Lessons Learned from Space Exploration Course EE-582

Minor in Space Technology
Electrical Engineering Department

Marc Toussaint
Retired from ESA

Spring Session 2024 / 2025

Introduction to the Course (EE-582)

Lessons Learned from Space Exploration / Leçons à tirer de la Conquête Spatiale

Goals of the lectures:

✓ To present the reasons which lead to the choices and decisions in the space exploration history
✓ To outline their consequences today, and for the coming decades
✓ To draw lessons learned from the analysis (Geopolitics impact on space exploration evolution)
✓ To perform a Conceptual Design Study at System level, in small teams
✓ Continuous semester evaluation through the project (Mid-term & Final reports)

The Cold War & the history of the space conquest:

✓ Origin of the Soviet successes (Sputnik, Luna, Vostok, Voskhod)
✓ American reactions (Missiles Gap, Mercury, Gemini), the first space disasters (Apollo 1, Soyuz 1)
✓ The Moon race (Apollo, Zond, N1, Luna)
✓ The first space stations: Soviet (Almaz, Salyut, Mir) & US (MOL, Skylab); US Space Shuttle (STS)
✓ The launchers in the World; the unmanned exploration missions (Moon, Venus, Mars)

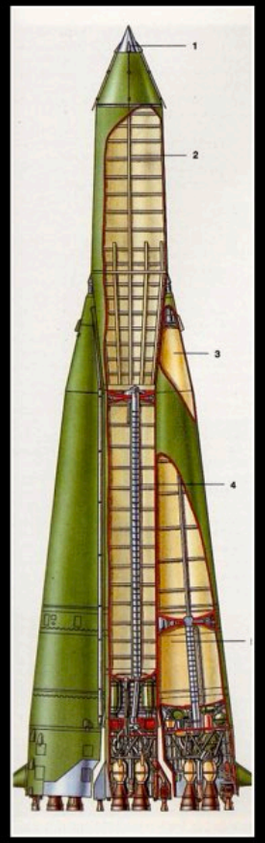
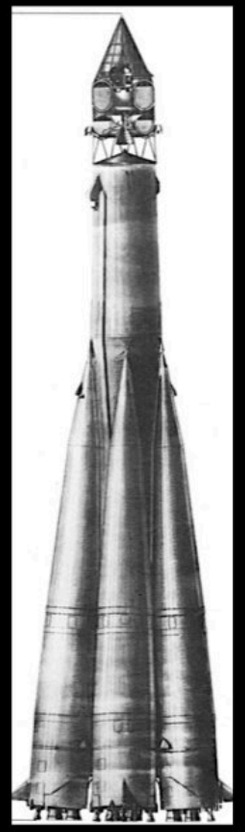
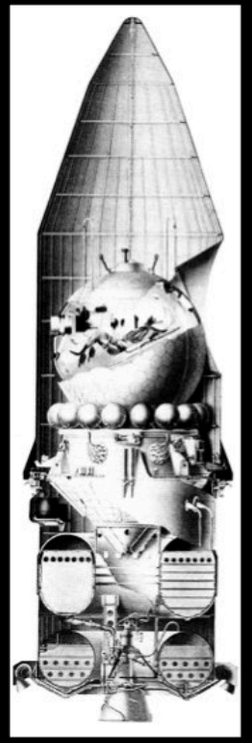
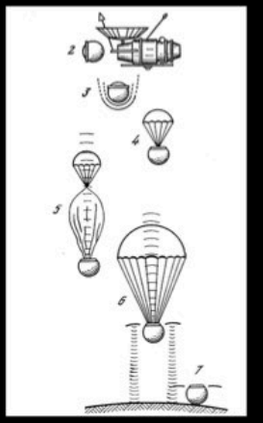
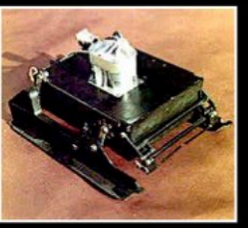
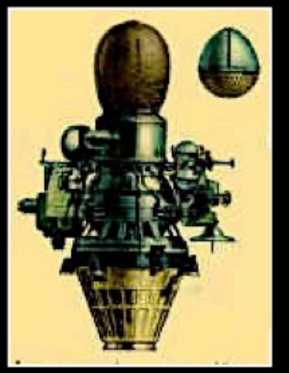
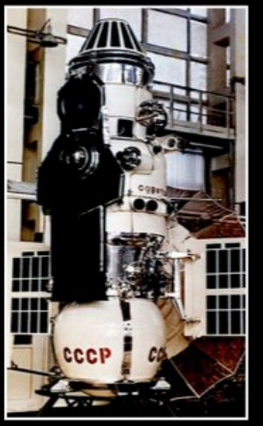
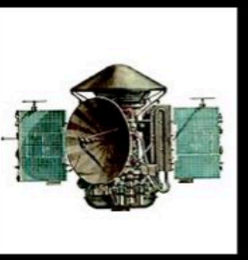
The end of the (1st) Cold War & the new space

