance diagram for Blotch.BlMipmap:



Public Member Functions

- BlMipmap (BlGraphicsDeviceManager graphics, Texture2D tex, int numMaps=999, bool reverseX=false, bool reverseY=false)

  Creates the mipmaps.
- void Dispose ()

  When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

Public Attributes

- bool IsDisposed = false

  Set when the object is Disposed.

6.4.1 Detailed Description

A mipmap of textures for a given BlSprite. You could load this from an image file and then assign it to a BlSprite::Mipmap. Note that this is a software mipmap (i.e. it isn't implemented in the 3D hardware). That is, only one resolution texture is used at time.

6.4.2 Constructor & Destructor Documentation

6.4.2.1 BlMipmap()

```
Blotch.BlMipmap.BlMipmap (
            BlGraphicsDeviceManager graphics,
            Texture2D tex,
            int numMaps = 999,
            bool reverseX = false,
            bool reverseY = false )
```

Creates the mipmaps.

Parameters

graphics	Graphics device (typically the one owned by your BlWindow3D)
tex	Texture from which to create mipmaps, typically gotten from BlGraphics::LoadFromImageFile.
numMaps	Maximum number of mipmaps to create (none are created with lower resolution than 16x16)
reverseX	Whether to reverse pixels horizontally
reverseY	Whether to reverse pixels vertically

6.4.3 Member Function Documentation

6.4.3.1 Dispose()

```
void Blotch.BlMipmap.Dispose ( )
```

When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

6.4.4 Member Data Documentation

6.4.4.1 IsDisposed

```
bool Blotch.BlMipmap.IsDisposed = false
```

Set when the object is Disposed.

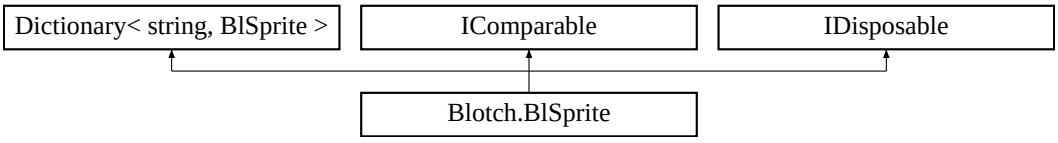
The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlMipmap.cs

6.5 Blotch.BlSprite Class Reference

A BlSprite is a single 3D object. Each sprite can also hold any number of subsprites, so you can make a sprite tree (a scene graph). In that case the child sprites 'follow' the orientation and position of the parent sprite. That is, they exist in the coordinate system of the parent sprite. The location and orientation of a sprite in its parent's coordinate system is defined by the sprite's Matrix member. Subsprites, LODs, and Mipmap are NOT disposed when the sprite is disposed, so you can assign the same one to multiple sprites.

Inheritance diagram for Blotch.BlSprite:



Public Types

- enum PreDrawCmd { PreDrawCmd.Continue, PreDrawCmd.Abort, PreDrawCmd.UseCurrentAbsoluteMatrix }

  Return code from PreDraw callback. This tells Draw what to do next.
- enum PreSubspritesCmd { PreSubspritesCmd.Continue, PreSubspritesCmd.Abort, PreSubspritesCmd.DontDrawSubsprites }

  Return code from PreSubsprites callback. This tells Draw what to do next.
- enum SetEffectCmd { SetEffectCmd.Continue, SetEffectCmd.Abort, SetEffectCmd.Skip }

  Return code from PreSubsprites callback. This tells Draw what to do next.
- enum PreLocalCmd { PreLocalCmd.Continue, PreLocalCmd.Abort }

  Return code from PreSubsprites callback. This tells Draw what to do next.

Public Member Functions

- delegate void FrameProcType (BlSprite sprite)

  See #FrameProc
- void ExecuteFrameProc ()

  Execute the FrameProc, if it was specified in the BlSprite constructor. (Normally you wouldn't need to call this because its automatically called by the BlWindow.)
- delegate PreDrawCmd PreDrawType (BlSprite sprite)

  See PreDraw
- delegate PreSubspritesCmd PreSubspritesType (BlSprite sprite)

  See PreSubsprites
- delegate Effect SetMeshEffectType (BlSprite sprite, Effect effect)

  See #SetMeshEffect
- delegate PreLocalCmd PreLocalType (BlSprite sprite)

  See PreLocal
- delegate void DrawCleanupType (BlSprite sprite)

  See DrawCleanup
- BlSprite (BlGraphicsDeviceManager graphicsIn, string name, FrameProcType frameProc=null)

  Constructs a sprite
- void Add (BlSprite s)

  Add a subsprite. (A BlSprite inherits from a Dictionary of BlSprites. This wrapper method to the dictionary's Add method simply adds the sprite where the key is the sprite's Name.)
- Vector2 GetViewCoords ()

  Returns the current view coordinates of the sprite (for passing to DrawText, for example), or null if it's behind the camera.
- void SetAllMaterialBlack ()

  Sets all material colors to black.
- double DoesRayIntersect (Ray ray)

