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Game theory and evolutionary algorithms applied to MDO in the AGILE European project

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In this paper, an optimization technique in aircraft design field, based on game theory and evolutionary algorithms to define the key variables for Multi-Disciplinary aircraft Optimization (MDO) into AGILE (*Aircraft 3rd Generation MDO for Innovative Collaboration of Heterogeneous Teams of Experts*) European project, is presented. This work represents one of the contributions given by UniNa (University of Naples “Federico II”) research group within the AGILE project, which is coordinated by the DLR and funded by EU through the project HORIZON 2020 that aims to create an evolution of MDO, promoting a novel approach based on collaborative remote design and knowledge dissemination among various teams of experts. Since the aircraft design field is very complex in terms of number of involved variables and the dimension of the space of variation, it is not feasible to perform an optimization process on all the design parameters; this leads to the need to reduce the number of the parameters to the most significant ones. A multi-objective optimization approach allows many different variables, which could be a constraint or an objective function for the specific investigation; thus, setting the constraints and objectives to reach, it is possible to perform an optimization process and control which parameters significantly affect the final result. Within AGILE project, UniNa research group aims to perform wing optimization processes in a preliminary design stage, coupling Nash game theory (N) with typical genetic evolutionary algorithm (GA), reducing computational time and allowing a more realistic association among objective functions and variables, to identify the main ones that significantly affect final result and that consequently must be considered by the partners of the AGILE consortium to perform MDO in the final part of project, applying the proposed optimization technique to novel aircraft configuration.

Nomenclature

AR	= Aspect Ratio
C_D	= drag coefficient
C_L	= lift coefficient
C_{root}	= root chord
C_f/c	= flap chord ratio
C_s/c	= slat chord ratio
MTOM	= Maximum Take Off Mass
N_z	= load factor
S_w	= wing area
W	= weight
b	= wing span
e	= Oswald factor
t/c	= mean airfoil thickness percentage
Λ_{LE}	= leading edge sweep angle
ε_t	= tip twist angle
ρ_{fuel}	= fuel density
λ	= wing taper ratio

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