Making a brick fly – a novel UAV airframe for survey applications

Dr. Steve Wright

Associate Professor of Aerospace Engineering

Department of Engineering, Design and Mathematics

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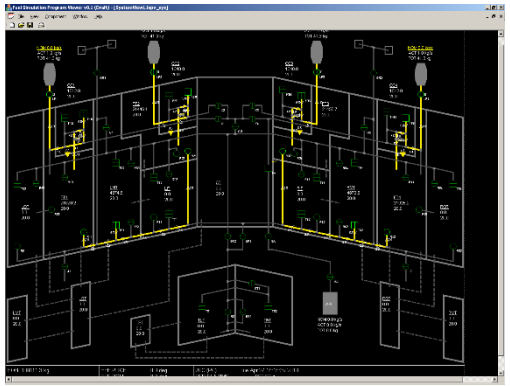
Dr Steve Wright

- Rolls-Royce 1989-97
- STMicroelectronics 1997-2000
- Airbus 2001-2014
- University of Bristol 2006-2009
- University of West of England 2014-



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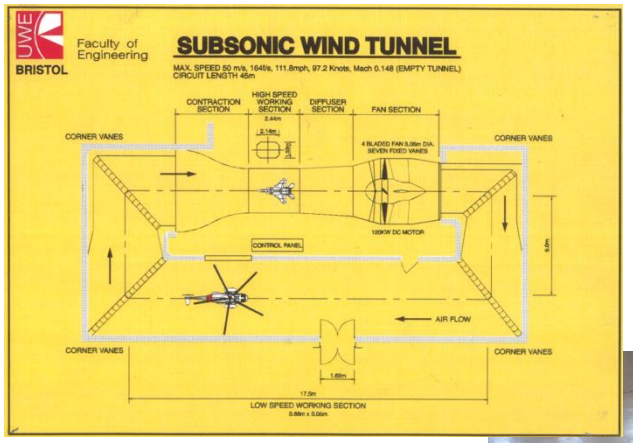
UWE-UFL – Skills & Resources

UAV development, manufacture, test flight

Expertise in:

- Aerodynamics
- Structures
- Manufacturing
- Avionics
- Robotics
- Propulsion



Facilities and equipment:

- Computational Fluid Dynamics tools
- Computer Aided Design tools
- Internal Combustion (IC) engine test cells
- High and low-speed wind tunnels
- Manufacturing in composites, metal, plastics, foam, wood

UWE-UFL Projects

MBDA

- Agile – high acceleration multicopter
- Jackdaw – autonomous endurance fixed wing
- Spectre – tilt-wing
- SpeedRacer – low-cost interceptor

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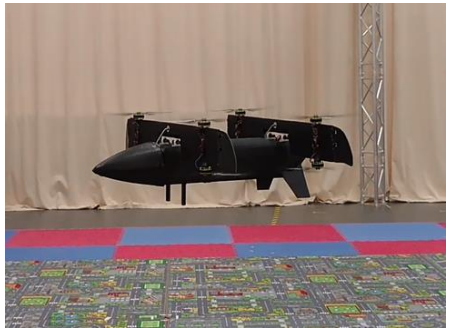
- Albatross – product design exhibition multicopter
- Wonderbot – aerospace teaching aid

EU Atlantic Coast Regional Development

- DURABLE - Solar farm inspection



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Objective

Placement ***and subsequent retrieval*** of *monitoring equipment in remote brownfield locations*

Application is monitoring of threatened wildlife in insecure areas

Solution concept

- Aerial insertion easy: recovery very hard
- *Entire UAV* inserted/extracted
- Vehicle is *disguised*

Concept Pros/Cons

Pro

- Eliminates crucial rendezvous requirement
- Mission reduced to two flights (not four)
- Power/communications infrastructure provided by airframe

Con

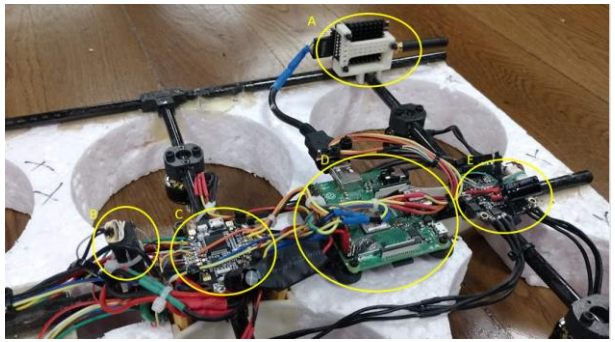
- Vehicle/payload combo much bigger than payload only
- Vehicle optimised for on-station phase, not flight

