Part 1: Typography and Layout

CS 148, Summer 2012
Introduction to Computer Graphics and Imaging
Justin Solomon
Non-Technical Aspects

“Darth Vader. Only you could be so bold.”

Intersection of art and design

http://www.ironicsans.com/2008/05/how_bold_can_darth_vader_be.html
Non-Technical Aspects

So you think you can tell Arial from Helvetica?

I've taken 20 logos that were originally designed in Helvetica, and I've redone them in Arial. Some people would call that blasphemy. I call it a challenge: can you tell which is the original and which is the remake?

1) Which one is the original (Helvetica)?

- AGFA
- AGFA

http://www.ironicsans.com/helvarialquiz/
Non-Technical Aspects

Arial & Helvetica

Relatively fine points

http://blog.ocad.ca/wordpress/thegoldenage/files/2011/11/Helvetica_vs_Arial_by_harajukumatt.jpg
http://www.swiss-miss.com/wp-content/uploads/2009/09/d8a5033cb029c5c30d2a93d402def1d9ba7582d_m.png
IDEA PROPOSED

Dave and Holly Combs of ban comic sans have been creating positive messages in public spaces since 2007. (2002 if you count the message to ban comic sans.) Their new project is called the Department of Public Words and it aims to create more positive messages in public spaces through art installations and murals. Find the project on Facebook, and give em a like. More info at: www.DPWords.org

THE COMIC SANS SONG

We wholeheartedly disagree with the message behind this song, but it's really well done so we're sharing it with you.

#22songs - The Comic Sans Song

IDEOLOGICAL BATTLES
Non-Technical Aspects

Department of Public Words

DEPARTMENT OF PUBLIC WORDS

The Comic Sans Song

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#22songs - The Comic Sans Song

Ideaogical battles
References

The Elements of Typographic Style
second edition, revised & enlarged
Robert Bringhurst

The Non-Designer's Type Book
Second Edition
Insights and techniques for creating professional-level type
Robin Williams
Typeface [tahyp-feys]:
Set of characters that share common design features; collection of glyphs.

http://en.wikipedia.org/wiki/Typeface#Types_of_typefaces
Font [font]:
A complete character set of a single size and style of a particular typeface.

http://en.wikipedia.org/wiki/Typeface#Types_of_typefaces
Font vs. Typeface

- Corbel
  - Typeface

- 72-Point Bold Corbel
  - Font
Typeface Variety

Serif (Minion Pro)
- Old Style (Adobe Jenson Pro)
- Transitional (ITC New Baskerville)
- Modern (Bodoni)

Slab Serif (Clarendon)

Sans serif (Myriad)
Typeface Variety

Blackletter (Teutonic No. 1)

DISPLAY (LiquidCrystal)

Monospaced (Courier)

Dingbat (ITC Zapf Dingbats)
Typeface Anatomy

Anatomy of Typography

Nordenx © 2010

http://sirnaseniku.blogspot.com/
Eltra Corp v. Ringer

Typefaces are not eligible under copyright law as “works of art.”
Legal Issues

Ex parte Tayama 1992

Novel and non-obvious typeface designs can be subject to a design patent.


Adobe’s Utopia font protectable under copyright thanks to creative selection of control points
“[T]ypefaces and the characters they contain are ... utilitarian objects whose utility outweighs any merit that may exist in protecting their creative elements. [T]he computer file(s) associated with a scalable font will generally be protected even though the specific design of the characters is not. Furthermore, a rasterized representation ... of the characters in a scalable font is not protected by copyright in the United States.... [T]ypography and calligraphy are not copyrightable in themselves in the U.S.”

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Measuring Fonts

Points (pt)
72 points = 0.996 in
72 points = 1.0 in (for Adobe)

Picas (pc)
12 points = 1 pica
Measuring Fonts

M

Em
Measuring Fonts

Modern definition: Point size

Em
Measuring Fonts

\[ En = \frac{Em}{2} \]
Font size should *not* be measured in pixels.
Font size should not be measured in pixels. 

"Pixels per inch" (PPI)
# Storage: ASCII

![ASCII Table](http://en.wikipedia.org/wiki/ASCII)

## American Standard Code for Information Interchange
Storage: TrueType

- **Character map**
  Unicode to glyph

- **Glyphs**
  Quadratic Bézier curves

- **Hinting**
  Short programs in fonts
Character map
Unicode to glyph

Glyphs
Cubic Bézier curves

Glyph metrics
To help with layout
Text: Words/Sentences

Kerning

[Diagram showing the concept of kerning with the words 'AVWa' and 'AVWa' demonstrating the effect of kerning applied and not applied]
**Text: Words/Sentences**

If you really hate someone, teach them to recognize bad kerning.