  Returns the distance along the ray to the first point the ray enters the bounding sphere (BoundSphere), or null if it doesn't enter the sphere.
- List< BlSprite > GetRayIntersections (Ray ray, ulong flags=0xFFFFFFFFFFFFFFFF, List< BlSprite > sprites=null)

  Returns a list of subsprites that the ray hit (i.e. those that were within their radius of the ray)
- void Draw (Matrix? worldMatrixIn=null, ulong flagsIn=0xFFFFFFFFFFFFFFFF)

  Draws the sprite and the subsprites.
- Texture2D **GetMipmapLod** ()
- void SetupBasicEffect (BasicEffect effect)

Sets up in the specified BasicEffect all matrices and lighting parameters for this sprite. BlSprite::DrawInternal calls this for the BasicEffects embedded in the LOD models. App code might call this from a SetEffect delegate if, for example, it is using a modified form of the stock BasicEffect.fx, like the Blotch3D's BasicEffectWithAlphaTest.

- void SetupBasicEffect (BlBasicEffect effect)

  Sets up in the specified BlBasicEffect with all matrices and lighting parameters for this sprite. App code might call this from a SetEffect delegate if, for example, it is using one of the BlBasicEffectxxx effects, like the BasicEffectWithAlphaTest.
- override string **ToString** ()
- int CompareTo (object obj)

  This makes a Sort operation sort sprites far to near. That is, the nearer sprites are later in the list. For sorting near to far, use something like myList.Sort(new Comparison<EsSprite>((b, a) => a.CompareTo(b)));
- void Dispose ()

  When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

Static Public Member Functions

- static Vector3 NearestPointOnLine (Vector3 point1, Vector3 point2, Vector3 nearPoint)

  Returns the point on the line between point1 and point2 that is nearest to nearPoint

Public Attributes

- ulong Flags = 0xFFFFFFFFFFFFFFFF

  The Flags field can be used by callbacks of Draw (PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect) to indicate various user attributes of the sprite. Also, GetRayIntersections won't hit if the bitwise AND of this value and the flags argument passed to it is zero.
- List< object > LODs = new List<object>()

  The objects (levels of detail) to draw for this sprite. Only one element is drawn depending on the ApparentSize. Each element can be a Model, a triangle list (VertexPositionNormalTexture[]), or null (indicating nothing should be drawn). Elements with lower indices are higher LODs. So index 0 has the highest detail, index 1 is second highest, etc. LOD decreases (the index increases) for every halving of the object's apparent size. You can adjust how close the LODs must be to the camera with LodScale. When the calculated LOD index is higher than the last element, then the last element is used. So the simplest way to use this is to add a single object to the list. You can add multiple references of the same object so multiple consecutive LODs draw the same object. You can set an element to null so it doesn't draw anything, which is typically the last element. A model can be assigned to multiple sprites. These are NOT disposed when the sprite is disposed.
- double LodScale = 9

  Defines the LOD scaling. The higher this value, the closer you must be to see a given LOD. A value of 9 (default) indicates that the highest LOD (LODs[0]) occurs when an object with a diameter of 1 roughly fills the window. Set to a large negative value, like -1000, to disable LODs (i.e. always use the highest resolution LOD).
- BlMipmap Mipmap = null

  Mipmap textures to apply to the model. These work the same as LODs (see LODs for more information). The texture used depends on the apparent size of the model. The next higher mipmap is used for every doubling of model size, where element zero is the highest resolution, used when the apparent size is largest. If a mipmap is not available for the apparent size, the next higher available on is used. So, for example, you can specify only one texture to be used as all mipmaps if you like. Note that for a texture to display, the model must include texture coordinates. It must also include normals if lighting other than 'emissive' is desired. Most graphics subsystems do support mipmaps, but these are software mipmaps, so only one image is used over a model for a given model apparent size rather than nearer portions of the model showing higher-level mipmaps. These are NOT disposed when the sprite is disposed, so a given BlMipmap may be assigned to multiple sprites.
- double MipmapScale = 5

  Defines the mipmap (Textures) scaling. The higher this value, the closer you must be to see a given mipmap. Set to a large negative value, like -1000, to disable mipmaps (i.e. always use the highest resolution mipmap).

- BoundingSphere BoundSphere = null

  The bounding sphere for this sprite. This is automatically updated when a model is drawn, but not if vertices are drawn. In that case you should set/update it explicitly if any of the internal functions may need it to be roughly correct, like if auto-clipping is enabled or a mouse selection or ray may hit the sprite and the hit be properly detected.

- bool SphericalBillboard = false

  Spherically billboard the model. Specifically, keep the model's 'forward' direction pointing at the camera and keep its 'Up' direction pointing in the same direction as the camera's 'Up' direction. Also see CylindricalBillboardX, CylindricalBillboardY, CylindricalBillboardZ, and ConstSize.

- Vector3 CylindricalBillboardX = Vector3.Zero

  If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the X axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardY, CylindricalBillboardZ, and ConstSize.

- Vector3 CylindricalBillboardY = Vector3.Zero

  If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the Y axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardX, CylindricalBillboardZ, and ConstSize.

- Vector3 CylindricalBillboardZ = Vector3.Zero

  If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the Z axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardX, CylindricalBillboardY, and ConstSize.

