

Avionics & Mechanisms

AVDASI 2 · Introduction

Dr. Steve Bullock



Today

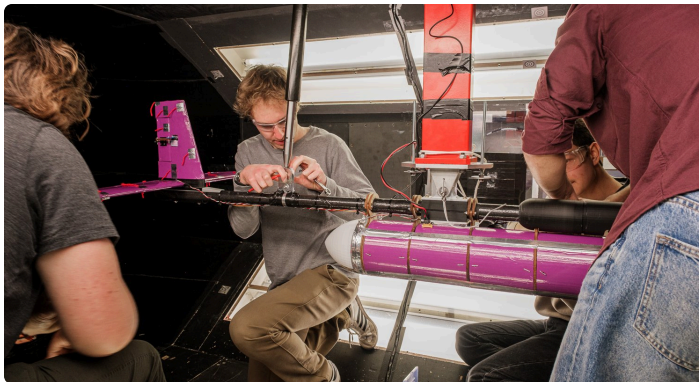
Who we are, and where things happen

Part 1 — Avionics

What it does in your aircraft · what the requirements ask for · integration · the workshops, and how to get ready

Part 2 — Mechanisms

What has to move · the design task · where it meets avionics · the sessions





Who's who



Steve Bullock

Avionics
Mechanisms



George Burns

Avionics



Tim Ward

Avionics



Robin Carter

Avionics



Mark Graham

Mechanisms



Vince Maes

Mechanisms



Where things happen

Space	Room	What for
Stack Room	QB F.05	Avionics workshops, Friday mornings
Avionics lab	QB M.003	Kit issue and return, supervised tool use
Design Suite	QB 1.59	Mechanisms sessions, Thursdays
The Hangar	QB L.080	Main lab, open access
Here	QB PLT	Pugsley Lecture Theatre

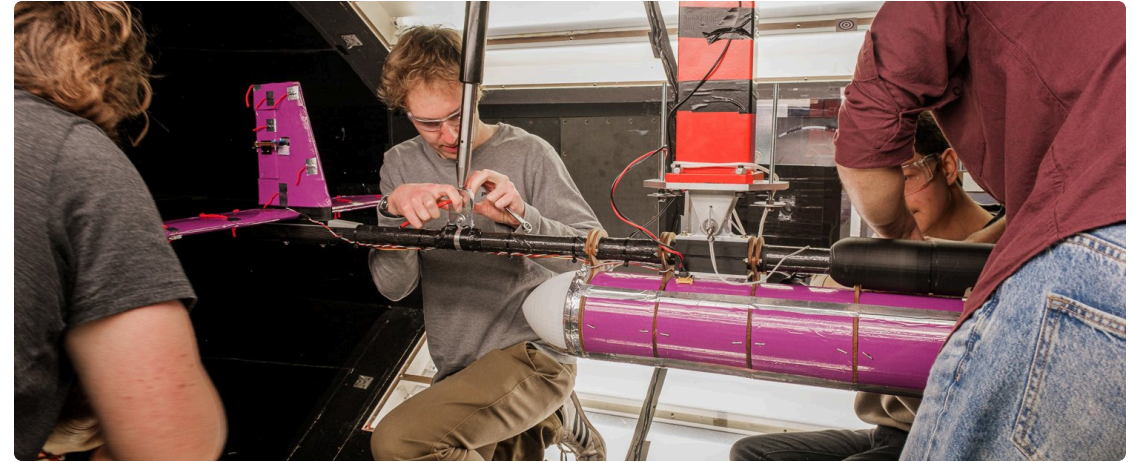
Room numbers link to the map. All of these are in Queens Building.



The model is only as good as what moves it



Last year's fuselage in the 7×5 tunnel



Photos: Ross Dewar

- Your model has **control surfaces**, and something has to move them repeatably
- Your test campaign needs **data** — measured, time-stamped, logged
- Your aerodynamicists need **the angle you asked for**, not the one you got
- Avionics and mechanisms turn foam and carbon into an **instrumented test article**



Flight-grade kit, off-design





What the spec asks of avionics

"Aircraft control systems **shall** comprise a flight control system (FCS), radio control system (RCS), telemetry system (TMS), and ground control station (GCS), with associated power, wiring harnesses, antennae etc."

