Scrum To The Stars
Agile Innovation in Aerospace

Tom Friend

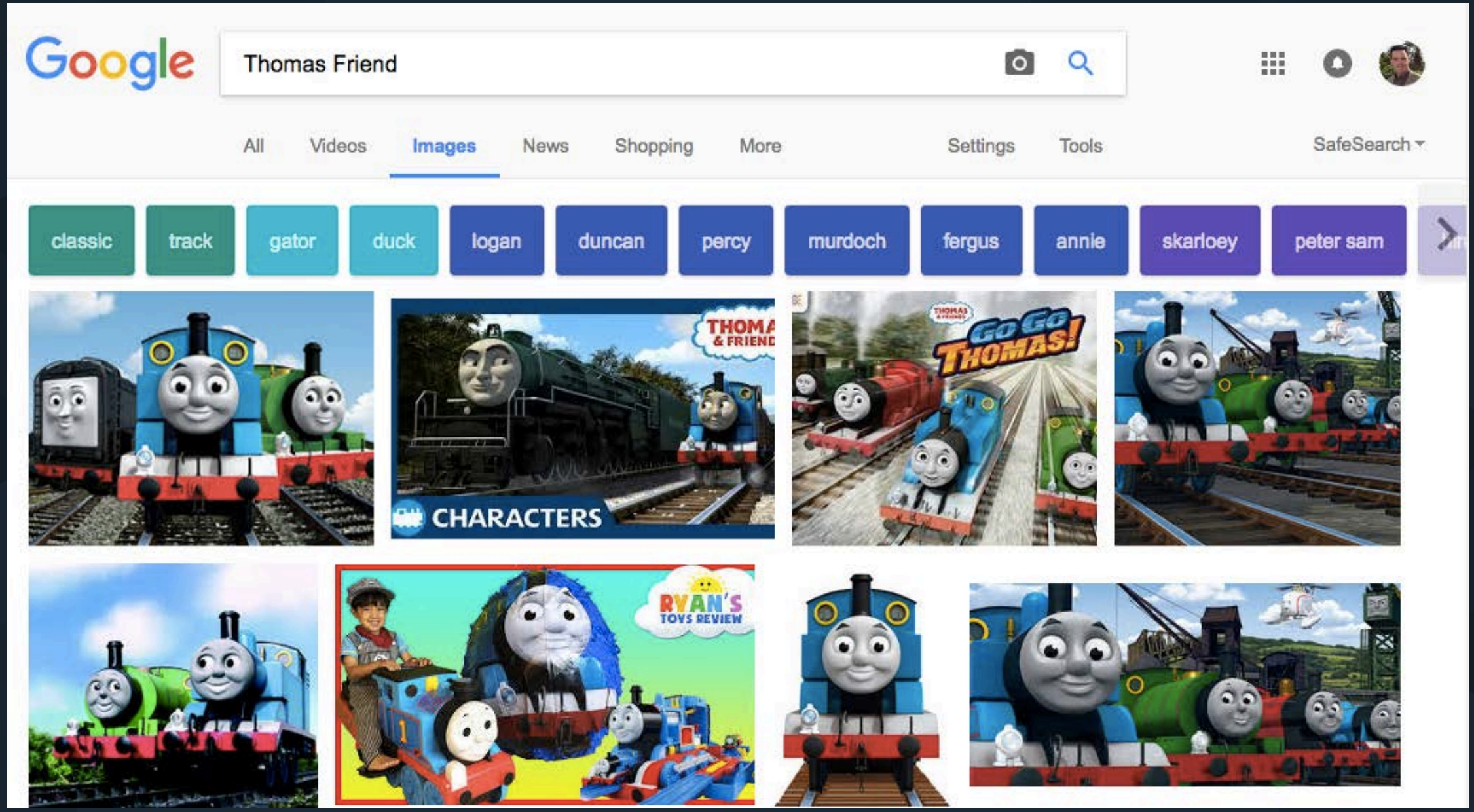
Introductions

Corporate IT

- Agile Scrum Coach
- 12+ Years Agile Scrum
- 25+ Year IT Application Dev
- Airline Transport Pilot

Military / Aviation

- US Naval & Air Force Pilot
- Air War College
- Squadron Commander
- B.S. Aeronautics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logan
duncan
percy
murdoch
fergus
annie
skarloey
peter sam
CHARACTERS
GO GO THOMAS!
RYAN'S TOYS REVIEW

This presentation is a conversation

4 CASE STUDIES

1. Agile in the history of manned flight
2. Agile innovation at the Skunk Works
3. NASA Agility with “Faster, Better, Cheaper”
4. CubeSat open source in Outer Space

Introduce Yourself

What is your name?

What is your passion?

Why are you here?

What Is Your Agile Experience Level?

守 破 離

Shu
Student

Ha
Apprentice

RI
Master

What is Agility?

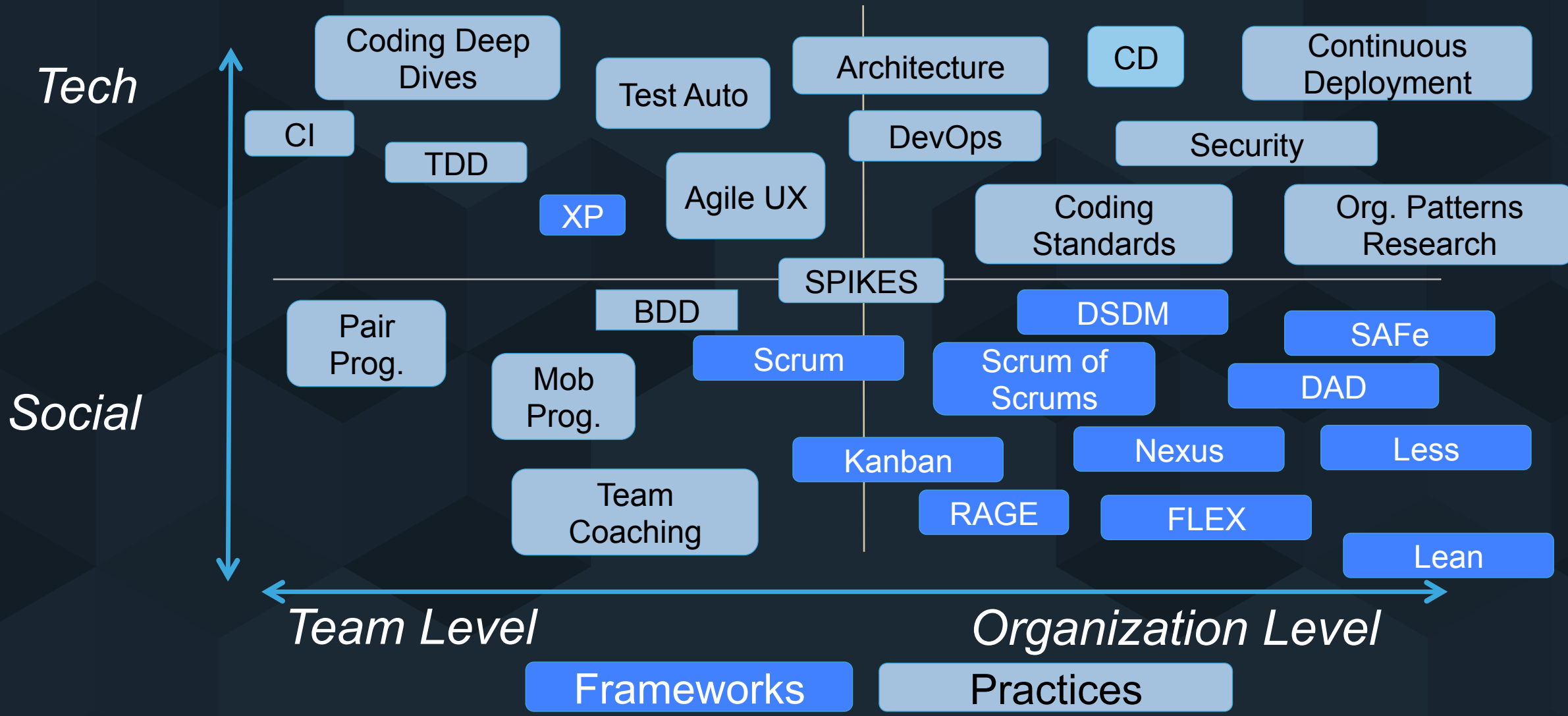
Property consisting of quickness, lightness, and ease of movement

1. Fast response *to sudden changes*
2. Quickly reprioritize *resource.*
3. Incremental*, AND* iterative *delivery*

Maximizing **BUSINESS VALUE *with*** *right sized, just-enough, and just-in-time processes and documentation*

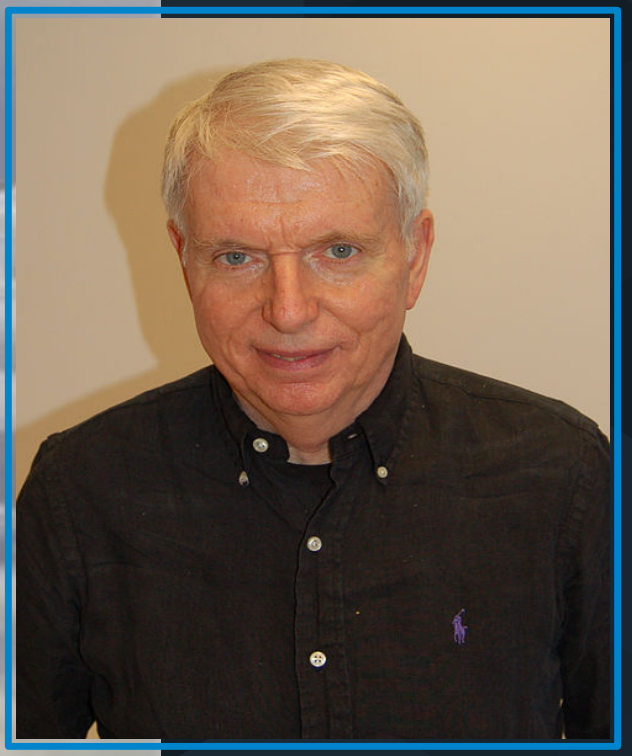
Highsmith, J. A. (2002). *Agile Software Development Ecosystems*. Boston, MA: Addison-Wesley.

Agile Frameworks and Practices



Scrum Framework

Jeff's Sutherland’s RF-4C

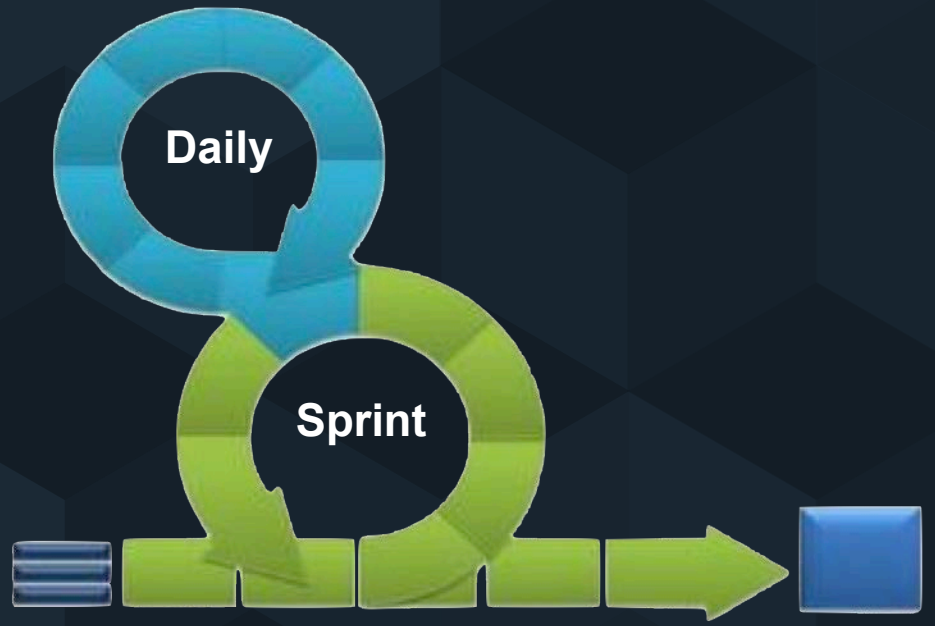


John Boyd F-86 Pilot - OODA

OODA

改善

SCRUM



Kaizen

Continuous Improvement

INSPECT AND ADAPT

"Those who don't know history are doomed to repeat it"

-Edmund Burke, 1729-1797

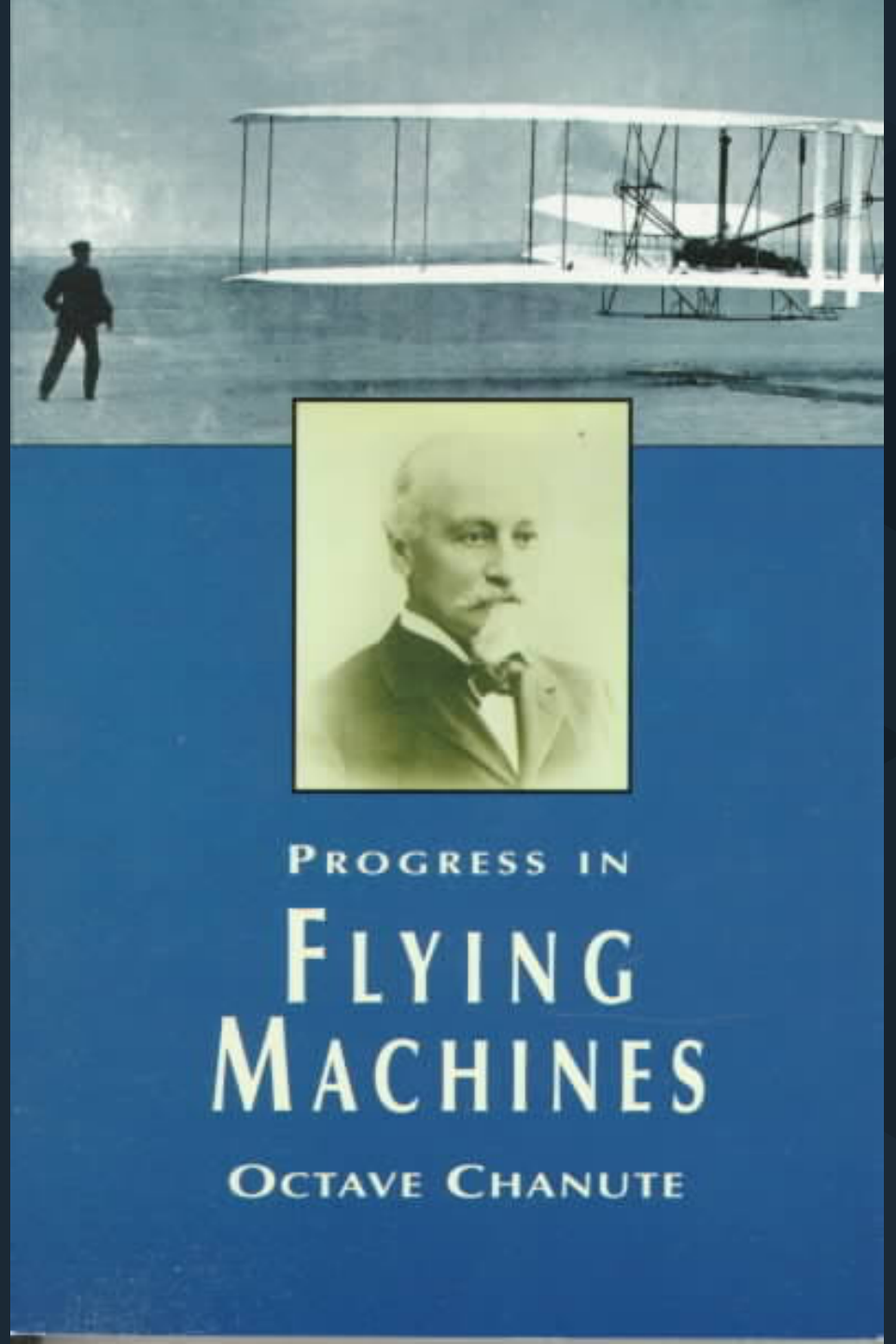
Inspecting and Adapting In Aerospace History

The rich history of Successes and Failures

The Quest for Manned, Powered Flight

1894

1. Wings and Parachutes
2. Screws that Lift
3. Aeroplanes



Get it right before roll out.

Fig. 9 – DEGEN -1812

"With this apparatus Degen was stated, in 1809, to have risen to a height of 54 ft by beating his wings rapidly."

Make your failures small enough to learn and recover from.

