Teaching the New Cohort what they don't know they don't know about RPA

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Talk overview

• Introduction and (brief) history of research-RPA courses

• Lessons we’ve learnt from the lessons: Conflicts and Tensions:
  flying platforms vs running payloads
  technical savvy vs science manager

• Cohorts and Teams: the new environment?
History of the Research-RPA School

(apologies for UK-centric coverage!)

QuestUAV: first UK commercial group to focus on research RPA ~2011.

Initially a beach-art photography group, invited to the NCAS Atmospheric Measurement Summer School on Arran:

QuestUAV recognised the need for simple-to-fly Earth Observation platform coupled to training for University-style operators: get results in under a week!

This approach was possible due to ‘uncertainty’ whether research and teaching was Arial Work. Still an unresolved issue in UK...
History of the Research-RPA School

QuestUAV became the *de facto* one-stop-shop for UK Universities and Environmental agencies, mostly by word of mouth.
History of the Research-RPA School

Post ES0802: Norway, UK (+ please send me other examples!) started UAV training courses for early career scientists. SAMS offered non-piloting Continual Professional Development (CPD) courses from 2012, with guest lectures from the (small!) UK RPA community.

A bit cheeky, as the lecture group had limited flight experience, but we wished to host an evolving network of UK RPA users.

Feedback very positive, but market saturated by 2016.
History of the Research-RPA School

The Natural Environment Research Council (NERC) Advanced Training Course: (Rick, Keri and Phil! (plus Rob MacKenzie)

Fully funded for 12-25 UK PhD students, 4 day residential course. No formal pilot qualifications, although includes 1 day of flying indoor missions.

RKP Team have won the funding for the course for four consecutive years.

Heavily focused on getting the student aware of issues around operating RPA for science.
History of the Research-RPA School

Happy students taking ground based observations during the out-door survey of Oban Airport

In-door day, and five teams coordinate to map, survey and sense the scenarios:
History of the Research-RPA School

Worried students sending their instrumented Parrot towards an active volcano!

Beyond the mountains, Tracy Island and The Lost World are threatened by an oil slick and tectonic activity...
History of the Research-RPA School

NEXUSS: 2016-2020+

“Centre for Doctoral Training”

“Smart and Autonomous Observing Systems (SAOS) technology”

“highly engaging SAOS Grand Challenge events”

The NEXt Generation Unmanned Systems Science (NEXUSS) Centre for Doctoral Training is funded by the NERC and Industry, in partnership with the Universities of St Andrews, Edinburgh, Glasgow, Heriot-Watt, University of Hull, University of Strathclyde, University of the Highlands and Islands, the Scottish Association for Marine Science and the University of Plymouth.

The Centre will tackle major challenges in the environmental sciences through the development and application of Smart and Autonomous Observing Systems (SAOS) technology. NEXUSS will develop a generation of future environmental scientists through an innovative sector-led training programme centred around highly engaging SAOS Grand Challenge events.
Our vision is to develop, deliver and disseminate the world’s first environmental science doctoral training programme founded around competitive team grand challenges (GCs) that are sponsored fully by industry.

Annual GC events will be the centre piece of the NEXUSS community, in which first year student teams with mixed skill sets coached by senior student cohorts will design and deploy SAOS technologies and apply vigorous data analysis techniques to address and report on a simulated, real-world environmental problem.”

Year 1 (2017) to be hosted at SAMS: ISARRA opportunity?
Lessons we’ve learnt from the lessons #1: flying platforms vs running payloads

Initial efforts for the SAMS RPA team in 2012 focused on getting a camera and a thermometer in the air. Simulator training was sufficient for piloting, followed by hands on with a cheap ‘styrene airframe, electric power and open source avionics.

RPA Team experience: flight failure more frequent due to system errors (check list error), rather than pilot skill. For teaching RPA, in a limited time, the emphasis was on science (sensors and mission planning) and flight theory (what you can sensibly ask the aircraft to do). But,

Most students wanted to fly the plane…
Lessons we’ve learnt from the lessons #1: flying platforms vs running payloads

Question: will the future of research groups operating robotics include piloting within the skill set?

