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3D Authoring Tool “BS Content Studio” supports Deferred Rendering for improved visual quality

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BS Content Studio

- BS Content Studio manages hundreds of lights
- WYSIWYG editor to create, manipulate and enrich your 3D models – authoring tool facilitates content generation
- visualisation in integrated 3D engine “BS Contact”
- Deferred Rendering reduces complexity of 3D scene

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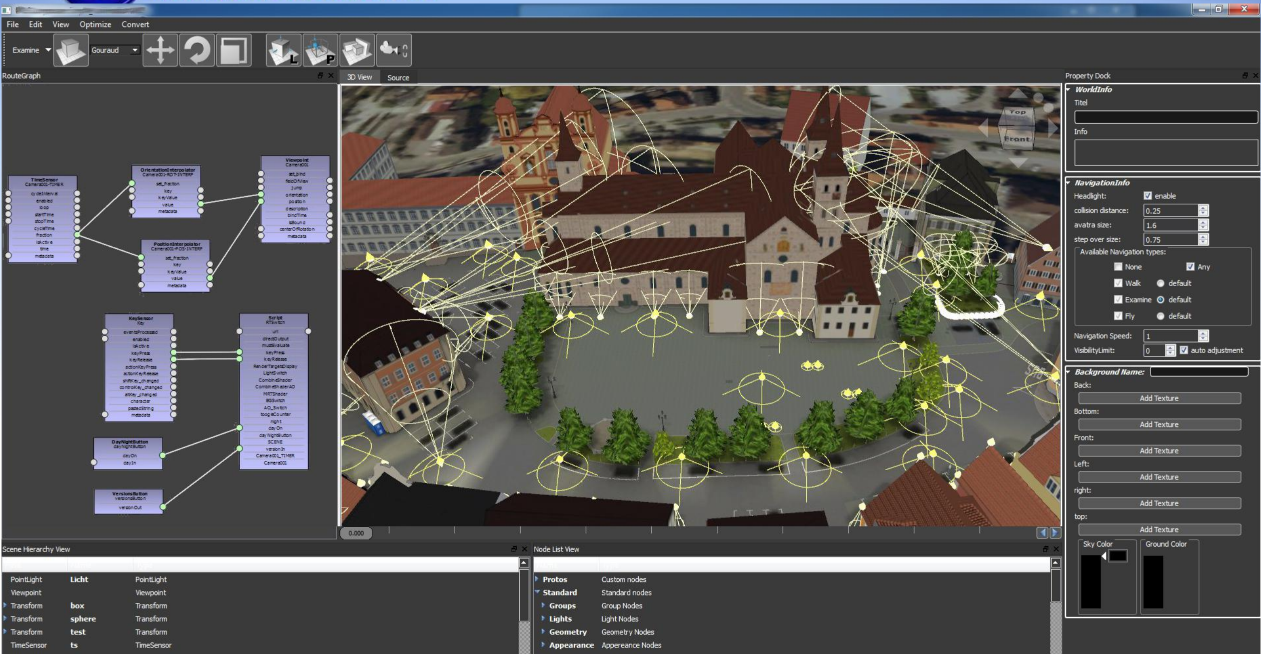
BS Content Studio



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Concept

- Improve the lighting
- Get rid of the light limitation (8 HW lights)
- More light $\rightarrow$ more realism
- Decouple the lighting of object from the rendering of object

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History

- Inventor 1988 Michael Deering et al.
  - Pixel colour calculation after resolving depth
- Current concept from 1990 Saito and Takahashi
  - Introduce the G-Buffer
-

Forward rendering

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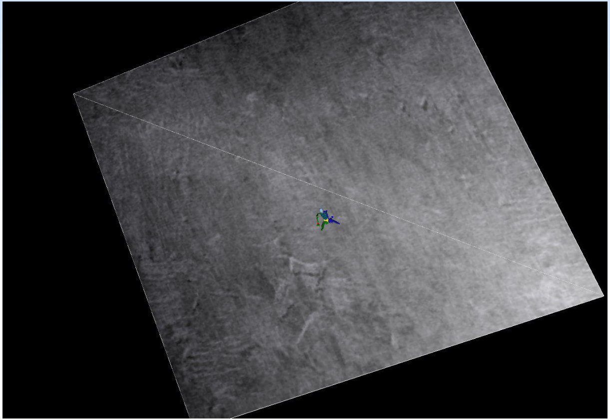
- Classical forward rendering for each pixel per object
  - Determine depth (culled or not)
  - Normals + diffuse color + light color = final color
- Each pixel has to be rendered for every light
- Complexity O(m*n)
  - m number of object
  - n number of lights

