A HAMSTER MINI-TALK

ENERGY MANAGEMENT

INTRODUCTION

- Introduce the concepts of Energy–Manoeuvrability Theory as the core tactic in dogfighting.
- E-M Theory formalised by Col John Boyd and Thomas P Christie.

AIM

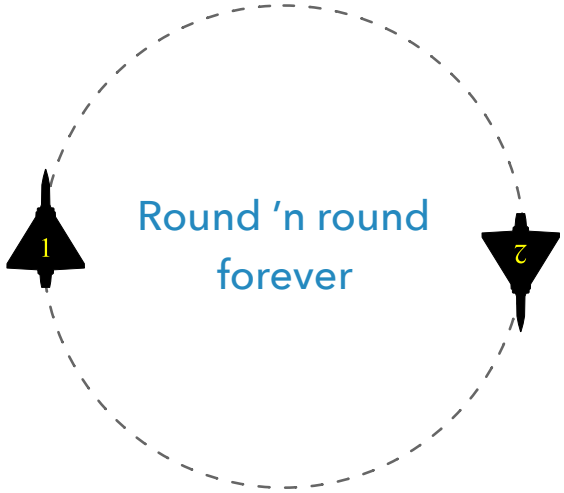
- Understand what a fighter's energy state is.
- Think about a dogfight in terms of energy management.
- Given equal pilot skill: understand how the fighter with the higher energy reserves has almost all the advantage.

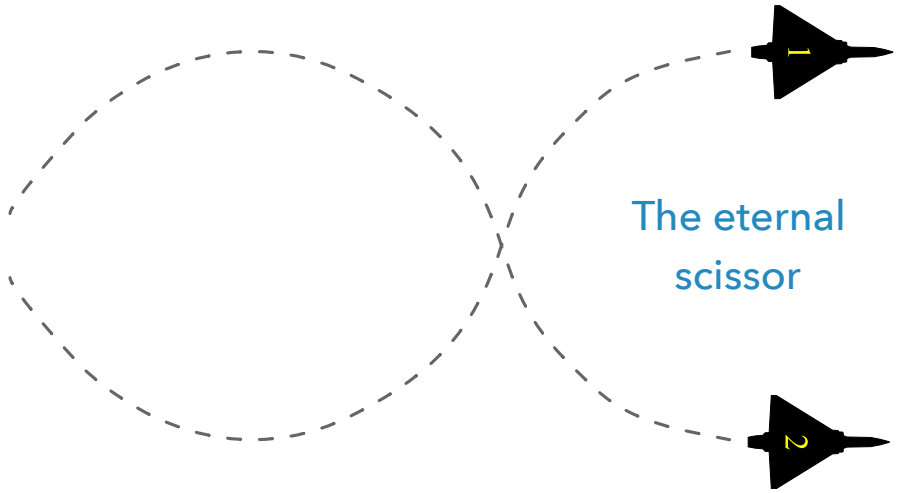
WHAT IS ENERGY

- A fighter manoeuvres by **converting it's available energy** into **changes in motion**.
- A fighter has three things that contribute to it's available energy:
  - **Thrust** - Energy **generated** by the engine
  - **Altitude** - Energy **stored** in the form of potential energy
  - **Speed** - Energy **stored** in the form of relative momentum

PURE ENERGY PARITY

- A fighter is always using all it's generated energy (i.e. most dogfights are conducted at maximum power)
- Two fighters at the **same height**, **same speed**, and with the **same thrust** are forced to wait for the opponent to make a mistake. There is no manoeuvring victory available.