Provided to you

- The flight controller
- The radio control system
- The telemetry system
- Servos, from a set list

Yours to design

- Power distribution and harnesses
- Mounting and installation
- Logging, calibration, evidence
- Everything that connects them



What it has to do

- Every surface — elevator, rudder, aileron, flap — **commandable from both the radio and the telemetry link**, to specific angles
- **PID stability augmentation** in pitch, tuned on the provided flight controller, switchable on and off
- **Log flight data: 5 Hz minimum, 20 Hz preferred** — pitch angle and rate, servo demand, and whatever else your Company needs
- Everything **removable**, fixed with mechanical fasteners, for maintenance and recycling
- **Nothing above 15 V**, anywhere on or connected to the aircraft



What "done" looks like — for now

"A bench-top prototype of full FCS, RCS, TMS, GCS, and associated systems **shall be demonstrated working** at Gate 2a."

- The **step-by-step guide** takes you there: kit, autopilot, telemetry, power, servos, sensors, logging
- Mechanism prototypes are demonstrated with **servo testers**, not the flight controller
- **This is done for this teaching block only — integration comes next.** A bench that works is not an aircraft that works



Avionics depends on integration

With	You need to agree
Aerodynamics	Surface sizes and deflections, and so hinge moments, and so servo torque
Mechanisms	Where the boundary sits: they own torque, servo choice and kinematics; you supply the PWM
Structures	Mounting, access, cable routes, mass
Test	Power, comms, what's logged, how it's handed over

- Avionics is not only an integration job, but it **depends on integration more than most**
- This table is a **starting point, not the answer** — read the spec for your own remit, then **agree each interface** with the division opposite
- Interfaces agreed late are the ones that fail