The UAV

2kg hexacopter with rotors inboard of robotic “disguise carapace”

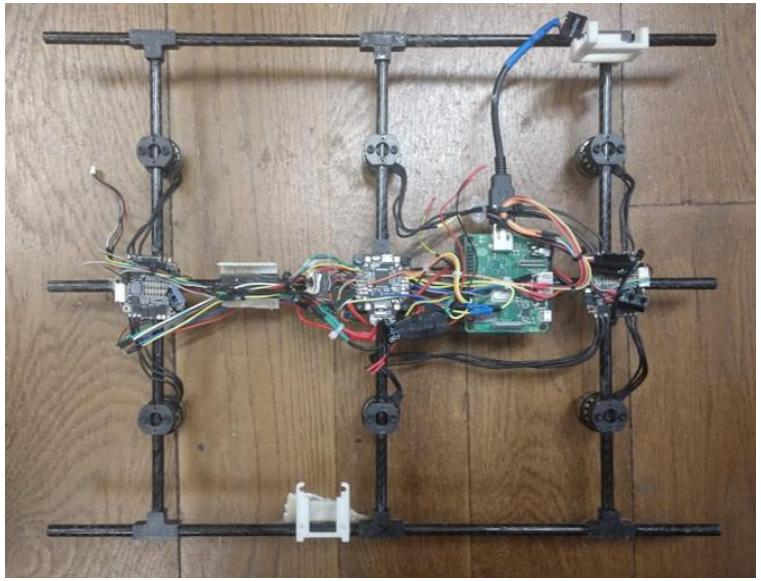
Development threads

- Airframe/propulsion
- Avionics/ground-control (“Systems”)
- Disguise



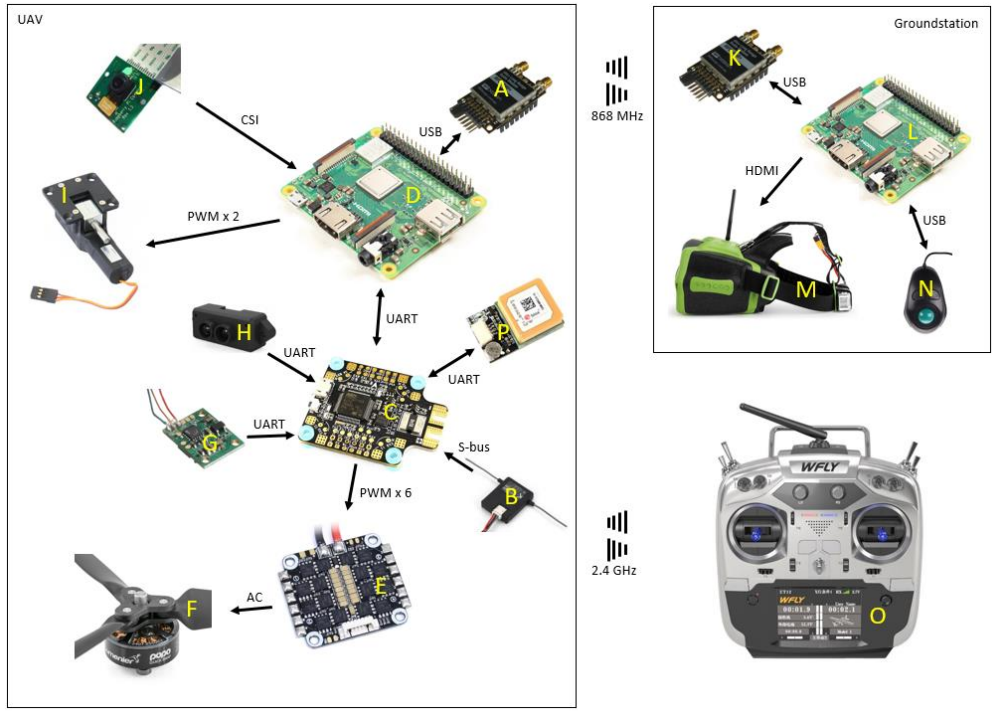
Airframe & propulsion

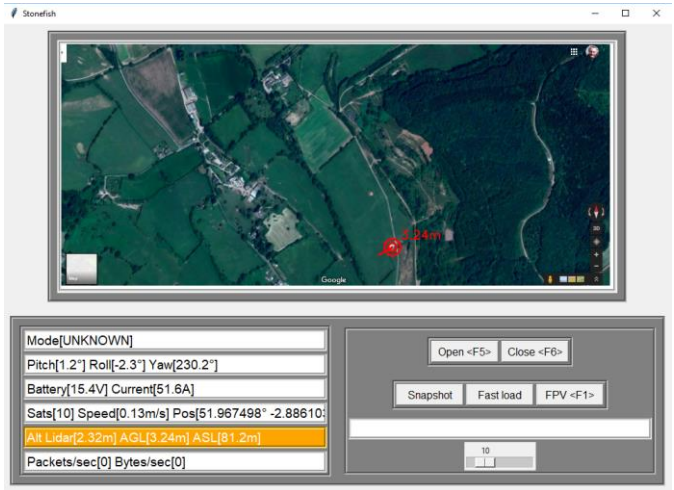
- Narrow hexacopter
- Dimensions: 460 x 360 x 100mm
- MTOW: 2kg
- Power at hover: 16V x 50A = 800W

