Creating Real Shaders in FX Composer

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HLSL for both Artists and Programmers

• High-Level talk here at GDC
• Examples of what you can do in FX Composer
  – Code details in these slides, available at http://developer.nvidia.com along with complete source code
• Your Models, Your Game Engine...
• Using FX Composer with DCC tools
  – Alias Maya
  – 3DS Max 7
  – RTZen Ginza
Touring the SDK Effects Examples

• What’s in there: more than we can show in the next few minutes!
• Start projects from the NVIDIA SDK Browser, or look in these directories:
  – MEDIA\project: FX Composer project files
  – MEDIA\HLSL: individual .fx files
  – MEDIA\scripts: VB & C# script samples
• Names identify general classes of .fx files: regular materials, “scene_xxx,” “post_xxx,” “pre_xxx,” and “paint_xxx”
• Projects show shaders set up, and sometimes show shaders interacting
Programmers: HLSL Beyond the Manual

• This talk will include examples that show how to:
  – Use the CPU to generate textures etc
  – Use DirectX/XNA’s DXSAS scripting
  – Write shaders for both DCC apps and FX Composer
  – Call on macros and functions from the NVIDIA #include files (.fxh) with FX Composer:
    • Quad.fxh, shadowMaps.fxh, Noise_3d.fxh,
      noise_2d.fxh, Spot_tex.fxh, nvMatrix.fxh

• Get at new NV4x Features
DXSAS Scripting

- These examples include techniques for:
  - MRTs
  - Loops of Passes
  - Looping on Booleans
  - FXCOMPOSER_RESET
  - Re-Using Texture Samplers
  - Using the GPU for Texture Creation
Example Shader: scene_lineDraw.fx

- Uses `#include`
- Uses MRT
- Uses “half” data
- Uses DXSAS scene commands
- Uses static data
Edge Detect Based on Normals

- Potential, but Has Artifacts

Worldspace Normals

Edges
Edge Detect Based on Depth

- Has Different Artifacts
Combining Results

• Much Smoother, Artifacts tend to cancel even in bad cases
Parameters We Will Need

• The parameters we borrow from the original shaders:
  – Two edge-detect thresholds
  – Hither/Far values for depth image

• For scene commands:
  – Color for screen-clear
  – Value for depth-clear (hidden)
We include “Quad.fxh” for macros, types, and shader functions.

QUAD_REAL defaults to “half”
  - We can override it by defining QUAD_FLOAT before including Quad.fxh.

We will use Quad.fxh Render-to-Texture Declaration Macros.

Quad.fxh also provides vertex and pixel shader functions for simplest screen-aligned-quad cases: writing “straight” textures.

#include "Quad.fxh"
lineDraw - starting DXSAS

- This shader is a “scene” effect
- We provide multiple techniques, for different HW profiles
- Two extra techniques for artist tuning

```cpp
float Script : STANDARDGLOBAL <
    string UIWidget = "none";
    string ScriptClass = "scene";
    string ScriptOrder = "standard";
    string ScriptOutput = "color";
    string Script =
        "Technique=Technique?NV3X:NV4X:NormsOnly:DepthOnly;";
    > = 0.8; // version #
```
lineDraw “untweakables”

- Tracked automatically by app - no user override
- UIWidget = “none” improves performance

```cpp
float4x4 WorldITXf : WorldInverseTranspose <
    string UIWidget="None"; >;
float4x4 WorldViewProjectionXf : WorldViewProjection <
    string UIWidget="None"; >;
float4x4 WorldViewXf : WorldView <
    string UIWidget="None"; >;
float4x4 WorldXf : World <
    string UIWidget="None"; >;
float4x4 ViewIXf : ViewInverse <
    string UIWidget="None"; >;
```
**lineDraw static parameters**

- Static values are “invisible” to the UI
- Calculated by the CPU
- Can call most HLSL functions, intrinsic or user-defined
- QUAD_REAL type declared by Quad.fxh
- QuadTexOffset and QuadScreenSize are hidden parameters declared by Quad.fxh

```
static float EdgeT2 = (Threshold * Threshold);
static float DeepT2 = (ThresholdD * ThresholdD);

static QUAD_REAL2 TexelCornerOffset =
    QUAD_REAL2(QuadTexOffset/(QuadScreenSize.x),
               QuadTexOffset/(QuadScreenSize.y));
```
lineDraw Texture Declarations