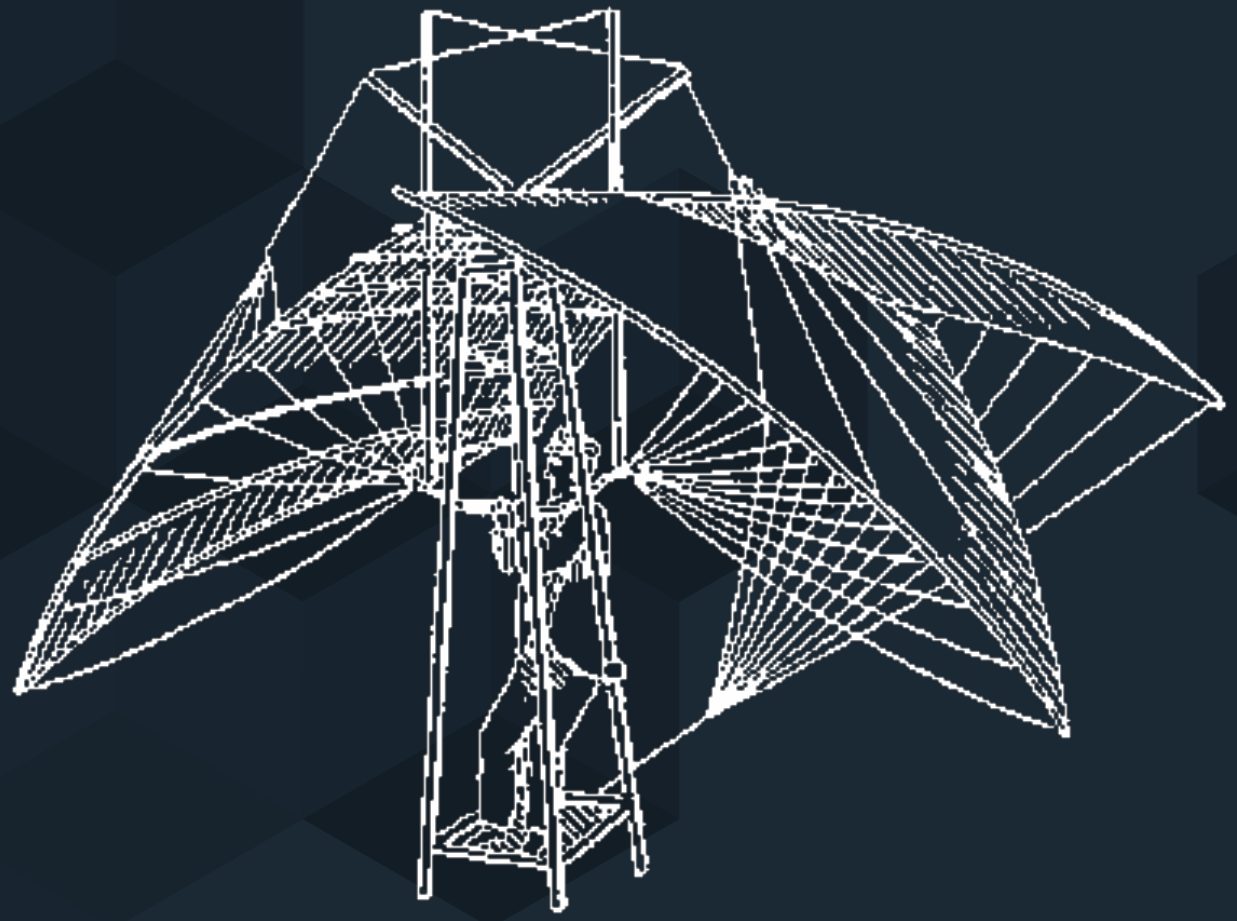


Fig. 9 – DE GROOF -1864

"…pressure gathered under the moving wings… they were seen to collapse together overhead and to assume a vertical position, when De Groof came down like a stone, and was **killed on the spot.**"

Big Project Failure

FIG. 12. -- GÉRARD -- 1784

"… an aerial locomotive…

"…the wings worked vigorously, but the machine jerked up and down, rushed from side to side, and, in fact, performed **all kinds of gymnastic movements except flight.**

This experiment was terminated by the explosion of the boiler…"

No Risk No Reward

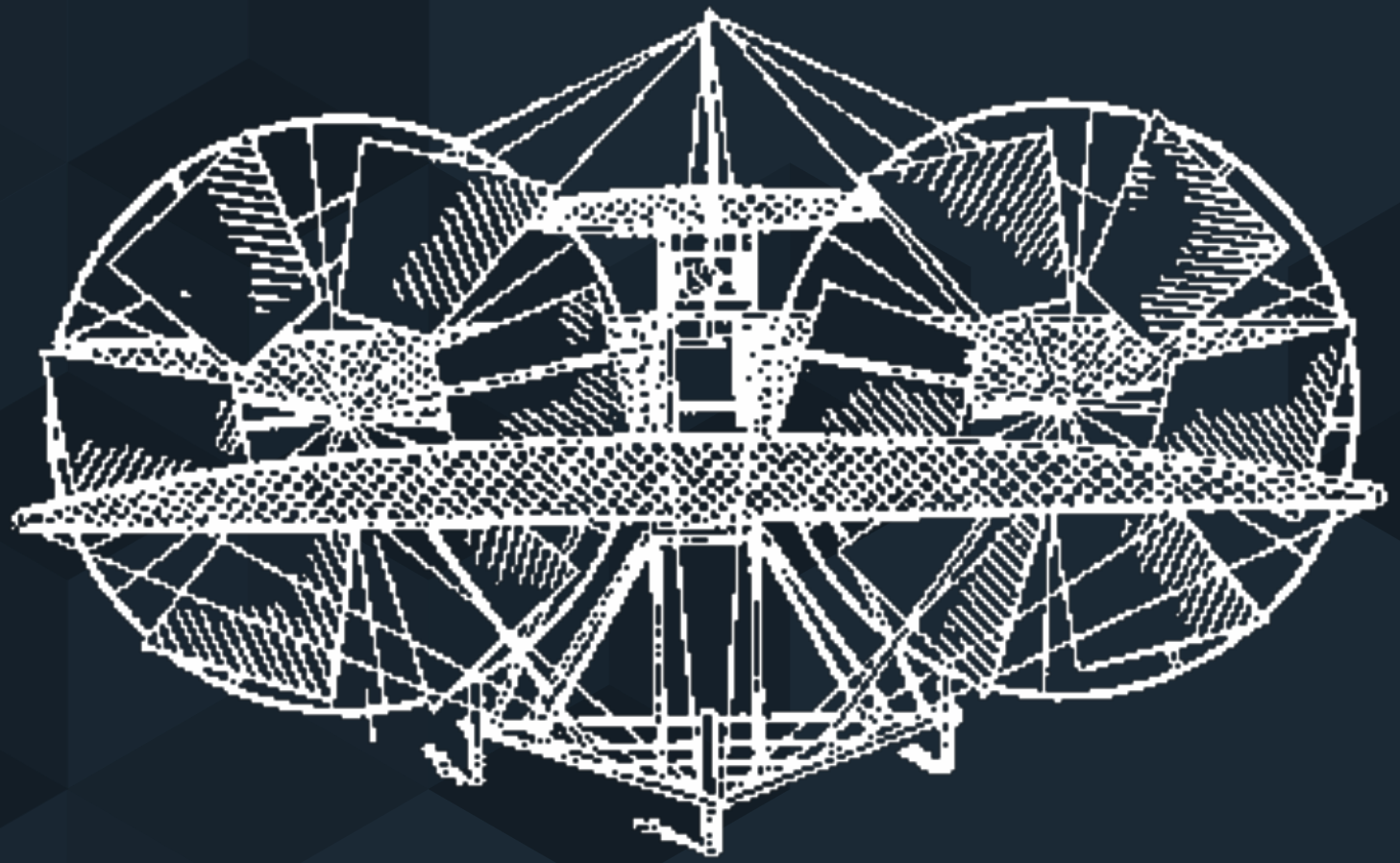


Fig. 55 – MOY - 1875

[Moy] considered… launching the apparatus from a height, or down an incline, but then **this costly machine**, built wholly at his own expense, would sure have come to grief…

"[So he] needlessly handicapped himself in starting from the ground by a level run…

Simple, Small, Experimental & Successful

Fig. 53 – PENAUD - 1871

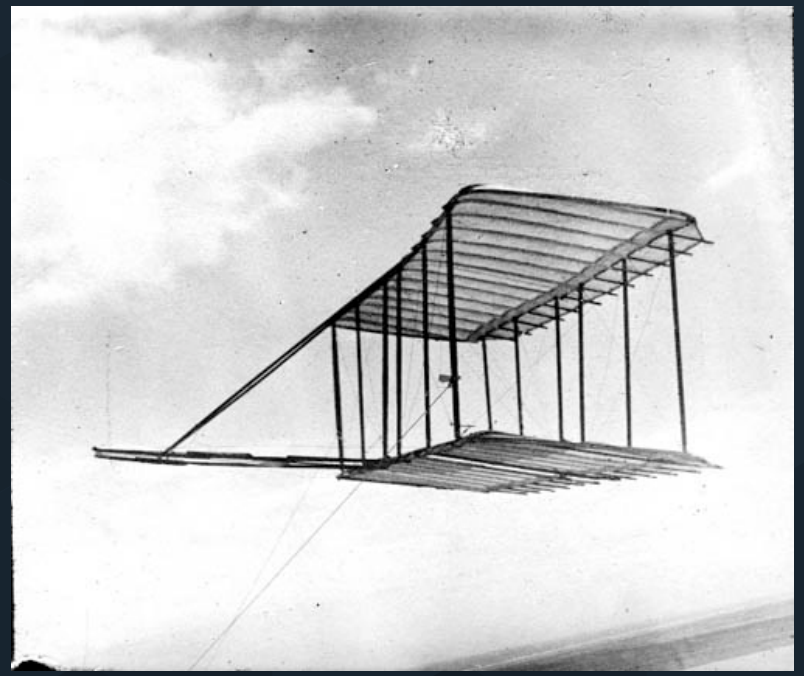
"This next experiment… was **important** and quite **successful** upon the **small scale** on which it was tried."

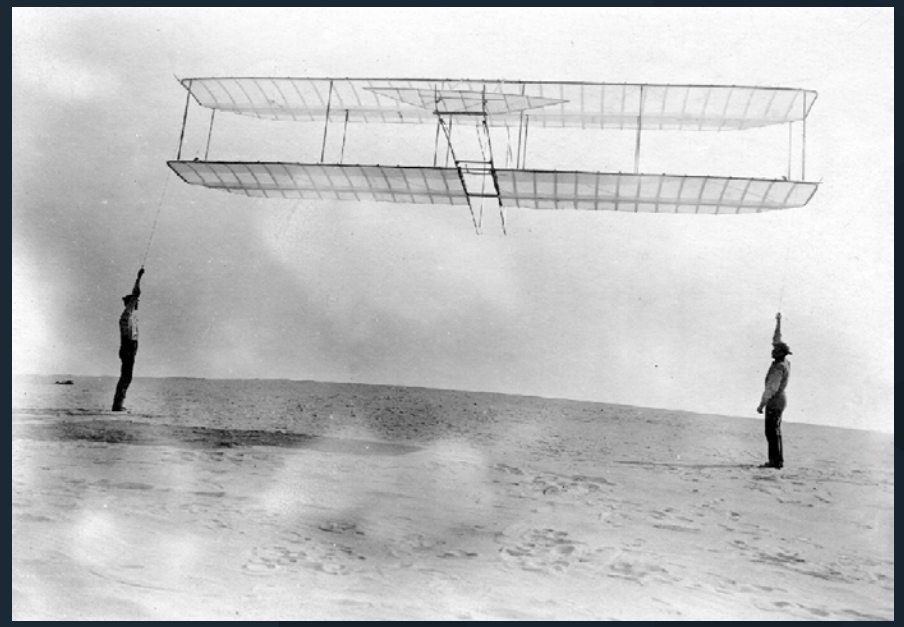
Campaign of Experiments

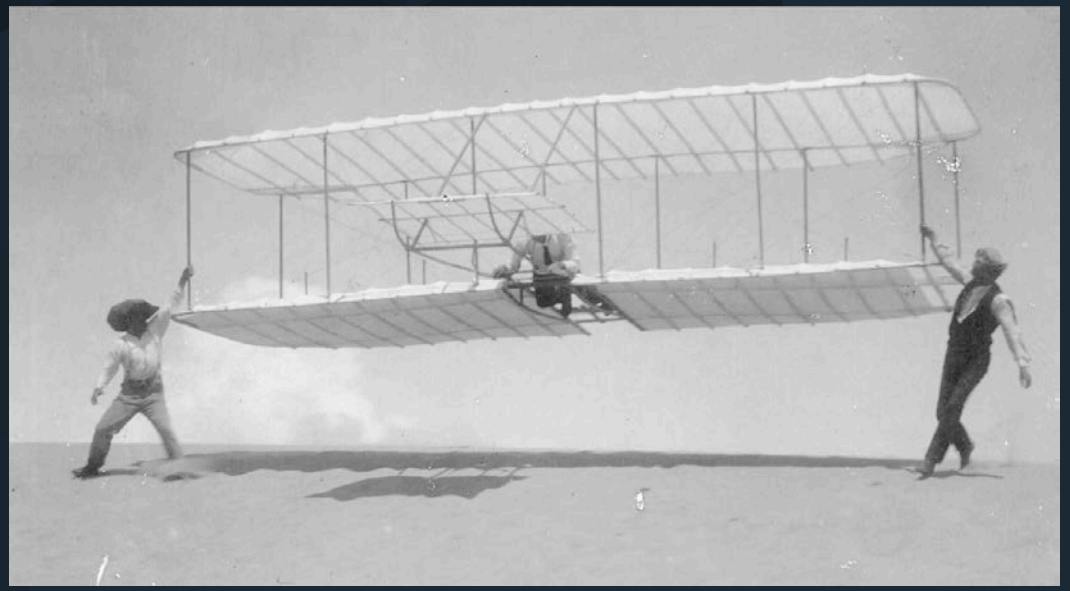
"Trying to do too much in a single experiment greatly increases the probability that the experiment will generate little in the way of useful information or experience, and therefore be of little value.

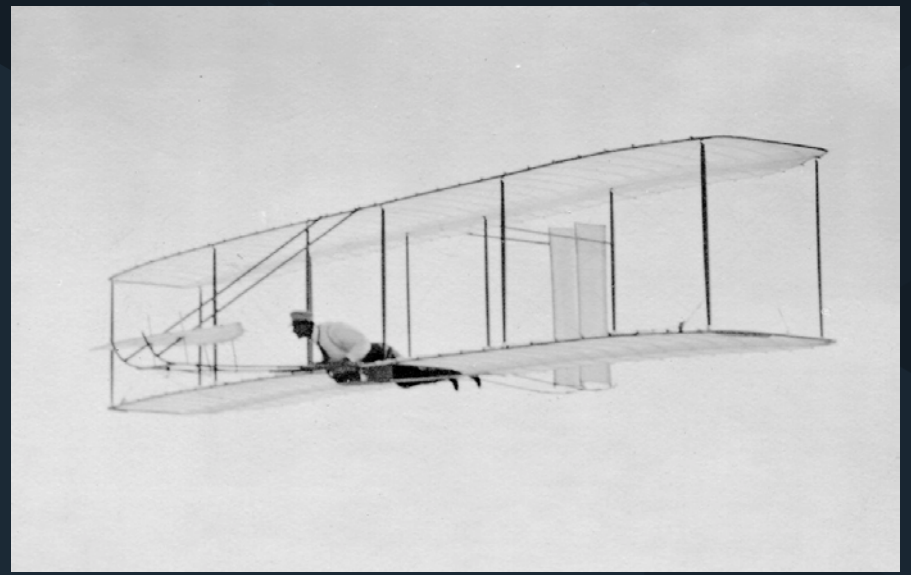
"Overly ambitious efforts are a waste of time, talent, and resources."

-pg 3









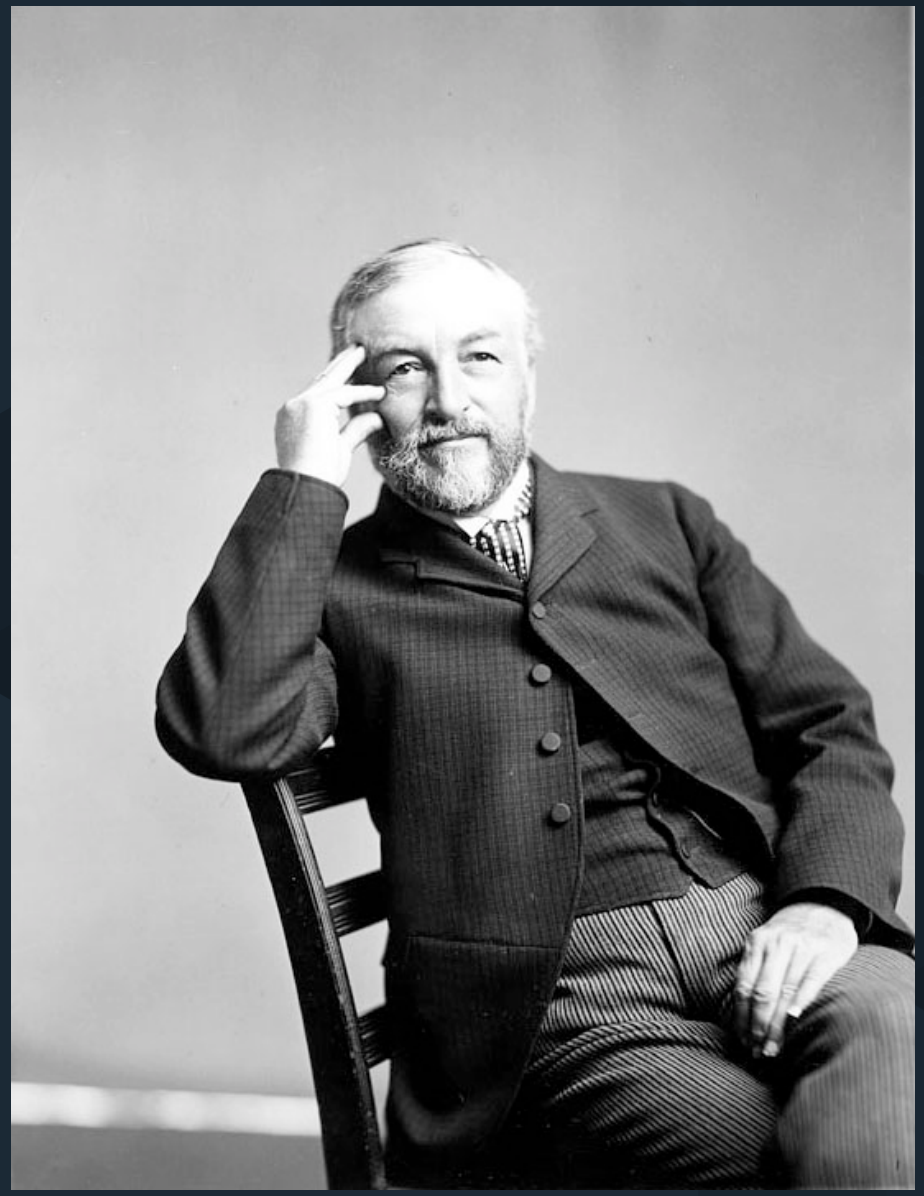
The Wright Brothers 1903

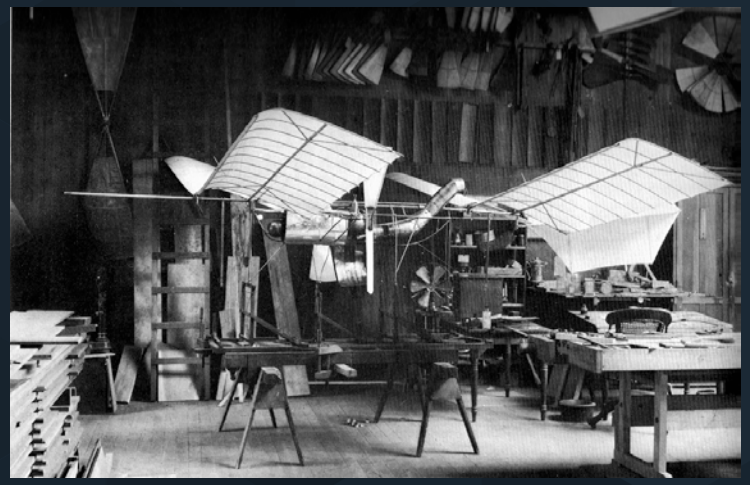
1. Self Funded
2. No Formal Education
3. Obscurity
4. Dismissed by the Smithsonian
5. Ignored by the Media
6. Unpaid Volunteers

