

# Commercial Space Our Future Opportunities

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# Subject is Public (non-Government) opportunities for the spaceflight experience.

1. History; those who have flown in space.
2. The disappointment of tiny progress in 49 years since Gagarin.
3. Can Technology Cycles extend into a Public Spaceflight industry?
4. Paul Allen's SpaceShipOne research program.
5. Sir Richard Branson's Commercial Spaceline program.
6. What might we see in our lifetime?
7. Current costs and forecast costs.
8. What is a reasonable goal for safety?
9. Why the public wants to fly in space. Will the reasons change?
10. Q & A

## For Perspective: Statistics for Government Manned Spaceflight

- **Suborbital** - Two Redstone flights the first year (1961) and two X-15 flights in 1963. Then, none after that.
- **Orbital** - Two Vostok flights the first year (1961). Maximum was 11 flights in 1985. Average was 5.5 flights per year for the entire 49-year period.
- **Moon** - Nine missions to moon, 1968 to 1972 (six to the lunar surface). Then, none after that.

# The U.S. Manned Space Renaissance 1961 to 1973

- Progress accelerated by Sputnik/Gagarin ‘losses’ – The need to regain National prestige
- A wild ride to recover prestige
  - Mercury, Gemini, Apollo lunar, Skylab and planetary exploration
- Enormous courage applied to huge risks
  - Five launch systems in seven years
  - Apollo 8/Saturn 5 risk
  - Lunar-orbit-rendezvous decision

# America's Manned Launch Systems

Redstone



Atlas



Titan



Saturn



Shuttle



Flights: 2

4

10

15

114

Each was abandoned when a **more expensive** one became available - never matured for **affordability**.

# The Collapse that Followed - 1973 to Present

- Abandoned genuine search for safe, efficient orbital manned capability.
- Abandoned lunar capability
- Risk-averse attitude: study it, do not try to fly.
- Lacked the courage to fly new research programs



# Orion/Ares

NASA's hardware program for a shuttle replacement.

Now cancelled.

- Retreat to Apollo/Shuttle-era hardware for manned orbital and lunar operations.
- No opportunity to discover cost/performance breakthroughs.
- Lack of technical challenge for another full generation of spacecraft designers. Concept innovation/creativity not needed nor encouraged.
- Main justification - the maintenance of a U.S. manned spaceflight capability.



# NASA - What to do now?

## Restructuring of Government manned spaceflight

- Competitive 'New-space' can do LEO, but NASA must do forefront exploration.
- Move to commercial sounds attractive, but does it have real advantages? The tech oversight and the ISS safety requirements limit innovation.
- Clearly SpaceX and Orbital will succeed on LEO access, but will it end at the Gemini capability? (1965), or will they really explore?



Sorry about that, kid.





# High Risk breeds innovation

## Most impressive aircraft - Lockheed SR-71

Designed in 1959, only 14 years after first USAF jet.  
First flown in 1963.  
Abandoned in 1998, retreated to 1956 U-2.



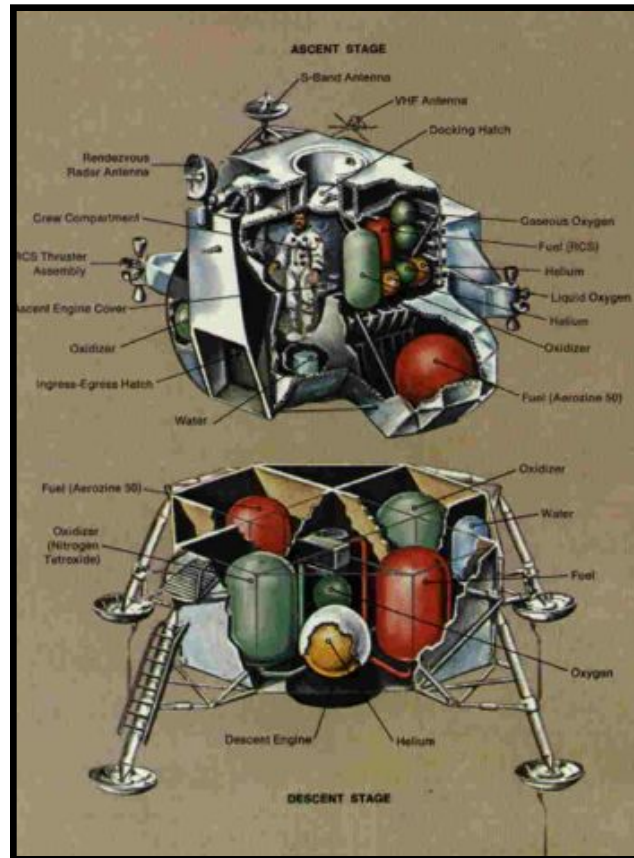
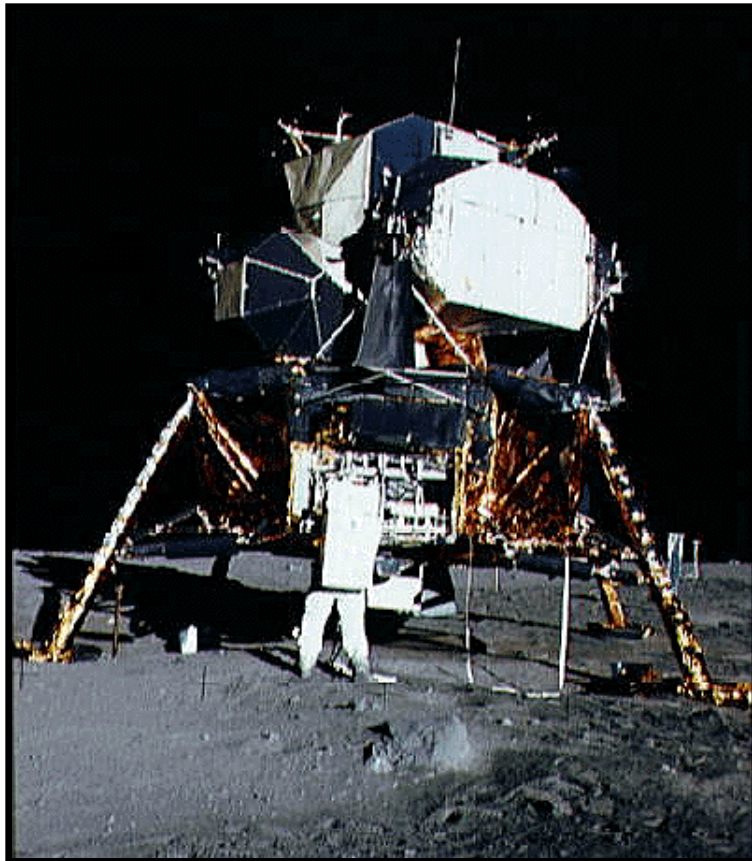
P-80  
1945



# High Risk breeds innovation

## Most impressive Spacecraft - Lunar Module

Designed in 1964, only three years after Gagarin/Vostok  
First flight 1968. Abandoned the capability in 1973