- Macros from “Quad.fxh” for common RTT texturing
- Standard declarations (like these) match screen size exactly (so resizing the window will re-allocate them)

DECLARE_QUAD_TEX(NormTexture,NormSampler,"X8R8G8B8")
DECLARE_QUAD_TEX(DeepTexture,DeepSampler,"X8R8G8B8")
DECLARE_QUAD_DEPTH_BUFFER(DepthBuffer, "D24S8")
lineDraw Template

- QUAD_REAL data
- We perform both edge detects and multiply the results
- :COLOR semantic on function itself

```cpp
QUAD_REAL4 edgeDetect2PS(EdgeVertexOutput IN) : COLOR {
    QUAD_REAL n = edgeDetectGray(IN, NormSampler, EdgeT2);
    QUAD_REAL d = edgeDetectR(IN, DeepSampler, DeepT2);
    QUAD_REAL line = 1 - (n * d);
    return line.xxxx;
}
```
Complete Technique

- Looks Complex but Just 4 (or 3) Chunks:
  - Script; Normal, Depth, & Edge Passes

```csharp
technique NV3X {
  string Script = "Pass=Norms;"
  "Pass=Depth;"
  "Pass=ImageProc;"
}

pass Norms {
  string Script = "RenderColorTarget0=NormTexture;"
  "RenderDepthStencilTarget=DepthBuffer;"
  "ClearColor=BlackColor;"
  "ClearDepth=ClearDepth;"
  "Clear=Color;"
  "Clear=Depth;"
  "Verifier=;"
}

pass Depth {
  string Script = "RenderColorTarget0=DeepTexture;"
  "RenderDepthStencilTarget=DepthBuffer;"
  "ClearColor=BlackColor;"
  "ClearDepth=ClearDepth;"
  "Clear=Color;"
  "Clear=Depth;"
  "Verifier=;"
}

pass ImageProc {
  string Script = "RenderColorTarget0=; // re-use"
  "RenderDepthStencilTarget=;"
  "Clear=Buffer;"
}

cullmode = none;
ZEnable = false;
ZWriteEnable = false;
AlphaBlendEnable = false;
VertexShader = compile vs_1_1 edgeVS();
PixelShader = compile ps_2_0 edgeDetect2PS();
```
Technique: Chunk 1 of 4

- DXSAS scripts at each step
- The “Technique” script is optional for this case (one pass after another)

```c
 technique NV3X <
    string Script = "Pass=Norms;"
    "Pass=Depth;"
    "Pass=ImageProc;";
>
   // . . .
```
• We redirect color output to “NormTexture” & Draw the Model Geometry

```c
pass Norms <
    string Script = "RenderColorTarget0=NormTexture;"
    "RenderDepthStencilTarget=DepthBuffer;"
    "ClearColor=ClearColor;"
    "ClearDepth=ClearDepth;"
    "Clear=Color;"
    "Clear=Depth;"
    "Draw=Geometry;";
>
{ VertexShader = compile vs_2_0 simpleVS();
  ZEnable = true;
  ZWriteEnable = true;
  CullMode = None;
  AlphaBlendEnable = false;
  PixelShader = compile ps_2_a normPS();
}
```
Technique: Chunk 3 of 4

- **Redirect Color Output to “DeepTexture” & Draw Model Again**

```csharp
        pass Depth <
        string Script = "RenderColorTarget0=DeepTexture;"
        "RenderDepthStencilTarget=DepthBuffer;"
        "ClearColor=BlackColor;"
        "ClearColor=Depth;"
        "Clear=Color;"
        "Clear=Depth;"
        "Draw=Geometry;";
    > {
        VertexShader = compile vs_2_0 simpleVS();
        ZEnable = true;
        ZWriteEnable = true;
        CullMode = None;
        AlphaBlendEnable = false;
        PixelShader = compile ps_2_a deepPS();
    }
```
Technique: Chunk 4 of 4

- Combine, Edge Detect, write result to Frame Buffer
- *Ignore scene geometry*

```c
pass ImageProc <

string Script = "RenderColorTarget0=;"
"RenderDepthStencilTarget=;"
"Draw=Buffer;";

{ > { cullmode = none;
ZEnable = false;
ZWriteEnable = false;
AlphaBlendEnable = false;
VertexShader = compile vs_1_1 edgeVS();
PixelShader = compile ps_2_0 edgeDetect2PS();
}
```
lineDraw MRT Technique

