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WHAT SPEED FOR A FUTURE HIGH SPEED TRANSPORTATION SYSTEM ?

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Extended ABSTRACT

Many technical and economic studies are presently underway in the major aeronautical countries, in order to evaluate the interest of inter-continental transport systems operating at supersonic cruise speed (2000-3000 km/h), or in the hypersonic regime (5000-7000 km/h), over the next 25 years.

. The main objective of this survey paper is to point out that the governing factor is the choice of the most favourable cruise speed (Mach number), giving the best global economy for airlines while satisfying stringent constraints relative to safety and acceptable environmental impact (noise, pollution, etc.).

. As a starting point, there is a consensus on some "minimum" characteristics for a future high-speed transport:
- more than twice the Concorde capacity (200-300 passengers),
- more than twice the Concorde range (about 6500 nm/12000 km, for transpacific service),
- Intercontinental journey block-time cut to less than half, compared to existing subsonic service.

. However, the proposed cruise speed results in two different aircraft types:
- the SST, with supersonic cruise Mach number between 2 and about 3,
- the HST, with hypersonic cruise Mach number, between 4.5 and not larger than 6 (using ramjet and not scramjet, with cryogenic fuels).

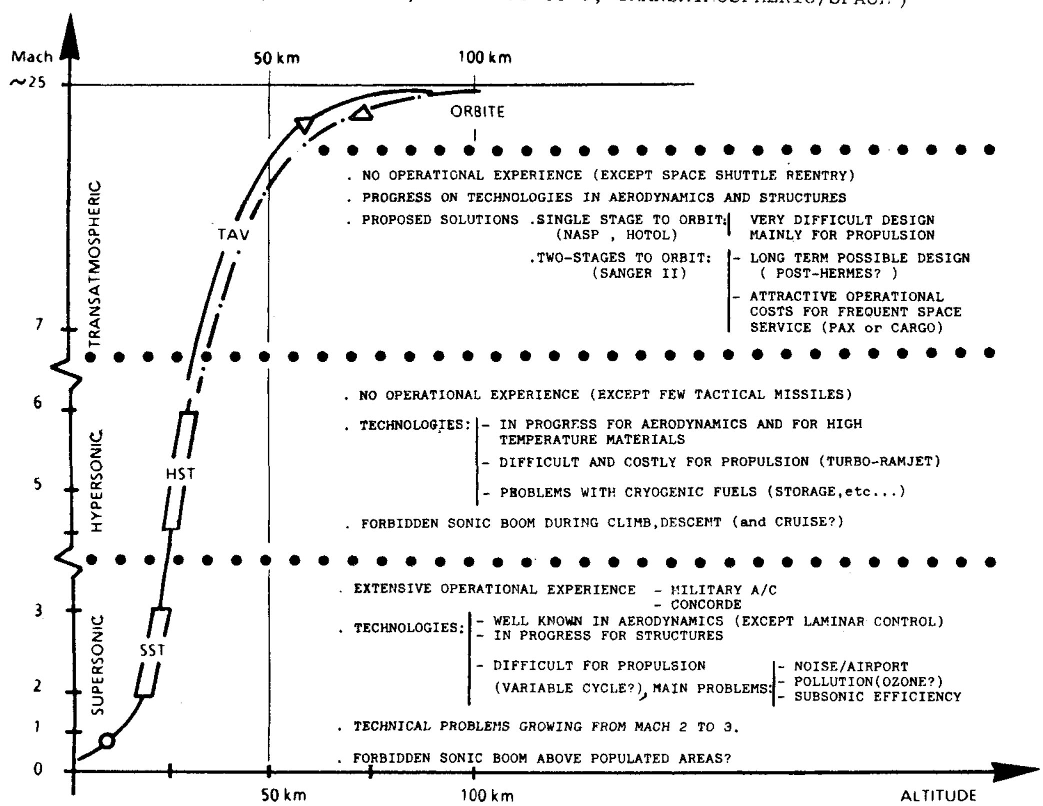
. The operational implications of these cruise speeds are important for:
- the trip time saving and the aircraft productivity (number of flights per day);
- the increasing cruise altitude with Mach number, reaching perhaps the fragile ozone layer concentration when cruising between Mach 3 and 4, but reducing the sonic boom signature on the ground for a given aircraft weight (a difficult chalenge for the same range/payload).

