

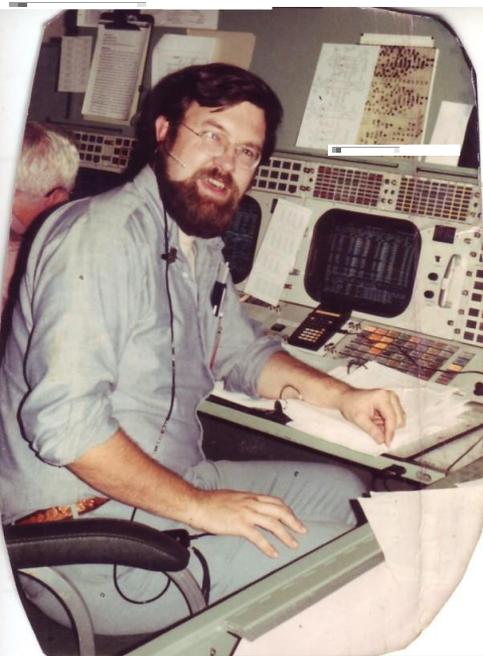
# Comparative Influences of Human Factors on National Space Activities and Practices [United States, Russia, China, and others]



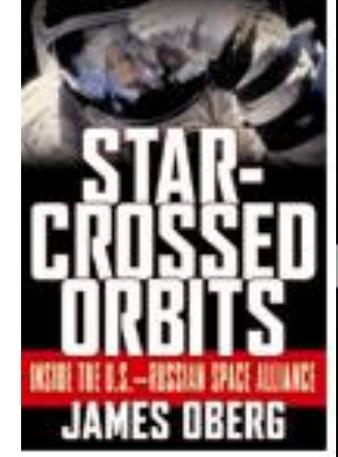
- National Space Biomedical Research Institute [NSBRI]
- Piloting Spacecraft Guidance & Control of Human Space Vehicles
- September 21-22, 2016
- Houston, Texas
- James Oberg [[WWW.jamesoberg.com](http://WWW.jamesoberg.com)]

# Approach

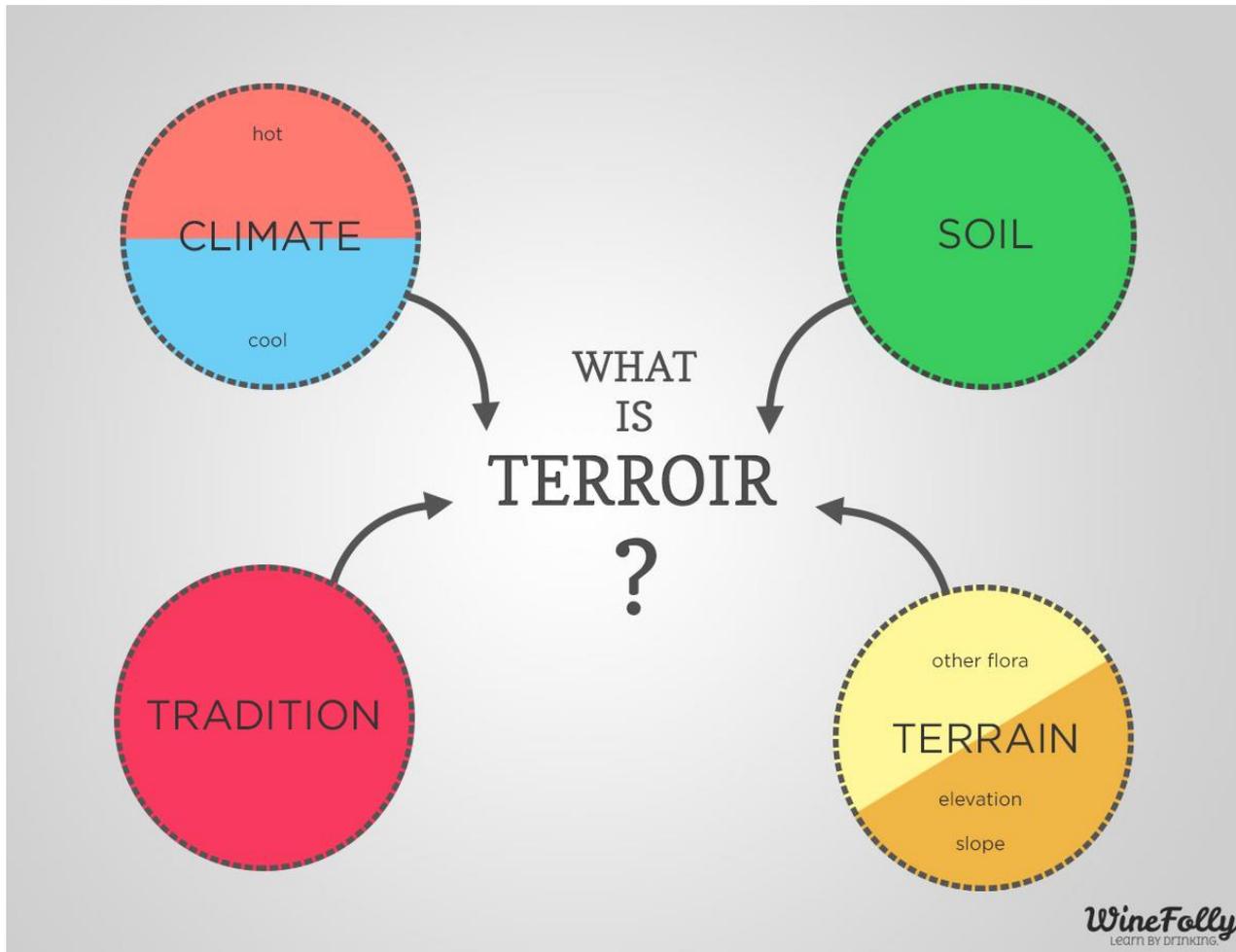
- How do external cultural and other national factors influence a space program?
- What illuminating analogies offer insights?
- What differences can we see in national programs that can be traced back to such human [as opposed to technological] factors?
- How can lack of appreciation for these subtle influences diminish assessment accuracy?
- Why is this BAD?
- How can realistic appreciation for these subtle influences help future joint projects?



