

Crossing the Consumer Chasm through engineering design

Freshman Seminar EN0012a/b
Spring, 2015

People are very open-minded about new things -
as long as they're exactly like the old ones.

Charles Kettering

Professor Rick Fleeter

A detailed view of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including multiple modules, solar panel arrays, and a large antenna, is clearly visible. Below the station, the Earth's surface shows a mix of blue oceans, white clouds, and green landmasses. The perspective is from a high angle, looking down at the planet.

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Crossing the Chasm

Do not dwell in the past, do not
dream of the future, concentrate
the mind on the present moment.

—Buddha

We idiots
over 50
didn't create
all the
stupidities
of this
world
but...

But we are
guilty
anyway
unless...

Unless we
got old
fighting it
all the way.

Anyway,
that's my
excuse.

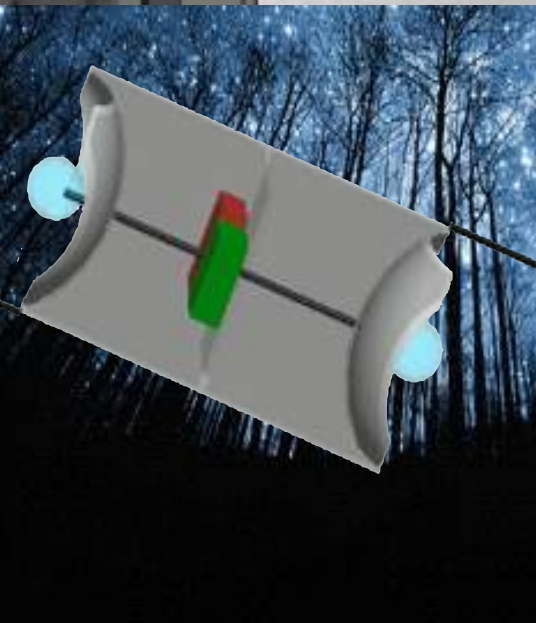
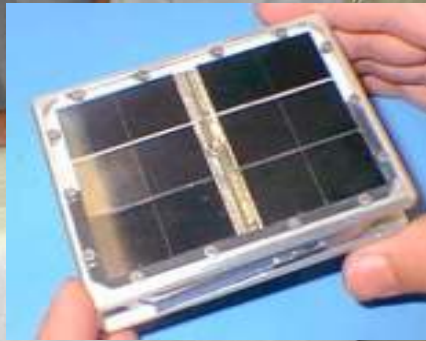
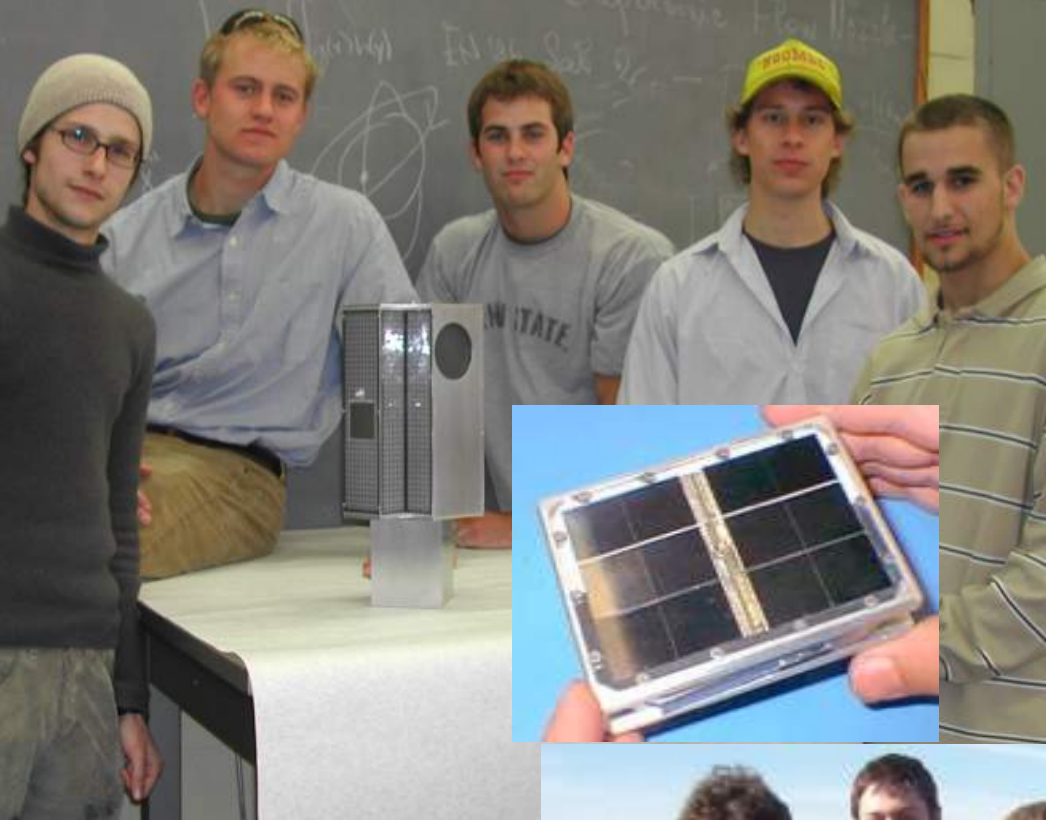


more of Rick Fleeter:

Design of Space Systems Engineering 176 spring semester

[http://www.youtube.com/watch?](http://www.youtube.com/watch?v=CYYsHzM09dY&feature=mh_lolz&list=HL1316676883)

[v=CYYsHzM09dY&feature=mh_lolz&list=HL1316676883](http://www.youtube.com/watch?v=CYYsHzM09dY&feature=mh_lolz&list=HL1316676883)





μ Rover

New Horizons



A workshop on next-generation microrovers for planetary exploration

Benefits

Smaller scale permits high
Multiple diverse configurations
Pass data unit-to-unit from
Send spare units to mitigate

Challenges

Requires a new architecture
Logistics of dozens increasing
Autonomous rover array
No flight heritage: How can



Workshop

February 16, 2012
Brown University
School of Engineering

<http://www.brown.edu/Departments/Engineering/Workshops/Microrover> <http://tinyurl.com/microrover>



ChipSat

The MicroChip IS the Satellite

Benefits
Low cost, high probability of success - Launch many, count on one
Maneuvering without propellant by harnessing perturbation forces
Very low ballistic coefficient allows reentry without damage
Single or multi-point constellation sensing missions
Potential for deep-space and near-Earth operations

Challenges
How to launch and manage traffic congestion during deployment
More "space junk" in the near-Earth orbital environment

Workshop
February 17, 2011
Brown University
School of Engineering

www.engr.brown.edu/chipsat

D Δ V

Desktop Delta-V

Emerging Space Technology
Workshop
February 17, 2011
Brown University
School of Engineering

and tested in lab desktop environment
Low cost, student and amateur built spacecraft
Small and other special facilities and handling
and sustainable transportation solutions

versus conventional systems?
New technologies in flight missions:
Suitability to particular mission classes:
Support their development?

