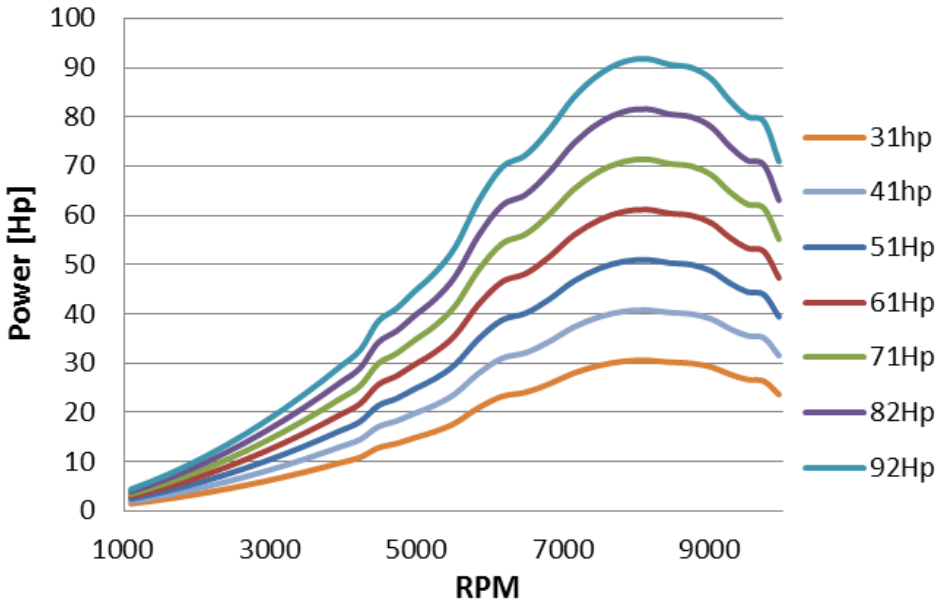
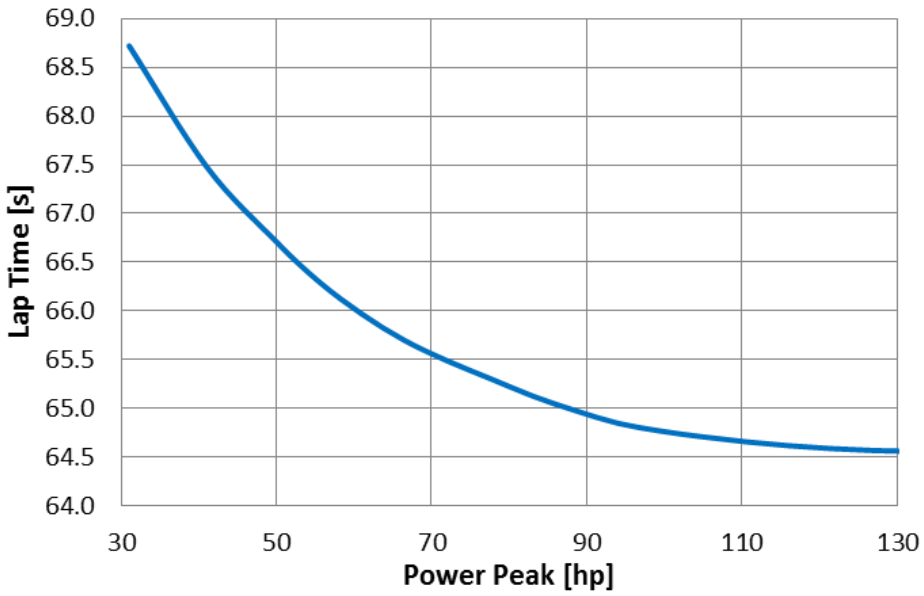
The Case about Weight.

Why and How to Include Minimum Weight as One of the Key Parameters in Formula Student Car Concept and Design