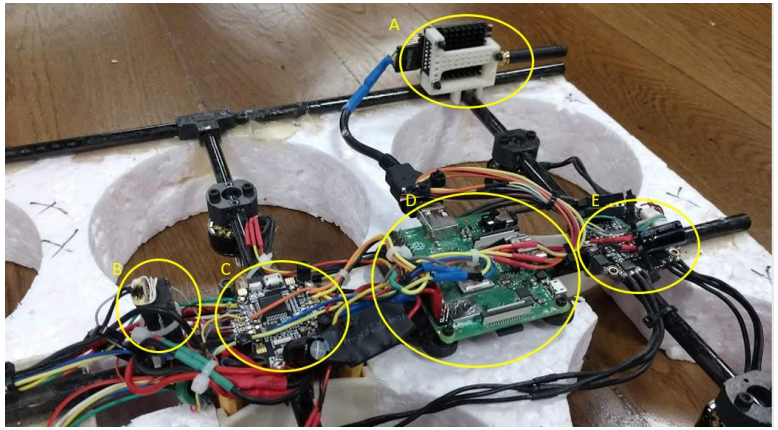


Systems

- Separate Flight Control and Mission Management Units
- Open source software
- Custom ground station GUI
- 600m communications range







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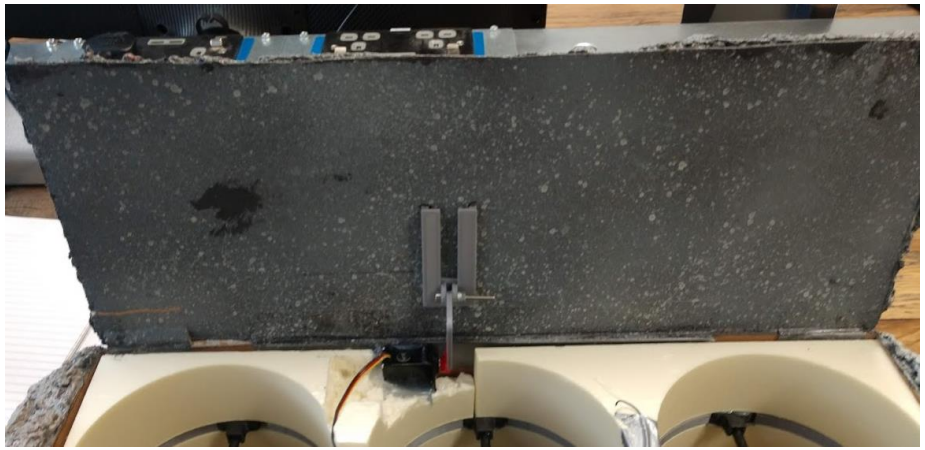
Disguise

- Developed by professional museum exhibit artist
- Water-resistant ply base, painted polystyrene
- Light-weight, flexible, knock-resistant

