Engineering Graphics and Presentations

- Lecture #11 – October 1, 2024
- Presentation graphics
- Levels of hardware visualization
  - Sketching
  - Drawing
  - Drafting
  - Solid modeling
- Visual presentation of data
- PowerPoint - friend or foe?
- Designing slides and presentations

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Highly Effective Engineering Communication

- There is no single element more important to your career advancement than the ability to plan and present a clear, concise, and interesting technical presentation
- 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

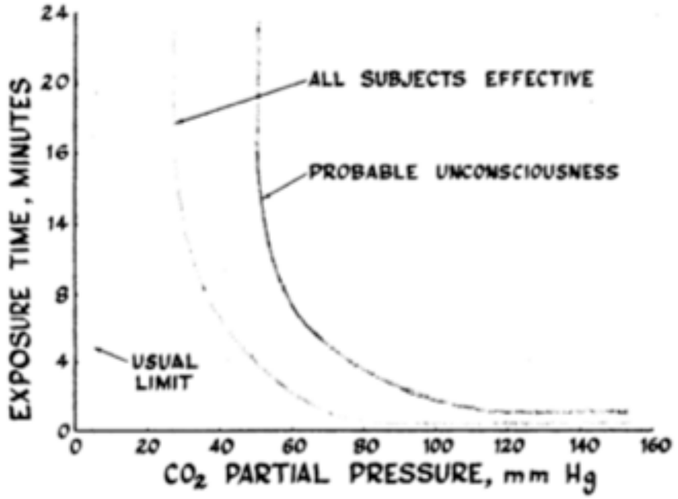
Presentation Graphics - The (Good/Bad) Old Days

GARRETT

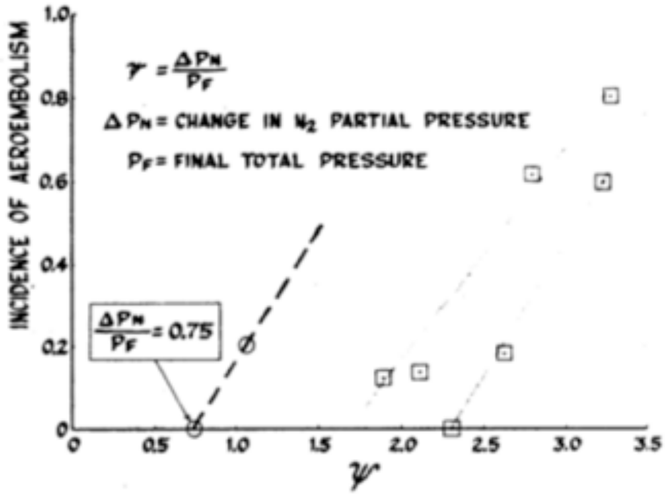
ENVIRONMENTAL PARAMETERS

ATMOSPHERIC SELECTION

CO_2 PARTIAL PRESSURE LIMIT



AEROEMBOLISM CRITERION



RECOMMENDED ATMOSPHERIC COMPOSITION

CONSTITUENT	MAX LIMIT	MIN LIMIT	PARTIAL PRESSURE
O_2	TOXICITY (425 mm Hg)	HYPOXIA (110 mm Hg)	158 mm Hg
N_2	AEROEMBOLISM (136 mm Hg)	FIRE HAZARD (NOT ESTABLISHED) PHYSIOLOGICAL (UNKNOWN)	136
CO_2	HYPERVENTILATION (30 mm Hg)	NONE	5
H_2O	DEW POINT (13 mm Hg)	COMFORT ZONE (3 mm Hg)	11
			310 mm Hg (6.0 psia)

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 be 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.)

Slide title

Unobtrusive graphical element(s) for visual interest

Who's responsible for this product?

What is this presentation?

What does this fit into?

Slide Layout

Slide title

Unobtrusive graphical element(s) for visual interest

- 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

Low-Cost Return to the Moon

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!
- Proofreed! Chek teh grammer andd speling!
- 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

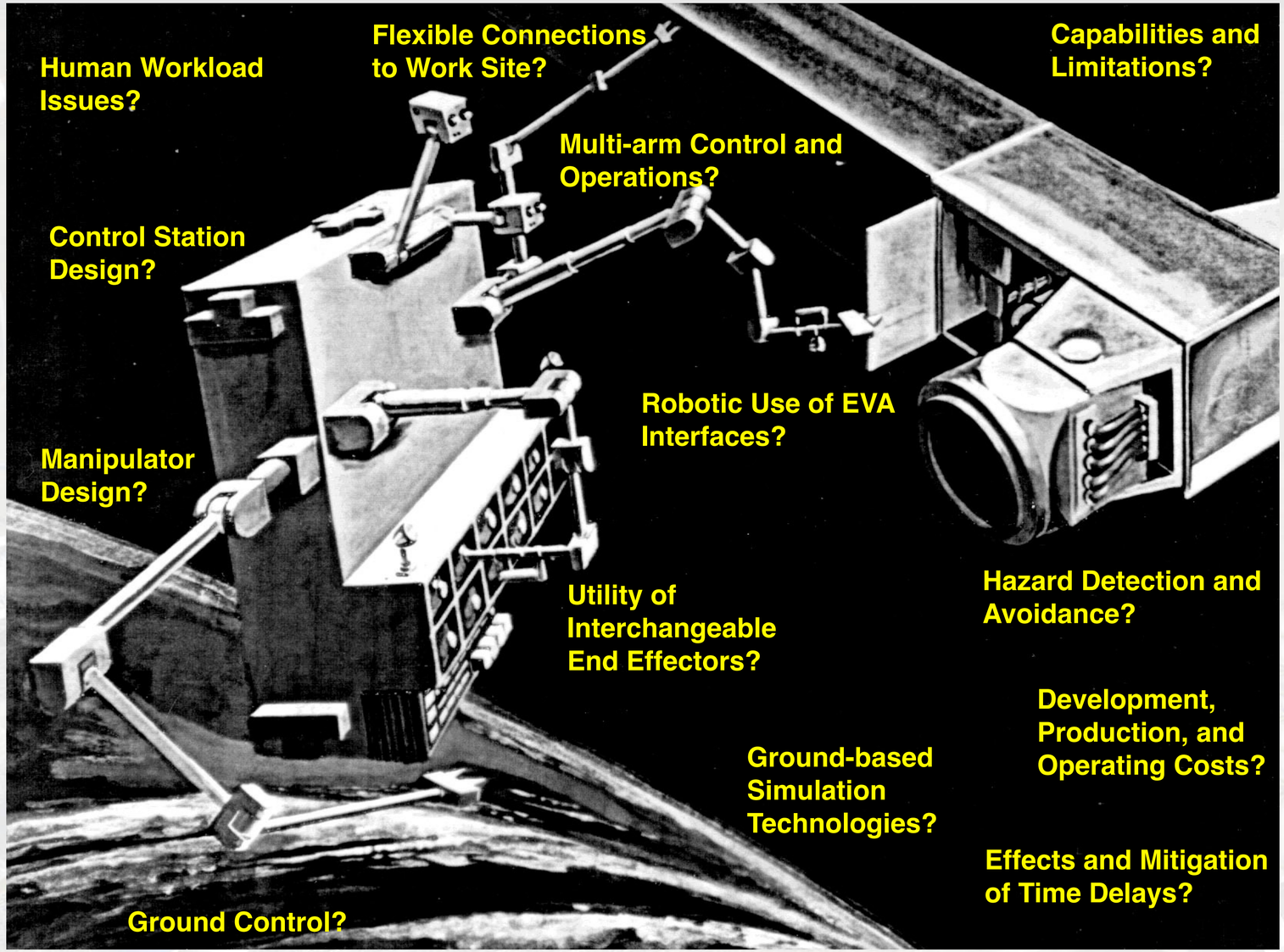
Only six words on each line

They're totally wrong!

What are the Unknowns in Space Robotics?
(An example of ineffective information transfer)

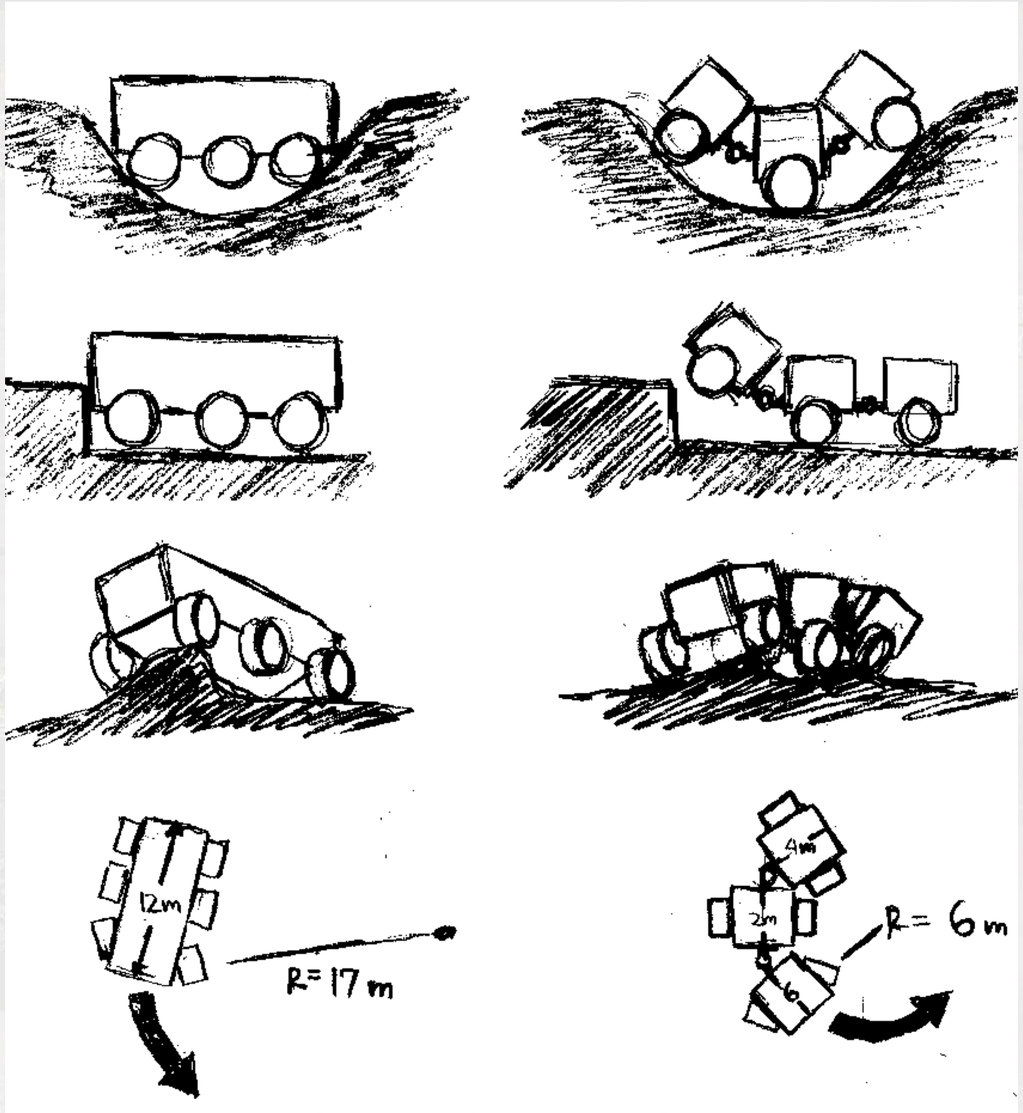
- Can we count on dexterous robotics to work when planning future missions? What are their capabilities and limitations? Can we build a useful robot for a reasonable amount of money?
- Can we teleoperate in orbit from the ground? What are the performance hits due to time delays? Can advanced control 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?