www.engr.brown.edu/delta

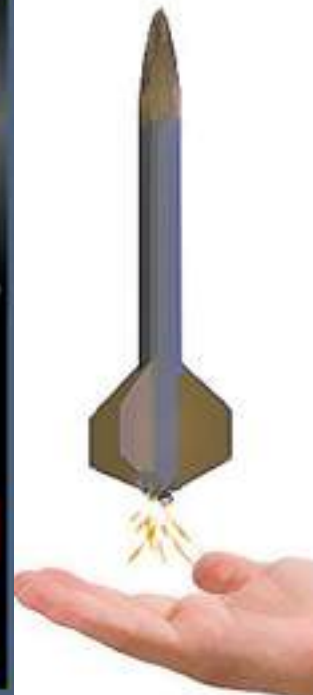
<http://>

www.youtube.com/

[watch?v=erdeWSaqce0](http://www.youtube.com/watch?v=erdeWSaqce0)

Micro
meets
Macro

feb. 21:
2013



Space: 0 infrastructure

Earth: infrastructure inescapable



SPACE INFRASTRUCTURE

International Policy Workshop **February 19, 2014** - Space Engineering Workshop **February 20, 2014**
Brown University School of Engineering and Brown University Planetary Geosciences Group

SPACE HORIZONS 2014

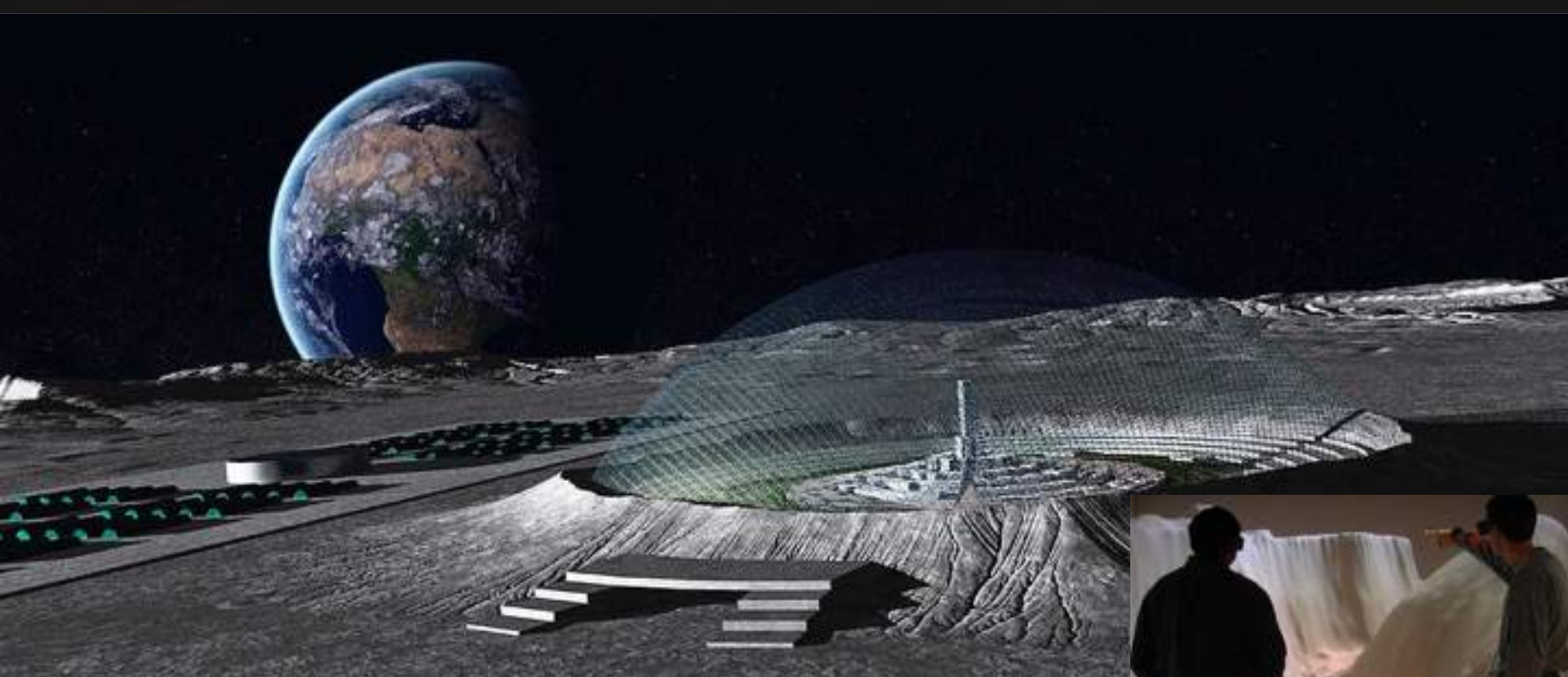
<http://spacehorizonworkshops.wordpress.com>

**Space Systems:
Infrastructure
Changes
Everything**



Space Horizons 2014



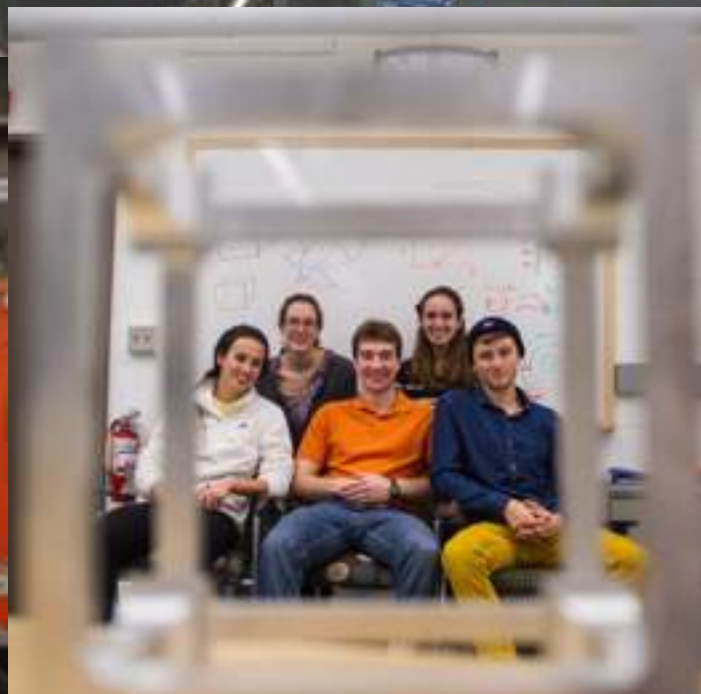
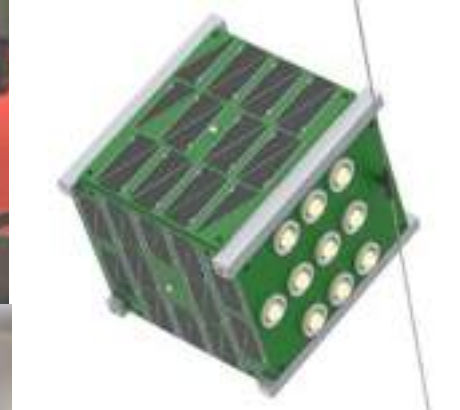
👉 I/S metaplaneta & Lunar City 👉
The CAVE →