Forward rendering

- Shading is done in place
- HW lighting depends on vertex density



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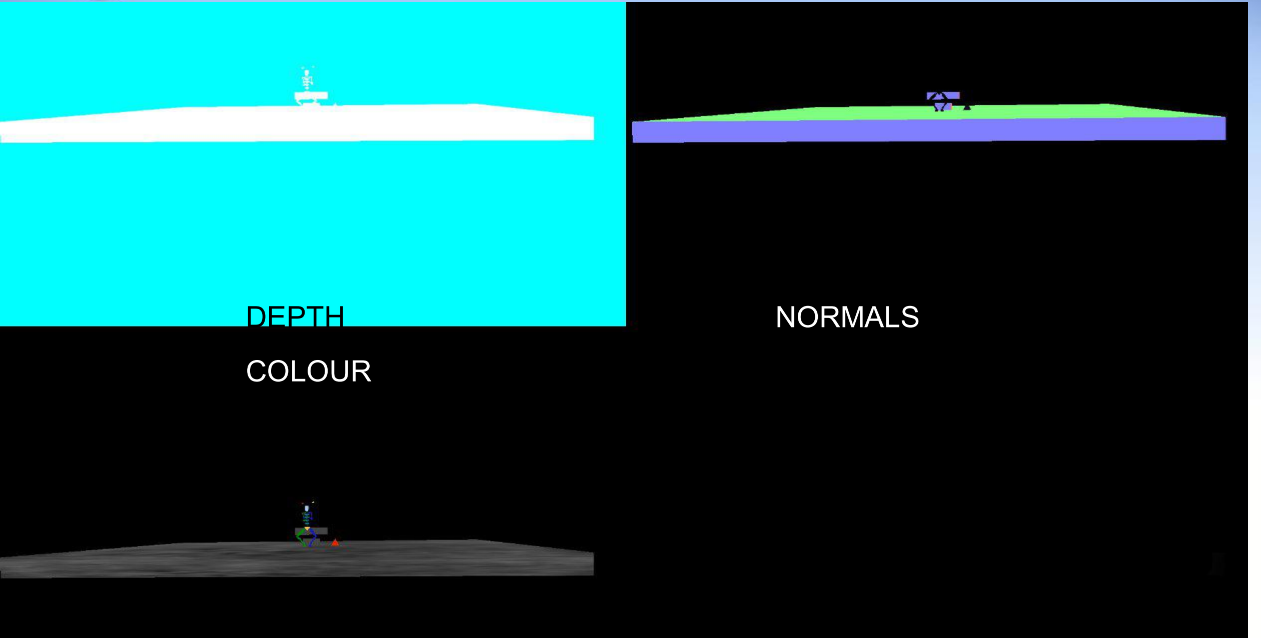
Deferred Lighting

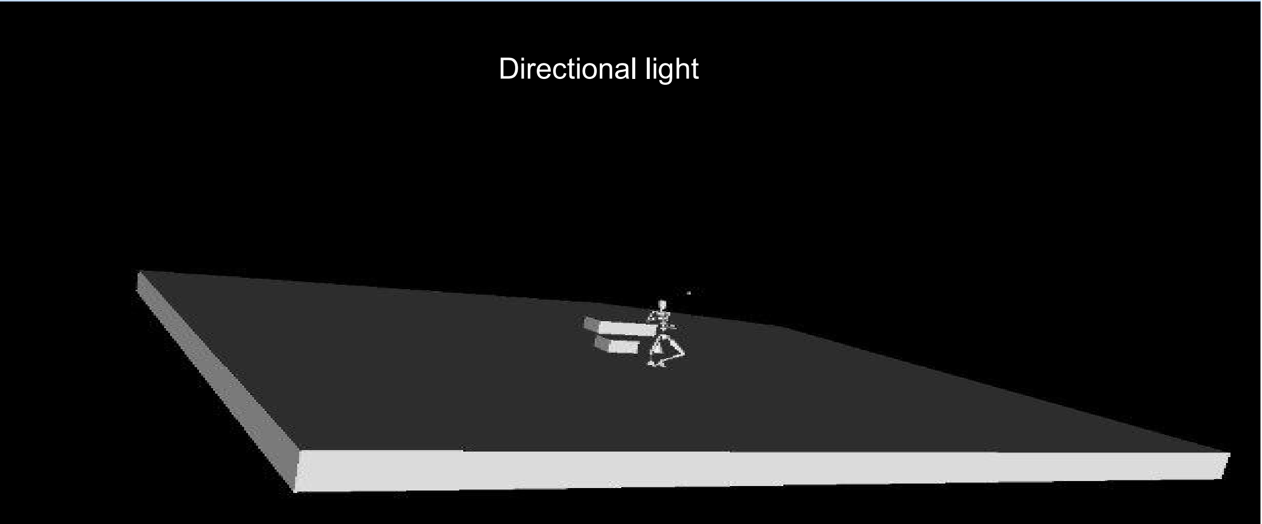
- 1. Pass collects geometry information
- G-Buffer (Geometry Buffer) contains information
  - Depth
  - Diffuse colour
  - Normal
- G-Buffer are MRT (multiple render targets) textures

