Computational aerodynamics

Introduction to aerodynamic design and analysis

Introduction

- Anything with an engine powerful enough will fly.
- Adding wings and using the right incidence angle (or angle of attack) will help a lot.
- Our task in aerodynamics is to make the body stay aloft by generating the required lift, and to make it happen in an efficient way, that is, with low drag.
- Where low drag translates into reduced fuel consumption and extended operating range, among many things.

Photo credit: https://www.programmes.uliege.be/cocoon/20172018/cours/APRI0004-1.html

Photo credit: https://johneaves.wordpress.com/2009/08/25/its-a-mish-mash-tuesday/

Introduction

- Then things get more complicated as everything becomes multidisciplinary:
  - Environmental concerns, that is, less pollutant emissions and decreased perceived external noise (among many ecological concerns).
  - Operational costs, such as, fuel consumption, operating range, endurance, and payload.
  - Stability, controllability, and improved flight performance (flight mechanics and flight dynamics).
  - Good handling qualities.
  - Safety concerns and human behavior.
  - Regulatory requirements.
  - Operational requirements.
  - Aeroelasticity, structural design, and structural weight.
  - Maintainability and reliability.
  - And so on.

Introduction

- Hereafter, we will focus on airfoils and wings.
- However, the principles that we are going to study can be applied to any field where aerodynamics/hydrodynamics is relevant. For example,
    - Downforce generation for high performance cars.
    - Automotive applications – Car, buses, and trucks.
    - Trains and mass transportation systems.
    - Naval applications.
    - Compressors and turbines.
    - Wind turbines.
    - Sports aerodynamics.
    - Energy harvesting applications.
    - Civil engineering – Bridges, buildings, and skyscrapers.
    - And many more.
- In some applications, you might be interested in changing the sign of a force or zeroing a force, *e.g.*, generation of negative lift (downforce) or mitigating lateral forces.