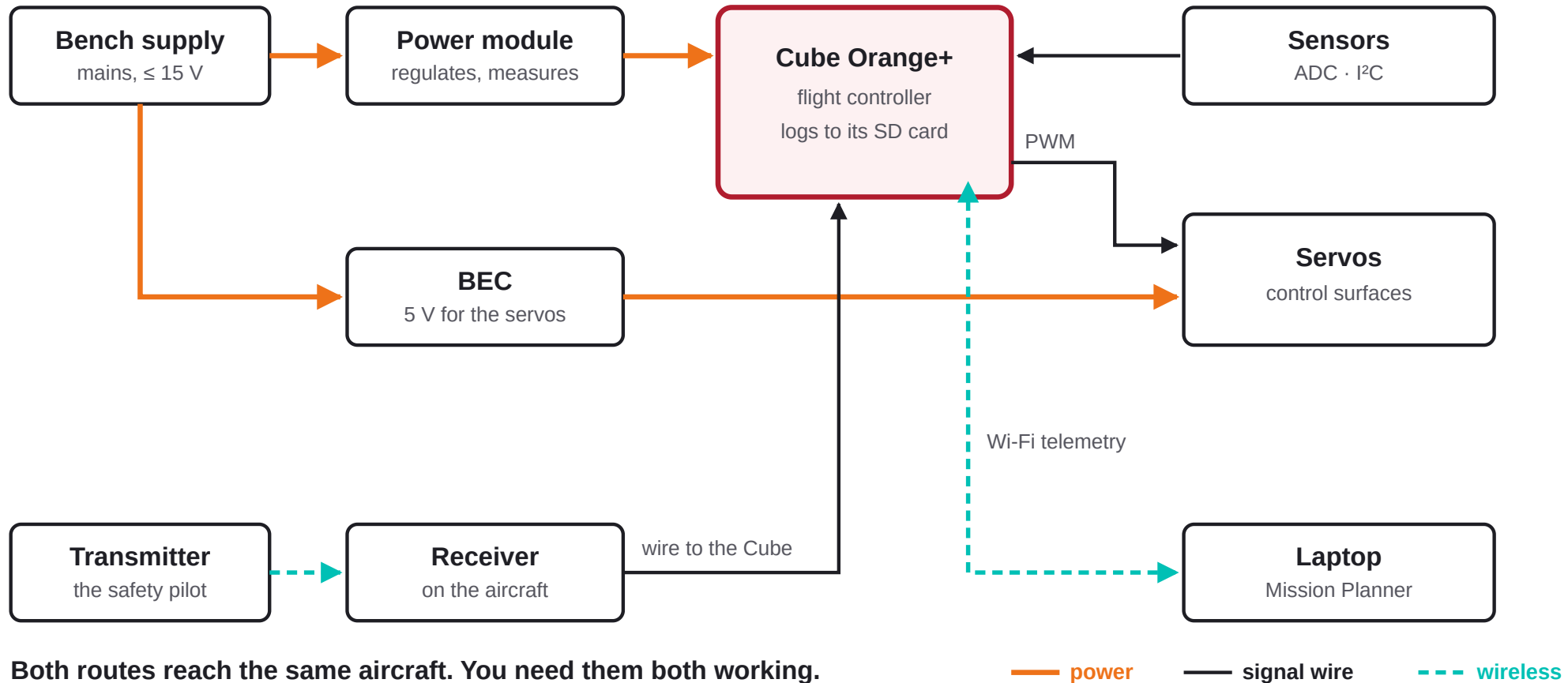


Interfaces to pin down early

- **Torque and travel:** what the surface needs, and what the servo gives with margin when it is stalled — **servo stall, not aerodynamic stall**
- **Power:** what each component draws, at what voltage, from which supply
- **Connectors and cables:** which plug, which route, and who crimps it
- **Data:** what's logged, at what rate, in what units, and who uses it
- **Command:** who moves which surface in the tunnel, and how you stop it
- Most of these depend on **other teams' work that hasn't happened yet**. Start with a rough number — theirs, or your own gut — and **track what has to be firmed up, and by when**
- **This list is not exhaustive.** Yours will be longer



The system on the bench





Avionics workshops

Week	When	Where	Focus
1	Friday, 09:00–11:00	Stack Room + M.003	Kit issue; Cube, Mission Planner, telemetry, power
2	Friday, 09:00–11:00	Stack Room	Servos and Lua scripting
4	Friday, 09:00–11:00	Stack Room	Sensors: ADC and I ² C
5	Friday, 09:00–11:00	Stack Room	To be confirmed

No session in week 3 — Company Day. Full schedule on SharePoint.



Friday: kit day

1. **09:00** A short taught intro in the Stack Room: the kit, and the requirements in more depth
2. **From 09:30** Groups go up to **M.003**, one at a time, to collect a kit
3. **While you wait** Read the guide's first pages (*Kit*, *Cube*), with no hardware yet
4. **Kit in hand** Work through the guide to the Friday checkpoint
5. **To finish** How not to break each component

Friday checkpoint: Cube on Plane firmware, buzzer quiet, connected over Wi-Fi, running on bench power.



Getting ready

- **Install Mission Planner on a Windows laptop** before Friday — one working laptop per group
- **Bring** that laptop, charged
- **Read** the guide's index, *Kit* and *Cube* pages
- Everything you need: avdasi2.github.io → Avionics → Getting ready
- The Cube setup, scripts and guidance are **being revised this month** — a more robust version is coming, with a one-step settings file

