GDC 12

THE VOODOO ART OF DYNAMIC WEBGL

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GAME DEVELOPERS CONFERENCE
SAN FRANCISCO, CA
MARCH 5-9, 2012
EXPO DATES: MARCH 7-9
2012

QUICK INTRODUCTION

- Who am I?
- What do I do?
- What is GameMaker:HTML5
- Why WEBGL?

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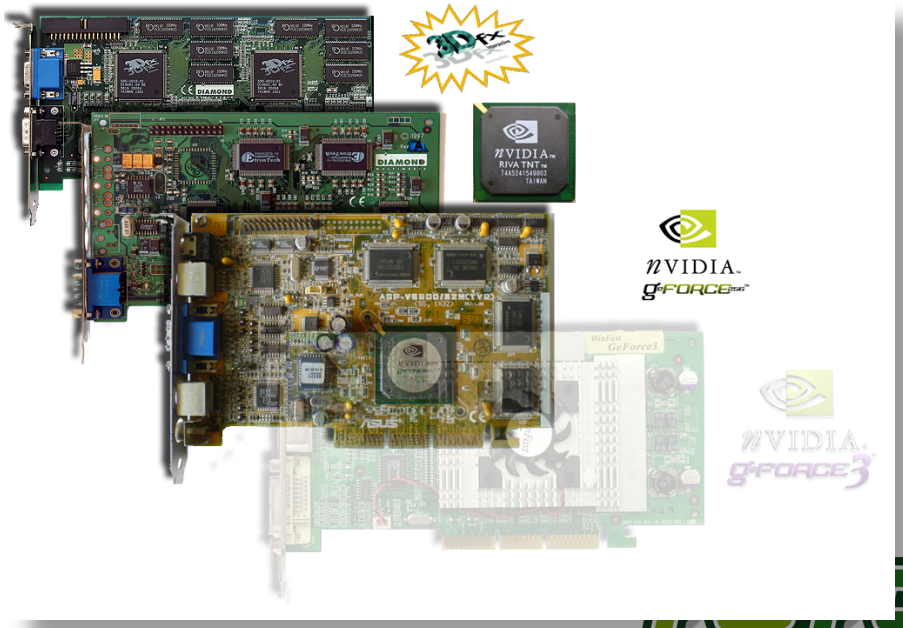
A BRIEF HISTORY LESSON

- THE EVOLUTION OF GRAPHICS CARDS
- WHY THE HELL DO I CARE ABOUT THAT?



GOLDEN RULES OF RENDERING

- Batch
- Batch
- Batch
- Batch
- BATCH!
- OH DEAR LORD YES! BATCH!!
- Render lots.

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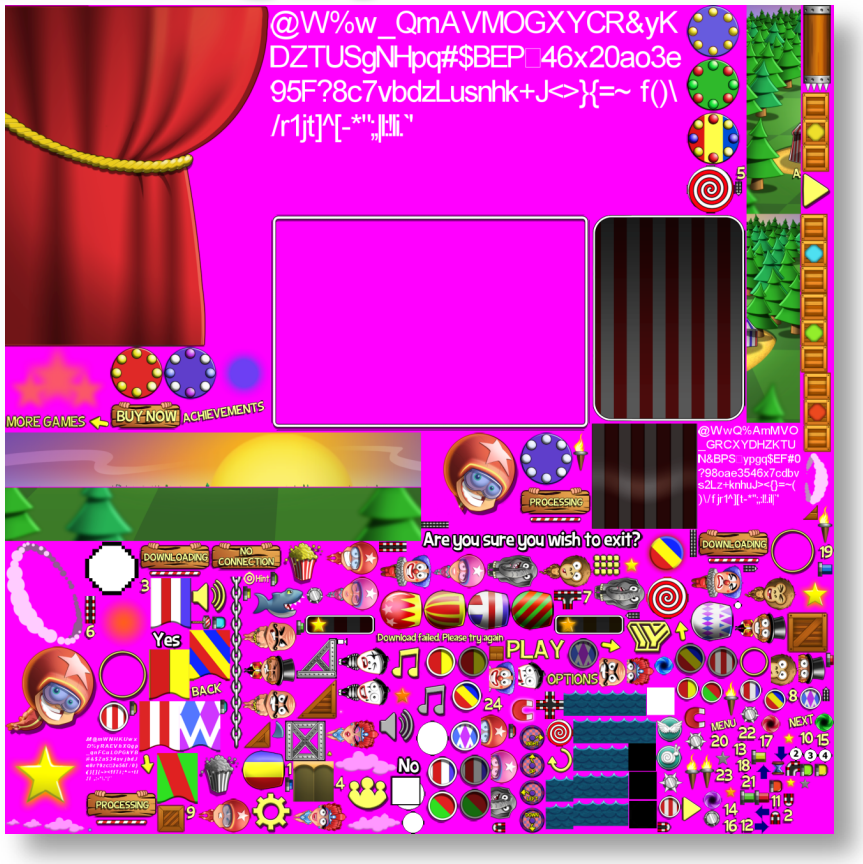
TEXTURE PAGES



