Case Studies: Stability & Control

Or relating concepts to real life examples

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Case study 1: Tail volume ratio

Recall the horizontal tail volume ratio

\[ V_H = \frac{S_t l_t}{S_w c} \]

The tail volume ratio is a normalized measure of the tail effectiveness.

Effectiveness of a tail depends on both its surface area and moment arm.

Question: What are typical values for \( V_H \)?
# Horizontal tail volume ratio of combat aircraft

<table>
<thead>
<tr>
<th>Flight</th>
<th>Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-15</td>
<td>0.54</td>
</tr>
<tr>
<td>F-16</td>
<td>0.47</td>
</tr>
<tr>
<td>F-18</td>
<td>0.6</td>
</tr>
<tr>
<td>F-14</td>
<td>0.49</td>
</tr>
<tr>
<td>F-5</td>
<td>0.52</td>
</tr>
<tr>
<td>F-4</td>
<td>0.25</td>
</tr>
<tr>
<td>F-104</td>
<td>0.49</td>
</tr>
<tr>
<td>Mirage</td>
<td>NA</td>
</tr>
<tr>
<td>MiG-21</td>
<td>0.41</td>
</tr>
<tr>
<td>Jaguar</td>
<td>0.55</td>
</tr>
<tr>
<td>MiG-25</td>
<td>0.44</td>
</tr>
</tbody>
</table>

**Question:** Can you spot the atypical cases?

**Question:** Any comment on the given values?

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Question: Why does the F-4 have a low $V_H$?

F4  $b = 11.8$ m  
$V_H = 0.25$

F16  $b = 9.8$ m  
$V_H = 0.47$

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Case study 2: Horizontal tail location

Question: What’s the difference?

A4

F5

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Question: Should the horizontal tail be placed any higher?
Moral

Correct horizontal tail location requires an appreciation of the aircraft’s function and aerodynamics

Question: Is a tail configuration the only possible configuration?
Case study 3: Canard configuration

Idea: Put the “tail” in front

Question: So what exactly is a canard? Any real examples?
Definition of a canard from FAR Part 1.1

“Canard means the forward wing of a canard configuration and may be a fixed, movable, or variable geometry surface, with or without control surfaces.”

“Canard configuration means a configuration in which the span of the forward wing is substantially less than that of the main wing.”

Is this a radical new idea?

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Question: Can we do without tails and canards?
Homework : Assessing static longitudinal stability

Comment on the static stability of the Beech Starship

Length : 14.05 m
Wingspan : 16.58 m
Height : 3.94 m
Wing area : 26.1 m²
Empty weight : 4,590 kg
Loaded weight : 6,823 kg
Max takeoff weight : 6,760 kg