Part 2: Mechanisms

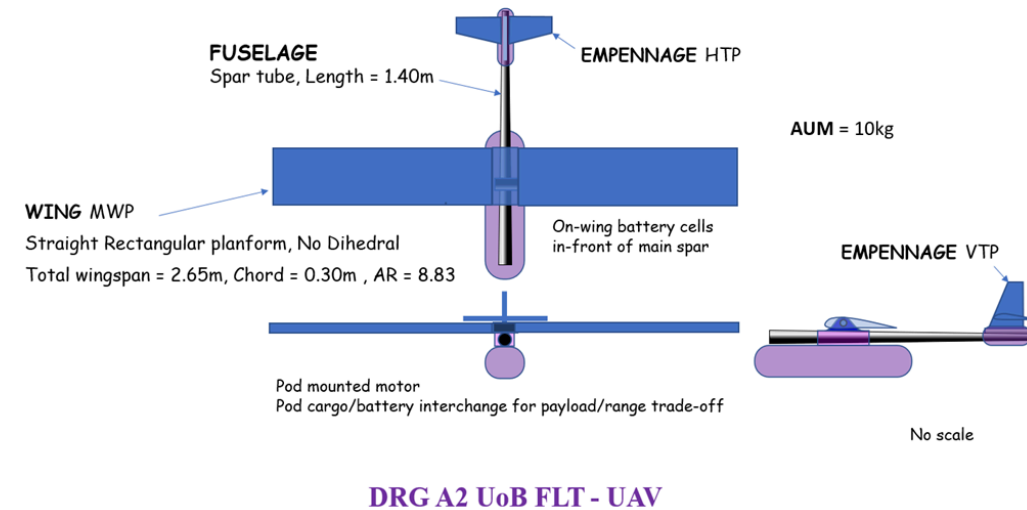
From servo to surface



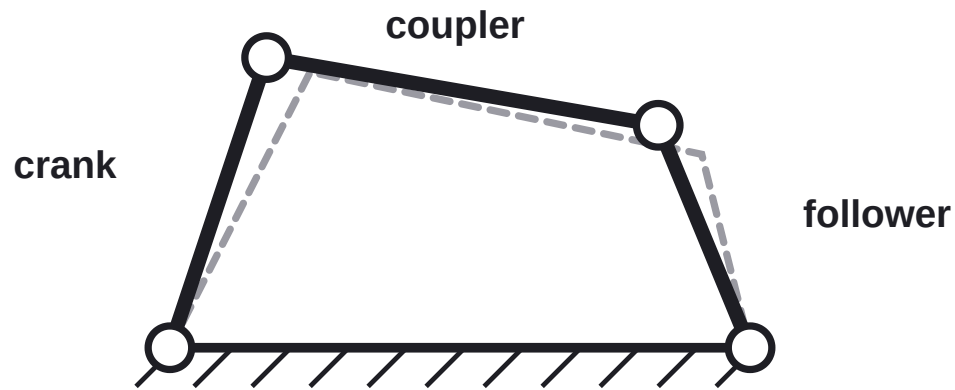
What mechanisms have to deliver

Every moving surface needs a mechanism designed, built and proved:

- **Flap** — plain, slotted or Fowler, 0° to 30°
- **Aileron, elevator, rudder** — four-bar linkages, $\pm 40^\circ$ to $\pm 45^\circ$
- **Leading edge device** — droop or slat, starboard wing
- **Landing gear** — deployable, behind a door
- Each holds its angle **under aerodynamic load**, to a stated tolerance, within a stated time

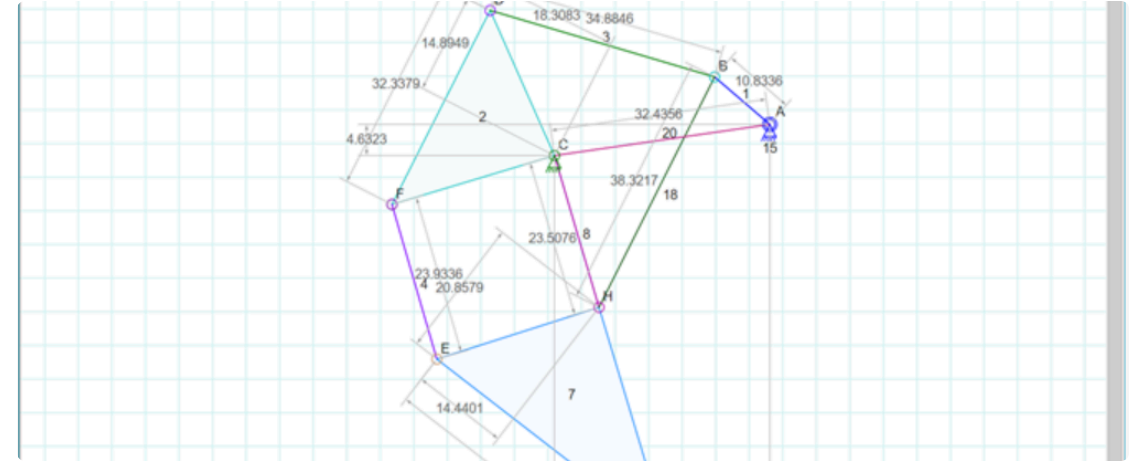


The design task



The parts of a **4-bar linkage**

- **Kinematics:** four-bar linkages, mobility, function generation
- Drawn and checked in the **Linkage app**