Professional specialty – human  
spaceflight operations [1975-1997]  
Baykonur & Star City etc.  
Congressional Testimony [1997,1998]



# Analogy with “Terroir” – influence of environmental factors on quality of wine



# “Terroir” for a space program

CLIMATE

SOIL

TRADITION

TERRAIN

An analogy with wine, and how its quality reflects its environment – both NATIONAL and INTERNATIONAL

# International Environmental Factors

Space programs don't exist in isolation

Competition often spurs on each player

Space programs develop special capabilities which they protect

'Many justifications for learning from others

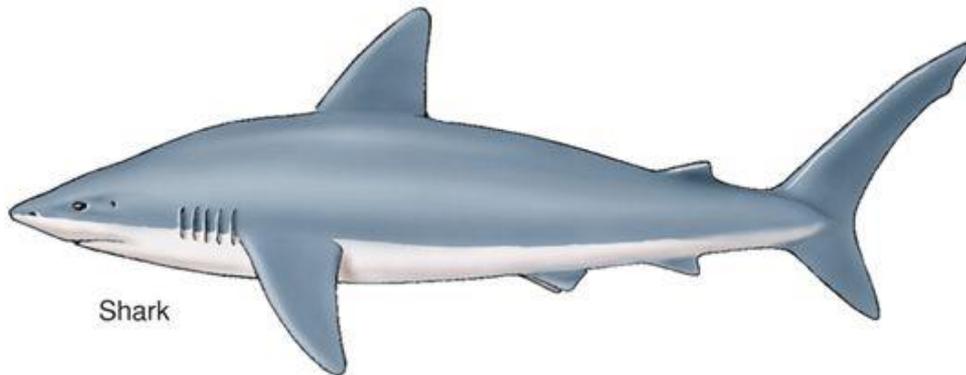
Direct copying not always 'best fit'

ASSUMING copying by others can be misleading

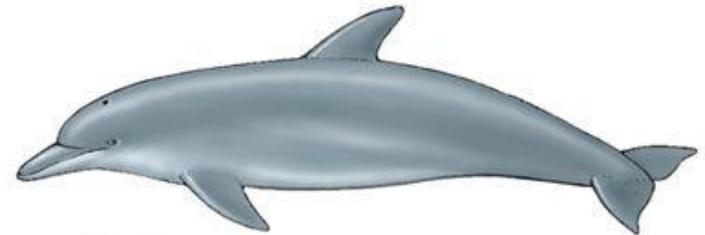
## CAUTIONARY COMMENT REGARDING THE CONCEPT OF “COPYING”

# Convergent Evolution: Streamlining

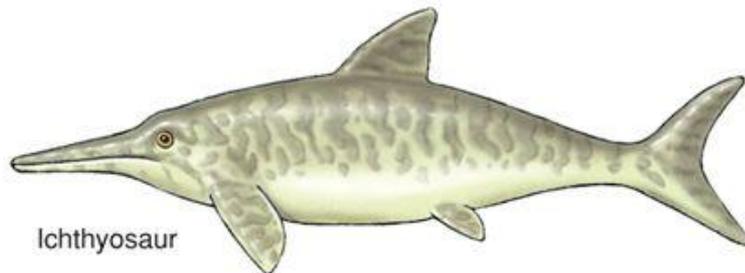
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Shark



Dolphin



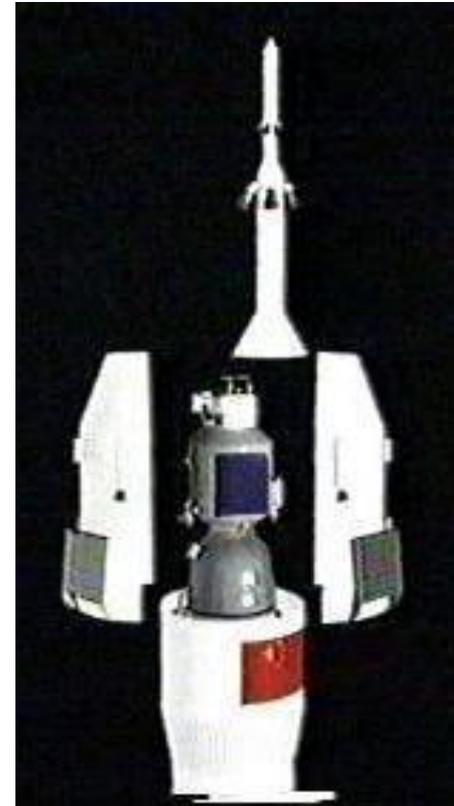
Ichthyosaur



Penguin

Convergent evolution is the process by which unrelated species evolve similar physical characteristics because they have similar lifestyles