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TEXTURE PAGES

- Fit as many sprites onto a page as possible
- Pack as efficiently as possible
- GameMaker Packing rules
  - Remove surrounding space first
  - Remove duplicates where possible
  - Order by size (simple x*y)
  - Add a sprite to position that LEAVES the most space
  - Add a "software" CLAMP border
  - Resize textures for best POW2 fit

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REMOVING SPACE

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REMOVING SPACE

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REMOVING SPACE

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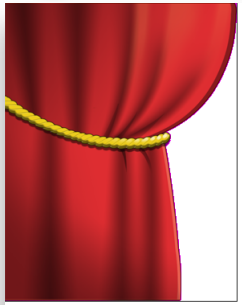
BUILDING THE TEXTURE PAGE



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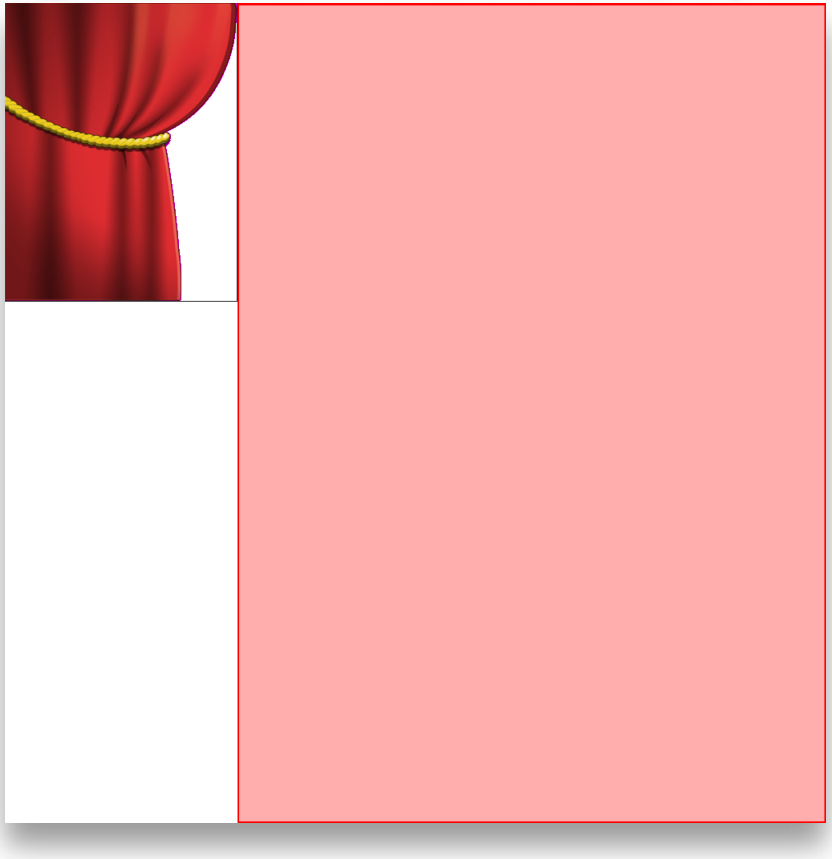