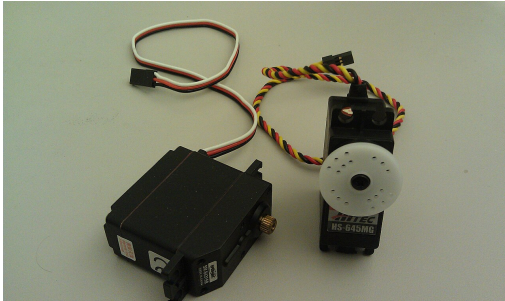


A flap mechanism drawn and simulated in the Linkage app

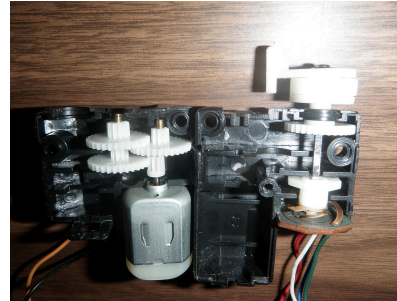
- **Then the real world:** bearings, slop, backlash, friction
- Materials, failure modes, and taking it apart again



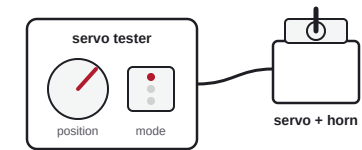
Where mechanisms meets avionics



Standard servos — HJ and Parallax. The kit also has blue micro servos



Inside one: motor, gear train, board — and a pot reading the output shaft



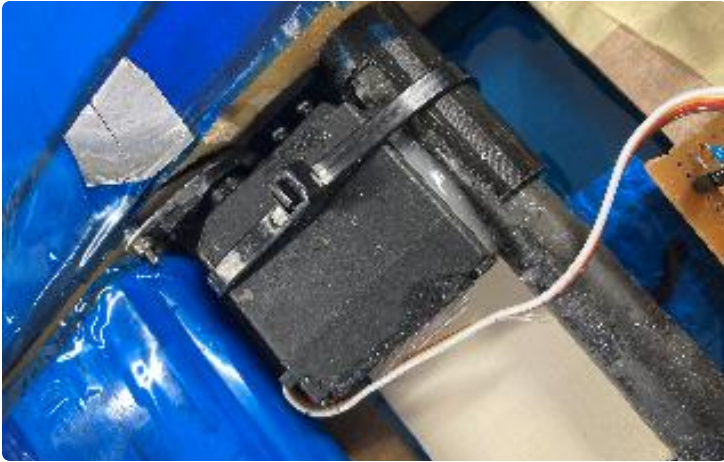
No flight controller. No code. Just: does the mechanism move as designed?

Proved on a **servo tester** before the flight controller

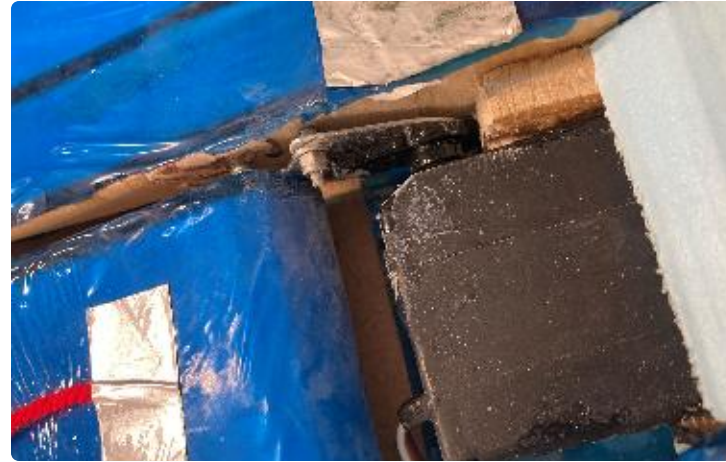
- **The boundary is the servo cable**
- **Mechanisms own** torque, servo selection, kinematics — and **sensor integration**
- **Avionics own** the PWM, servo rail power, commanding angles, logging
- **Sensor selection is joint:** readable as well as mountable