*Inspiration may be as influential as direct 'copying'*



Humanned spacecraft with aero shroud and 'escape tower':  
left, Russian Soyuz; center & right, Chinese Shenzhou.  
Huang Chunping on stabilization flaps: *"This is the most difficult part of the escape system. We once wanted to inquire about it from Russian experts, but they set the price at \$10 million. Finally we solved the problem on our own."*

# DIRECT COPYING – SOYUZ CABIN SUITS, SHENZHOU CABIN SUITS





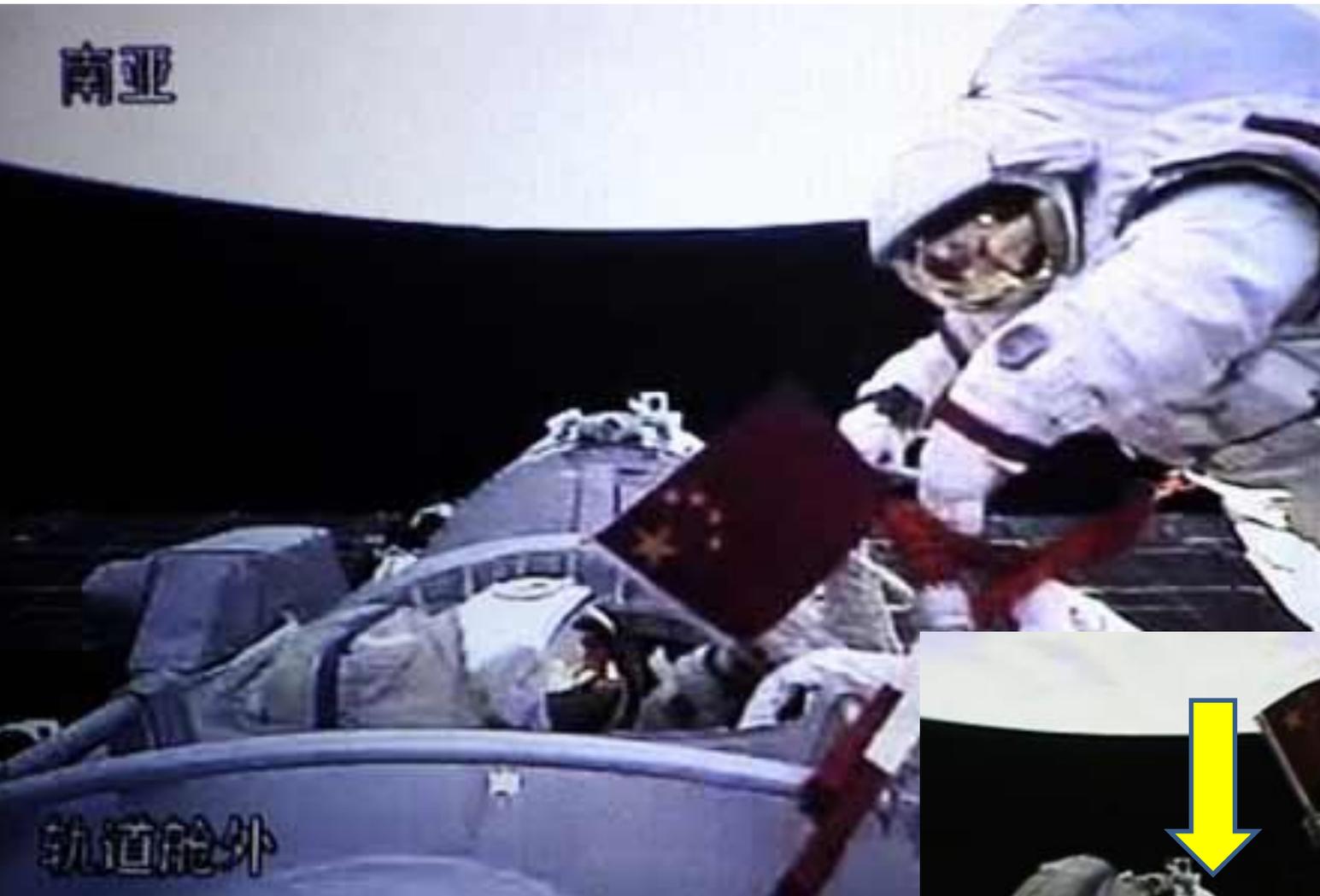
COPY AND UPGRADE

CHINESE EVA SUIT [LEFT]  
RUSSIAN EVA SUIT [BELOW]

NOTE THAT RUSSIAN SUIT [RIGHT],  
OPTIMIZED FOR EXTERNAL TRAVERSE  
ALONG SPACE STATION HANDHOLDS,  
HAS SMALL WINDOW ON HELMET TOP –  
SORT OF A “MOON ROOF”

