



Model and High Power Rocketry

Mike Williams, 802





Me

- Mike Williams, UKRA founder member, former chairman now running the MAP program.
- G6BMZ
- SMAS member 802



Bad Language Warning

- Some terms are horribly interchangeable
- Its all metric except when its Imperial except when it isn't
- Mass is not weight and weight is not mass, kinda
- Some videos need to be loud, and sort of shouty

The top questions

1. Is it Legal?
 2. How high do they go?
 3. What is the fuel?
- ... and how do they work?

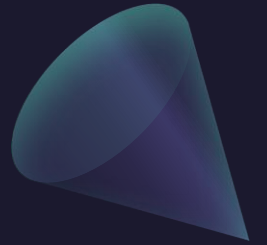
Is it legal?

SHORT ANSWER

- Yes
- Law treats model rockets in a very similar way to garden fireworks
- Making your own pyrotechnic motors is illegal

BIT LONGER ANSWER

- Stay within the rules
- HSE covers most motor issues
- Air navigation orders apply
- Very large flights are rarely practical
- Things falling from space can be a problem



How high do they go?

SHORT ANSWER

- Give me enough space and a big enough bang and 50km is possible.
- Models, 2000 feet
- High Power, 10,000 feet

BIT LONGER ANSWER

- Easy to acquire motors are good for about 3000 feet
- Largest motors can get much higher, say 20km.
 - Flight calculations and simulation
 - Flight electronics



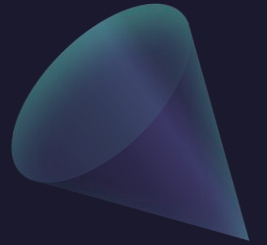
What is the fuel?

MODEL ROCKETS

- Black powder
 - Clay and cardboard surround
 - Typical legal requirements are like a firework
 - Fixed ejection delay

HIGH POWER (APCP)

- HTPB binder
- Perchlorates
- Metal filings
 - Hard plastics and aluminum surround
 - Limited use of cardboard
 - [often] Variable delay



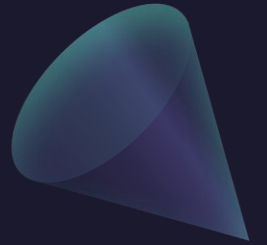
but wait, there's more...

HYPRID MOTORS

- Two or more substances in different states
- Very safe
- Simple legal requirements
- Cheap for high power
- Can be very time consuming

TYPICALLY

- NOx oxidiser
- ABS plastic fuel
- GOx starter
- Complex GSE



Finally...

HUMAN

- Stomp Rocket
- Aquajet







Midpoint Questions

How do they work?

Construction

MODEL ROCKETS

- Mainly cardboard
- ABS plastic
- Balsa
- Elastic or rubber bands
- Any odd craft stuff
- Polythene

HIGH POWER

- Phenolic tubing or purpose designed plastics
- Fiberglass
- plywood
- Kevlar
- Ripstop nylon



How do they work?

Anything you can find

- Balsa
- Most things tubular
- Can get heavy
- Pringles a favourite
- Recovery



How do they work?