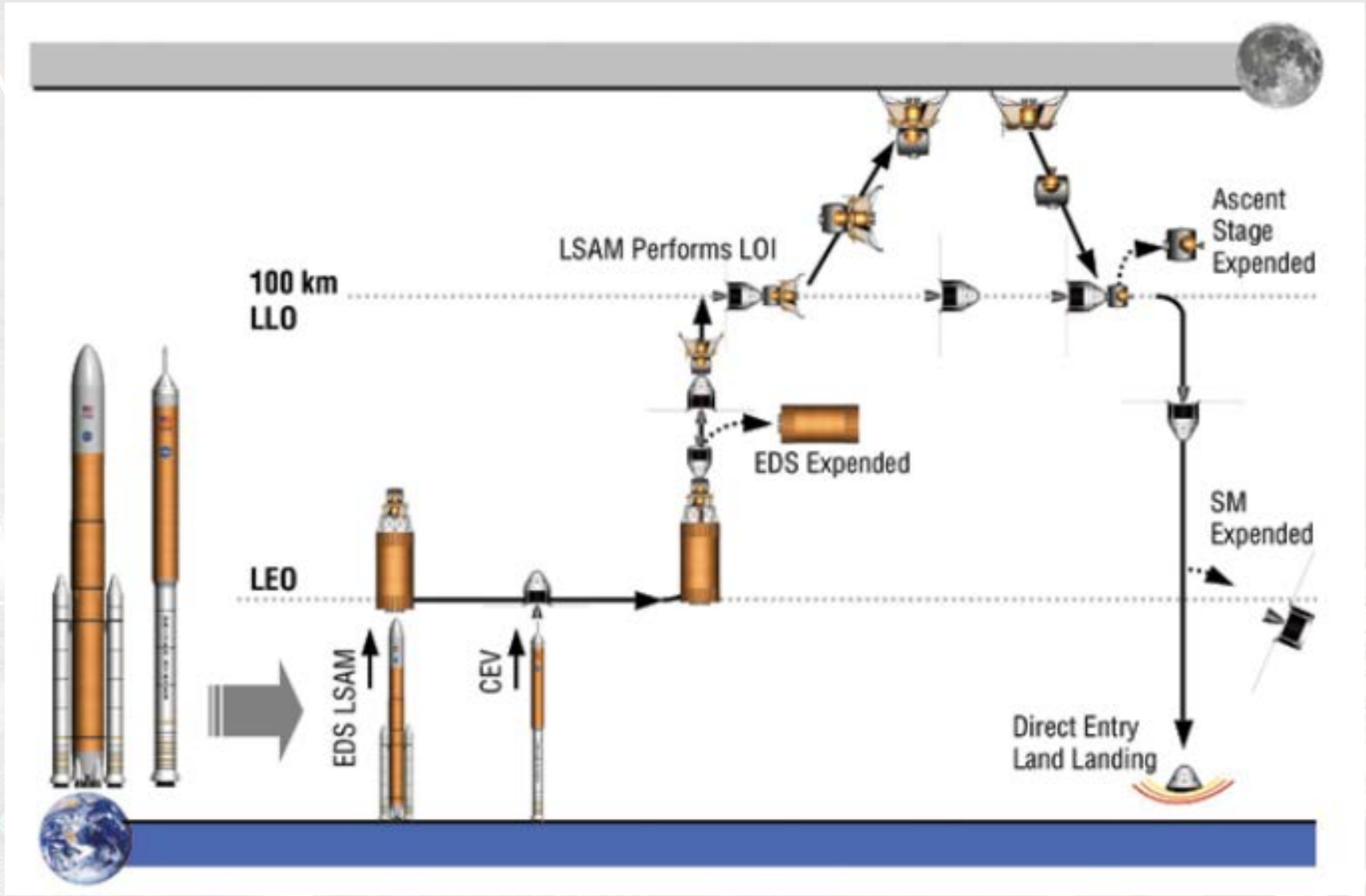


Sketching

- 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



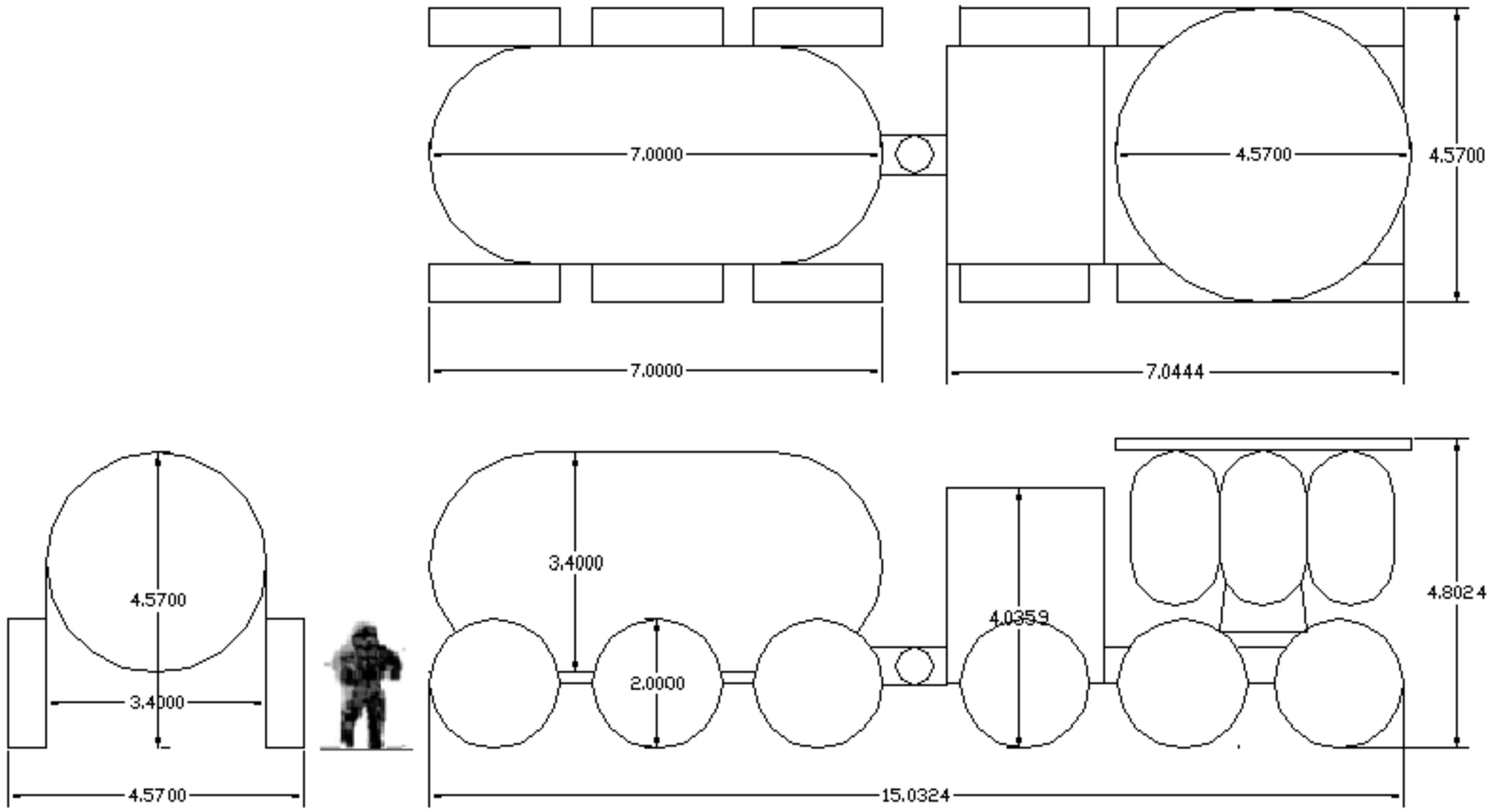
Sketching to Effectively Communicate



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

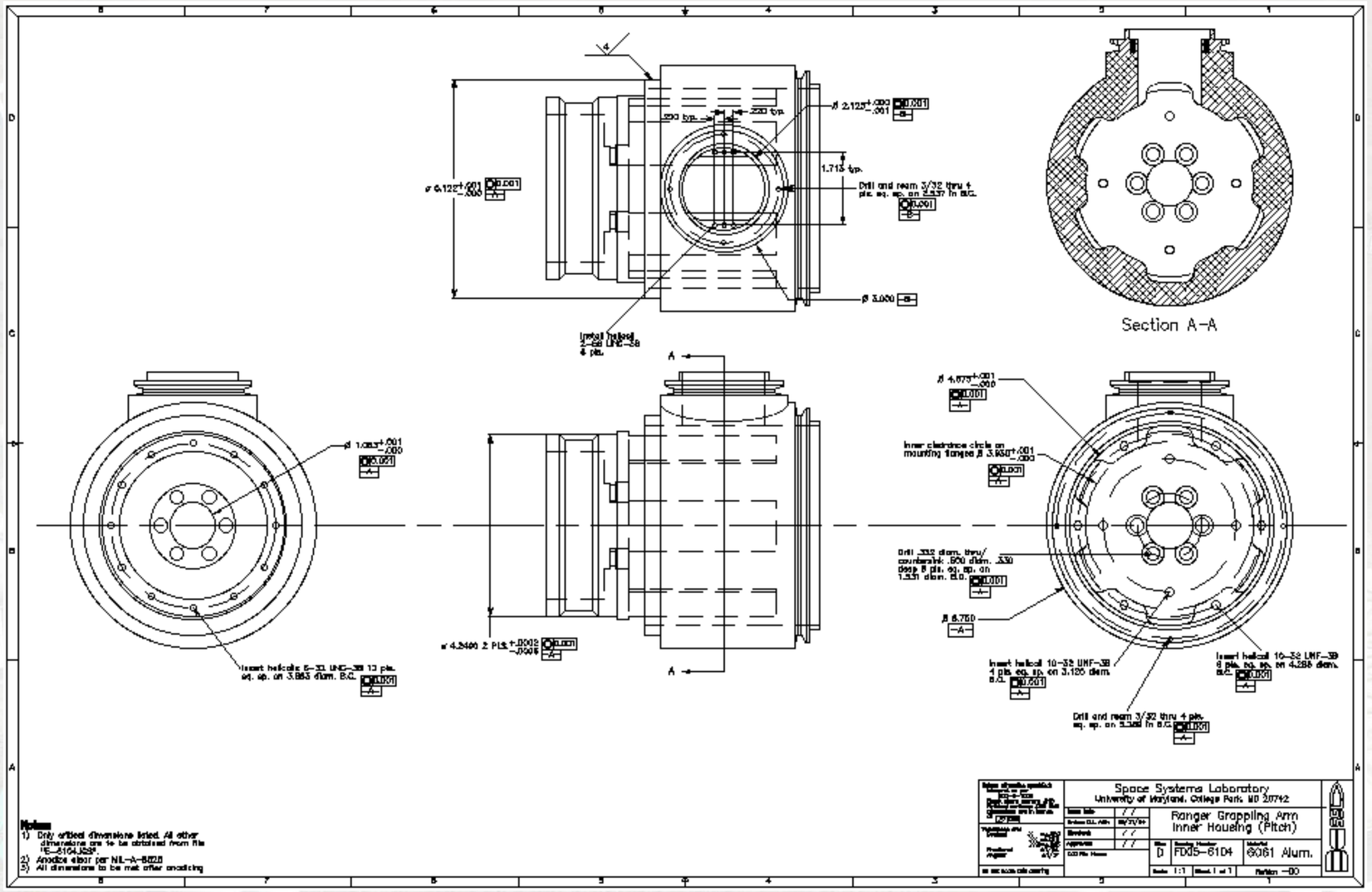


All dimensions in meters

Drafting

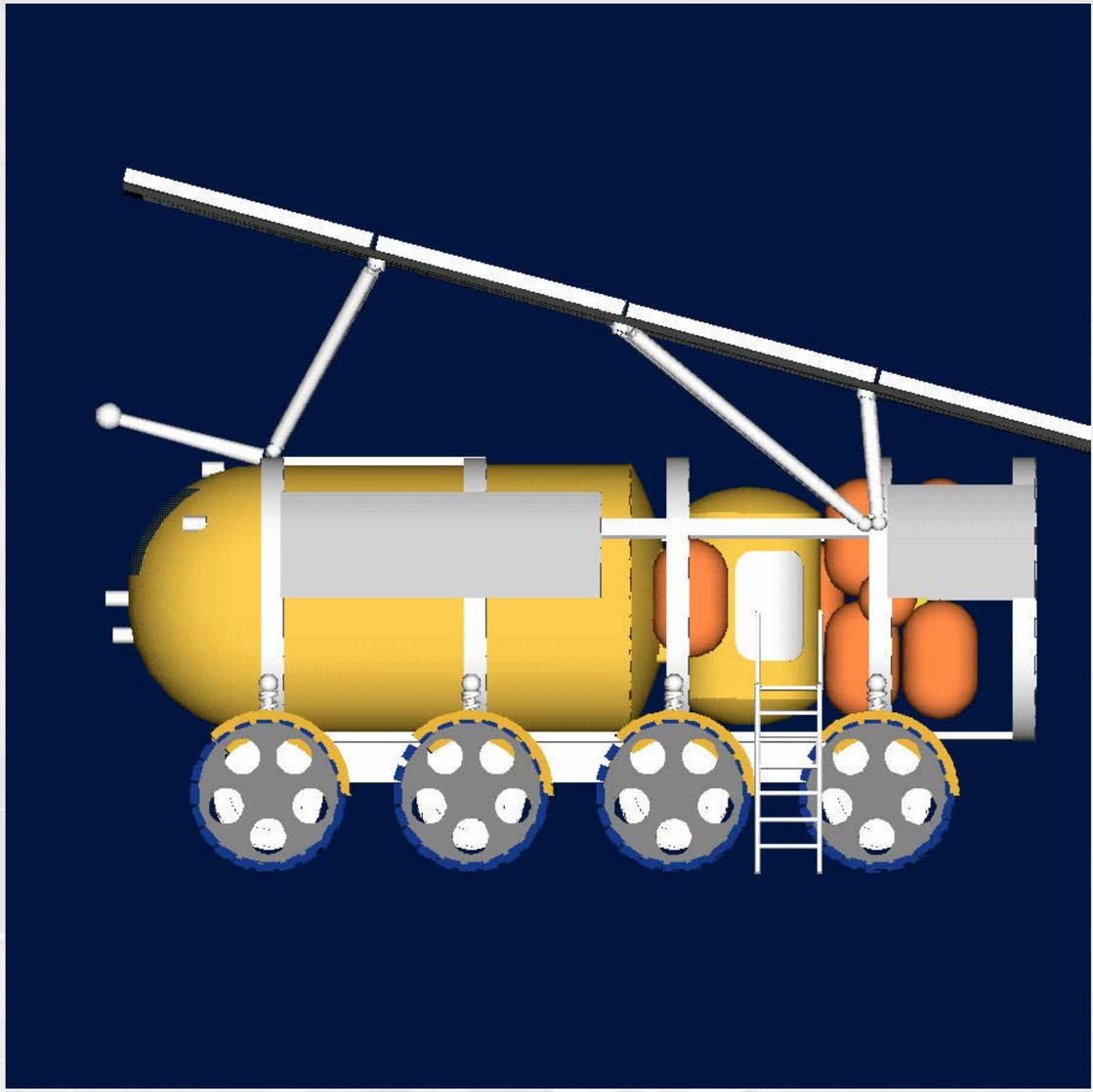
- Highly formalized representation of all details of component
- 2D representation of 3D objects through multiple views
- Required mastery of sophisticated software package(s)
- Not generally appropriate for preliminary design activities

