• Lecture #05 – September 10, 2019
• Presentation graphics
• Levels of hardware visualization
  – Sketching
  – Drawing
  – Drafting
  – Solid modeling
• Visual presentation of data
• PowerPoint - friend or foe?
• Designing slides and presentations
Highly Effective Engineering Communication

• A technical presentation stands on three “legs”:
  – Organization
  – Presentation
  – Technical content

• If any of these are missing or messed up, the entire presentation will fail!
Presentation Graphics - The Old Days

Environmental Parameters

Atmospheric Selection

CO₂ Partial Pressure Limit

- All Subjects Effective
- Probable Unconsciousness

Exposure Time, Minutes

CO₂ Partial Pressure, mm Hg

Recommended Atmospheric Composition

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Max Limit</th>
<th>Min Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂</td>
<td>Toxicity (425 mm Hg)</td>
<td>Hypoxia (110 mm Hg)</td>
</tr>
<tr>
<td>N₂</td>
<td>Aeroembolism (136 mm Hg)</td>
<td>FIRE HAZARD (NOT ESTABLISHED)</td>
</tr>
<tr>
<td>CO₂</td>
<td>Hyperventilation (30 mm Hg)</td>
<td>Physiological (UNKNOWN)</td>
</tr>
<tr>
<td>H₂O</td>
<td>Dew Point (13 mm Hg)</td>
<td>Comfort Zone (3 mm Hg)</td>
</tr>
</tbody>
</table>

Partial Pressure

- 158 mm Hg
- 136 mm Hg
- 11 mm Hg

\[ \frac{\Delta P_m}{P_F} = 0.75 \]

\[ \Delta P_m = \text{change in } O_2 \text{ partial pressure} \]

\[ P_F = \text{final total pressure} \]
Presentation Graphics

- Always use landscape, not portrait layout
  - Better fit to screens and projectors
  - Follows natural eye motions
  - Not much choice with computer projections, anyway

- When printed as 8.5”x11”, all features should be readable when laid on the ground at your feet

- All the data goes on the slide - presentations live on after the talk!

- Maximize information density while maintaining legibility, audience comprehension - “bandwidth”
Choosing a Background Format

- Unifying graphical element throughout the presentation
- Especially important for a multi-person team presentation
- Some critical issues to think about:
  - Do the graphics add or detract from the focus of the presentation?
  - Are there other implications for canned backgrounds?
  - How do they look printed out in B&W?
  - How will they look when projected in each possible format (computer, viewgraphs, etc.)?
Slide Layout

• Easy-to-read text
• Adaptable to multiple elements (text, figures, pictures, equations, etc.)

Who’s responsible for this product?

What is this presentation?

What does this fit into?
Slide Layout

- White-on-dark is actually easier to read in partially lighted room
- Problems with printed copies and graphic elements (e.g., equations)

Who’s responsible for this product?

What is this presentation?

What does this fit into?
Another Example of Slide Layout

- Subtle reminder of what the project is all about
- What is the project or program?
- Unobtrusive graphical element for visual interest
- Graphical icon for organization
- Who’s responsible for this product?

Space Systems Laboratory – University of Maryland
Presentation Pitfalls

• Don’t OVERDO The Use Of Capital Letters - And At least Be consistent!
• Proofread! Check the grammar and spelling!
• Jest besides you’re spell-checker don’t flag some ding didn’t mean thee slid is all write!
• Be wary of fancy transitions and effects
• Resist the urge to play games with lots of multiple fonts and colors and sounds and sizes
• Don’t read the viewgraphs to the audience
• Don’t face the screen when you talk
☞ The audience’s attention should be focused on what you’re saying, not how you’re presenting it!
Low Information Density (a haiku)

Some say just six lines
Only six words on each line
They’re totally wrong!
What are the Unknowns in Space Robotics?

(An example of ineffective information transfer)

- Can we count on dexterous robotics to work when planning future missions? What are their capabilities and limitations? Can we build a useful robot for a reasonable amount of money?
- Can we teleoperate in orbit from the ground? What are the performance hits due to time delays? Can advanced control station technologies ameliorate these hits?
- Can a robot be designed to use interfaces other than ones specifically designed for robots? Can robots adapt to EVA interfaces, reducing (or eliminating!) the design overhead for robotic servicing?
- How does increasing the capabilities of a robot through greater numbers of manipulators affect system performance? How can we increase degrees of freedom without proportional increases in operator workload?
- Are interchangeable end effectors a viable approach to increasing dexterity without increasing degrees of freedom? Can we perform EVA tasks without EVA dexterity?
- How does robotic performance change in the presence of realistic (i.e., not perfectly rigid) attachment to the work site? Can robot repositioning capability add to system performance?
What are the Unknowns in Space Robotics?

