To reduce fuel consumption, Mass Properties Discipline can help on two parameters.

- **Weight**
  - Reduce aircraft weight

- **Center of Gravity**
  - Optimised Center of Gravity (CG) position to reduce trim drag to minimum.
Reduced fuel consumption

- Aircraft are designed to be safe, satisfy certification requirements and meet mission performance requirements.

- To be competitive this requires low weight and optimized C. G. to ensure aircraft operating costs are kept to a minimum and this is principally achieved by low mission fuel burn.

- Weight minimization, aircraft drag reduction and engine fuel burn are areas that are continuously challenged throughout an aircraft development program.
Rule of thumb, for regional jets and business applications:

- additional fuel requirement: approx 2.6% of OWE weight increase x hours flown
  - e.g. extra weight = 500 kg
  - flight time = 1.5 hours ~ 500 nm.
  - extra fuel burn = 30 - 50 kg
  - extra CO$_2$ = 100 - 160 kg

- For Every Flight!
AVIATION OPERATIONAL MEASURES FOR FUEL AND EMISSIONS REDUCTION WORKSHOP

Rule of thumb, for regional jets and business applications:

- assuming 3,000 hours/year
  - extra fuel burn = 60 000 – 100 000 kg
  - extra CO$_2$ = 190 000-315 000 kg
  - extra cost = $ 41 000 – 69 000 $US / years / aircraft (@ 2.10$US /Gallon)
    - and that’s just the extra-cost due to fuel, per aircraft!

- Weight control is important
Weight Saving Opportunities.

- **Usage of ‘fly by wire’** (load alleviation) (up to -600 lbs)
- **Use of new technology material**
  - (composites, AL-LI, titanium, plastic, etc.) (up to -3000 lbs)
- **Integrated Avionics / Utilities** (merge multiple avionic boxes together) (up to -250 lbs)
- **System Integration** (more electric aircraft, electrical generators imbedded within the engine, starter generators) (up to -1000 lbs)
- **Composite wiring & connectors** (up to -120 lbs)
- **Usage of light carpet** (up to -125 lbs)
- **Usage of Chromate free paint** (up to -150 lbs)
Weight Saving Opportunities.

• Windshield wipers replacement with rain repellent windshield coating
  - Aircraft weight reduction by approximately 24lb as well as aircraft drag;
  - Can be achieved if regulators amend 121.313 to allow use of equivalent means for rain dispersal.

• Minimize operating items to minimum (Ft Ops)
  (no extra water, paperless cockpit, consumables for 1 flight only, over water kit only if required, etc.)

• Take advantages of summer vs winter passenger weight. (Ft Ops)
Center of Gravity Optimization.

- Flight with an aft center of gravity help to minimized trim drag.
  - Design flight envelope to minimized trim drag.
  - Move heavy equipment at the back of the A/C.
  - Develop fuel burn sequences between fuel tanks to control CG.
  - Optimized climb profile to minimize fuel burn
  - Manage passenger seating configuration to optimized CG position. (Flt Ops)
Center of Gravity Optimization.

- Fuel trim tank in empennage can help to control the CG at optimum point.
Center of Gravity Optimization.

• Wing position and interior arrangement also influences CG position.
Weight Management - Summary

• Weight management is an issue to be addressed by both the aircraft manufacturer and the operator.

• The manufacturer
  - To be competitive, provides lowest weight aircraft possible, meeting mission requirements.
  - Is well aware of the compounded effect of additional empty weight needing more fuel to complete mission

• The operator
  - Manages passenger loads, c.g., aircraft / engine maintenance and mission fuel reserves to minimize operating costs
  - Is well aware that mission fuel is biggest contributor to the variable operating costs (approx 1/3 of costs, considering crew, aircraft & engine maintenance, navigation & landing fees)
Thank you!