Performance Optimization

Lap Time Vs. Power



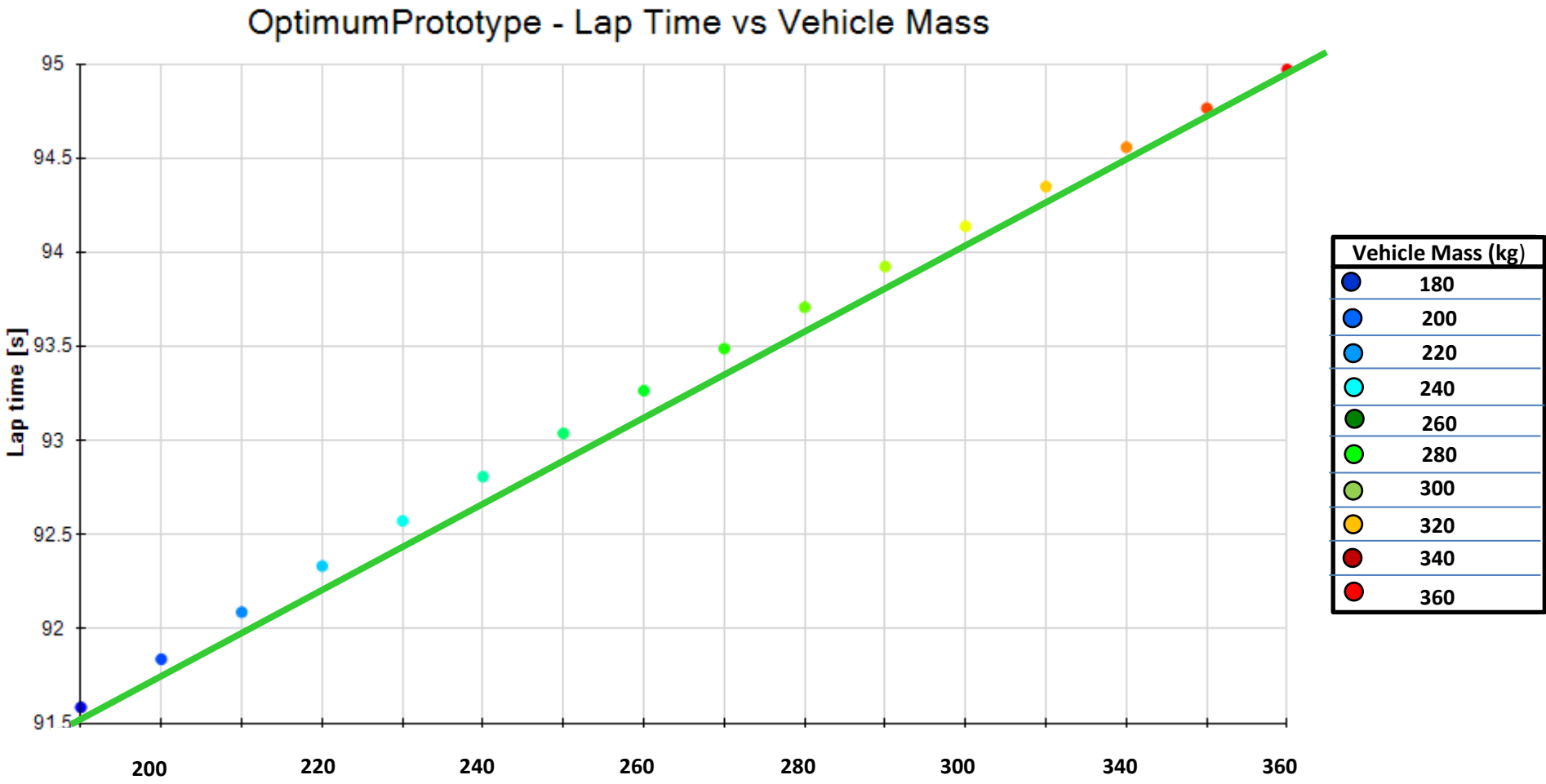


Engine power in Formula SAE/Student

Do you need 90 HP do be competitive in Formula Student?

Performance Optimization

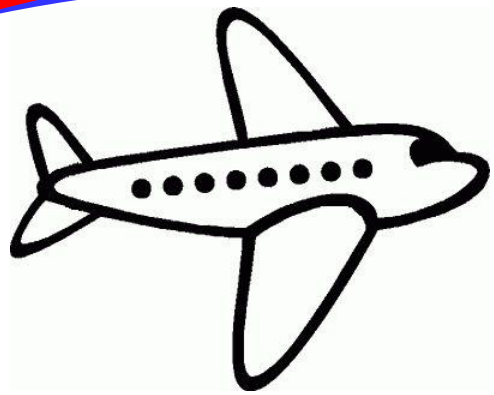
Mass Sweep



What is our weight reduction limit?

What if your weight limit was your imagination?

Mass and Energy….



A

B

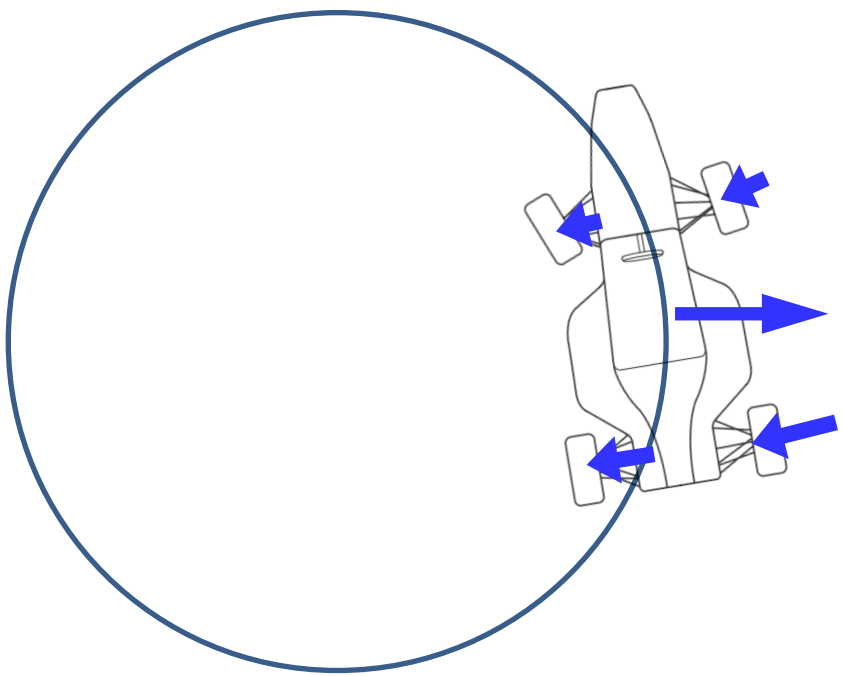
C

A - B 4000 miles

A - C 6000 miles

Problem		Solution
Need more fuel	→	Bigger Fuel Tank
Cannot take off	→	Bigger Engine
Need more fuel	→	Bigger Fuel Tank

