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Design Guidelines for High Capacity Innovative Regional Turboprop Aircraft

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This paper deals with the Multi-Disciplinary Analysis and Optimization (MDAO) of an innovative high capacity regional turboprop aircraft. To cope with the Top-Level Aircraft Requirements (TLARs), different design solutions have been analyzed and compared in terms of weights, balance, aerodynamics, performance, emissions and Direct Operating Costs (DOC). Response surfaces and Pareto fronts have been generated for each aircraft configuration assuming different values of lifting surfaces and geometrical design parameters. Optimal solutions have been selected from Pareto fronts according to specific performance, emissions and DOC objective functions. Those have been compared to illustrate relative benefits and drawbacks.

This kind of innovative regional platform is supposed to be competitive on the short/medium range with regional jets. A regional jet similar to the Airbus A220 has been chosen as the reference regional jet aircraft to which compare all optima configuration coming from the MDAO process. Comparisons have been made in terms of block fuel, block time and DOC. The three-lifting surfaces configuration has been identified as the most promising choice for the higher gain in terms of block fuel and direct operative costs.

Nomenclature

AR_C	=	Canard Aspect Ratio
AR_H	=	Horizontal tail Aspect Ratio
AR_w	=	Wing Aspect Ratio
b_C	=	Canard span
b_H	=	Horizontal tail span
BPR	=	engine By-Pass Ratio
b_w	=	Wing span
CG	=	Center of Gravity
C_{Lmax}	=	Max. Lift Coefficient at stall condition
D_f	=	Fuselage maximum diameter
DOC	=	Direct Operative Costs
E_{cr}	=	Aircraft aerodynamic cruise efficiency
i_C	=	Canard incidence angle
i_H	=	Horizontal tail-plane incidence angle
L_f	=	Fuselage length
LFL	=	Landing Field Length
$_{LND}$	=	Landing
MAC	=	Wing Mean Aerodynamic Chord
M_{CR}	=	cruise Mach number
MDAO	=	Multi-Disc. Analysis and Optimization
MTOW	=	Maximum Take-Off Weight
MLW	=	Maximum Landing Weight
OEW	=	aircraft Operative Empty Weight
RJ	=	Regional Jet
S.S.M.	=	longitudinal Static Stability Margin
SAR	=	Specific Air Range
S_C	=	Canard area
S_H	=	Horizontal tail area
S_V	=	Vertical tail area
S_w	=	Wing area
T_0	=	engine maximum static thrust
TLAR	=	Top Level Aircraft Requirements
$_{TO}$	=	Take-Off
TOFL	=	Take-Off Field Length
TP	=	Turboprop
TSFC	=	Thrust Specific Fuel Consumption
W_{TO}	=	Maximum Take-Off Weight
X_{LEC}	=	Canard apex long. position
X_{LEH}	=	Horizontal tail apex long. position
X_{LEw}	=	Wing apex long. position

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