- bool ConstSize = false

  If true, maintain a constant apparent size for the sprite regardless of camera distance or zoom. This is typically used along with one of the Billboarding effects (see SphericalBillboard, CylindricalBillboardX, etc.). Note that if ConstSize is true, ApparentSize, LodScale, and MipmapScale still act as if it is false, and therefore in that case you may want to disable them (set them to large negative values. If both ConstSize and any Billboarding is enabled and you have asymmetric scaling (different scaling for each dimension), then you'll need to separate those operations into different levels of the sprite tree to obtain the desired behavior. You'll also probably want to disable the depth stencil buffer and control which sprite is drawn first so that certain sprites are 'always on top'. See the examples.

- Matrix AbsoluteMatrix = Matrix.Identity

  The Draw method takes an incoming 'world' matrix parameter which is the coordinate system of its parent. AbsoluteMatrix is that incoming world matrix parameter times the Matrix member and altered according to Billboarding and ConstSize. This is not read-only because a callback (see PreDraw, PreSubsprites, PreLocal, and #SetMesh↩ Effect) may need to change it from within the Draw method. This is the matrix that is also passed to subsprites as their 'world' matrix.

- Matrix Matrix = Matrix.Identity

  The matrix for this sprite. This defines the sprite's orientation and position relative to the parent coordinate system. For more detailed information, see AbsoluteMatrix.

- BIGraphicsDeviceManager Graphics = null

  Current incoming graphics parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

- Matrix LastWorldMatrix = null

  Current incoming world matrix parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

- bool IncludeInAutoClipping = true

  Whether to use depth testing, and whether to participate in autoclipping calculations when they are enabled.

- ulong FlagsParameter = 0

  Current incoming flags parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

- Vector3 Color = new Vector3(.5f, .5f, 1)

  The color of the material. This is lit by both diffuse and ambient light. If null, MonoGame's default color is kept.

- Vector3 EmissiveColor = new Vector3(.1f, .1f, .2f)

The emissive color. If null, MonoGame's default is kept.

- Vector3 SpecularColor = null

  The specular color. If null, MonoGame's default is kept.

- float SpecularPower = 8

  If a specular color is specified, this is the specular power.

- PreDrawType PreDraw = null

  If not null, Draw method calls this at the beginning before doing anything else. From this function one might examine and/or alter any public writable BlSprite field, and/or control the further execution of the Draw method.

- PreSubspritesType PreSubsprites = null

  If not null, Draw method calls this after the matrix calculations for AbsoluteMatrix (including billboards, CamDistance, ConstSize, etc.) but before drawing the subsprites or local model. From this function one might examine and/or alter any public writable BlSprite field.

- SetMeshEffectType SetEffect = null

  If this not null, then the Draw method executes this delegate for each model mesh effect instead using the default BasicEffects. See the SpriteAlphaTexture for an example. The return value is the new or altered effect. If this is called when the thing to draw is a VertexPositionNormalTexture, then the effect parameter passed in is a null.

- PreLocalType PreLocal = null

  If not null, Draw method calls this after drawing subsprites (if appropriate) but before drawing the local model. From this function one might examine and/or alter any public writable BlSprite field, and/or abort the Draw method.

- DrawCleanupType DrawCleanup = null

  If not null, Draw method calls this at the end.

- string Name

  The name of the BlSprite

- bool IsDisposed = false

  Set when the object is Disposed.

Properties

- double ApparentSize `[get]`

  This is proportional to the apparent 2D size of the sprite. (Calculated from the last Draw operation that occurred, but before any effect of ConstSize)

- double LodTarget `[get]`

  This read-only value is the log of the reciprocal of ApparentSize. It is used in the calculation of the LOD and the mipmap level. See LODs and Mipmap for more information.

- double CamDistance `[get]`

  Distance to the camera.

6.5.1 Detailed Description

A BlSprite is a single 3D object. Each sprite can also hold any number of subsprites, so you can make a sprite tree (a scene graph). In that case the child sprites 'follow' the orientation and position of the parent sprite. That is, they exist in the coordinate system of the parent sprite. The location and orientation of a sprite in its parent's coordinate system is defined by the sprite's Matrix member. Subsprites, LODs, and Mipmap are NOT disposed when the sprite is disposed, so you can assign the same one to multiple sprites.

6.5.2 Member Enumeration Documentation

6.5.2.1 PreDrawCmd

`enum Blotch.BlSprite.PreDrawCmd [strong]`

Return code from PreDraw callback. This tells Draw what to do next.

Enumerator

Continue	Continue Draw method execution
Abort	Draw should immediately return
UseCurrentAbsoluteMatrix	Continue Draw method execution, but don't bother re-calculating AbsoluteMatrix. One would typically return this if, for example, its known that AbsoluteMatrix will not change from its current value because the Draw parameters will be the same as they were the last time Draw was called. This happens, for example, when multiple calls are being made in the same draw iteration for graphic operations that require multiple passes.

6.5.2.2 PreLocalCmd

`enum Blotch.BlSprite.PreLocalCmd [strong]`

Return code from PreSubsprites callback. This tells Draw what to do next.