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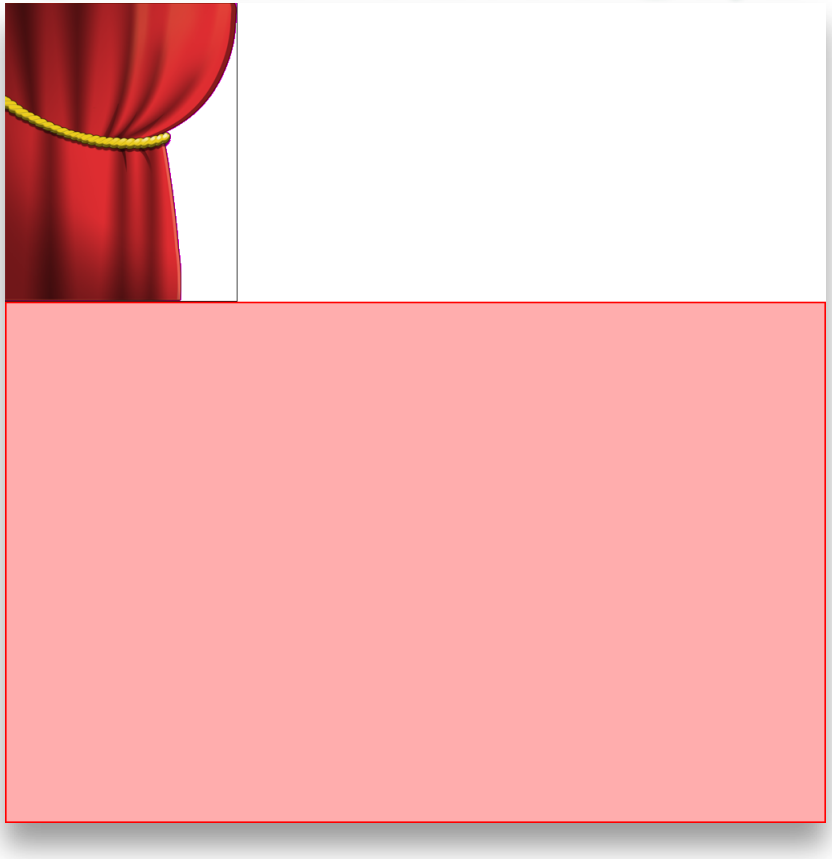

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BUILDING THE TEXTURE PAGE

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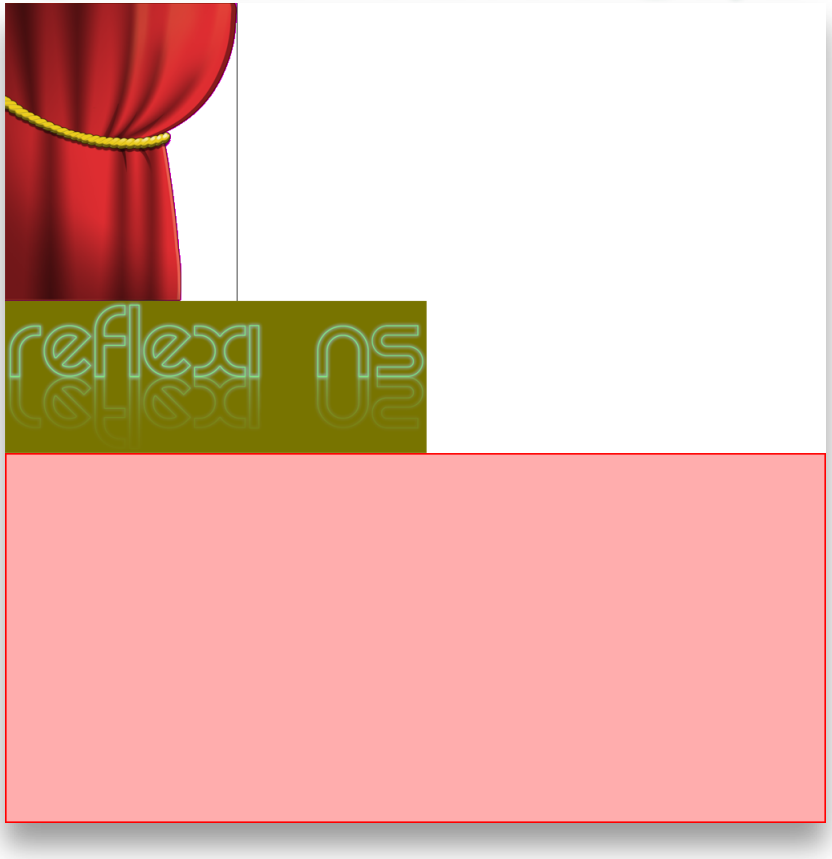