Operating the Parrot using a cheap ‘Hudl’ tablet... sufficient skill 10 minutes... or never

Ideal if not interested in including piloting!
Lessons we’ve learnt from the lessons #1: flying platforms vs running payloads

If some level of “mission operation” is desirable, we now need an (cheap) indoor Add-on or Plug-in to the avionics (Paparazzi, 3DR etc). Rick’s work in progress...
Lessons we’ve learnt from the lessons #1: flying platforms vs running payloads

Back to ISARRA group:

Question: do we have institutes that have sufficient in-house pilot access, or should we move to assuming we can always get access to commercial (SME-level) piloting.
Lessons we’ve learnt from the lessons #2: technical savvy vs science manager

Question: will the future of research groups operating robotics include piloting engineering within the skill set?

Analogy with sensor building:

1980: PhD student built their own 6809 computer
1990: PhD student programmed a commercial computer in C
2000: Student operated a shiny white instrument with 193 page manual
2010: Student builds Arduino based mesh network of sensors programmed using python… : )
Lessons we’ve learnt from the lessons #2: technical savvy vs science manager
Lessons we’ve learnt from the lessons #2: technical savvy vs science manager

Will the future of research groups operating robotics need to include engineering within the skill set?

Yes, at least at some level

Introducing the **Nadiroscope™**
Lessons we’ve learnt from the lessons #1: technical savvy vs science manager

Introducing the Nadiroscope™

Precise, optically exact positioning every time, converting your FPV AR.Drone into a High Definition mapper!
Lessons we’ve learnt from the lessons #2: technical savvy vs science manager

Introducing the Nadiroscope Version II™
Lessons we’ve learnt from the lessons #2:
technical savvy vs science manager

In NEXUSS design, there was a “lively internal discussion” whether to include engineering-focused projects, or whether NEXUSS should even encourage the concept of tech-savvy.

Argument for: many Universities do not ‘share’ their actual engineers (which do not mean “Engineering Department lecturers”) leading to poor equipment (build by environmental scientists) trying to support 1st class science. Including engineering-focused projects would encourage inter-disciplinary teams

Argument against: NEXUSS was about using robotics, not designing them (which was already strongly funded).
Lessons we’ve learnt from the lessons #2:
technical savvy vs science manager

Solution was for all project to be science driven (-ish*) but to encourage engineers to apply for science projects. Including strong tuition to get engineers up to speed on science back ground and advertising PhD opportunity actively in engineering departments.

Lively discussion continues!

* -ish e.g. a terrain following project (incorporating a small laser altimeter into the avionics) was proposed as a necessity for surface layer flux measurement in the SBL over lakes. A genuine science need, but a technical problem.
Lessons we’ve learnt from the lessons #2: technical savvy vs science manager

Back to ISARRA group:

Question: do we have institutes that have sufficient engineer support to operate airborne robotics, or do our meteorological departments need to employ dedicated engineers?
Cohorts and Teams: the new environment?

Final few thoughts on the way NEXUSS teaching and Environmental grants are developing (again UK-centred, but likely to be universal).

Robotics are only a new technique, a method to have a mobile (rather than static) sensor. But, ...

• Added complexity means it is unlikely the student or early stage researcher is encouraged to delve into robotics if they want to get to early publication. (Discuss!)

• Rapid evolution means that mature researchers are soon out-of-date with technology. (Discuss again!)

• Diverse skills sets means that running and participating in successful teams is essential in the environmental sciences, and ever more so in the future.
  • The day of the lonely PhD is over.
Reflection

Teaching is not just a by-product of our research. It should be a crystal ball, our guess at what future science avenues will be fertile, and how to place our students so fall into their Medevar Zone:

In *The Art of the Soluble*, Medawar suggested that there seems to be a certain time when scientific questions seem especially ripe for answering, whereas other questions remain elusive and out-of-reach from investigation.

Success in doing *and* teaching “Atmospheric Research with RPA” both rely on successfully betting on the future, and what the new technology will make accessible to us.
Shane Rodwell and 3DR laser-mapping crevasses, Svalbard