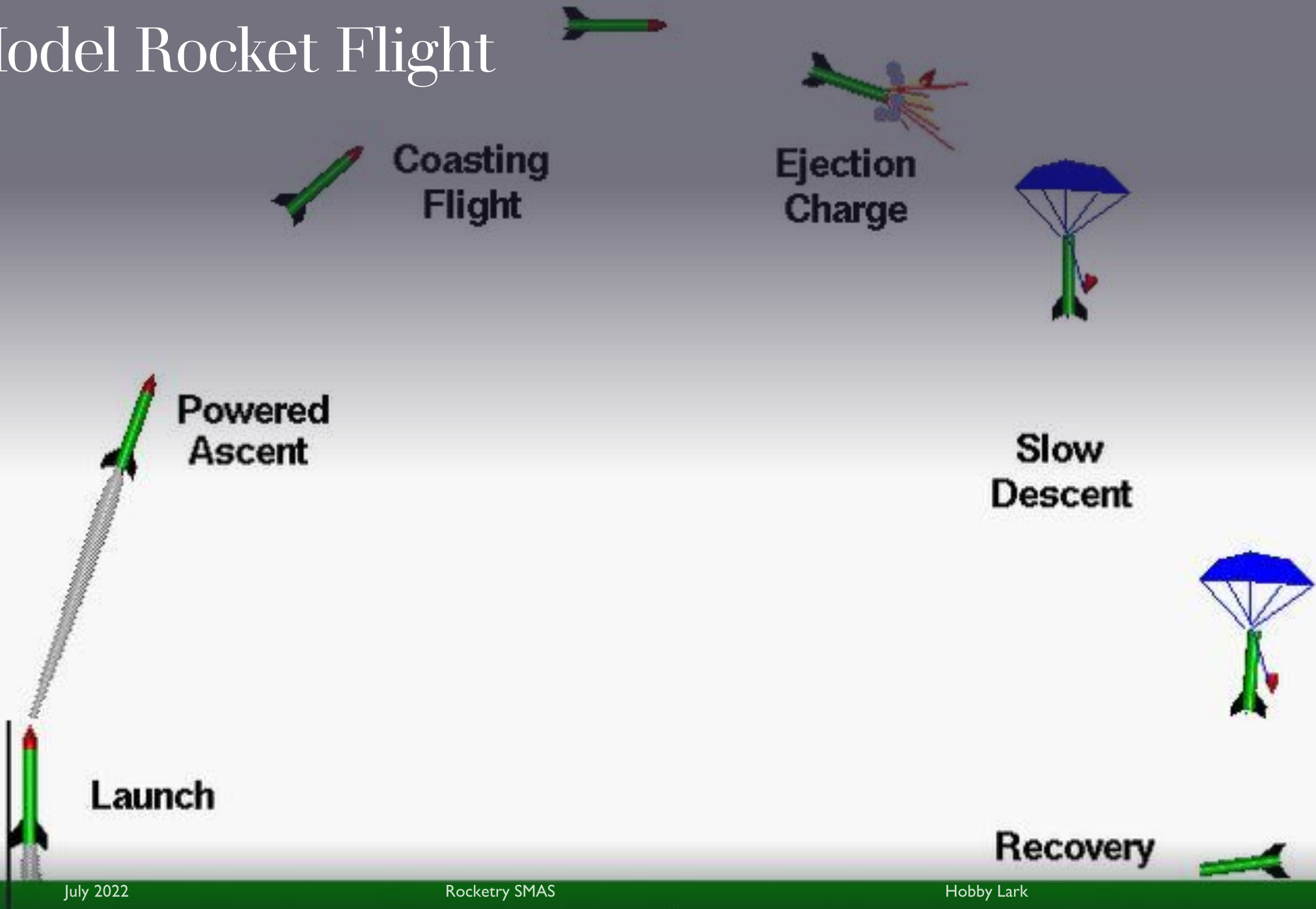
A horrible truth, 3D printing

3D PRINTED PLA AND PLA+

- Can sort of work
- Usually rushed
- Similar loads to balsa wood but much heavier
- Z Axis weakness
- Goes soft in the sun



Model Rocket Flight



How do they work?

Basic Operation

30 SECONDS OF TERROR

- Mechanical support, GSE
- Electrical ignition
- Lift
- Sustain/Delay
- Eject/deploy recovery
- Hits ground, long walk



A simple model rocket

- Sustainer
 - Nose cone
 - Body tube
 - Trapezoidal fin set
 - Inner Tube
 - Engine block
 - Centering ring
 - Centering ring
 - Shock cord
 - Parachute
 - Wadding
 - Launch lug

