

Space Tourism: Risks & Rewards

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Science
Festival Cambridge Science Festival
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Suborbital & Orbital Flight

Edge of space defined as **100km (62 miles)** above Earth's surface.

Orbital spaceflight

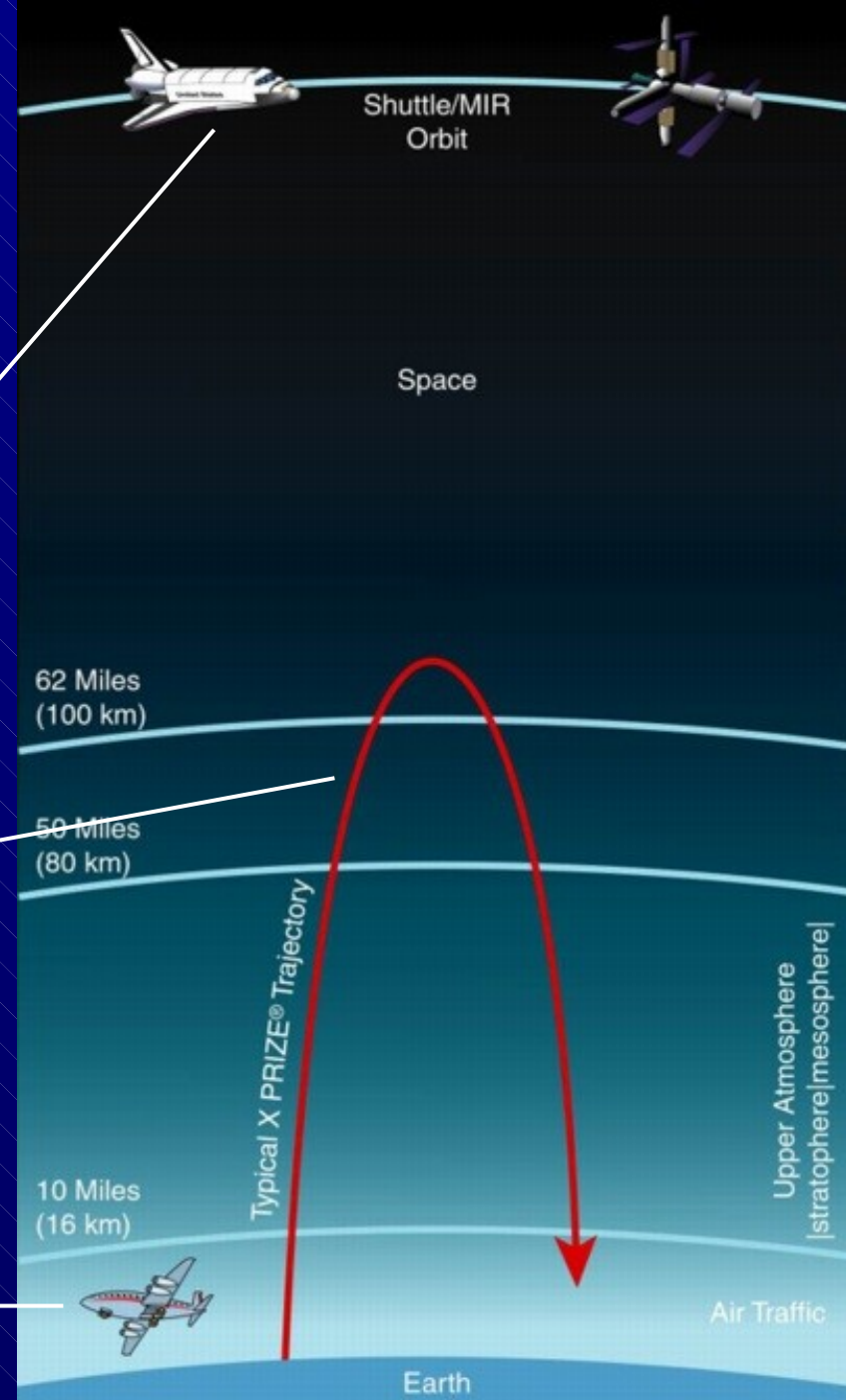
Altitude 150 miles+, speed 17,500mph+