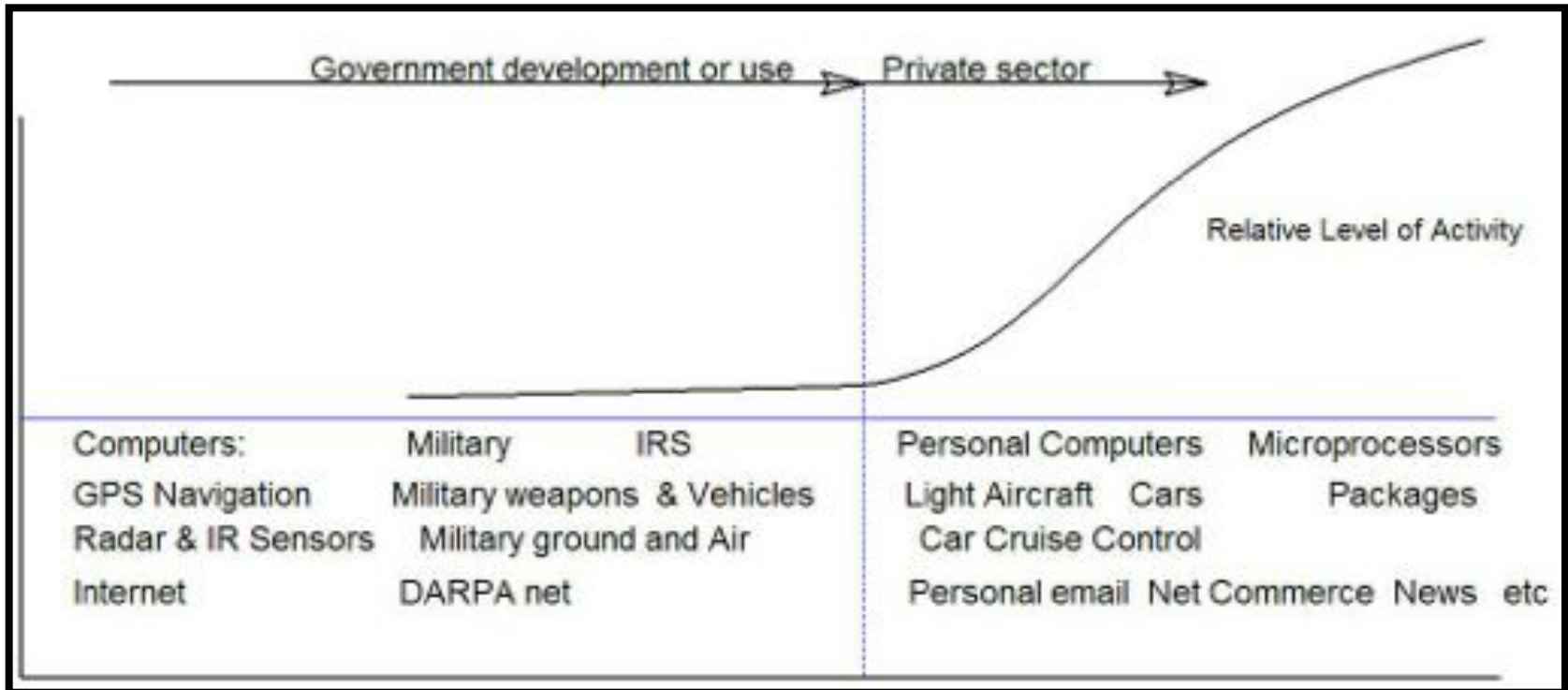


Gagarin's Vostok  
1961

# Technology Cycles

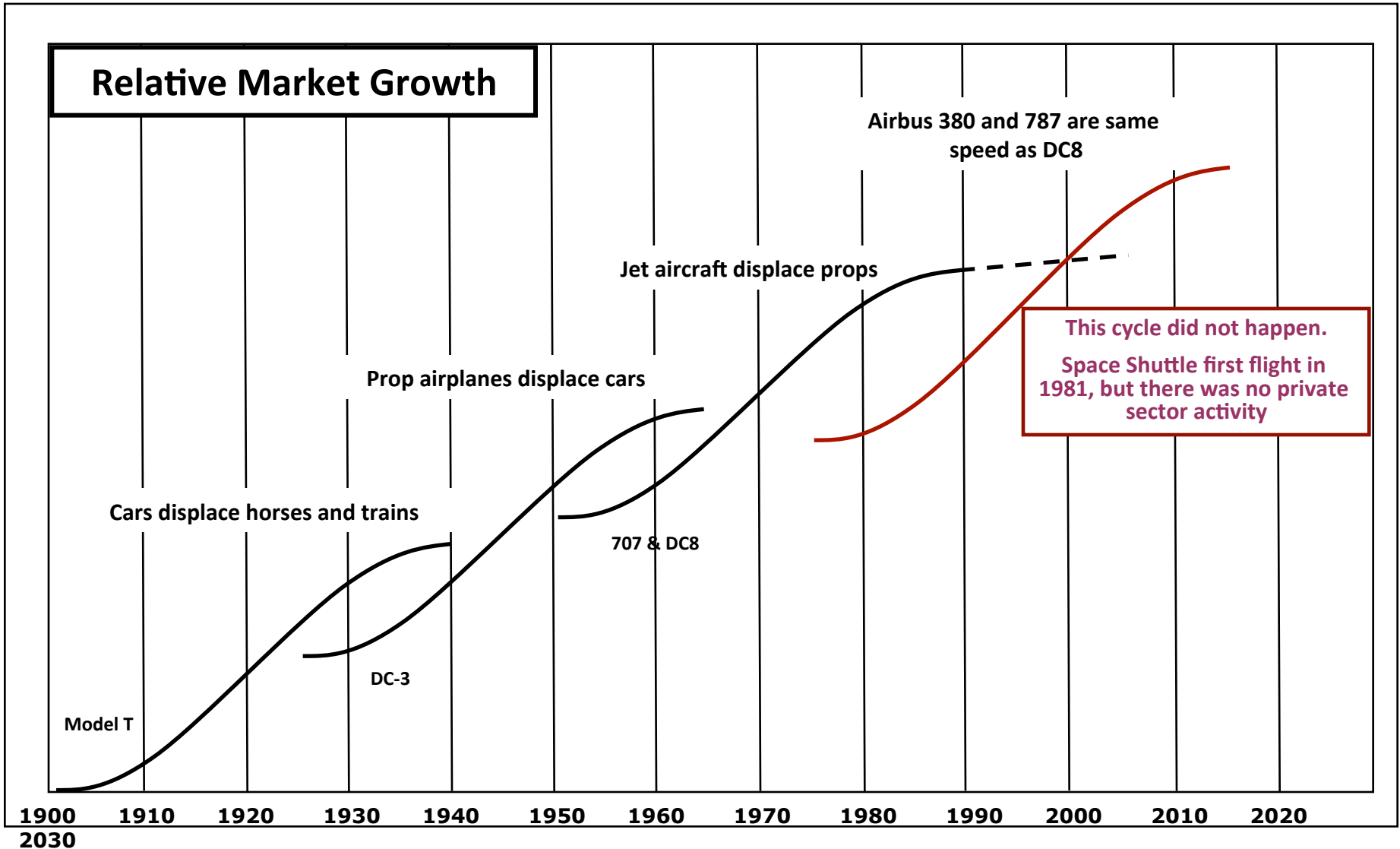
## Government - Private Sector Dynamics

Real cycles develop only in the private sector



# Higher Speed Transportation Technology Cycle – “S-curve” gets replaced every 25yr.

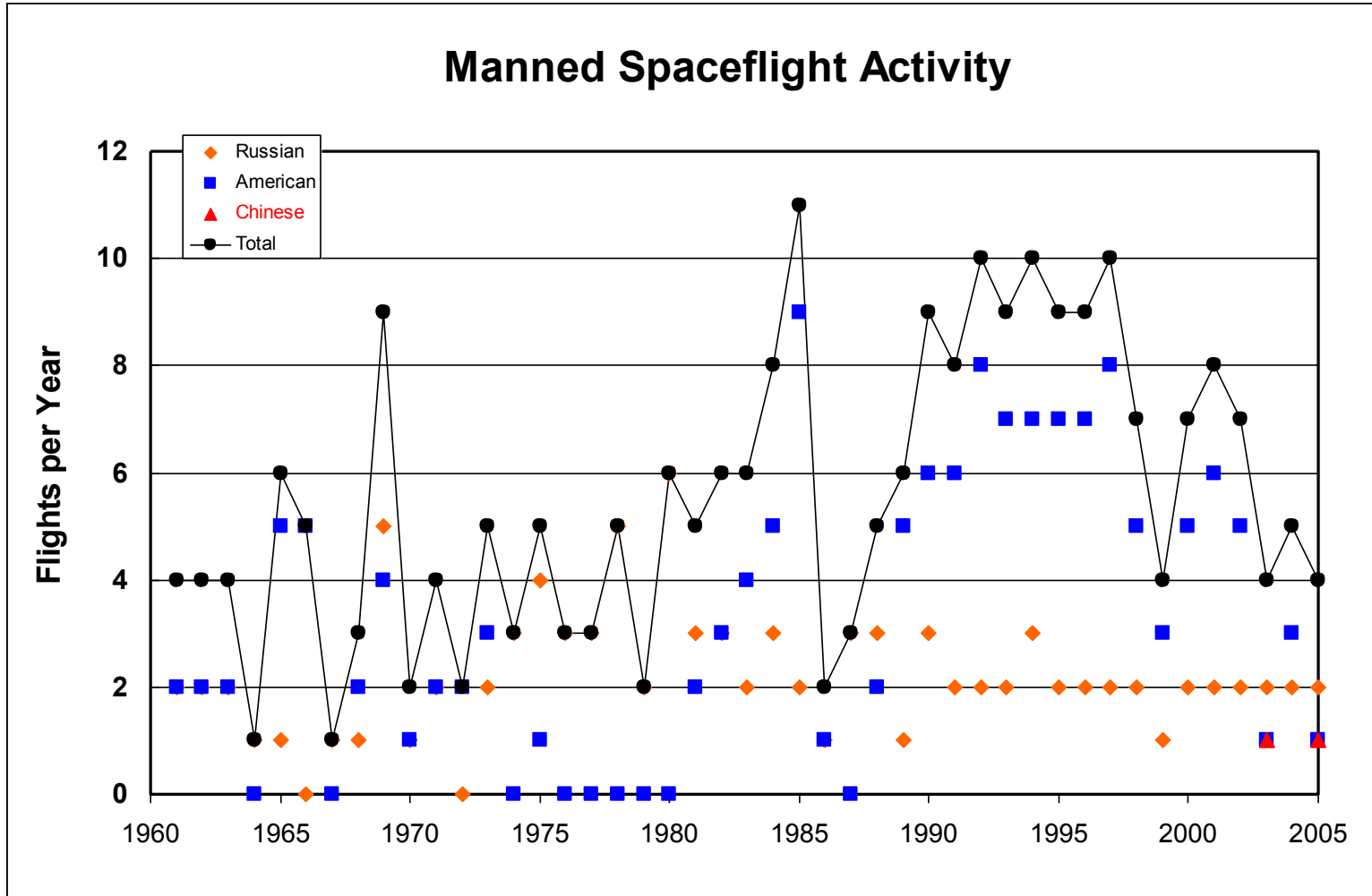
We are overdue – the recent cycle is missing.