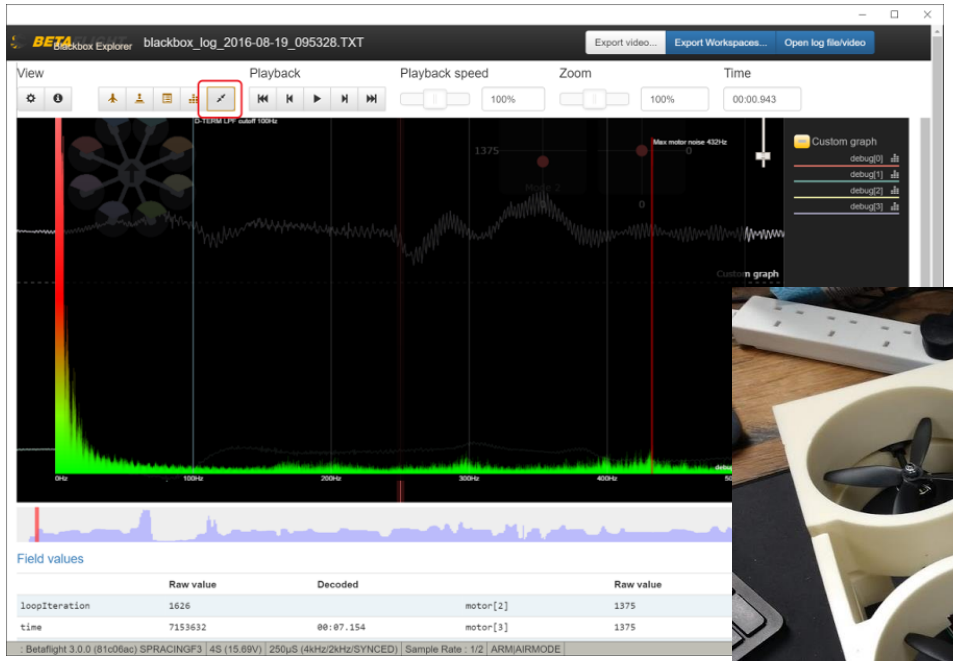


Does it work?

- Controlled flight achieved
- Problems:
  - Rotors too small (high disk loading)
  - Carapace too large, (vibration, drag, inertia)
- All issues anticipated, but greater than expected

Carapace vibrations

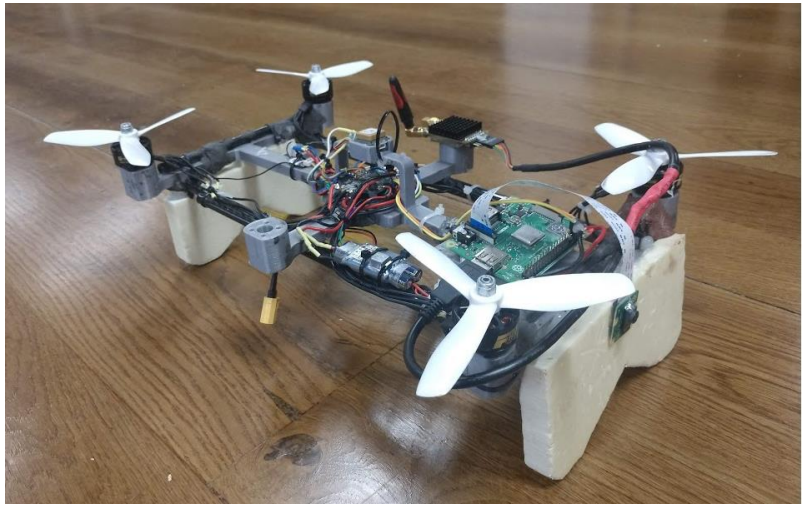
- Careful configuration of notch filters on IMU inputs
- Bracing and baffling of airframe