Move up

Move down

Edit

New stage

Delete

Add new component

Body components and fin sets

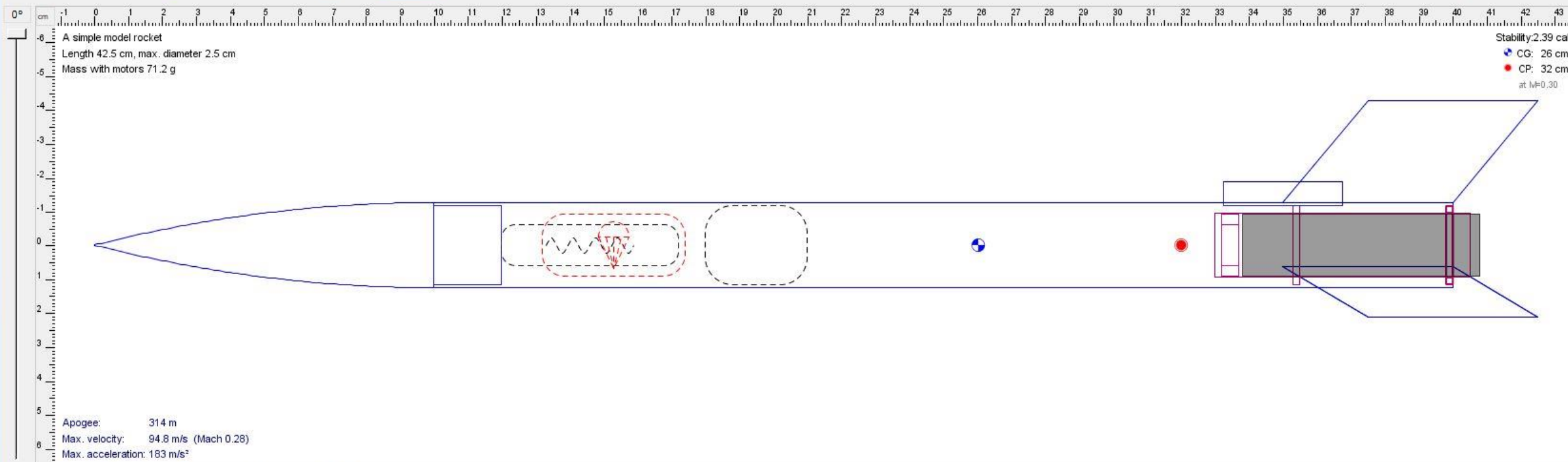
- Nose cone
- Body tube
- Transition
- Trapezoidal
- Elliptical
- Fredform
- Tube fins
- Launch lug