Deferred Lighting



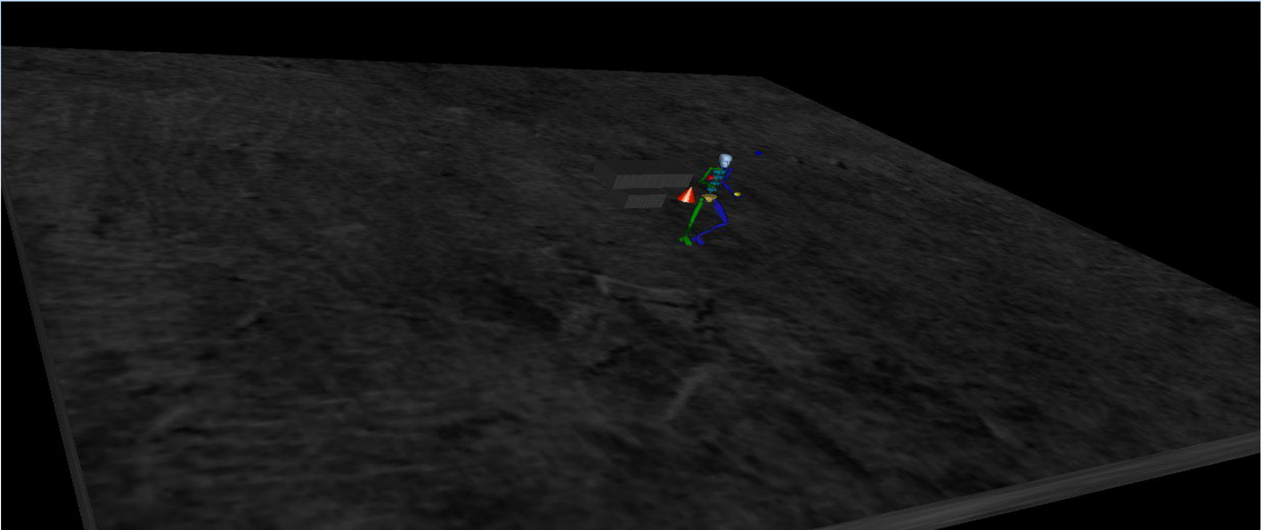
Deferred Lighting

- 2. Pass collects Light information



Deferred Lighting

- 3. Pass combine light and geometry information



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Transparency

- Transparency is complicated
- Transparent object receive light and blends with scene
- Transparent object use the old forward rendering style

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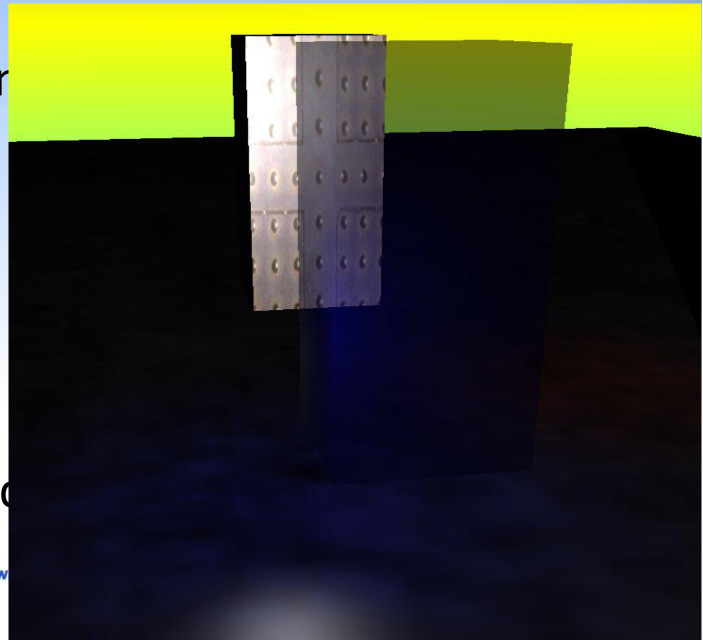
Transparency

