



The aeromedical challenges of commercial space flight

Lt.Col. Francesco Torchia

2nd International Symposium
"Hypersonic Flight: from 100.000 to 400.000 ft"

1983



Charlie Walker
1° Commercial payload specialist

2001



Dennis Tito –
1° space tourist

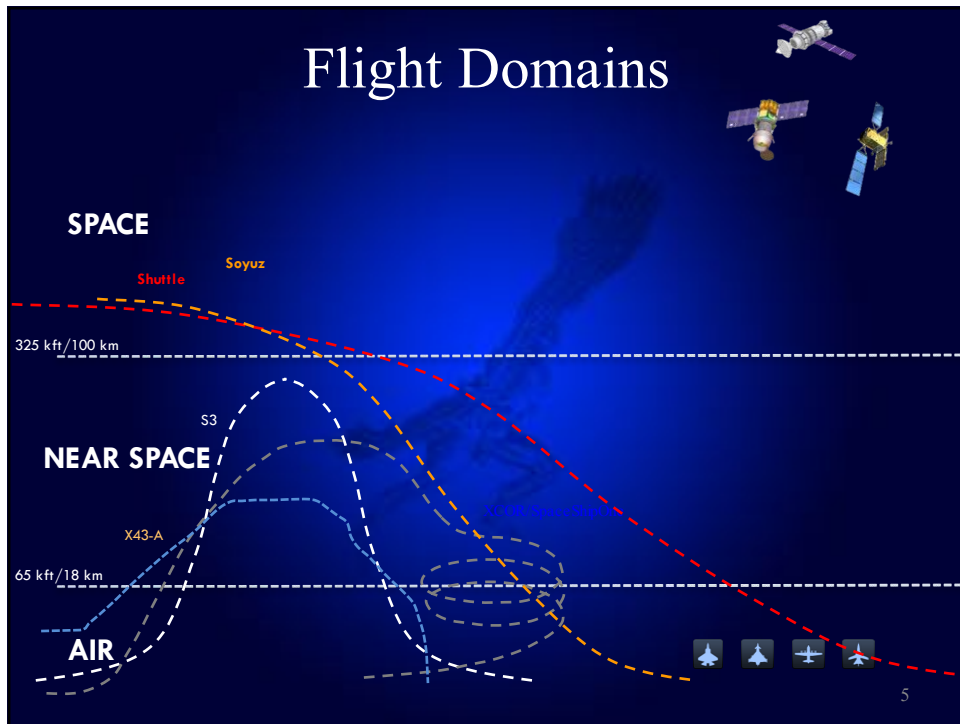
Space Adventures



 **COMMERCIAL
SPACEFLIGHT
FEDERATION**



Flight Domains



Commercial orbital spaceflight

Private companies winner of NASA Commercial Resupply Service (CRS) Program

- **Space X**
– Dragon
- **Orbital Corporation**
– Cygnus



Commercial orbital spaceflight

NASA Commercial Crew Development (CCDev2) Program

- Space X
 - Dragon V2 manned
- Boeing
 - CST-100



Commercial orbital space flight



Excalibur Almaz

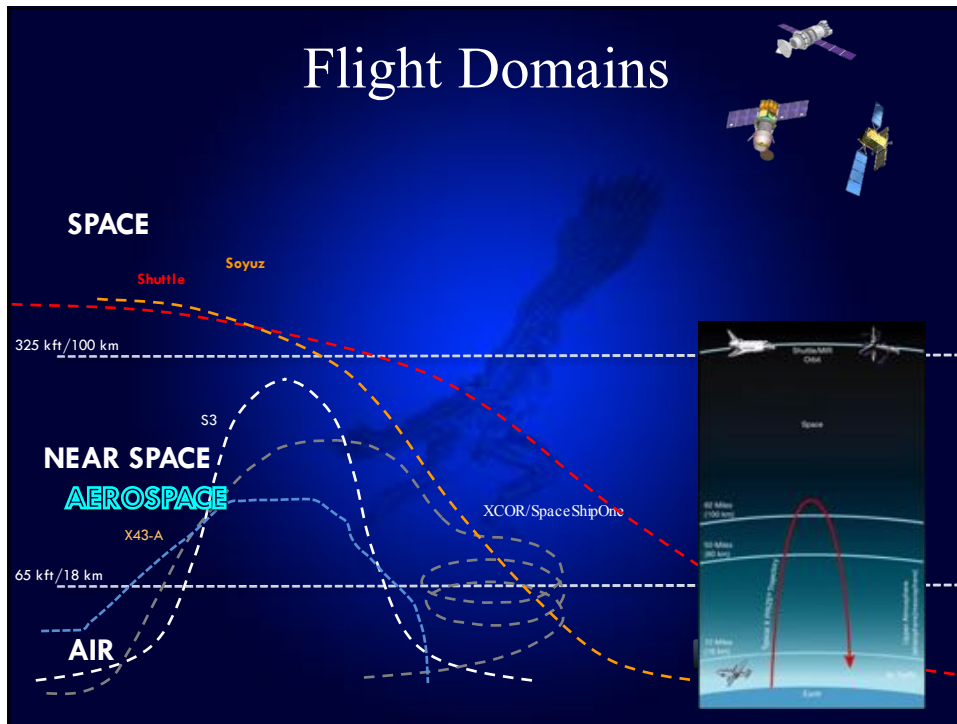


Denis Tito's Mars Inspirations

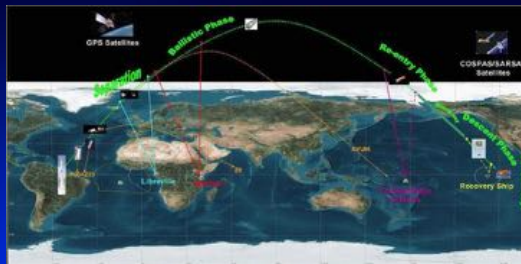


Planetary Resources
Space Adventures

Flight Domains



Hypersonic Flight IXV ESA



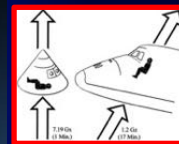
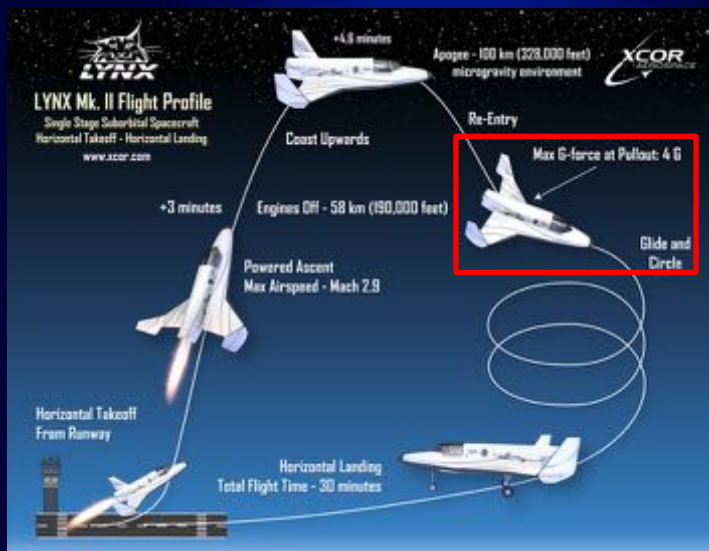
Commercial suborbital space flight

Virgin Galactic Spaceship 2

- will fly over 100 km
- 2 pilots + 6 passengers
- 3-hours suborbital flight
(3-4 minutes of microgravity)



Lynx flight path





Most of the medical and physiological data collected to date are based on the effects of space flight on generally normal and healthy individuals (career astronauts and cosmonauts)

Commercial orbital flights

Space tourist Gregory Olsen

- 57ys old: history of pneumothorax, moderately severe emphysema, bilateral parenchymal bullae, mediastinal mass, ventricular and atrial ectopy
- Received preventive treatment of these conditions, before being cleared to fly in space
- Completed medical evaluation in analog environments (altitude chamber, high altitude mixed-gas simulation, zero-G flight, high-G centrifuge)



Jennings RT et al. "Medical Qualification of a Commercial Spaceflight Participant: Not Your Average Astronaut." Aviat Space & Env Med Journal, Vol 77, No.5, May 2006. (Dr. Olsen released his medical data)