Drafting Example

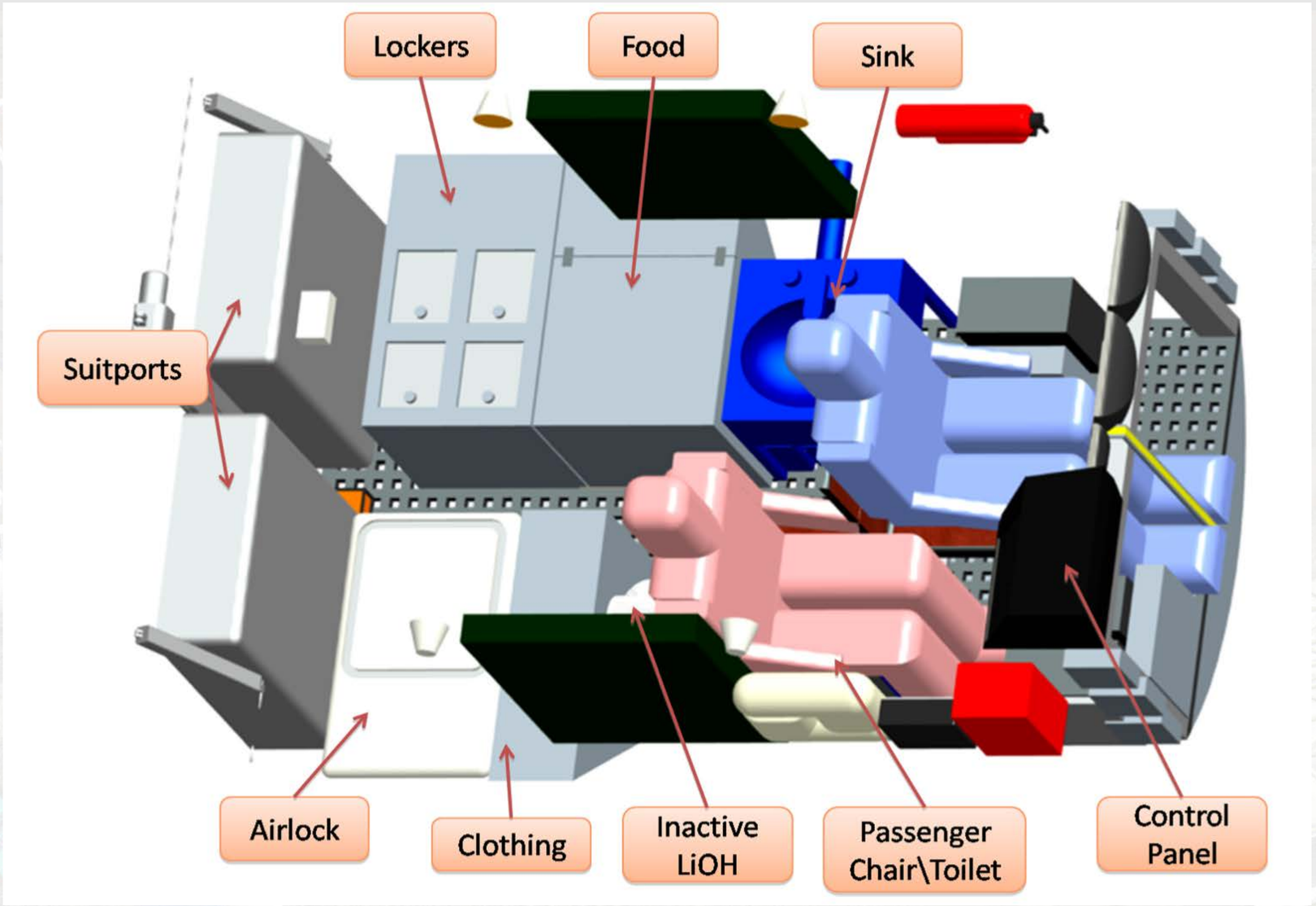


Solid Models

- 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



Internal Layouts



Multilevel Interior Layout

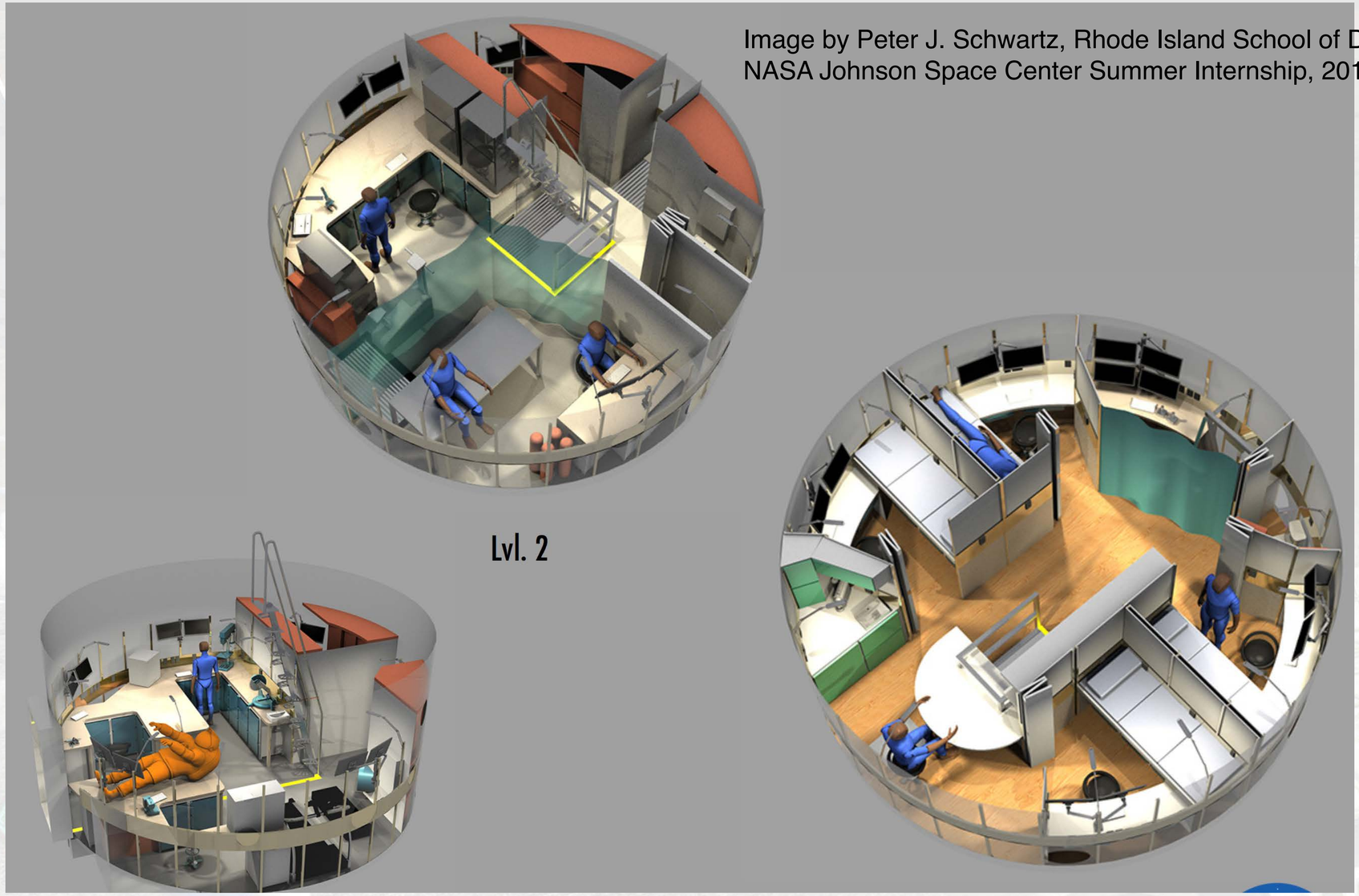
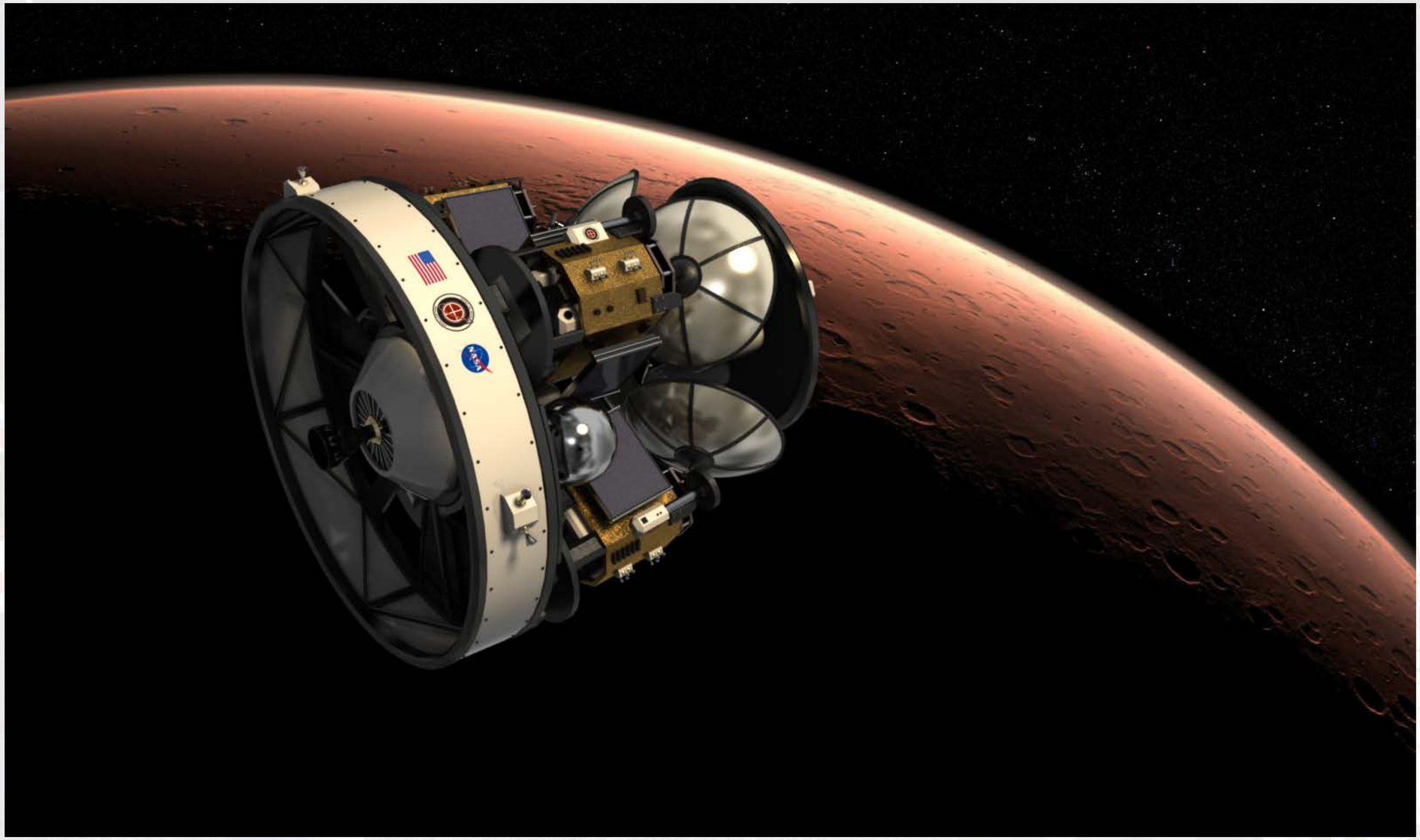