Enumerator

Continue	Continue Draw method execution
Abort	Draw should immediately return

6.5.2.3 PreSubspritesCmd

`enum Blotch.BlSprite.PreSubspritesCmd [strong]`

Return code from PreSubsprites callback. This tells Draw what to do next.

Enumerator

Continue	Continue Draw method execution
Abort	Draw should immediately return
DontDrawSubsprites	Skip drawing subsprites

6.5.2.4 SetEffectCmd

`enum Blotch.BlSprite.SetEffectCmd [strong]`

Return code from PreSubsprites callback. This tells Draw what to do next.

Enumerator

Continue	Continue Draw method execution for the mesh
Abort	Draw should immediately return
Skip	Draw should skip the current mesh

6.5.3 Constructor & Destructor Documentation

6.5.3.1 BlSprite()

```
Blotch.BlSprite.BlSprite (
            BlGraphicsDeviceManager graphicsIn,
            string name,
            FrameProcType frameProc = null )
```

Constructs a sprite

Parameters

graphics↩ In	The BlGraphicsDeviceManager that operates on this sprite
name	The name of the sprite (must be unique among other sprites in the same subsprite list)
frameProc	The delegate to run every frame

6.5.4 Member Function Documentation

6.5.4.1 Add()

```
void Blotch.BlSprite.Add (
            BlSprite s )
```

Add a subsprite. (A BlSprite inherits from a Dictionary of BlSprites. This wrapper method to the dictionary's Add method simply adds the sprite where the key is the sprite's Name.)

Parameters

s	

6.5.4.2 CompareTo()

```
int Blotch.BlSprite.CompareTo (
            object obj )
```

This makes a Sort operation sort sprites far to near. That is, the nearer sprites are later in the list. For sorting near to far, use something like myList.Sort(new Comparison<EsSprite>((b, a) => a.CompareTo(b)));

Parameters

obj	

Returns

6.5.4.3 Dispose()

```
void Blotch.BlSprite.Dispose ( )
```

When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

6.5.4.4 DoesRayIntersect()

```
double Blotch.BlSprite.DoesRayIntersect (
            Ray ray )
```

Returns the distance along the ray to the first point the ray enters the bounding sphere (BoundSphere), or null if it doesn't enter the sphere.

Parameters

ray	

Returns

How far along the ray till the first intersection, or null oif it didn't intersect

6.5.4.5 Draw()

```
void Blotch.BlSprite.Draw (
            Matrix?  worldMatrixIn = null,
            ulong flagsIn = 0xFFFFFFFFFFFFFFFF )
```

Draws the sprite and the subsprites.

Parameters

worldMatrixIn	Defines the position and orientation of the sprite
flagsIn	Copied to LastFlags for use by any callback of Draw (PreDraw, PreSubspriteDraw, PreLocalDraw, and SetMeshEffect) that wants it

6.5.4.6 DrawCleanupType()

```
delegate void Blotch.BlSprite.DrawCleanupType (
            BlSprite sprite )
```

See DrawCleanup

Parameters

sprite	

6.5.4.7 ExecuteFrameProc()

```
void Blotch.BlSprite.ExecuteFrameProc ( )
```

Execute the FrameProc, if it was specified in the BlSprite constructor. (Normally you wouldn't need to call this because its automatically called by the BlWindow.)

6.5.4.8 FrameProcType()

```
delegate void Blotch.BlSprite.FrameProcType (
            BlSprite sprite )
```

See #FrameProc

Parameters

sprite	

6.5.4.9 GetRayIntersections()

```
List<BlSprite> Blotch.BlSprite.GetRayIntersections (
            Ray ray,
            ulong flags = 0xFFFFFFFFFFFFFFFF,
            List< BlSprite > sprites = null )
```

Returns a list of subsprites that the ray hit (i.e. those that were within their radius of the ray)

Parameters

ray	The ray we are searching
flags	Check for a hit only if flags & BlSprite::Flags is non-zero
sprites	An existing sprite list to load. If null, then this allocates a new sprite list.

Returns

A list of subsprites that the ray hit

6.5.4.10 GetViewCoords()

```
Vector2 Blotch.BlSprite.GetViewCoords ( )
```

Returns the current view coordinates of the sprite (for passing to DrawText, for example), or null if it's behind the camera.

Returns

The view coords of the sprite

6.5.4.11 NearestPointOnLine()

```
static Vector3 Blotch.BlSprite.NearestPointOnLine (
            Vector3 point1,
            Vector3 point2,
            Vector3 nearPoint )  [static]
```

Returns the point on the line between point1 and point2 that is nearest to nearPoint

Parameters

point1	
point2	
nearPoint	

Returns

Point on the line nearest to nearPoint

6.5.4.12 PreDrawType()

```
delegate PreDrawCmd Blotch.BlSprite.PreDrawType (
            BlSprite sprite )
```

See PreDraw

Parameters

sprite	

Returns

6.5.4.13 PreLocalType()

```
delegate PreLocalCmd Blotch.BlSprite.PreLocalType (
            BlSprite sprite )
```

See PreLocal

Parameters

sprite	

Returns

6.5.4.14 PreSubspritesType()

```
delegate PreSubspritesCmd Blotch.BlSprite.PreSubspritesType (
            BlSprite sprite )
```

See PreSubsprites

Parameters

sprite	

Returns

6.5.4.15 SetAllMaterialBlack()

```
void Blotch.BlSprite.SetAllMaterialBlack ( )
```

Sets all material colors to black.

