SCOTTISH ASSOCIATION *for* MARINE SCIENCE

ISARRA
23rd May 2016
Toulouse, France

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

Phil Anderson

Scottish Association for Marine Science, Oban, Scotland

Scottish Marine Institute,
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Teaching the New Cohort what they don't know they don't know about RPA

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?

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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:

University of Newcastle

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...

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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.

NATURAL ENVIRONMENT RESEARCH COUNCIL
British Antarctic Survey
National Centre for Atmospheric Science
Science & Technology Facilities Council
northumbria UNIVERSITY
Newcastle University
UNIVERSITY OF EXETER
Durham University
UNIVERSITY OF COPENHAGEN
UNIVERSITY OF Southampton
KING'S College LONDON
THE UNIVERSITY of York
SAMS
UNIVERSITY OF LEEDS
Centre for Ecology & Hydrology
Cefas

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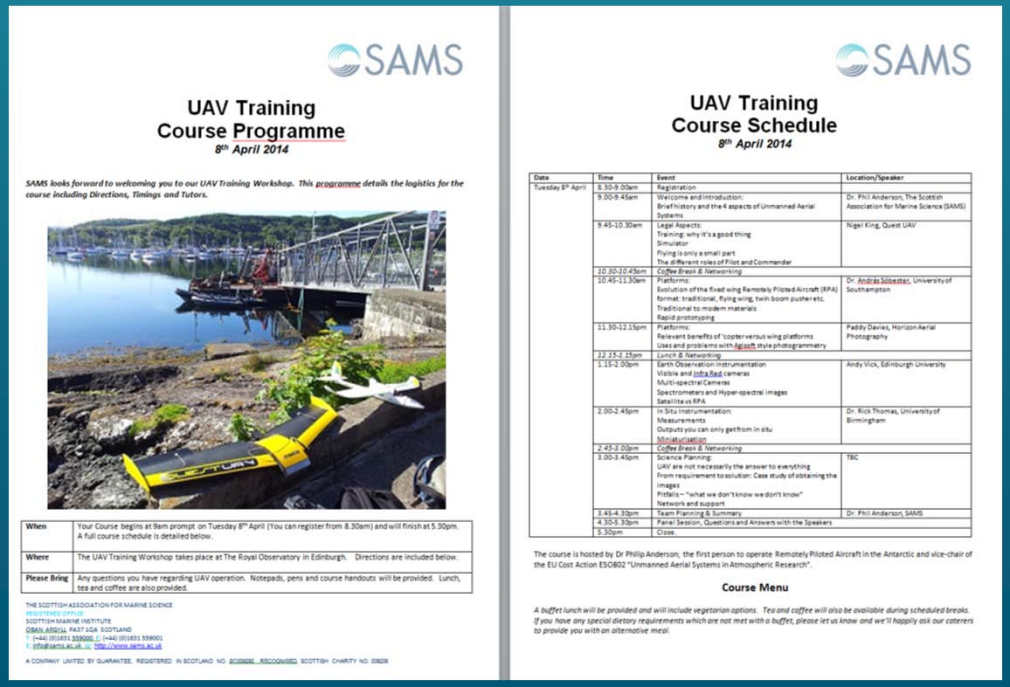
History of the Research-RPA School

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.



SAMS

UAV Training
Course Programme
8th April 2014

SAMS looks forward to welcoming you to our UAV Training Workshop. This programme details the logistics for the course including Directions, Timings and Tutors.

When	Your Course begins at 9am prompt on Tuesday 8th April (You can register from 8.30am) and will finish at 5.30pm. A full course schedule is detailed below.
Where	The UAV Training Workshop takes place at The Royal Observatory in Edinburgh. Directions are included below.
Please Bring	Any questions you have regarding UAV operation. Notepads, pens and course handouts will be provided. Lunch, tea and coffee are also provided.