F = M * A
Action = Reaction

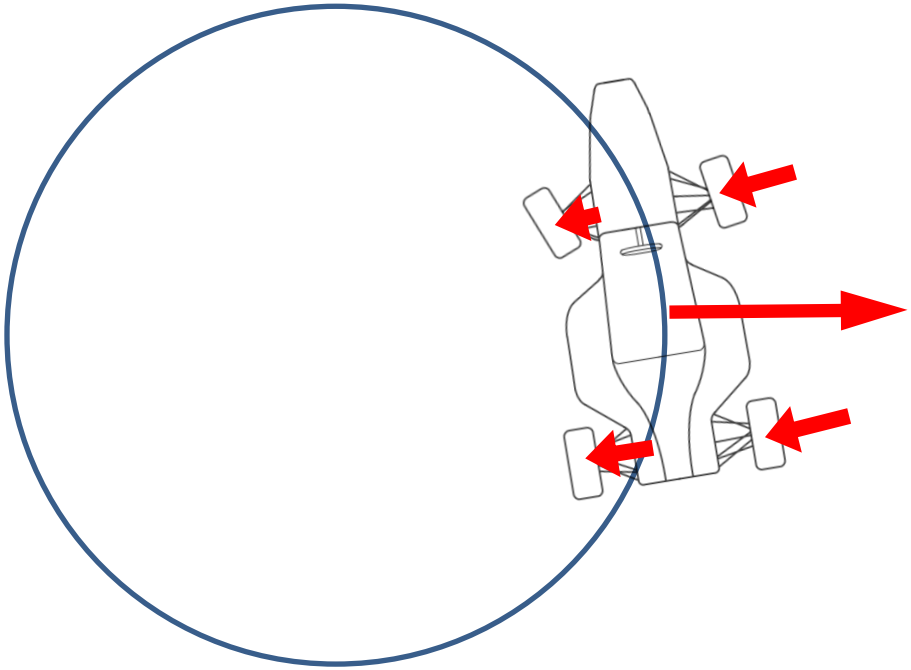


Mass 200 Kg

Lateral Acceleration = 1.5 G

F = M * A

= 200 * 1.5 * 9.81 ≈ 3000 N



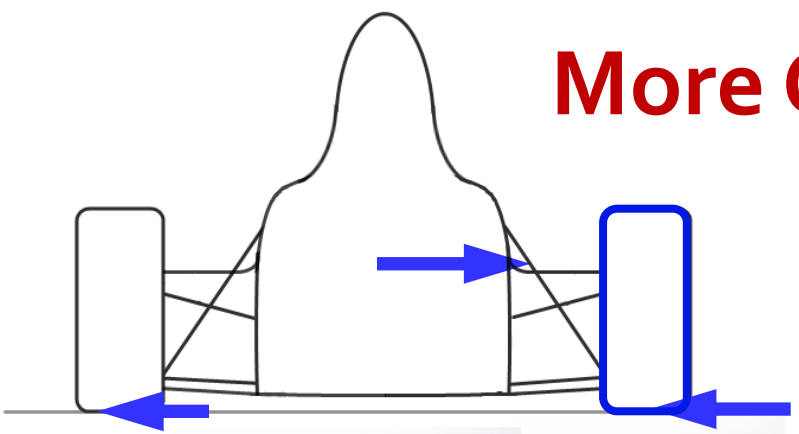
Mass 300 Kg

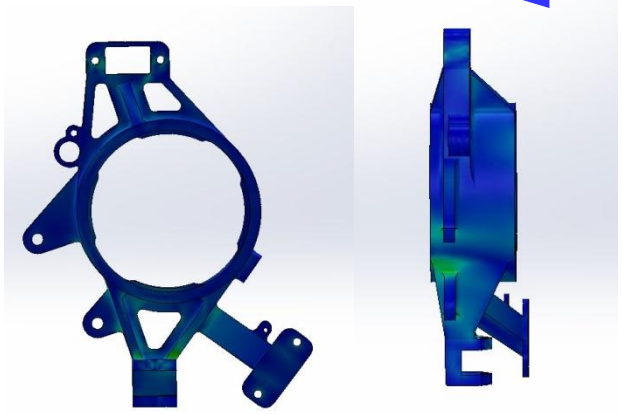
Lateral Acceleration = 1.5 G

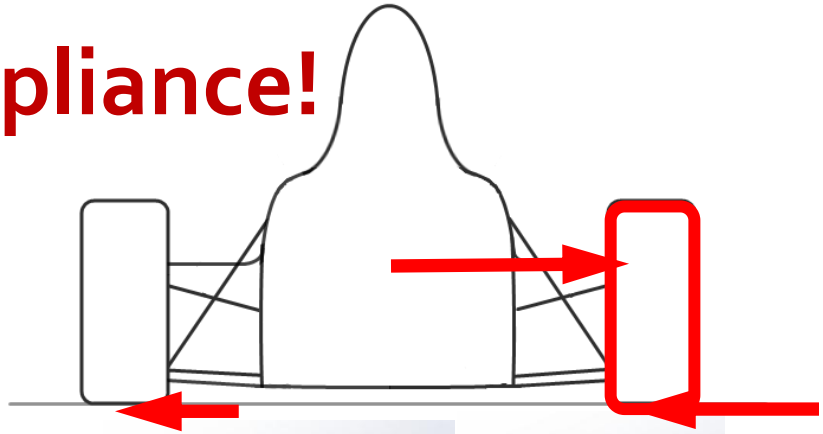
F = M * A

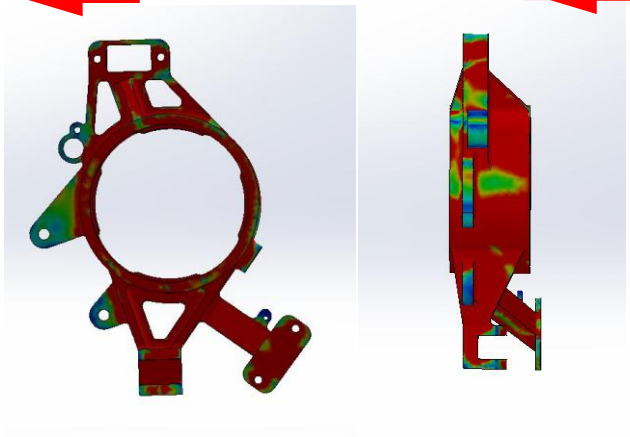
= 3000 * 1.5 * 9.81 ≈ 4500 N

Same Lateral Acceleration
More Mass = More Force
More Compliance!









Mass 200 Kg
Lateral Acceleration = 1.5 G
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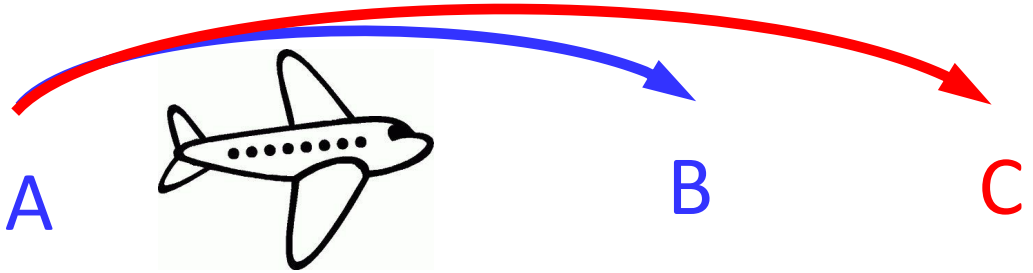
Mass 300 Kg
Lateral Acceleration = 1.5 G
F = M * A
= 3000 * 1.5 * 9.81 ≈ 4500 N