6.5.4.16 SetMeshEffectType()

```
delegate Effect Blotch.BlSprite.SetMeshEffectType (
            BlSprite sprite,
            Effect effect )
```

See #SetMeshEffect

Parameters

sprite	
effect	

Returns

6.5.4.17 SetupBasicEffect() [1/2]

```
void Blotch.BlSprite.SetupBasicEffect (
            BasicEffect effect )
```

Sets up in the specified BasicEffect all matrices and lighting parameters for this sprite. BlSprite::DrawInternal calls this for the BasicEffects embedded in the LOD models. App code might call this from a SetEffect delegate if, for example, it is using a modified form of the stock BasicEffect.fx, like the Blotch3D's BasicEffectWithAlphaTest.

6.5.4.18 SetupBasicEffect() [2/2]

```
void Blotch.BlSprite.SetupBasicEffect (
            BlBasicEffect effect )
```

Sets up in the specified BlBasicEffect with all matrices and lighting parameters for this sprite. App code might call this from a SetEffect delegate if, for example, it is using one of the BlBasicEffectxxx effects, like the BasicEffect↩ WithAlphaTest.

6.5.5 Member Data Documentation

6.5.5.1 AbsoluteMatrix

```
Matrix Blotch.BlSprite.AbsoluteMatrix = Matrix.Identity
```

The Draw method takes an incoming 'world' matrix parameter which is the coordinate system of its parent. AbsoluteMatrix is that incoming world matrix parameter times the Matrix member and altered according to Billboarding and ConstSize. This is not read-only because a callback (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect) may need to change it from within the Draw method. This is the matrix that is also passed to subsprites as their 'world' matrix.

6.5.5.2 BoundSphere

```
BoundingSphere Blotch.BlSprite.BoundSphere = null
```

The bounding sphere for this sprite. This is automatically updated when a model is drawn, but not if vertices are drawn. In that case you should set/update it explicitly if any of the internal functions may need it to be roughly correct, like if auto-clipping is enabled or a mouse selection or ray may hit the sprite and the hit be properly detected.

6.5.5.3 Color

```
Vector3 Blotch.BlSprite.Color = new Vector3(.5f, .5f, 1)
```

The color of the material. This is lit by both diffuse and ambient light. If null, MonoGame's default color is kept.

6.5.5.4 ConstSize

```
bool Blotch.BlSprite.ConstSize = false
```

If true, maintain a constant apparent size for the sprite regardless of camera distance or zoom. This is typically used along with one of the Billboarding effects (see SphericalBillboard, CylindricalBillboardX, etc.). Note that if ConstSize is true, ApparentSize, LodScale, and MipmapScale still act as if it is false, and therefore in that case you may want to disable them (set them to large negative values. If both ConstSize and any Billboarding is enabled and you have asymmetric scaling (different scaling for each dimension), then you'll need to separate those operations into different levels of the sprite tree to obtain the desired behavior. You'll also probably want to disable the depth stencil buffer and control which sprite is drawn first so that certain sprites are 'always on top'. See the examples.

6.5.5.5 CylindricalBillboardX

```
Vector3 Blotch.BlSprite.CylindricalBillboardX = Vector3.Zero
```

If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the X axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardY, CylindricalBillboardZ, and ConstSize.

6.5.5.6 CylindricalBillboardY

```
Vector3 Blotch.BlSprite.CylindricalBillboardY = Vector3.Zero
```

If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the Y axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardX, CylindricalBillboardZ, and ConstSize.

6.5.5.7 CylindricalBillboardZ

```
Vector3 Blotch.BlSprite.CylindricalBillboardZ = Vector3.Zero
```

If non-zero, this is the rotation vector and magnitude of cylindrical billboarding where the angle calculation assumes this vector is the Z axis, even though it may not be. The more this varies from that axis, the more eccentric the billboarding behavior. The amount of billboarding is equal to: 2∗mag^2 - 1/mag^2. So if this vector's magnitude is unity (1), then full cylindrical billboarding occurs. A vector magnitude of 0.605 produces double reverse cylindrical billboarding. Also see SphericalBillboard, CylindricalBillboardX, CylindricalBillboardY, and ConstSize.

6.5.5.8 DrawCleanup

```
DrawCleanupType Blotch.BlSprite.DrawCleanup = null
```

If not null, Draw method calls this at the end.

6.5.5.9 EmissiveColor

```
Vector3 Blotch.BlSprite.EmissiveColor = new Vector3(.1f, .1f, .2f)
```

The emissive color. If null, MonoGame's default is kept.

6.5.5.10 Flags

```
ulong Blotch.BlSprite.Flags = 0xFFFFFFFFFFFFFFFF
```

The Flags field can be used by callbacks of Draw (PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect) to indicate various user attributes of the sprite. Also, GetRayIntersections won't hit if the bitwise AND of this value and the flags argument passed to it is zero.