- Human Workload Issues?
- Control Station Design?
- Manipulator Design?
- Ground Control?
- Flexible Connections to Work Site?
- Multi-arm Control and Operations?
- Robotic Use of EVA Interfaces?
- Utility of Interchangeable End Effectors?
- Ground-based Simulation Technologies?
- Capabilities and Limitations?
- Hazard Detection and Avoidance?
- Development, Production, and Operating Costs?
- Effects and Mitigation of Time Delays?
- Utility of Interchangeable End Effectors?
- Control Station Design?
Sketching

- Pencil-and-paper or simple drawing programs
- Quick representation of concepts
- Invaluable for ensuring that all team members share a common concept
- Talent helps - but lack of it isn’t an excuse for skipping the sketch
Sketching to Effectively Communicate
Drawing

- Formal adherence to dimensions, spatial relationships
- Typically done on specialized drawing or 2D drafting packages (or manually)
- More time-consuming than sketching; arguably faster than solids modeling
- Line drawing typically well suited to publication
Technical Drawing (Three-View) Example

All dimensions in meters
Drafting

- Highly formalized representation of all details of component
- 2D representation of 3D objects through multiple views
- Required mastery of sophisticated software package(s)
- Not generally appropriate for preliminary design activities
Drafting Example
Solid Models

- Allows 3D design, provides most realistic rendering, allows virtual manipulation for comprehension
- Takes the place of several older skills:
  - Technical illustrator
  - Graphic artist
  - Model-maker
Multilevel Interior Layout

Image by Peter J. Schwartz, Rhode Island School of Design
NASA Johnson Space Center Summer Internship, 2016
“Beauty Shots” (Virginia Tech)
and also...
Visualization Models
Full-Scale Mockups
Functional Mockups
Logos and Program Names
Numerical Precision and Units

• Precision: every digit you use says that you know the parameter to that level of accuracy
  – “1 mile” - accurate to ~ 1/2 mile (~800 m)
  – “1.609344 km” - accurate to .0005 m

• Precision is only associated with trailing zeros after the decimal point
  – 13,400; 134; 1.34; .000134 all to 3 places
  – 1.34000 is 6 places of precision

• Only nondimensional parameters should ever appear without units attached
Visual Presentation of Information

The classics in this field are by Edward R. Tufte of Yale University

- *The Visual Display of Quantitative Information*
- *Envisioning Information*
- *Visual Explanations*
- *Visual and Statistical Thinking: Displays of Evidence for Making Decisions*

All from Graphics Press
Basic Concepts

• The primary responsibility is to the data
  – Don’t falsify it
  – Don’t withhold it
  – Don’t obscure it
  – Don’t decorate it

• Maximize the data-ink ratio

• Eliminate chartjunk

• Maintain graphical integrity
Misrepresentation of Data

- Chart only represents one piece of data (26.5°)
- Extra chartjunk (lines, shading, symbols) obscure information content
Misuse of Plotting Features

- Smoothing function without data markers implies continuity that doesn’t exist
- Smoothing function with data markers implies actual data points that don’t exist
- Show actual data with markers - use line only for analytical curve fit
Why Pie Charts Suck

• Absolute data is eliminated in favor of relative comparisons
• Extremely low data-ink ratio
The Only Acceptable Pie Chart

Pie I have eaten

Pie I have not yet eaten
More Bad Plotting Ideas

From USA Today, http://www.usatoday.com, 9/14/05
The “Best Graphic Ever Made”

The “Worst Graphic Ever Made”

The Slide That Was Presented

The Slide That Should Have Been...

Is PowerPoint the Spawn of the Devil?

• Increasing tendency to use PowerPoint presentations as archival documentation

• Unless authors are (unusually) vigilant, much of the modeling and analysis is omitted from review presentation

• In the absence of traditional narrative reporting, critical intellectual content is lost after authors leave

• Conclusions without underlying knowledge frequently create false understandings
Lincoln’s Gettysburg Address

Fourscore and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation or any nation so conceived and so dedicated can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of it as a final resting place for those who died here that the nation might live. This we may, in all propriety do. But in a larger sense, we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead who struggled here have hallowed it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is rather for us the living, we here be dedicated to the great task remaining before us--that from these honored dead we take increased devotion to that cause for which they here gave the last full measure of devotion--that we here highly resolve that these dead shall not have died in vain, that this nation shall have a new birth of freedom, and that government of the people, by the people, for the people shall not perish from the earth.
Gettysburg Cemetery Dedication

Abraham Lincoln

(Concept and implementation by Peter Norvig - see http://www.norvig.com/Gettysburg/
http://www.norvig.com/Gettysburg/making.html
http://www.norvig.com/lancet.html)
Agenda

- Met on battlefield (great)
- Dedicate portion of field - fitting!
- Unfinished work (great tasks)
Not on Agenda!