TEAM Equisat

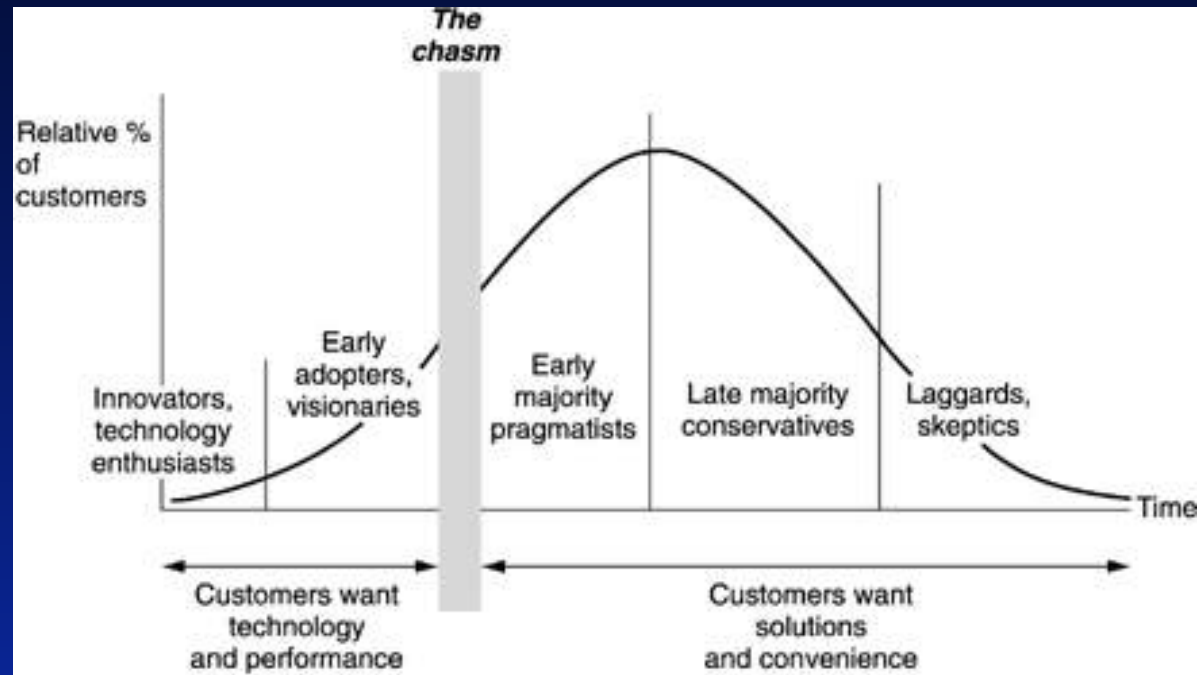
CHARLES H. GIANCARLO ENGINEERING LABORATORIES





Introductory Topics

- Course Genesis:
 - redefinition of engineering education at Brown
 - if not engineering period.
 - space as a metaphor for any engineered product
- What is “the Chasm” and why should we care?
 - “Crossing the Chasm”
Geoffrey A. Moore
(<\$12 at Amazon)
- Why Cross it
and with what?
- How would you
cross it?
- Case Study Method
(by accident?)
- Where is your idea now?



012 Landscape

012a Crossing the Consumer Chasm

Vocabulary

- What is the chasm
Spending a semester on 1 concept?
- Crossed, Didn't and Why
- Magic Bullets:
Complexity, Utility, ROI
life imitating art and vice versa
new technology
- Barriers (*blocks*), Serendipity, Beachhead
- Disruption:
victory through mediocrity
- Quality, Safety, Reliability
- Pre-Chasmatics: Marketing Classic
- Magic

012b finished here:

- service drivers
- recycling parallel to charitable giving
- blocks, honesty, parallels

Curriculum

- Take a concept across the chasm:
 1. identify a concept
the landscape:
population of adapters
sm
not to date
development, current niche,
attempts and failing to cross
 3. plot your own course across the chasm
- TAs, Section, Writing Fellows
- Reading, Videos /Films
- Homework, Presentations
- Guest Lectures, Field Trip
- Picnic!

012 Landscape

012b Crossing the Space Chasm

Vocabulary

- What is the chasm
 - Spending a semester on 1 concept?
- Crossed, Didn't and Why:
- Magic Bullets: classic cross strategies
- Barriers, Serendipity, Beachhead
- Smart Innovation
 - The Dark Side of Crossing (pollution, wars, destruction)
 - Tools: design, regulation, infrastrtr.
- Disruption: victory via mediocrity
- Pre-Chasmatics: Marketing Classic

Curriculum

- Take a concept across the chasm:
 1. identify a concept and its chasm
 2. the concept to date
 - level of development, current niche, attempts and failiures to cross
 3. depict the world post-chasm-cross
 - with current innovation mindset
 - with smart-innovation approach
 - what will be the S-I elements?
- TAs, Section, Writing Fellows
- Reading, Videos /Films
- Homework, Presentations
- Guest Lectures, Field Trip
- Pinic!

