Solid Rocket Motor

Part 3 Inputs for Solid Rocket Design

Solid Rocket Motor Design

Input of SRM Design

- Vehicle mission, requirements
- Company experience/capability
- Available technologies

Performance characteristic

- Total Impulse: I_t
- Work time: t
- Thrust time profile (F-t)
- Thrust vector control (Maximum lateral thrust, frequency response)
- Reliability(99.9%...)
- …

Solid Rocket Motor Design

Other Confinements from vehicle

- **Diameter (D)**: to ensure the aerodynamic shape of the aircraft, usually the engine and the missile body outside diameter.
- **Ratio of Length/Diameter (L/D):** To make the aircraft easy to control, the L/D ratio should be limitted
- **Total mass (m_m):** the total energy in a certain conditions, limit the mass of the rocket
- **Centroid position (C_x):** limit the centroid position and its shift range
- **Stage separation:** for multistage propulsion system
- …

Solid Rocket Motor Design

Environmental Confinements

- **Storage environment**: Temperature, humidity, salinity, mold, etc.
- **Transport environment:** Transportation, transport distance and speed
- **Launch environment :** mode, temperature, humidity, weather and the ignition height
- **Flight environment:** altitude, velocity, overload, vibration and shock

Economic requirements

- **The cost during the full life cycle**

Solid Rocket Motor Design

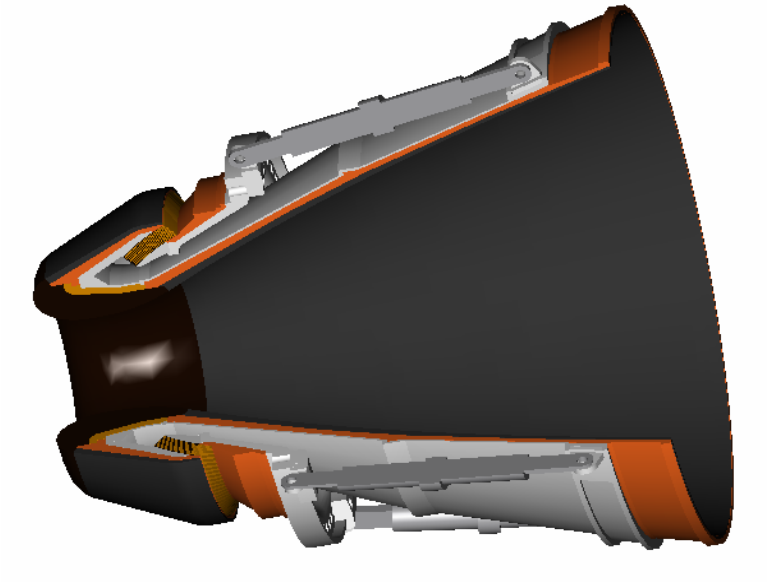
Content of SRM Design

- Preliminary Design
  - Select the structure, propellant and case material
  - Determine the working pressure, expansion ratio, package size and other design parameters