More Compliance ?
Two solutions

Add More Material
= Add More Weight

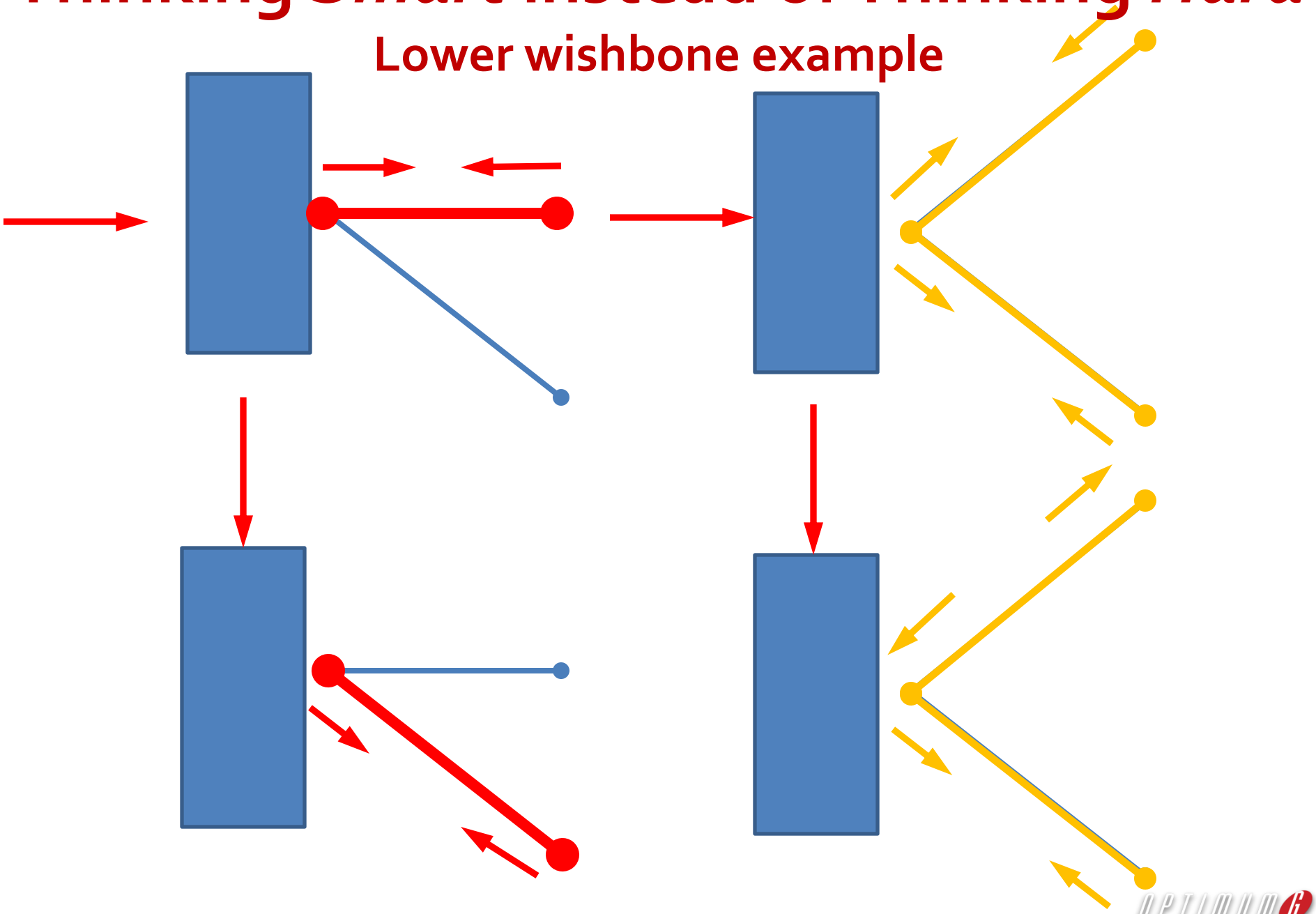
Smart Design



