

## Essay Guide

Four effects will have to be elaborated on:

- The effect on aircraft overall sizing and layout
- The effect on the wing layout
- The effect on the wing aerodynamics
- The effect on the wing structure and wing sub systems

Just answer every subquestion with increase/decrease, higher/lower etc.

### ***The effect on aircraft overall sizing and layout***

Focus on the following aspects; what will happen to..

- The number of passengers?
- The size of the fuselage?
- MTOW?
- OEW?
- Payload Weight?

*If* the MTOW decreases, the required lift decreases and thus the drag. Therefore less thrust is required, which may result in smaller engines (less weight) or at least less required fuel.

### ***The effect on the wing layout***

Focus on the following aspects:

- They will always want you to say that  $W/S$  stays constant to stay close to the design point, so always mention this.
- The wing area either goes up or goes down. This has 2 possible effects on the aspect ratio.
- $A$  remains constant and the span changes. What are the effects on..
  - Manoeuvrability?
  - Operational empty weight (think of structural issues)?
  - Fuel storage? (Fuel will still need to fit in the wing)
- The aspect ratio changes and the span remains constant. What are the effects on...
  - Drag performance, i.e. induced drag.
  - Comparison with the airfoil performance? (Lower/higher induced angle of attack resulting in better/worse approximations to the 2D case)

Mention the following effects due to a constant  $W/S$ :

- Constant stall speed, since it is proportional to  $W/S$ .
- Same design point, Mach number and  $W/S$  the same, same design lift coefficient.
- Same design lift coefficient means same airfoil.
- Same mach number, same airfoil? -> Same sweep angle.

### ***The effect on the wing aerodynamics***

The wing planform remains the same, it is just scaled up or down a bit. Mention that

- The wing planform generally stays the same.
- The area of the high lift devices will scale with the wing area accordingly
- Since  $W/S$  remains the same, take-off and landing speeds won't change and the type of high lift devices remain the same.

### ***The effect on the wing structure and wing sub systems***

The required lift will either be larger or smaller due to less or more weight. What will this mean in terms of...

- Bending moments?
- Resulting stresses?

The wing becomes smaller or larger, so the wingbox will become smaller or larger. In itself, this may leave the structure unaffected. However,...

- The center of pressure shifts along the span due to a smaller or bigger wing leading to less/more stresses
  - This could result in thinner/thicker less/more stringers, spars etc.
- The landing gear size has to be decreased/increased accordingly to the change in weight.

For the extra question just think carefully and remember the snowball effect (structure guys are somehow very fond of snowballs...).