Suborbital spaceflight

Max altitude 62 miles+, speed 2500mph+

Commercial air traffic

Altitude 8 miles, Speed 600mph



1968: Space Tourism in Film



MGM PRESENTS A STANLEY KUBRICK PRODUCTION

2001: a space odyssey

STARRING
KEIR DULLEA · GARY LOCKWOOD

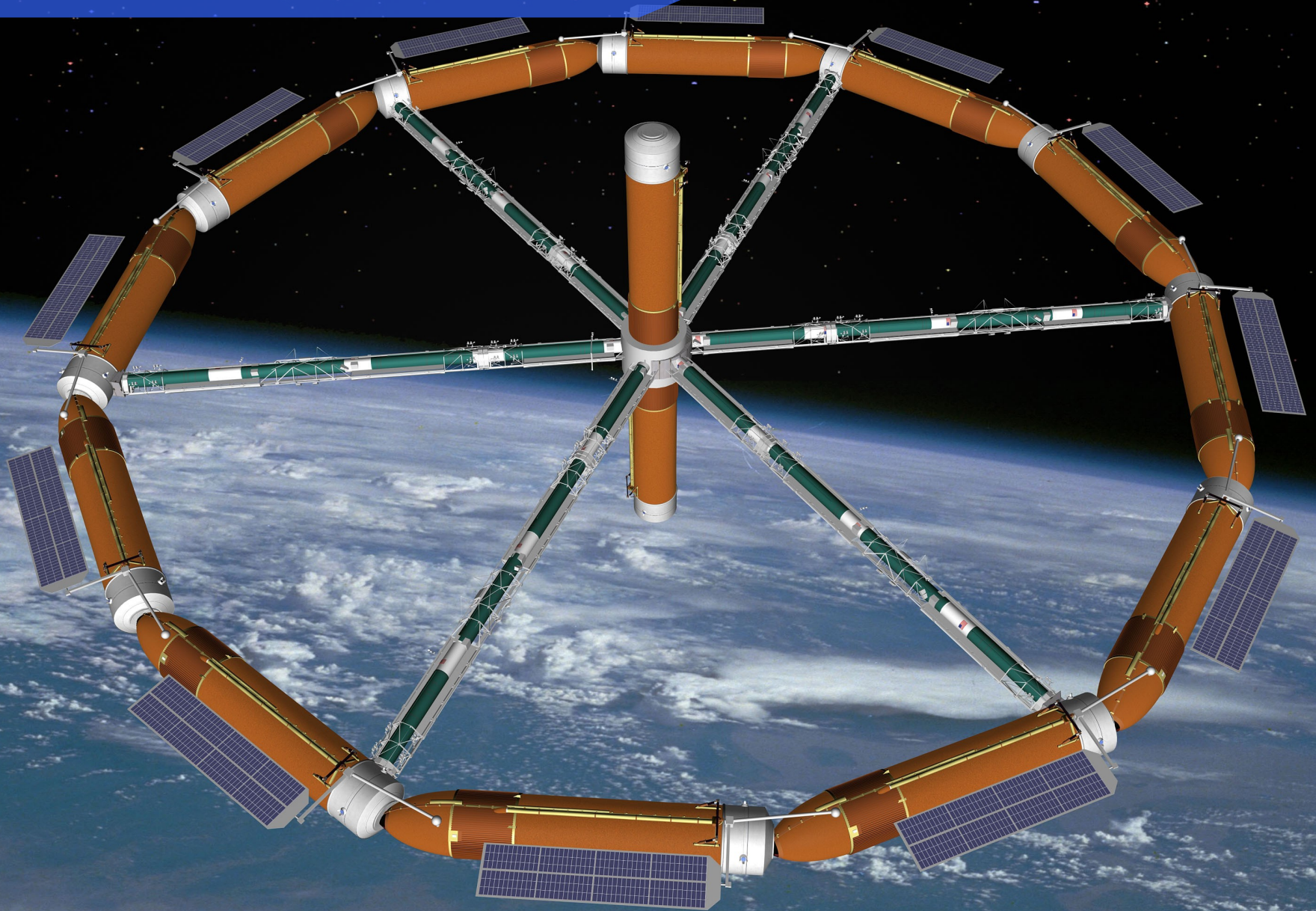
SCREENPLAY BY
STANLEY KUBRICK AND ARTHUR C. CLARKE