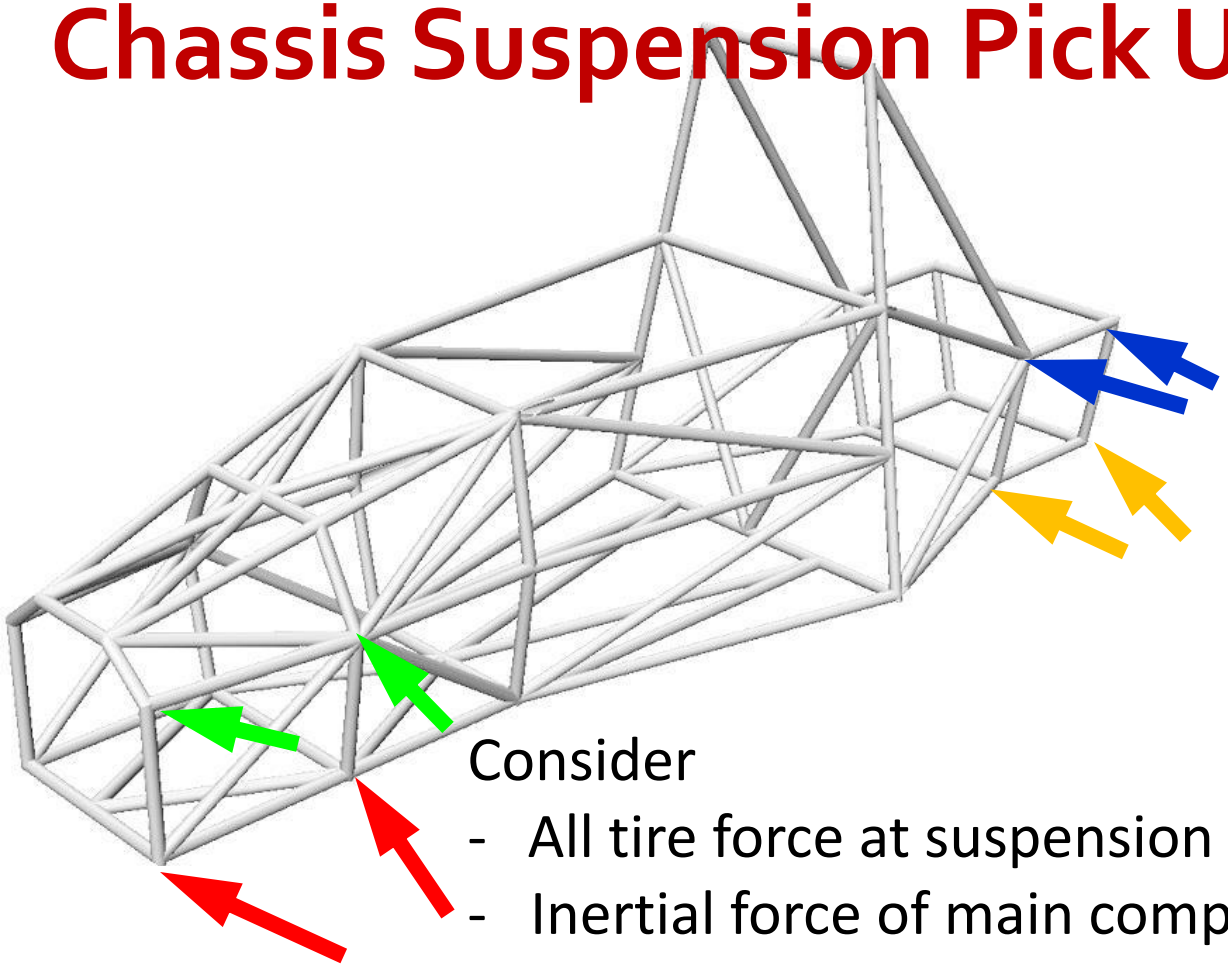
= Add more Force
= Add more Material
The ugly crescendo keeps going on….