- We can collapse the first two passes
- Remember to reset *all* outputs!

```c
pass NormsAndDepth <
    string Script = "RenderColorTarget0=NormTexture;"
    "RenderColorTarget1=DeepTexture;"
    "RenderDepthStencilTarget=DepthBuffer;"
    "ClearSetColor=BlackColor;"
    "ClearSetDepth=ClearDepth;"
    "Clear=Color;"
    "Clear=Depth;"
    "Draw=Geometry;";
> { VertexShader = compile vs_2_0 simpleVS();
    ZEnable = true;
    ZWriteEnable = true;
    CullMode = None;
    AlphaBlendEnable = false;
    PixelShader = compile ps_2_a geomMRT_PS();
}"
```
lineDraw MRT shader

- Use “out” to specify multiple return values
- Func can be “void” or return a value via function semantic

```c
QUAD_REAL4 vecColorN(QUAD_REAL3 V) {
    QUAD_REAL3 Nc = 0.5*(normalize(V)+((1.0).xxx));
    return QUAD_REAL4(Nc,1);
}

void geomMRT_PS(
    vertexOutput IN,
    out QUAD_REAL4 normColor : COLOR0,
    out QUAD_REAL4 deepColor : COLOR1
) {
    normColor = vecColorN(IN.WorldNormal);
    QUAD_REAL d = (IN.EyePos.z-Near)/(Far-Near);
    deepColor = QUAD_REAL4(d.xxx,1);
}
```
MRT shader alternative form

- Shader function can be “void” or return a value via function semantic
- :COLOR0 is the same as :COLOR

```
QUAD_REAL4 geomMRT_PS(
    vertexOutput IN,
    out QUAD_REAL4 deepColor : COLOR1) : COLOR0
{
    QUAD_REAL d = (IN.EyePos.z-Near)/(Far-Near);
    deepColor = QUAD_REAL4(d.xxx,1);
    return vecColorN(IN.WorldNormal);
}
```
**lineDraw Tuning Technique 1**

- Provide a visualization for artists to tune params for edgeNorms

```plaintext
technique NormsOnly {
    pass Norms <
    // . . .
}
```

*Tuned Normals Edges*
lineDraw Tuning Technique 2

- Likewise for Depth and edge parameters

```
technique DepthOnly {
    pass Depth <
    // . . .
}
```

Live Texture Display in FX Composer

Tuned Depth Edges
Example Shader: SeeSpaces.fx

- Artist Visualization
- Uses texture generation and texture derivatives on CPU for fast AA
- Debugging

Sample from “DebugCab.fxproj”
Generating procedural textures

- :COLOR semantic like a pixel shader
- :PSIZE input semantic gives texel size as function is called for each MIP level
- This is the only way to get at the HLSL noise() intrinsic

```c
float4 MakeStripe(float2 Pos : POSITION, float ps : PSIZE) : COLOR
{
    float v = 0;
    float nx = Pos.x + ps; // keep the last column full-on, always
    v = nx > Pos.y;
    return float4(v.xxxx);
}
```

```
#define TEX_SIZE 128
texture stripeTex <
    string function = "MakeStripe";
    string UIWidget = "None";
    float2 Dimensions = { TEX_SIZE, TEX_SIZE };
>;

sampler2D StripeSampler = sampler_state {
    Texture = <stripeTex>;
    MinFilter = LINEAR; MagFilter = LINEAR; MipFilter = LINEAR;
    AddressU = WRAP;
    AddressV = CLAMP;
};
```

No user interface needed

Call generator function

Output Semantic

Input Semantic

Be sure to set address modes appropriate for individual texture and algorithm
Example Shader: uvDetective

- **Visualization for Artists**
- **Tuning Models**
- **Black - texture should be around 512x512 for close-to-texel-sized pixels**

*Black areas for 512x512 texture*
Can be set to any size

- Now black is for 256 res
- Blue shows area where a higher-res texture could be useful
Show Related Visualizations Too

- Direct Derivatives and (CPU-generated) false MIP coloring

Direct Visualization of Texture Derivatives (Amount of texture stretching)

“False Color MIP Texture” Display (texture generated by uvDetective.fx)
Example Shader: shadowSpot2.fx

