CASE STUDY - SKYLON

The SKYLON by Reaction Engines

The Skylon is a single stage to orbit reusable spacecraft based on air breathing and rocket engines. Currently at concept stage.

Advantages:

- Air breathing saves fuel
- Wings provide lift -reduce gravity losses
- Thrust of engines can be below vehicle launch mass

Disadvantages:

- Mass of air-breathing kit
- Mass of wings
- Increased drag losses

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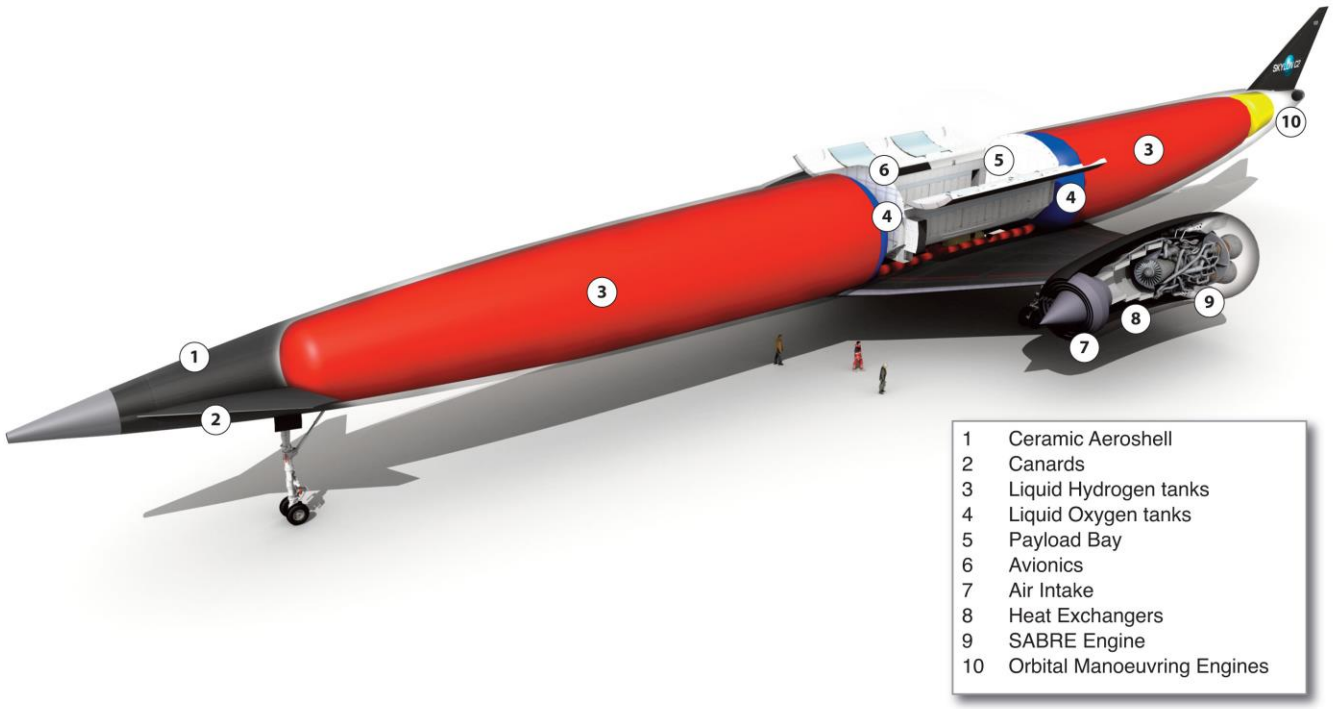
Targets

- 200 reuses
- 1% abort rate per mission
- 1:20000 loss rate per mission
- 48 hours turn around



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Challenges

The SKYLON three main challenges are:

- Be trim-able during aerodynamic flight.

- Offer a mass fraction which allows to carry useable payload to orbital speeds.

- Develop its engine with available technologies.