SUPERPANAVISION®
AND METROCOLOR

PRODUCED AND DIRECTED BY
STANLEY KUBRICK



1981: Promise Unfulfilled



“Space Island” Station Concept Using Shuttle External Tanks

2001: A Space Adventure

US company *Space Adventures* forms agreement with Russian Space Agency for space tourism trips to International Space Station. Cost \$20-30 million



Dennis Tito (US)
Soyuz TM-32, Apr 2001



Anousheh Ansari (Iran/US)
Soyuz TMA-9, Sep 2006



**Mark Shuttleworth
(S. Africa/UK)**
Soyuz TM-34, Apr 2002



**Charles Simonyi
(Hungary/US)**
Soyuz TMA-10, Apr 2007



Greg Olsen (US)
Soyuz TMA-7, Oct 2005



Richard Garriott (UK/US)
Soyuz TMA-13, Oct 2008?

The Ansari X-Prize & SpaceShipOne

Ansari X-Prize:

\$10 million for first vehicle to carry 3 people (or 1+equivalent mass) to 100km and back twice in two weeks.

Winner:

Scaled Composites *SpaceShipOne* designed by Burt Rutan.

Programme cost \$25-30 million

Technology licensed to Virgin Galactic for passenger-carrying service.





Virgin Galactic: SpaceShipTwo



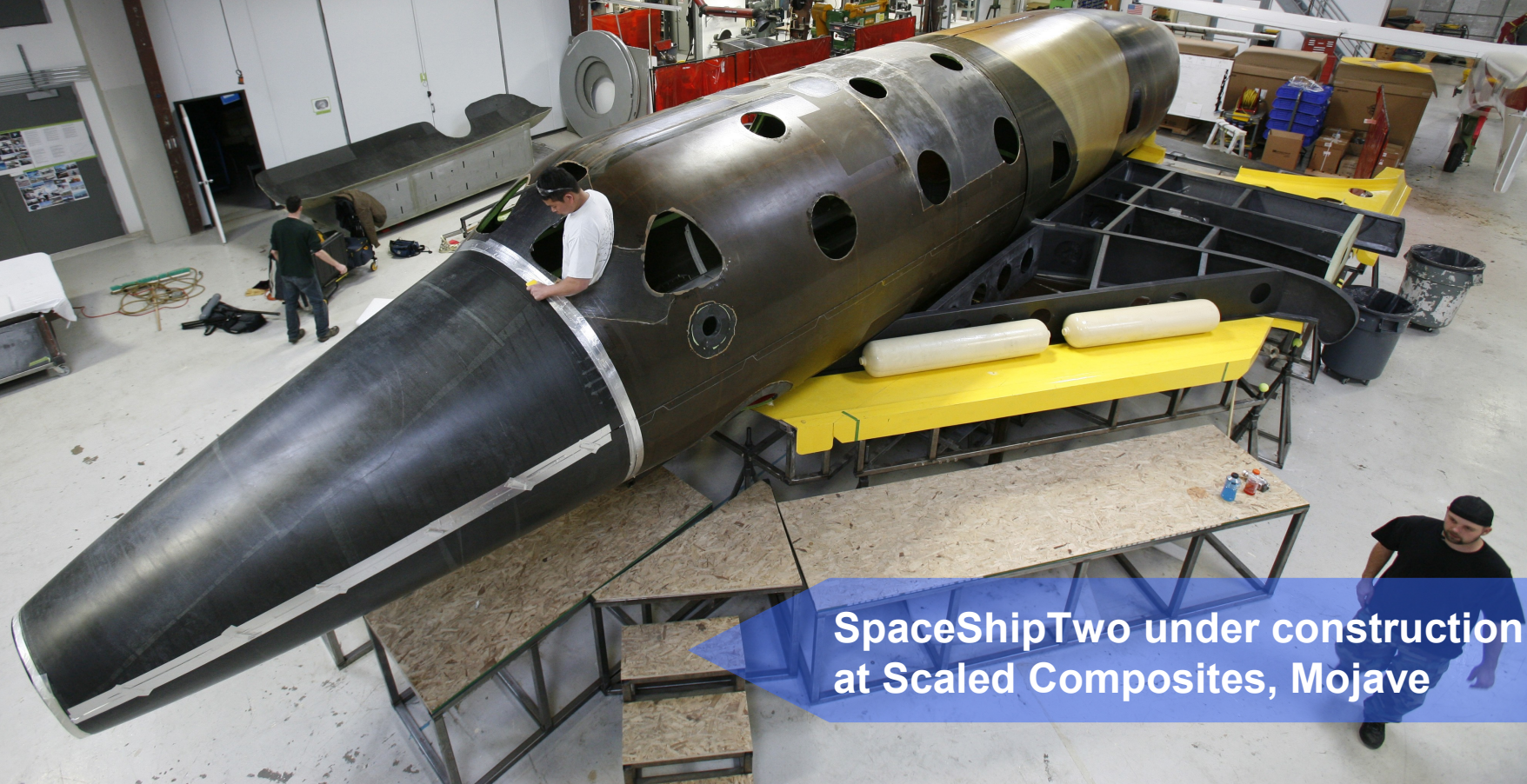
SpaceShipTwo/WhiteKnightTwo
6 passengers & 2 pilots to 100km+
Tickets \$200,000 per seat