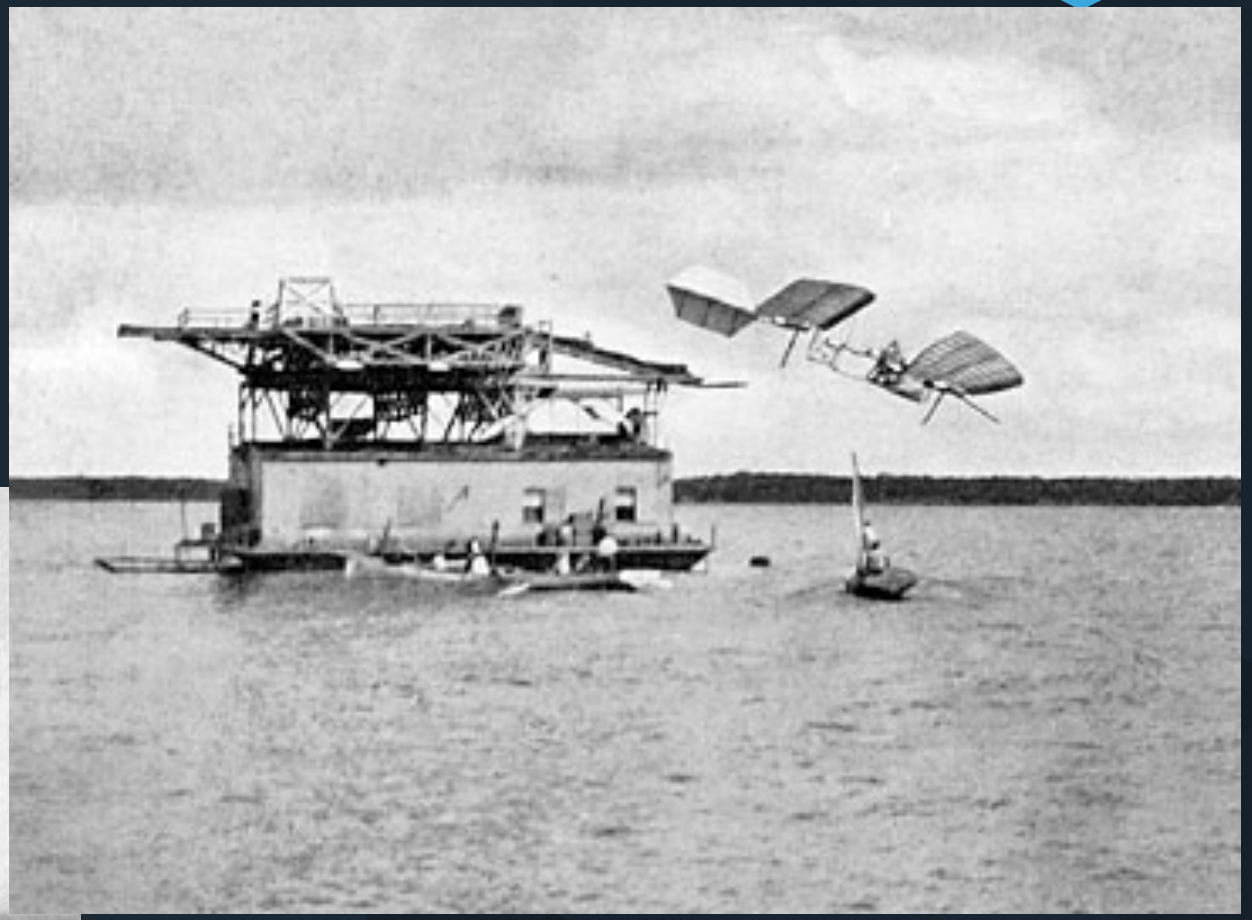
The first flight was less than the wingspan of the C-5 Galaxy

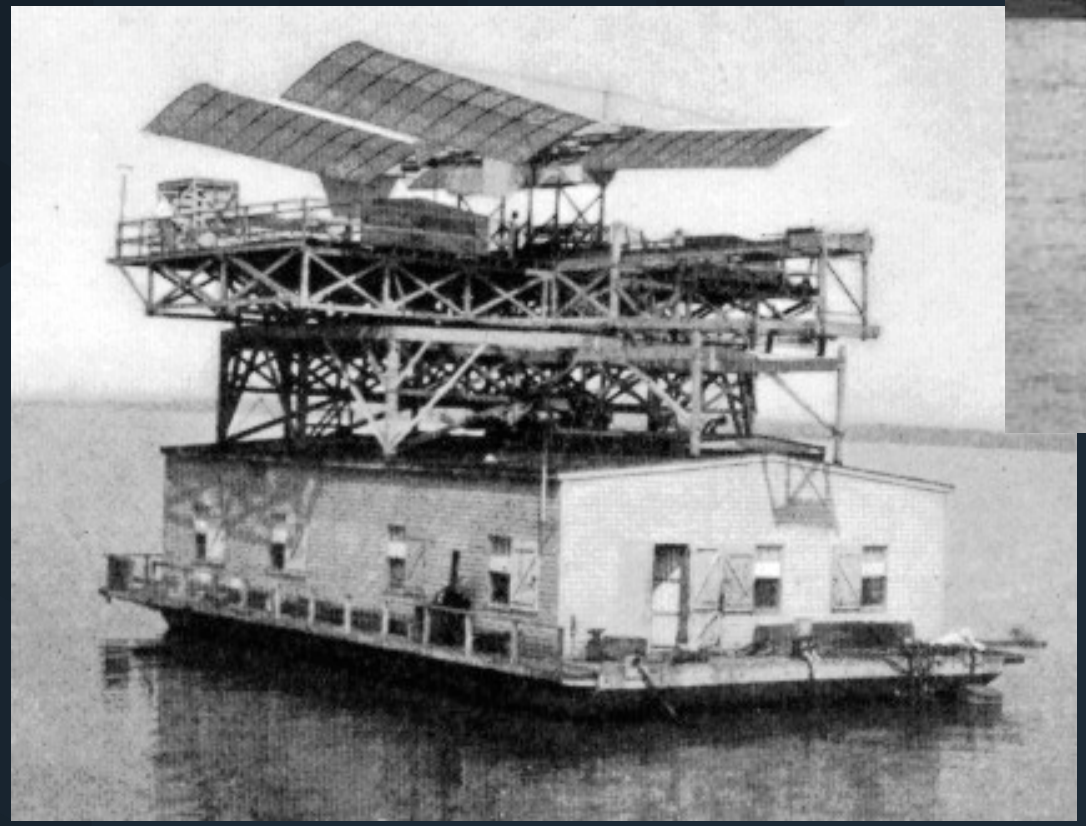
Samuel Langley

1. Well Funded
2. Team of PHDs and Engineers
3. Support of the War Department
4. Followed by the media
5. Backing of the Smithsonian



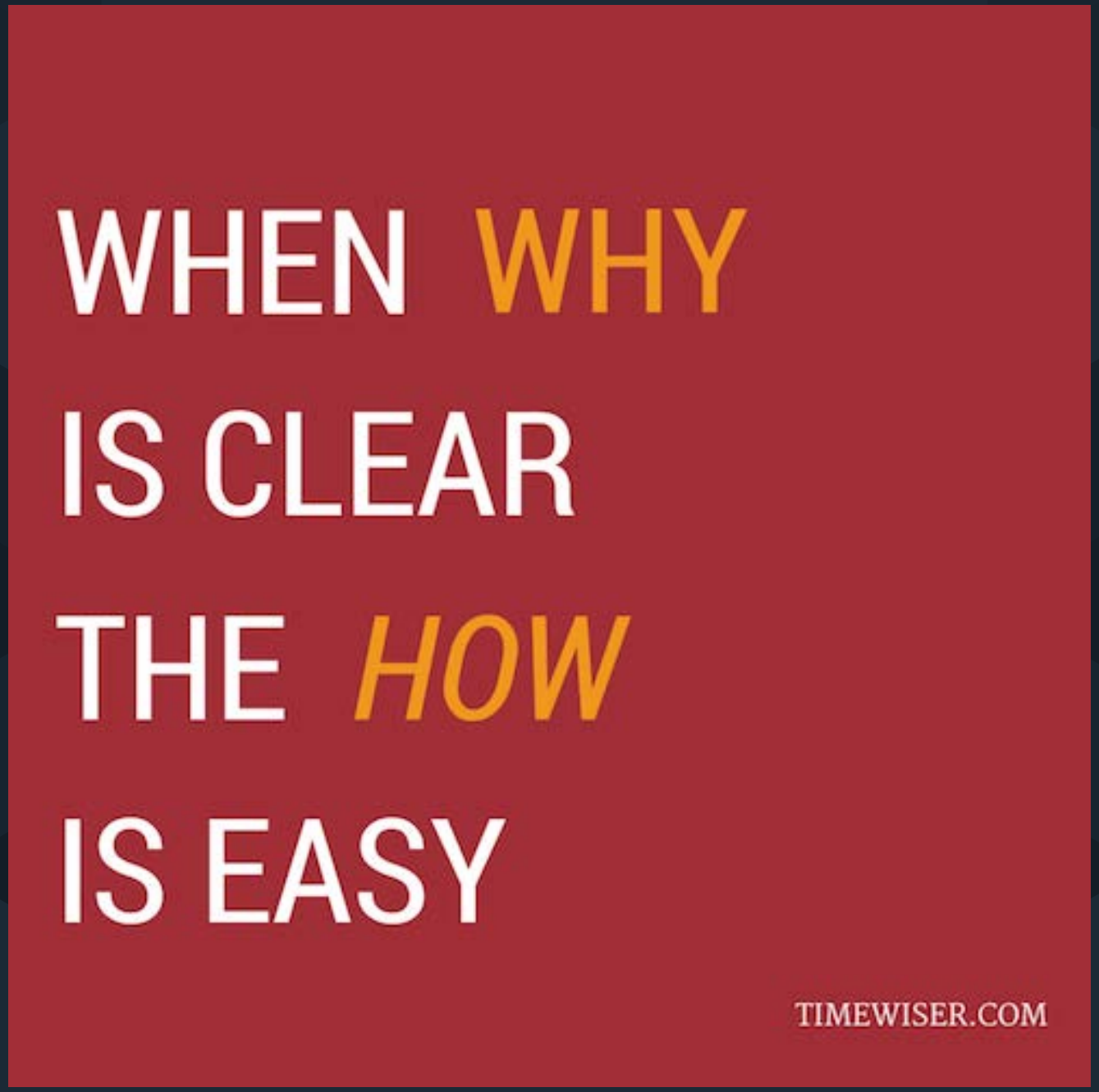






Question #1

Why did the Wright Brothers succeed where Samuel Langley did not?


WHEN WHY
IS CLEAR
THE HOW
IS EASY
TIMEWISER.COM

Skunk Works is the the unofficial name for the Advanced Development Programs (ADP)

Skunk Works is responsible for a number of famous aircraft designs, including the U-2, SR-71, F-117, F-35.

Requirements: Fly Really High, Take Pictures, and don’t get shot down

Requirements: Fly Really Fast, take pictures, and don’t get Shot down

Requirements: Be Stealthy, drop bombs, and don’t get shot down.

Fly Supersonic and be a Intra Service Multi-Mission capable solution for Emerging Global Threats Leveraging 5th Generation Stealth, Advanced Electronic Warfare, Air to Surface active electronically-scanned array radar, Fully integrating intelligence, Surveillance and Reconnaissance using a next generation core processor that can perform more than 400 billion operations per second empowering the Electro-Optical Targeting Systems providing the pilot 360-degree coverage while maintaining interoperability with all legacy aircraft and full information sharing across all spectrums of warfare.

DoD Waterfall vs. DoD Agile

American F-35 Lightning vs. the European JAS-39 Gripen

Cumulative cost 1.5 trillion dollars

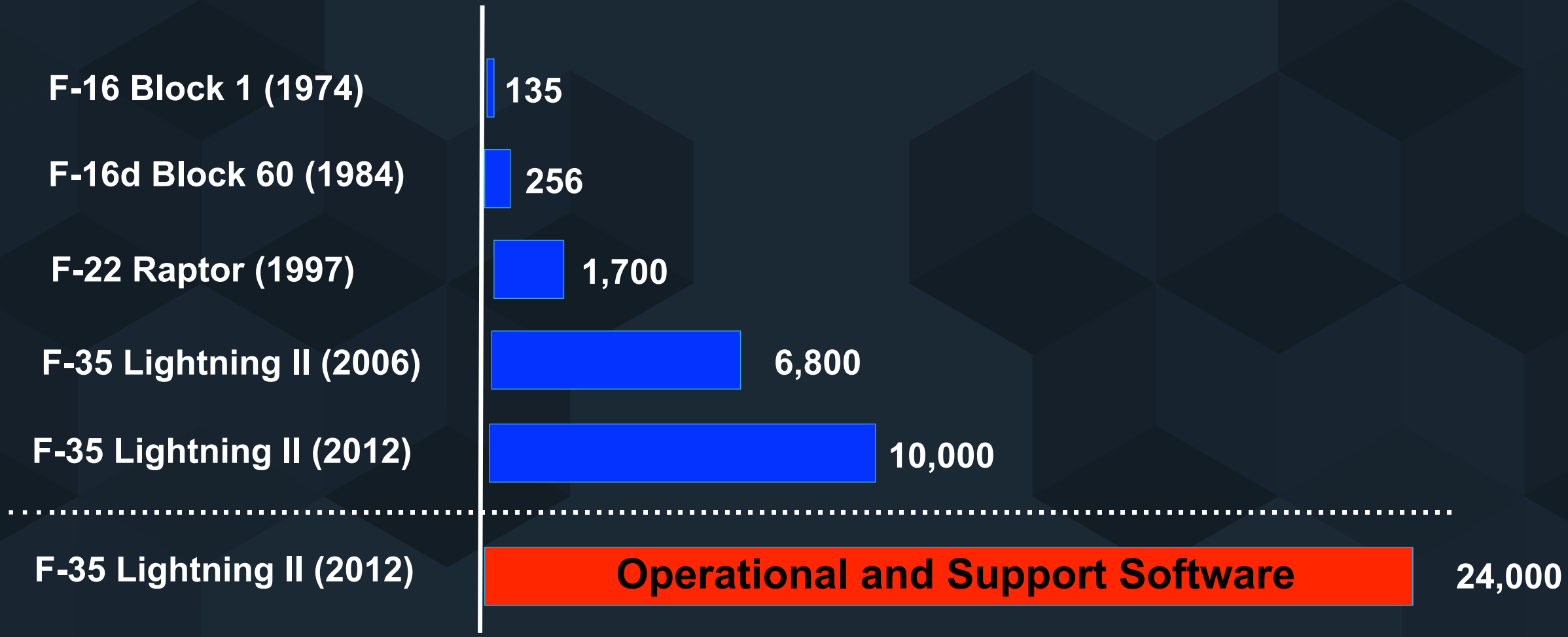
- $143 billion over budget
- Delayed until 2022
- Cost of Navy F-35C $337 million
- $31,000 Hour Flight cost

Cumulative program cost of $15 billion

- New iteration every 6 months
- $43M cost[1] (20% of F-35)
- $4,000 Hour Flight Cost

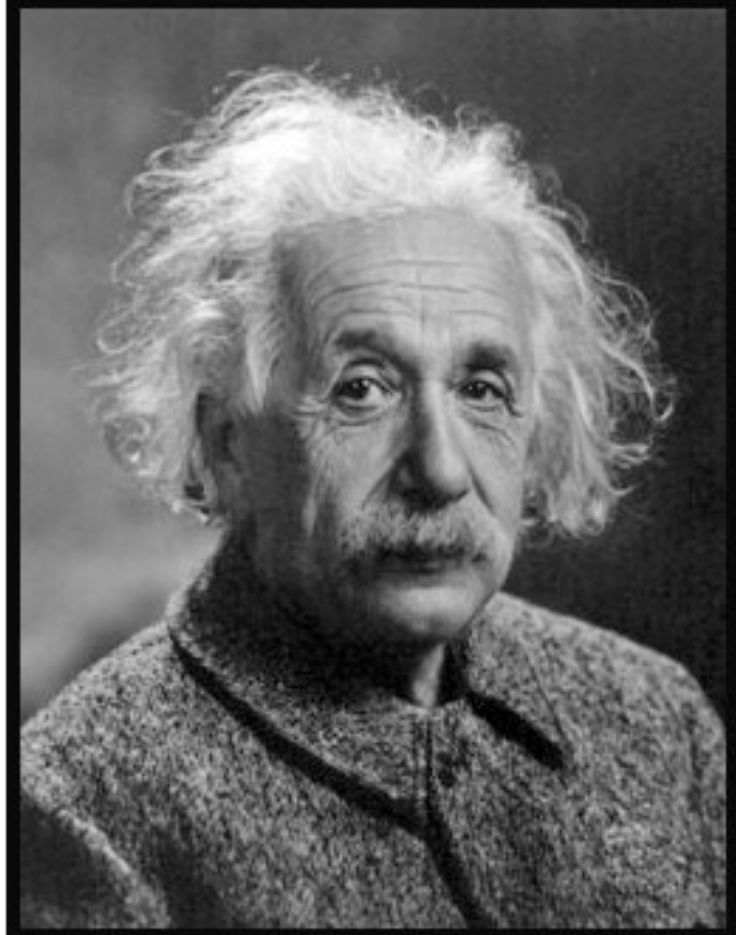
1. According to Jane's Aviation Weekly, the Gripen is the world's most cost-effective military aircraft

Source Lines of Code (SLOC) "In Thousands"



Question # 2

Why was the Skunk Works pattern of success not able to deliver on the F-35?