Inner component

- Inner tube
- Coupler
- Centering ring
- Bulkhead
- Engine block

Mass objects

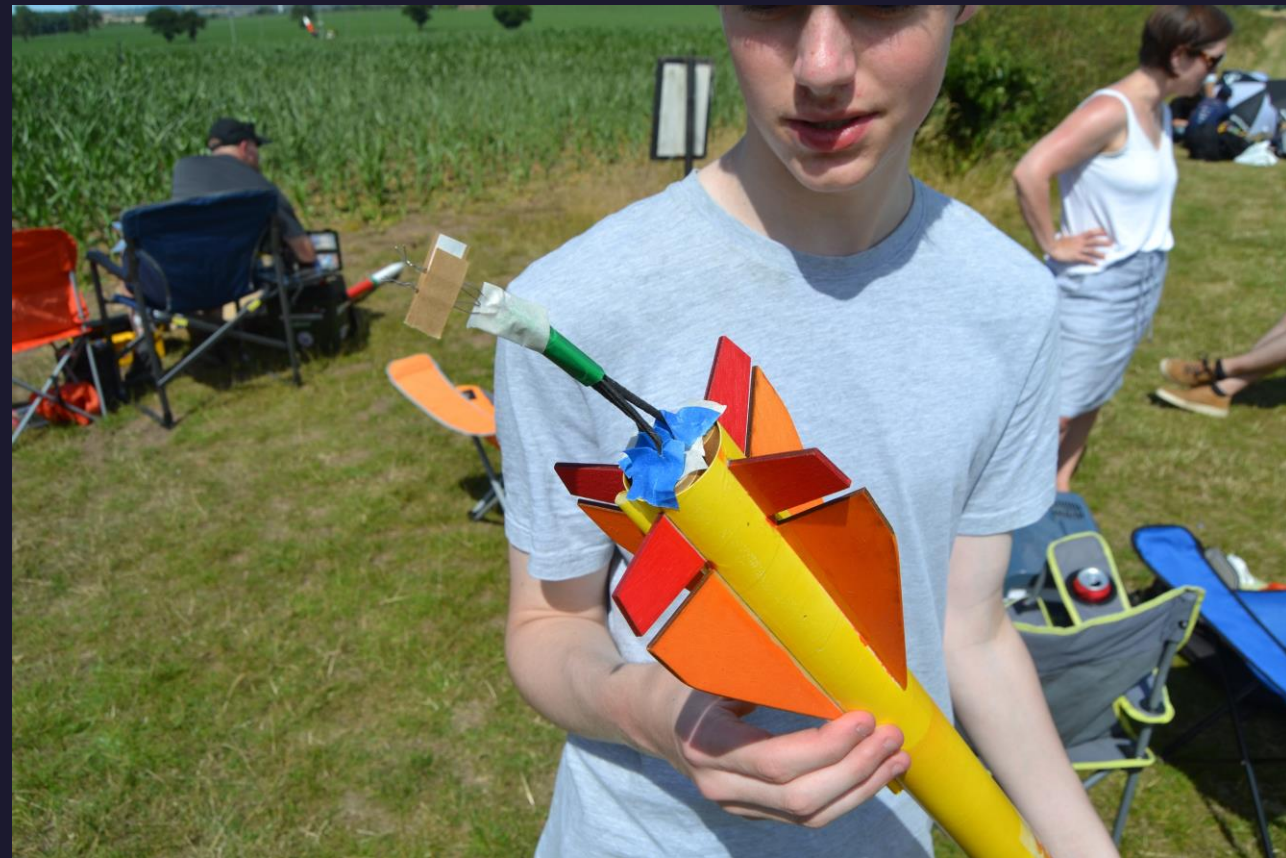
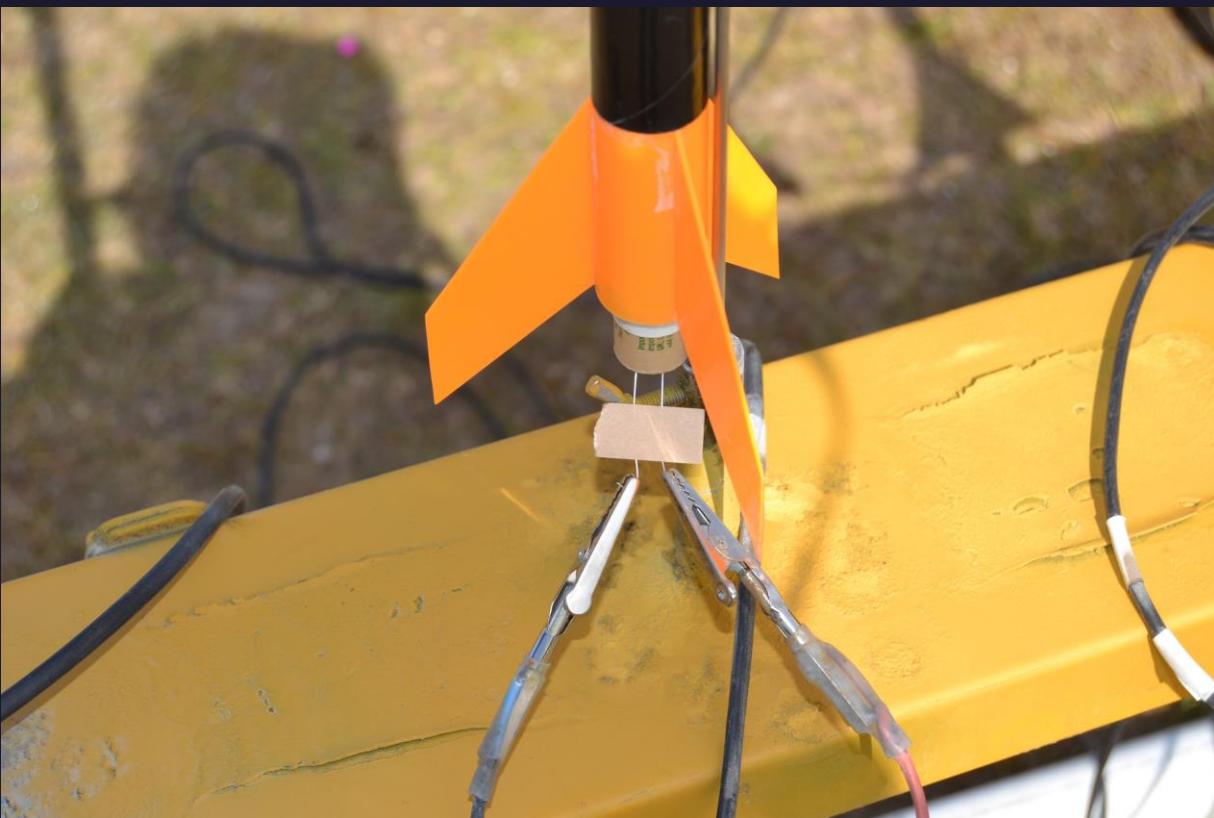
- Parachute
- Streamer
- Shock cord
- Mass component





How do they work?