6.5.5.11 FlagsParameter

```
ulong Blotch.BlSprite.FlagsParameter = 0
```

Current incoming flags parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

6.5.5.12 Graphics

```
BlGraphicsDeviceManager Blotch.BlSprite.Graphics = null
```

Current incoming graphics parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

6.5.5.13 IncludeInAutoClipping

```
bool Blotch.BlSprite.IncludeInAutoClipping = true
```

Whether to use depth testing, and whether to participate in autoclipping calculations when they are enabled.

6.5.5.14 IsDisposed

```
bool Blotch.BlSprite.IsDisposed = false
```

Set when the object is Disposed.

6.5.5.15 LastWorldMatrix

```
Matrix Blotch.BlSprite.LastWorldMatrix = null
```

Current incoming world matrix parameter to the Draw method. Typically this would be of interest to a callback function (see PreDraw, PreSubsprites, PreLocal, and #SetMeshEffect).

6.5.5.16 LODs

```
List<object> Blotch.BlSprite.LODs = new List<object>()
```

The objects (levels of detail) to draw for this sprite. Only one element is drawn depending on the ApparentSize. Each element can be a Model, a triangle list (VertexPositionNormalTexture[]), or null (indicating nothing should be drawn). Elements with lower indices are higher LODs. So index 0 has the highest detail, index 1 is second highest, etc. LOD decreases (the index increases) for every halving of the object's apparent size. You can adjust how close the LODs must be to the camera with LodScale. When the calculated LOD index is higher than the last element, then the last element is used. So the simplest way to use this is to add a single object to the list. You can add multiple references of the same object so multiple consecutive LODs draw the same object. You can set an element to null so it doesn't draw anything, which is typically the last element. A model can be assigned to multiple sprites. These are NOT disposed when the sprite is disposed.

6.5.5.17 LodScale

```
double Blotch.BlSprite.LodScale = 9
```

Defines the LOD scaling. The higher this value, the closer you must be to see a given LOD. A value of 9 (default) indicates that the highest LOD (LODs[0]) occurs when an object with a diameter of 1 roughly fills the window. Set to a large negative value, like -1000, to disable LODs (i.e. always use the highest resolution LOD).

6.5.5.18 Matrix

```
Matrix Blotch.BlSprite.Matrix = Matrix.Identity
```

The matrix for this sprite. This defines the sprite's orientation and position relative to the parent coordinate system. For more detailed information, see AbsoluteMatrix.

6.5.5.19 Mipmap

```
BlMipmap Blotch.BlSprite.Mipmap = null
```

Mipmap textures to apply to the model. These work the same as LODs (see LODs for more information). The texture used depends on the apparent size of the model. The next higher mipmap is used for every doubling of model size, where element zero is the highest resolution, used when the apparent size is largest. If a mipmap is not available for the apparent size, the next higher available on is used. So, for example, you can specify only one texture to be used as all mipmaps if you like. Note that for a texture to display, the model must include texture coordinates. It must also include normals if lighting other than 'emissive' is desired. Most graphics subsystems do support mipmaps, but these are software mipmaps, so only one image is used over a model for a given model apparent size rather than nearer portions of the model showing higher-level mipmaps. These are NOT disposed when the sprite is disposed, so a given BlMipmap may be assigned to multiple sprites.

6.5.5.20 MipmapScale

```
double Blotch.BlSprite.MipmapScale = 5
```

Defines the mipmap (Textures) scaling. The higher this value, the closer you must be to see a given mipmap. Set to a large negative value, like -1000, to disable mipmaps (i.e. always use the highest resolution mipmap).

6.5.5.21 Name

```
string Blotch.BlSprite.Name
```

The name of the BlSprite

6.5.5.22 PreDraw

```
PreDrawType Blotch.BlSprite.PreDraw = null
```

If not null, Draw method calls this at the beginning before doing anything else. From this function one might examine and/or alter any public writable BlSprite field, and/or control the further execution of the Draw method.

6.5.5.23 PreLocal

```
PreLocalType Blotch.BlSprite.PreLocal = null
```

If not null, Draw method calls this after drawing subsprites (if appropriate) but before drawing the local model. From this function one might examine and/or alter any public writable BlSprite field, and/or abort the Draw method.

6.5.5.24 PreSubsprites

```
PreSubspritesType Blotch.BlSprite.PreSubsprites = null
```

If not null, Draw method calls this after the matrix calculations for AbsoluteMatrix (including billboards, CamDistance, ConstSize, etc.) but before drawing the subsprites or local model. From this function one might examine and/or alter any public writable BlSprite field.

6.5.5.25 SetEffect

```
SetMeshEffectType Blotch.BlSprite.SetEffect = null
```

If this not null, then the Draw method executes this delegate for each model mesh effect instead using the default BasicEffects. See the SpriteAlphaTexture for an example. The return value is the new or altered effect. If this is called when the thing to draw is a VertexPositionNormalTexture, then the effect parameter passed in is a null.

6.5.5.26 SpecularColor

```
Vector3 Blotch.BlSprite.SpecularColor = null
```

The specular color. If null, MonoGame's default is kept.