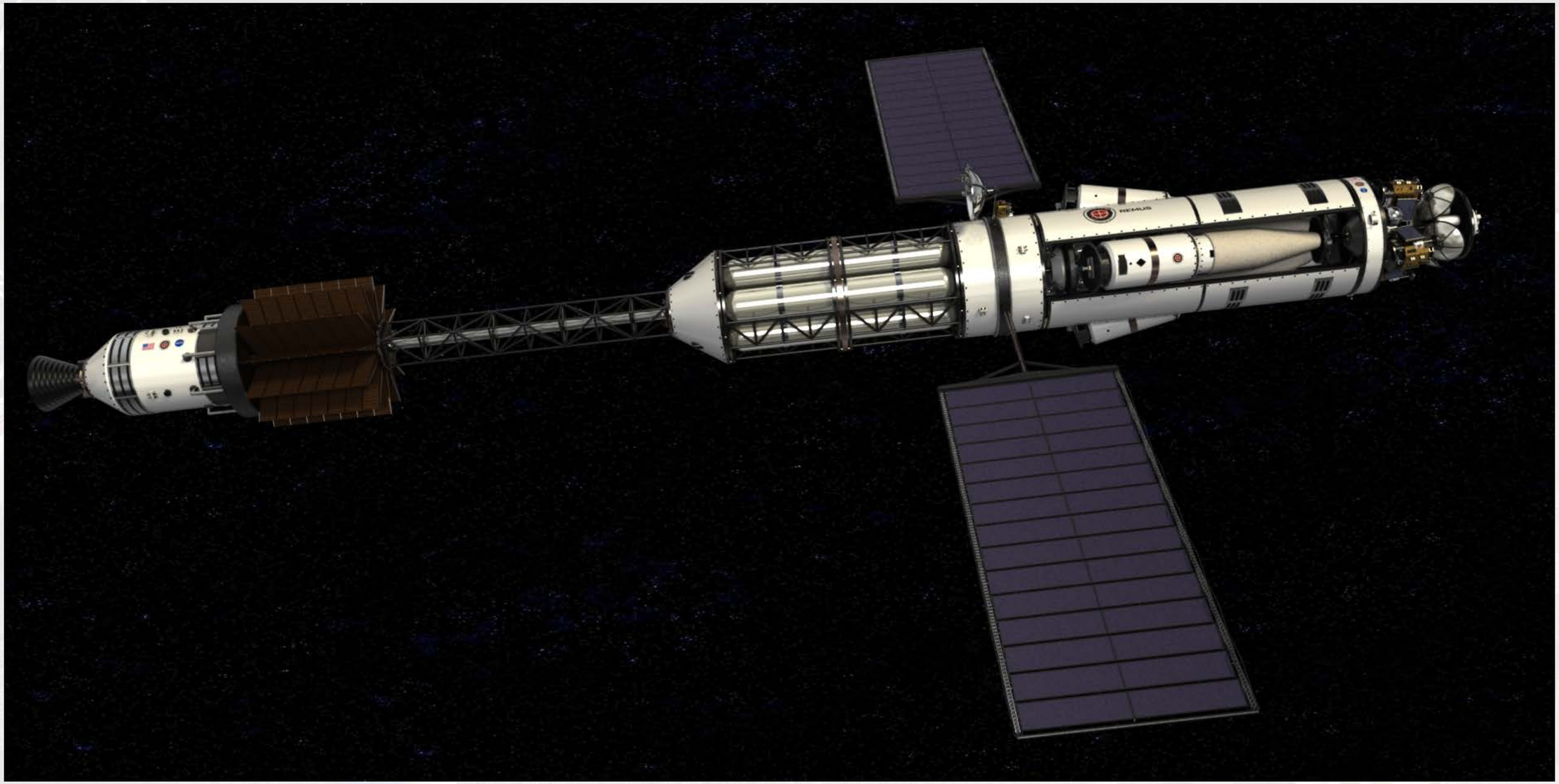


Image by Peter J. Schwartz, Rhode Island School of Design
NASA Johnson Space Center Summer Internship, 2016

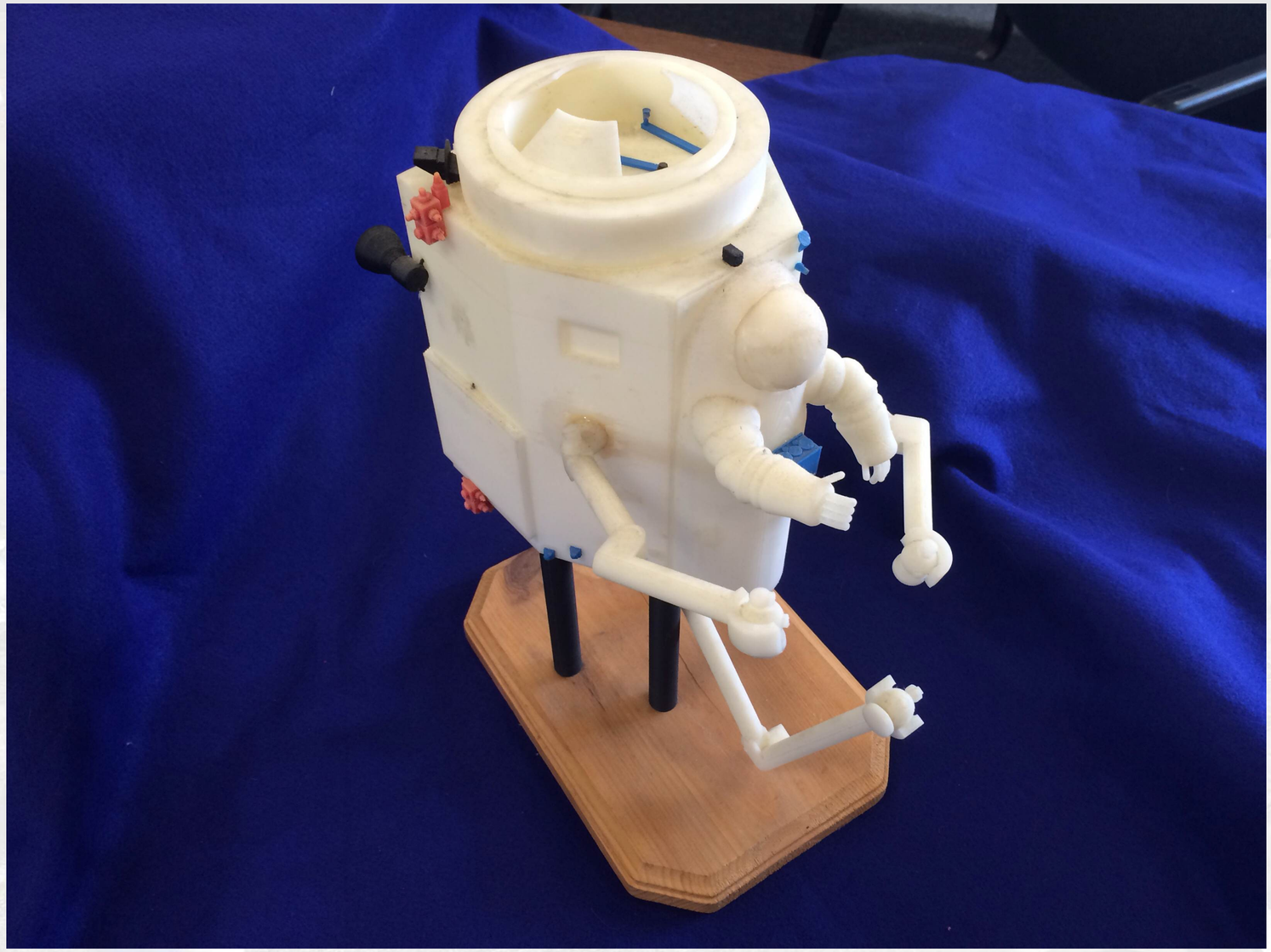
“Beauty Shots” (Virginia Tech)