✓ The International Space Station (ISS), the Chinese space power rise
✓ Artemis - the new space race and return to the Moon ; preparing missions to Mars
✓ The ‘new space’, early stage and rise of space tourism
✓ The next 40 - 50 years: a prospective analysis

EE-582: Lessons Learned from Space Exploration

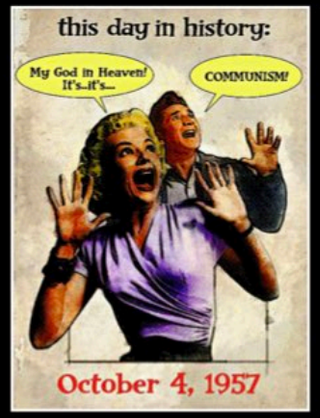
Dates	Week	Time	Room	Subjects	Project
Thursday					
20 / 02	# 08	13h15 - 17h00	MXG-110	Introduction to the Project & Lecture #1: History of the space conquest	Groups set-up
06 / 03	# 10	13h15 - 17h00	MXG-110	Lectures #2a & #2b: The US / Soviet Moon race (and the Soviet failures, N1 & Soyuz)	latest 10 / 03
20 / 03	# 12	13h15 - 17h00	MXG-110	Lecture #3: Soviet / Russian Space Stations programmes (Salyut stations, Mir)	
03 / 04	# 14	13h15 - 17h00	MXG-110	Lecture #4: Post-Apollo, Skylab / Space Shuttle / ISS / International Cooperation	Mid-Term Report
17 / 04	# 16	13h15 - 17h00	MXG-110	Lectures #5 & #6a: The Chinese Space power rise & Crewed exploration programmes	14 - 15 / 04
Eastern	# 17				
08 / 05	# 19	13h15 - 17h00	MXG-110	Lectures #6b & #7a: Automated exploration missions & The European launchers	
22 / 05	# 21	13h15 - 17h00	MXG-110	Lectures #7b & #8: The Launchers in the World & Prospective views (2050 +)	
		17h15 - 18h15	MXG-110	2 Movies (Soviet history, new robots & rovers)	Final Report
					30 / 05

Soviet Race for the 'Firsts' in Space

Sputnik-1 04/10/1957	Sputnik-2 03/11/1957	Lunik-2 04/09/1959	Y. Gagarin 12/04/1961	V. Tereshkova 16/06/1963	A. Leonov 18/03/1965	Luna-9 03/02/1966	Venera-7 15/12/1970	Mars-3 02/12/1971
								
								
								
								

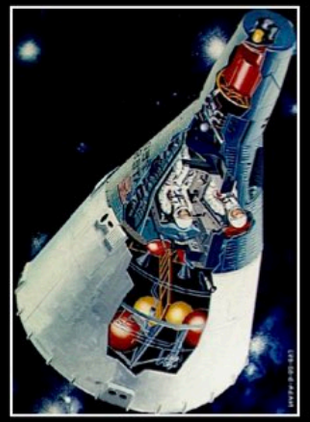
US Reactions and the Moon race

J.F. Kennedy 25/05/1961



J. Glenn 20/02/1962

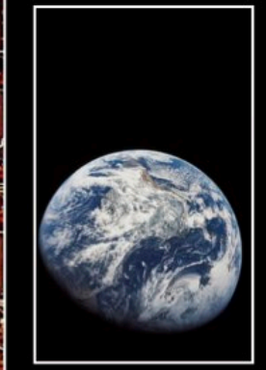
Gemini 1965 - 1966



Apollo 1 27/01/1967

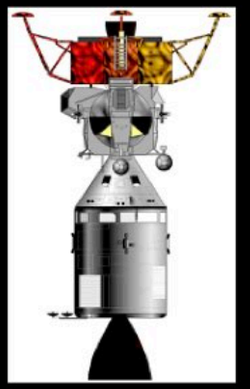
Apollo 4 09/11/1967

Apollo 8 21/12/1968



Apollo 11 16/07/1969

Apollo 13 11/04/1970



Apollo 17 07/12/1972

Key Dates & Events in Space Exploration

1957 : 04th October 1st satellite in space – *Sputnik 1*

1961 : 12th April 1st man in space – *Yuri Gagarin*; 25th May Kennedy Speech "*Start of the Moon Race*"

1963 : 16th June 1st woman in space – *Valentina Tereshkova*

1966 : 03rd February 1st soft landing on the Moon – *Luna 9*

1967 : 27th January *Apollo 1* (3 dead); 24th April *Soyuz 1* (1 dead)