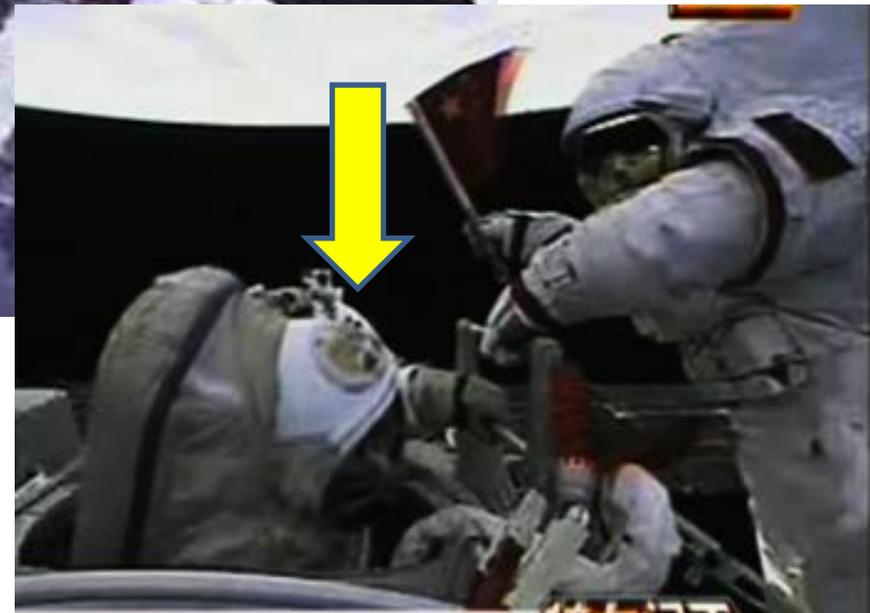


商亚



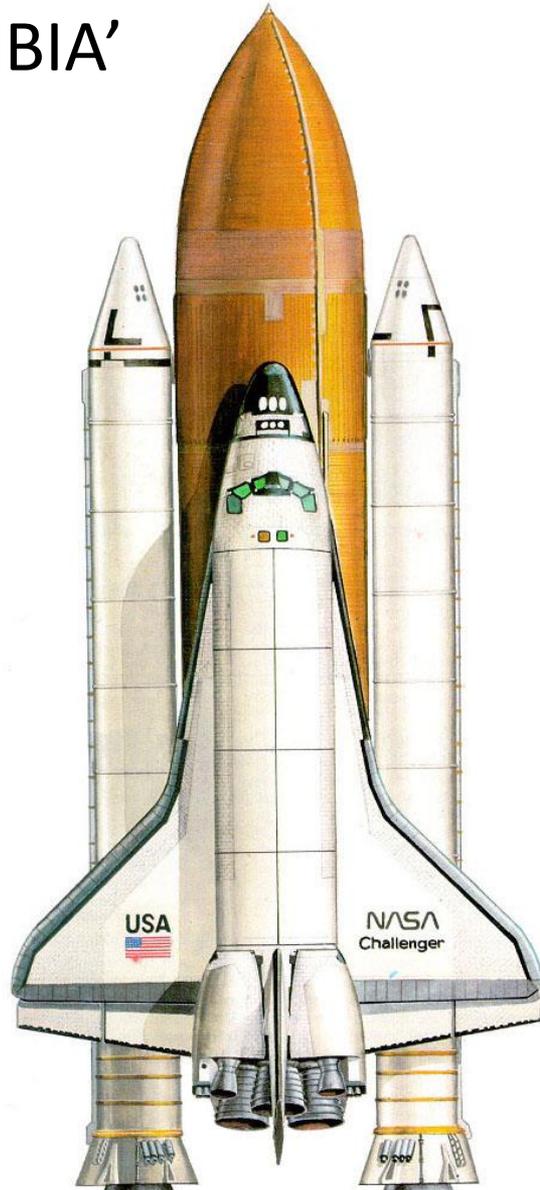
FOR CHINESE EVA [2012], DOMESTIC FABRICATED SUIT USED OUTSIDE BUT AS BACKUP, THE RUSSIAN PURCHASED SUIT WORN BY SECOND MAN

POINT OUT ONE MAJOR DESIGN CHANGE BASED ON DIFFERENT USER NEEDS – RUSSIAN BUILT SUIT IN HATCH, CHINESE SUIT FULLY OUTSIDE AIRLOCK. DIFFERENCE?