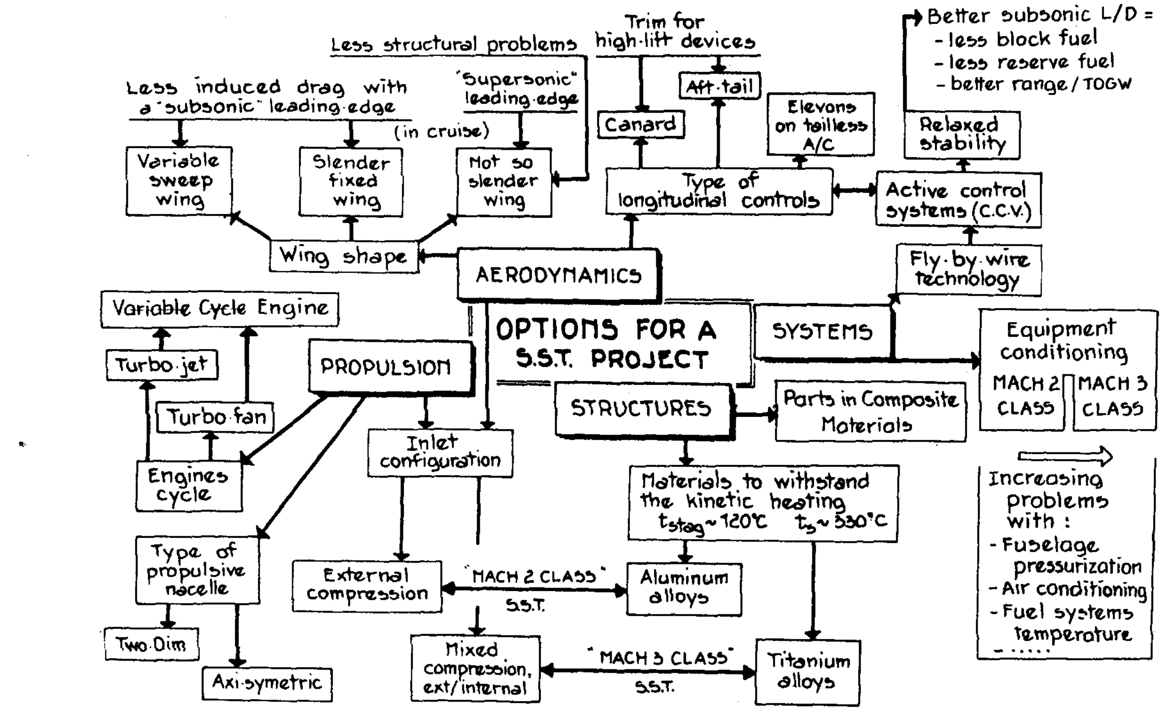
. The technical implications are considerable:
- for aerodynamics: wing shape, inlet and nozzle configurations for the propulsive nacelles and their integration to the wing fuselage;
- for propulsion: engine cycle, from variable-cyble turbo-fan-jet to turbo-ram-jet, using conventional or cryogenic fuels;
- for structures: increasing temperature with Mach number imposes the use of more sophisticated structures, including active cooling and advanced high temperature materials.

Taking into account the predicted technology progress during the next decades, we may conclude that:

