Multidisciplinary optimization of a configuration for a radio-controlled aircraft using modeFRONTIER

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PRESENTATION TOPICS

• Company Overview;

• Problem Description;

• Methodology;

• Goals;

• Conclusion and next steps.
Company Overview

University of Brasília
School of Technology
Department of Mechanical Engineering

2004 ➔ Team foundation
2005 ➔ Best rookie team
2006 ➔ Best design
2007 ➔ 7th place
2008 ➔ Larger wingspan regular class
2009 ➔ First experience with optimization
2010 ➔ Multidisciplinary Optimization
Problem Description

• Obtain an optimal configuration for a radio-controlled aircraft, the DV UAV-2010, which will participate in the twelfth edition of “SAE BRASIL Aero Design 2010” at the city “São José dos Campos” – SP – Brazil;
Problem Description

- Takeoff in 30.5m or 61m;
- Payload of at least 3.5 kg;
- Landing on 61m.
Problem Description

- $4 \text{ m} < \text{dimensional sum} < 6.5 \text{ m}$;
- Engine OS 0.61 FX;
- Engine K&B 0.61 ABC.
Methodology

• The routine uses modeFRONTIER to perform a multidisciplinary optimization of the disciplines: geometry, aerodynamics, stability, performance and structures. The project was created in the modeFRONTIER using the programs: MatLab, AVL (Athena Vortex Lattice) and the Xfoil.

• We used 20 input variables, the optimizer algorithm used was MOGAII and the parameters defined as the optimization goals were: empty weight and payload of the aircraft.
Methodology

• Inputs

  – Aspect ratio and taper of the wing, the rudder and the elevator; (6)
  – Taper ratio and twist ratio of the wing; (2)
  – Wing chord at the root; (1)
  – Maximum thickness, maximum camber and their positions along the chord, for the root and the tip of the wing; (8)
  – Vertical and horizontal tail volume coefficients ; (2)
  – Tail boom’s length. (1)
Methodology

Inputs ➔ Airfoil Cd x Cl x alpha ➔ Geometry ➔ Plane CD x CL x alpha ➔ Performance
  ➔ Plane stability ➔ Evaluation of empty weight ➔ score
Methodology

Input Variables

Output Variables

Objectives
Goals
### Goals

<table>
<thead>
<tr>
<th>Name</th>
<th>Optimization value</th>
<th>Final value</th>
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<tbody>
<tr>
<td>Aspect ratio Wing</td>
<td>5.6 m</td>
<td>5.6 m</td>
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<tr>
<td>Aspec ratio Elevator</td>
<td>4.0 m</td>
<td>3.2 m</td>
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<tr>
<td>Aspect ratio Rudder</td>
<td>1.03 m</td>
<td>1.5 m</td>
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<tr>
<td>Wing’s taper ratio</td>
<td>0.41</td>
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<td>Wing’s twist ratio</td>
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<tr>
<td>Horizontal tail volume coefficient</td>
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<tr>
<td>Vertical tail volume coefficient</td>
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<td>0.01</td>
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<tr>
<td>Wing’s tip maximum camber</td>
<td>0.0881c m</td>
<td>0.0881c m</td>
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<tr>
<td>Wing’s root maximum camber</td>
<td>0.1100c m</td>
<td>0.1100c m</td>
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<tr>
<td>Root’s chord</td>
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<td>Tail boom’s length</td>
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<tr>
<td>Position of maximum camber at the wing’s tip</td>
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<tr>
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<td>0.5060c m</td>
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<tr>
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<tr>
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<td>Elevator’s taper</td>
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<td>Rudder’s taper</td>
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<tr>
<td>Wing’s tip maximum thickness</td>
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<td>0.1760c m</td>
</tr>
<tr>
<td>Wing’s root maximum thickness</td>
<td>0.1930c m</td>
<td>0.1930c m</td>
</tr>
</tbody>
</table>
Goals
Conclusion and next steps

• Our project proved to be satisfactory, being able to carry 14kg payload, weighting 2.5 kg;

• The team plans to continue to perform optimization in later years in order to improve our design which will represent the team well in the future.