

HOW TO BALANCE A FORMULA 1 CAR?

or:

What the heck are those engineers doing....?

By: Ton serné

Race Car Performance Engineer

www.cursuswegligging.nl

Engine

Fuel Tank

Changing mass in CoG

Aerodynamics

Front wing, bodywork, underbody, rear wing



Mass: > 743 kg

'Mechanical Handling'

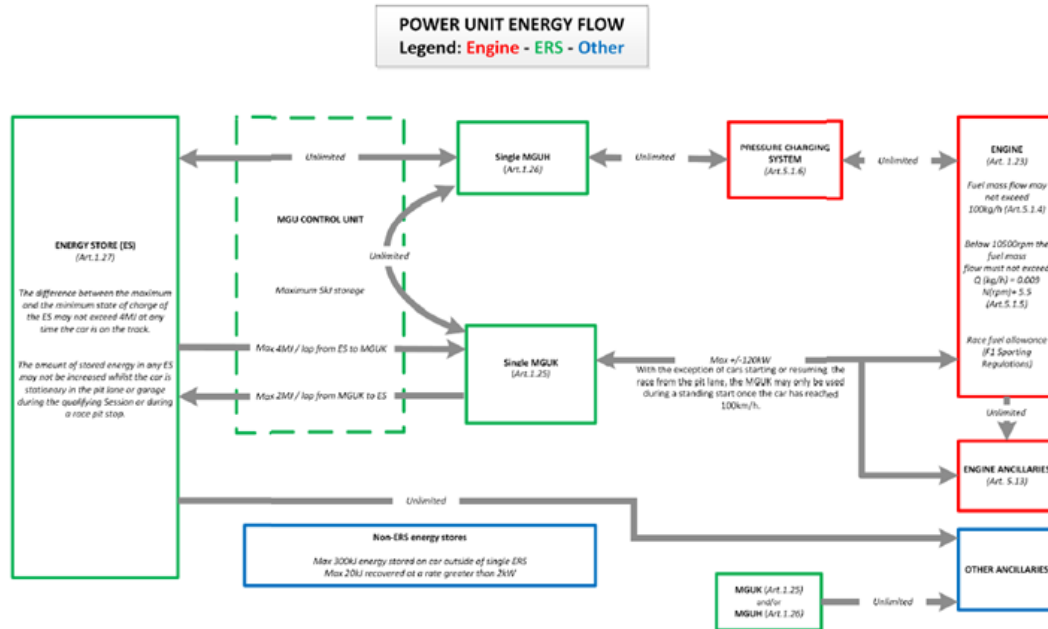
By the Springs, Shockabosorbers, Anti-roll bar and Geometry

Tyres

ENGINE

Engine: V6 1.600cc <15.000 RPM
 Fuel consumption < 100 kg/h
Power output: approx 1.000 hp !!!!!

Energy Recovery System using kinetic (=brake) and heat (=exhaust) systems



Control of Energy Management:
 -One sensor is connected to measure all electrical energy into and out of the Energy Store.
 -One sensor is connected to measure all electrical energy into and out of the MGU-K.
 -The DC-DC converter may only consume energy. This will be verified by inspection.