We cannot solve our problems with the same thinking we used when we created them.

(Albert Einstein)

izquotes.com

Reducing the cost of space travel:

"The resulting economies may bring operating costs down as low as one-tenth of those of present launch vehicles."

Richard M. Nixon

"Factor of ten."

James Fletcher

President Richard M. Nixon and NASA Administrator James Fletcher, San Clemente, CA, 5 January 1972.

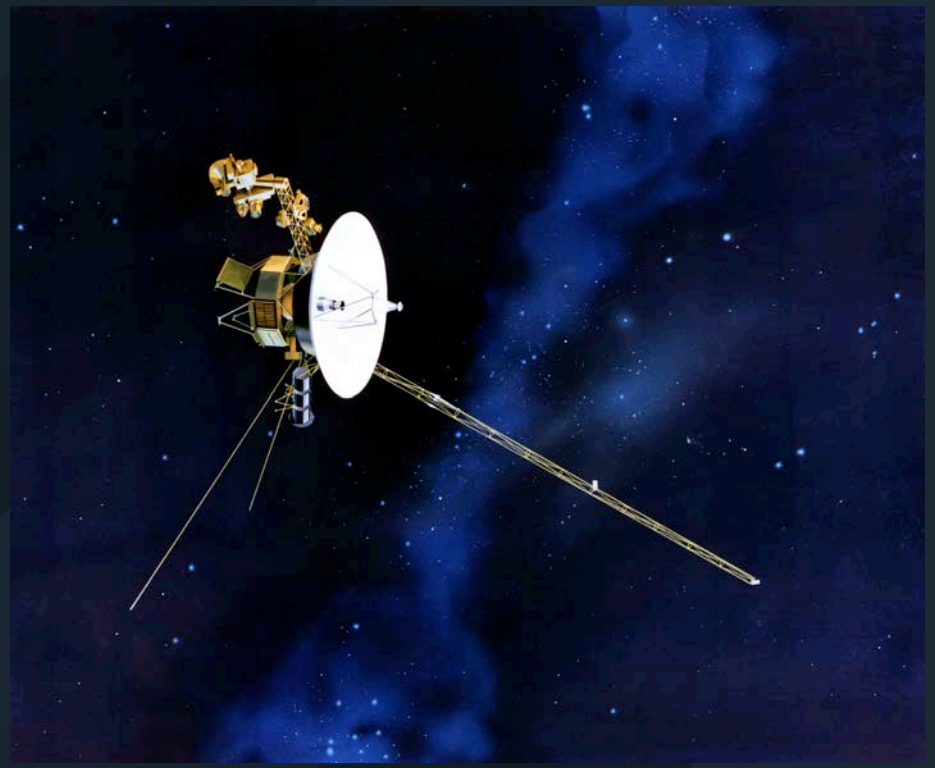
Space Travel Exploration Key Variables

1. Mass
2. Power
3. Distance to travel
4. Service Life
5. Communication
6. Number of instruments

$16,437 Ounce

Mars Polar Explorer

Voyager did it: a factor of three.



- NASA wanted $1 billion for four spacecraft to Tour of the solar system
- Congress appropriated $360 million for two spacecraft to visit Jupiter and Saturn.
- JPL built two spacecraft that visited four planets.
- Launched in 1977 it's still working.

"Grand Tour" became Voyager.

Spitzer Space Infrared Telescope: factor of five.

Original estimate:
12,500 pounds, $2.2 billion

Actual telescope:
1,650 pounds, $473 million

Launched 2003; still operating in a warm mode.

X-33 / VentureStar team tried.

- Joint Venture Lockheed Martin
  - NASA invested $922 million
  - Lockheed Martin $357 Million
- Innovative technologies
  - Aerospike engine
  - Graphite-epoxy composite fuel tanks
  - Lightweight single stage to orbit
- Cancelled by NASA in 2001
  - Technological obstacles
  - Growing costs

1992 Dan Goldin NASA Administrator .

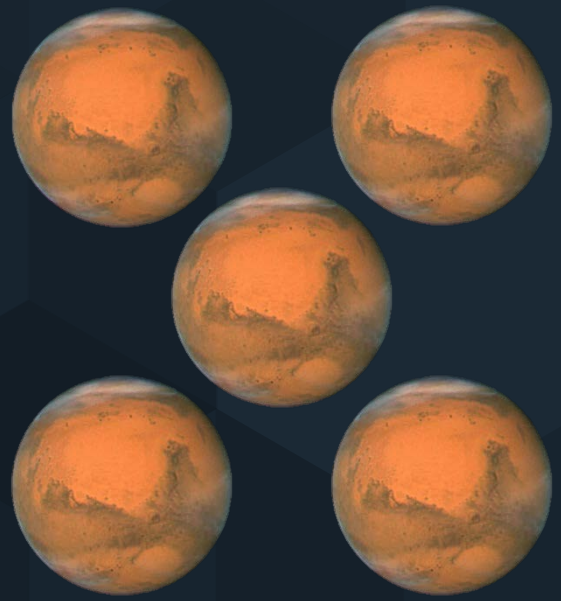
Faster - Better – Cheaper (FBC)

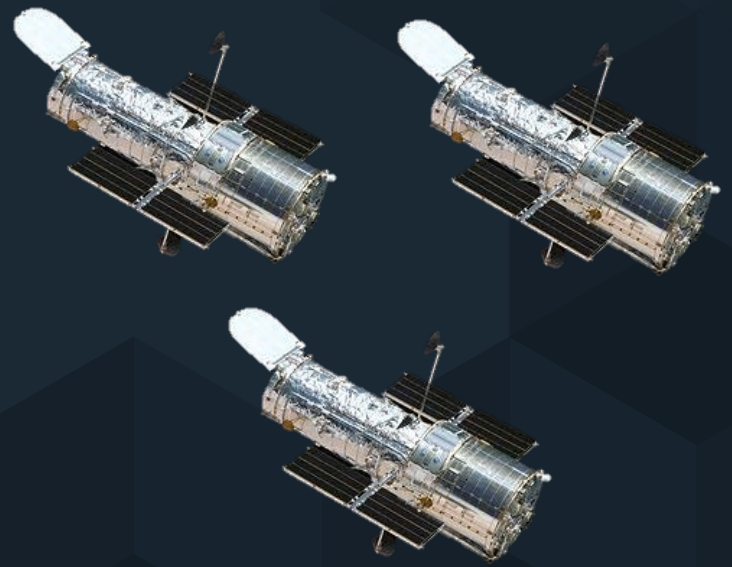
1. Smaller Missions - No more eggs in one basket
2. Incorporate Advanced technology
3. Reduce NASA HQ oversight push responsibility to the centers
4. Construct Exciting Visions and Roadmaps
5. It’s ok to fail, which was not well understood.

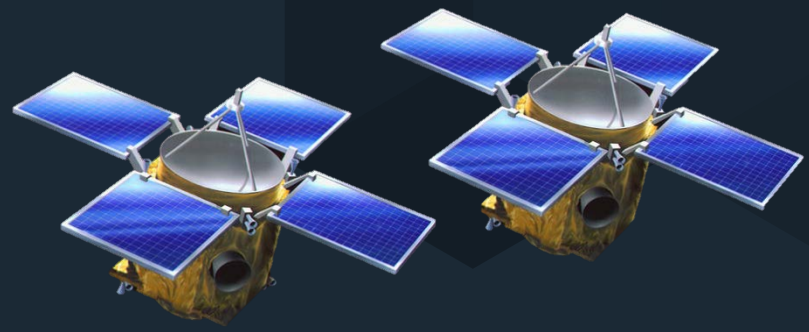
FBC Boiled down to two basic things

1. FBC attempted to improve performance by being more efficient and innovative, and it applies to everything and everyone.

2. There is an intangible element and team spirit associated with doing FBC and people are the most important ingredient.