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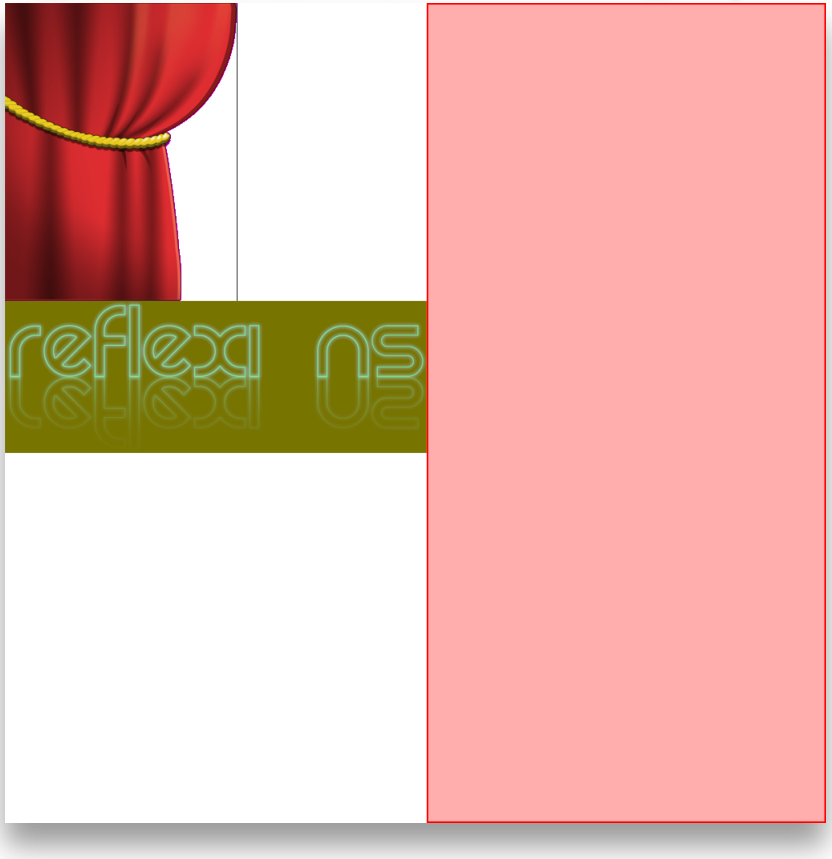

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BUILDING THE TEXTURE PAGE

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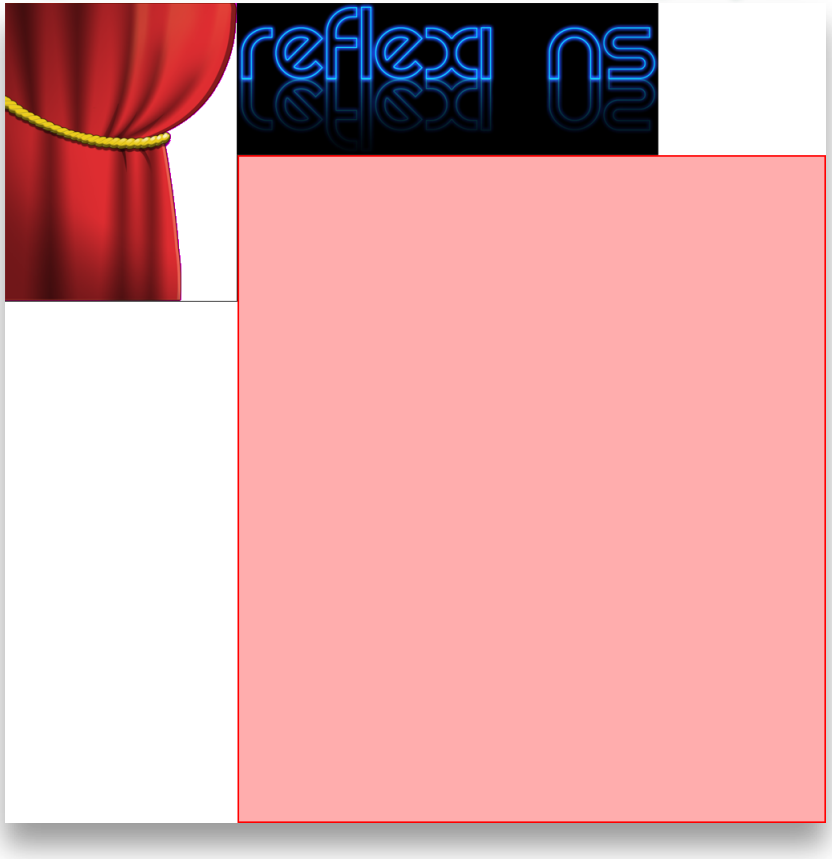