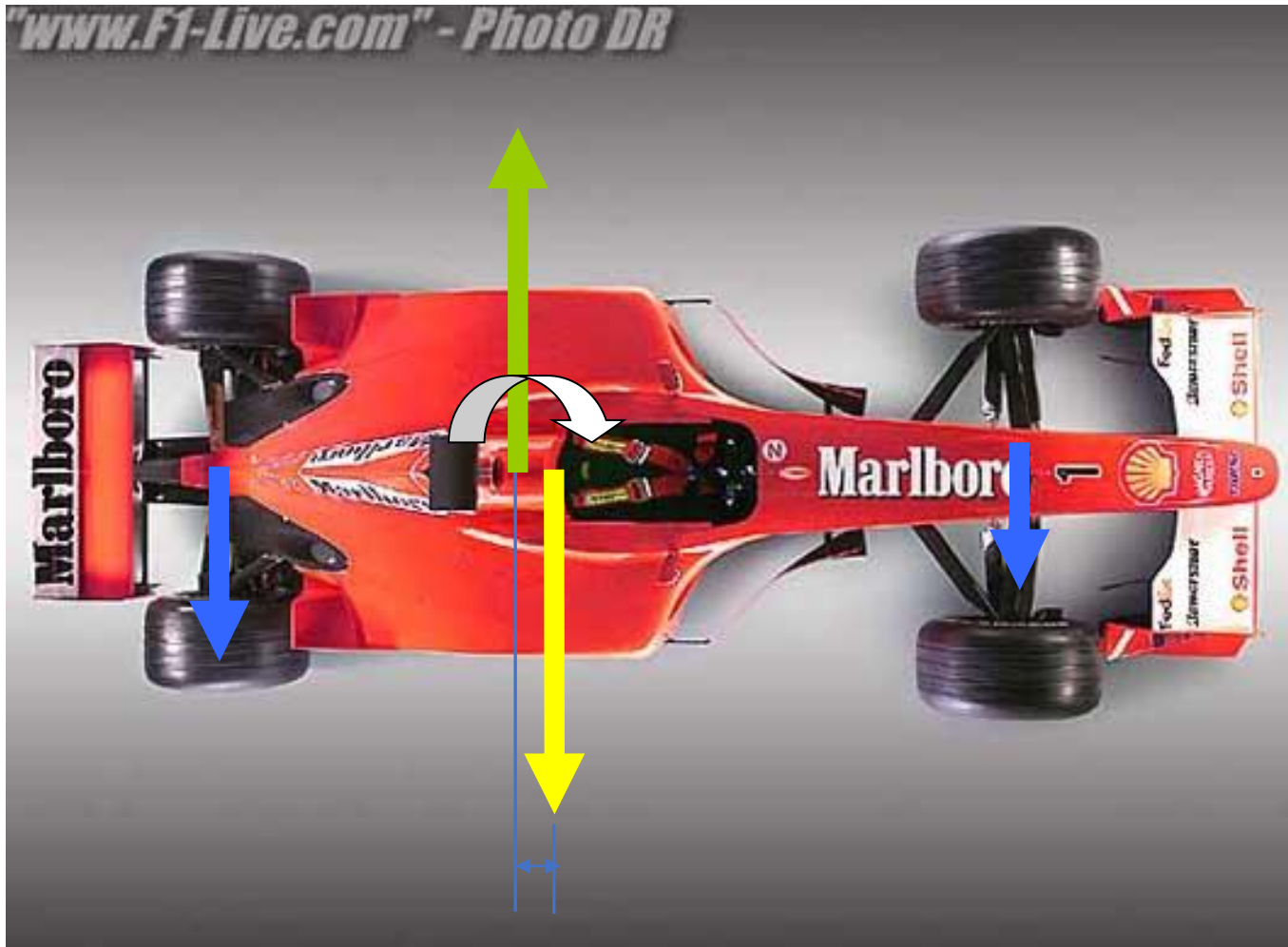
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For the technical interested fans to understand what is really going on : www.fia.com/regulation/category/110

BALANCE OF A RACING CAR

EXAMPLE: OVERSTEER



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1 - Front & rear axles produce the **lateral forces** (blue)

2 - These add up to the Total **Centripetal Force** (yellow) which is the action force.

3 - Because of inertia the mass resists against this force. This reaction is called **Centrifugal Force** (green) which has the same magnitude but is opposit directed.

4 - Centrifugal Force **ALWAYS** takes place in the **Centre of Gravity**.

5 - Here: Centripetal Force takes place ahead of the CoG, causing a right hand moment in a right hand corner: oversteer!

6 - It is the engineers challenge to get the Centrifugal Force and the Centripetal Force in **ONE LINE!**