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SAMS

UAV Training
Course Schedule
8th April 2014

Date	Time	Event	Location/Speaker
Tuesday 8th April	8.30-9.00am	Registration	
	9.00-9.45am	Welcome and Introduction: Brief history and the 4 aspects of Unmanned Aerial Systems	Dr. Phil Anderson, The Scottish Association for Marine Science (SAMS)
	9.45-10.30am	Legal Aspects: Training: why it's a good thing Simulator Flying is only a small part The different roles of Pilot and Commander	Nigel King, Quest UAV
	10.30-10.45am	*Coffee Break & Networking*	
	10.45-11.30am	Platforms: Evolution of the fixed wing Remotely Piloted Aircraft (RPA) format: traditional, flying wing, twin boom pusher etc. Traditional to modern materials Rapid prototyping	Dr. András Sóbester, University of Southampton
	11.30-12.15pm	Platforms: Relevant benefits of 'copter versus wing platforms Uses and problems with Agisoft style photogrammetry	Paddy Davies, Horizon Aerial Photography
	12.15-1.15pm	*Lunch & Networking*	
	1.15-2.00pm	Earth Observation Instrumentation Visible and Infra Red cameras Multi-spectral Cameras Spectrometers and Hyper-spectral Images Satellite vs RPA	Andy Vick, Edinburgh University
	2.00-2.45pm	In Situ Instrumentation: Measurements Outputs you can only get from in situ Miniaturisation	Dr. Rick Thomas, University of Birmingham
	2.45-3.00pm	*Coffee Break & Networking*	
	3.00-3.45pm	Science Planning: UAV are not necessarily the answer to everything From requirement to solution: Case study of obtaining the images Pitfalls – "what we don't know we don't know" Network and support	TBC
	3.45-4.30pm	Team Planning & Summary	Dr. Phil Anderson, SAMS
	4.30-5.30pm	Panel Session, Questions and Answers with the Speakers	
	5.30pm	Close	

The course is hosted by Dr Philip Anderson; the first person to operate Remotely Piloted Aircraft in the Antarctic and vice-chair of the EU Cost Action ES0802 "Unmanned Aerial Systems in Atmospheric Research".

Course Menu

A buffet lunch will be provided and will include vegetarian options. Tea and coffee will also be available during scheduled breaks. If you have any special dietary requirements which are not met with a buffet, please let us know and we'll happily ask our caterers to provide you with an alternative meal.

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.

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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 includes1 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.

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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:

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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 threated by an oil slick and tectonic activity...

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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"

NEXt generation Unmanned Systems Science

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NEXUSS: 2016-2020+

Next Generation Unmanned System Science (NEXUSS) Centre for Doctoral Training

Overview | Funding and eligibility | How to apply | About NEXUSS

SAMS (Scottish Association for Marine Science) is offering fully funded PhD studentships to outstanding candidates from the UK or EU.

Studentships are offered through NEXUSS (Next Generation Unmanned System Science), a new centre of doctoral training in the use of Smart and Autonomous Observation Systems (SAOS) for the environmental sciences, funded jointly by NERC and EPSRC.

Students will be based at The Scottish Association for Marine Science (SAMS) in Oban, on the west coast of Scotland. SAMS is an academic partner of the University of the Highlands and Islands and is one of the UK's premier marine research institutes.

Candidates can apply for the following PhD project:

From above and below: the Double Boundary Layer problem

Applicants should have, or expect to obtain, a first class or upper second-class honours degree in a relevant subject or equivalent qualification.

Closing date for applications: 1st May 2016

Training programme

Students will experience a programme of approximately 16 weeks of highly experiential training in the development and application of state-of-the-art SAOS technologies and approaches in the environmental sciences, alongside comprehensive personal and professional development.

There will be extensive opportunities for students to expand their multi-disciplinary outlook through interactions with a wide network of academic, research, industry, government and policy partners.

Grand Challenge

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.

"Grand Challenge

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Year 1 (2017) to be hosted at SAMS: ISARRA opportunity?

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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…

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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?

Ideal if not interested in including piloting!

Operating the Parrot using a cheap 'Hudl' tablet… sufficient skill 10 minutes.. or never

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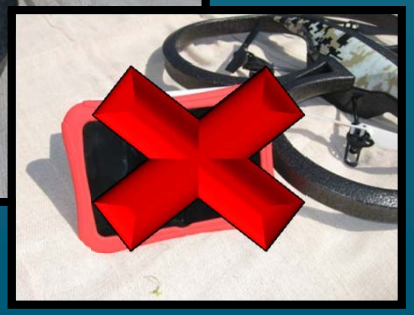
Lessons we've learnt from the lessons #1: flying platforms *vs* running payloads

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...