6.5.5.27 SpecularPower

```
float Blotch.BlSprite.SpecularPower = 8
```

If a specular color is specified, this is the specular power.

6.5.5.28 SphericalBillboard

```
bool Blotch.BlSprite.SphericalBillboard = false
```

Spherically billboard the model. Specifically, keep the model's 'forward' direction pointing at the camera and keep its 'Up' direction pointing in the same direction as the camera's 'Up' direction. Also see CylindricalBillboardX, CylindricalBillboardY, CylindricalBillboardZ, and ConstSize.

6.5.6 Property Documentation

6.5.6.1 ApparentSize

```
double Blotch.BlSprite.ApparentSize  [get]
```

This is proportional to the apparent 2D size of the sprite. (Calculated from the last Draw operation that occurred, but before any effect of ConstSize)

6.5.6.2 CamDistance

```
double Blotch.BlSprite.CamDistance  [get]
```

Distance to the camera.

6.5.6.3 LodTarget

```
double Blotch.BlSprite.LodTarget  [get]
```

This read-only value is the log of the reciprocal of ApparentSize. It is used in the calculation of the LOD and the mipmap level. See LODs and Mipmap for more information.

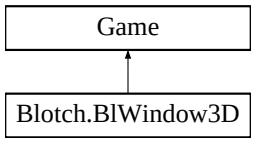
The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlSprite.cs

6.6 Blotch.BlWindow3D Class Reference

To make a 3D window, you must derive a class from BlWindow3D and override the Setup, FrameProc, and FrameDraw methods. When it comes time to open the 3D window, you instantiate that class and call its "Run" method from the same thread that instantiated it. The Run method will call the Setup, FrameProc, and FrameDraw methods when appropriate, and not return until the window closes. All code that accesses 3D resources must be done in that thread, including code that creates and uses all Blotch3D and MonoGame objects. Note that this rule also applies to any code structure that may internally use other threads, as well. Do not use Parallel, async, etc. code structures that access 3D resources. Other threads that need to access 3D resources can do so by passing a delegate to EnqueueCommand and EnqueueCommandBlocking.

Inheritance diagram for Blotch.BlWindow3D:



Public Member Functions

- delegate void Command (BlWindow3D win)

  See EnqueueCommand, EnqueueCommandBlocking, and BlWindow3D for more info
- BlWindow3D ()

  See BlWindow3D for details.
- void EnqueueCommand (Command cmd)

  Since all operations accessing 3D resources must be done by the 3D thread, this allows other threads to send commands to execute in the 3D thread. For example, you might need another thread to be able to create, move, and delete BlSprites. You can also use this for general thread safety of various operations. This method does not block. Also see BlWindow3D and the (blocking) EnqueueCommandBlocking for more details.
- void EnqueueCommandBlocking (Command cmd)

  Since all operations accessing 3D resources must be done by the 3D thread, this allows other threads to send commands to execute in the 3D thread. For example, you might need another thread to be able to create, move, and delete BlSprites. You can also use this for general thread safety of various operations. This method blocks until the command has executed. Also see BlWindow3D and the (non-blocking) EnqueueCommand for more details.
- void FrameProcSpritesAdd (BlSprite s)

  Used internally
- void FrameProcSpritesRemove (BlSprite s)

  Used internally
- new void Dispose ()

  When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

Public Attributes

- BlGraphicsDeviceManager Graphics

  The BlGraphicsDeviceManager associated with this window. This is automatically created when you create the BlWindow3D.
- ConcurrentDictionary< string, BlGuiControl > GuiControls = new ConcurrentDictionary<string, BlGuiControl>()

  The GUI controls for this window. See BlGuiControl for details.
- bool IsDisposed = false

  Set when the object is Disposed.

Protected Member Functions

- override void Initialize ()

  Used internally, Do NOT override. Use Setup instead.
- override void LoadContent ()

  Used internally, Do NOT override. Use Setup instead.
- virtual void Setup ()

  Override this and put all initialization and global content creation code in it. See BlWindow3D for details.
- override void Update (GameTime timeInfo)

  Used internally, Do NOT override. Use FrameProc instead.
- virtual void FrameProc (GameTime timeInfo)

  See BlWindow3D for details.
- override void Draw (GameTime timeInfo)

  Used internally, Do NOT override. Use FrameDraw instead.
- virtual void FrameDraw (GameTime timeInfo)

  See BlWindow3D for details.

6.6.1 Detailed Description

To make a 3D window, you must derive a class from BlWindow3D and override the Setup, FrameProc, and FrameDraw methods. When it comes time to open the 3D window, you instantiate that class and call its "Run" method from the same thread that instantiated it. The Run method will call the Setup, FrameProc, and FrameDraw methods when appropriate, and not return until the window closes. All code that accesses 3D resources must be done in that thread, including code that creates and uses all Blotch3D and MonoGame objects. Note that this rule also applies to any code structure that may internally use other threads, as well. Do not use Parallel, async, etc. code structures that access 3D resources. Other threads that need to access 3D resources can do so by passing a delegate to EnqueueCommand and EnqueueCommandBlocking.