TYRES

Each race: choice of three out of five compounds

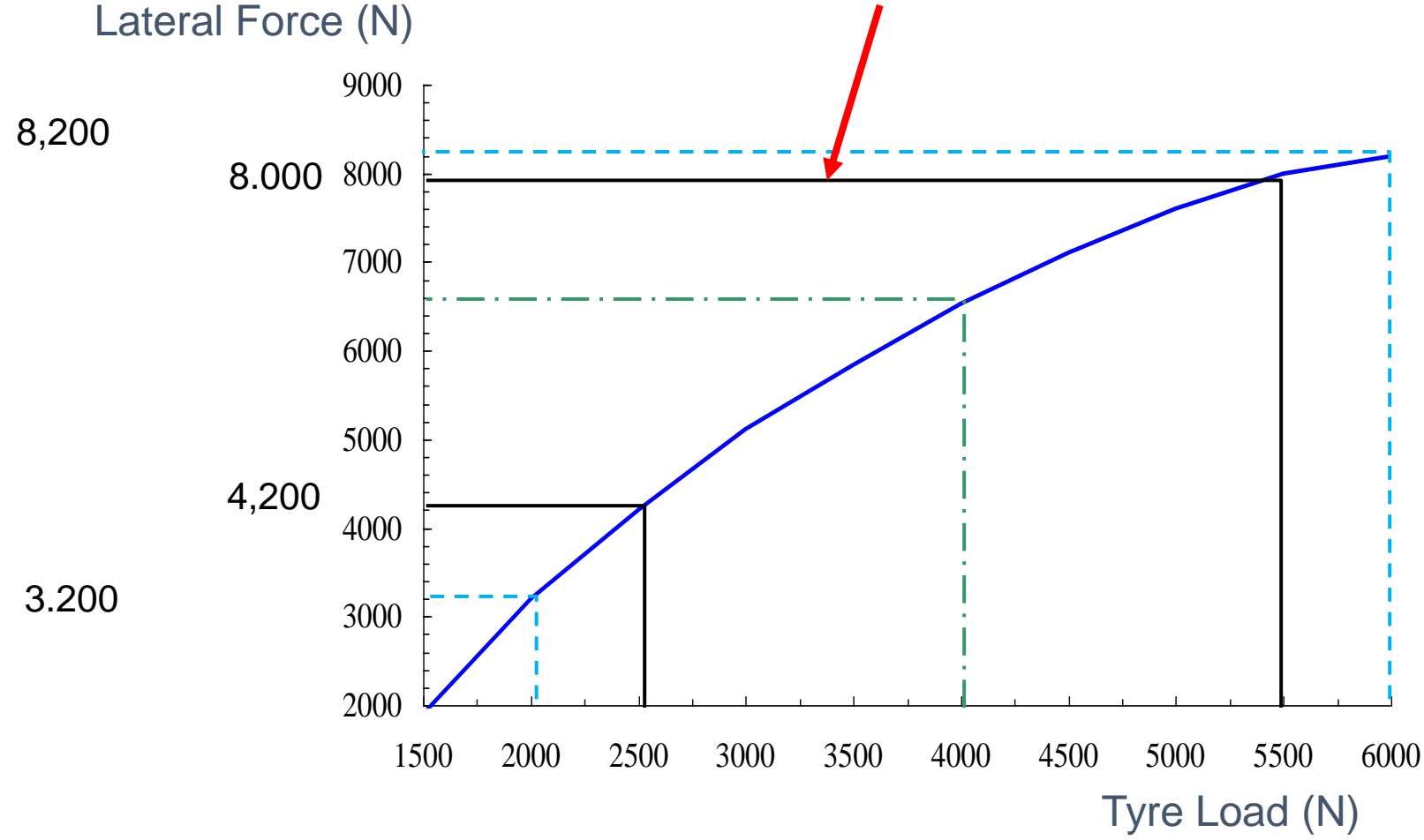


**IMPORTANT TO UNDERSTAND
FROM TYRES:**

**A PAIR OF TYRES GAIN
LATERAL GRIP
WHEN THE LOAD
TRANSFER DECREASES.....**

<https://youtu.be/edXVQcBSD6o>

Antirollbar softer



Softening the load transfer at one axle (e.g. by softer springs or anti-roll bar) reduces the load transfer, resulting in more lateral force.

LESS LOAD TRANSFER = MORE LATERAL FORCE

MORE LOAD TRANSFER = LESS LATERAL FORCE

11,400N 12,200N

Delta = +800N

AERODYNAMICS

The aerodynamic challenge to serve two contradictory objectives:

increase downforce : results in better performance by the tyres

decrease drag: minimizes resistance at high speeds

Example of the dimensions:

$$1 \text{ bar} = 100.000 \text{ N/m}^2 \Rightarrow 0,01 \text{ bar} = 1.000 \text{ N/m}^2$$

Effective Underbody of $3\text{m}^2 \Rightarrow$ a pressure difference of 0,01 bar means