Lo Staff

Rick Fleeter

Ken Ramsley

Cindy Abarca

Alden Richards

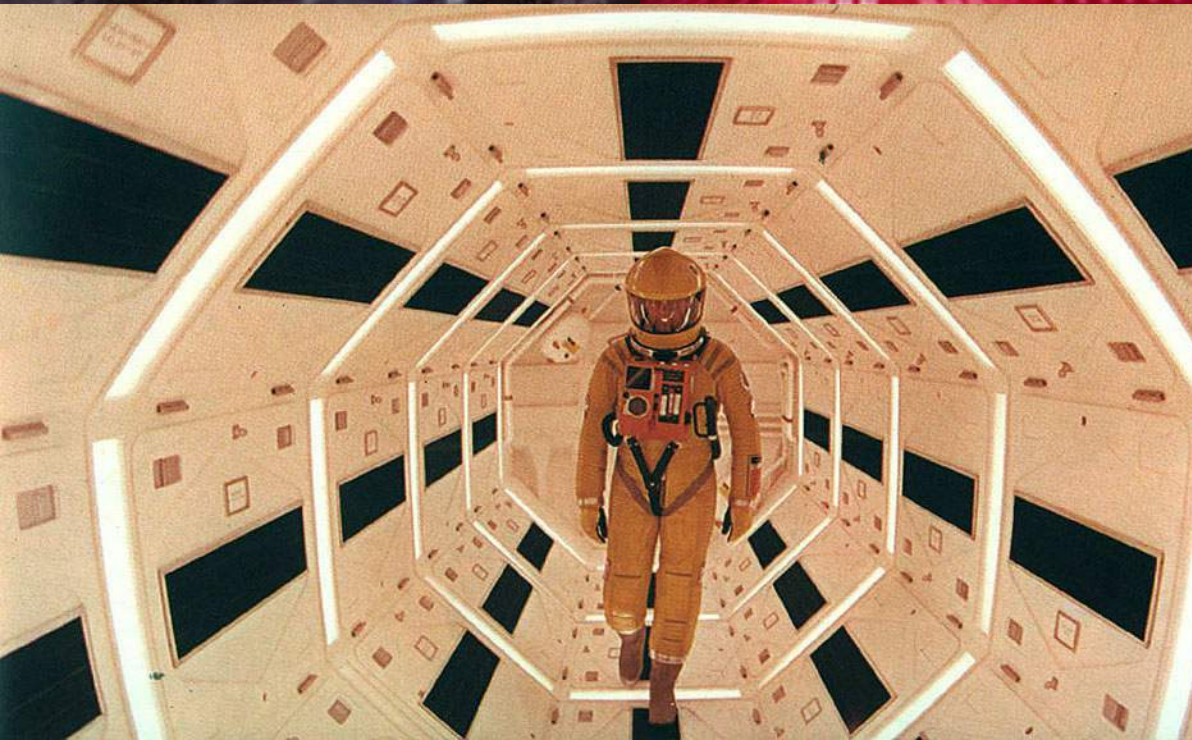
Writing Fellows

Emily Hornig
Sara Peletz
Stephen Starr
Claire Su



Happened

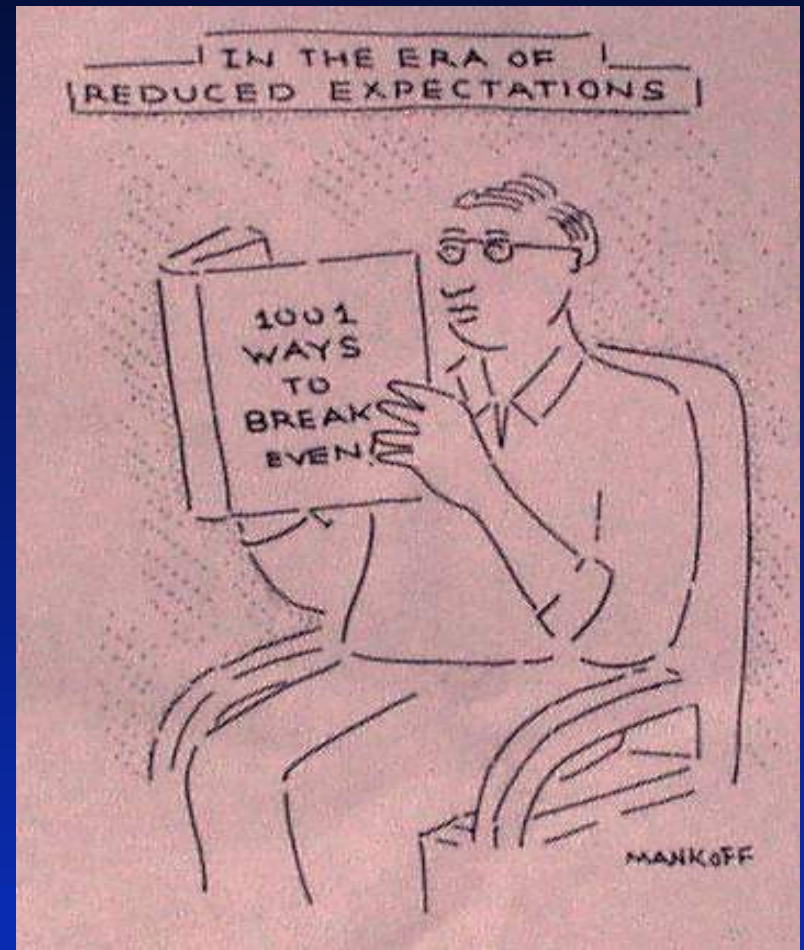




Didn't

More Chasmatics

- What is the space chasm made of?
 - Transportation
 - Missions
 - Politics and Economics
 - (long) delayed satisfaction
 - The mission mindset
- Building Bridges
 - Government Space
 - International Orgs
 - A common Enemy?
 - Commercial Space?
 - Technology



Cultured Chasm: *Mikimoto*



1893



Philadelphia 1930

NY 1939
12,500 pearls
366 diamonds

- **Technology:** (1888-1916)
Pearls, Culturing, spheres, colors, patents, oceans
- **Legitimacy:** (1888-1939)
Paris, London, Philadelphia, Chicago, Kobe, Tokyo, NYC
- **Marketing & Distribution:** (1899 - ∞)
Paris, Philadelphia, Chicago, Kobe, Tokyo, NYC



1905



御木本 幸吉
Mikimoto, Kokichi
(1858-1954)



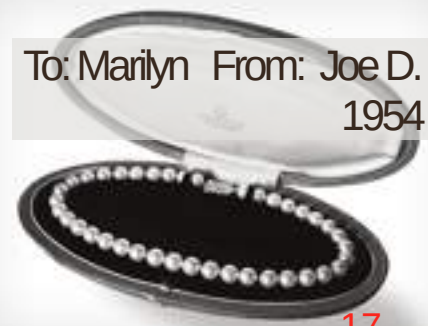
Kobe 1932



Chicago 1933



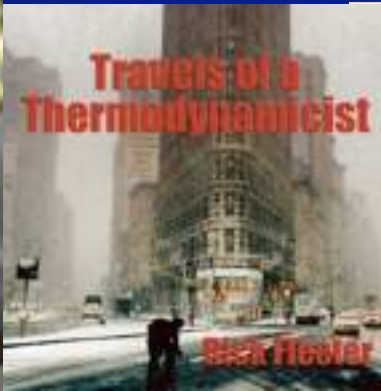
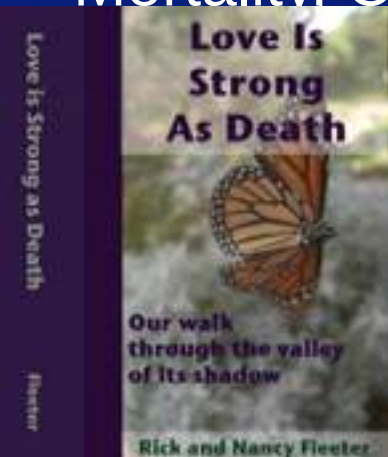
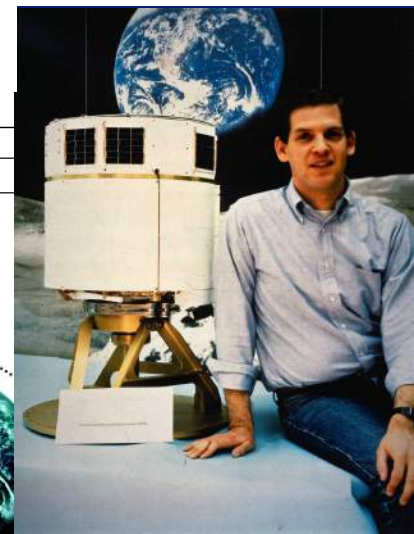
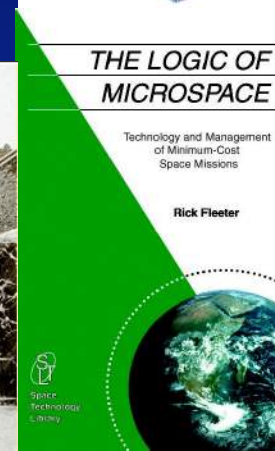
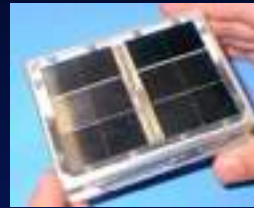
Ginza 1899