# A True Cycle for Manned Spaceflight?

No, not even close.

Today's activity is similar to the **first** year.



# Aviation's Renaissance

## 1908 to 1914

- Early 1908, < 12 pilots
  - Then, “I can do it”.
- By 1912
  - Hundreds of aircraft types in 39 countries.
  - Aircraft invented by ‘Natural Selection’.



# Our Responsibility Now

## Create Progress to Inspire our Kids

- Our Technology Leaders had initial inspiration in exciting times, periods of extreme technical progress.

# Standout Memories

## The Real Inspiration

- The Disney-Werner von Braun Vision, Disneyland television 1955
- The “Moonliner” at Tomorrowland 1954





# Kids Were Inspired by Aviation's Renaissance – these kids

- **Every one** of those that inspired **me**.
  - Wernher von Braun
  - Kelly Johnson
  - Charles Lindbergh
  - Jack Northrop
  - Ed Heinemann
  - Howard Hughes
  - Sergei Korolev
  - Alexander Lippisch
  - Bill Lear



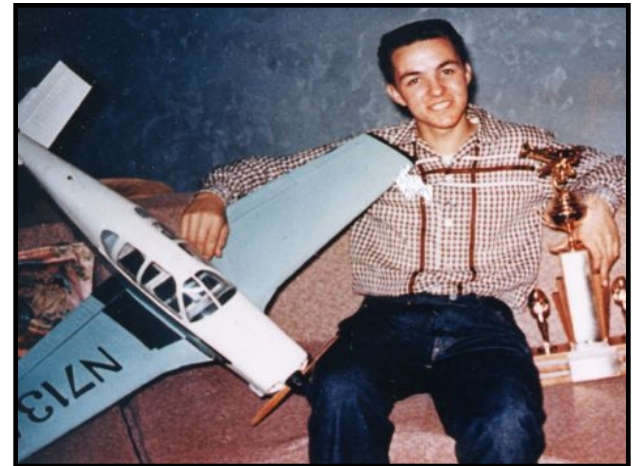
# Aerospace Activity 1946 to 1957

During my Childhood (age 3 to 14)

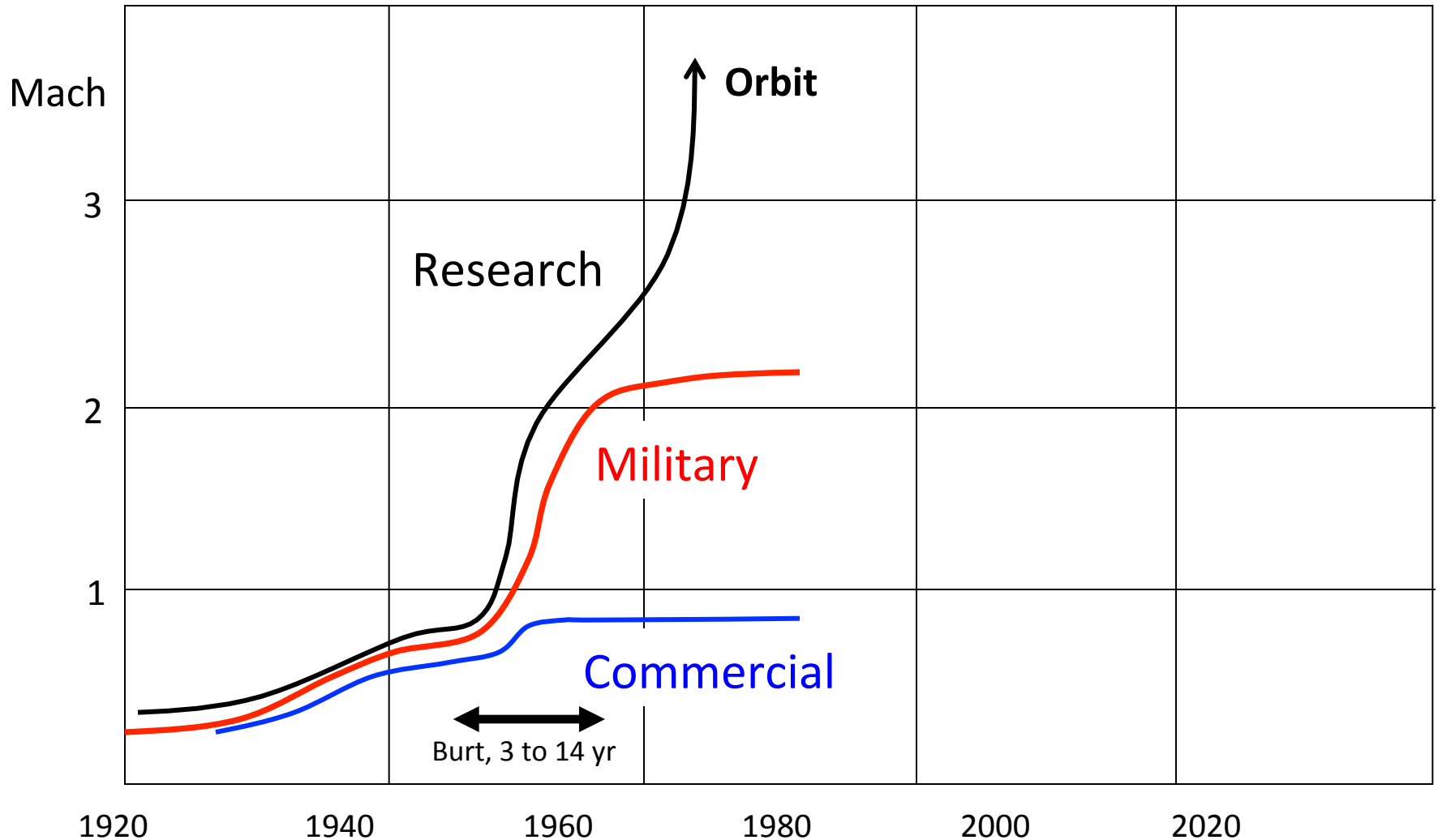


The Jet Age starts. The Missile Age starts.

# Childhood Activities Were Driven by Aviation Progress



# A Jump in Aviation Performance: My inspiration during childhood



## Something Is Missing in Space R & D

Space R & D needs aviation's  
'Natural Selection' process.

“.....100,000 different varieties of airplane were flown during these years [up to 1926]. Many of the pilots crashed, and many of the airlines became bankrupt. Out of 100,000 types of airplane, about 100 survived to form the basis of modern aviation. **The evolution of the airplane was a strictly Darwinian process in which almost all the varieties of airplane failed**, just as almost all species of animal became extinct. Because of the rigorous selection, the few surviving airplanes are astonishingly economical, & safe”.

**"The Darwinian process is ruthless, because it depends on failure.** Planes crashed, pilots were killed, and investors were ruined.....After the crash, new pilots and new investors would always appear with new dreams of glory."

**Freeman Dyson, Imagined Worlds, 1997**

## Self-funded space flyers (Soyuz-ISS)

1. Dennis Tito, US citizen, April 28 to May 6, 2001.
2. Mark Shuttleworth, South Africa, April 25 to May 5, 2002.
3. Gregory Olsen, US citizen, October 1<sup>st</sup> to 11<sup>th</sup>, 2005.
4. Anousheh Ansari, Iran/US citizen, September 18<sup>th</sup> to 29<sup>th</sup>, 2006.
5. Charles Simonyi, Hungary/US citizen, April 7<sup>th</sup> to 21<sup>st</sup>, 2007 (also flew second flight March 26<sup>th</sup> to April 8<sup>th</sup>, 2009).
6. Richard Garriott, US citizen, October 12<sup>th</sup> to 23<sup>rd</sup>, 2008.
7. Guy Laliberté, Canada citizen, Sept 30<sup>th</sup> to October 11<sup>th</sup>, 2009.

## Business-funded (non-Government) space flyers

1. Toyohiro Akiyama, Japan citizen, funded by Tokyo Broadcasting System, December 2<sup>nd</sup> to 10<sup>th</sup>, 1990, Soyuz-Mir.
2. Helen Sharman, British citizen, funded by Project Juno (some funds from Soviet Union), May 18<sup>th</sup> to 26<sup>th</sup>, 1991, Soyuz-Mir.
3. Mike Melvill, US citizen, funded by Paul Allen, June 21<sup>st</sup> & September 29<sup>th</sup>, 2004, SpaceShipOne (non-government spaceship).
4. Brian Binnie, US citizen, funded by Paul Allen, October 4<sup>th</sup>, 2004, SpaceShipOne (non-government spaceship).