- Scene with transparen
object
- Light on transparent object use forward shading
- Transparent blends with deferred rendere
object

www



Pro & Contra

- Pros
  - multiple lights for objects
  - complexity O(m+n) m = Object; n = lights
  - No limits of hardware lighting
  - Only visible geometry get lighted
  - Shadow maps easier to maintain
  - Post effects easy to add

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Pro & Contra

- Contra
  - Transparent objects hard to handle
  - Driver and graphic cards need MRT support
  - Shader Model 3 required
    - DX9
    - OGL version 2
  - Currently not available for OGLES 2.0

“BS Contact” 3D Engine

- New node **DeferredNode** in X3D Syntax

```
<DeferredNode>
  <PackagedShader containerField='globalShader' /> <!-- MRT Writer -->
  <PackagedShader containerField='lightShader' /> <!-- light shader -->

  <CompositeTexture3D containerField='renderTargets' parameter='"mipmap=false" "format=R32F" "depth=D24X8"'/> <!-- MRT for depth -->
  <CompositeTexture3D containerField='renderTargets' parameter='"mipmap=false" "format=A8R8G8B8" "depth=NONE"'/> <!-- MRT diffuse -->
  <CompositeTexture3D containerField='renderTargets' parameter='"mipmap=false" "format=A8R8G8B8" "depth=NONE"'/> <!-- MRT normal -->

  <CompositeTexture3D containerField='lightRenderTarget' parameter='"mipmap=false" "format=A8R8G8B8" "depth=NONE"'/> <!-- MRT light color -->

  <PackagedShader containerField='combinePostProcess' /> <!-- combine shaader -->
</DeferredNode>
```

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- Children contains nodes for deferred lighting
- MRT must have same bit rate
  - A8R8G8B8
  - R32F
  - G16R16
- GlobalShader field for MRT shader writer
- MRT's are filled in one pass

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DX9 HLSL pixel shader example for material MRT

```
PO PS_Colors_material(in VO input)
{
	PO result = (PO)0;
	result.normal = 0.5f * (normalize(input.normal) + 1.0f);
	result.depth  = input.depth.x / input.depth.y;
	result.normal.a = material.power/128;

	result.diffuse.rgb = material.diffuseColor.rgb*input.color.rgb;
	result.diffuse.a = 1;
	return result;
}
```

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- 1. RT is depth with 32 bit precision
- 2. RT is colour 8bit for each RGB channel
- Last 8 bit are free to use (emissive colour factor?)
- 3. RT is normal 8bit precision for each axis xyz
  - Lead to quantization
  - Solution 16bit for x and y axis reconstruct z axis