To: Marilyn From: Joe D.
1954

How did I get here

- Academic (\$ scale ~ 10^4)
- Space agnostic + swim / music / PhD avoidance strategy
- Amsat (\$ scale ~ 10^4)
- Airplanes
- JPL / TRW (\$ ~ 10^9) DSI / AeroAstro
- Teaching: CSLB; UCLA; Brown, Rome
- Writing & Professional courses
- Mortality, Constituency, Inclusivity







SAPIENZA
UNIVERSITÀ DI ROMA

FACOLTÀ DI INGEGNERIA CIVILE E INDUSTRIALE
DIPARTIMENTO DI INGEGNERIA MECCANICA
E AEROSPAZIALE

VIA EUDOSSIANA 18, ROMA

MASTER IN SATELLITI E PIATTAFORME ORBITANTI



Logistics

- Class Meetings:

- M/W/F 11 - 11:50 / 2 - 2:50
- Section mtg 1x/week
tba

- Office (*B-H lobby*) hours:

- Class days 12-1 and after 3 - by arrangement
(email whenever, cell / mssg for other times, check with me / TAs)

- Reaching me:

- rick_fleeter@brown.edu
- Phone / sms / WA 401 225.7397

- TAs:
Cyndy Abarca (*more equal*)
cindy_abarca@brown.edu

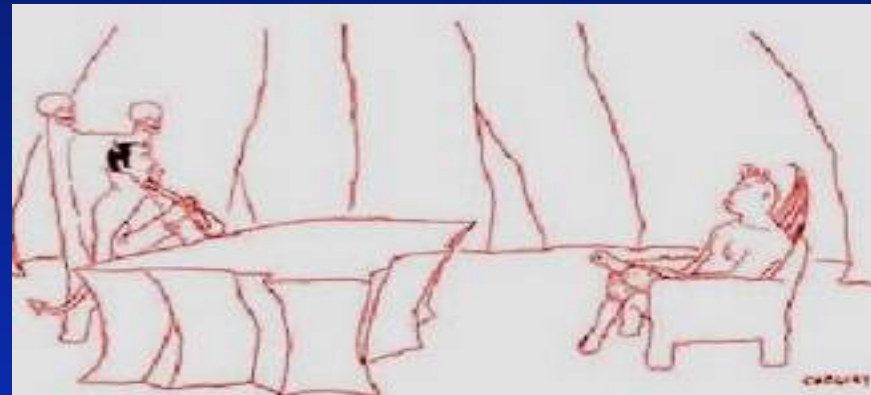
Emily Hornig
emily_hornig@brown.edu

Sara Peletz
sara_peletz@brown.edu

Stephen Stahr
stephen_stahr@brown.edu

Claire Su
claire_su@brown.edu

- Visiting: Ken Ramsley
kenramsley@gmail.com



Crossing the

"I need someone well versed in the art of torture—"



MEDIA



- Got books?
 - **Crossing the Chasm** (Geoffrey A. Moore) (required)
 - **The Innovator's Dilemma** (Christensen) (required)
 - **The Case for Mars** (Robert Zubrin) (optional)
- Harvard Business Review reprints (REQUIRED!)
 - **Disruptive Technologies** **Catching the Wave**
 - **The Empire Strikes Back** **Counterrevolutionary Strategies**
- DVDs (required to view at least one):
 - **2001 - A Space Odyssey**, Stanley Kubrick and Arthur Clarke, 1968 a space sci-fi film used in 012 space version filled with chasm crossing predictions
 - **A Clockwork Orange**, 1962 novel by Anthony Burgess, X rated film by Stanley Kubrick in 1971 (contains violence, some sexual)
 - **The Complete Metropolis** restored 1927 German film by Fritz Lang, the most expensive silent film ever made



Activities

- Reading
 - Weekly, mostly short, assignments
 - PLEASE do THEM! It shows
- Writing
 - Weekly editorial from you to me **15% matters**
 - Projects - 2 work-in-progress papers plus final paper
- Talking (citizenship)
 - **Contribute! in class and in section**
 - **One brief presentation of your ideas**
 - **Plus the elevator pitch**
- Listening (citizenship)
 - to me, your TAs, writing fellows and Ken
 - guests
- Watching: ≥ 1 DVD
- Visiting: field trip **12** March Ideo, **16** Hasbro
- **Picnic May 3?**



Assignments and Valuation

Note: no final exam

- Weekly:
 - Reading assignments & suggestions
 - < 1 page op-ed piece: 15% of grade (1%/week + bonus)
- Course Project
 - ϕ 1: Choose and defend your topic: draft Feb. 6
 - ~ 5 pages including cartoons, 10% of grade
 - ϕ 2: Research and survey topic: draft March 6
 - ~ 10 pages including graphics, 20% of grade
 - ϕ 3: $\Rightarrow$ Your Plan for crossing the chasm: draft April 17
 - ~ 15 Pages including figures, 30% of grade
 - Oral presentation of any one of the 3 phases
 - ~8 minutes + questions and conversation, 15% of grade
- Citizenship and Wiggle Room: 10%

more Assignments and Valuation

- the elevator pitch (up to 10% bonus)





Intelligent Innovation



The side-effects of crossing the chasm:

- scaling consumption (petroleum, space junk)
- scaling systems (roads)
- laws of large numbers (drugs)
- down marketing (low Q product and users)

The digital Divide, car inspections, UL
fake turbine blades, motor scooters
catalytic heaters, skiers who don't turn



Intelligent Innovation *in the curriculum*



- Two approaches to project selection and phase III
- Final Four Homeworks
 1. scaling issues
 2. implications of scaling
 - i.e. lower price, pollution, use while driving
 3. patches, work-arounds, prevention
 4. implementation of SI strategy (policy, design. . .)