- Special shadow format
- DXSAS:
  - “sceneorobject”
  - ScriptClass
  - Script/No Script
- Uses RenderPort
- Uses CPU intrinsics
- Include files:
  - shadowMap.fxh
  - spot_tex.fxh
shadowSpot2 - shadow texture

- Shadow texture format
- We throw away color portion
- Vertex shader declared for us

```cpp
#include "shadowMap.fxh"

DECLARE_SHADOW_XFORMS("light0", LampViewXf, LampProjXf, ShadowViewProjXf)
DECLARE_SHADOW_BIAS
DECLARE_SHADOW_MAPS(ColorShadMap, ColorShadSampler, ShadDepthTarget, ShadDepthSampler)
```
Inside shadowMap.fxh - Maps

- DECLARE_SHADOW_MAPS will set up two map and sampler pairs
- Default Size is 512
- We can override by pre-#defining SHADOW_SIZE
- Uses format "D24S8_SHADOWMAP" which will provide HW-accelerated multisample PCF filtering

DECLARE_SHADOW_MAPS(ColorShadMap, ColorShadSampler, ShadDepthTarget, ShadDepthSampler)
Inside shadowMap.fxh - Transforms

• DECLARE_SHADOW_XFORMS declares attachable transforms using special “frustum” annotation and an additional “static” declaration:

```
// DECLARE_SHADOW_XFORMS("light0",LampViewXf,
// LampProjXf,ShadowViewProjXf)
// expands to:

float4x4 LampViewXf : View < string frustum = "light0"; >;
float4x4 LampProjXf : Projection < string frustum = "light0"; >;
static float4x4 ShadowViewProj = mul(LampViewXf,LampProjXf);
```

“frustum” annotation

“static” declaration executes HLSL code on CPU each frame
Inside shadowMap.fxh - Bias

• DECLARE_SHADOW_BIAS will set up a user parameter “ShadBias”
• We can override range for small or large models by pre-#defining MAX_SHADOW_BIAS

DECLARE_SHADOW_BIAS
Inside `shadowMap.fxh` - Shaders

- **Vertex shader for creating shadow maps:** “shadCamVS”
- **No pixel shader needed for shadow creation passes**
- **Vertex shader for using shadow maps:** “shadowUseVS”
  - Shadow projection TexCoords (UVs) passed in “LProj”
- **Code sample in .fxh for usage in Pixel shaders**
shadowSpot2 - spotlight pattern

- “SpotSamp” sampler will be declared for you and filled
- Compile-time shaping options

```
#include "spot_tex.fxh"
```

- Call “SpotSamp” using light projection UVs like so:

```
float cone = tex2Dproj(SpotSamp, IN.LProj);
```
shadowSpot2 - pixel shader

- Just shadow portion
- “LProj” provided by vertex shader “shadowUseVS”

```cpp
float4 useShadowPS(ShadowingVertexOutput IN) : COLOR
{
    float3 litPart, ambiPart;
    lightingCalc(IN, litPart, ambiPart);
    float4 shadowed = tex2Dproj(ShadDepthSampler, IN.LProj);
    return float4((shadowed.x*litPart)+ambiPart, 1);
}
```
shadowSpot2 - pixel shader

- Compare to a completely unshadowed version:
  - We supply an *unshadowed* version for apps with limited DXSAS scripting, like 3DStudio Max
    - And declare ScriptClass = "sceneorobject";

```c
float4 unshadowedPS(ShadowingVertexOutput IN) : COLOR
{
    float3 litPart, ambiPart;
    lightingCalc(IN, litPart, ambiPart);
    return float4(litPart+ambiPart,1);
}
```
shadowSpot2 - shadow technique

- **Vertex shader from .fxh file:**
- **Note assign of “RenderPort”**

```c
technique Shadowed <
    string Script = "Pass=MakeShadow;"
    "Pass=UseShadow;";
>
{  
    pass MakeShadow <
    string Script = "RenderColorTarget0=ColorShadMap;"
    "RenderDepthStencilTarget=ShadDepthTarget;"
    "RenderPort=light0;"
    "ClearSetColor=ShadowClearColor;"
    "ClearSetDepth=ClearDepth;"
    "Clear=Color;"
    "Clear=Depth;"
    "Draw=geometry;";

    > {
    VertexShader = compile vs_2_0 shadowGenVS(WorldXf, WorldITXf, ShadowViewProjXf);
    ZEnable = true;
    ZWriteEnable = true;
    ZFunc = LessEqual;
    CullMode = None;
    // no pixel shader!
    }
    // . . . Continued . . .

“RenderPort” sets clipping etc correctly for this view

Provided by shadowMap.fxh
```
shadowSpot2 - technique (cont’d)