First test flights: summer 2008
First commercial flight: 2010?



Virgin Galactic: SpaceShipTwo



SpaceShipTwo under construction
at Scaled Composites, Mojave

Explosion at Mojave

26 July 2007: Nitrous oxide detonation during cold flow test kills three Scaled Composites employees





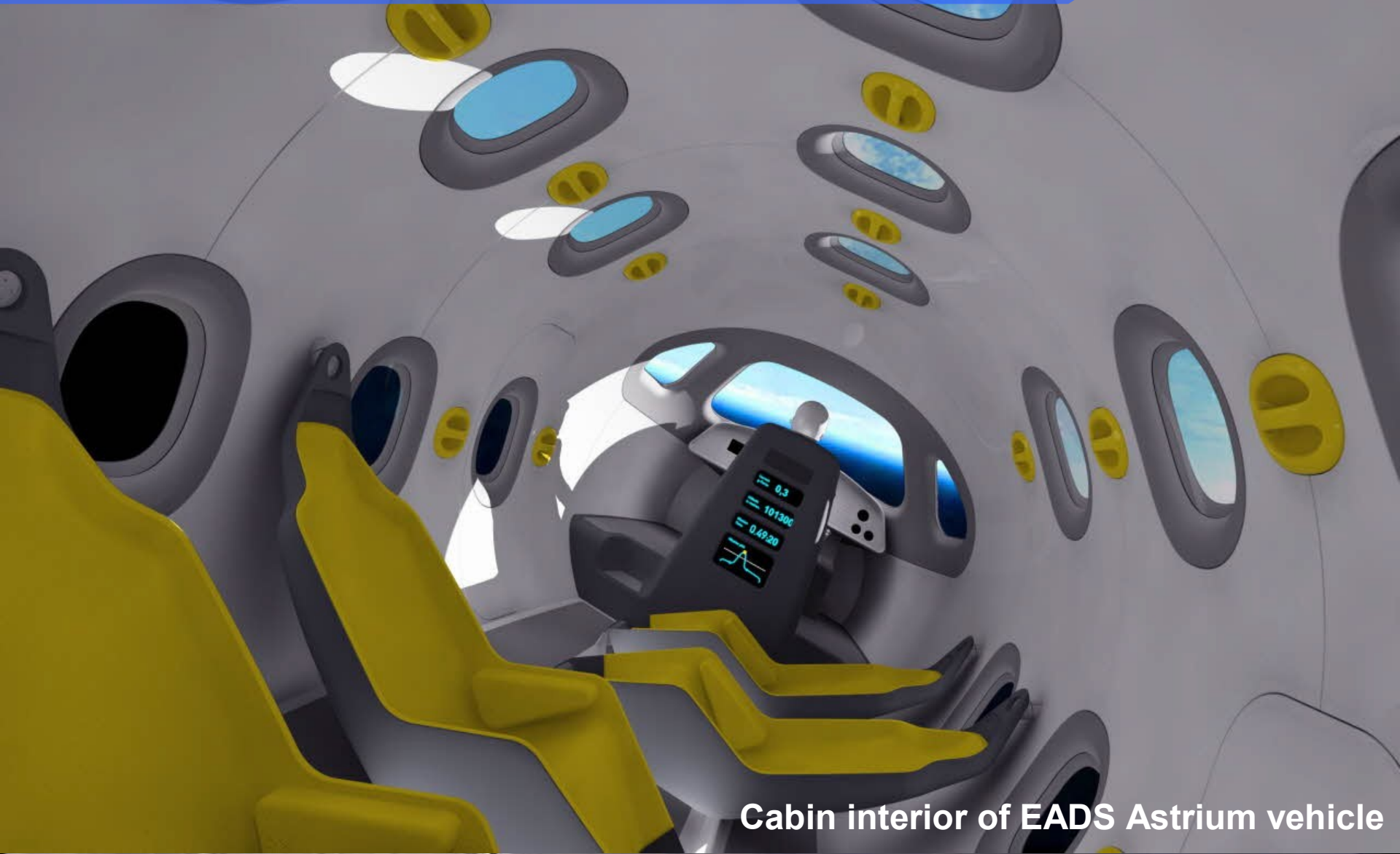
Virgin Galactic: Spaceport America

FUTURE SITE OF THE
NEW MEXICO
SPACEPORT

Spaceport America
Upham, New Mexico,
Environmental approval: late 2008
Operational: late 2010



Space Tourism in Europe: EADS Astrium



Cabin interior of EADS Astrium vehicle



Vertical Takeoff/Vertical Landing: Blue Origin

US private spaceflight firm,
owned by **Jeff Bezos**
(founder of Amazon.com)
Spaceport on 260mi² (670km²) of private land
in NW Texas



Prototype unmanned vehicle 'Goddard',
takes off and lands vertically (**VTVL**).

First flight: 13 Nov 2006 (300ft altitude)
At least 3 test flights to date.

Second test vehicle under construction.

Planned "New Shepard" manned suborbital
vehicle, 1 flight/week to 100km by 2010?





Space on a Shoestring: Armadillo Aerospace



US firm owned by John Carmack
(creator of Doom, Quake)

Small team working part-time,
limited budget (around \$3M to date)