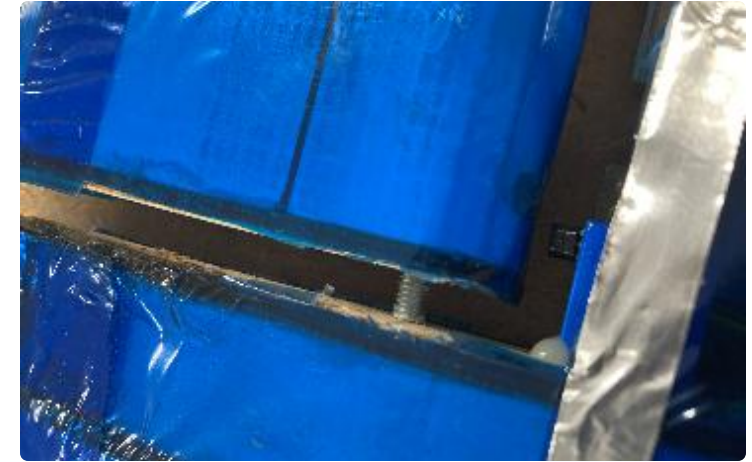
Learn from what broke last year



Actuator cable-tied **and glued** to the false rear spar



Weak linkages, **no washers**, nothing to reduce friction



Threaded rod as a pivot, into an oversize hole and into the foam

- Start simple, prototype early, design for disassembly



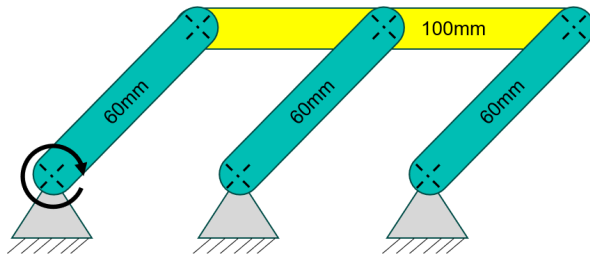
Mechanisms sessions

Week	When	Where
3	Thu, 11:00–13:00	QB 1.59 Design Suite
4	Thu, 11:00–13:00	QB 1.59 Design Suite
5	Thu, 11:00–13:00	QB 1.59 Design Suite

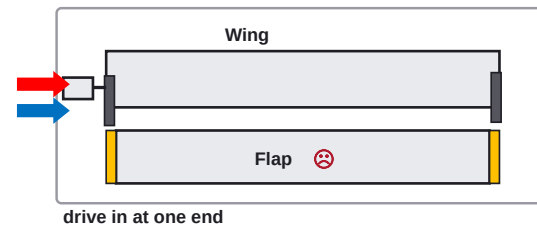
Install the [Linkage app](#) before week 3 — **Windows only**; the macOS version is in early beta.

Mechanisms — design realisation

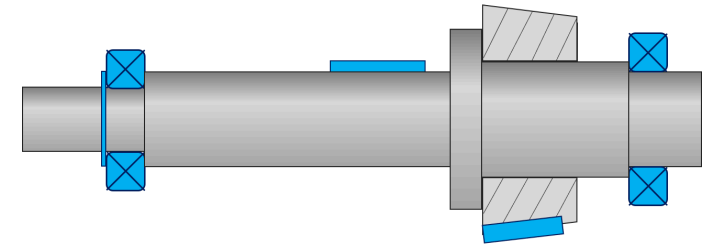
From kinematics to practical geometry



Transferring torque and motion



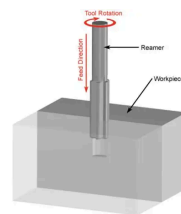
Design of pivots and joints



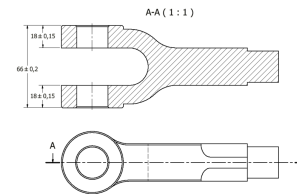
Standard parts and their uses



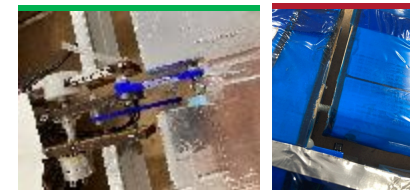
Precision machining and metrology



Functional tolerancing and tolerance analysis



Examples and non-examples



Questions

Avionics: Friday, 09:00, Stack Room

Mechanisms: week 3