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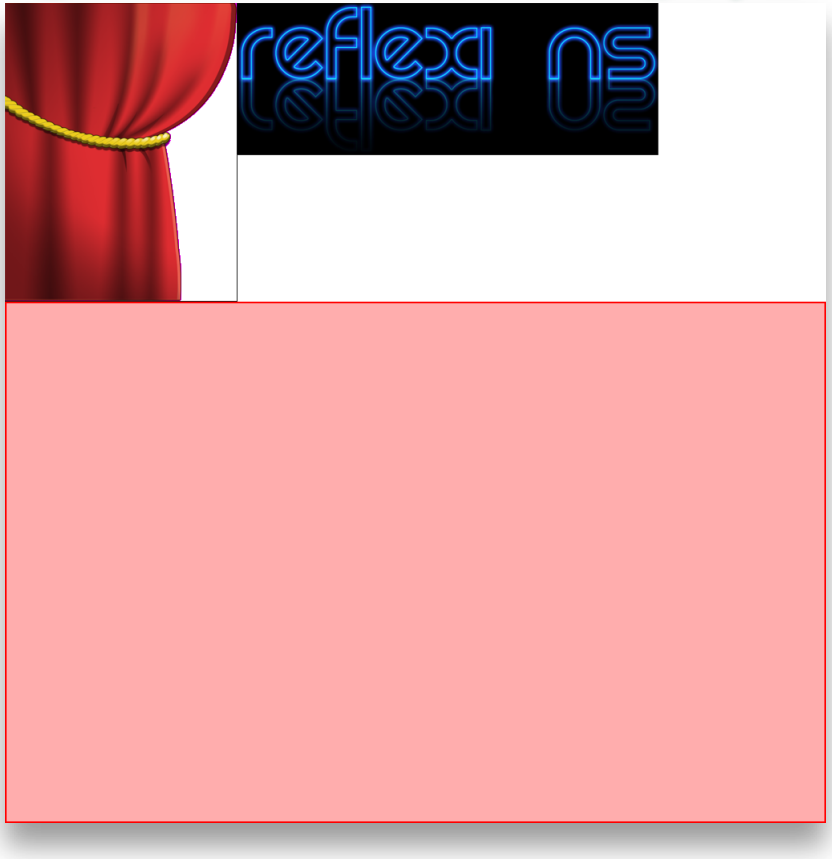

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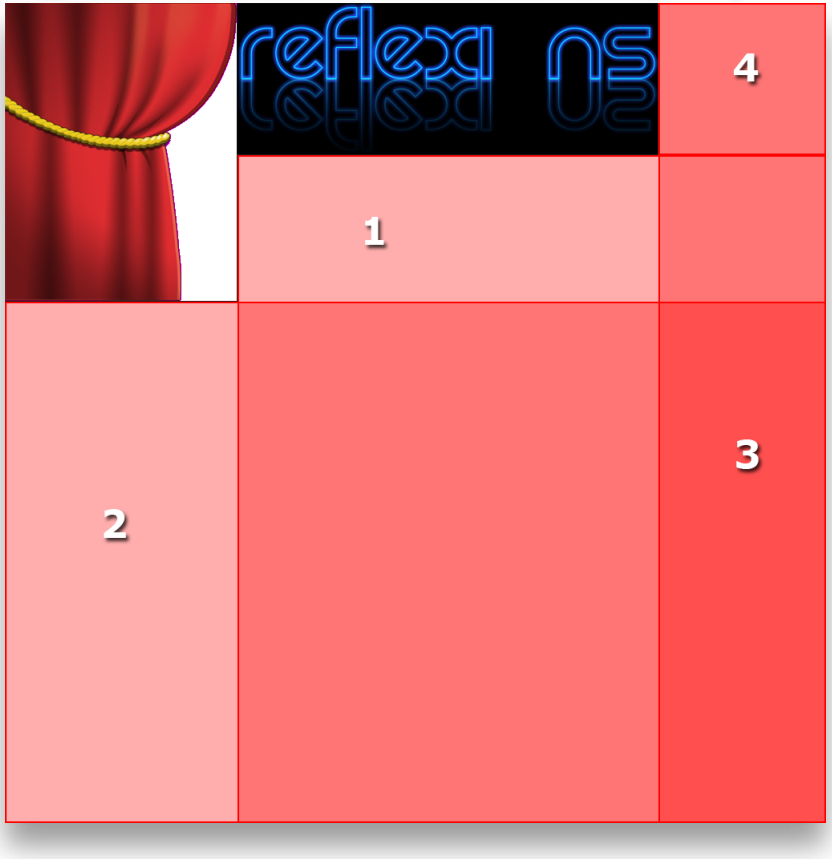