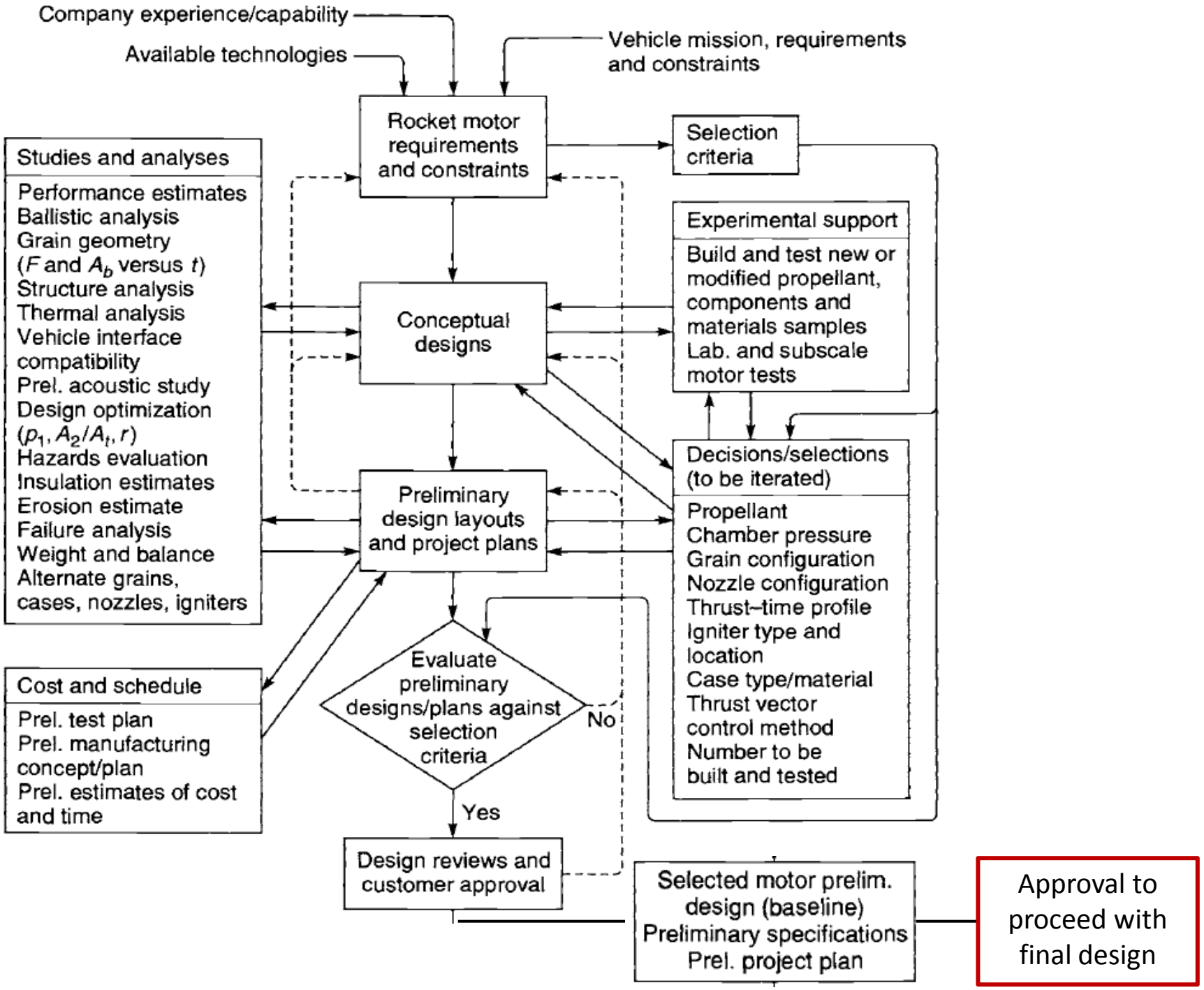
- Propellant grain Design
  - Select the configurations, determine geometry
  - Thermodynamic calculation
  - Evaluate the internal ballistic performance
  - Structural analysis

Solid Rocket Motor Design

Content of SRM Design



- Combustion chamber Design
  - Case design
  - Internal insulation design
- Nozzle Design
  - structural design
  - thermal protection design
- Igniter device Design
  - type and structure selection
  - energy release system design
- Thrust vector control and termination Design


Company experience/capability
Available technologies
Vehicle mission, requirements and constraints
Rocket motor requirements and constraints
Selection criteria
Studies and analyses
Performance estimates
Ballistic analysis
Grain geometry (F and A_b versus t)
Structure analysis
Thermal analysis
Vehicle interface compatibility
Prel. acoustic study
Design optimization ($p_1, A_2/A_t, r$)
Hazards evaluation
Insulation estimates
Erosion estimate
Failure analysis
Weight and balance
Alternate grains, cases, nozzles, igniters
Experimental support
Build and test new or modified propellant, components and materials samples
Lab. and subscale motor tests
Conceptual designs
Decisions/selections (to be iterated)
Propellant
Chamber pressure
Grain configuration
Nozzle configuration
Thrust–time profile
Igniter type and location
Case type/material
Thrust vector control method
Number to be built and tested
Preliminary design layouts and project plans
Cost and schedule
Prel. test plan
Prel. manufacturing concept/plan
Prel. estimates of cost and time
Evaluate preliminary designs/plans against selection criteria
No
Yes
Design reviews and customer approval
Selected motor prelim. design (baseline)
Preliminary specifications
Prel. project plan
Approval to proceed with final design

THE END