# Paul Allen's SpaceShipOne Research Program

## The First Non-Government Manned Space Program

Three manned space flights: Jun, Sep & Oct 2004



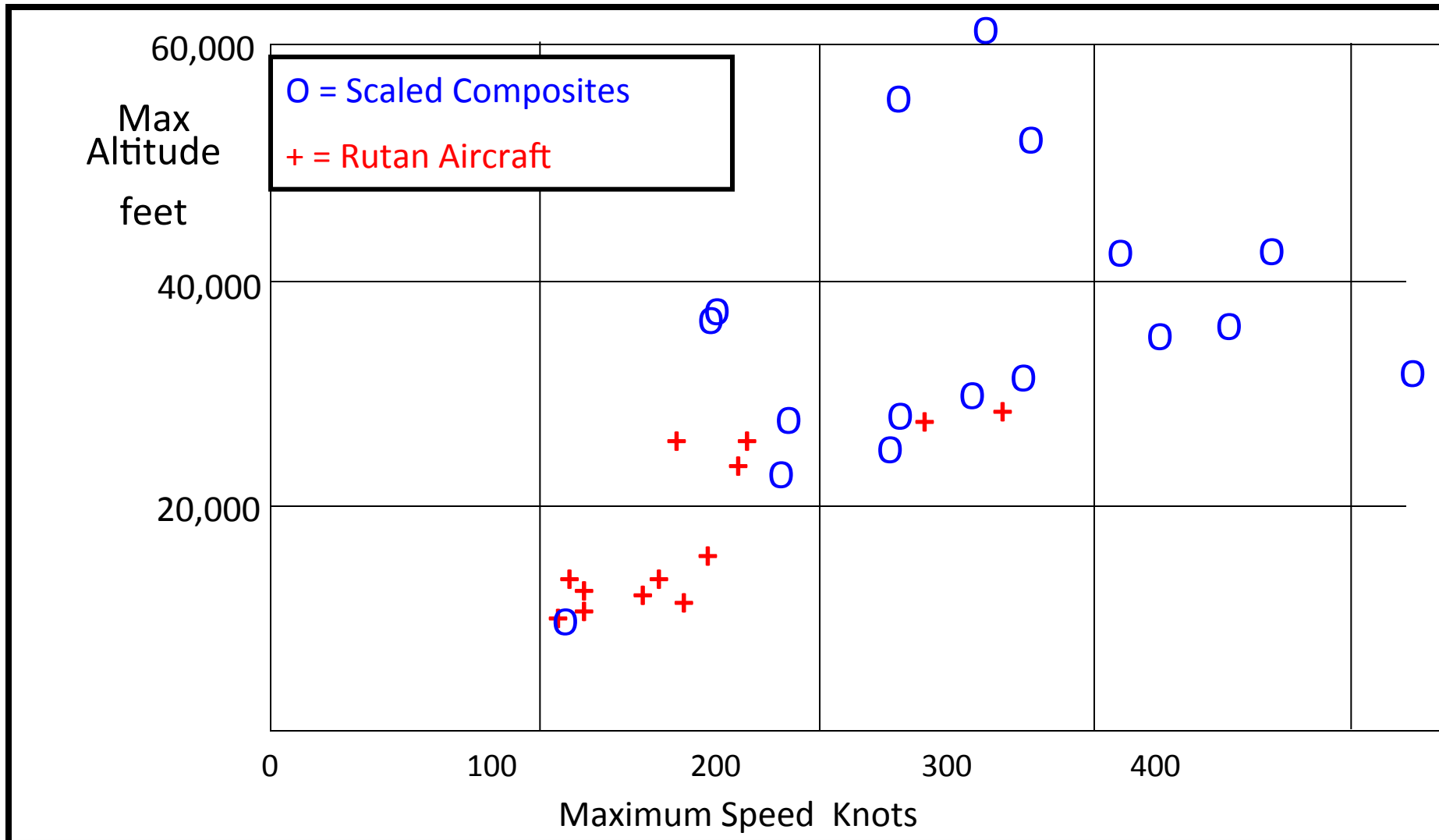
The X-Prize

National Air & Space  
Museum

Our Second Collier

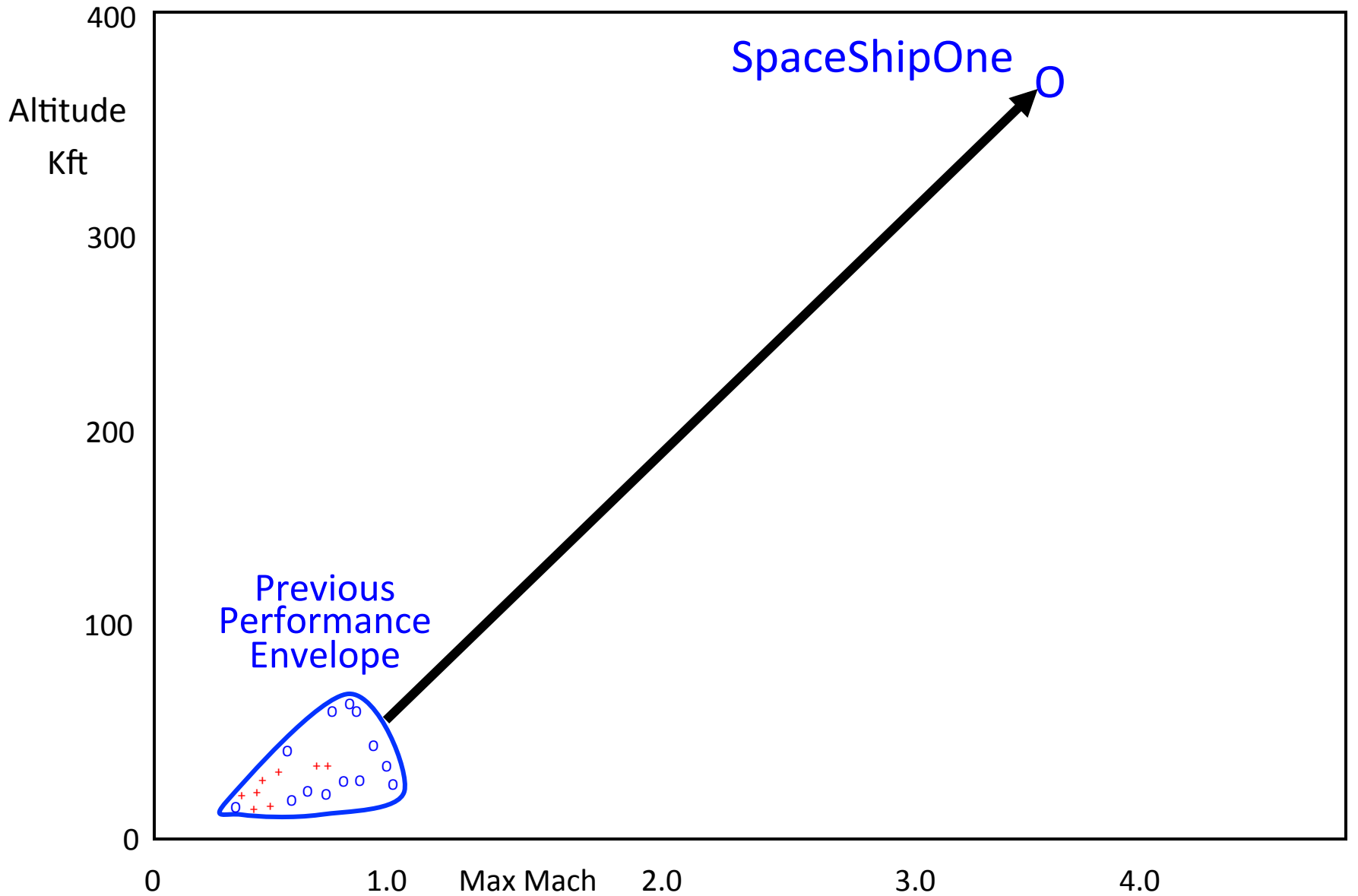


# Performance of Rutan-Designed Manned Aircraft Pre-2004





# The Big Jump into Space 2004



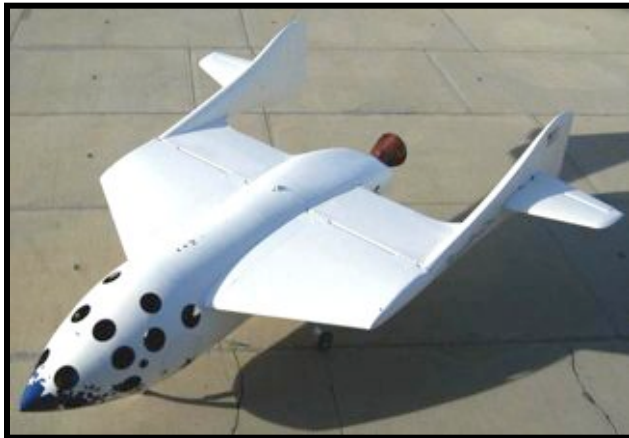
# Launch Aircraft - White Knight

- Identical systems components to Spaceship.
- Provides pilot training for boost, entry & landing.