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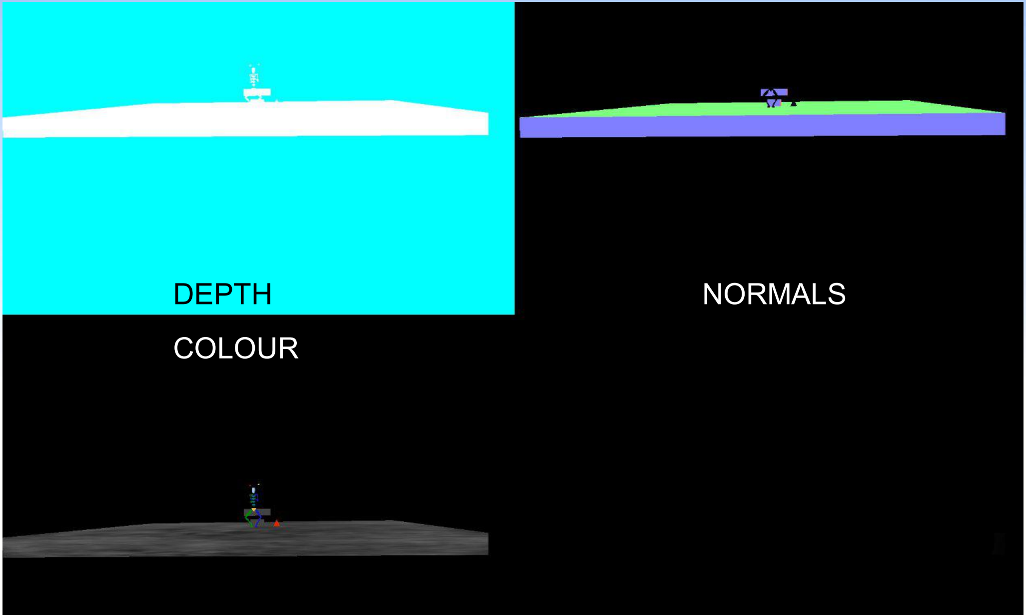

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- LightShader field for light colour calculation
- Light is rendered as geometry
- For each light type seperate shader
- Result Shader information stored in render target
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DX HLSL pixel shader for directional light

```
float4 PixelShaderDirectionalFunction(VertexShaderOutput input) : COLOR0
{
    //get normal data from the normalMap
    half4 normalData = tex2D(normalSampler,input.TexCoord);

    //tranform normal back into [-1,1] range
    half3 normal = 2.0f * normalData.xyz - 1.0f;

    //get specular power, and get it into [0,255] range]
    half specularPower = normalData.a*128;

    //read depth
    float depthVal = tex2D(depthSampler,input.TexCoord).r;
   //compute screen-space position
   float4 position;
   position.x = input.TexCoord.x * 2.0f - 1.0f;
   position.y = -(input.TexCoord.y * 2.0f - 1.0f);
   position.z = depthVal;
   position.w = 1.0f;
   //transform to world space
   position = mul(position, g_mViewProjInvers);
   position /= position.w;
```

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```
    //surface-to-light vector
    float3 lightVector = -normalize(light.direction);
    //compute diffuse light
    half NdL = max(0,dot(normal,lightVector));
    half3 diffuseLight = NdL * light.diffuseColor;
    //reflexion vector
    half3 reflectionVector = (reflect(lightVector, normal));
    //camera-to-surface vector
    half3 directionToCamera = normalize(cameraPos - position);

   //compute specular light
  half dotProd = dot(reflectionVector, directionToCamera);

    half specularLight= 0;
    if(specularPower>0 && NdL >0)
        specularLight = /*specularIntensity * */ pow( saturate(dot(reflectionVector, -directionToCamera)), specularPower);

