Texturing

Cylinder

Textured Cylinder

Template
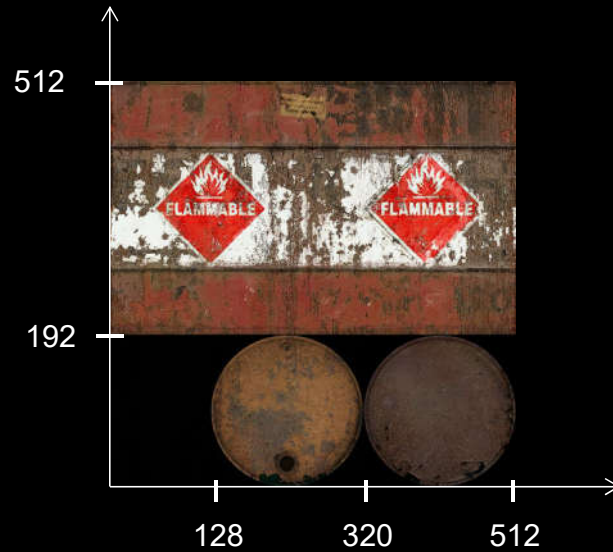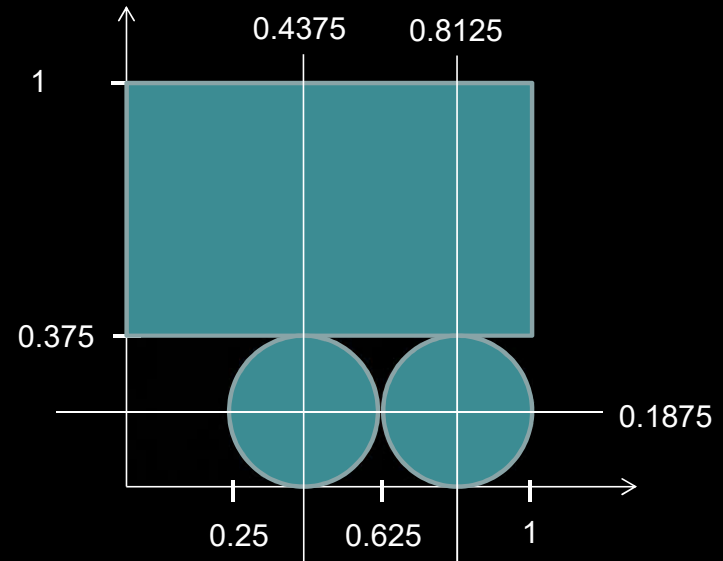
DevIL

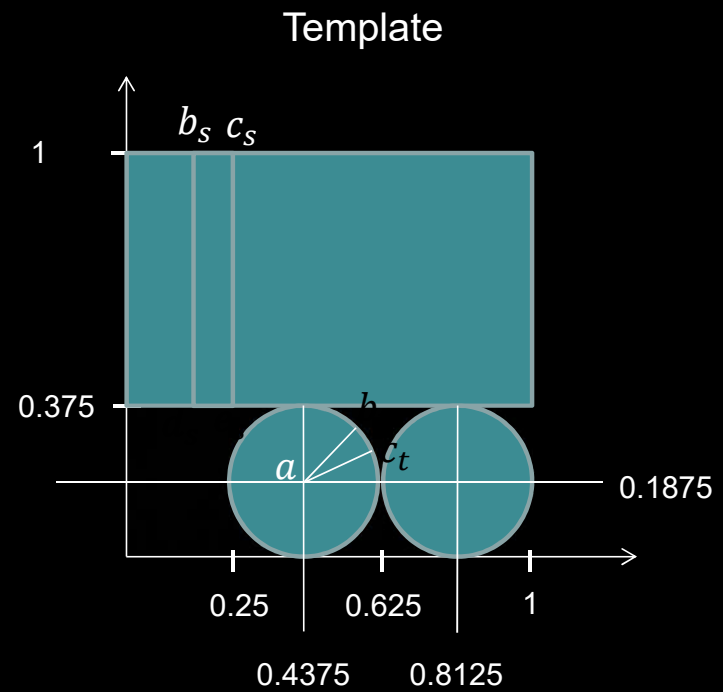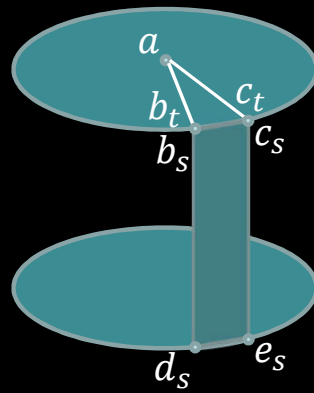- Open an image file and define origin of image space in DevIL

```
// setup – done once
ilInit();
ilEnable(IL_ORIGIN_SET);
ilOriginFunc(IL_ORIGIN_LOWER_LEFT);


// for each image …
ilGenImages(1,ima); // unsigned int ima[...]
ilBindImage(ima[0]);
ilLoadImage((ILstring)filename); // char *filename
```