• **Vertex Shader provided from .fxh**

• **Remember, Reset “RenderPort”**

```c
// . . .
pass UseShadow <
string Script = "RenderColorTarget0=;
"RenderDepthStencilTarget=;
"RenderPort=;
"ClearSetColor=ClearColor;
"ClearSetDepth=ClearDepth;
"Clear=Color;
"Clear=Depth;
"Draw=geometry;";

> {
VertexShader = compile vs_2_0 shadowUseVS(WorldXf,WorldITXf,
    WorldViewProjXf,ShadowViewProjXf,
    ViewIXf,ShadBiasXf, SpotLightPos);

ZEnable = true;
ZWriteEnable = true;
ZFunc = LessEqual;
CullMode = None;
PixelShader = compile ps_2_a useShadowPS();
}
```
shadowSpot2 - unshadowed technique

- Provided for apps like 3DS Max
- Just one pass, shared code
- DXSAS Script optional
- Declare ScriptClass “sceneorobject”

```cpp
technique Unshadowed {
    pass NoShadow {
        VertexShader = compile vs_2_0 shadowUseVS(WorldXf, WorldITXf, WorldViewProjXf, ShadowViewProjXf, ViewIXf, ShadBiasXf, SpotLightPos);
        ZEnable = true;
        ZWriteEnable = true;
        ZFunc = LessEqual;
        CullMode = None;
        PixelShader = compile ps_2_a unshadowedPS();
    }
}
```

Provided by shadowMap.fxh
Differing Shadow Formats & Algorithms

**D24S8 Shadow Maps**
- Fast, good quality
- Antialiased on NVIDIA hardware
- Sharp edges
- Trivial to use

**Floating Point**
- Most flexible
- AA calculated in shader, so anything is possible
- Can be mixed with RGB in one texture
Example Shader: paint_blur

- Uses FP16 Blending
- Uses DXSAS accumulation loops
- Uses “bool loops”
- Uses CPU funcs and static vars for mouse tracking
**Paint_blur - Three key params**

- **Loop counter & limit**
- **RESET pulse boolean**
  - Can also be toggled manually

```c
float passnumber <string UIWidget = "none">;
floa[npasses <
    float U1Step = 1.0;
    string UIName = "# of blur passes";
> = 8.0f;
bool bReset : FXCOMPOSER_RESETPULSE <
    string UIName="Clear Canvas?";
>;
```
Declaring Floating Point Textures

- Just like any other texture
- Our paint strokes are added using Alpha
  Blending - works fine on FP16 formats
- Caution: FXC will still compile if a format is not available - it will switch to 8bit int

DECLARE_QUAD_TEX(PaintTex, PaintSamp, "A16B16G16R16F")

A sample “live” displacement texture
Paint_blur - DXSAS looping

• **Loop value from parameter in technique script**
  – Change value to change blur quality

```c
string Script =
// Clear Accum Buffer
"RenderColorTarget0=AccumBuffer;"
"ClearSetColor=ClearColor;"
"Clear=Color;"
// paint into blur-dir buffer...
"Pass=paint;"
// accumulate
"LoopByCount=npasses;"
  "LoopGetIndex=passnumber;"
  "Pass=Accumulate;"
"LoopEnd;"
// draw accum buffer to framebuffer
"Pass=FinalPass;";
```

User-defined loop limit

Script counter assignment
Effects of Changing Pass Count

• Tune for Quality versus Performance
Paint_blur - DXSAS “bool” looping

- Loop value from RESET, inside script for “Paint” pass
  - Painting clears itself as needed
  - Otherwise “PaintTex” persists from frame to frame

```c
string Script =
    "RenderColorTarget0=PaintTex;"
    "RenderDepthStencilTarget=";
    "LoopByCount=bReset;"
    "ClearSetColor=ClearColor;"
    "Clear=Color0;"
    "LoopEnd=";
    "Draw=Buffer;";
```