    //output the two light values
    return float4(diffuseLight.rgb, max(0,specularLight)) ;
}
```

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- LightRenderTarget field contains result from shader
- 32 bit texture RGB channels contains light colour
- 8 bit Alpha channel for specularity
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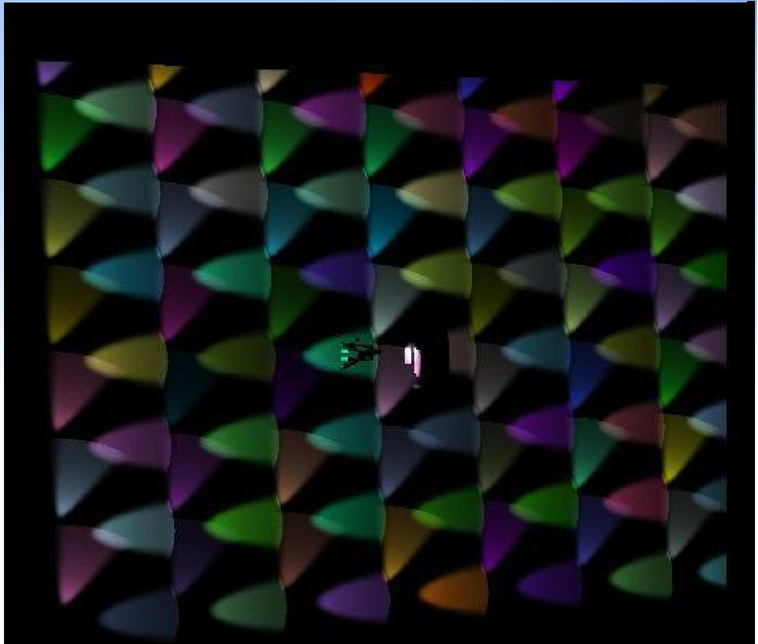
Light RT
with
98 Lights
and
random
colour

All lights



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- combinePostProcess field for PostProcess node to process results from colour RT and light RT
- PostProcess node contains shader for combine process
- Chaining of PostProcess nodes are flexible to add own effects
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- Post process effects simple to implement using the already computed RT
  - SSAO
  - Shadow
  - Blur
  - Bloom
  - Motion Blur

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- BS Contact can handle hundreds of lights from different types
- Performance depends on size and range of light
- Directional light is costly because full scene lighting
- Small point lights could be cheap

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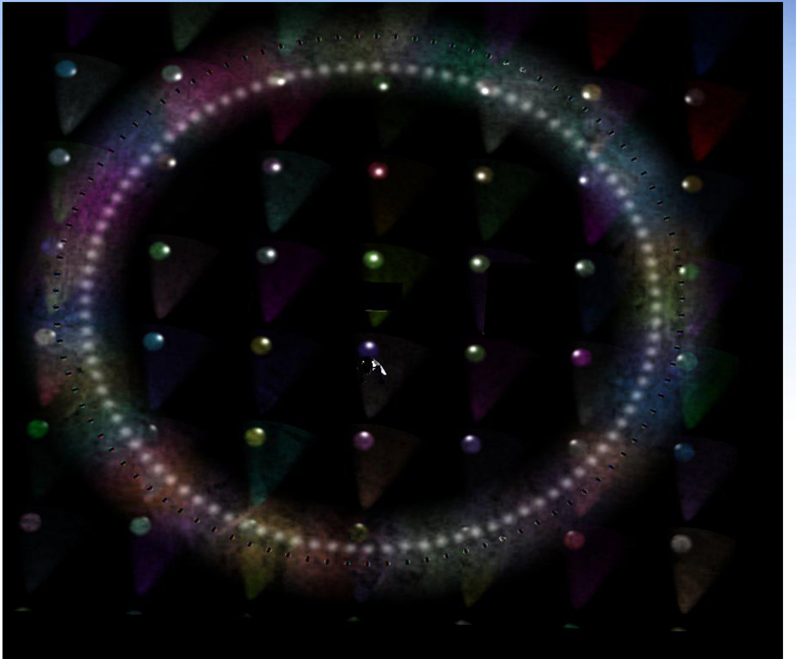
- 100 point lights
- 98 spot lights
- all animated



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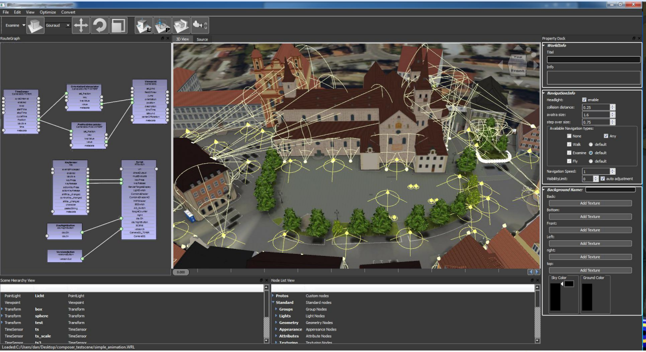
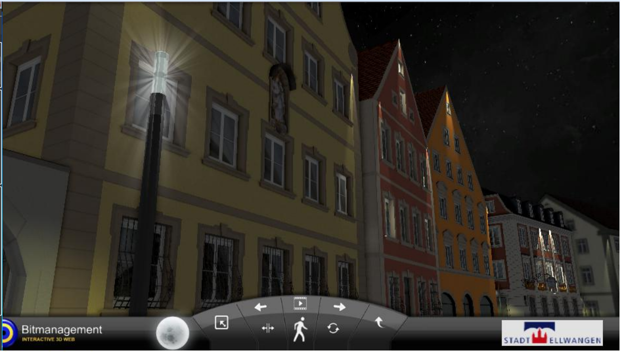
Deferred Rendering effects simply applied (placing of lights in interactive 3D scene):

BS Content Studio Result





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- Demo Scene available on

http://www.bitmanagement.de/en/company/research-development