Fixed Trade Calculator – Application

Use of fixed trades to inform decision making in technology selection

Context

When improving passenger experience through IFE system upgrade, additional technology must be added to the aircraft. In this example[1], the additional functionality requires an external fuselage mounted blister antenna. Two options (A & B) are considered for the antennae, both of which will add weight to the aircraft and change its external shape, adding to total drag.

One option (A) is lighter, while the other (B) has a smaller impact on total drag. Both increasing weight and increasing drag will tend to increase aircraft fuel burn, CO_2 emissions and aircraft operating cost. Which technology option would have the smallest impact on an aircraft?

Using the Fixed Trade Calculator

The impact of both options can be considered at the whole aircraft level using the ATI Fixed Trade Calculator.

Calculation choices:

- Aircraft type selection: Narrowbody (short haul) aircraft with technology levels representative of a year 2015 Entry into Service (EIS)[2].
- Flight definition: default flight range and utilisation options for the selected aircraft type 750NM range with 1700 flights/year
- Fuel Price[3] selection: 3.25 $/US Gal

Results:

Inputs for 2015 EIS Aircraft		A	B
Changes in weight - δOEW	Kg	136	160
Changes in shape – δDrag	%	0.34	0.07
Outputs			
Increase in block fuel burn per flight	%	0.48	0.27
	kg	18	10
Increase in block fuel burn cost per aircraft per year	$	33,400	18,800
Increase in cash operating cost per year	%	0.18	0.11
Increase in CO_2 emitted per aircraft per year	kg	98,900	55,500

[1] Data for this example has been gathered from PD marketing materials published by the manufacturer of one of the antennae.
[2] ATI Fixed Trade Calculator Version # 1.3.1.1.1 used for this calculation
[3] Fuel price data is available from IATA average jet fuel price for 2023 (29-Sep-23) $3.13/Gal(US)

A similar analysis can be performed on the aircraft with an EIS of 2035.
The 2035 aircraft has improved aerodynamics relative to the 2015 aircraft, so the impact on aircraft drag of the additional IFE system upgrade is assessed to be slightly worse (a larger increase) on the 2035 aircraft than the 2015 one, as shown in the calculation choices below:

Calculation choices:

- Aircraft type selection: Narrowbody (short haul) aircraft with technology levels representative of a year 2035 Entry into Service (EIS).
- Flight definition: default flight range and utilisation options for the selected aircraft type 750NM range with 1700 flights/year
- Fuel Price[4] selection: 3.25 $/US Gal

Results:

Inputs for 2035 EIS Aircraft		A	B
Changes in weight - δOEW	Kg	136	160
Changes in shape – δDrag	%	0.35	0.08
Outputs			
Increase in block fuel burn per flight	%	0.52	0.31
	kg	22	13
Increase in block fuel burn cost per aircraft per year	$	18,700	11,000
Increase in cash operating cost per year	%	0.12	0.08
Increase in CO_2 emitted per aircraft per year	kg	119,600	70,500

Discussion

This case demonstrates the importance that small changes in total drag can have at whole aircraft level. For the year 2015 EIS narrowbody aircraft over 750NM with 1700 flights per year, the heavier blister antenna with lower drag impact has a smaller impact on fuel burn, cost and carbon emissions than the lighter option.

It should be noted, that the Fixed Trade Calculator does not account for the changes in electrical demand of each IFE system. The change in energy demand for this system is likely to be a second order effect, so the user should state this as an assumption when quoting the output of the Fixed Trade Calculator.

The outputs show that drag minimisation should be a target during the development of these systems. They highlight areas of interest when discussing potential replacement systems and raise awareness of the relative importance of the fixed trade variables considered.

One option of interest for the user could be to turn the calculation around, and to set a technology development target. For example:

- Starting with technology B, and assuming the weight is accurate, how much could the drag impact increase before technology B loses its benefit over technology A?
- Or, assuming the drag variables are fixed, how high could the weight grow during development of Antenna B before the advantage over technology A is lost?

[4] Fuel price data is available from IATA average jet fuel price for 2023 (29-Sep-23) $3.13/Gal(US)