# SpaceShipOne

Air-launched  
Feathered entry  
Runway landing

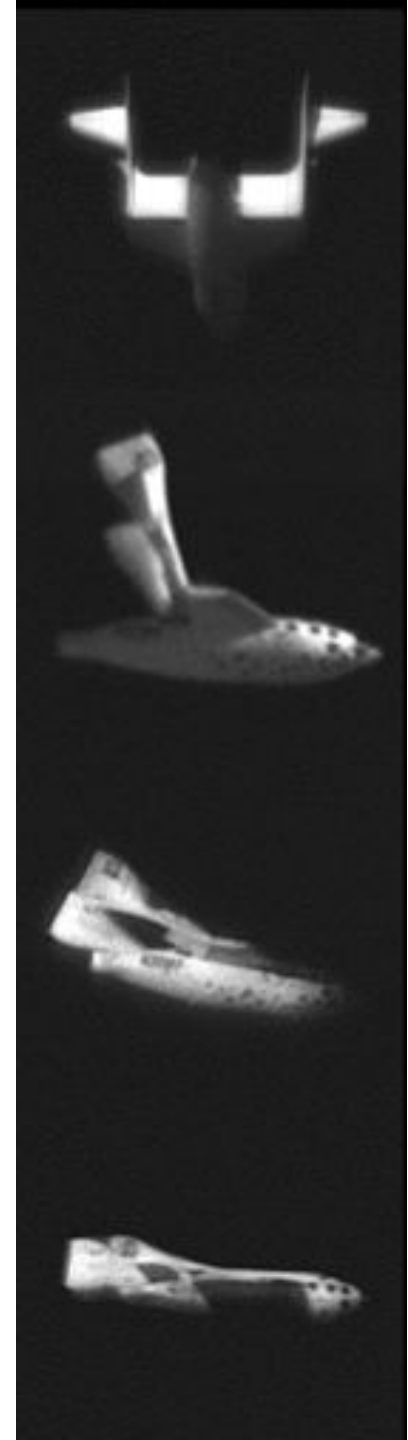
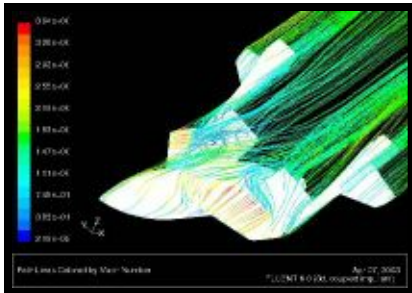


# The Re-entry Feather

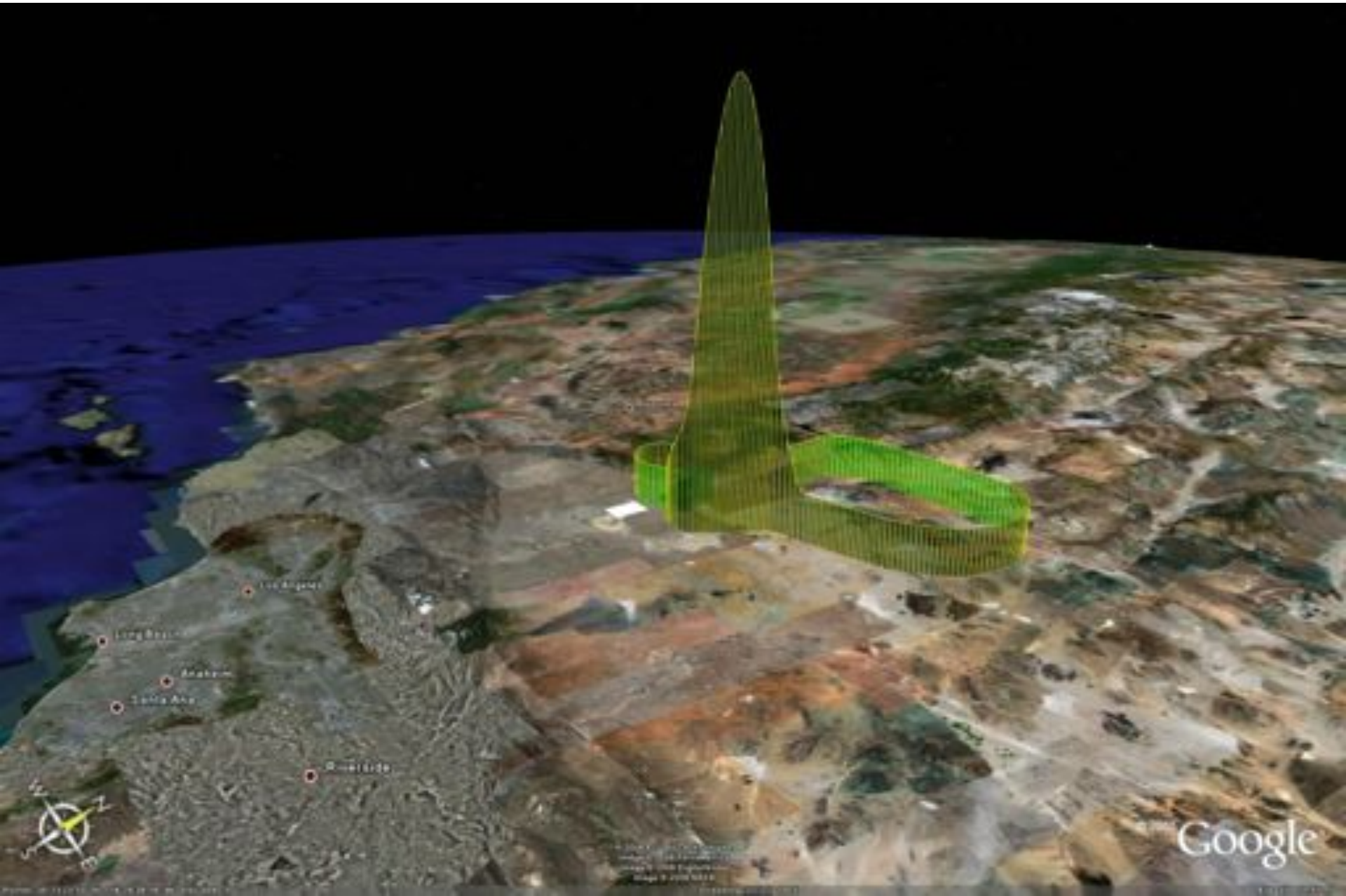
## Immune to accidents caused by entry attitude and trajectory controls

Forces Ship to a Stable High Alpha Condition.  
Active controls not needed.

- High Drag = Lower loads & Lower Heat
- Result: 'Care-Free' atmospheric entry



# Your View from 130 Km altitude



## Some new friends



# Why we stopped flying SpaceShipOne



# Is a Public Space Renaissance Possible?

## What Is Needed?

- **Environment that existed for aircraft in 1909**
  - Entrepreneurs in competition for market share.
  - Belief that “I can do that”.
- **Courage to try risky concepts**
  - Breakthroughs needed to achieve safety goals for orbital flights.
- **Research justified by exploration and fun**
  - Not just politics and ‘science’.