Thinking *Smart* instead of Thinking *Hard*

Lower wishbone example



The Tire Load Path Ends at Each Chassis Suspension Pick Up Points

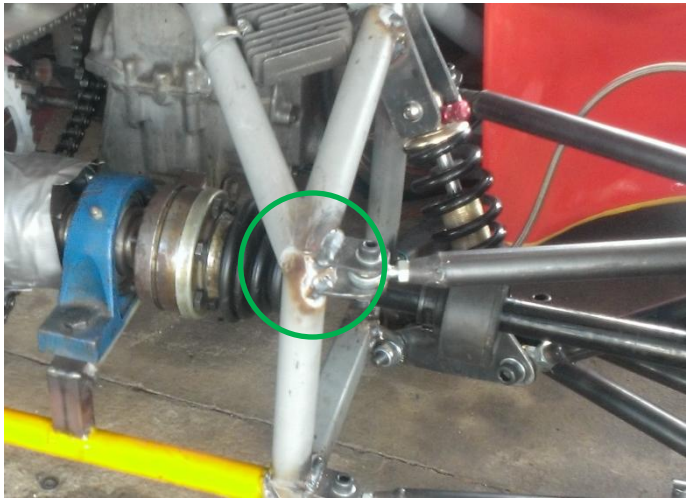


Consider

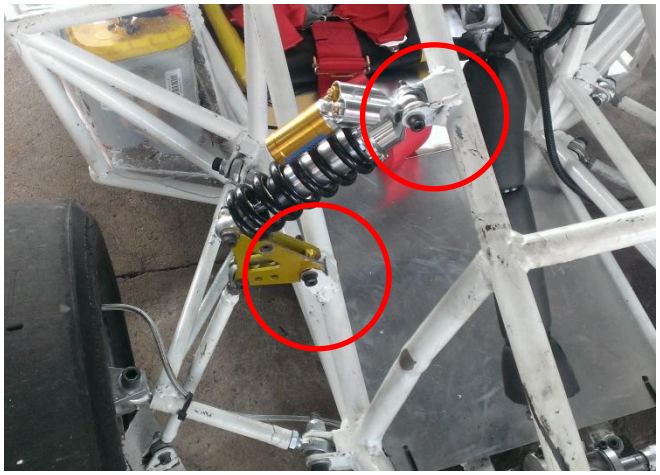
- All tire force at suspension pick up points
- Inertial force of main components (engine, gearbox, pedal box, driver seat belts...) at chassis attachment points

How to avoid compliances (just a few examples)

The suspension link axis must go through one node of the chassis



Yes



No

Use double and not single shear suspension attachment

Yes

No

A Formula Student Electric Example

FSG E 2011

Team A	Team B
80 Kw	82 Kw
4 WD	4 WD
No Wing	No Wing
145 Kg	230 Kg

Same Concept but Why is Car B Heavier ?

Wait …… Weight!

Car B Heavier……. Because it is Heavier!

More Weight… More Battery… More Weight

The lighter the car is… the lighter it can be

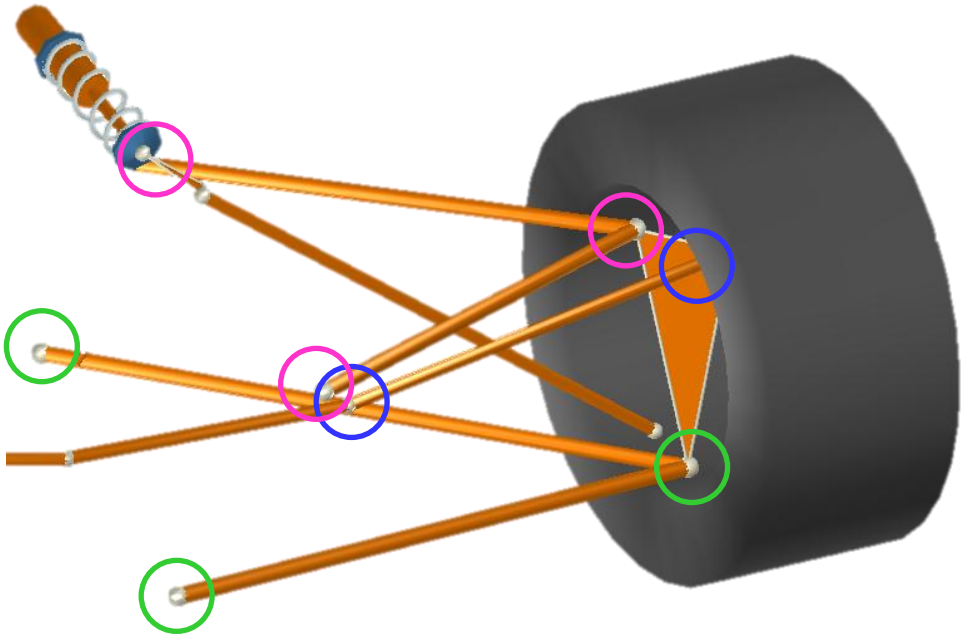
The heavier a car is… the heavier it will have to be