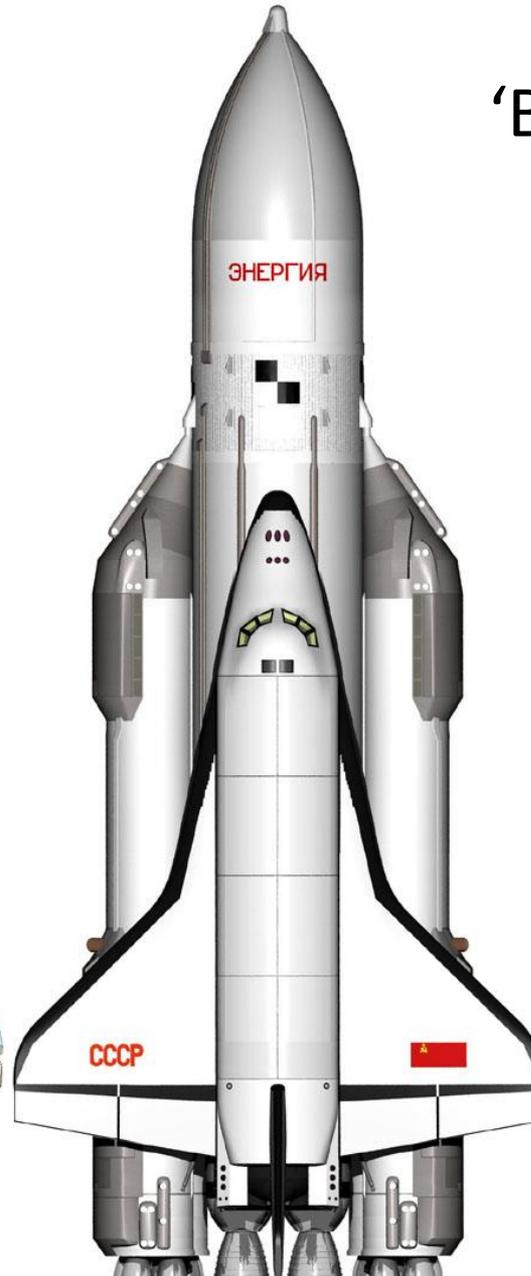


# THE ULTIMATE IN SPACE COPY-CATTING – OR IS IT?

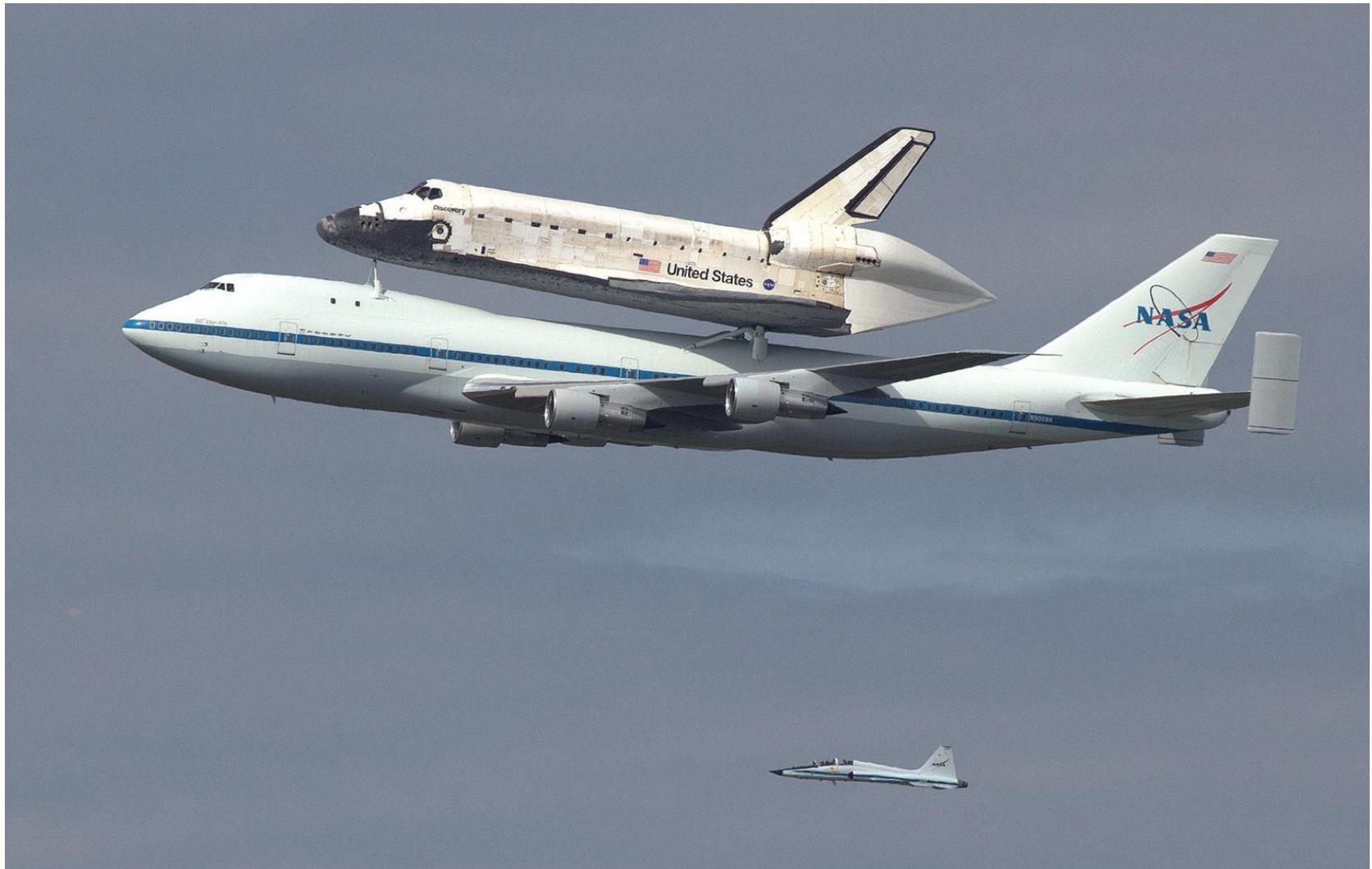
‘COLUMBIA’



‘BURAN’



From early on, NASA planned to use 747 to carry orbiter point-to-point – only later thought up ‘drop tests’





# Serendipitous capture of overhead view led to ‘mirror-imaging’ of Buran

ABOVE: Simulated reccesat photo of Buran on Bison, near Moscow, 1982

RIGHT: Official US Defense Department publication, “Soviet Military Power”, 1985”



# Major US technical intelligence oversight re 'Buran'

Primary Error: **They didn't notice something that wasn't there.** Read this twice.

Here's what they missed, that led them astray.

Without Soviet waterborne barge transport capability for heavy spacecraft and booster components from fabrication to launch site, US assessment of alternative application of aircraft piggy-backing on Soviet a/c was incomplete

Assumption of Soviet copy-catting too tempting

# BARGE TRANSPORT – THE MISSING RUSSIAN CAPABILITY



# Post-USSR Collapse – release of photos of actual ‘shuttle carrier aircraft’ utilization



# Bison/Buran piggyback replicas & art



Bison also  
carried  
boosters  
and tanks



# Visible differences



Buran approach/landing tests [above] were made using undetected jet engined 'flying analogue'. Resulting Buran nosewheel strut [right] was much longer ['nose high'] than NASA ['nose low'] to allow horizontal takeoff.