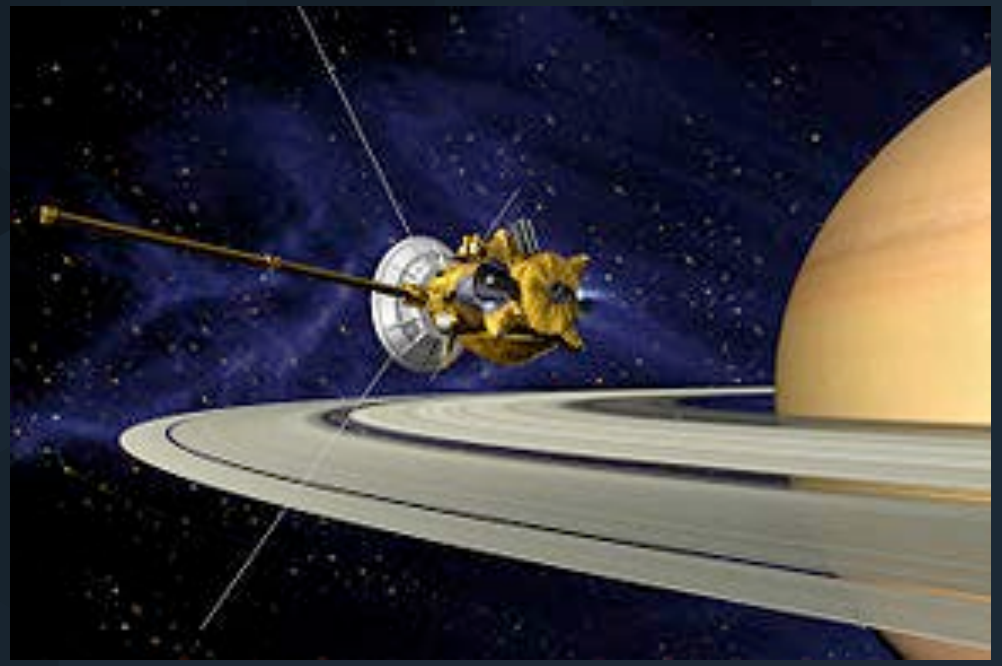


Cassini–Huygens 1997 Launch

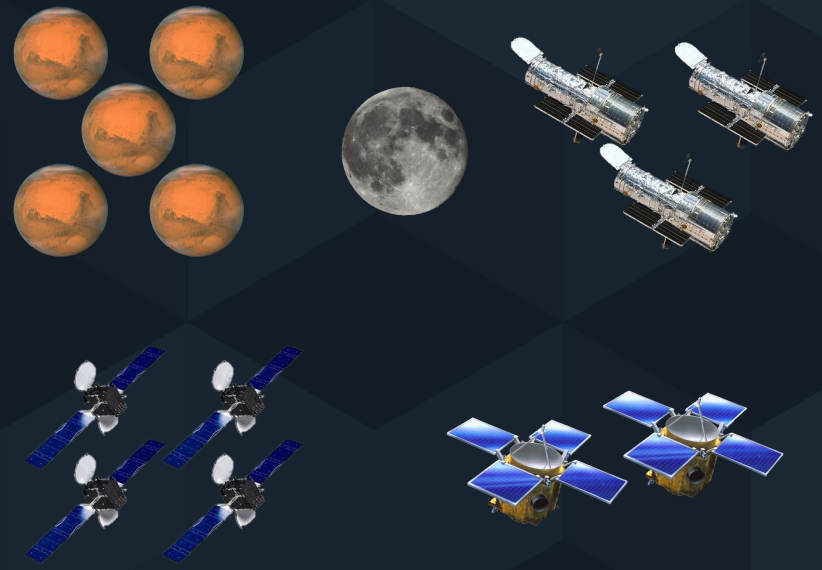
Development started 1980s

3.3 Billion & 12,346 Lbs

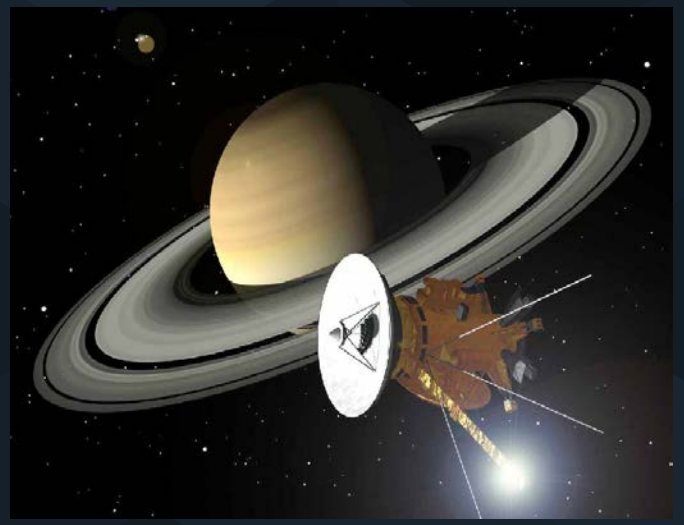
Size of a Yellow School Bus

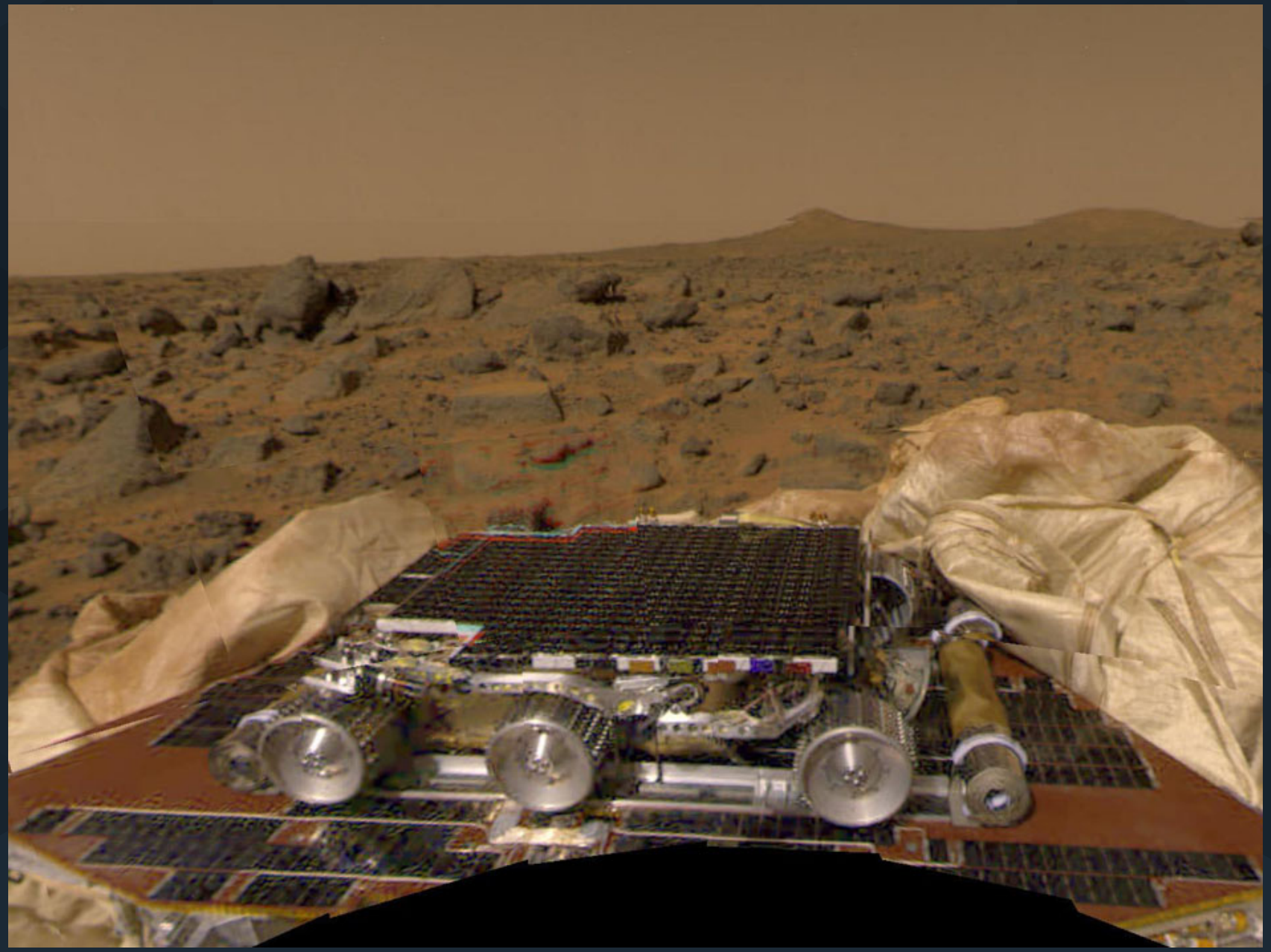


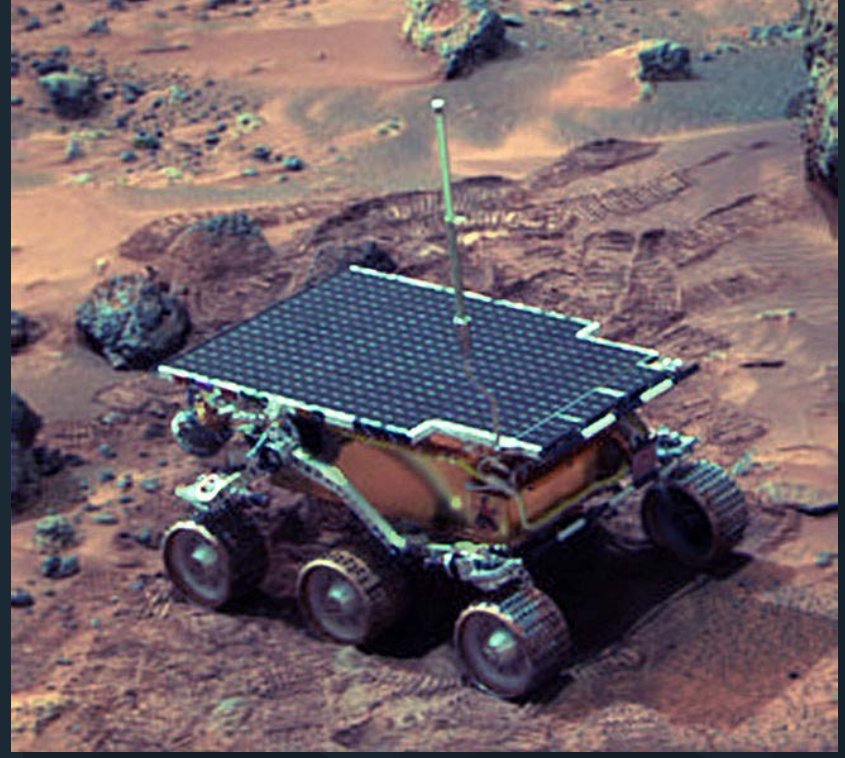
FBC



Cassini







VIKING

1970’s

$3.6B

6 years

2257 people

PATHFINDER

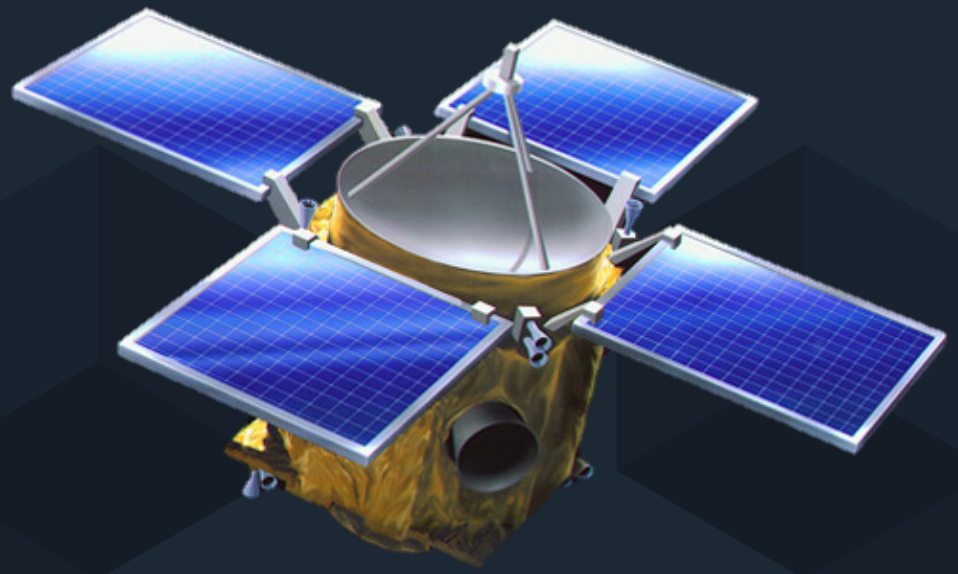
1990’s

$265M

3 years

354 people

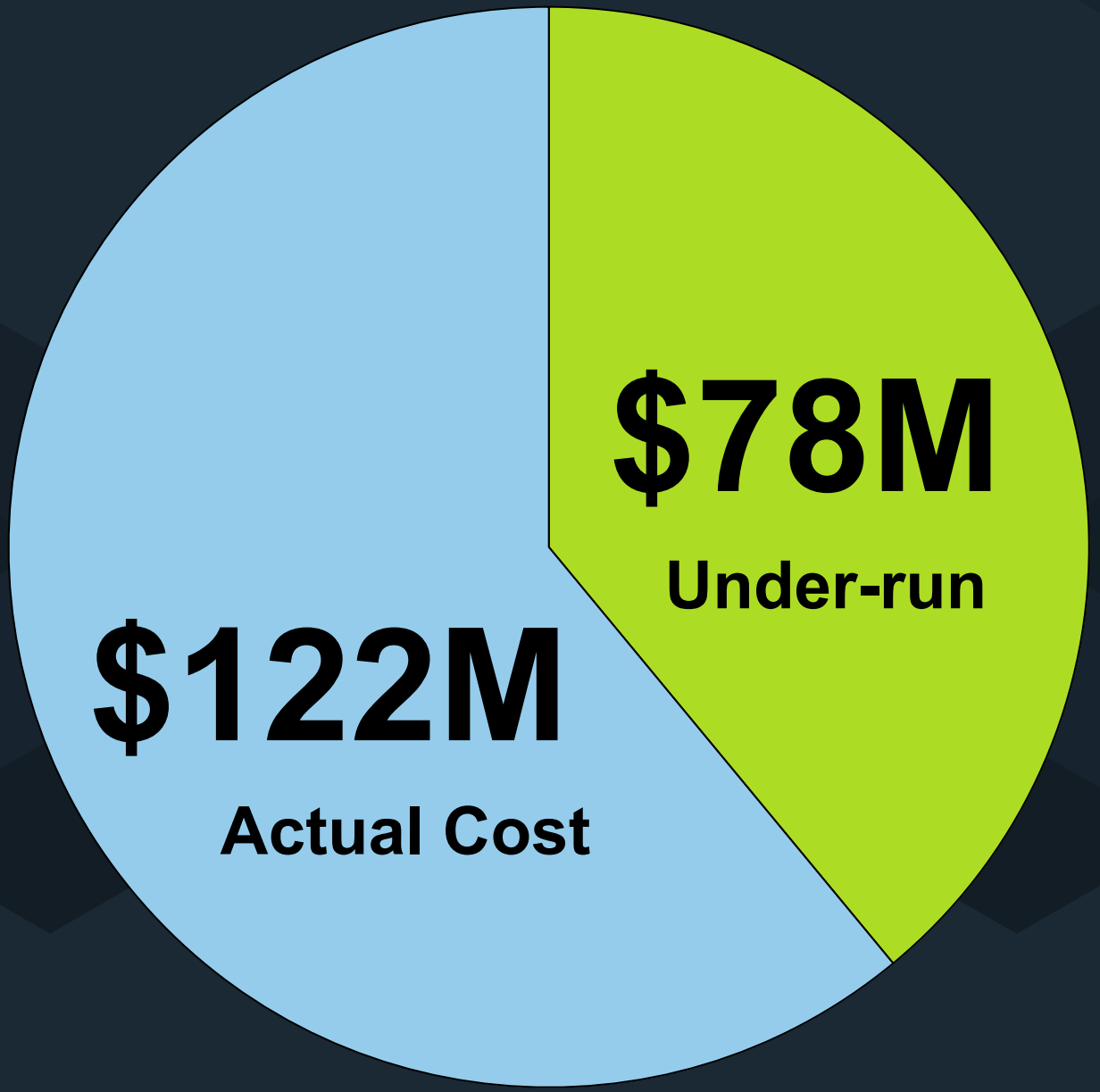
Near Earth Asteroid Rendezvous (NEAR) Mission



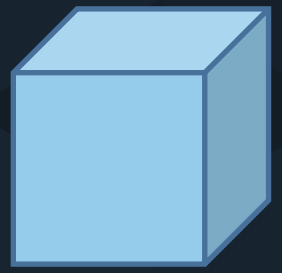
2,000,000,000 miles*

**That's "Billion-with-a-B"*

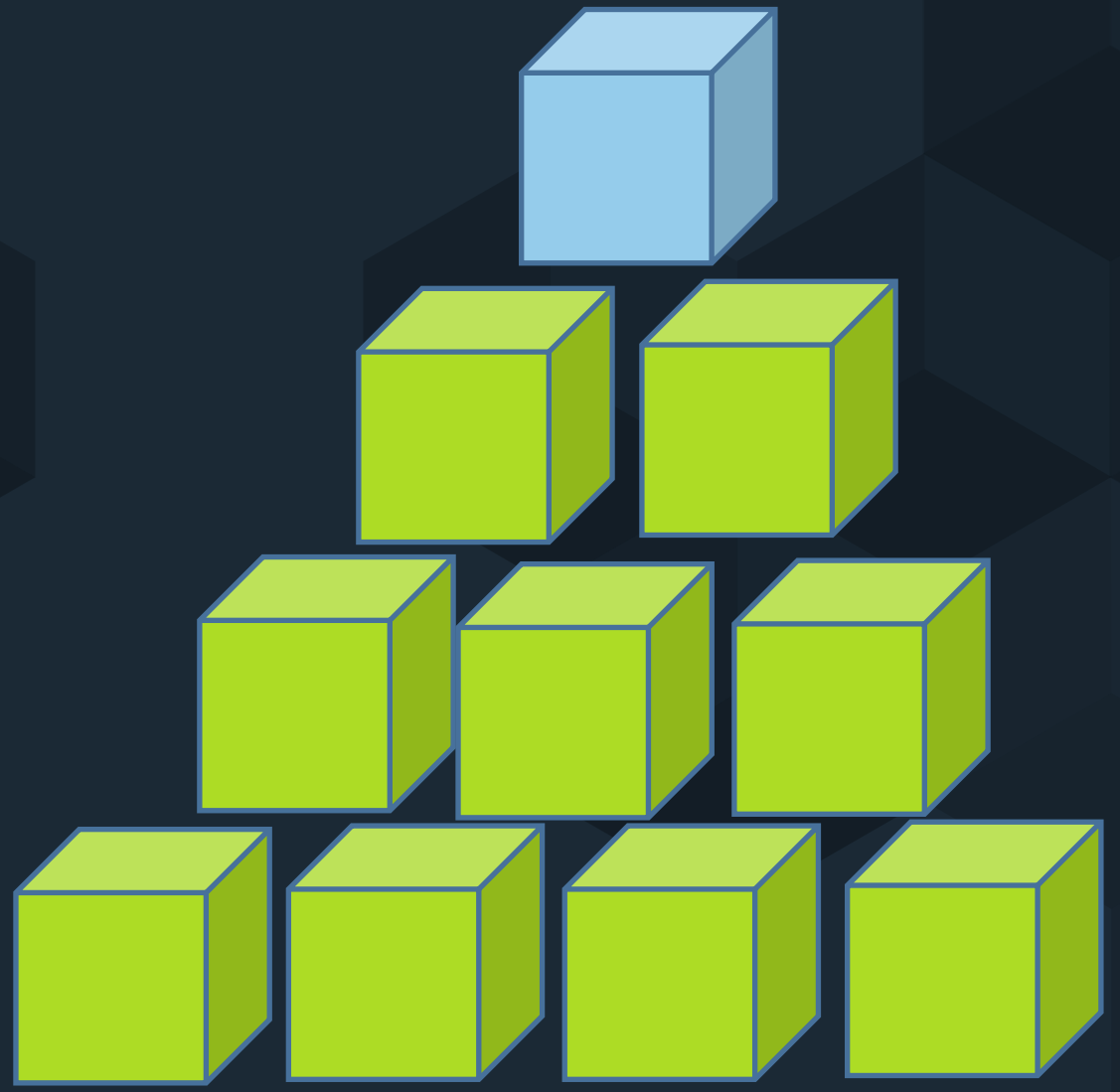
NEAR's Budget: $200M



How Much Data NEAR Expected To Collect



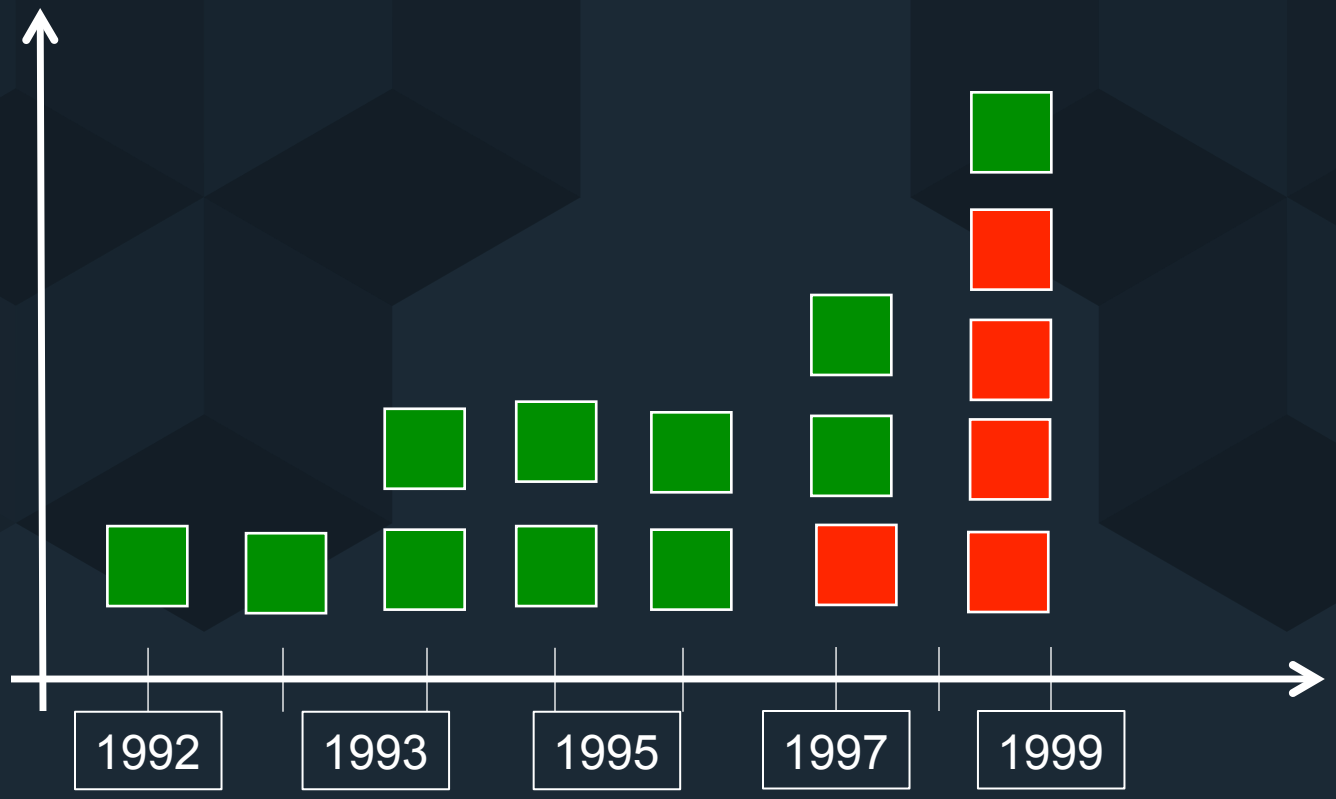
How Much Data NEAR Actually Collected



FBC RESULTS FROM 1992 - 1998

WINS	LOSSES

FBC FAILURE DISTRIBUTION



Lesson Learned

Those doing the work do the estimation.