The goal is not to reduce last year car by x kg

The goal is to start from a blank sheet of paper from 0 Kg and to increase the weight to the minimum

Form Follows Function

Heavy and Light Car Components



Car B (230 kg)

Lower wishbone rod ends Ø = 8 mm

Top wishbone rod ends Ø = 8 mm

Toe link rod ends Ø = 8mm

Car A (145 Kg)

Lower wishbone rod ends Ø = inboard 5 mm
outboard 6 mm

Top wishbone rod ends Ø = inboard 4 mm
outboard 5 mm

Toe link rod ends Ø = 3 mm

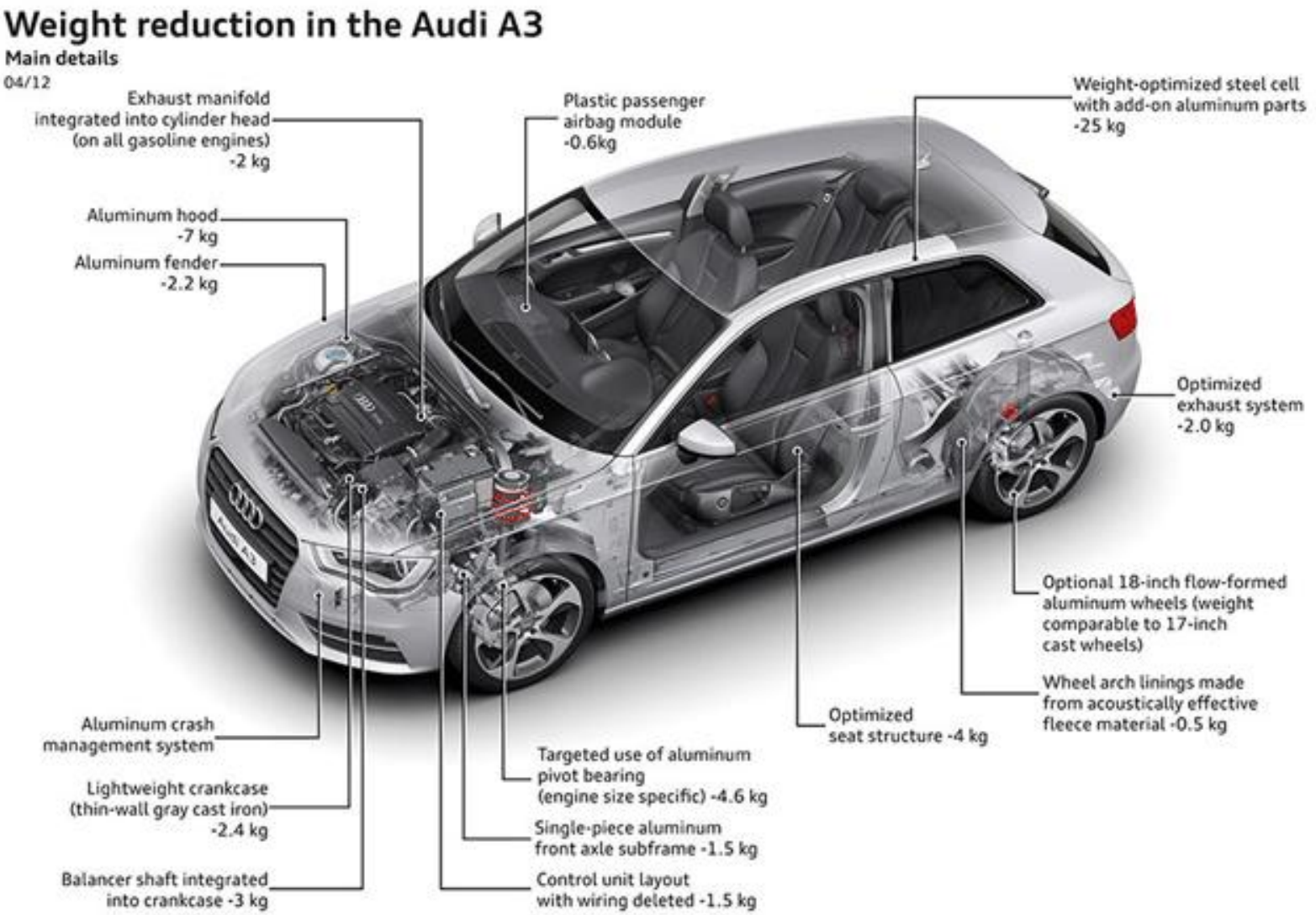