and also…



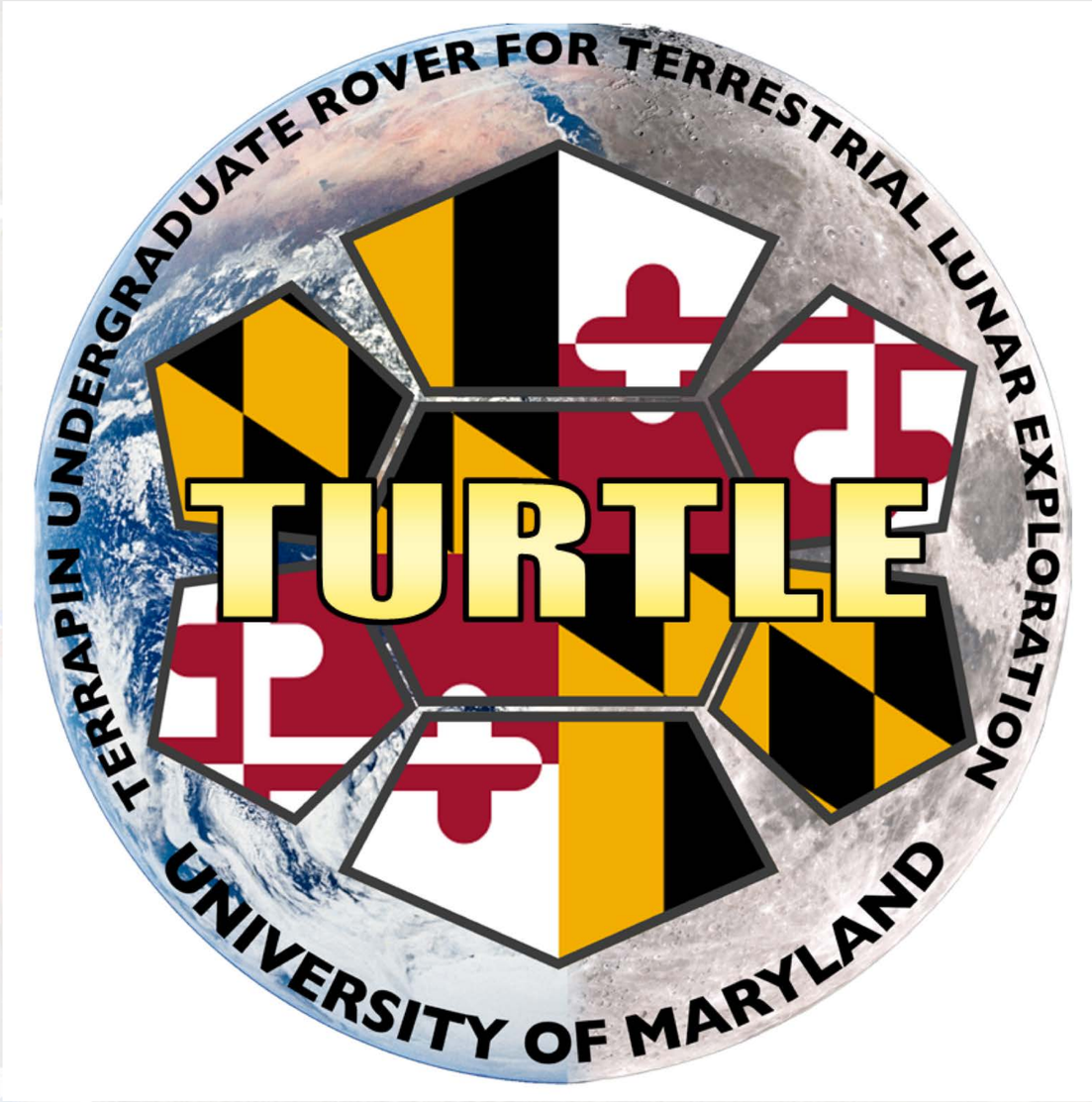
Visualization Models



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*

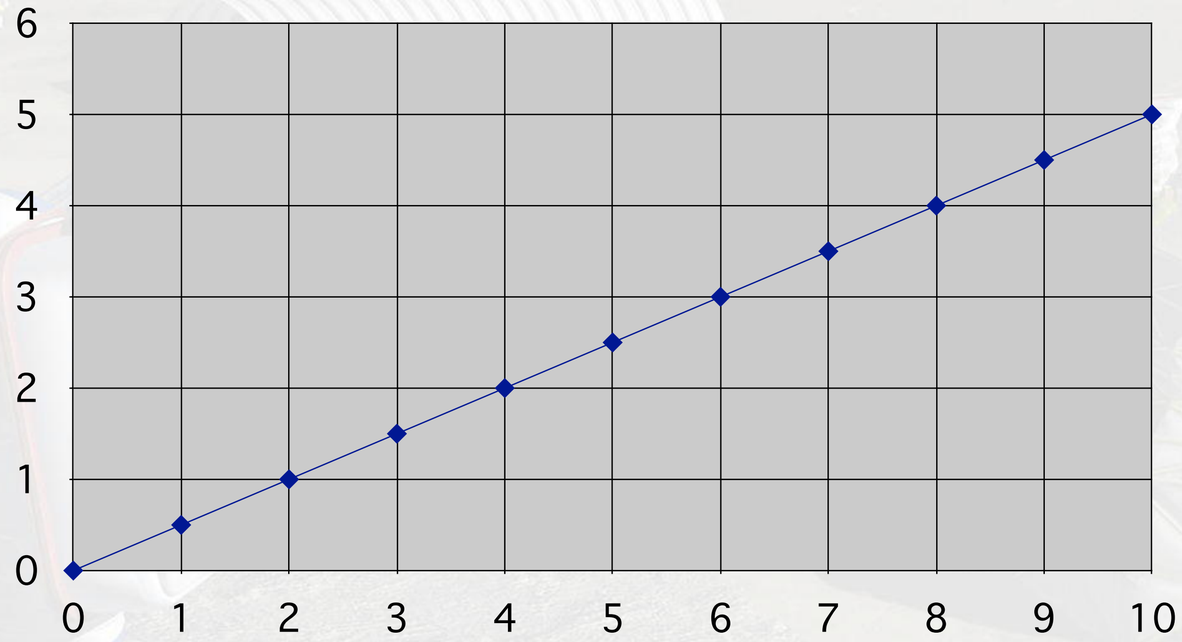
All from Graphics Press

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

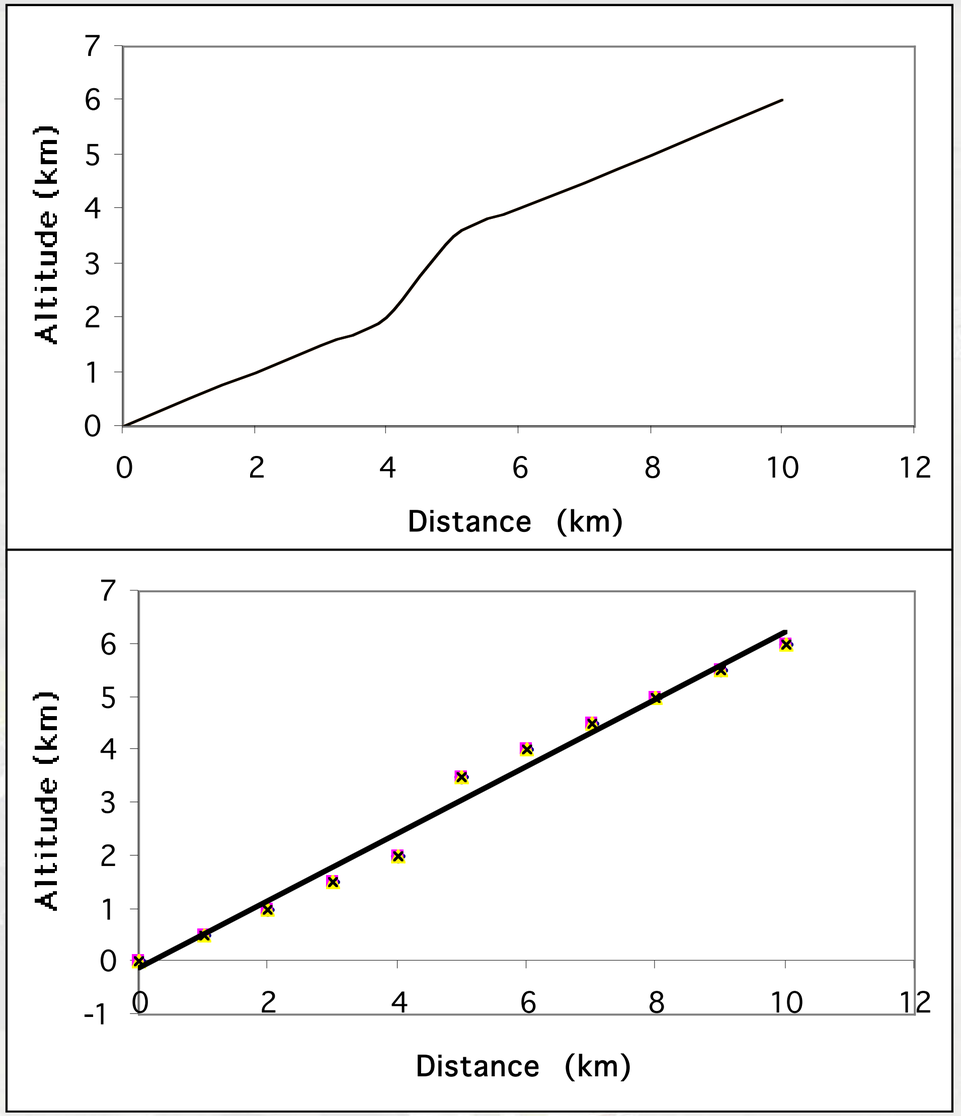
Misrepresentation of Data

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



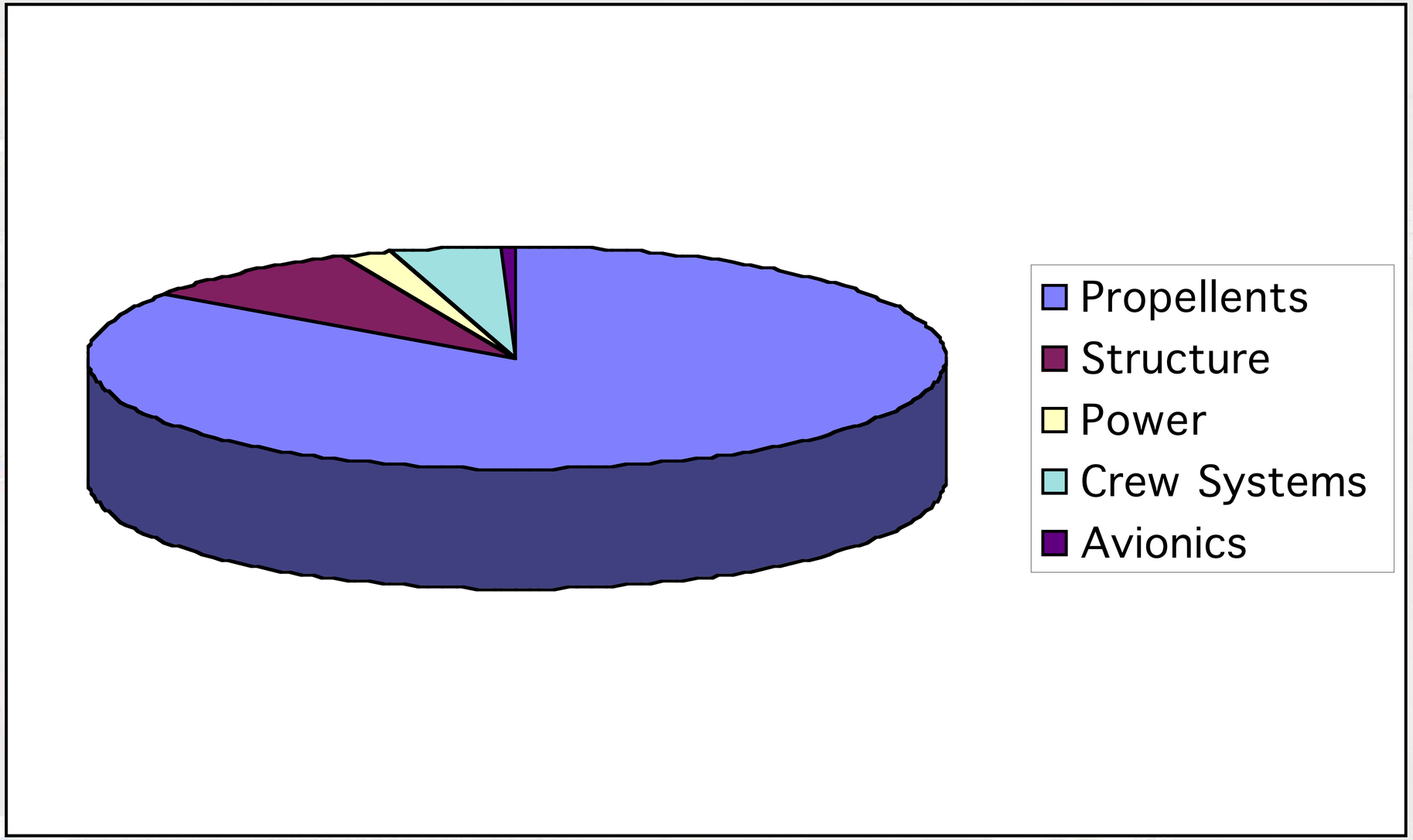
Misuse of Plotting Features