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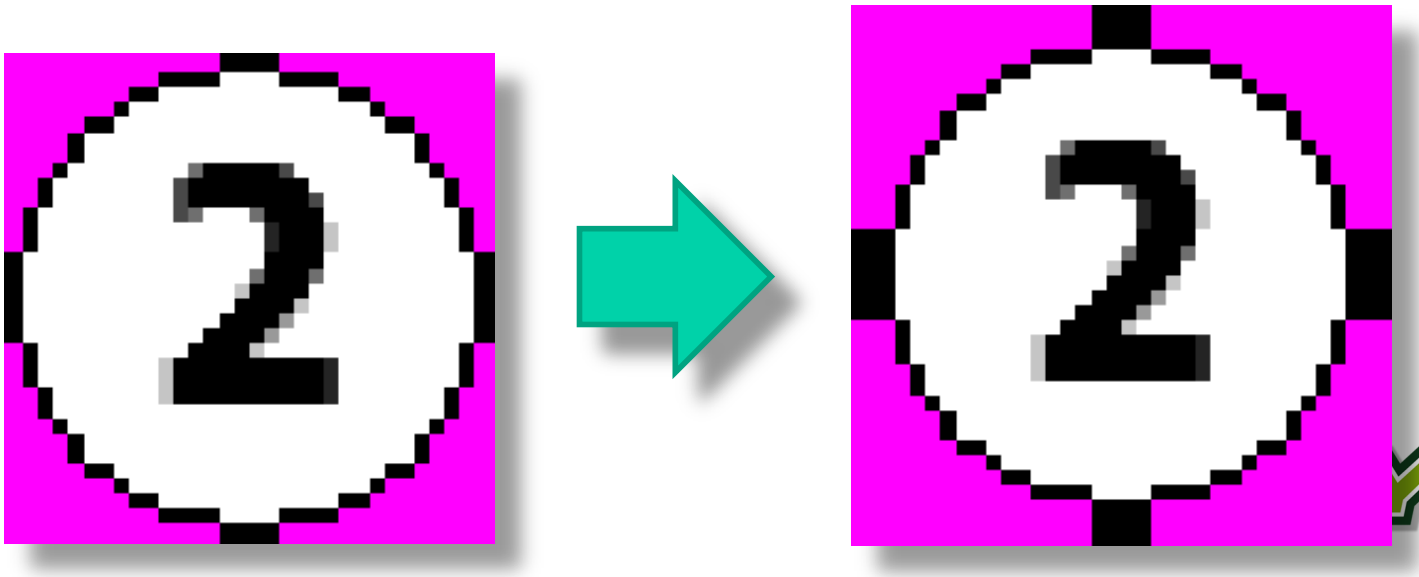
Software Clamp

