Concept of Variants

Rocket Variants Concept

Optimal staging solutions provide configurations that result in **best** possible ideal **performance.**

However, there are **many** situations where an optimally designed **configuration** needs to be **modified** for a marginally **different** mission.

Rocket Variants Concept

This could be **either** in terms of a slightly **higher** burnout velocity or **more** commonly, a higher **payload.**

In general, such **requirements** are addressed by slightly **modifying** optimal configuration to ensure that **modified** configuration also remains **optimal.**

Atlas Variants Examples

	Atlas IIAS	Atlas III
Height	47.4 m (156 ft) with LPF fairing	IIIA: 52.8 m (173.2 ft) IIIB: 53.1 m (174.2 ft) with EPF fairing
Gross Liftoff Mass	237.2 t (522.9 klbm)	IIIA: 220.7 t (486.5 klbm) IIIB: 225.4 t (496.9 klbm)
Thrust at Liftoff	3.0 MN (676.2 klbf)	2.6 MN (585,000 klbf) (~70% throttle)

IIAS: 8,618 kg @ 185 km GTO

IIIA: 8,640 kg @ 185 km GTO

IIIB: 10,759 kg @185 km GTO

PSLV Variants Examples

Mass:

PSLV (295T), PSLV-CA (230T), PSLV-XL (320T)

Payload:

PSLV: 1,678 kg @ 620 km SSO

PSLV-CA: 1,100 kg @ 620 km SSO

PSLV-XL: 1800 kg @ 620 km SSO

Variant Design Strategy

Typically, a **variant** is created by modifying / replacing an **existing** stage in terms of structure, **propellant** mass or its specific **impulse**.

The **modifications** / replacements are usually a small **fraction** of the existing stage, in order to **minimize** impact on other design / operational **aspects.**

Variant Design Strategy

In order to arrive at a **variant**, which continues to remain **optimal**, without the need for a complete **redesign**, most **efficient stages** are used for modification / replacement.

This also helps in overall **inventory** management.

A **commonly** employed quantitative **tool** for this purpose is the stage **trade-off** ratio, which helps **us** to create a new **version** using the parameters of the **old** version.

Concept of Trade-offs

As we know, **staging** has significant impact on **V* & π_*,** and hence it is **useful** to know about **stages** that are more **efficient,** in order to decide about **changes.**

Trade-off ratios are parameters that show **efficiency** of a stage and are useful in **creating** launch vehicle **variants**.

Trade-offs in Multi-stage Rockets

In addition, **trade-off** ratios provide a mechanism to correct **minor** deficiencies in the designed **vehicle.**

Lastly, **trade-off** ratios also indicate how a **small** change in the stage **configuration** affects the performance, and, thus, also **establish** the robustness of the **design**.

Summary

Thus, to **summarize**, variants are useful versions of the **same** rocket family that have **common** parts so that a large number **missions** can be created from a **few** rockets.

Further, **these** are only marginally **different** from their parent **design** so that overall effort in **creating** a new rocket is also **managed** better.