- 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



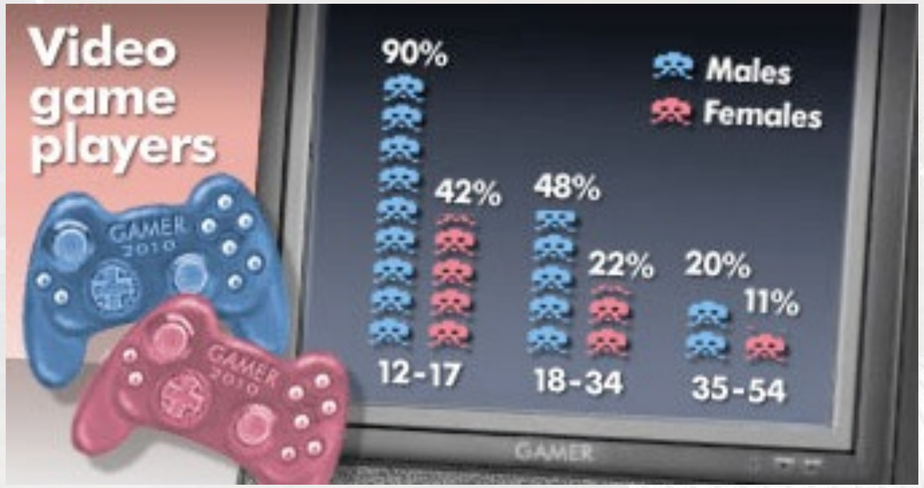
Why Pie Charts Suck

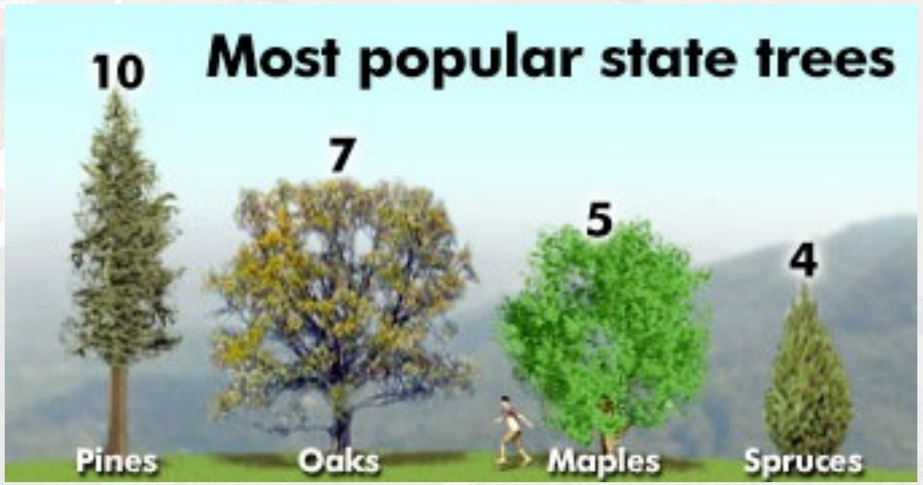
- Absolute data is eliminated in favor of relative comparisons
- Extremely low data-ink ratio



The Only Acceptable Pie Chart

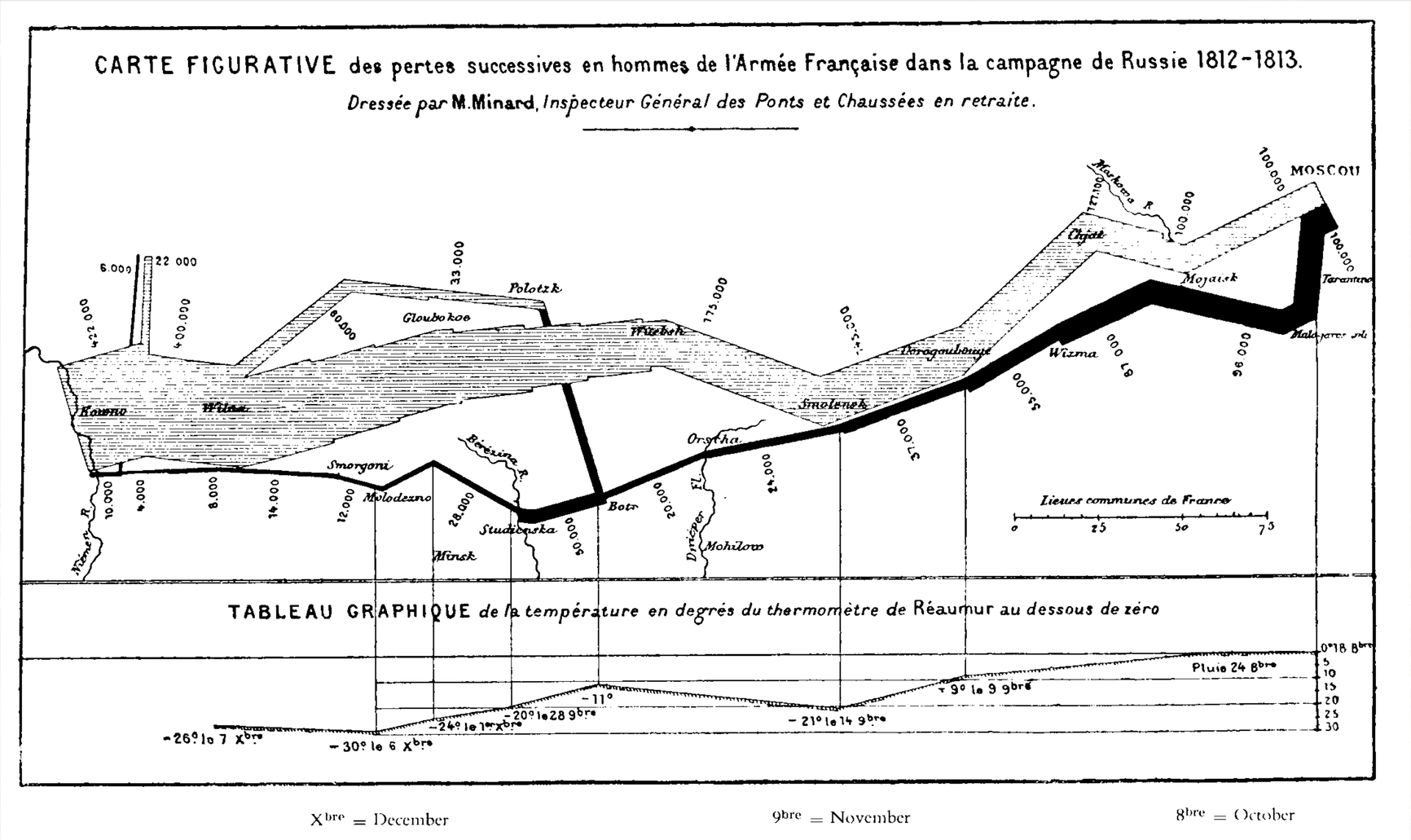
More Bad Plotting Ideas





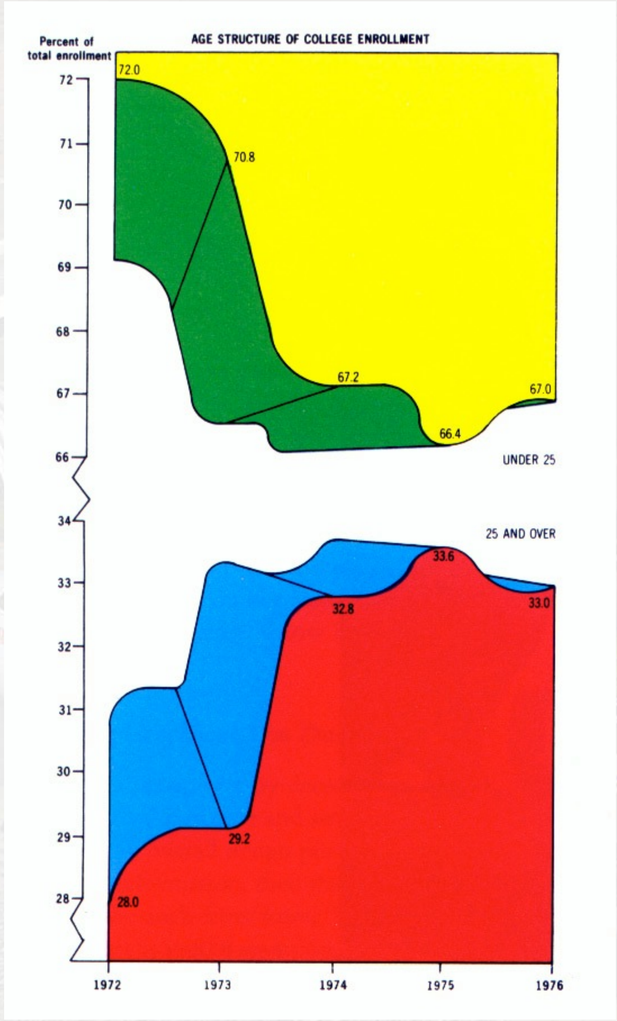
From USA Today, http://www.usatoday.com, 9/14/05

The "Best Graphic Ever Made"