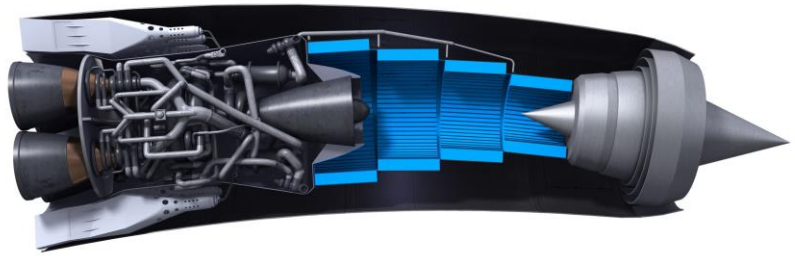
This challenges must be satisfied with a design that is robust enough to achieve aircraft-like reliability.

SKYLON’s SABRE Engine

SABRE: Synergetic Air-Breathing Rocket Engine.

Uses pre-cooled and compressed air in the atmosphere as the oxidiser in its rocket chamber.

Once the momentum limit is reached (once the atmosphere runs out), it switches to liquid oxygen.



It is both an air breather and a pure rocket:

- Simpler
- Saves weight
- Reduces drag

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SABRE Engine Performance

- Inferior Specific Impulse to a Jet but better than a Rocket.
- Takes the SKYLON to more than Mach 5 before switching to a rocket engine.
- Average exhaust velocity of about 6100m/s on a flight to orbit.
- Offers double the thrust to weight ratio of a rocket with less deadweight once in orbit.

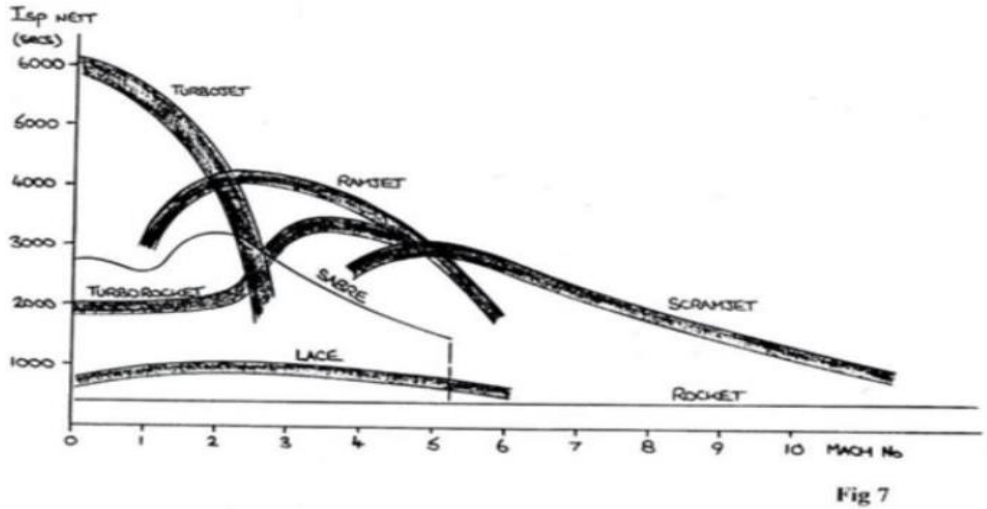
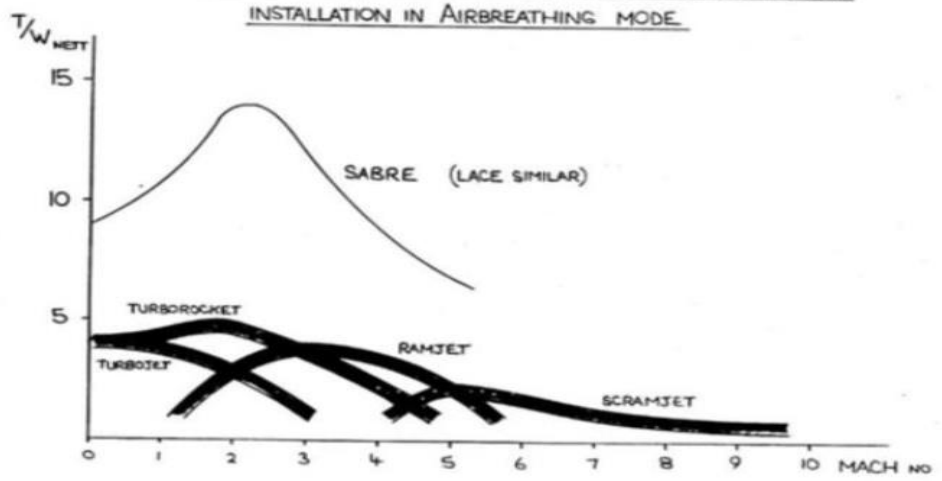