Question # 3

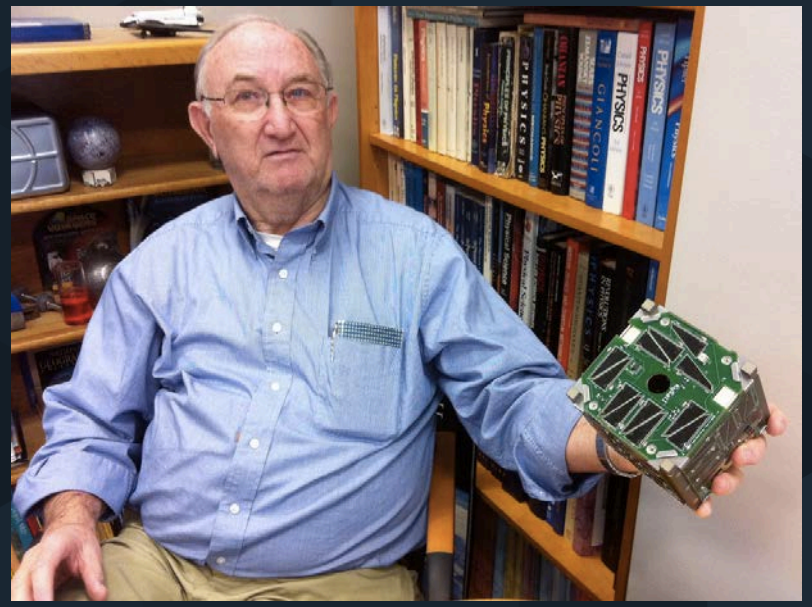
What working agreements could have helped prevent these failures, or at a minimum level set that failure was acceptable within limits?

simplicity

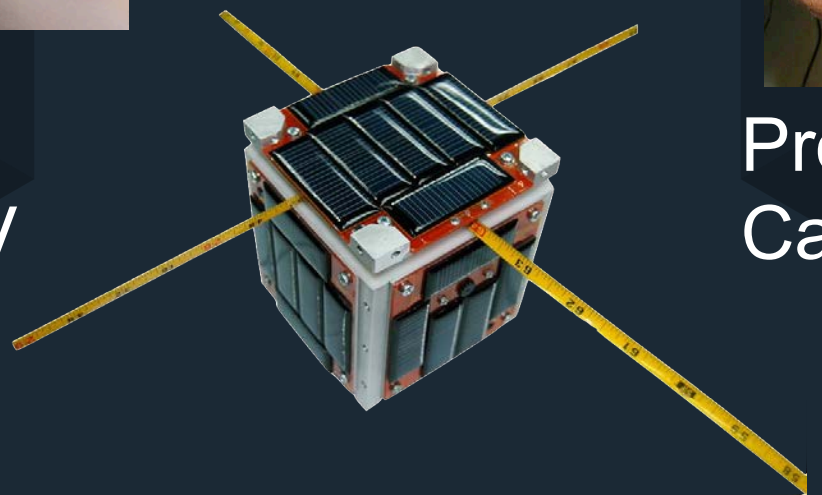
less stuff. less work.
less expense. equals.
more money. more
time. more joy.

less equals more

Agility Meets Fractionated Space

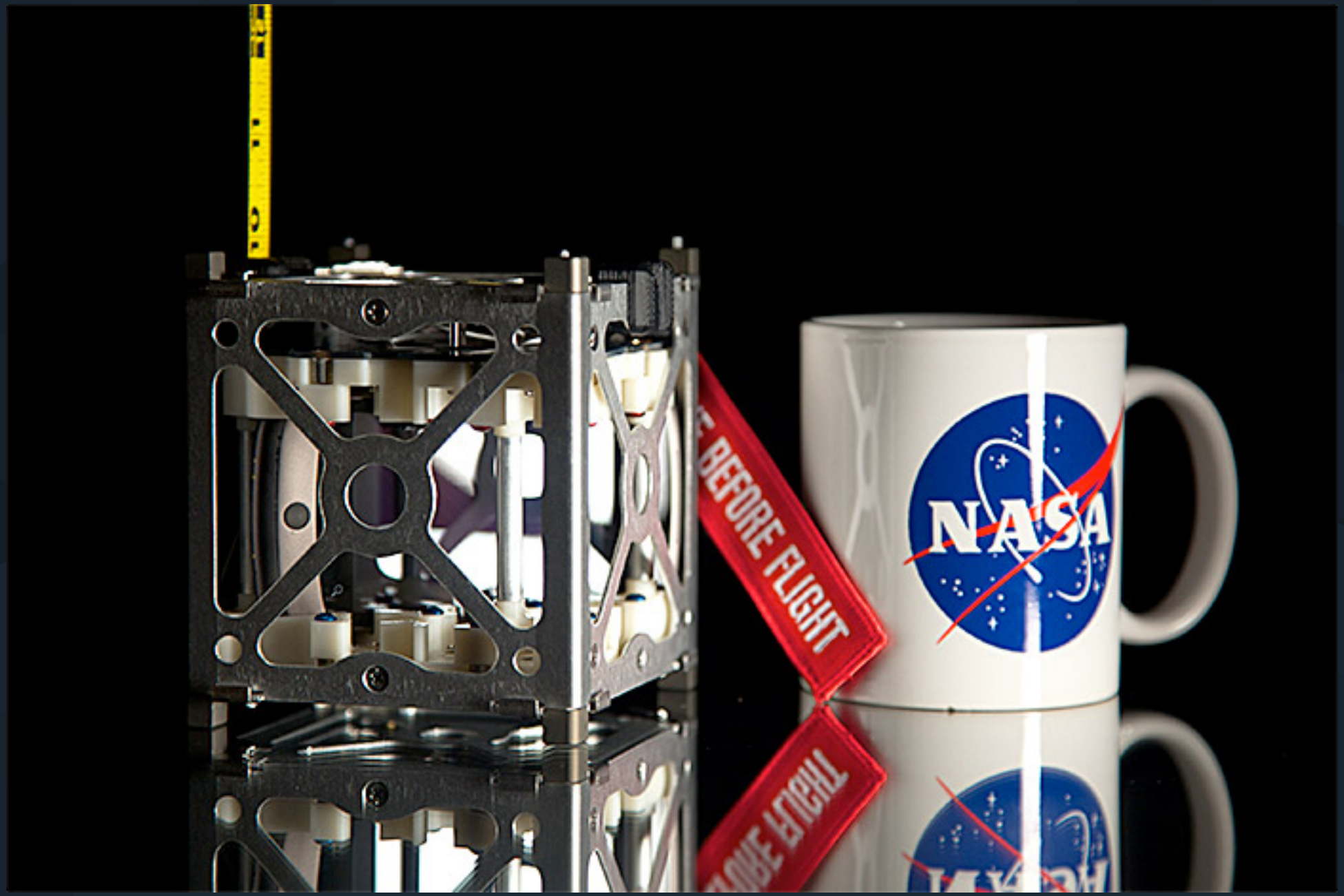


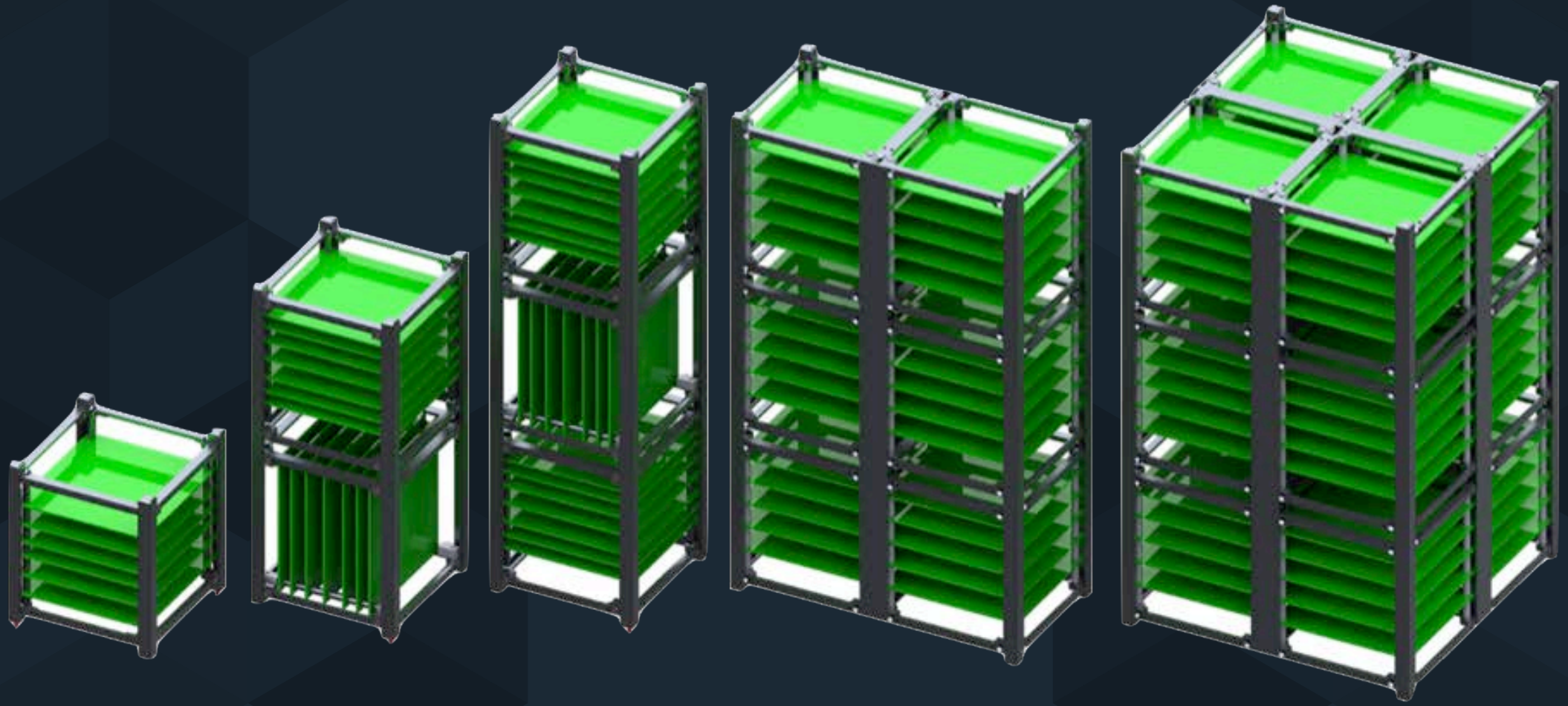
Prof Bob Twigs
Stanford University



Prof Jordi Puig-Suari
CalPoly – San Luis Obispo

1. Structure
2. Power Storage
3. Charging
4. Video
5. Attitude Sensor
6. Computer
7. Communications
8. GPS
9. Motion Sensor
10. Camera


BEFORE FLIGHT
NASA



1U 2U 3U 6U 12U

Source Radius Space
www.RadiuSpace.com

Explorer 1 1958

ChipSatellites

PicoSatellites

NanoSatellites

MicroSatellites

Deep Impact

Curiosity

MSL Cruise

Voyager

New Horizons

MRO

Hayabusa

Mariner 10

Galileo

Spitzer Telescope

Juno

Hubble Telescope

Cassini

< 1 oz | < 1 kg | < 20 kg | < 100 kg | < 500 kg | < 1000 kg | < 5000 kg | < 10,000 kg | < 20,000 kg

Small Satellites

Poly - PicoSatellite Orbital *Deployer* (P-POD)

Power On At Deployment

Standardized
Attach points

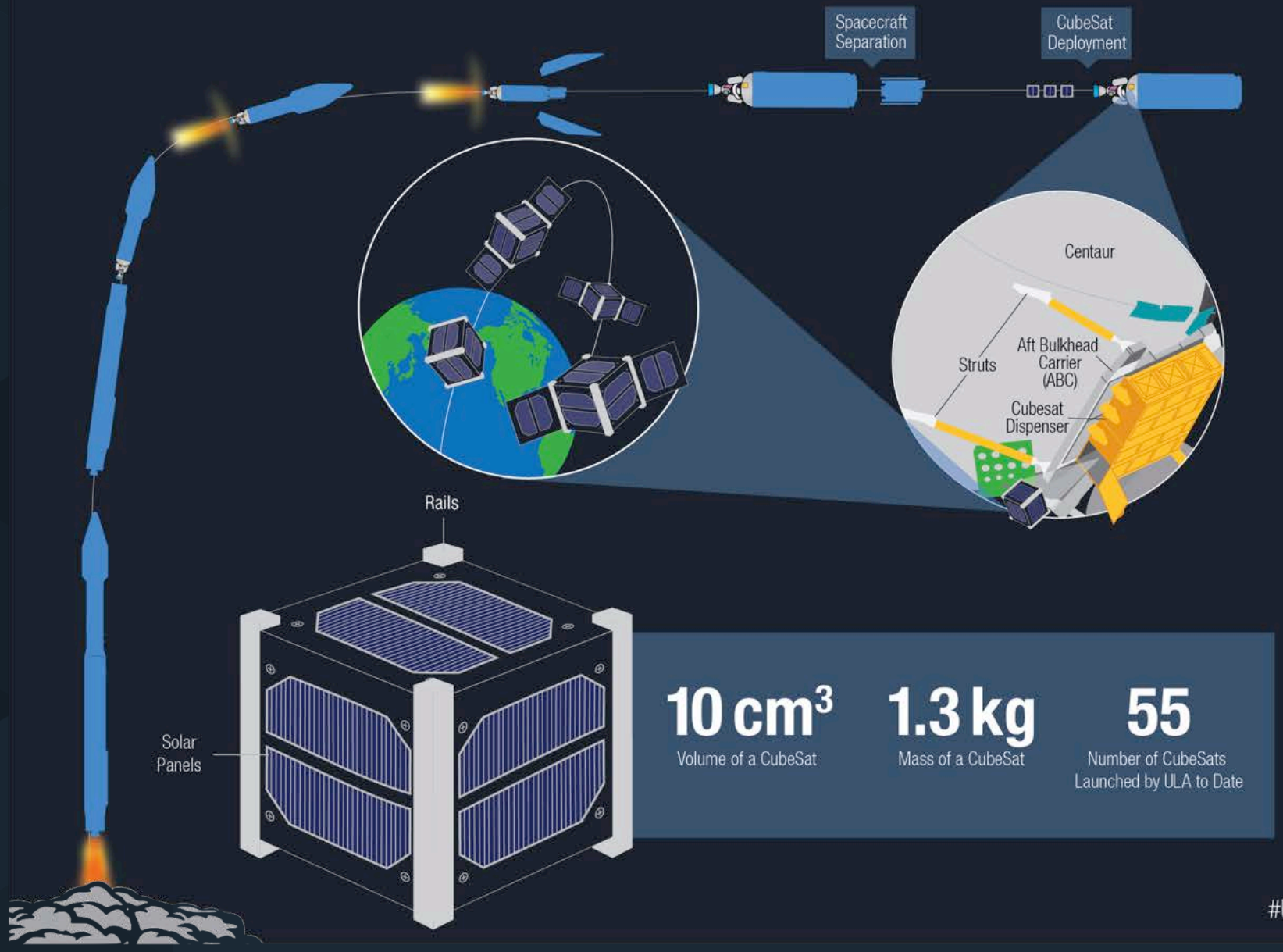
Spring Opened Door

Deployment Spring

JAPAN

ULA™
America's Ride to Space

Anatomy of a CubeSat Mission



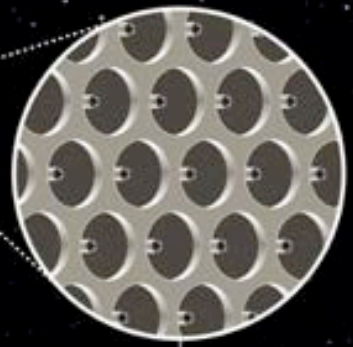
ULA®
United Launch Alliance
UNITED LAUNCH ALLIANCE

An Ionic Micro-motor for Nanosatellites

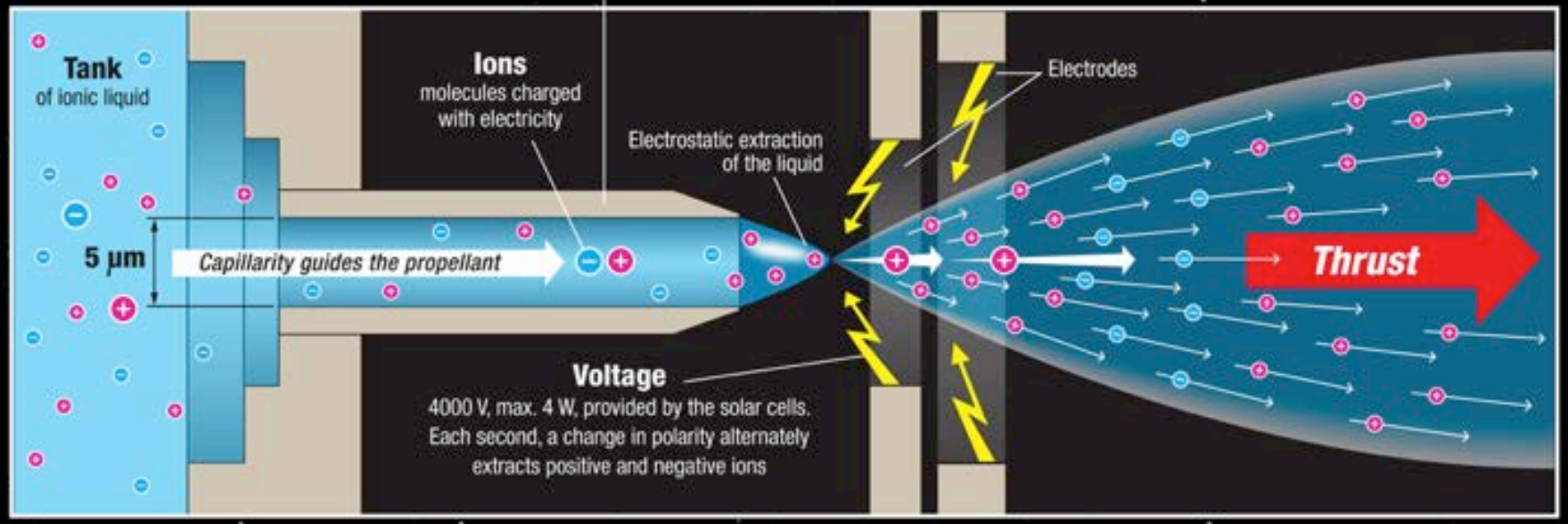
An ultra-miniaturized ionic motor opens the path to inexpensive space exploration in small satellites - they could make it to the Moon or to Mars. The European project called MicroThrust is coordinated at EPFL.

