Airfoil force approach to the rocket propulsion

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Current approach

The thrust of a rocket can be modeled from a generalization of Newton’s 2nd Law to include a variable mass:\(^1\):

\[ F_{net\ external} = \frac{d(mv)}{dt} = m \frac{dv}{dt} + v \frac{dm}{dt} \]

Which eventually give us expression for rocket thrust:

\[ F = -\nu R = -\nu \frac{dM}{dt} \]

\( \nu \) - velocity of exhaust relative to rocket

\( R \) - rate of mass ejection

Similar expression here:

**Rocket Thrust Summary**

**Thrust:** \[ F = m\ \nu_e + (p_e - p_0)\ A_e \]

\( \nu_e = \nu \) - velocity of exhaust relative to rocket
\[ \dot{m} = R - \text{rate of mass ejection} \]

Note that in this approach force (rocket thrust) is linearly dependent on:

1. Exhaust velocity.
2. Rate of the mass ejection (propellant loss rate.)
Airfoil force approach (my proposal)

If we force the exhaust gases to go around airfoils we will have upward lift (airfoil is connected to the rocket).

Note that in this approach force (rocket thrust) has quadratic dependence on the velocity:

This quadratic dependence on the velocity is giving us opportunity to reduce rate of mass ejection (fuel loss).

To maximize the effect biggest possible exhaust velocity is needed.

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**Velocity Effects on Aerodynamic Forces**

\[ F = \text{Force} \]
\[ L = \text{Lift} \]
\[ D = \text{Drag} \]
\[ V = \text{Velocity} \]

Aerodynamic force is related to square of velocity.

\[ F = \text{Constant} \times V^2 \]

then

\[ L = \text{Constant} \times V^2 \]

Double the Velocity --> Quadruple the Lift

and

\[ D = \text{Constant} \times V^2 \]

Double the Velocity --> Quadruple the Drag
In other words

My proposal for initial testing

Current situation

The end
Interesting demonstration for the nonbelievers 😊

http://www.nhn.ou.edu/~see/fluid/2c20.35.gif

https://www.youtube.com/watch?v=lnSk7C6LsUU

https://www.youtube.com/watch?v=89-V410VhFw

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**FLUID MECHANICS**

**2C20.35**

**DYNAMICS OF FLUIDS**

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**Bernoulli Force**

**BALL AND FUNNEL**

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A large, glass funnel hangs upside-down. Its narrow end is connected to the air supply under the lecture bench.
- Turn on the air supply.
- Hold the ping-pong ball in the funnel and release it. It remains.

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i  
http://hyperphysics.phy-astr.gsu.edu/hbase/rocket.html

ii  
https://exploration.grc.nasa.gov/education/rocket/rktthsum.html

iii  
http://wright.nasa.gov/airplane/vel.html