In typography, kerning (via wikipedia) is the process of adjusting the spacing between characters in a proportional font, usually to achieve a visually pleasing result. Kerning is the adjustment of the space between individual letter forms.

As you can see in the above comic, the spacing between the C and I and the C and E are different than the rest of the words. And now all of us are going to be those people that recognize bad kerning everywhere we go. Thanks, Randall.

http://xkcd.com/1015/
http://www.explainxkcd.com/2012/02/10/kerning/
Good


Bad


Bad

Text: Words/Sentences

\[ \text{AE} \rightarrow \text{ÅE} \quad \text{ij} \rightarrow \text{ij} \]

\[ \text{ae} \rightarrow \text{æ} \quad \text{st} \rightarrow \text{ṣt} \]

\[ \text{OE} \rightarrow \text{Œ} \quad \text{ft} \rightarrow \text{ſt} \]

\[ \text{oe} \rightarrow \text{œ} \quad \text{et} \rightarrow \& \]

\[ \text{ff} \rightarrow \text{ff} \quad \text{fs} \rightarrow \text{ß} \]

\[ \text{fi} \rightarrow \text{fi} \quad \text{ffi} \rightarrow \text{ffi} \]
Boxes and glue
Layout: The TeX Approach

Box:
- Width
- Height
- Depth

Boxes and glue
Layout: The TeX Approach

Boxes and glue

http://net.ytu.edu.cn/share/%D7%CA%C1%CF/texbook.pdf
Layout: The TeX Approach

Glue:
Space, stretch, and shrink

Boxes and glue
Layout: The TeX Approach

Glue:
Space, stretch, and shrink

Boxes and glue
Layout: The TeX Approach

Glue:
Space, stretch, and shrink

Boxes and glue
- Vertical mode. [Building the main vertical list, from which the pages of output are derived.]
- Internal vertical mode. [Building a vertical list for a vbox.]
- Horizontal mode. [Building a horizontal list for a paragraph.]
- Restricted horizontal mode. [Building a horizontal list for an hbox.]
- Math mode. [Building a mathematical formula to be placed in a horizontal list.]
- Display math mode. [Building a mathematical formula to be placed on a line by itself, temporarily interrupting the current paragraph.]
Recall:

ClearType (Microsoft, 1998)

Subpixel antialiasing

http://en.wikipedia.org/wiki/ClearType
Font Rasterization

1. Outline grid-fitting
2. Outline scan conversion
3. Filling

Adjust for readability
Font Rasterization

Outline grid-fitting

a) character center lying on a pixel center
b) character center lying half-way between pixel centers
Font Rasterization

Recall:

Outline scan conversion
Font Rasterization

Outline scan conversion

Recall:
Font Rasterization

Outline scan conversion
Font Rasterization

Flag = first pixel of a span

Flag image memory

Bit map

Part II: Game Programming Techniques

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“We don’t make big game design documents, rather, we start by creating a playable prototype.... From there, we take an iterative approach to development, in which we play and improve, play and improve for as long as it takes to make a great game.”

- Sid Meier, Firaxis Games
Ludonarrative
[loo-doh-nar-uh-tiv]:
Aspects of storytelling in a video game that are controlled by the user.
http://en.wikipedia.org/wiki/Ludonarrative
Variety of Requirements

First person shooter

2D puzzle

Role playing game

Adventure

Sports

Strategy
Game Loop

While (user doesn't exit)
  Check for user input
  Run AI
  Move enemies
  Resolve collisions
  Draw graphics
  Play sounds
End while

http://en.wikipedia.org/wiki/Game_programming
Considerable Challenge

Many platforms
Considerable Challenge

Many platforms
Scaling [skey-ling]:
Adjusting graphics quality in response to system capabilities.
Limited Resources

- Fill command buffer with GPU commands to prevent “GPU starvation”
- Carefully measure frame rate (easy on fixed hardware)
- Allocate heterogeneous resources
Textures and geometry are expensive!

- **Size**: Amount of space
- **Latency**: Time between request and fulfillment (blocking or non-blocking)
- **Bandwidth**: How much data you can transfer at once
Implementation is hard, deadlines are tight!
Game Engines

- Abstract hardware
- Simplify common rendering tasks
- Maintain scene graph
- Deal with sound and other media
- Provide physics, AI, networking, threading, other features
Primary Bottleneck

Shaders.
Reducing Rendering Load

Use distance to determine model.