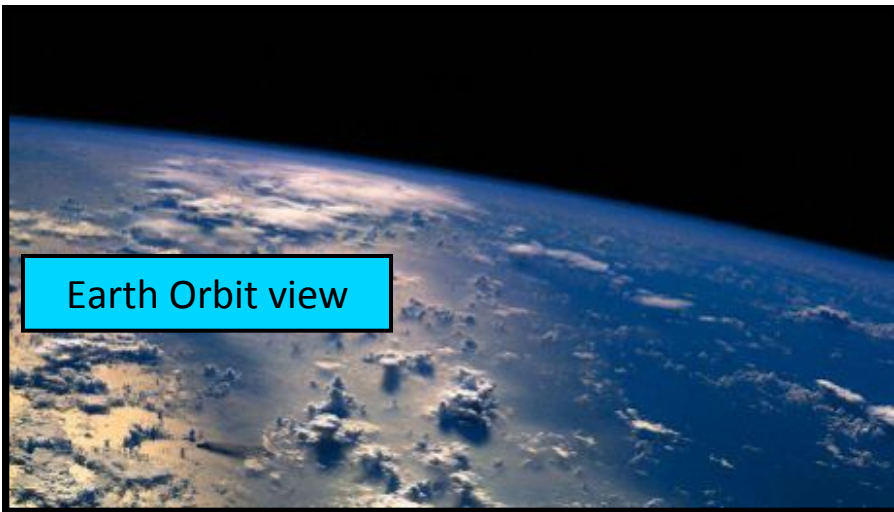
# The Virgin Galactic commercial suborbital spaceship system



# A New Industry

## Public Access to Sub-Orbital Space

### The Goal is Fun



Earth Orbit view

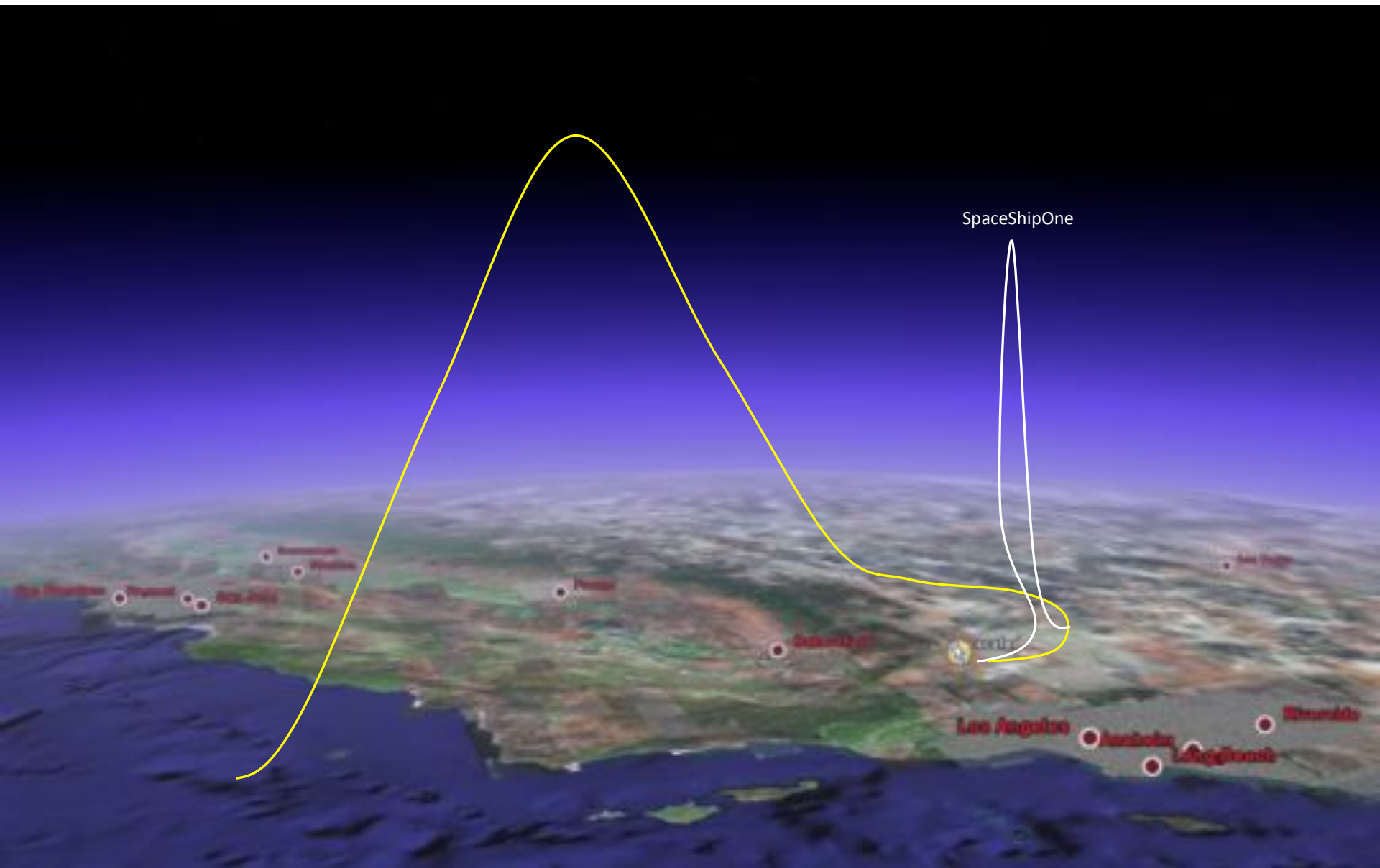


Sub-Orbital View

**To stimulate a Private Spaceflight industry, so the public can enjoy this view**

# Trajectories

## Commercial Sub-Orbital Private Spaceflight



# The Next Steps for Private Spaceflight

- Sub-orbital flights
  - Launch Spaceline - Virgin Galactic.
  - Experience – optimized: Large cabins, large windows and body weightless float.
- Multi-Spaceport Operations with 40 spaceships
  - Competing Spacelines, plan to fly 100,000+ people (first 12 years of commercial operations).



# Space, for us – Why Now?

- SpaceShipOne was a personal goal, not a customer request
- Inspiration from visionaries' courage
  - Required my exposure **as a child**, not a view of current aerospace practice.
- The 'New Space' investors/developers – were, **as children** inspired by big progress - Sputnik to Apollo.
  - Allen, Musk, Bezos, Branson, Bigelow, Page/Brin, Carmack and others.

# What Good is a Private Sub-orbital Space Industry? Just for Fun?

- The home computer – Internet example
  - ‘Fun’ really **is** defensible.....initially.
- Inspiration for kids
  - Today’s technology products are enablers, not goals.
  - Kids need to be inspired by far-out goals involving breakthroughs/discoveries.

# Space flight really is too dangerous

## Airliner experience as a model

### **Risk statistics, fatal risk per flight**

- All manned space flight = 1 per 74 flights.
- First airliners (1927 & 1928) = 1 per 5500. Same aircraft, but after ‘maturity’ (1934) = 1 per 31,000.
- Child, 16 years in family car ~ 1 per 1,000.
- Modern airlines = 1 per several million.

### **Logical Public Spaceflight goal:**

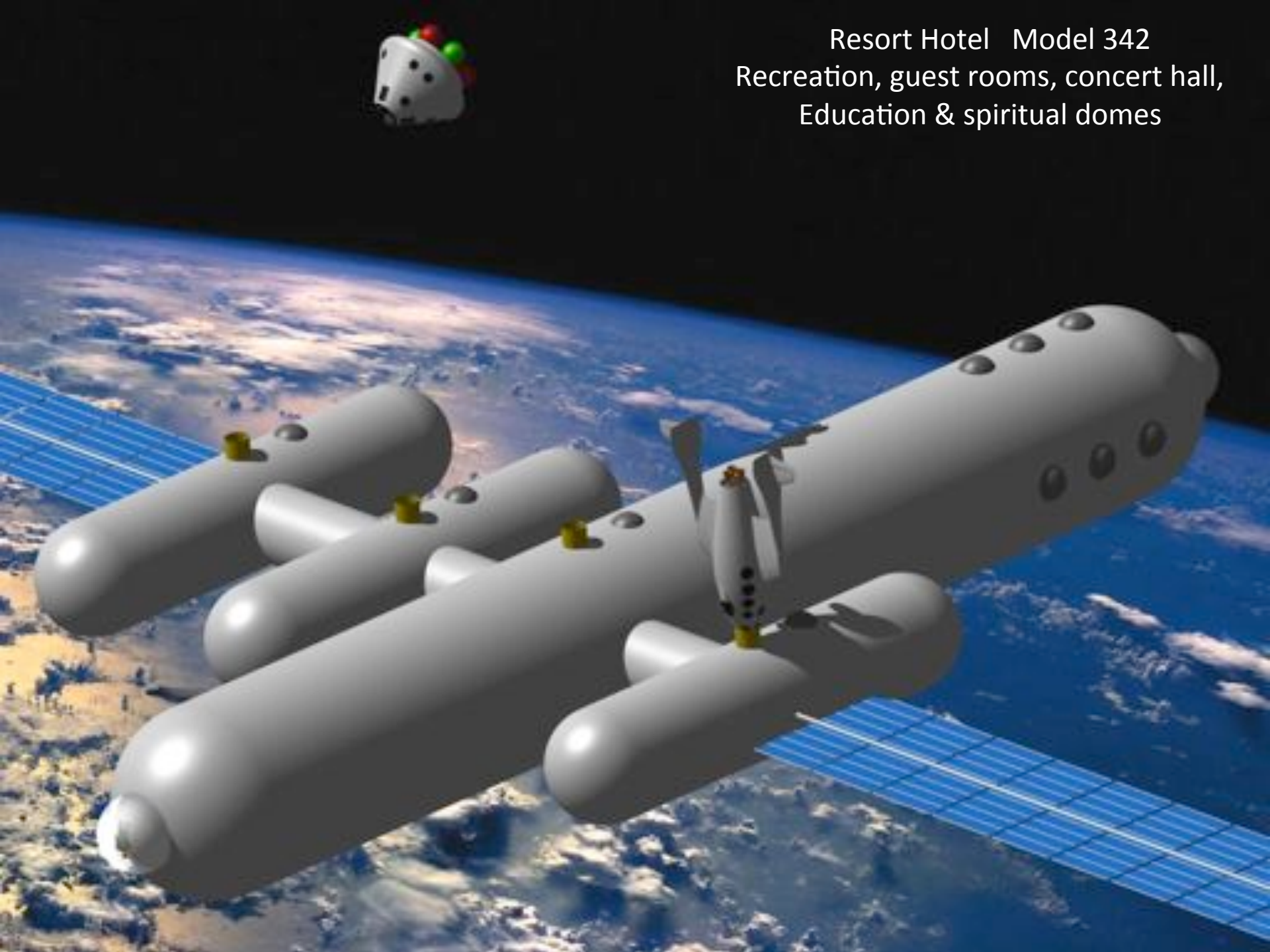
- Better than the first airliners.
- < 1% of the historic government space risk.
- Achievable now, only for sub-orbital flights.