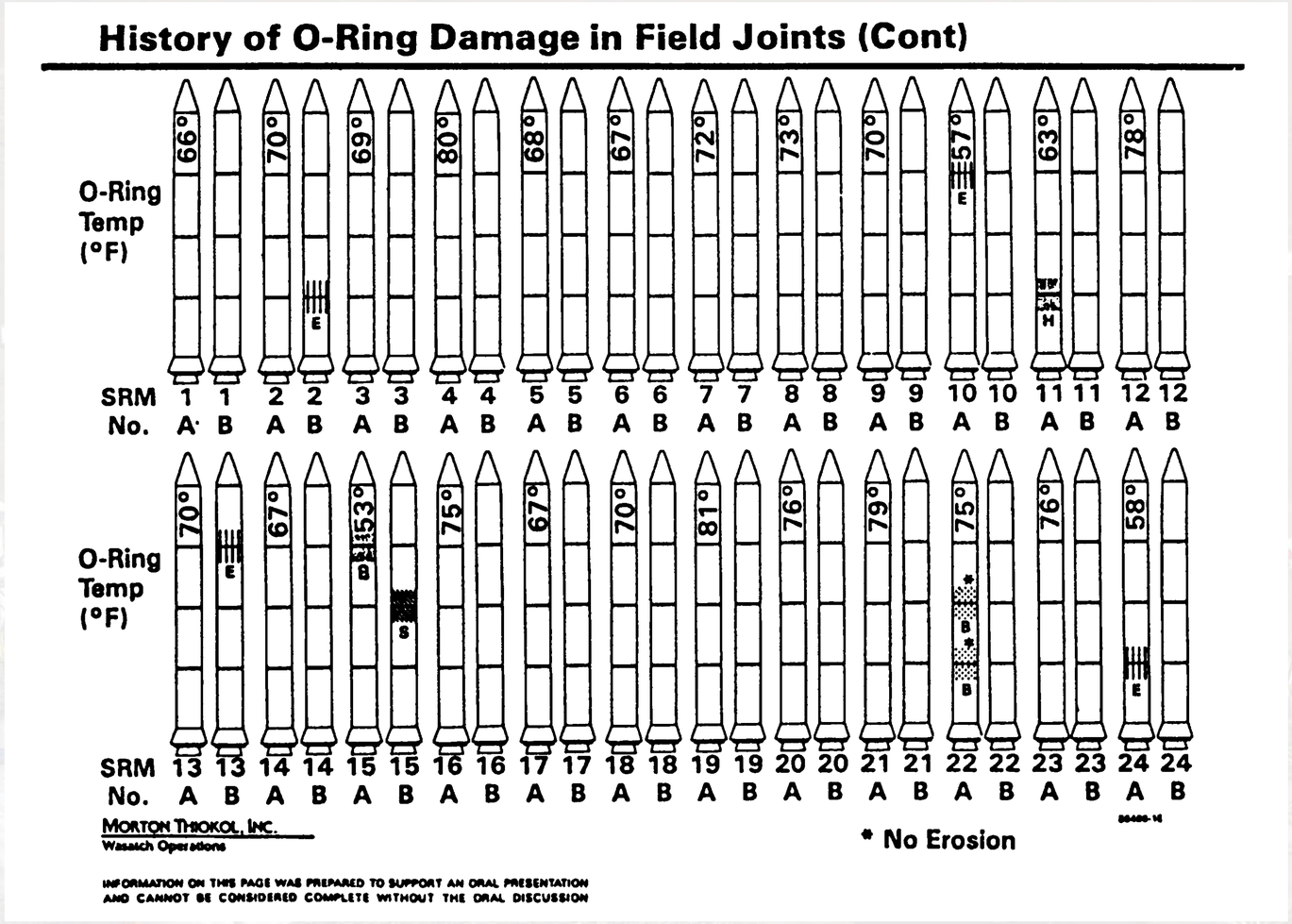
From Edward R. Tufte, *The Visual Display of Quantitative Information* Graphics Press, 1983

The "Worst Graphic Ever Made"



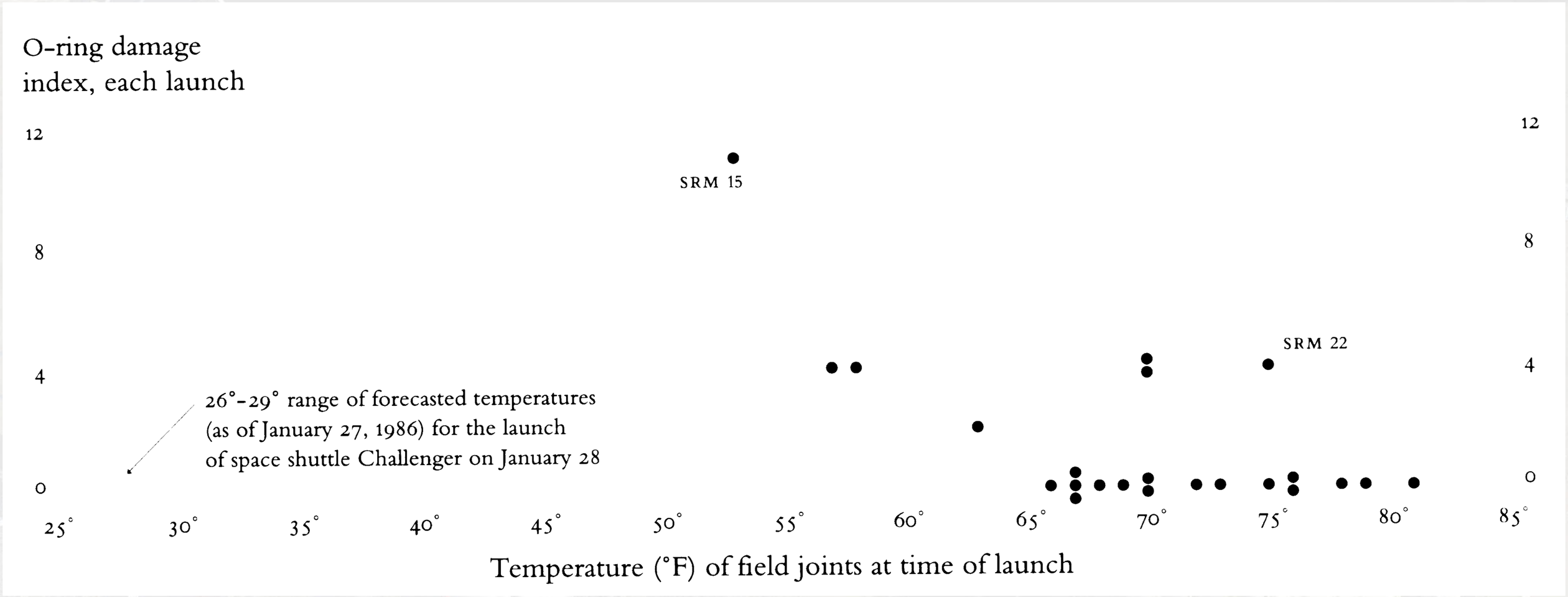
From Edward R. Tufte, *The Visual Display of Quantitative Information* Graphics Press, 1983

The Slide That Was Presented



From Edward R. Tufte, *Visual and Statistical Thinking: Displays of Evidence for Making Decisions* Graphics Press, 1997

The Slide That Should Have Been...



From Edward R. Tufte, *Visual and Statistical Thinking: Displays of Evidence for Making Decisions* Graphics Press, 1997

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

11/19/1863

(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)

11/19/1863

Not on Agenda!