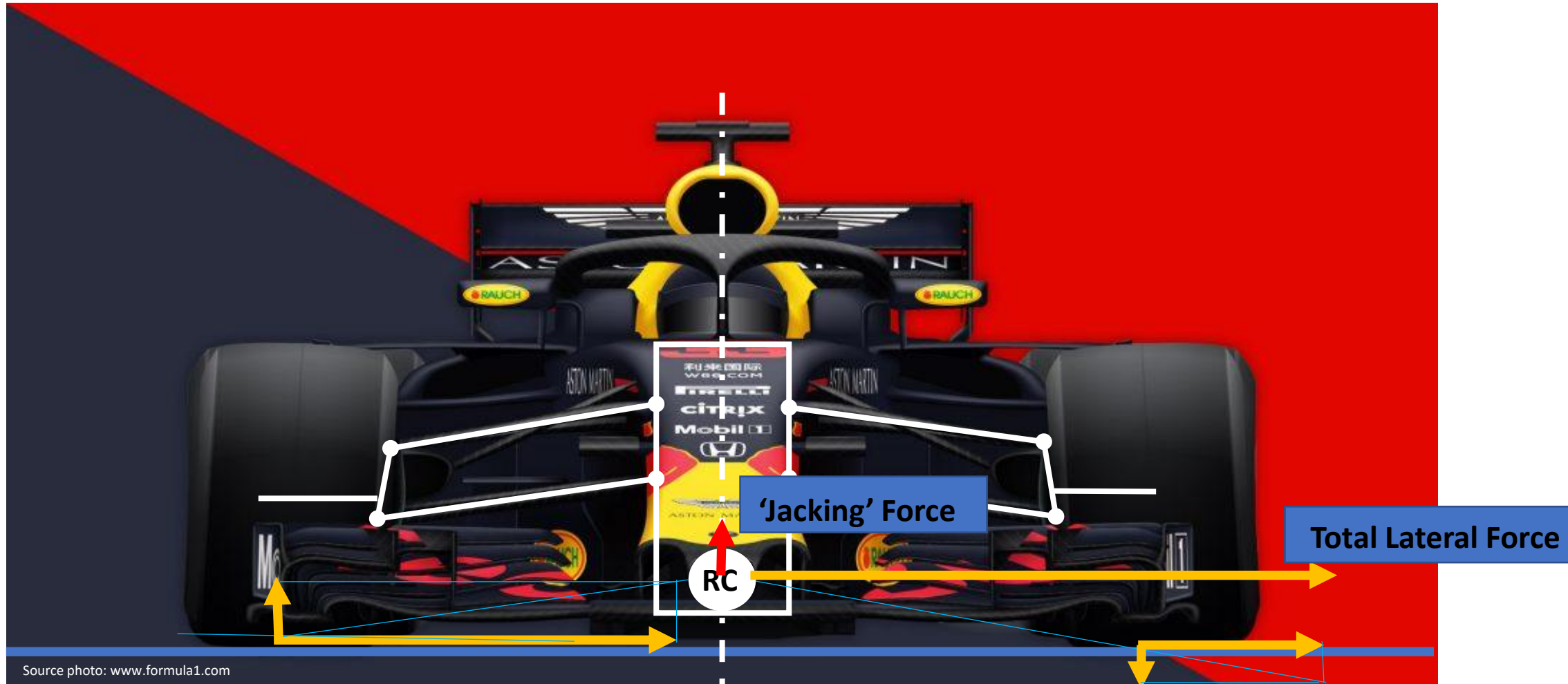
$$1.000 \text{ N/m}^2 * 3\text{m}^2 = 3.000 \text{ N (approx 300kg)}$$

AERODYNAMICS ABOVE MECHANICAL HANDLING...



Source photo: www.formula1.com

.....BUT TO A PRICE!



**Geometry, hence the mechanical handling of the race car, has been made secondary to the aerodynamics!
The high positioned Roll Centre generates large Jacking Forces which try to lift the car.**

THANK YOU VERY MUCH AND GOOD LUCK WITH THE STUDY!

Want to know more?

Visit my workshop 'Magic Numbers from Race Cars'

Date of next workshop to be determined, see TAC Academy Waalwijk

<http://tacacademy.nl/aanbod/workshop-magic-numbers-voor-racewagens/>

Or

www.cursuswegligging.nl

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