DevIL

- Convert to RGBA

```
ilConvertImage(IL_RGBA, IL_UNSIGNED_BYTE);
```

DevIL

- Get the required info

```
int width = ilGetInteger(IL_IMAGE_WIDTH);
int height = ilGetInteger(IL_IMAGE_HEIGHT);

unsigned char *imageData = ilGetData();
```

Texture Creation in OpenGL

```
// create a texture slot
    glGenTextures(1,&texID);
// bind the slot
    glBindTexture(GL_TEXTURE_2D,texID);

// define texture parameters
    glTexParameteri(GL_TEXTURE_2D,   GL_TEXTURE_WRAP_S,GL_REPEAT);
    glTexParameteri(GL_TEXTURE_2D,   GL_TEXTURE_WRAP_T,GL_REPEAT);

    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER,GL_LINEAR);
    glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER,GL_LINEAR);

// send texture data to OpenGL
    glTexImage2D(GL_TEXTURE_2D, 0, GL_RGBA, tw, th, 0,
            GL_RGBA, GL_UNSIGNED_BYTE, texData);
```

Texture Setup

- Code to create a texture from a file (DevIL + OpenGL):

```
unsigned int t, tw, th;
unsigned char *texData;
ilGenImages(1,&t);
ilBindImage(t);
ilLoadImage((ILstring)"Oil_Drum001h.jpg");
tw = ilGetInteger(IL_IMAGE_WIDTH);
th = ilGetInteger(IL_IMAGE_HEIGHT);
ilConvertImage(IL_RGBA, IL_UNSIGNED_BYTE);
texData = ilGetData();

glGenTextures(1,&texID); // unsigned int texID  - variavel global;

glBindTexture(GL_TEXTURE_2D,texID);
glTexParameteri(GL_TEXTURE_2D,  GL_TEXTURE_WRAP_S,      GL_REPEAT);
glTexParameteri(GL_TEXTURE_2D,  GL_TEXTURE_WRAP_T,      GL_REPEAT);

glTexParameteri(GL_TEXTURE_2D,  GL_TEXTURE_MAG_FILTER,     GL_LINEAR);
glTexParameteri(GL_TEXTURE_2D,  GL_TEXTURE_MIN_FILTER,     GL_LINEAR);

glTexImage2D(GL_TEXTURE_2D, 0, GL_RGBA, tw, th, 0, GL_RGBA, GL_UNSIGNED_BYTE, texData);
```

Textures

- Activate 2D texturing (init):

  `glEnable(GL_TEXTURE_2D);`

  Setup

- Before drawing:

  `glBindTexture(GL_TEXTURE_2D, texID);`

- Drawing (VBOs or immediate mode)

- After drawing:

  `glBindTexture(GL_TEXTURE_2D, 0);`

  Render

Tex Coords in immediate mode

- For each vertex define its texture coordinate:

```
glBegin(GL_TRIANGLES);
    glTexCoord2f(s1, t1);
    glVertex3f(x1,y1,z1);
    glTexCoord2f(s2, t2);
    glVertex3f( x2,y2,z2);
    …
glEnd();
```

Textures w/ VBOS - Setup

- Activate arrays:

```
glEnableClientState(GL_VERTEX_ARRAY);
glEnableClientState(GL_NORMAL_ARRAY);
glEnableClientState(GL_TEXTURE_COORD_ARRAY);
```

Textures w/ VBOS - Setup

- Add an array with texture coordinates:
  - Two components per vertex
  - Create an extra VBO;

```
unsigned int vertices, normals, texCoords;
float *v,*n,*t;
int count; // store the number of vertices
...
 glGenBuffers(1, &vertices);
 glBindBuffer(GL_ARRAY_BUFFER, vertices);
 glBufferData(GL_ARRAY_BUFFER, sizeof(float) * 3 * count, v,    GL_STATIC_DRAW);

 glGenBuffers(1, &normals);
 glBindBuffer(GL_ARRAY_BUFFER, normals);
 glBufferData(GL_ARRAY_BUFFER, sizeof(float) * 3 * count, n,    GL_STATIC_DRAW);

 glGenBuffers(1, &texCoords);
 glBindBuffer(GL_ARRAY_BUFFER, texCoords);
 glBufferData(GL_ARRAY_BUFFER, sizeof(float) * 2 * count, t,    GL_STATIC_DRAW);
```

Textures w/ VBOS - Render

- Semantics:

```
glBindBuffer(GL_ARRAY_BUFFER,vertices);
glVertexPointer(3,GL_FLOAT,0,0);

glBindBuffer(GL_ARRAY_BUFFER,normals);
glNormalPointer(GL_FLOAT,0,0);

glBindBuffer(GL_ARRAY_BUFFER,texCoords);
glTexCoordPointer(2,GL_FLOAT,0,0);
```

- Texture bind and call glDraw*

Assignment

- Compute the texture coordinates for the cylinder and floor and apply the given textures:

    - `drawFloor`: add texture coordinates in immediate mode
    - `prepareCylinder`: add texture coordinates using VBOs
    - `drawCylinder`: add texture coordinates buffer and define its semantic
    - `renderScene`: bind textures

Going Further

- Create another texture compatible with the provided template

- Create a template and an example texture for a box

- Are there any issues when applying automatic mipmapping to atlas textures?