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

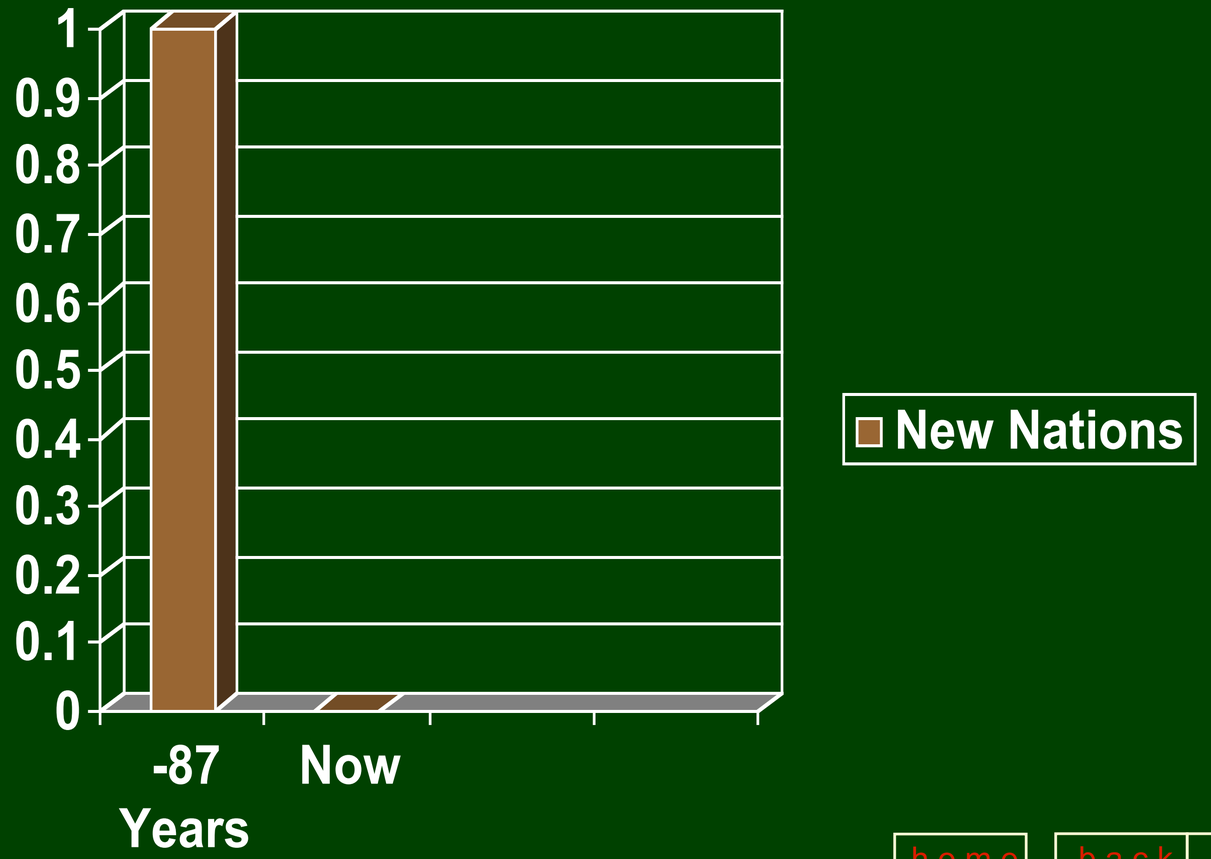
11/19/1863

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

11/19/1863

Organizational Overview



11/19/1863

Summary

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

11/19/1863

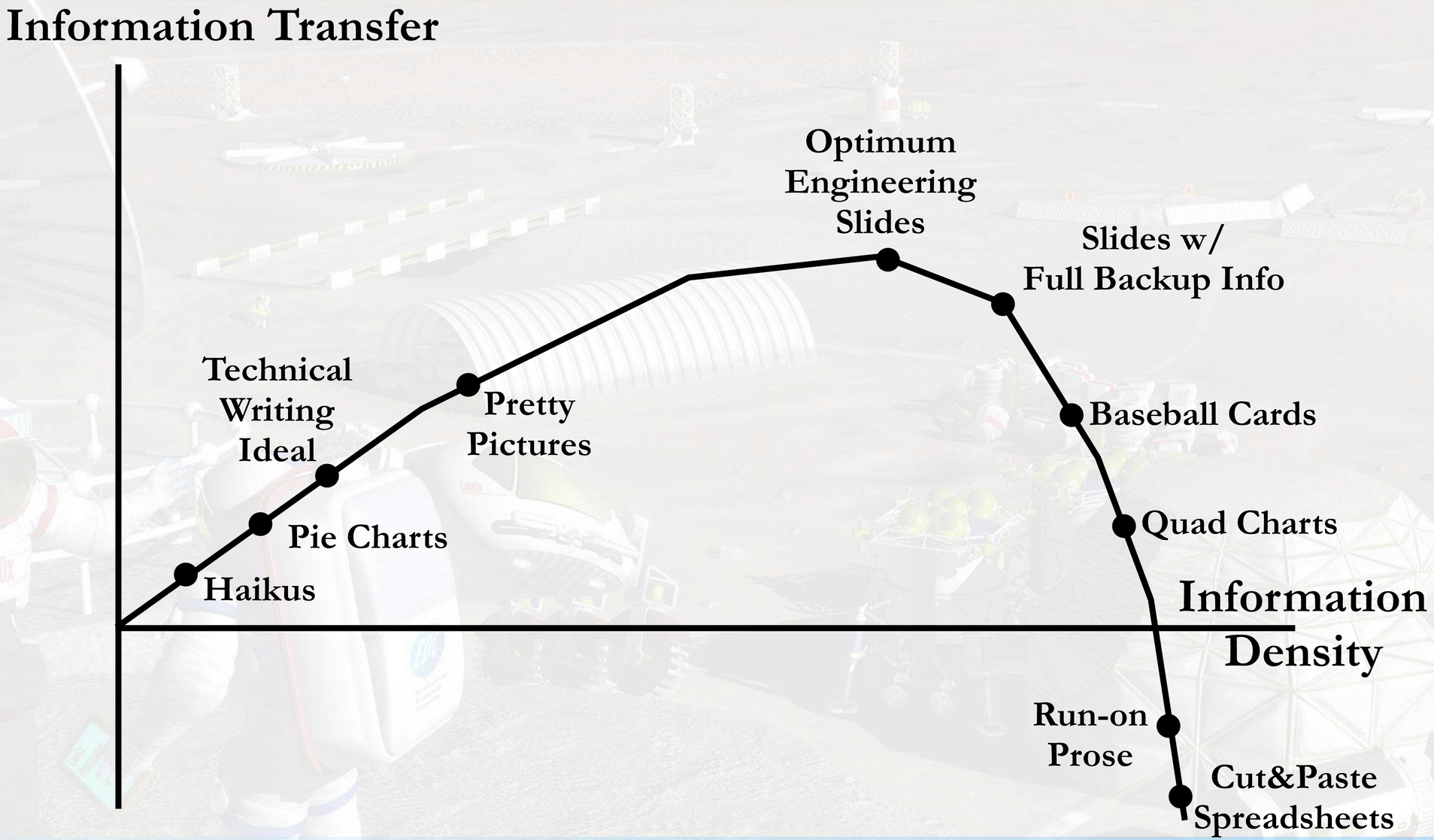
Solution: High Bandwidth Slides

- Engineering presentations are all about 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



Deep Space Habitat

Design Constraints/Parameters

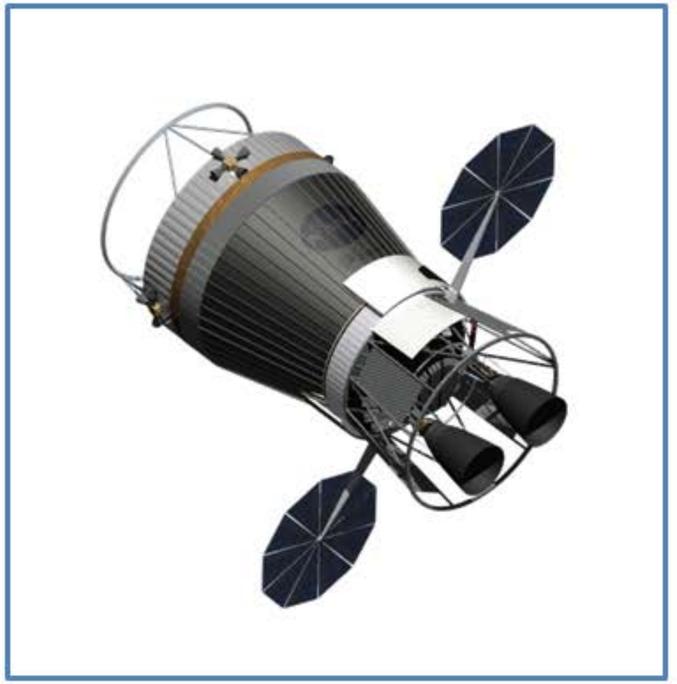
Pressurized Vol.	115 m^3
Habitable Vol.	54 m^3
Crew Capacity	3
Crewed Mission Duration	459 days
Solar power generation	16 kW
Total battery energy storage	13 kW-h
Number of Batteries	3
Depth of Discharge	80 %
ECLSS Closure	Closed-Loop
Habitat Structure	Vertical Rigid Cylin
Habitat Height	6.06 m
Habitat Diameter	4.57 m
Mass Growth Allocation	20 %
Project Manager's Reserve	10 %

Description

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.

Category	Mass, kg
Structure	**1,720**
Protection	**336**
Propulsion	**0**
Power	**1,032**
Control	**0**
Avionics	**453**
Environ./Active Therm	**5,970**
ECLSS	3,492
Thermal Control System	579
Crew Accommodations	1,899
Other - Doors, Hatches, Docking Mech.	**1,131**
Growth	**3,193**
DRY MASS SUBTOTAL	**13,835**
Non-cargo	**6,521**
Recreational Equipment	75
Crew Health Care	657
Personal Hygiene	135
Clothing	211
Housekeeping Supplies	262
Operational Supplies	129
Maintenance Equip. & Spares	1,625
Photography Supplies	120
Sleep Accommodations	27
Food	3,281
Cargo - Radiation Protection (waterwa	**2,055**
INERT MASS SUBTOTAL	**22,411**
Non-propellant	**1,229**
O2	161
N2	399
H2O	669
Propellant	**0**
TOTAL WET MASS	**23,640**

Cryo-Propulsion Stage



Design Constraints/Parameters

Propellants	O2/H2
Stage PMF	0.802
Stage Diameter	7.5 m
Stage Length	12.31 m
# Engines / Type	2 / RL-10-30k
Engine Thrust (100%)	133,447 N
Engine Isp (100%)	455 s
RCS Propellants	NTO/MMH
RCS Tank Storage Pressure	225 psia
# RCS Thrusters / Type	16 / Press-fed
RCS Thruster Isp	301 sec

Broad Area Cooling of Cryogenic Tanks
0.5% per month H2 boiloff
0% per month O2 boiloff
50 layer of MLI
IDSS docking adapter w/ fluid transfer interfaces
2 x 8.4 kW Gallium Arsenide Arrays
6 x 5 kW Lithium Ion Batteries (80% DoD)
2 x 4.7 kW Radiators

Description

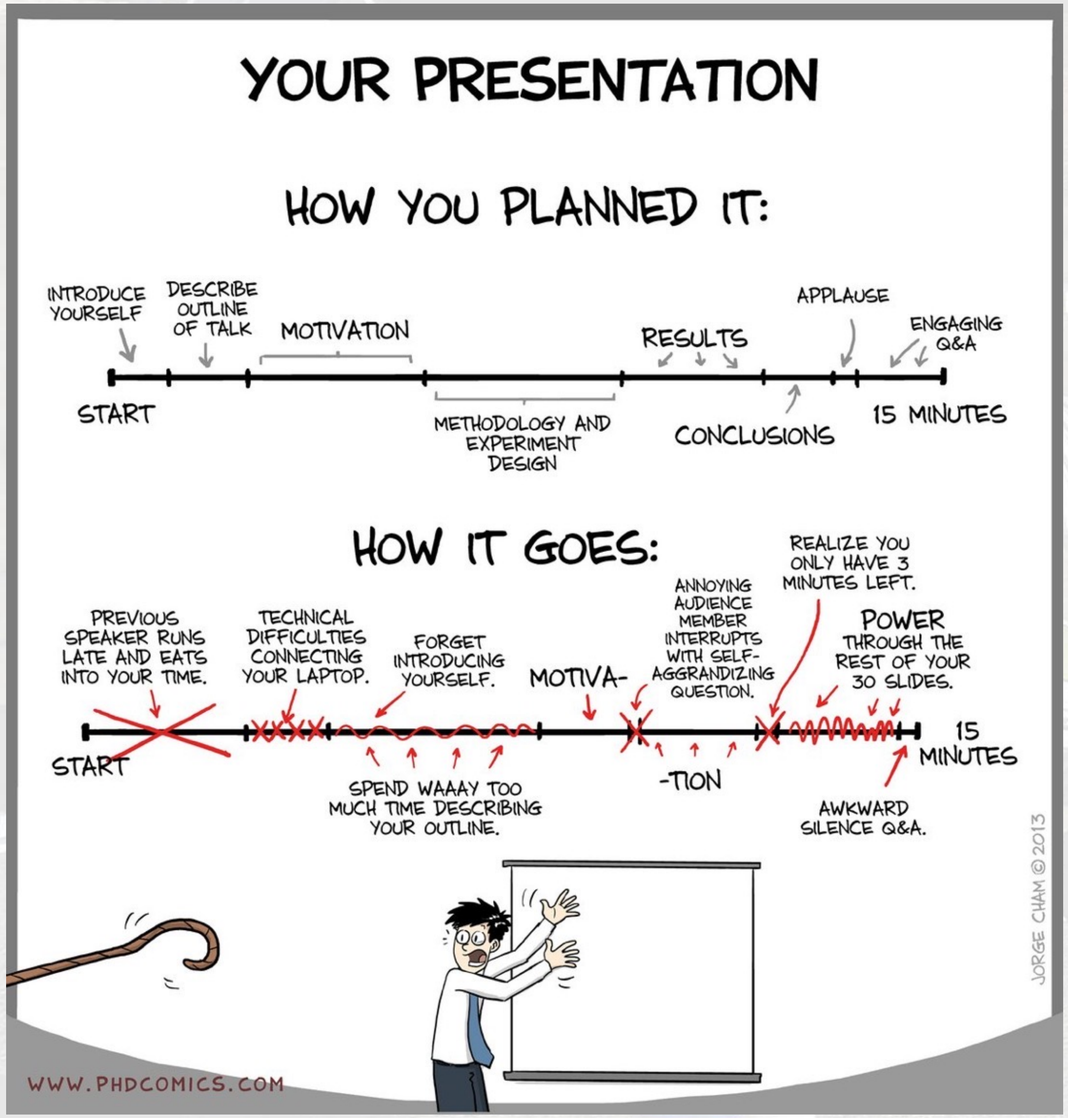
The Cryo Propulsion Stage (CPS) is sized to deliver an MMSEV one-way from ISS to Earth-Moon L1. The CPS is delivered to ISS with a commercial launch vehicle in the "Heavy" class with offloaded propellant. It is then refueled in orbit. The reusable stage is capable of one way trips for crew and cargo between LEO and various HEO destinations, including both GEO and Earth-Moon L1. The CPS includes the avionics, propulsion and attitude control for automoted 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 LH2 boiloff to 0.5 %/month with no LOx boiloff.

Category	Mass, kg
Structure	**1,545**
Protection	**289**
Propulsion	**3,667**
Rocket Engine	653
Fuel Tank, Feed & Press	1,512
Oxidizer Tank, Feed & Press	761
Repress System	90
RCS System	652
Power	**650**
Control	**0**
Avionics	**396**
Environment (TCS)	**907**
Other	**979**
Broad Area Cooling	313
Resupply/CFM/Docking	620
Restart System	46
Range Safety & HazGas	0
Growth + PjMR (30%)	**2,530**
DRY MASS SUBTOTAL	**10,962**
Non-cargo	**1,083**
Pressurization Helium	250
Unused Fuel	188
Unused Oxidizer	646
Cargo	**0**
INERT MASS SUBTOTAL	**12,045**
Non-propellant	**0**
Propellant	**48,781**
Main Fuel	6,971
Main Oxidizer	40,990
RCS Fuel	310
RCS Oxidizer	511
TOTAL WET MASS	**60,827**

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)

Presenting – Adapt or Die!



- Something WILL go wrong (or, "Murphy was an optimist")
- Always be prepared to cut your talk short
- Keep track of the one essential thing you want to get across
- For a group presentation running overtime, everyone should go faster to reach the end on time

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.

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"