## Like early airlines, initial ticket prices are very high for public spaceflights

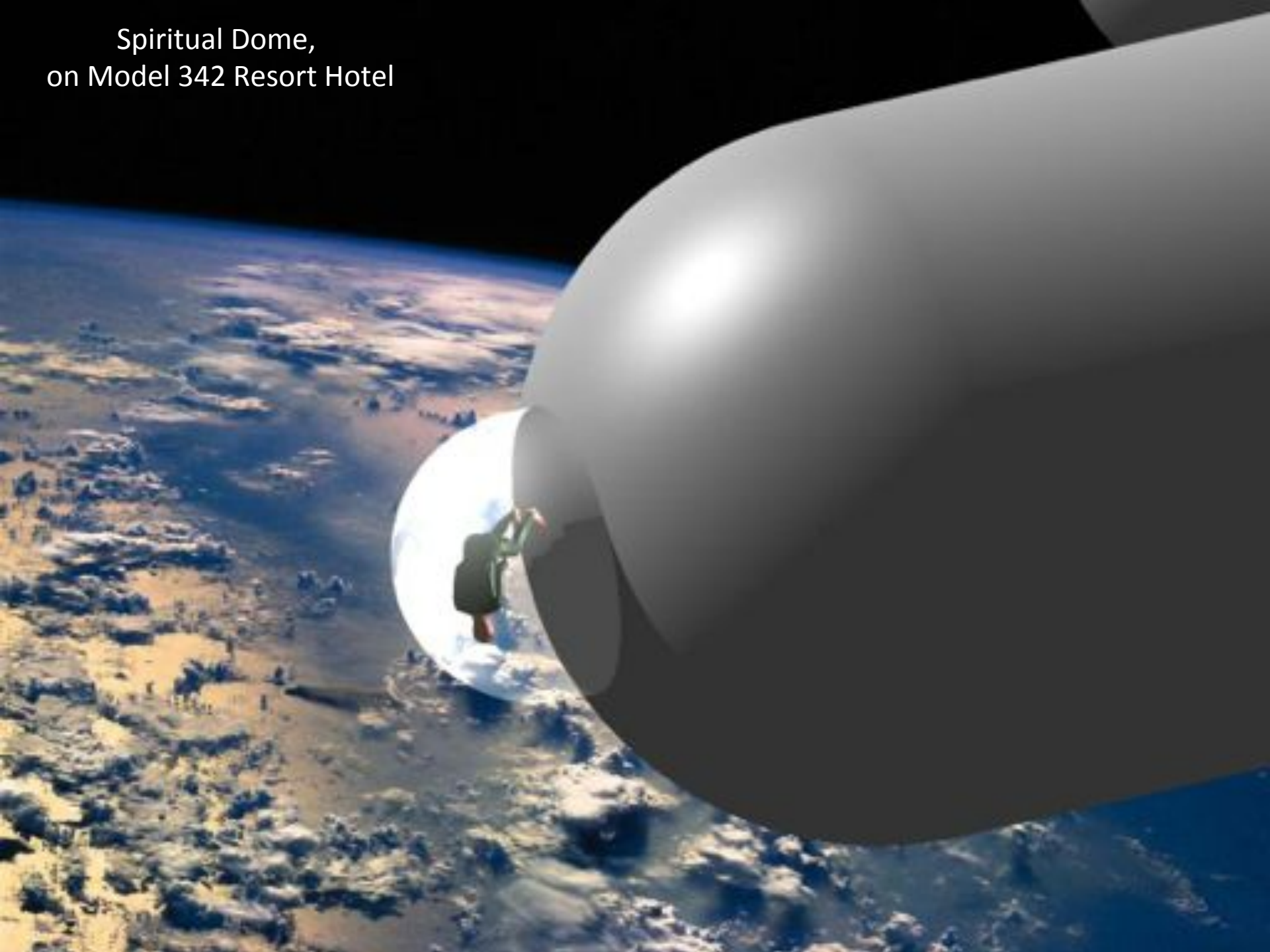
- Those few who have flown commercially have paid 20 to 30 \$M for orbital flights of ~ 8 days.
- Sub-orbital tickets now cost about 1% of orbital.
  - Both will come down significantly with volume.
  - The cost ratio for suborbital/orbital will likely remain at 1% as volume increases.
- Volume to meet demand will require significant investment over the next decade.
  - 40+ suborbital spaceships with 1 to 2 flights per day.
  - Orbital access will require a resort-like destination.

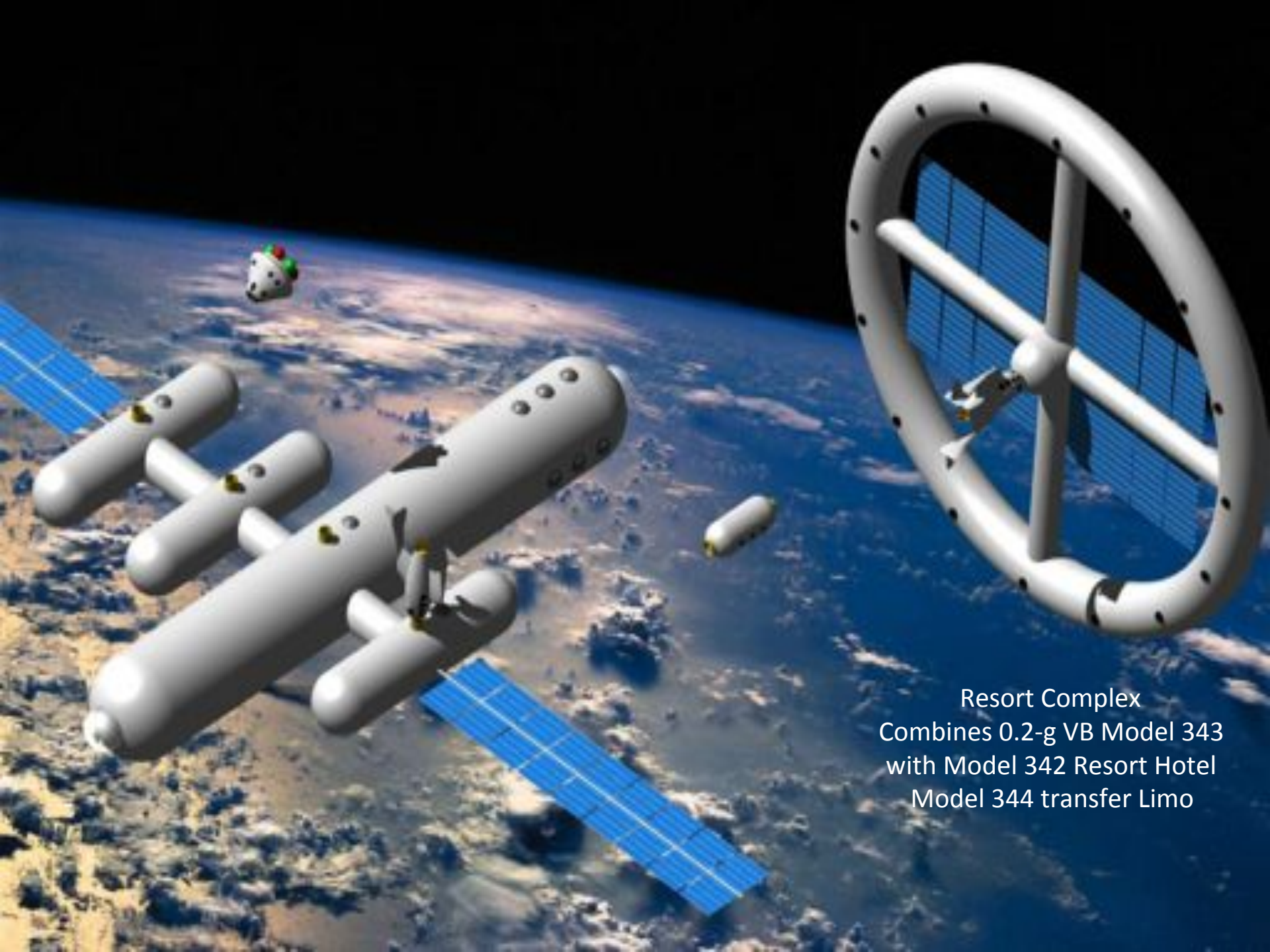


Resort Hotel Model 342  
Recreation, guest rooms, concert hall,  
Education & spiritual domes