Ignition and launch



How do they work?

Trying to go high

SIMPLE

- Go straight
- Three fins good, four fins better
- No mass you don't need
- Keep the diameter down
- Make sure it's stable
- The weather!

NOT SO SIMPLE

- Motor selection
- Spin stabilisation
- Staging, serial and/or parallel
- Sustainer darts
- Stability margins

How do they work?

Stability margin

HEAVY AT THE POINTY END DRAGGY AT THE OTHER
END

- Centre of pressure
- Centre of gravity



Stable vs Unstable



Engine Selection – Single Use

Banging and pushing



Engine Selection – Reload

Banging and pushing



How do they work?

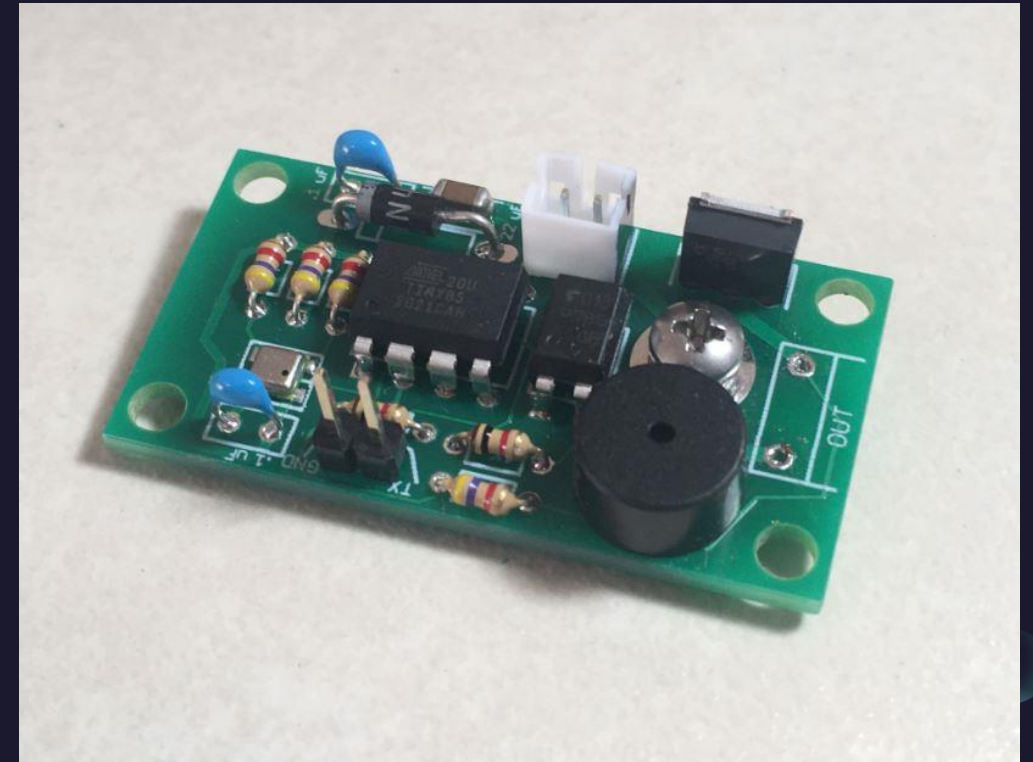
Recovery

SIMPLE

- At ignition a chemical delay grain starts to burn
- During flight delay grain burns for a predictable number of seconds
- Once burnt through a black powder charge ignites forces out a parachute*

NOT SO SIMPLE

- Electronic devices, Mike talks....



How do they work?