# Utterly divergent engine design

**MAIN ENGINES FOR BURAN WERE ON EXPENDABLE MAIN STAGE;  
TWO OMS ENGINES WERE CENTERED AT AFT END; JET ENGINES  
FOR ATMOSPHERIC FLIGHT WERE ON BOTH SIDES OF TAIL.**



NASA DESIGN CARRIED  
THREE REUSABLE MAIN  
ENGINES ON END, WITH  
OMS ENGINES ON TAIL.



# Effects of national geography on space flight operations

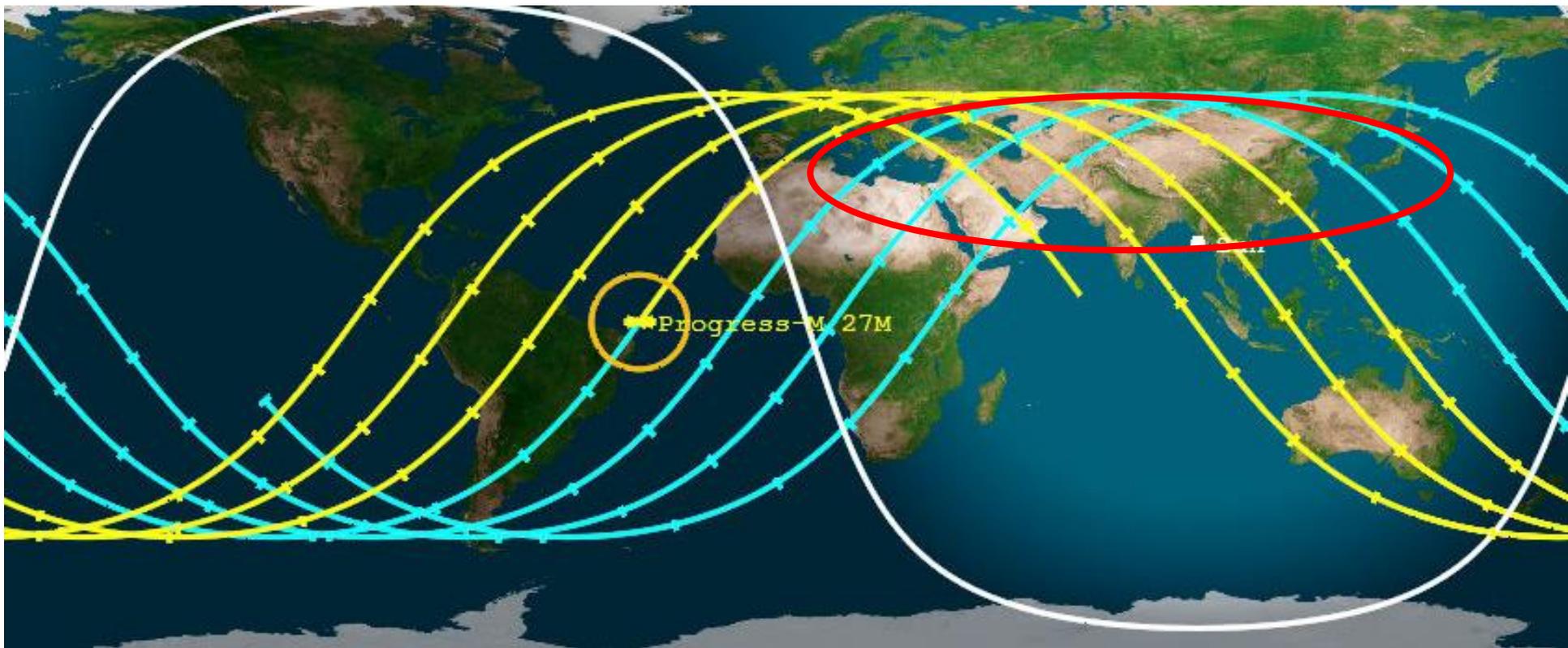
Developing a strategy for getting to where you want to go starts with knowing where you have to start

In space, all 'locations' are in motion

Earthside measures are obsolete. "Distance" is no longer measured in kilometers but in delta-V and travel time

Earth itself gets in the way of desirable functions such as point-to-point comm and solar power generation