- Adding a border between images
- Helps avoid scaling issues



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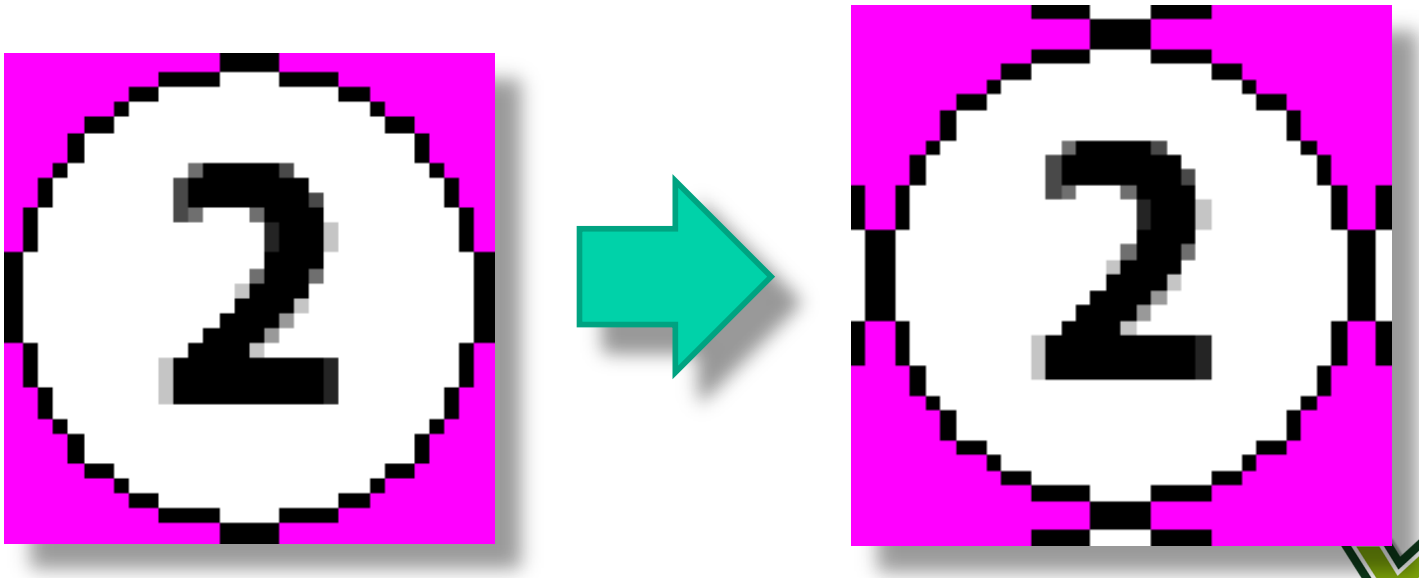
Software Wrap

- Allows proper tiling, even when scaling.



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PRIMITIVE BUILDING AND SUBMISSION

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General Goals

- As fast as possible
- Keep state changes down
- as few vertex buffers as possible
- Automatically batch sprites

Thinking a little differently

- Don't submit as they come
- Build up a whole scene
  - Allows better batching
  - Allows best use of Vertex Buffers

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Drawing a Sprite

- Allocate vertex space
  - Flush primitives on breaking types
    - Primitive Type
    - Texture
    - Buffer Full
  - Remember prim type and texture.
- Add Primitives to the allocated buffer

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DRAWING A SPRITE

```
pBuff = g_VBufferManager.AllocVerts( PRIM_TRIANGLE,        _pTexturePage,
                                     WEBGL_FORMAT_2D,    6 );
pCoords = pBuff.coords;
Index    = pBuff.current;

pCoords[index+ 0] = pCoords[index+ 11] = _x;
pCoords[index+ 1] = pCoords[index+ 12] = _y;

// fill in prim data

pCoords[index+ 9]   = _x;
pCoords[index+ 10] = _y + _height;

pBuff.current += 6;                  // tell the buffer we've used the space
```

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Allocating Vertex Space

- Same type+size+Texture as last request?
  - Return previous buffer if enough space.
- Does it have a breaking change?
  - Flush to command chain
- Record PrimType, TexturePage, Vertex Size
- Loop through buffers and find space
  - If found, return buffer
- Add new buffer to chain and return it