Commercial orbital flights

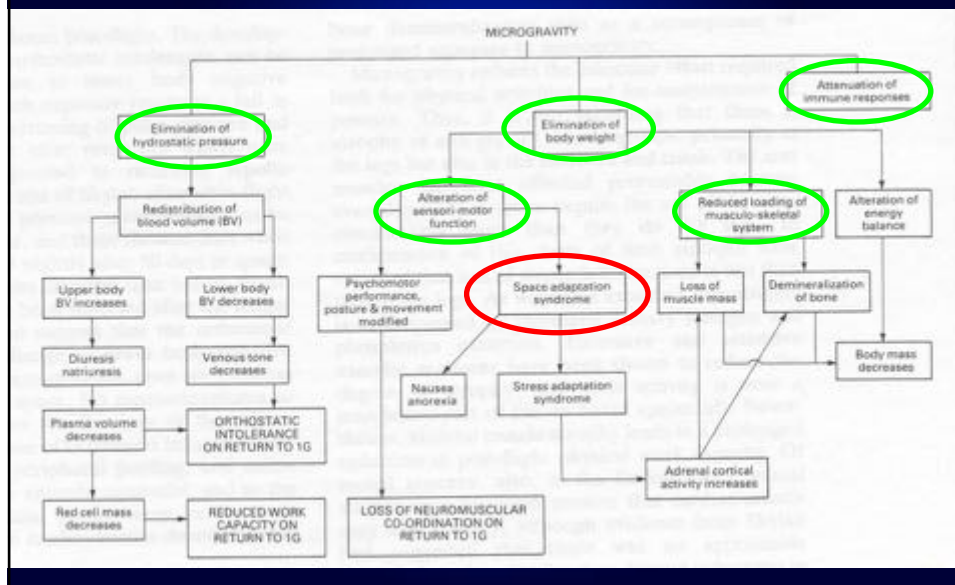
Dr. Eng. Gregory Olsen

- Had no difficulties during the training and performed well during spaceflight
- Post-flight medical testing showed that he was in excellent condition and unchanged medically by the flight



Jennings RT et al. "Medical Qualification of a Commercial Spaceflight Participant: Not Your Average Astronaut." *Aviat Space & Env Med Journal*, Vol 77, No.5, May 2006. (Dr. Olsen released his medical data)

Consequences of microgravity



Future space voyager

- A good compromise between:
 - Safety of passengers and of the flight
 - Avoiding imposing an obstacle to the successful establishment of the manned space transportation industry
 - to consent a larger subset of population to participate to future space exploration
- 1-time medical clearance for 1-flight passenger
- Crew: repetitive suborbital flights

Shuttle Medical standards

Item	Pilots (Class I)	Mission Specialist (Class II)	Payload Specialist (Class III)	Participants to Spaceflight (Class IV)
Distant vision	20/20 or better uncorrected; correctable to 20/20 each eye	uncorrected; correctable to 20/20 each eye	eye	Same as Class III
Near vision	Uncorrected < 70/20 each eye	Uncorrected < 20/20 each eye	Not specified	Not specified
Hearing	Each ear: 30 dB @ 500 Hz 25 dB @ 1,000 Hz 25 dB @ 2,000 Hz 50 dB @ 4,000 Hz	Same as Class I	Better ear: 35 dB @ 500 Hz 30 dB @ 1,000 Hz 30 dB @ 2,000 Hz	Must hear whispered voice at 1 m (hearing aid allowed)
Height	162-191 cm	152-191 cm	Not specified	150-190 cm (Some)
Refraction/astigmatism	Specified	Specified	Not specified	Not specified
Constriction visual field	15 deg	15 deg	30 deg	Not specified
Phorias	exo > 15; eso > 8 hyper > 2	exo > 15; eso > 8	Not specified	Not specified hyper > 2
Depth perception	No errors in 16 presentations of the Verhoeff stereopter Test	Same as Class I	Not specified	Not specified
Cardiac response	Para-Farrington	Para-Farrington	Not specified	Not specified
Blood pressure	Latham Test 140/90	Latham test 140/90	150/90 allowed	150/90 allowed
Respiration apparatus	Not specified	Not specified	Not specified	Not specified

Table 7-61. Medical requirements for NASA Class I, II, III and IV astronaut applicants.