Demonstrated unmanned VTVL
reusable modular rockets

Working on one-man suborbital vehicle



Orbital Space Tourism



SpaceX *Dragon*

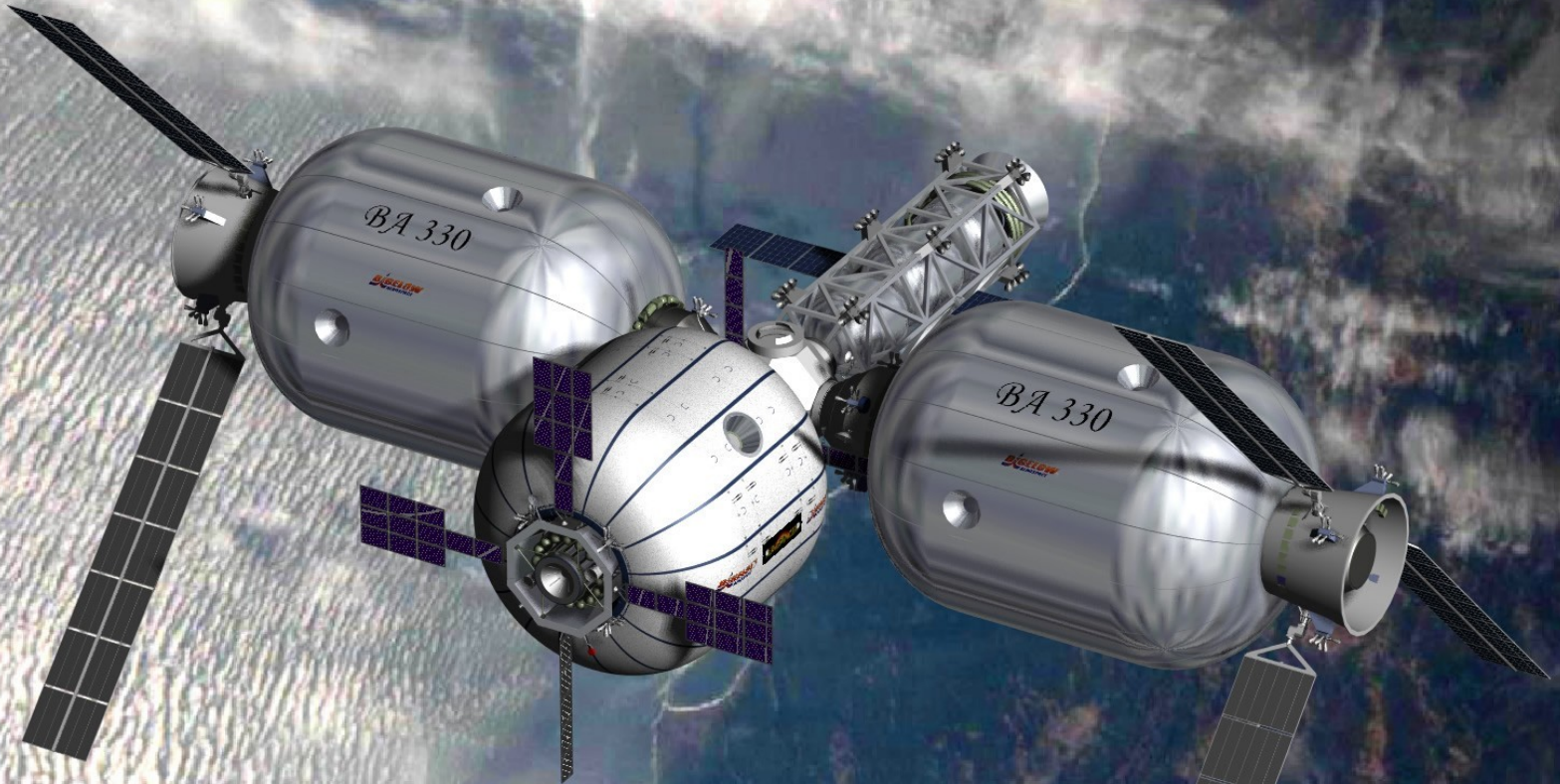


SpaceDev *DreamChaser*

First generation of commercial manned orbital spacecraft.
First flights 2010-2012. Tickets \$10-15 million per seat.



Hotels in Space?



Bigelow Aerospace habitats

Space station modules for rent
\$8 million/month
First operational in 2012



Passenger Safety

- Risk of fatal accident with current manned spacecraft: ~1 in 70
- Aiming for **at least 100x** improvement with new suborbital spacecraft, comparable to first generation of civil airliners in the 1930s.
- Comprehensive health screening: vast majority of passengers will be 'fit to fly'
- FAA will require informed consent by passengers
- Insurance is a challenge! Lloyds studying risks

Environmental Impact of Space Tourism

- Carbon footprint
- Toxic pollution
- Noise pollution – sonic boom
- Effect on wildlife
- Debris hazard from in-flight accidents
- Emissions in upper atmosphere

**EPA
spaceport
assessment**

**FAA vehicle
certification**

Benefits of Space Tourism

- Personal experience – the ‘overview effect’
- Variety of technical approaches (not “one true way”)
- Incremental development (“build a little, test a little”)
- Safer and more robust spacecraft
- Much easier access for space science experiments
- Cheaper, more routine access to space
- **MONEY TO FUND FUTURE DEVELOPMENT!**

The Future



“Kankoh Maru”



Design study for VTVL SSTO by
Japan Rocket Society
50 passengers to orbit



“Skylon”

UK design for HTHL SSTO
using airbreathing rockets
60 passengers to orbit
Tickets “less than £50,000”