Level-of-detail (LOD)

http://www.opensg.org/wiki/Tutorial/OpenSG2/NodeCores
Garland/Heckbert: Quadric Error Metrics

http://www1.cs.columbia.edu/~cs4162/html05s/garland97.pdf
Offline Simplification

Garland/Heckbert: Quadric Error Metrics

http://www1.cs.columbia.edu/~cs4162/html05s/garland97.pdf
Progressive Meshes

M^0 \rightarrow \ldots \rightarrow M^{175} \rightarrow \ldots \rightarrow M^n

base mesh  \rightarrow  vertex split  \rightarrow  edge collapse  \rightarrow  original mesh

Progressive Meshes
Recall:

Subdivision Surfaces
Recall: Subdivision Surfaces

“Infinite LOD”

http://upload.wikimedia.org/wikipedia/commons/3/33/Catmull-Clark_subdivision_of_a_cube.svg
In the Background

Sprites and billboards

http://www.escapistimagery.com/geekpage.htm
http://ars.els-cdn.com/content/image/1-s2.0-S0169204601001220-gr3.jpg
Recall: Culling Techniques

http://www.gamerendering.com/category/optimizations/culling-optimizations/
Intersect objects instead of frustum
Problem: Transparency

What values should be in depth buffer?
Depth Pre-Pass

Render opaque objects into depth buffer first
Shadows

Goal: Render shadows that conform to shape

Shadows

Render depths from light’s point of view.

Shadows

Apply matrix transformation to map to camera space.

Shadow maps

Shadows

Find shadows.

Shadow maps

Shadows

Bad resolution!

http://www.phoesion.com/_/rsrc/1300357721993/features/lighting/shadowmaps/shadow.png

Shadow maps
Shadows

shadowed scene
wireframe shadow volumes

Recall: Silhouette Edge Condition

\[(\vec{k}_o \cdot \vec{N}_0)(\vec{k}_o \cdot \vec{N}_1) \cdot 0\]

Face normals on either side of edge change direction relative to eye.
Recall:

Common Shader Tasks

Bump/normal mapping
Game Physics

Particle systems

http://upload.wikimedia.org/wikipedia/commons/f/f2/Particle_sys_fire.jpg
http://upload.wikimedia.org/wikipedia/commons/7/70/Particle_sys_galaxy.jpg
Game Physics

Rigid body systems

http://rockonflash.wordpress.com/2008/04/07/physaxe-rigid-body-physics-for-haxe-flash-9/
http://static.wolfire.com/legacy/ODEthumb.jpg
http://www-scf.usc.edu/~chiaminc/index_files/image002.jpg
Game Physics

\[ \vec{F} = m \vec{a} \]

\[ \frac{d^2 \vec{x}}{dt^2} = \vec{a}(\vec{x}) \]

Leapfrog integration

Rigid body systems
Leapfrog integration

\[ f'(t) \approx \frac{f(t + \Delta t) - f(t)}{\Delta t} \]
Game Physics

\[ f'(t) \approx \frac{f(t + \Delta t) - f(t)}{\Delta t} \]

Choose relative to frame rate

Leapfrog integration

Rigid body systems
Game Physics

Leapfrog integration

Rigid body systems
Rigid body systems

Leapfrog integration

\[ \vec{v}_{i+0.5} = \frac{\vec{x}_{i+1} - \vec{x}_i}{\Delta t} \]
Game Physics

Leapfrog integration

Rigid body systems

\[ \vec{a}_i = \frac{\vec{v}_{i+0.5} - \vec{v}_{i-0.5}}{\Delta t} \]
Game Physics

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Rigid body systems
Game Physics

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Rigid body systems
Rigid body systems

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\[ \frac{d^2 \vec{x}}{dt^2} = \vec{a}(\vec{x}) \]

Leapfrog integration

\[ \vec{x}_{i+1} = \vec{x}_i + (\Delta t)\vec{v}_{i+0.5} \]

\[ \vec{v}_{i+0.5} = \vec{v}_{i-0.5} + (\Delta t)\vec{a}_i \]

\[ \vec{a}_i = \vec{a}(\vec{x}_i) \]

Rigid body systems
**Game Physics**

1. \( \vec{a}_i = \vec{a}(\vec{x}_i) \)

2. \( \vec{v}_{i+0.5} = \vec{v}_{i-0.5} + (\Delta t)\vec{a}_i \)

3. \( \vec{x}_{i+1} = \vec{x}_i + (\Delta t)\vec{v}_{i+0.5} \)

**Leapfrog integration**

**Rigid body systems**
Game Physics

Rigid body systems

http://www.youtube.com/watch?v=JncQOCggFSo&feature=relmfu
Be careful!
Rigid body systems
Ragdoll systems
The Gravitational Force in Angry Birds Space

By Rhett Allain  March 29, 2012 | 12:11 pm | Categories: Dot Physics, Science Blogs
Follow @rjallain

Now that Angry Birds Space is actually available on various platforms, I realize I made some mistakes. Just to be clear, my previous analysis was based ONLY on a preview video. Now that I actually have the game, I can do a much better job.

The first thing I have noticed is this stuff that I thought was the atmosphere or something.
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