Intelligent Innovation Strategies I

- Present and Past Innovations (not smart)
 - replacing the horse with the automobile
 - distance learning
 - “disposable” housing
 - Fast Food
- What to do with them:
 - Phase I: What was the innovation and how you know it crossed?
 - Phase 2: What got them across the chasm and what got damaged in the process?
(and maybe fought back)
 - Phase 3: How could the downsides have been ameliorated?

Intelligent Innovation Strategies 2

- Your or a not-yet-adopted innovation
 - electric vs. fossil fueled transportation (cars mostly)
 - internet kills radio and television / satellite virtual performance
 - cars that drive and park themselves
 - Implanted personal ID chip - Evoting
- What to do with them:
 - Phase I: Describe the innovation and the signal it crossed?
 - Phase 2: What could get them across the chasm?
(What are the barriers and how to overcome them)
What will get damaged in the process?
 - How could the downsides be ameliorated?
(without losing all the benefits or uncrossing

Course Projects of the past: In Space

Space Elevator **aka Magic**

(also space hotels, econoconcord, brainwave o/s)

Space Sports

(participate, telepresence, spectate)

Space Agriculture

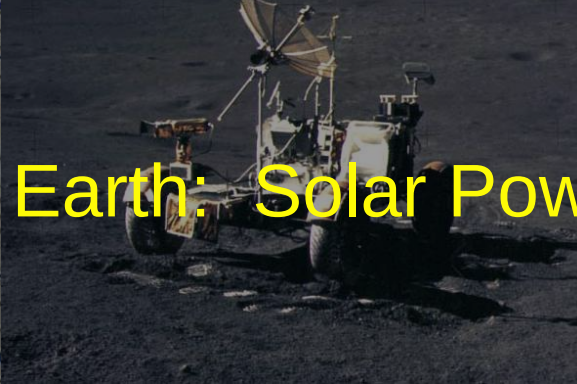
International Space Federation

Asteroid Mining for Imperialism and Profit

Lunar / Martian Living

Space Technologies on Earth: Solar Power

A Real Space Shuttle



Course Projects of the past: On Earth

- Automated Cars and Highways
- Electric Cars, bicycles and other small and/or human powered vehicles
- Personal, bicycle, luggage: Search and Rescue
- Solar Power, free solar power, free solar car power
- Smart Clothing, custom clothing
- Eating Bugs and other diet changes (sodastream)
- Smart house, smart roof, recycling
- Silent alarm watch
- Personal security alarm (one you would actually use)

Heritage ~~Chasm~~ Promotional Strategies

- Redesign / redefine a product or activity
 - increase relevance, impact, appeal (recycling)
 - reduce user cost: price; risk; complexity; time (laundry)
 - morph the application: Pressure Washer: Cars, Houses, decks
 - Your new product / service / activity here (warm ice cream)
- Build a bridge across the chasm
 - From an existing Technology or Product
 - sustainable • electric bicycle • public transportation
 - Sociologies: Product myths you'd like to believe...
 - Infrastructure (cost effective?)
 - Education (not easy!)
 - Incentives and discounts (band aid?)

nothing you can do that can't be done.
nothing you can sing that can't be sung.
nothing you can say but you can learn how to play the game.
It's easy.

nothing you can make that can't be made.
no one you can save that can't be saved.
nothing you can do but you can learn how to be you in time.
It's easy.

John Lennon



Wrungs

1 Introduction:

Chasmatics

Motivating Innovation

2 Historical Perspectives + complexities

3 Does Economics Define Utility?

4 Templates: successful xing

5 Notable (and dangerous) accidents: Airlines, GEO Comms, blue & green

6 Know the Enemies: tech & human

7 When reality imitates art

8 The Law of Unexpected Consequences: **Smart Innov.**

9 Serendipity & Disruption

10 Attempts to manage innovation

11 ~ Field Trip

12 How can smart innovation help to cross?

13 How to get smart innovation to cross.

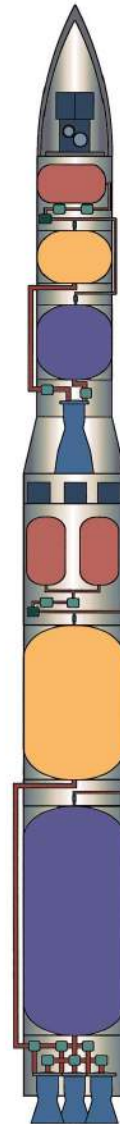
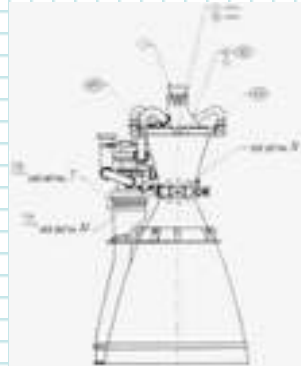
**occasionally:
Designer's Notebook**

Crossing the Chasm



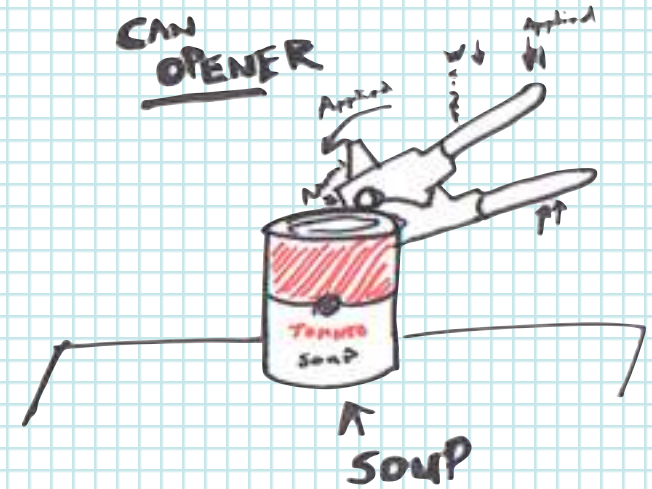
Designer's Notebook #1: Design Defined

- Aesthetic: **looks**
 - Picture frame; Automobile crease line
- Operational Aesthetic: **looks like**
 - Overall Automobile design
 - Architecture
- Product: **works like**
 - Hand friendly can opener
- Engineering: **works**
 - V-6 (car engines have styling?)
 - Apollo Capsule