# “GEOGRAPHY IS [SPACETRACK] DESTINY”

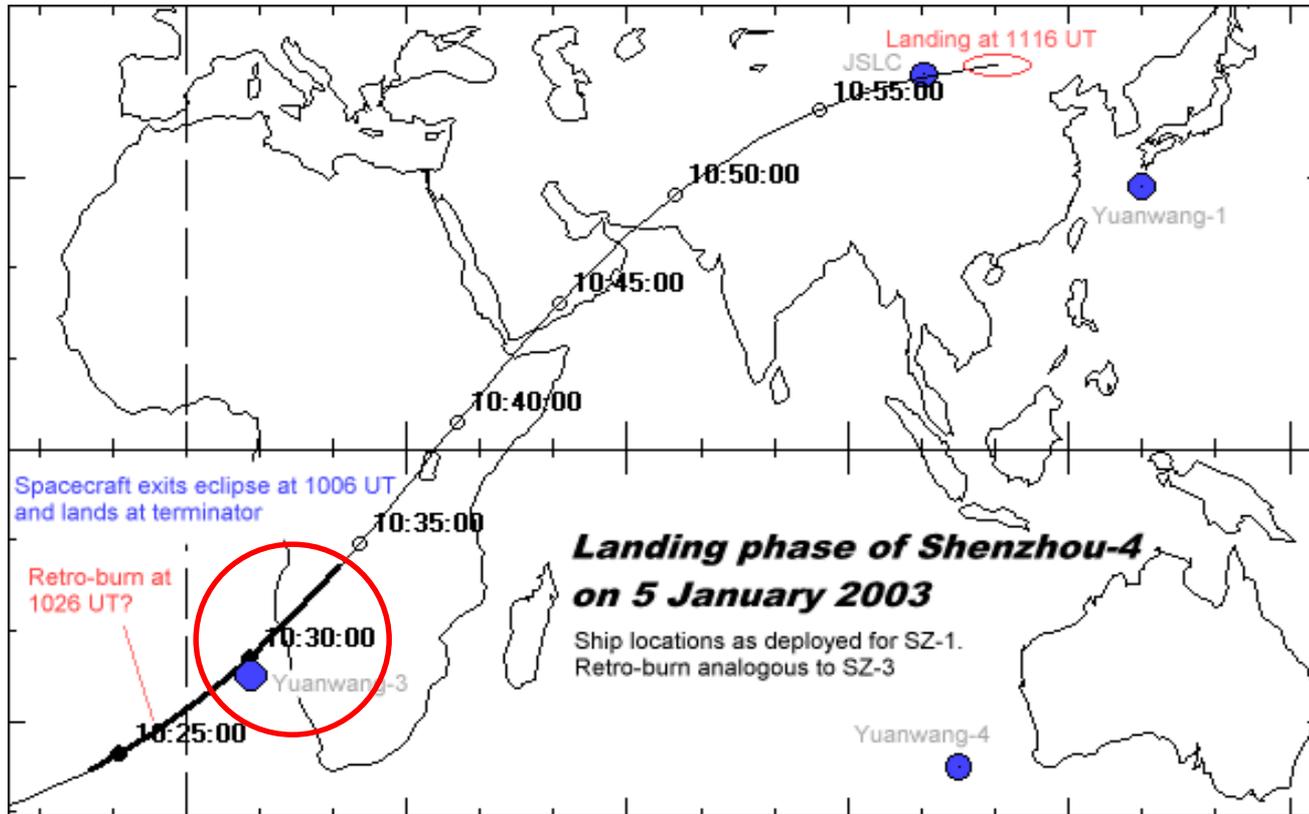


- Squashed ‘Slinky’ ground track of human spacecraft in LEO
- Russia’s longitudinal breadth gave repeated in-country passes for more than half orbits
- Mission critical events [dockings, spacewalks, etc] scheduled to occur in that interval
- Orbital plane precession westward made this interval occur earlier every day in 60-day cycle
- Due east launch from Baykonur [lat 46 N] passed outside USSR borders so path shifted north

# Inclinations have operational consequences

- For Russia, long periods of no comm meant uninterrupted 'down time' so 24-hour MCC shift [then 3 days off] worked
- Off days meant flight controllers could moonlight
- Precession meant that spacewalks could only have reliable comm only about a quarter of the time
- High inclination subjected vehicle to twice-annual full-sunlight periods lasting several days of thermal stress
- Higher launch azimuth out of Cape Canaveral cost STS about 30-35% payload penalty [much less for expendables]
- NASA extra launch costs for accessing Russia-compatible orbit were 15 to 20 billion dollars over original ISS orbit
- In 1998 I totally failed to explain this concept to Congress

# CHINESE GEOGRAPHICAL PREDESTINATION



Chinese 'Shenzhou' human spacecraft [42 deg inclination].  
Inclination selection based on launch track from NW China to east.  
Launch into 52 deg orbit [ISS] requires ascent pass over Taiwan.  
LANDING zone has descent/entry pass starting over southwest Africa.  
China has built space tracking site in Namibia to be directly under this.  
Launch from new site on Hainan can safely insert into 52 deg orbit.  
But landing FROM 52 deg orbit would pass out of range south of Namibia.

# MISSION OPERATIONS

Crew “task training” versus “skill training”

Handouts versus hand-written notes

Shuttle “frantic rush” versus station “steady advance”

Structured training versus apprenticeship

Documented ‘lessons learned’ versus veterans’  
memories and personal notebooks

# Moscow 'TsUP'



# NASA ISS Mission Control



# INSIGHTS FROM A COLLEAGUE

- TsUP has much more centralized command and control, tending to render their LEO crews much less autonomous.
- Thanks to the ISS US segments and the supporting TDRSS [relay satellites] infrastructure, this is becoming less the case.
- But it likely arose from compartmentalized Soviet military operations heritage.
- Crew autonomy should become of paramount importance to the Russians if they're serious about interplanetary human space flight.
- JO: Russian flight crews have a long tradition of autonomy, such as not keeping ground advised on events up to and including small fires

# INSIGHTS FROM A COLLEAGUE 2

- NASA tries to cover any single credible contingency with preflight analysis and documentation such as flight rules.
- As it was explained to me, TsUP can't afford this to anything like the degree NASA practices.
- If they have a bad day, the strategy is to wing it in real time, much the way MCC-H would for an unanticipated or less credible multi-failure scenario.
- Along similar lines, TsUP just won't pay for documentation to the level MCC-H would develop.
- So, the shortfall is made up by NASA paying for it, typically through Russian consultation and review together with MCC-H transcription and translation overhead.
- This is one reason why many in the ISS Program regard anticipated cost savings from international partnerships to be delusional.
- I guess it depends on the partner's culture and what resources they can bring to the effort.