Spiritual Dome,  
on Model 342 Resort Hotel



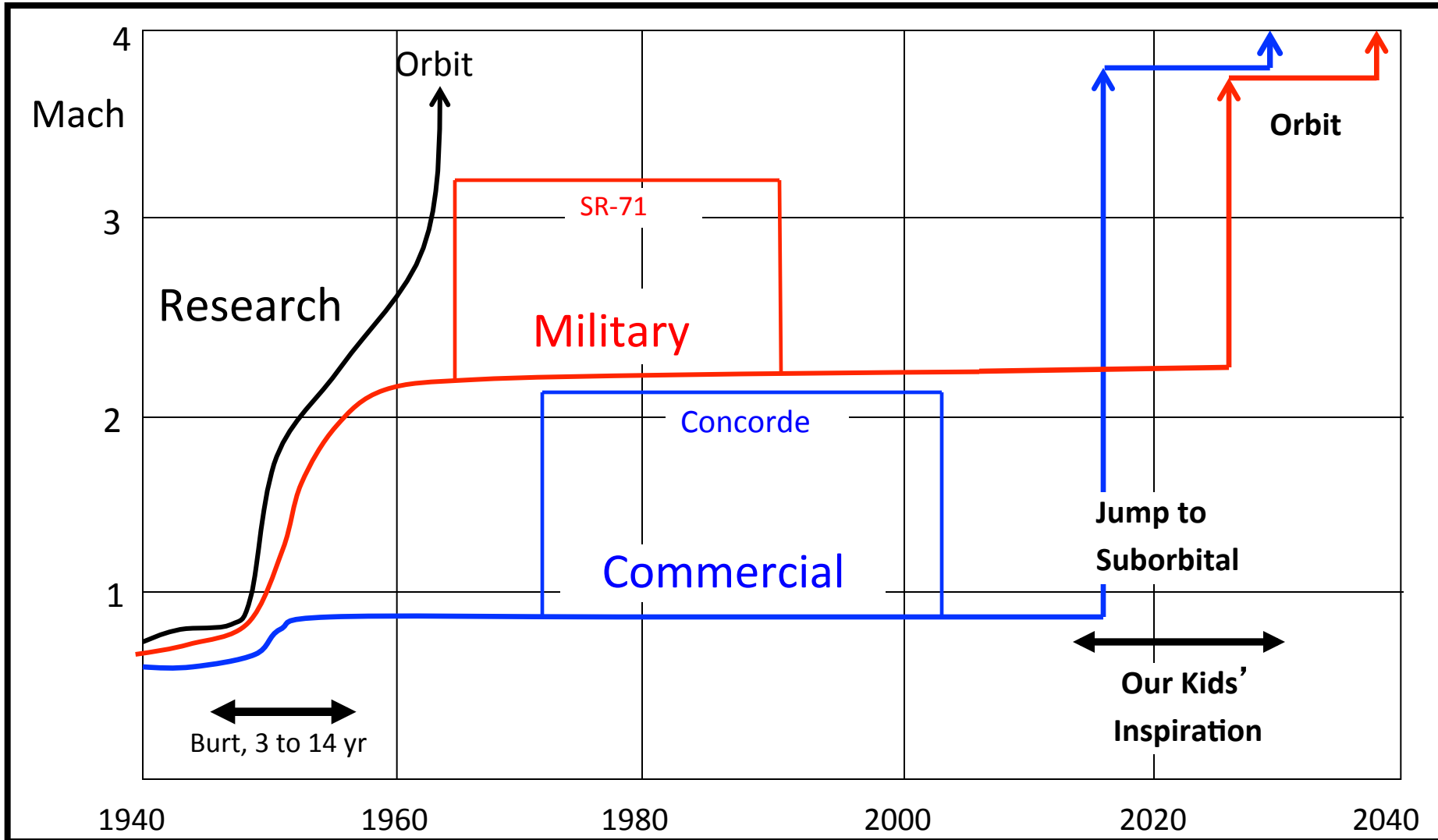


Resort Complex  
Combines 0.2-g VB Model 343  
with Model 342 Resort Hotel  
Model 344 transfer Limo

# U. S. Competitive Position Science and Engineering Education

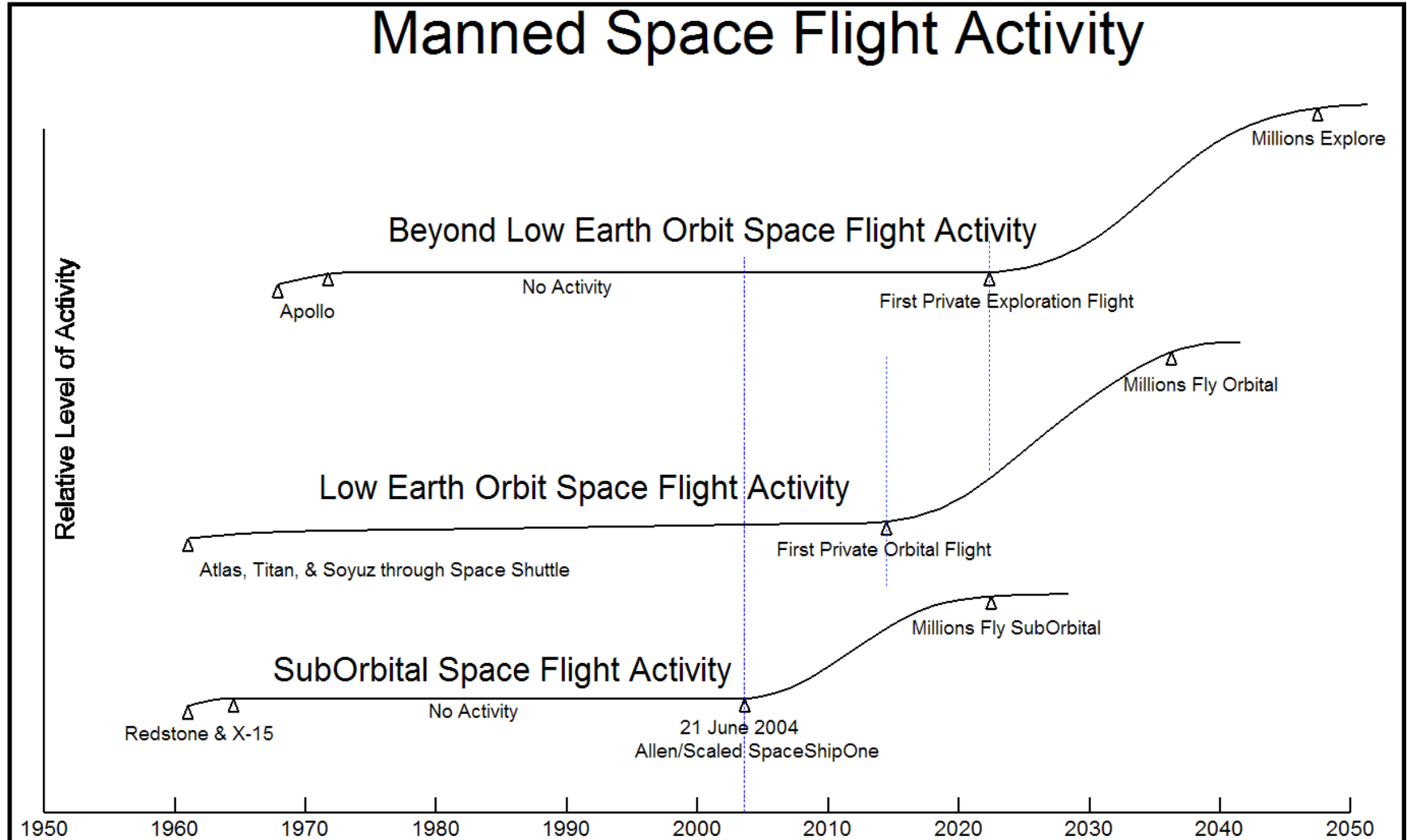
- The education statistics are bleak.
  - Science/engineering vs. lawyers/media/politicians/actors\*
  - \* And other criminals
- The real reason – We are boring our youth.
  - Development vs. research
- The solution – take real risks, to motivate our kids.
  - Exploration
  - Adventure
  - Breakthroughs
- Strive to be great, not to be ‘equal’ .

# A Prediction: Commercial Performance May Exceed Military



# Finally, predicted activity that may resemble true Technology Cycles.

Enabled by a shift to a competitive private sector



# Questions?