The thruster

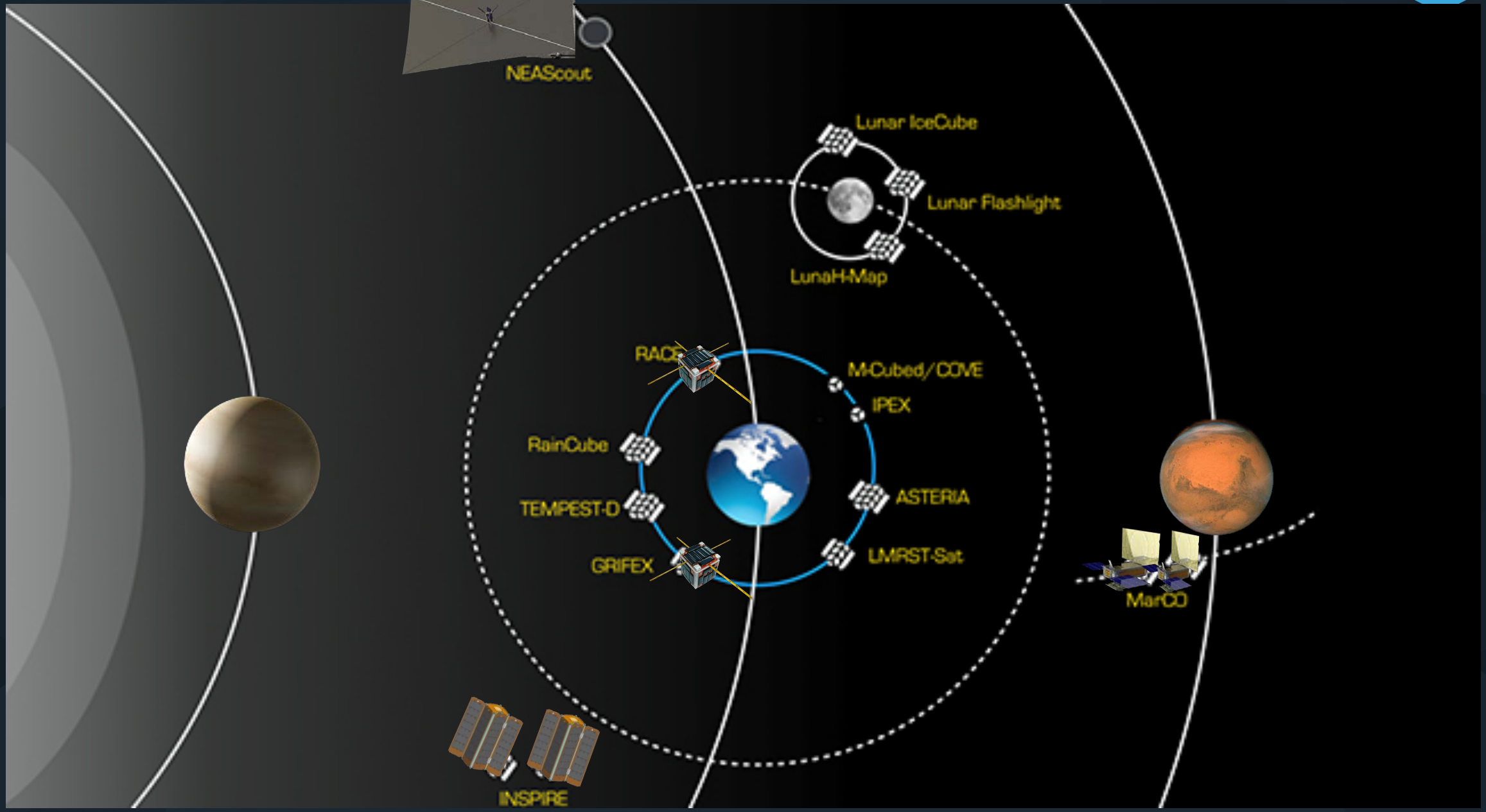
Mass: ~200 grams
Tank capacity: 50 to 200 ml

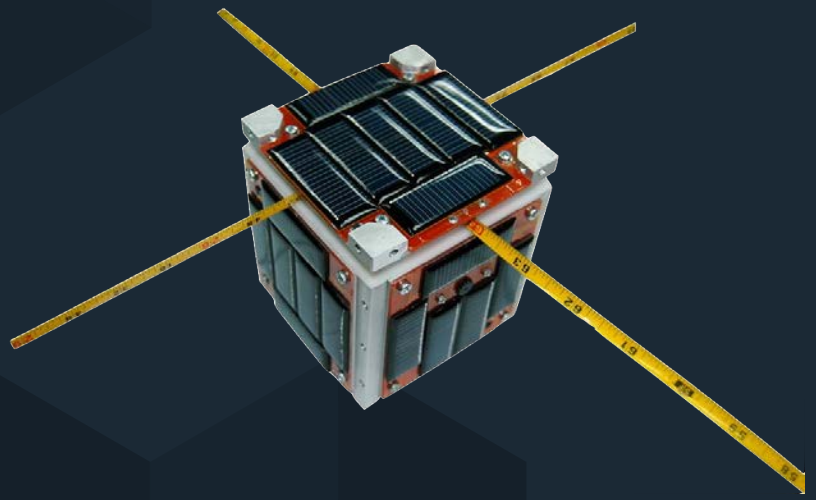


Emitters: ~1000 per cm²



Infographie: Pascal Coderay / EPFL


NEAScout
Lunar IceCube
Lunar Flashlight
LunaH-Map
RACE
M-Cubed/COVE
IPEX
RainCube
ASTERIA
TEMPEST-D
GRIFEX
LMRST-Sat
MarCO
INSPIRE



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100
75
50
25
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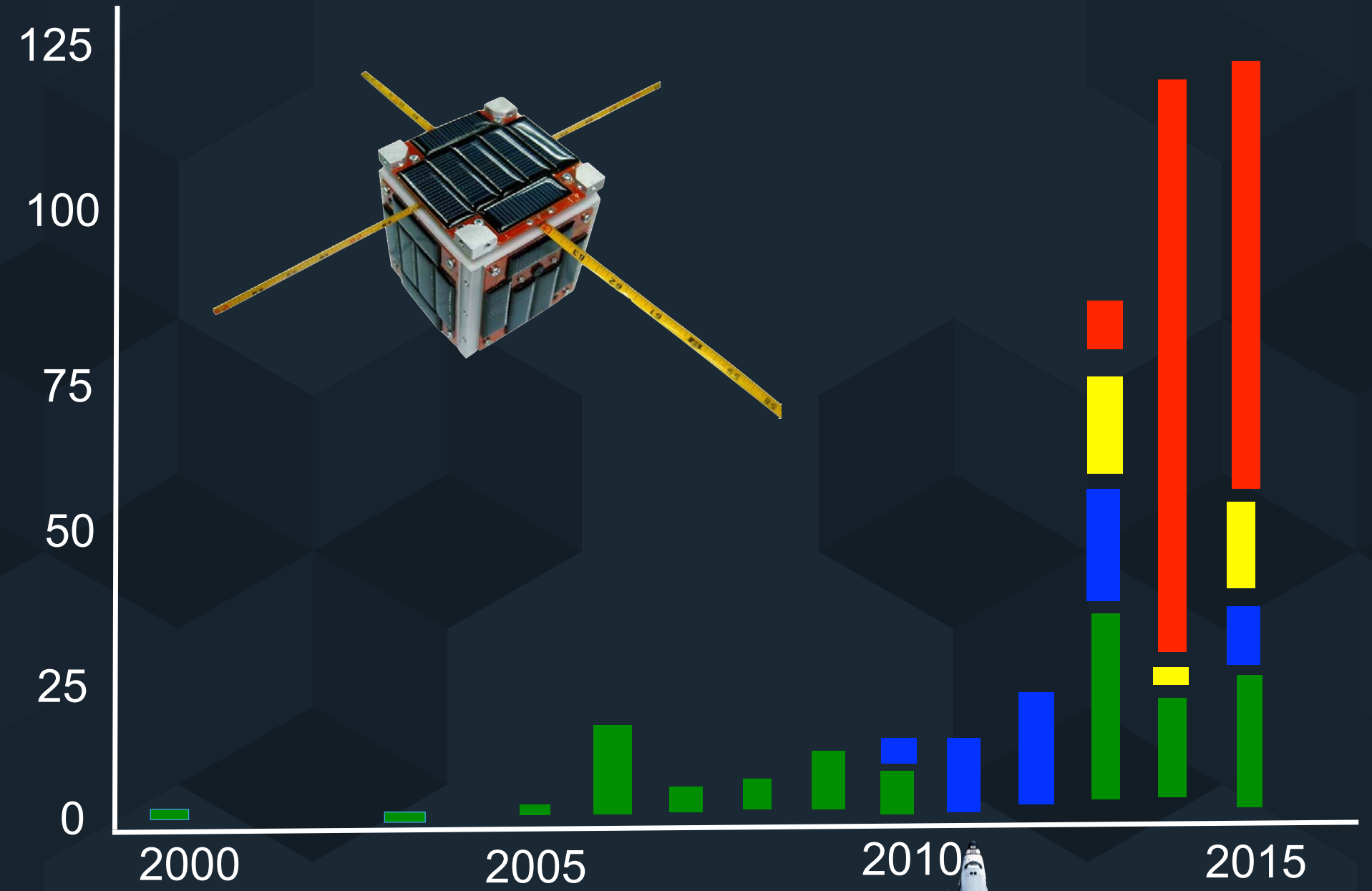
2000
2005
2010
2015


125
100
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2000
2005
2010
2015
University
Military
Civil - NASA
Commercial

cubesat

Accion
SYSTEMS

Tyvak International
A Terran Orbital Corporation

BCT

Planetary
Systems
Corporation

Orbital

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Technology

MARYLAND
AEROSPACE

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services

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ROCKETDYNE

AIAA
Shaping the Future of Aerospace

Space Dynamics
LABORATORY
Utah State University Research Foundation

VACCO
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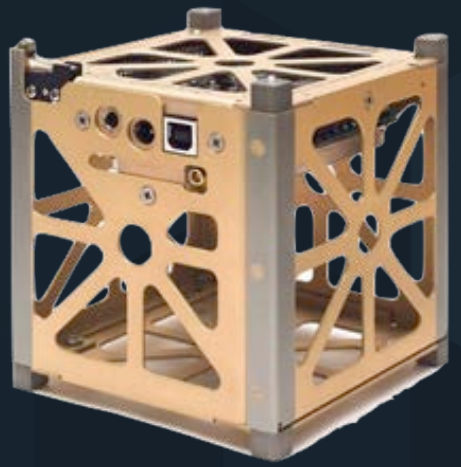
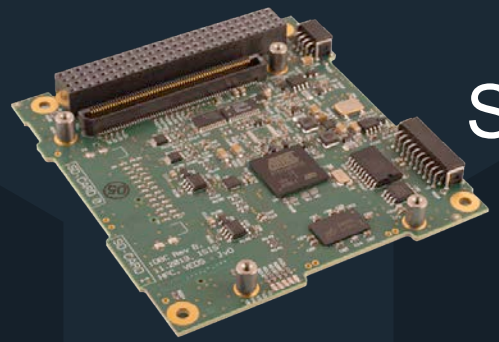
Terra Bella



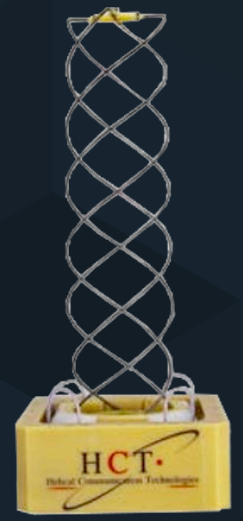
Frame

Reaction Wheels

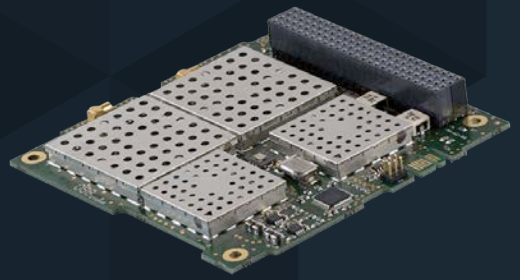


Onboard Computer

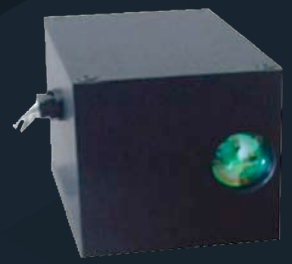
Sun Sensor



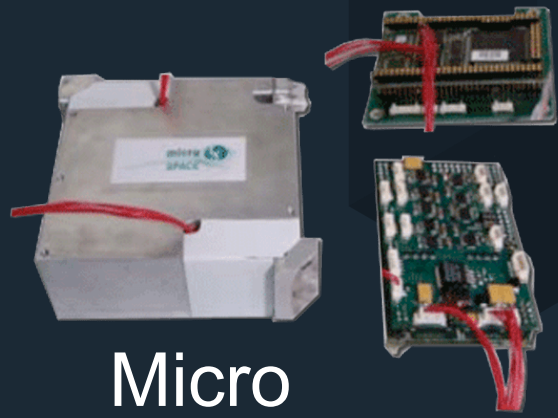
Helios Antenna



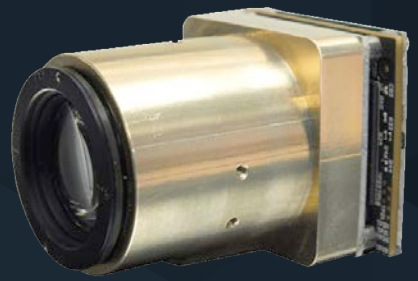
UHF Transceiver



Infrared Spectrometer



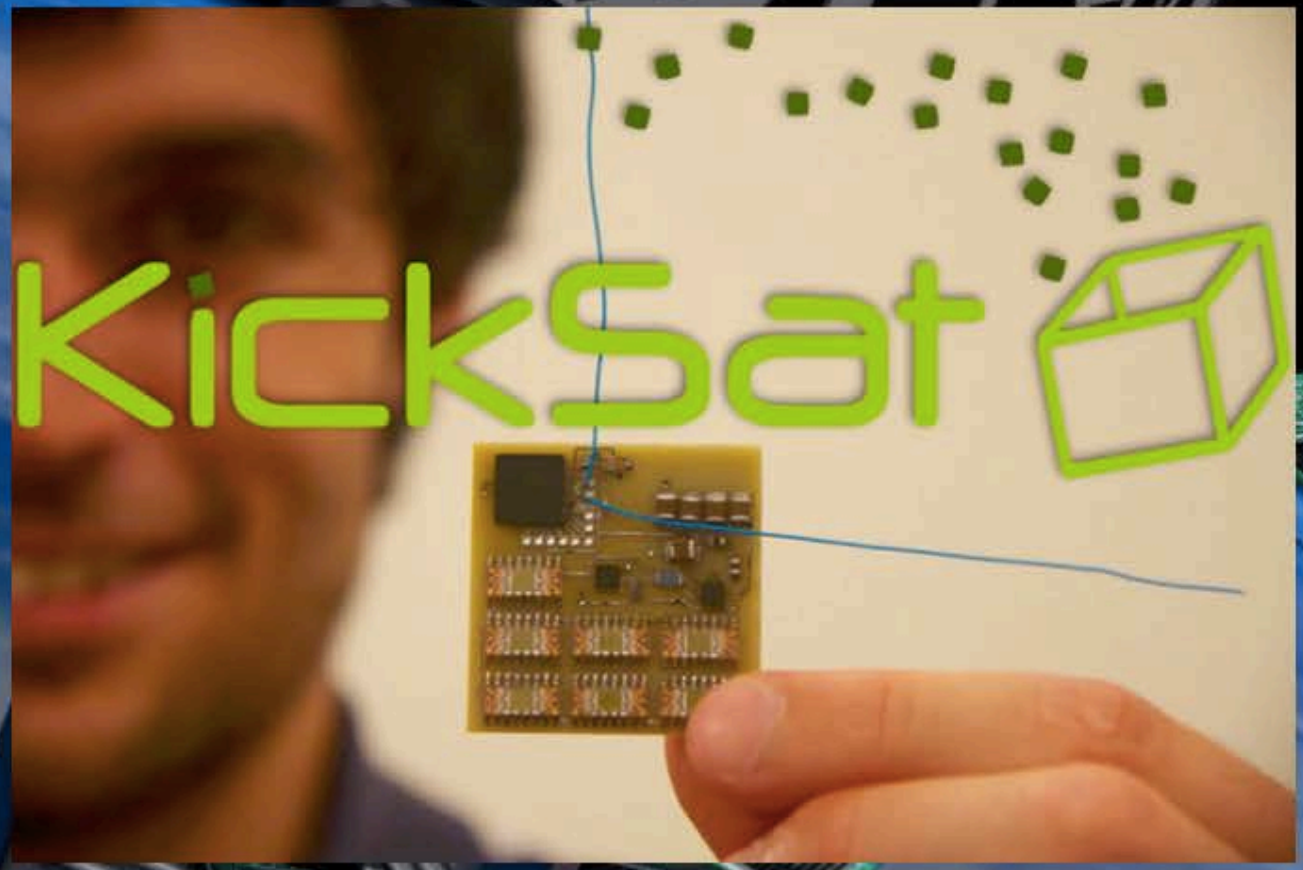
Micro Propulsion



Space Sextant

Explore Start a project For you KICKSTARTER

KickSat -- Your personal spacecraft in space!



Would you like to have your own spacecraft? Kickstart the personal space age by helping launch tiny spacecraft into low Earth orbit.

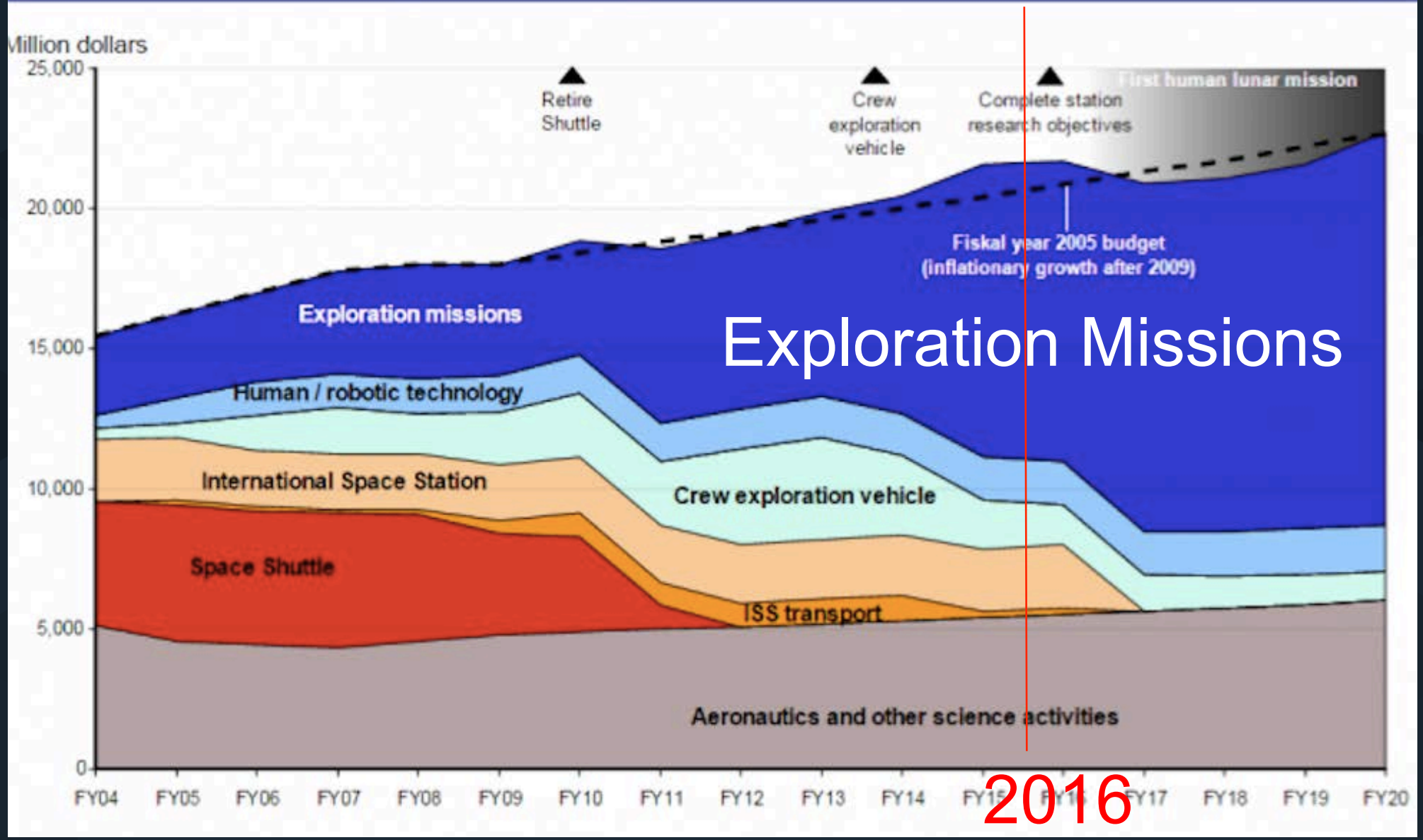
Fork us on GitHub!