- Dedicate
- Consecrate
- Hallow
  (in narrow sense)
- Add or detract
- Note or remember what we say

11/19/1863
Review of Key Objectives & Critical Success Factors

- What makes nation unique
  - Conceived in Liberty
  - Men are equal

- Shared vision
  - New birth of freedom
  - Gov’t of/for/by the people
Organizational Overview

11/19/1863

Years

-87 Now

New Nations
Summary

- New nation
- Civil war
- Dedicate field
- Dedicated to unfinished work
- New birth of freedom
- Government not perish

11/19/1863
Solution: High Bandwidth Slides

• Presentations are information transfer, not eye candy
• Explicitly (but succinctly) document your assumptions, model, analysis, results, and conclusions
• Goal: a knowledgeable person in the field can
  – Understand what you did
  – Replicate it themselves
  – Change assumptions and repeat the analysis to find new answers
High Bandwidth Slides

• …are not:
  – Long-winded prose in small fonts
  – Printed equations
  – Cut-and-paste spreadsheets with lots of numbers

• …are:
  – Succinct statements of assumptions
  – Simple, effective graphics communicating modeling and analysis approaches
  – Graphical presentation of results
Optimizing Bandwidth

Information Transfer

Information Density

- Technical Writing
- Ideal
- Pie Charts
- Haikus
- Pretty Pictures
- Optimum Engineering Slides
- Slides w/ Full Backup Info
- Baseball Cards
- Quad Charts
- Run-on Prose
- Cut&Paste Spreadsheets

Optimum Engineering Slides

Pictures — Pictures

Engineering Graphics and Presentations
ENAE 483/788D - Principles of Space Systems Design
Deep Space Habitat

The Deep Space Habitat, in combination with one MMSEV and the CTV, provides habitation for crew members while in transit to and from Near Earth Objects. The habitat has connection adapters in order to dock with the MMSEV, CTV, and the propulsion unit. The MMSEV will supply the main EVA operations for the habitation unit.
Cryo-Propulsion Stage

The Cryo Propulsion Stage (CPS) is sized to deliver an MMSEV one-way from ISS to Earth-Moon LL. The CPS is delivered to ISS with a commercial launch vehicle in the “Heavy” class with offloaded propellant. It is then loaded in orbit. The reusable stage is capable of one-way trips, for crew and cargo between ISS and various LEO destinations, including both GEO and Earth-Moon LL. The CPS includes the avionics, propulsion and attitude control for automated rendezvous and docking. A docking system with fluid transfer interfaces are provided for propellant resupply. Long duration cryogenic fluid management hardware is based on the GRC COLDEST design and limits U12 boiloff to 0.5% per month with no LOx boiloff.

BBC is for CPS #2, propellant for CPS #1 is 25,826 kg
Organizing the Presentation

• *Tell the story!*
• Think about the presentation from the standpoint of an outsider:
  – Why is it worth their time to listen?
  – What’s the critical information they need to know?
  – What message do you want them to take away with them?
• Pitfalls to avoid
  – Fluff and handwaving
  – Data dumps
  – Insufficient frames of reference
  – Needing to foresee the future (forward references)
Akin’s Laws of Spacecraft Design - #20

A bad design with a good presentation is doomed eventually. A good design with a bad presentation is doomed immediately.
Assignment for Today’s Class

• Each design team should select a past U.S. crewed spacecraft (Mercury, Gemini, Apollo, Skylab, Space Shuttle)

• Prepare a slide presentation on your spacecraft. It should include data on the spacecraft (mass, crew size, duration, etc.), mission profile, and a “baseball card” summary

• Everyone *must* use the NX solid modeling program to draw ALL of the graphics for your presentation
Assignment for Today’s Class (2)

• Each person *individually* should create and present their own version of
  – External *dimensioned* three-view
  – “Beauty shot(s)” of vehicle (full render)

• As a team, produce a composite highly detailed model of the spacecraft, including
  – Team exterior three-view and beauty shots
  – Detailed interior views of cabin and all other interior spaces
  – Spacecraft integrated to launch vehicle
  – “Baseball card” with vehicle design parameters

• Everyone on the team must contribute ~equally to the final assembly model - if there are 50 items in the assembly, each person should contribute ~10 *of equal complexity* (no fair specializing in spherical tanks or “mystery boxes”!)
Assignment for Today’s Class (3)

- The goal for this assignment is to give you experience in detailed modeling including complex assemblies.
- At least one of the assembly images should be color-coded to document who did which components.
- Individual grades will be based on the individual models of the vehicle, and the extent that contributions to the group model indicate complex modeling skills and attention to detail.
- Group grade will be based on overall quality and detail of group design models and images.
Just to Make Sure You Understand

For all the term projects you do in this class, you may not use any image of hardware, of any type, for any reason whatsoever, unless you created the image yourself.
Today’s Tools

- You should understand and be able to create and use
  - High information density engineering presentation slides
  - Correctly spelled and grammatically correct text
  - Graphics at all levels from sketching to highly detailed solid modeling
  - A well-planned, consistent presentation that “tells the story” and engages the viewer
  - Graphics which maximize information transfer and minimize obfuscation for the sake of “art”