# INSIGHTS FROM A COLLEAGUE 3

- When matters go awry during real time ops, TsUP offers up little more than what went wrong, even if the cause is known internally.
- The "why" behind an anomaly often must be pried out of TsUP, often in debrief sessions after the fact.
- IMHO, this behavior is again a product of military operations heritage and reluctance to share shortcomings or vulnerabilities with foreigners.
- Perhaps it is less common nowadays than during joint *Mir* ops or early ISS assembly.
- JO: Still are occasions when Russian side conceals failures, or failure causes, or blames failures on interference from non-Russian hardware or crewmembers

# Misunderstandings from Ignoring 'Terroir'

- 1973 -- Soviet distrust in early Apollo-Soyuz over NASA denial of 'secret military Skylab'
- 1976 – Soviet decision to build Buran based on feared hidden military use of NASA shuttle
- 1983 – 'Able Archer' brink of pre-emptive war
- 1984 – CIA misinterprets Buran/Bison piggyback
- 1985 – CIA overestimation of new Soviet booster power by misunderstanding size of pad
- 1996 – NORAD loses track of Russia's falling plutonium-carrying Mars probe [in Bolivia]
- 1997 – NASA repeatedly caught by surprise by crises aboard astronaut-visited Mir space station

# A FINAL AGRICULTURAL ANALOGY

Was the Soviet space program 'a hothouse orchid'?

*A fragile entity requiring many highly-specialized and unique environmental factors*



# *Unique USSR environmental factors*

- Focus of national fervor and pride
- Access to output from top industrial enterprises
- Recruited best from entire nation's institutes
- Promised epochal breakthrough achievements
- Provided exemption from military service
- Provided access to Western high-tech publications, open sources as well as surreptitious 'acquisitions'
- Offered otherwise unobtainable perks such as
  - Special commissaries
  - Special hospitals and resorts
  - Special schools and libraries

# As the USSR collapsed, all these factors vanished

- Popular and media contempt for 'waste'
- Revelations of failure and mismanagement
- With budget cuts, industries collapsed – and those that didn't, demanded cash
- With independence of non-Russian republics, key facilities and specialist teams were lost
- Salaries fell below many new career fields
- Top graduates entered business, or emigrated
- Special facilities opened up to anybody with the money or new political pull

# DEMOGRAPHICS IS DESTINY - CHAPTER 2

## KNOWLEDGE/WISDOM TRANSFER METHODOLOGY

***CHALLENGE: TRANSFER USEFUL KNOWLEDGE/INSIGHTS ACROSS GENERATIONS OF INDIVIDUALS/TEAMS, EFFECTIVELY***

SOVIET APPROACH: BUILD TEAMS, LEARN BY DOING [AND FAILING]  
***[SOVIET BASIC FLAW: ASSUME TEAM MEMBERS ARE IMMORTAL]***

\*\*\* IN USSR, 'KNOWLEDGE WAS POWER', AND MONOPOLIZING IT  
[RATHER THAN SHARING] PROVIDED JOB SECURITY

\*\*\* WORKERS KEPT REFERENCE MATERIALS IN PERSONAL NOTES  
OFTEN IN ABBREVIATIONS/CODES OF INDIVIDUAL INVENTION

\*\*\* REPLACEMENTS WERE TRAINED IN LONG APPRENTICESHIPS

\*\*\* 'LESSONS LEARNED' WERE USUALLY IN FORM OF FOLKLORE,  
OR ORAL TRADITION OF PERSONAL EXPERIENCES/GOSSIP

CHALLENGE IN RUSSIA IS TO RECRUIT & TRAIN REPLACEMENTS FOR AGING WORKFORCE, AND THEN PROVIDE NEW PROJECTS TO PRACTICE ON.

**RUSSIAN TV NEWS  
PROGRAM SHOWS  
VETERAN SOYUZ  
ESCAPE SYSTEM  
FINAL ASSEMBLY  
SPECIALISTS ARE  
STATLER AND  
WALDORF.**



**2018 PHOTO**

STATLER & WALDORF



## FLOWER FOOD FOR THOUGHT

IS THE US SPACE PROGRAM A HOTHOUSE ORCHID?

IS THE CHINESE PROGRAM A HOTHOUSE ORCHID?

IS SPACE-X A HOTHOUSE ORCHID?

DISCUSS

# Suggestions for future

- Everybody has a point of view deeply rooted in their experience and placing yourself in another's shoes isn't instinctive, it's a learned response that is crucial
- Gestures of cross-cultural respect create a positive feedback, a 'virtuous cycle' – and vice versa
- Trust is an earned commodity, not one that is bought by displaying passivity or condescending acquiescence
- Allowing yourself to be deceived only earns the amused contempt of the deceiver and guarantees more of same
- Especially in space, the old bumper sticker applies: "God forgives, Man forgives, Nature never".

# Moral

- People aren't alike all over
- People aren't even alike hereabouts
- Ignoring differences can be costly and dangerous and lead to unpleasant surprises
- Not expecting differences can prevent noticing other people's better ideas
- It's also often bad manners