It is not all about Formula Student

1976 Golf 1 → 2013 Golf 7

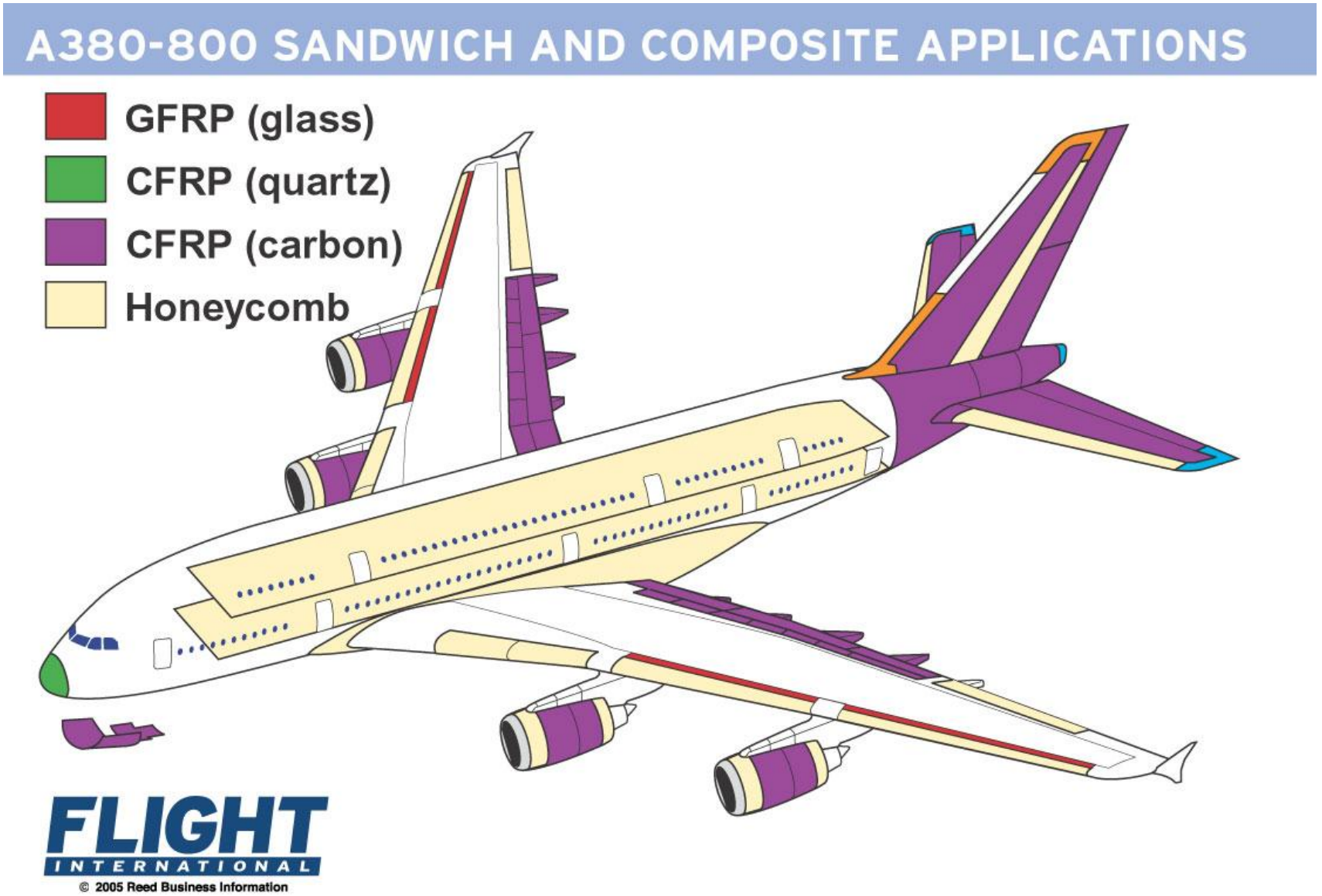
810 Kg → 1520 Kg

How ? What consequences ?

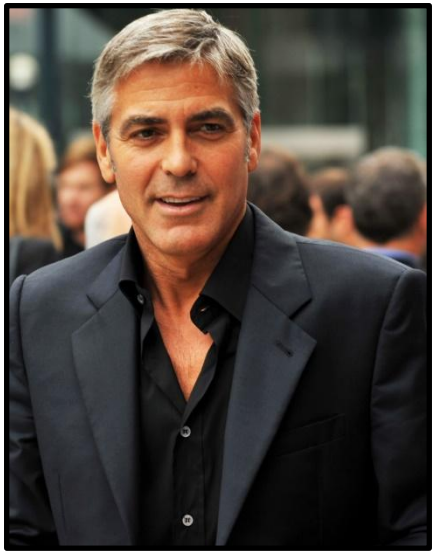
It is not all about Formula Student



It is not all about Formula Student



Which one do you prefer? ….



Which one do you prefer? ….

It is possible to make a car

- Simple
- Light
- Stiff
- Esthetic
- Cheap to manufacture
- Easy to maintain

Thank You!

Any question?

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