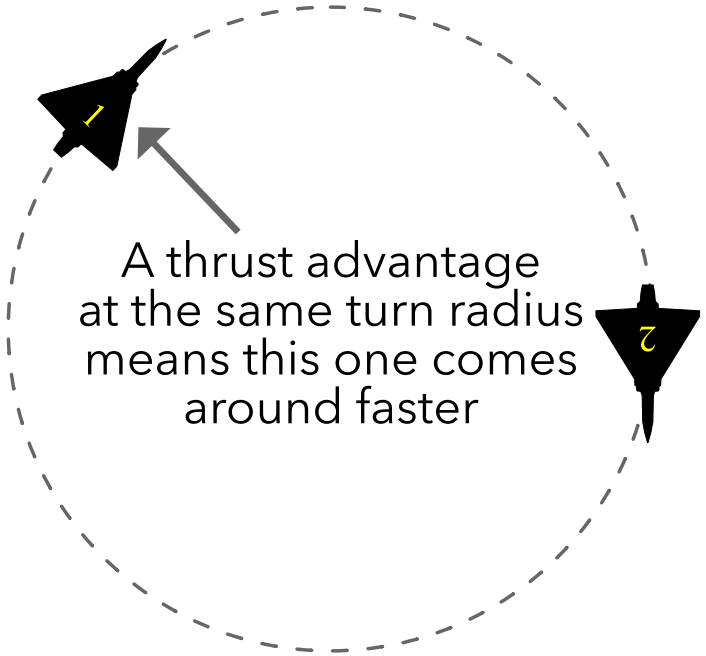


HOW DO YOU CONDUCT AN ENERGY FIGHT

- Dogfights are essentially turning fights whether you are using boom and zoom, pure one and two circle fighting, or in a scissors.
- An energy fighter spends excess energy to gain higher angular velocity
- Your manoeuvres will either exploit enemy errors to gain stored energy (i.e. altitude or speed) or spend stored energy to gain a positional advantage.

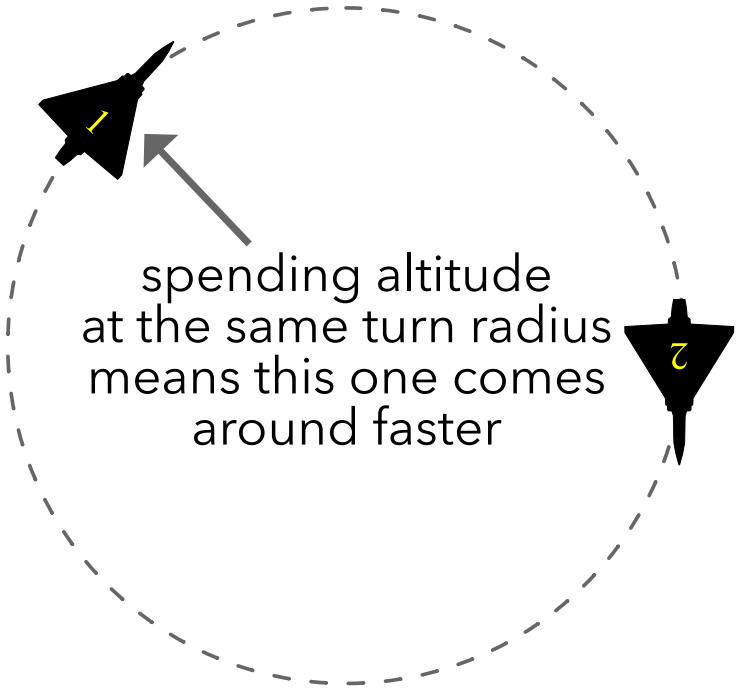
A THRUST ADVANTAGE (HIGHER THRUST-TO-WEIGHT RATIO) IS AN ENERGY ADVANTAGE

- Spending more energy as thrust means you can pull harder through the turn. If your turn radius matches your enemy then you will eventually catch up.
- Coming around faster means you have a higher angular velocity
- You are "spending your excess thrust" to "buy angular velocity".
- It's important to note that it's a fighters thrust-to-weight ratio that matters here, not just absolute thrust values.