6.6.2 Constructor & Destructor Documentation

6.6.2.1 BlWindow3D()

```
Blotch.BlWindow3D.BlWindow3D ( )
```

See BlWindow3D for details.

6.6.3 Member Function Documentation

6.6.3.1 Command()

```
delegate void Blotch.BlWindow3D.Command (
            BlWindow3D win )
```

See EnqueueCommand, EnqueueCommandBlocking, and BlWindow3D for more info

Parameters

win	The BlWindow3D object

6.6.3.2 Dispose()

```
new void Blotch.BlWindow3D.Dispose ( )
```

When finished with the object, you should call Dispose() from the same thread that created the object. You can call this multiple times, but once is enough. If it isn't called before the object becomes inaccessible, then the destructor will call it and, if BlDebug.EnableDisposeErrors is true (it is true by default for Debug builds), then it will get an exception saying that it wasn't called by the same thread that created it. This is because the platform's underlying 3D library (OpenGL, etc.) often requires 3D resources to be managed only by one thread.

6.6.3.3 Draw()

```
override void Blotch.BlWindow3D.Draw (
            GameTime timeInfo )  [protected]
```

Used internally, Do NOT override. Use FrameDraw instead.

Parameters

timeInfo	

6.6.3.4 EnqueueCommand()

```
void Blotch.BlWindow3D.EnqueueCommand (
            Command cmd )
```

Since all operations accessing 3D resources must be done by the 3D thread, this allows other threads to send commands to execute in the 3D thread. For example, you might need another thread to be able to create, move, and delete BlSprites. You can also use this for general thread safety of various operations. This method does not block. Also see BlWindow3D and the (blocking) EnqueueCommandBlocking for more details.

Parameters

cmd	

6.6.3.5 EnqueueCommandBlocking()

```
void Blotch.BlWindow3D.EnqueueCommandBlocking (
            Command cmd )
```

Since all operations accessing 3D resources must be done by the 3D thread, this allows other threads to send commands to execute in the 3D thread. For example, you might need another thread to be able to create, move, and delete BlSprites. You can also use this for general thread safety of various operations. This method blocks until the command has executed. Also see BlWindow3D and the (non-blocking) EnqueueCommand for more details.

Parameters

cmd	

6.6.3.6 FrameDraw()

```
virtual void Blotch.BlWindow3D.FrameDraw (
            GameTime timeInfo )  [protected], [virtual]
```

See BlWindow3D for details.

Parameters

timeInfo	

6.6.3.7 FrameProc()

```
virtual void Blotch.BlWindow3D.FrameProc (
            GameTime timeInfo )  [protected], [virtual]
```

See BlWindow3D for details.

Parameters

timeInfo	

6.6.3.8 FrameProcSpritesAdd()

```
void Blotch.BlWindow3D.FrameProcSpritesAdd (
            BlSprite s )
```

Used internally

Parameters

s	

6.6.3.9 FrameProcSpritesRemove()

```
void Blotch.BlWindow3D.FrameProcSpritesRemove (
            BlSprite s )
```

Used internally

Parameters

s	

6.6.3.10 Initialize()

```
override void Blotch.BlWindow3D.Initialize ( )  [protected]
```

Used internally, Do NOT override. Use Setup instead.

6.6.3.11 LoadContent()

```
override void Blotch.BlWindow3D.LoadContent ( )  [protected]
```

Used internally, Do NOT override. Use Setup instead.

6.6.3.12 Setup()

```
virtual void Blotch.BlWindow3D.Setup ( )  [protected], [virtual]
```

Override this and put all initialization and global content creation code in it. See BlWindow3D for details.

6.6.3.13 Update()

```
override void Blotch.BlWindow3D.Update (
            GameTime timeInfo )  [protected]
```

Used internally, Do NOT override. Use FrameProc instead.

Parameters

timeInfo	

6.6.4 Member Data Documentation

6.6.4.1 Graphics

```
BlGraphicsDeviceManager Blotch.BlWindow3D.Graphics
```

The BlGraphicsDeviceManager associated with this window. This is automatically created when you create the BlWindow3D.

6.6.4.2 GuiControls

```
ConcurrentDictionary<string, BlGuiControl> Blotch.BlWindow3D.GuiControls = new Concurrent↩
Dictionary<string, BlGuiControl>()
```

The GUI controls for this window. See BlGuiControl for details.

6.6.4.3 IsDisposed

```
bool Blotch.BlWindow3D.IsDisposed = false
```

Set when the object is Disposed.

The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlWindow3D.cs

6.7 Blotch.BlGraphicsDeviceManager.Light Class Reference

Defines a light. See the Lights field. The default BasicShader supports up to three lights.

Public Attributes

- Vector3 **LightDirection** = new Vector3(1, 0, 0)
- Vector3 **LightDiffuseColor** = new Vector3(1, 0, 1)
- Vector3 **LightSpecularColor** = new Vector3(0, 1, 0)

6.7.1 Detailed Description

Defines a light. See the Lights field. The default BasicShader supports up to three lights.

The documentation for this class was generated from the following file:

- C:/Users/kloum/Desktop/Source/Blotch3D/src/BlGraphicsDeviceManager.cs