Slowing down and stopping

SIMPLE

- Break the airframe
- Parachute, streamer, ribbon
- Unstable when falling, tumble
- Helicopter blades

NOT SO SIMPLE

- Multiple parachutes
 - Variations of above
- Mixed, such as tumble booster stage





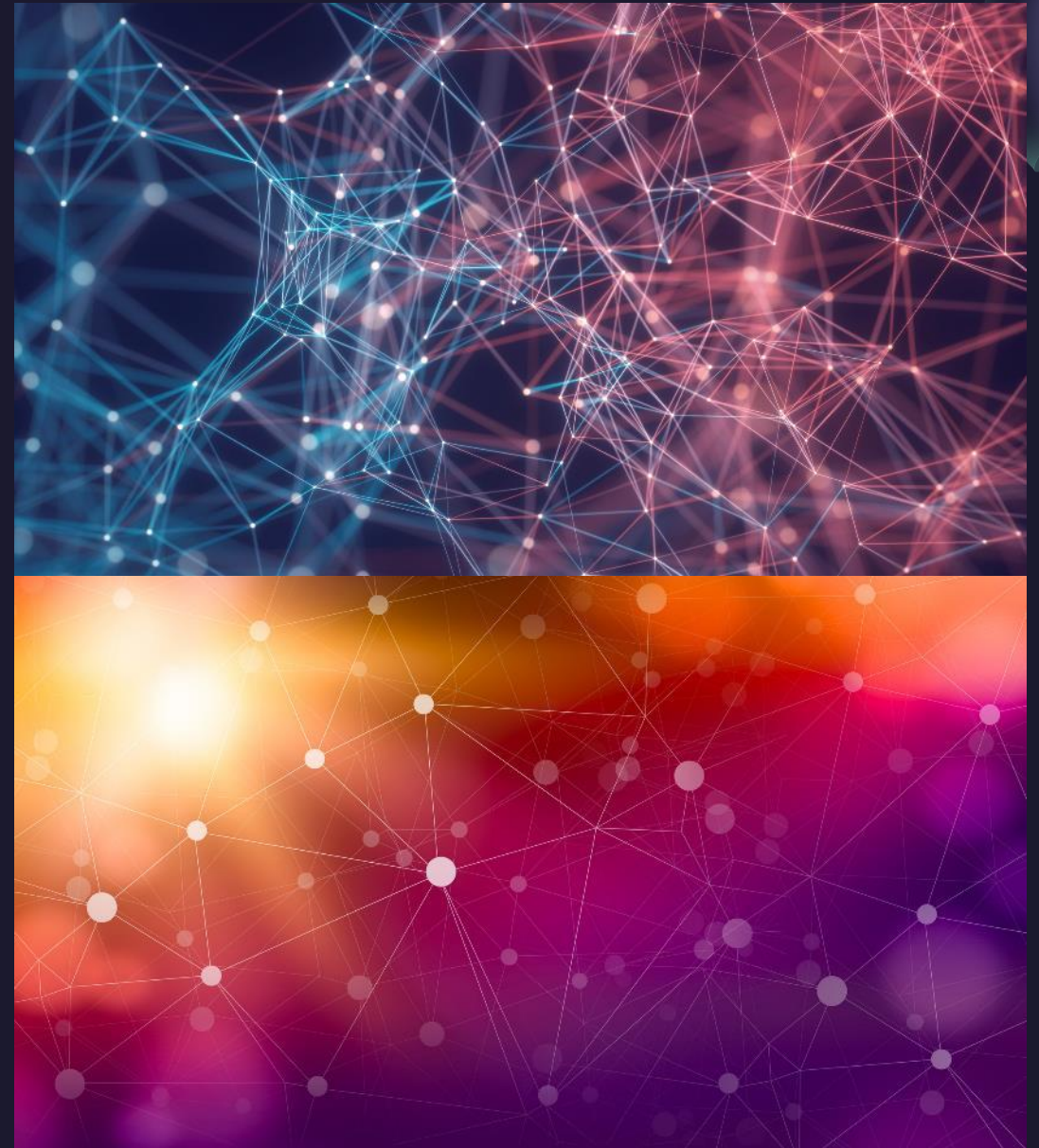
Summary Questions

Thank You

Michael Williams

ukra.org.uk

<https://ukra-map.org.uk/EE.html>



Bonus Material

- Hybrid – Not quite right
- Model – Next slide not all wood is Goodwood



Balsa



Open Rocket

- Simple Rocket SIM Demo