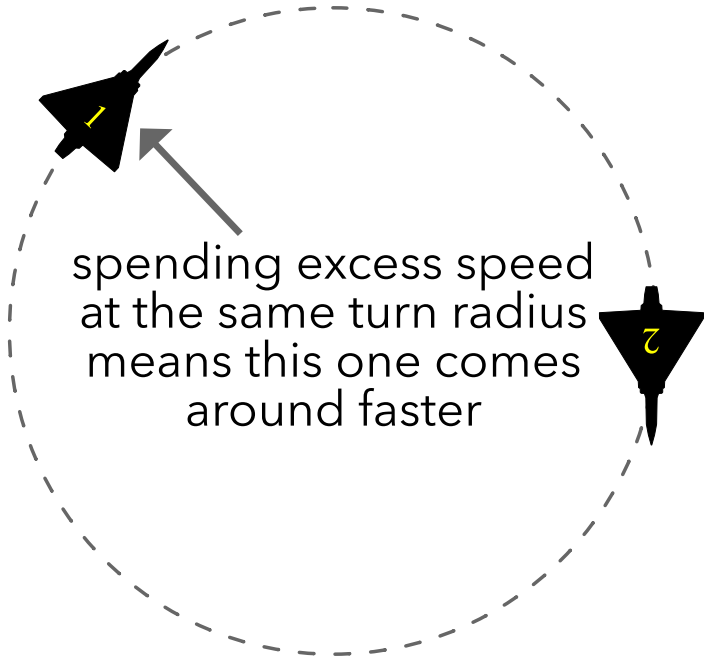
AN ALTITUDE ADVANTAGE IS AN ENERGY ADVANTAGE

- You can spend altitude for a higher angular velocity by maintaining your turn radius but putting the nose below the horizon. Gravity will add to your total thrust.
- Coming around faster means you have a higher angular velocity
- You are "spending your excess altitude" to "buy angular velocity".
- Note that once an altitude advantage is spent you can at best maintain your new relative position.



A SPEED ADVANTAGE IS AN ENERGY ADVANTAGE

- You can spend excess speed for a higher angular velocity by maintaining your turn radius and bleeding (or spending) excess speed with higher G.
- Coming around faster means you have a higher angular velocity
- You are "spending your excess speed" to "buy angular velocity".
- Note that once a speed advantage is spent you can at best maintain your new relative position.



A NEW WAY TO VIEW THE BASIC FIGHTER MANOEUVRES

- A high displacement roll (high yoyo) allows you to match the enemy turn radius and rate while maintaining your speed advantage.
- A low displacement roll (low yoyo) allows you to spend excess speed to gain angular velocity point a gun or missile at the enemy.
- A barrel roll serves the same purpose as a high displacement roll but also functions when the enemy isn't turning.

SOME BEGINNER SCENARIOS YOU CAN START PLAYING WITH RIGHT NOW

- If you have more energy and are otherwise in a neutral position try and convert it all into more altitude. If you opponent spends all their energy turning you will be above them and they won't be able to point their weapons at you without stalling, while you will be full able to manoeuvre.
- If you are about to overshoot, convert your excess speed into altitude immediately.
- If in a scissors try and reach minimum speed at a higher altitude than your opponent when they reach minimum speed.
- Being significantly above your opponent when your speeds match is essentially equivalent to being behind them. You just have to wait for them to make a mistake and then you have the stored energy (altitude) to exploit it.

DANGER SIGNS

- In the energy fight against a skilled opponent you will probably never get the opportunity to regain spent energy.
- If your total energy state falls below your opponent's and no mistakes are made, you will probably lose.

LAST THOUGHTS

- At first “seeing” your and your opponents energy states can be tricky.
- If you always try to interpret the energy states in a dogfight it will “click” - understanding will come - and then become second nature after some practice.
- Be warned you must be doing this continuously **every time you fight** and **all the time while fighting**. If you only do this sporadically the energy awareness may never form.
- If you don’t know your aircraft’s speed at all times in the dogfight you will not be able to form the energy picture. So remember to check it every two to three seconds!