1969 : 20th July 1st man on the Moon – *Neil Armstrong*

1971 : 19th April 1st crewed Space Station – *Salyut 1*; 30th June *Soyuz 11*: Death of crew (3) returning from Salyut 1

1981 : 12th April 1st Space Shuttle flight – *Columbia*

1986 : 28th January *Challenger* explosion after lift-off (7 dead)

1995 : 22nd March Longest Human Space Flight (MIR) – *Valeri Poliakov*

1998 : 20th November 1st element of ISS Space Station – *Zarya*

2003 : 01st February *Columbia* disintegration at re-entry (7 dead); 15th October 1st Chinese in Space – *Yang Liwei*

2004 : 04th October X-Prize won by *Spaceship One* @ 112 Km altitude

2010 : 08th December 1st Private launch & recovery of a space vehicle – *Dragon 1*

2012 : 16th June 1st Chinese women in Space – *Liu Yang* (Tiangong-1)

2015 : 21th December 1st Recovery of a 1st rocket stage – *Falcon 9*

2020 : 30th May 1st Private launch & recovery of crewed space vehicle (ISS) – *Dragon 2*

2027 / 28 : ? *Artemis Programme:* Return to the Moon

Marc Toussaint
Born in Charleroi in 1953
Middle & High Schools

Liège University
Physicist Engineer
(Space Technology)

Stanford University
Master of Science
California - USA

1st Contract:
Dornier Systems
Germany (6½ y.)

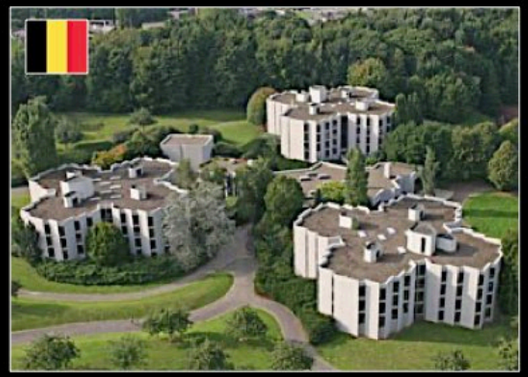
2nd Contract:
ESA / ESTEC
Holland (2¼ y.)