Crossing the Chasm

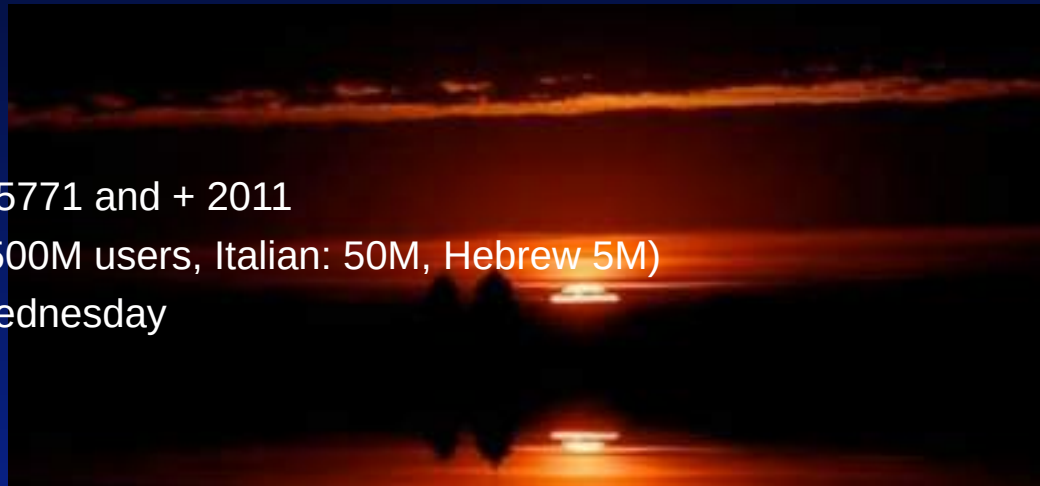
Before invention of the can opener, people opened cans with knives, chisels, hammers, heat or sometimes, their teeth



Crossing the Chasm



alla prossima



- Reading

- Start Chasm (pp. 3 - 7)
(next week through page 25)

- homework due Friday:

- op-ed:
A product that crossed between -5771 and + 2011
(Christianity!, Judaism?) (Spanish: 500M users, Italian: 50M, Hebrew 5M)
Email to TAS and me before class Wednesday

- See ya'

- Class M, W and F
- Sections:
 - Topic: brainstorming on candidate topics
 - Project organization: Groups vs. Individual





Cost The Ultimate Crossing Strategy?

or...

Will China Save Space?

Hubble Space Telescope

- ✦ **Physical Scale:** 13,2 m long, 11.110 kg
- ✦ **Risk:** \$1.5B investment plus \$1B launch
Largest aperture ever launched, stable to 0.007 arcsec
basketball thrown from New York in hoop at Los Angeles
- ✦ **Cooperation:** Joint NASA / ESA 20 year dvt program
Every NASA center + Lockheed + Perkin-Elmer
- ✦ **National and international Objectives + \$2.5B = Politics**
- ✦ **Team Management:** ~ 2500 engineers in US and Europe
- ✦ **New Capabilities:** Smoothest mirror ever manufactured
6 Tbyte science data per year
(a stack of books 50 km high)

Welcome to the Jungle 1:

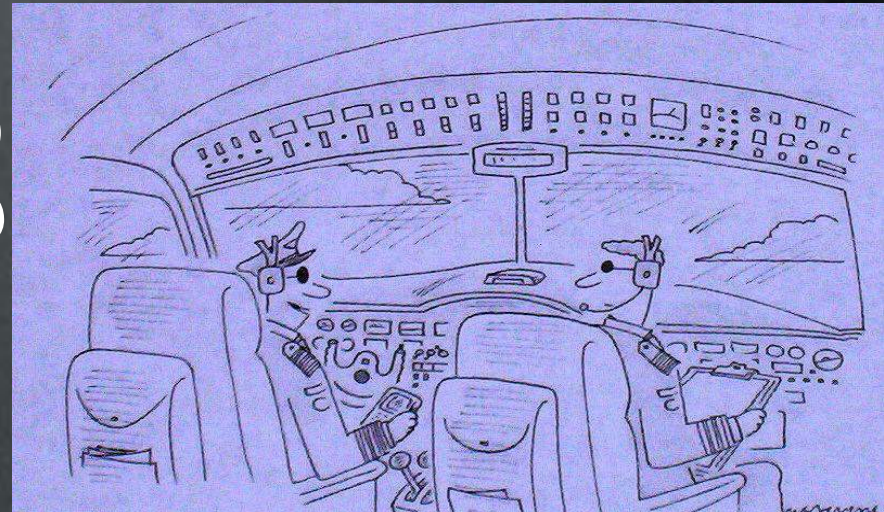
Space v. Aerospace

- 1950s style contracting and management of large, tech-based government programs at aircraft manufacturers
- Promoting Space as Aeronautics on steroids:
 - Air Force owns it
 - Space Shuttle as human piloted jet
 - Human instead of Robotic Space Exploration
 - Transportation:
 - commercial • affordable
 - scalable • frequent
 - Easy private sector transition



Welcome to the Jungle 1': Why space is not Aeronautics

- Mass Fraction: leaving and returning
- Launch / orbital / reentry complexity
- Space Environment
 - launch loads, radiation, 0 atmosphere, 0 gravity
 - reentry thermal environment and mass fraction
- Mission Duration:
 - “takeout” for 1 meal vs. 3000
 - $c, D = R \times T, \tau = 4 \text{ years (or 8)}$
and D to next planet
- Risk / Reliability



This is so cool! I'm flying this thing completely on my iphone

Welcome to the Jungle 1'':