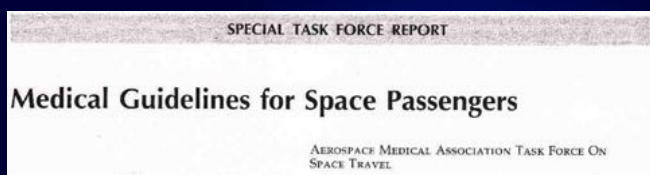
4 classes based on Astronaut position

Class I and II differ only for visual acuity and height

Class IV: Spaceflight Participants (never used)

ISS Medical Requirements

- **Medical Volume A**
– ISS long spaceflights
- **Medical Volume B**
– Medical operations
- **Medical Volume C**
– Spaceflight Participants
 - No deformities
 - Emergency egress capabilities
 - Preflight Training completed



AEROSPACE MEDICAL ASSOCIATION TASK FORCE ON SPACE TRAVEL.
Medical guidelines for space passengers. Aviat Space Environ Med
2001; 72:948-50.

**Aerospace Medical
Association**

**Task Force on Space Travel
2001
(orbital)**

CARDIOVASCULAR

- Coronary Artery Disease
Symptomatic = DQ
Asymptomatic = Evaluate for exception
- Arrhythmias/Conduction Defects
Hemodynamically significant = DQ
Nonhemodynamically significant = Evaluate for exception
- Pacemaker/Implantable Defibrillators = DQ
- Pericarditis/Myocarditis
DQ
Evaluate 6 months post-recovery
- Heart Transplant/Replacement
DQ
- Hypertension
Severe or poorly controlled = DQ
Well Controlled = Qualified with possible exceptions
- Structural/Valvular Defects
Symptomatic = DQ
Asymptomatic = Evaluate for exception
- Cardiomyopathy
Symptomatic = DQ
Asymptomatic = Evaluate for qualification

Medical Guidelines for Space Passengers—II

2002 “assumptions” (suborbital flights)

SPACE PASSENGER TASK FORCE: RAYMAN RB, ANTUÑANO MJ, GARBER MA, HASTINGS JD, ILLIG PA, JORDAN JL, LANDRY RF, McMEEKIN RR, NORTHUP SE, RUEHLE C, SAENGER A, SCHNEIDER VS. *Position Paper: Medical guidelines for space passengers-II. Aviat Space Environ Med* 2002; 73:1132-4.

- Space vehicle interior small and confining
- Suborbital flight 1 to 3 hr including x min. microgravity
- Cabin pressurized to sea level or 5-8000 ft.
- No life support equipment required
- Acceleration will range between 2 – 4.5 +Gz or Gx (depending on the space vehicle)
- Different emergency procedure (depending on the space vehicle)
- Few or no medical capabilities onboard



What potential risks should be disclosed?

What is an appropriate/sufficient full-disclosure of potential risks that would:

- Minimize liability for the operator?
- Not produce excessive fear among prospective space participants?

How conservative should medical screening guidelines be for space passengers in order to:

Promote the preservation of life and the safety of the flight?

and at the same time

Avoid imposing an obstacle to the successful establishment and growth of the manned commercial space transportation industry?

Future space voyager

- **Commercial Space Launch Amendment Act (2004):** US is the only country that established licensing requirements
“Passengers to be fully informed about the potential risks but allowing to fly at their own risk”

SPACE FLIGHT SURGEON

as

RISK MANAGER

that may recommend a risk mitigation strategy

Future space voyager

- **FAA 2005 “Guidance for Medical Screening of Commercial Aerospace Passengers”**

Suborbital: medical history and physical assessment decided by the space Flight Surgeon

Orbital: medical history and standardized physical assessment

- **FAA (2006): “Human spaceflight requirements for crew and spaceflights participants”**
 - Informed consent on risks of spaceflight
 - FAA Airmen Class II for crew (now Class I)
 - Only medical guidelines for passengers

Medical Requirements

- **FAA (2006): “Human spaceflight requirements for crew and spaceflights participants”**
 - Informed consent on risks of spaceflight:
“An operator must inform in writing any individual serving as crew that the US Gov has not certified the launch vehicle and any reentry vehicle as safe for carrying flight crew or space flight participants...before entering into any contract”
- **FAA Centre of Excellence for Commercial Space Transportation**
 - Medical Guidelines 2012
- **International Association for the Advancement of Space Safety (IAASS)**
 - Medical guidelines 2014
 - Radiation limits for suborbital flights

Preflight clearance

Human Centrifuge

Gagarin Centre



NASTAR Centre

Parabolic flight



Challenges

- Elderly people
- Pregnant women
- Operational medicine





Operator-owned medical databases will be of critical importance (medical & legal) to the success of the manned commercial space transportation industry, and, more importantly, to the health and safety of subsequent space flight participants