Created by

Zachary Manchester

315 backers pledged $74,586 to help bring this project to life.

Strategy Based on Long-Term Affordability



How do we get there?

- The key now is "implementation."
- This requires careful planning and lots of work.
- This requires unprecedented teaming and open, candid communications.
- No one person has the answer.
- It takes debate and evolution of ideas to get there.
- It takes courage to admit a wrong path and the need to move in another direction.

NASA FBC Task Final Report

Question #4 Extra Credit

What in your culture needs to be changed to get there?

How can you be a part of making this change?

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Credits Follow

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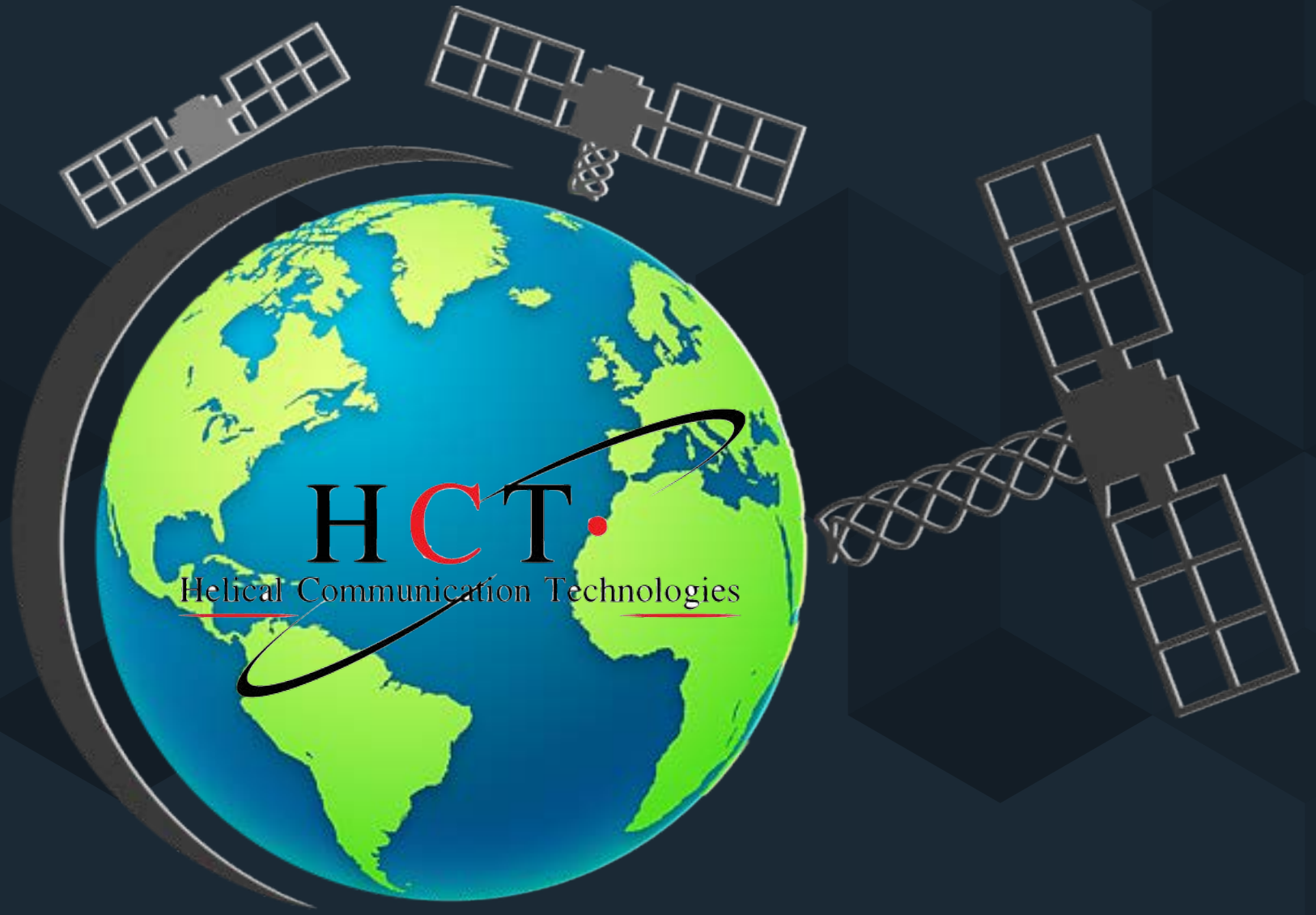

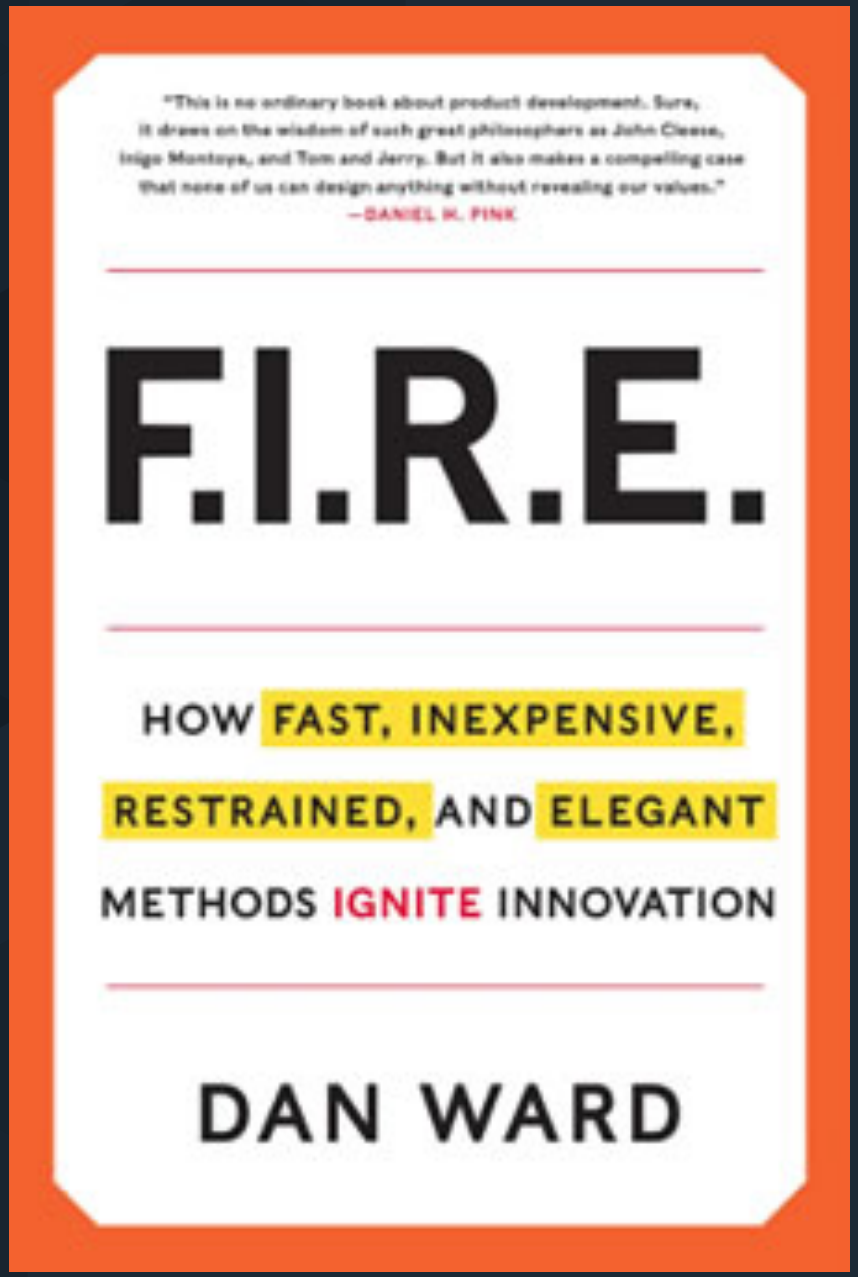
"This is no ordinary book about product development. Sure, it draws on the wisdom of such great philosophers as John Cleese, Iñigo Montoya, and Tom and Jerry. But it also makes a compelling case that none of us can design anything without revealing our values."
—DANIEL H. PINK
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HOW FAST, INEXPENSIVE, RESTRAINED, AND ELEGANT METHODS IGNITE INNOVATION
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FASTER
BETTER
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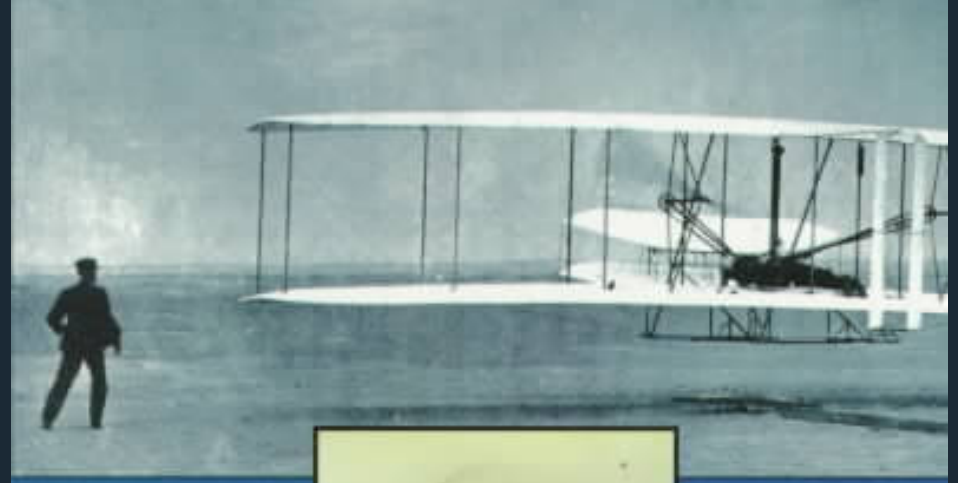
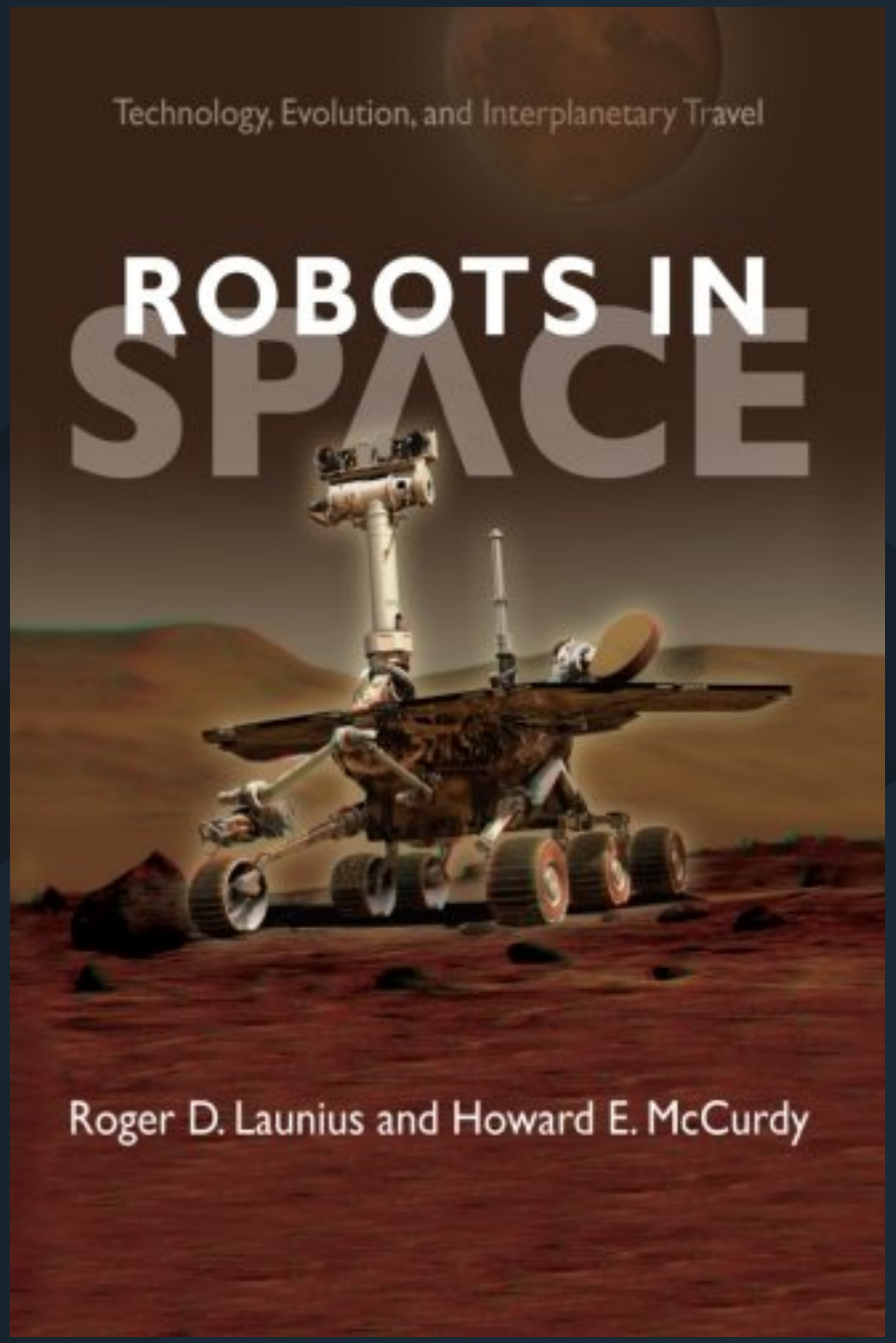
Low-Cost Innovation in the U.S. Space Program



PROGRESS IN

FLYING MACHINES

OCTAVE CHANUTE



Roger D. Launius

Howard E McCurdy

Cubesats

Andrew Klesh
MarCO Chief Engineer at JPL

NASA Jet Propulsion Laboratory
California Institute of Technology

von Kármán Lecture Series

NASA FBC TASK FINAL REPORT

Tony Spear - FBC Task Master

Preface

In the early 1990s, NASA adopted the Faster, Better, Cheaper (FBC) approach to project management of its Space and Earth Science Missions. The goal was to shorten development times, reduce cost, and increase the scientific return by flying more missions in less time. One of the first Faster, Better, Cheaper missions was Mars Pathfinder, which touched down on Mars on July 4, 1997, and became a resounding success. The Project Manager for Mars Pathfinder was Tony Spear, who recently retired after a long and successful career at the Jet Propulsion Laboratory. In mid-1999, Administrator Daniel S. Goldin met with Tony and asked him to undertake a personal study of the Agency s implementation of FBC. He was formally tasked in July 1999 to assess best practices through a series of interviews and workshops. These coupled with his personal experiences and expertise have led to the following observations.

Low-Cost Innovation in the U.S. Space Program: A Brief History

51st Robert H. Goddard Memorial Symposium
March 20, 2013

Howard E. McCurdy

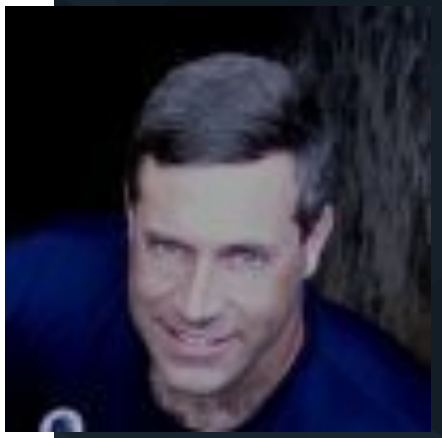
Agile Development Methods for Space Operations

Jay Trimble
NASA Ames Research Center, Mountain View CA, 94035, USA

Chris Webster
University of California Santa Cruz, NASA Ames Research Center, Mountain View CA, 94035, USA

The Mission Control Technologies (MCT) Project, developed at NASA Ames Research Center in collaboration with Johnson Space Center (JSC), has shortened its software release cycle from months to weeks. This agile development cycle is similar to state-of-the-art practice in industry, with modifications for safety in a mission operations environment. Software builds are made available to the customer for evaluation daily. The customer can download these nightly builds to provide feedback on new features as they are rolled out. Formal deliveries are made every three weeks. A formal release for operations is ready every three months.

Jay Trimble



Chris Webster

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