Why space is not Aeronautics

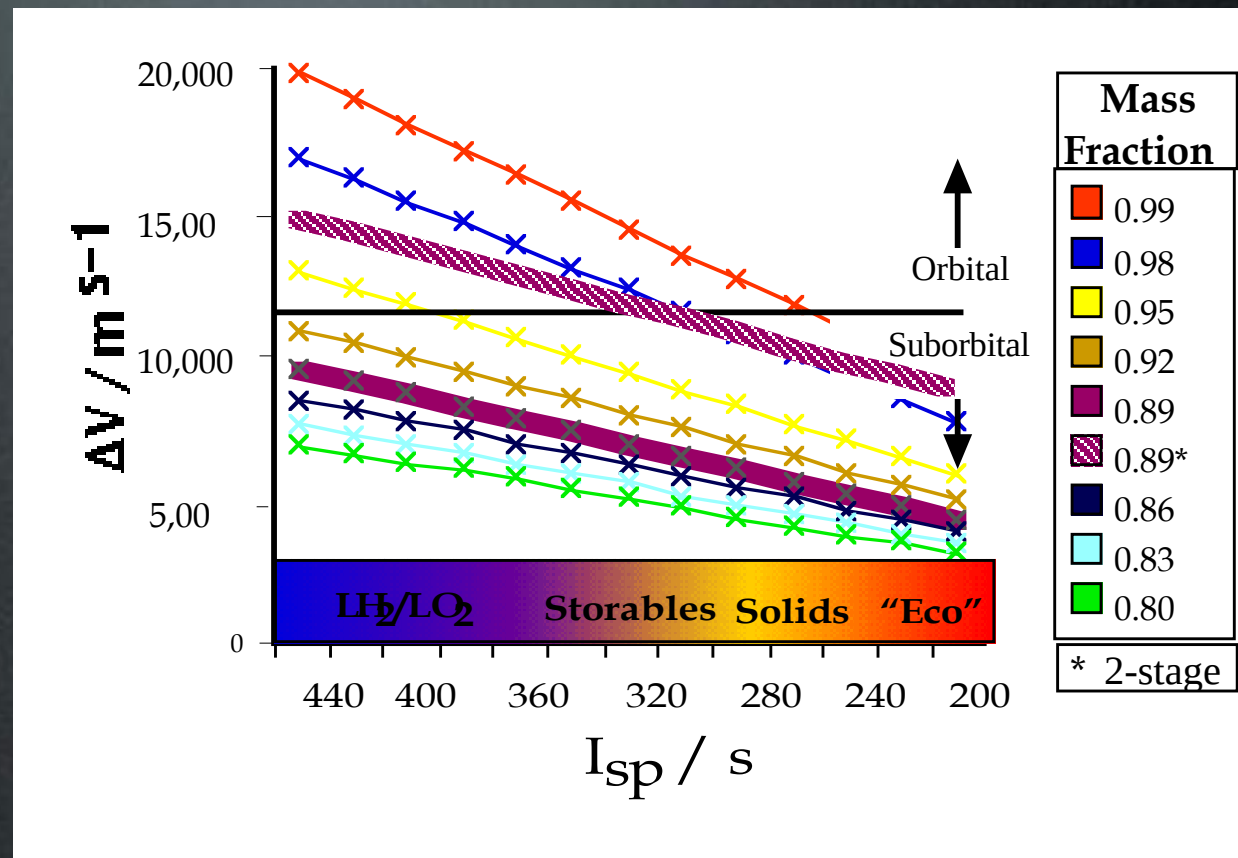
- More on Mass Fraction, ΔV , I_{sp} *

- Typical large rockets put <1% of their mass into orbit as payload, 9% of their mass is rocket, 90% is propellant

$$\frac{(M_i - M_{bo})}{M_i} \approx 0.9$$

- Typical jet transports are 1/3 fuel, 1/3 structure, 1/3 payload

$$\frac{(M_i - M_{bo})}{M_i} \approx 0.33$$

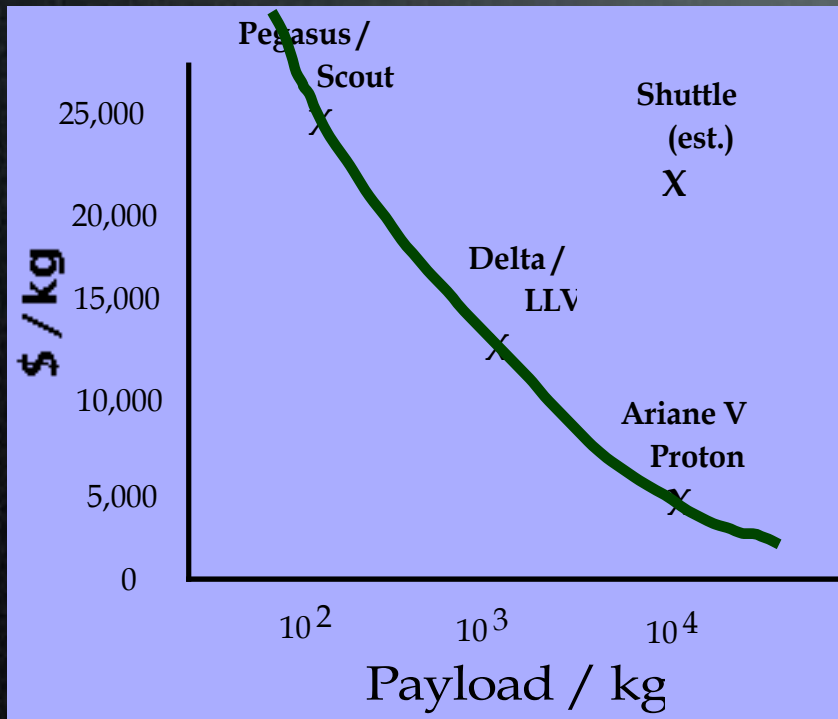


*

Rocketry as proof of existence of...

The last 1(00) mile(s)

- Naïve Observations:



- Bigger rockets are cheaper, regardless of who builds them
- '50s technology Scout costs LESS than '90s technology Pegasus
- Bringing things back from orbit and/or crewed vehicles:
-> costs more
- Marginal cost to fly a 10 kg payload: 50k€.



How Transportation Designs Society

Jet Travel: assume R/T ticket costs \$100,000

- Would airlines exist? ATC? FedEx?
- Would Akron, Exeter, Van Nuys, Bristol, Bergamo... have airports?
- Who would have access to air travel? For what “missions”?
- How would society determine what needs justify use of resource
- Would you have taken your last...
 - vacation
 - business trip
- Where would you / your kids go to college?
- Would you take a job 500, 1000, 1500 miles from family?
- Collaboration across US / Europe possible? ESA? NASA? ISS?

Road Trip: assume gas \$500/gal // 100€/litre, car costs €1M

- Would production lines exist?
- Autostrade? Gas stations? Provincial roads?
- Who would operate bus / train systems and determine where they offer service?
- Suburbia, Single Family Homes? Baltimore / Washington complex? Northeast Corridor? Florida?
- Could US be governed from DC? Who has access to leaders?
- Progress in Medicine? Technology? Trade?

How Transportation Designs the Satellite

Engineering Design

- Satellite \$ Budget = Launch Cost;
- Mass, Volume, Shape - Vehicle Determined;
- Structure defined by launch loads and Launch Vehicle interface;
- Safety requirements set by LV (inhibits, materials, parts spec);
- Design to be launched batteries charged or discharged;
- Last access timing and design of access (those tiny doors);
- Orbit insertion / accuracy may drive propulsion requirements;
- Non-US launch + ITAR determine technologies incorporated in satellite.

Mission Design

- Spontaneous /Responsive space impossible w/o responsive launch
- Low cost missions nonexistent without low cost launch
- SERB list driven by launch cost (and cost parity) and availability
- Many missions excluded by lack of reentry: materials, bioscience, manufacturing, space environment
- Satellite buildable independently - like PC - but not launch. => *Space cannot mimic evolution of PC*
- **Rockets are Weapons:** Safety / Defense implications limit free market interest / exploitation of space

**Result of 50 year / \$1B experiment:
Launch Vehicle Cost may not necessarily
be reduced by systems engineering,
politics and management**

"Research
is an organized method
of finding out
what you are going to do
when you can't keep doing
what you are doing now."

Charles Kettering
1935

Testo

Where do we go for answers?



CHINA

*the guys who bring you Walmart
(and almost everything else)*

- Doing all the same stuff:
 - human space, space station, GPS, Apollo V2.0
- And More:
 - open access GPS, lunar base, lunar mining
- And commercial space
 - tourism: orbital to station
and suborbital ride to 100 km for 12 minutes