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VERTEX BUFFER CREATION

```
function    yyVBuffer(_size, _FVF) {
        this.FrameLock = -1;
        this.coords =  new Float32Array(_size * 3);          // 24 byte vertex
        this.Uvs      = new Float32Array(_size * 2);
        this.Colours = new Int32Array(_size);

        this.max = _size;
       this.current = 0;
       this.FVF = _FVF;
       this.dirty = false;

        this.pVBuffer_Float  = gl.createBuffer();
        this.pVBuffer_UVs    = gl.createBuffer();
        this.pVBuffer_Colours = gl.createBuffer();

        gl.bindBuffer(gl.ARRAY_BUFFER, this.pVBuffer_Float);
        gl.bufferData(gl.ARRAY_BUFFER, this.coords, gl.DYNAMIC_DRAW);

        gl.bindBuffer(gl.ARRAY_BUFFER, this.pVBuffer_UVs);
        gl.bufferData(gl.ARRAY_BUFFER, this.UVs, gl.DYNAMIC_DRAW);

       gl.bindBuffer(gl.ARRAY_BUFFER, this.pVBuffer_Colours);
       gl.bufferData(gl.ARRAY_BUFFER, this.Colours, gl.DYNAMIC_DRAW);
}
```

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RECORDING THE SCENE

- SIMPLE JS ARRAY [ ] FOR COMMAND LIST
- COMMANDS FOR EVERYTHING.
  - CMD_SETTEXTURE = 1
  - CMD_DRAWTRIANGLE = 2
  - CMD_DRAWTRIFAN = 3
  - CMD_DRAWTRISTRIP = 4
  - CMD_DRAWLINE = 5
  - CMD_DRAWLINESTRIP = 6
  - CMD_DRAWPOINT = 7
  - CMD_SETMARTIX= 8
  - CMD_SETVIEWPORT = 10
  - CMD_SETVERTEXBUFFER = 11
  - CMD_CLEARSCREEN = 12
  - CMD_.....

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THE COMMAND LIST

- ## ADDING A COMMAND

```
yyCommandBuilder.prototype.SetTexture = function (_texture)
{
        // Track texture setting so we don't have redundant texture setting.
        if (this.LastTexture == _texture) return;
        this.LastTexture = _texture;

        this.CommandList.push("SetTexture");
        this.CommandList.push(CMD_SETTEXTURE);
        this.CommandList.push(_texture);
};
```

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COMMAND LIST EXECUTION

```
var i=0;
var CommandList = this.CommandList;
while (i < CommandList.length)
{
        switch (CommandList[i])
       {
            case CMD_SETTEXTURE:
            {
                 var texture = CommandList[i + 1];
                gl.activeTexture(gl.TEXTURE0);
                gl.bindTexture(gl.TEXTURE_2D, texture.webgl_textureid);
                gl.uniform2f(gl.Shader_2D.vertexOneOverUVAttribute, 1.0 / texture.m_Width, 1.0 / texture.m_Height);
                i += 2;
                break;
            }
        }
}
```

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THE SHADER

- **Standard shader – 24 bytes per-vertex**

```
void main(void)
{
   fcolor = color;
   texc   = UV;
   gl_Position = (pmatrix * vmatrix) * vec4( vertex.x, vertex.y, vertex.z, 1);
}
```

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VERTEX FORMATS

- Typed Arrays
  - Int8Array, UInt8Array
  - Int16Array, UInt16Array
  - Int32Array, UInt32Array
  - Float32Array

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BANDWIDTH IS KING

- Optimised shader – 12 bytes per-vertex

```
void main(void)
{
   fcolor = color;
   texc   = UV * oneoveruv;
   gl_Position = (pmatrix * vmatrix) * vec4( vertex.x, vertex.y, 1, 1);
}
```

```
vb_coords = new Int16Array(_size * 2);  // 12 byte vertex
vb_UVs    = new Int16Array(_size * 2);
vb_Colours = new Int32Array(_size);

gl.vertexAttribPointer(gl.Shader_2D.vertexPositionAttribute, 2, gl.SHORT, false, 0, 0);
```

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RESULTS!!

- Chrome
  - 110,000 up from 7000!
- Firefox
  - 80,000 up from 6000
- Opera
  - 20,000 up from 6000
  - a bug has been identified by Opera
- IE9 – ZERO support
  - 3500
  - Use Chrome frame plug-in

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CURRENT CONCERNS

- Chrome has issues @ 60FPS
- Firefox okay, but below par at top end
  - Seems more stable than Canvas!
- Opera 12 not quite ready, but getting there
- Safari. Not on PC, must be enabled on Mac.
- IE9 – ZERO support
  - Use Chrome frame plug-in
  - Chrome + Firefox = over 90% of the HTML5 games market!

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QUESTIONS ? !

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