

3.6.5 Trade Studies

There are several different types of trade studies, and Raymer describes three types. These trade studies are a somewhat simplified version of trade studies that will be carried out later in the design process. For example, in the range trade study described in Section 3.6.5, the weight growth coefficients in Table 3.1 apply to aircraft which in general have a larger payload as the MTOGW increases. This implies a larger fuselage size for the larger aircraft. In a range trade study the fuselage will typically not increase in size because the fuel is normally carried in the wing. So the gradient of the curve of empty weight as a function of MTOGW will be less, and the growth factors correspondingly reduced.

In the composite structure trade study, weight reduction is applied to all empty weight components, whether structural or not. A more detailed structural weight trade study should apply weight reductions to structure only.

Advanced Technology Sensitivity Study

A useful trade study is to determine the sensitivity of the design to changes in technology, such as cruise L/D, cruise Mach number (not shown in the figure), cruise sfc, and empty weight from the use of composites.

Configuration	(L/D) _{max}	Cruise SFC	Structural weight reduction factor	OEW	TOGW
Baseline	18.0	0.50	1.0	???	???
L/D improvement	19.8	0.50	1.0	???	???
SFC improvement	18.0	0.45	1.0	???	???
Structural weight reduction	18.0	0.50	0.90	???	???
All technologies applied	19.8	0.45	0.90	???	???

Notional values shown

Fig. 3.6.5.1 Advanced Technology Sensitivity Study

When coupled with the cost of achieving these advances in technology, this trade study provides guidance as to where money should be invested for the largest return on investment.

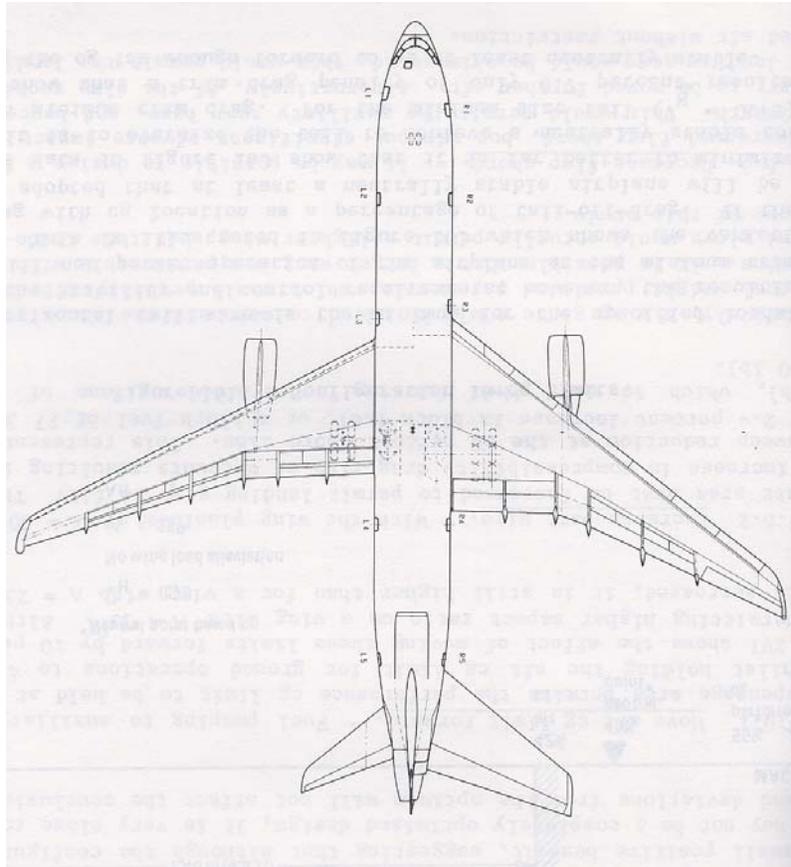


Fig. 3.6.5.2 Comparison of Baseline (on the right) and Advanced Technology Lockheed L-1011 TriStar

Fig. 3.6.5.2 shows an example of a technology trade study, as applied to a Lockheed L-1011. The advanced technology configuration included aerodynamics, propulsion, structures, relaxed longitudinal stability and control, and airplane systems (Ref. 3.6.5.1).

Weight Growth Factors

Related to design trade studies is the weight growth factor. In the conceptual or preliminary design phases of an aircraft, a fixed weight (W_x) added to (or subtracted from) the airplane does not simply add (or subtract) the same value of the weight to the maximum takeoff gross weight (MTOGW) in order to achieve the same payload and range, as Raymer showed in the third trade study. The MTOGW of the airplane changes by an amount considerably greater than W_x . The ratio $\Delta\text{MTOGW}/W_x$ is the weight growth factor, and is discussed in detail in the annotation to Section 19.5.1 Trade Study Categories.

References

- 3.6.5.1 Hays, A., et al., "Integrated Technology Wing Design Study", NASA CR-3586, Aug 1982