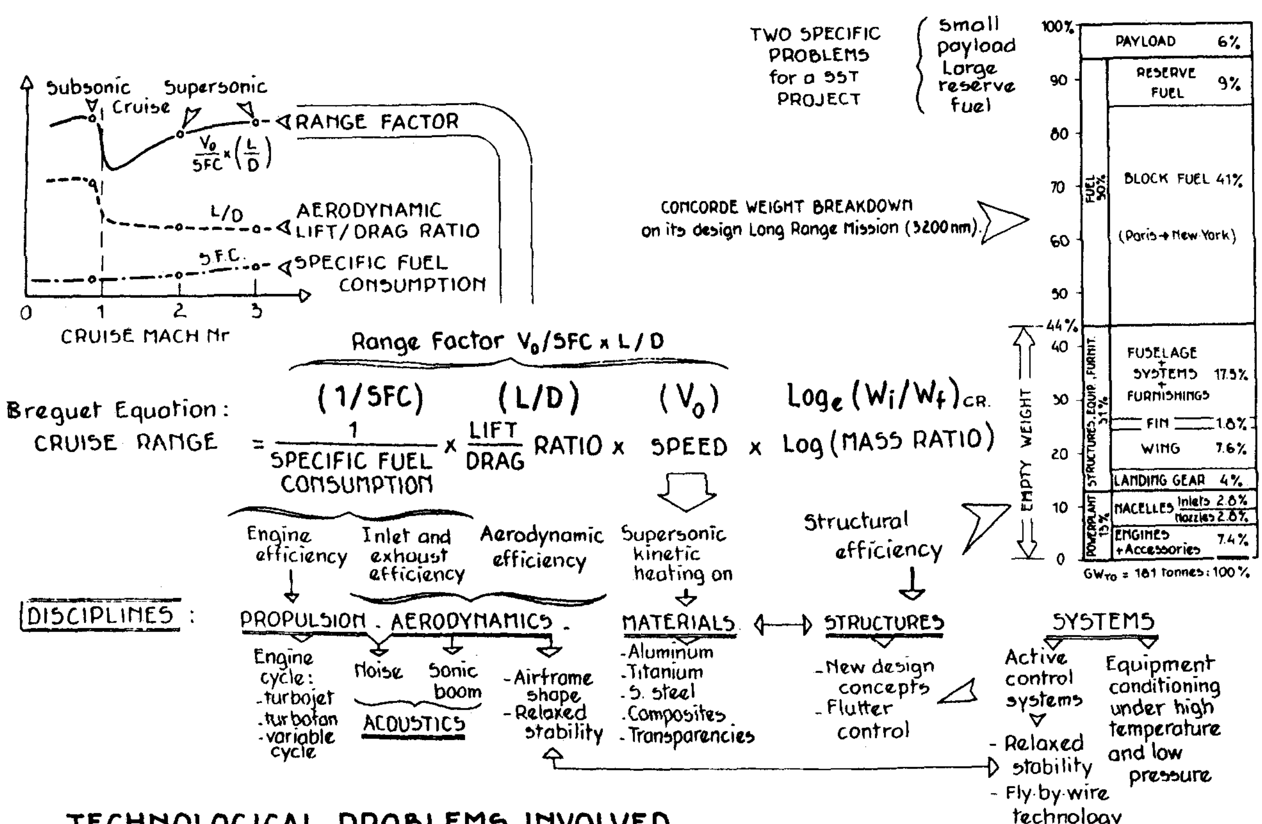
- a SST airliner, cruising around Mach 2.2-2.4, seems the most attractive choice for a commercial service in about 15 years. A faster SST -Mach 2.7-3.2 class- will present more technical risks, i.e. more development time and funding for a small gain on its productivity (taking into account realistic airline schedules between megapoles around the world).
- In every case, a new SST must be optimized to have very good aerodynamic efficiency and low fuel consumption at the transonic cruise regime (Mach 0.95) imposed to avoid sonic boom above the populated area.
- On the other hand, a hypersonic civil transport would require much more R and D (including flight validations on "demonstrators") and probably some space and/or military application before it can be developed; it could be expected to enter commercial service about ten years after the SST, if compatible with airline operations (including cryogenic fuel storage).
- The most chalenging problem for the development of a new high speed transport system will be to satisfy some "World environmental regulations" on airport noise limits, on authorized sonic boom corridors around the world, and on the level of a "negligible pollution" in the stratosphere. That is why such a project needs an urgent close cooperation between the major aeronautical countries to define "the rules" and then to launch the required common research programmes before its development.

SOME CONCLUSIONS ON FUTURE HIGH SPEED TRANSPORT SYSTEMS
(MACH 2 to 3, MACH 4.5 to 6, TRANSATMOSPHERIC/SPACE)





SST OPTIONS BETWEEN MACH 2 and 3.



TECHNOLOGICAL PROBLEMS INVOLVED
for the DEVELOPMENT of a SUPERSONIC TRANSPORT