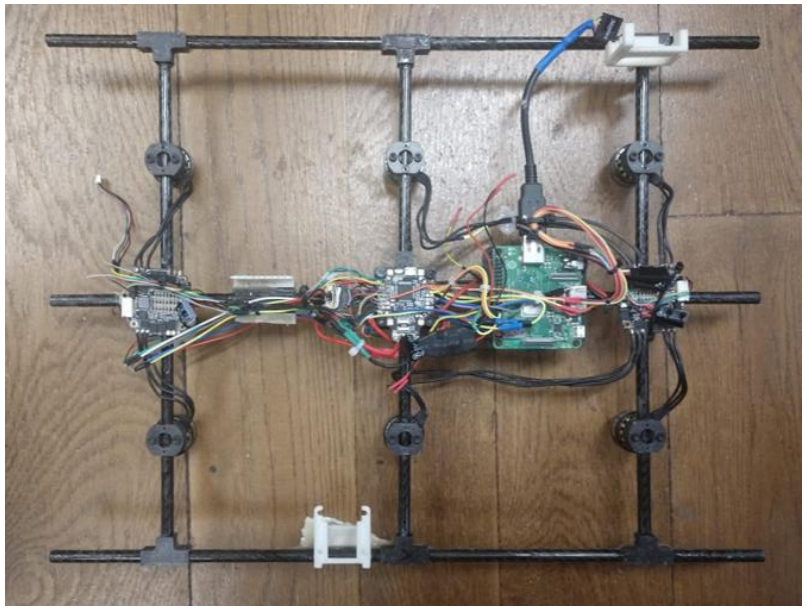


Roll stability

Narrow airframe stable
…until carapace added

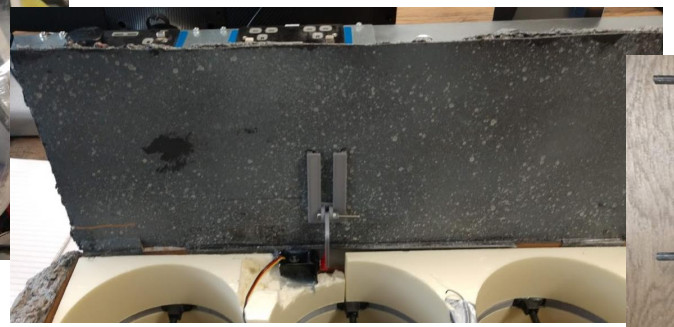
- Reduction of carapace weight
- Tuning of roll PID
- Switch of firmware (iNav to ArduCopter)

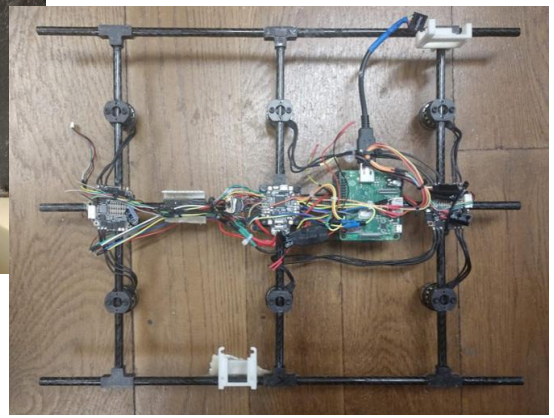




Lessons learned

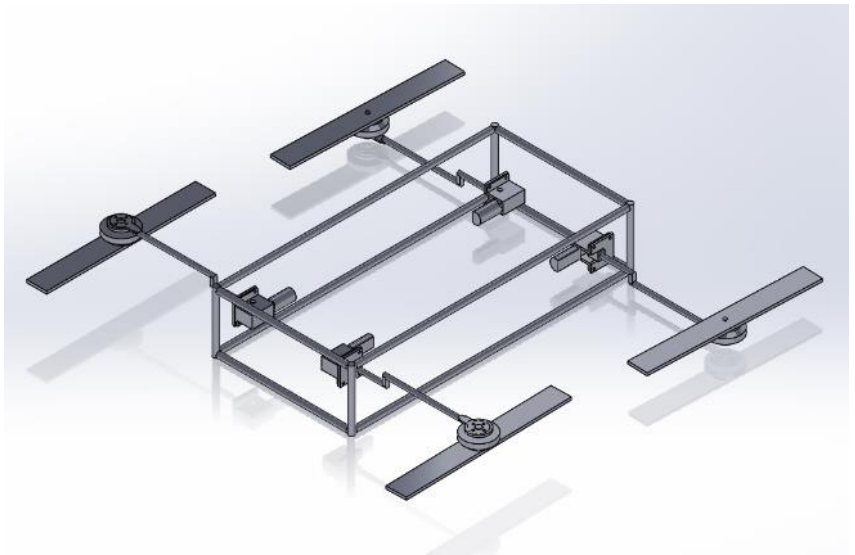
- Overloading of rotors (even) worse than calculated
- Vibrational feedback through resonant structures in fuselage
- Roll instability due to narrow GA *plus* excessive moment of inertia





The future

- New design solves problems of vibration and inertia
- Expecting new issues to arise with robotics and rigidity



See you next year?

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Questions?