ESA Headquarter
Paris - France (29¼ y.)
Retired end of 2017

1989-2017

1971

1978



1979

1980-86

1986-88


1966


25.10.1990
36 parabolas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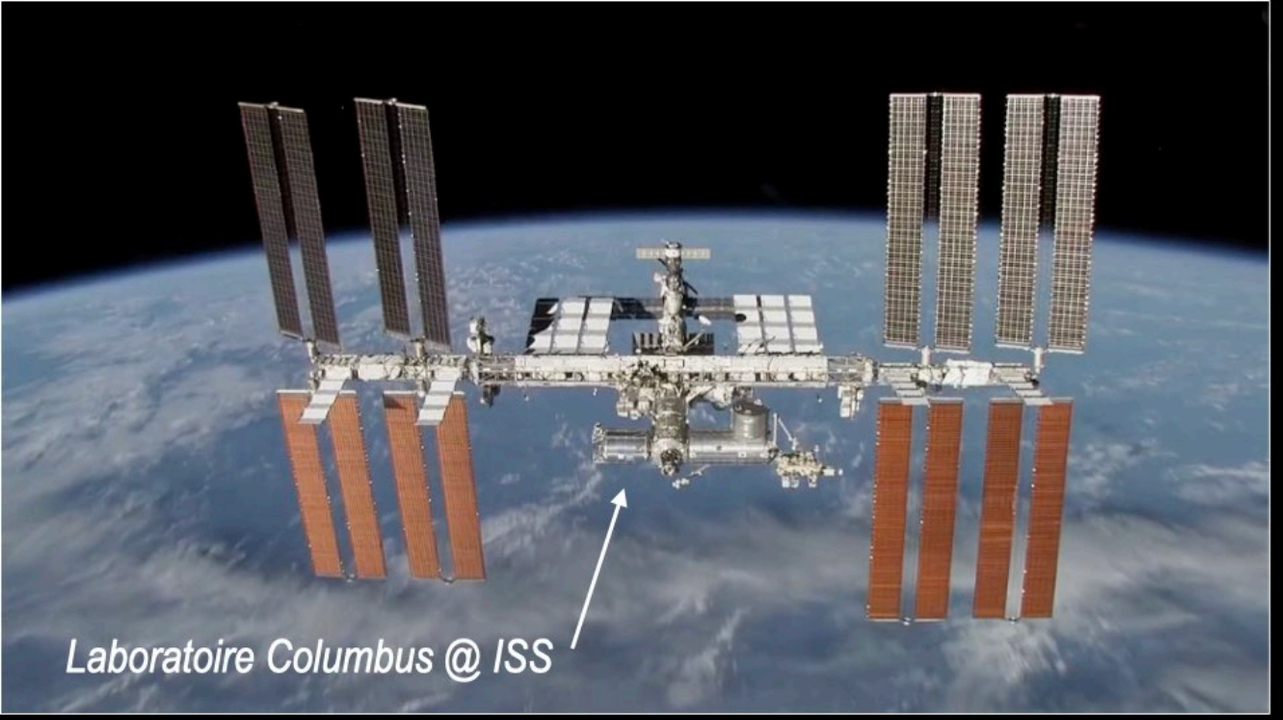
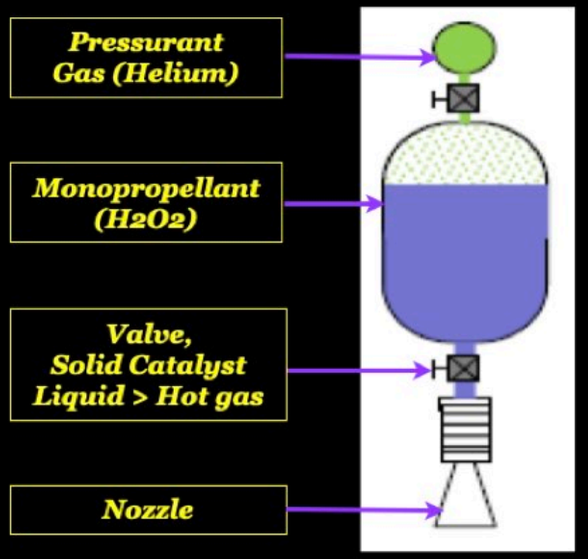
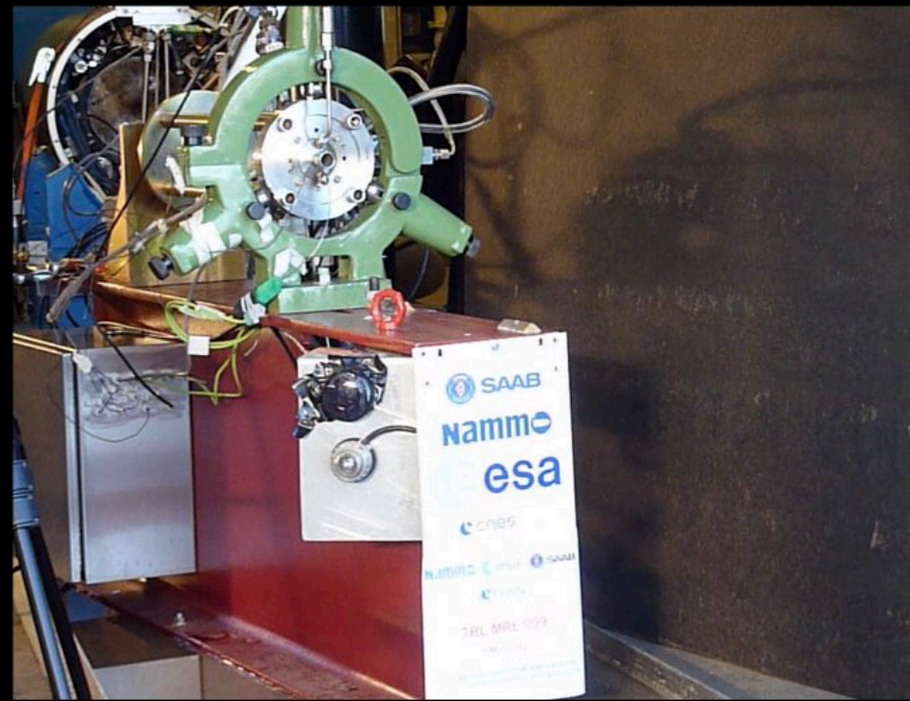


Monopropellant Rocket Engine





Space Missions Euromir

(1992- 94 Negotiations with RKA & Enerjia)

Euromir - 94
Ulf Merbold (D)
Soyouz TM-20
Oct.94 - Nov.94
30 days

Euromir - 95
Thomas Reiter (D)
Soyouz TM-22
Sept.95 - Feb.96
179 days
2 EVA

Never hesitate to learn and speak (correctly) more languages

Young Graduates' program @ ESA can be a good professional kick

But try to make your (first) experiences in the Space Industry

Educate yourself to 'The other side of the coin & 360° stand point'

Stay always alert to advanced technology developments and evolution

Never hesitate to take on more responsibilities (incl. management)

If you feel that you have nothing more to learn in your work, change it

As soon as you can, transfer your knowledge and experiences