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: Narrow body (short haul) aircraft representing 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: 2.0 $/US Gal

Results:

Inputs		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	$	20,600	11,600
Increase in cash operating cost per year	%	0.14	0.09
Increase in CO_2 emitted per aircraft per year	kg	98,900	55,500

Discussion

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

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[1] Data for this example has been gathered from public domain (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 2019 (27/12/179) $1.98/Gal(US)

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It should be noted that, the weight and drag implications of these two technology solutions have been gathered from public domain marketing materials published by the manufacturer of one of the antennae (option B). While it is likely that the data is accurate for their own system it is possible that the competitor data may not be fully comparable. For example, it is not clear whether both weight deltas account for the same items (antennae, blister wiring, …). The data available also does not address structural impact of mounting the excrescence, electrical demand of the system or potential impact of power offtakes required if any.

The outputs of the fixed trade calculator are indicative in this case, 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.

Options for next steps following this analysis could include:

- Conducting a small parametric study using the Fixed Trade Calculator to understand the sensitivity of the results to the technology A inputs (given their uncertainty)

- Making further enquiries with users or manufacturers of these or comparable systems to gather further data points for comparison.

- Turning the calculation around, to set technology development targets. 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 that the external shape and surface roughness are fixed such that the total drag delta is constant, how much weight gain could occur during development before the advantage over technology A is lost.