Fig 7

INSTALLED THRUST/WEIGHT OF THE TOTAL SSTO PROPULSION INSTALLATION IN AIRBREATHING MODE.



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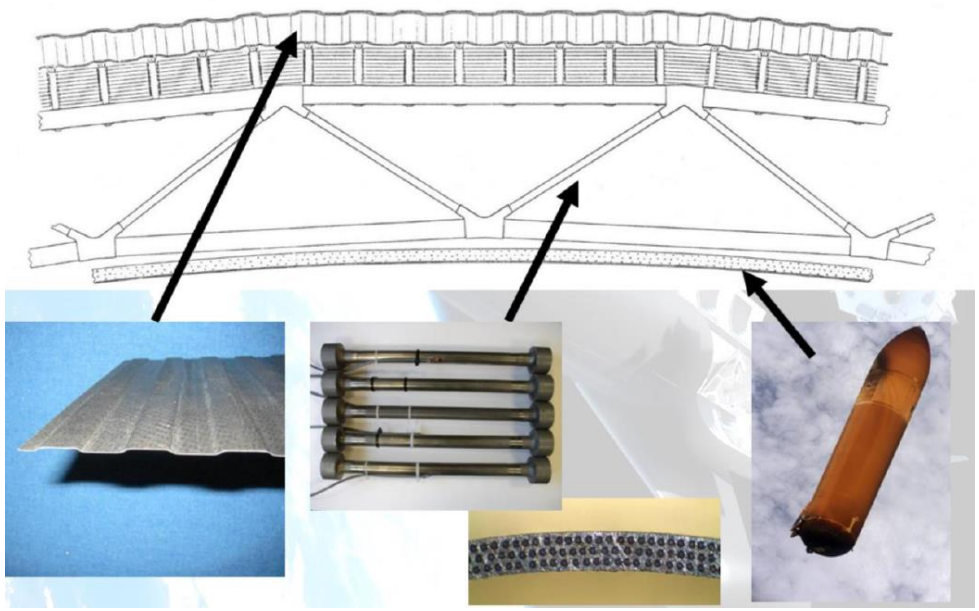
Mass Ratio and Structural Technology

- Systems approach means that the SABRE Engine is not sufficient on its own.
- Need a mass ratio improvement to reach 22% instead of 44%.
- Double improvement on a rocket but only half on an intercontinental airliner.
- Air frame is almost entirely a Hydrogen tank: low density.

SKYLON Structure

- Outer aeroshell is made of reinforced glass ceramic: can withstand high temperatures both at Mach 5 and re-entry.
- This outer skin is supported by nickel posts designed for very low thermal conductivity. (Black color)
- Behind aeroshells, multilayer metallic heat shield.
- Main structure consists of a space frame made of titanium struts reinforced with silicon carbide fibres.
- Propellant tanks are made from aluminium lithium alloy covered in a foam insulation suspended in the truss framework by Kevlar ties.



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Conclusion on System Optimism

- Structural optimism requires 4 times improvement on structure weight while system optimism two.
- Engine optimism requires a specific impulse double that of a rocket while system optimism 50%.
- Question: are two smaller breakthroughs better than a single bigger one?