With “bool” value, acts like “if()”

“PaintTex” display
Example shader: paint_sculpt

- Uses FP blending
- Converts to FP32
- Uses FP32 VTF

Live texture sculpting on static plane
Paint_sculpt - mixing data

- **FP16 blending for paint, as before**
- **Extra copy pass for VTF FP32**
- **Use Quad.fxh utility shaders**

```cpp
pass boost <
  string Script = "RenderColorTarget0=DisplaceMap;"
                "Draw=Buffer;";
>
  VertexShader = compile vs_3_0 ScreenQuadVS();
  ZEnable = false;
  ZWriteEnable = false;
  CullMode = None;
  PixelShader = compile ps_3_0 TexQuadPS(PaintStrokeSampler);
}
```

Provided by Quad.fxh
Example shader(s): post_holga & friends

- Uses noise_2d, spot_tex, Quad.fxh,
- FP16 if you have it
- DXSAS Effect stacking
Post_holga - noise textures

- Textures are still the fastest way to get noise in pixel shading
  - This noise, at low scales, will also be pretty continuous at a variety of visible sizes
- Emulate Optical Distortion by Offseting screen U,V with 2D Noise
- Default NOISE2D_SCALE was 500 - we want much smoother noise for this application

```c
#define NOISE2D_SCALE 1
#define NOISE2D_FORMAT "A16B16G16R16F"
#include "noise_2d.fxh"
```
Post_holga - spot_tex

- Using this texture for a different purpose - to isolate distortion to the edges of the frame, and to control the vignetting effect
- Change a couple of defaults to get a different shape

```c
#define SPOT_TEX_SIZE 128
#define SPOT_TEX_INSIDE 0.2
#include "spot_tex.fxh"
```
Post_holga - buffering the scene

- Post_holga (and other postprocess effects) are declared `ScriptOrder="postprocess"`
- We use "ScriptExternal=" to hand-off scene rendering to FX Composer, while using our own texture ("SceneMap") as the scene render target, rather than the framebuffer.

```csharp
string Script = "ClearSetDepth=ClearColor;"
    "RenderColorTarget=SceneMap;"
    "RenderDepthStencilTarget=DepthMap;"
    "ClearSetColor=ClearColor;"
    "ClearSetDepth=ClearDepth;"
    "Clear=Color;"
    "Clear=Depth;"
    "ScriptSignature=color;"
    "ScriptExternal="
    "Pass=DownSample;"
    "Pass=GlowH;"
    "Pass=GlowV;"
    // . . .
```
Adding More Shaders to the Scene

- Use the ScriptExecute Sorter, found in the menu of the Materials Pane
- Build up the look you like
- Maybe reduce to one shader later (maybe not)
FX Composer & Maya

- Microsoft DX9 Viewer
  - Newest in February 2005 DirectX SDK Update
  - Special sub-dialog from Attribute Editor
  - Maya 6 or Maya 5
  - DirectX in Maya window or “floater”
  - Integrates .X exporter
FX Composer & 3DS Max 7

- **3DStudio Max support for DX9 built-in**
  - Define shaders in Max Materials Pane
  - Limited DXSAS support so far
  - Which is why we make shadow scripts “smart”
  - New NVB exporter from 3DS Max will carry all FX Composer attributes too.
C# Scripting

- Can use C# or Visual Basic, with full text-edit intellisense etc
  - Works off .NET “CLR” so others could work too
- Setting Animation Keys
  - From Programs or External Files
- Creating Objects
  - From Primitives or External Files
  - Can call C++ plugins or work directly
- Cycling Through Shaders and Projects
  - Preview examples like “Scatter_scene.cs”
- Exporting
  - See example “export_material_keys.cs” to access and export all properties of the current scene to XML
- Most FX Composer Internals Are Exposed
  - Use the OLE Viewer in Visual Studio, expand library “nvsys”
    - Data types, structures, and methods are all there
Sample C# Script: “rtzImport.cs”

- Creates a tweaked copy of your Ginza shader, then opens it.
- Be sure to include the RTZen path “...\RTShaderGinza\media\images\” in your FX Composer Settings... dialog
Connecting Outside of FX Composer

- User-defined annotations and semantics: “...\data\fxmapping.xml”
- Geometry Importers & C++ SDK
- More!
  - Details coming up from Chris Maughan...
- Thanks!
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