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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.

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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 Aduino based mesh network of sensors programmed using python… :)

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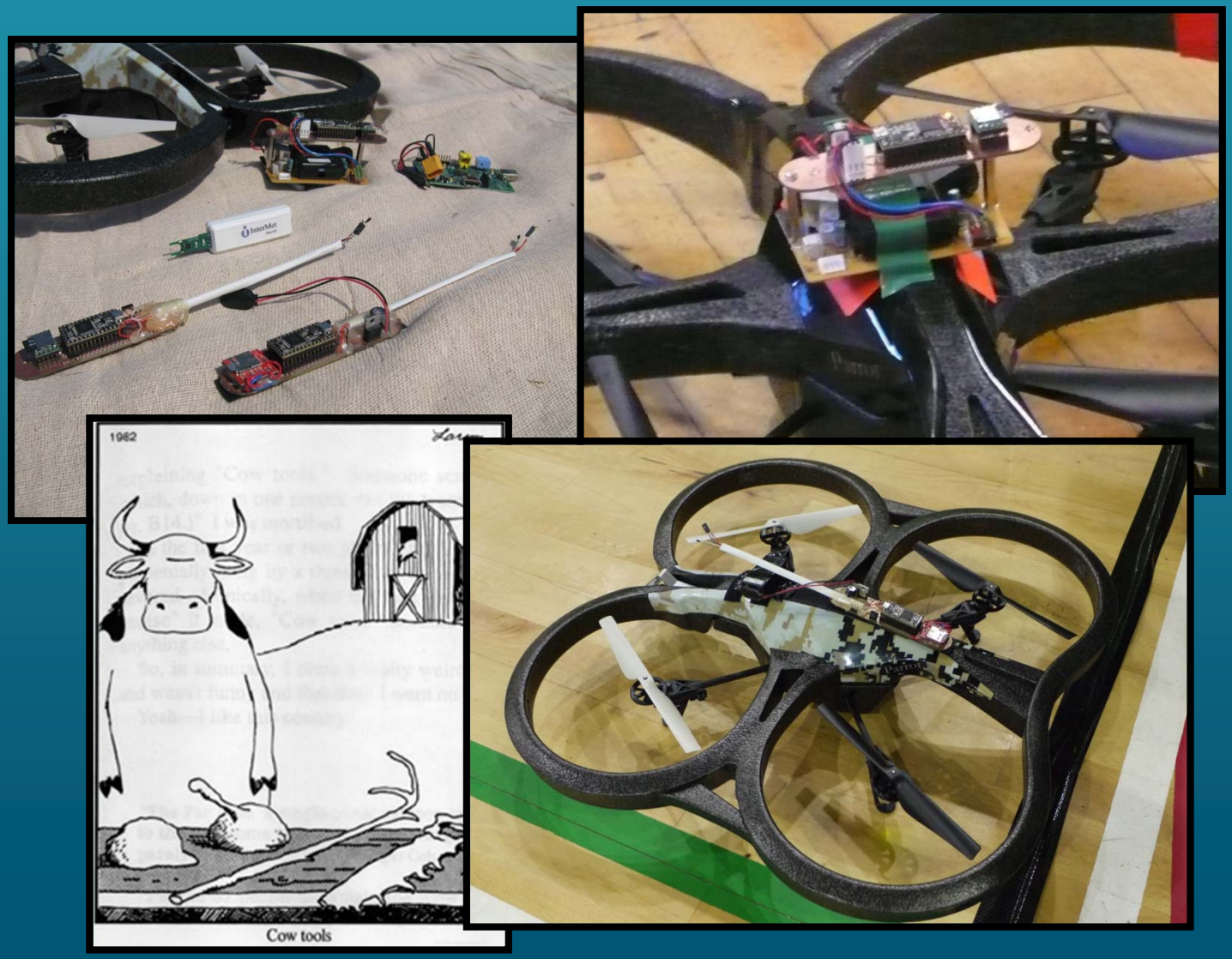
Lessons we've learnt from the lessons #2: technical savvy *vs* science manager



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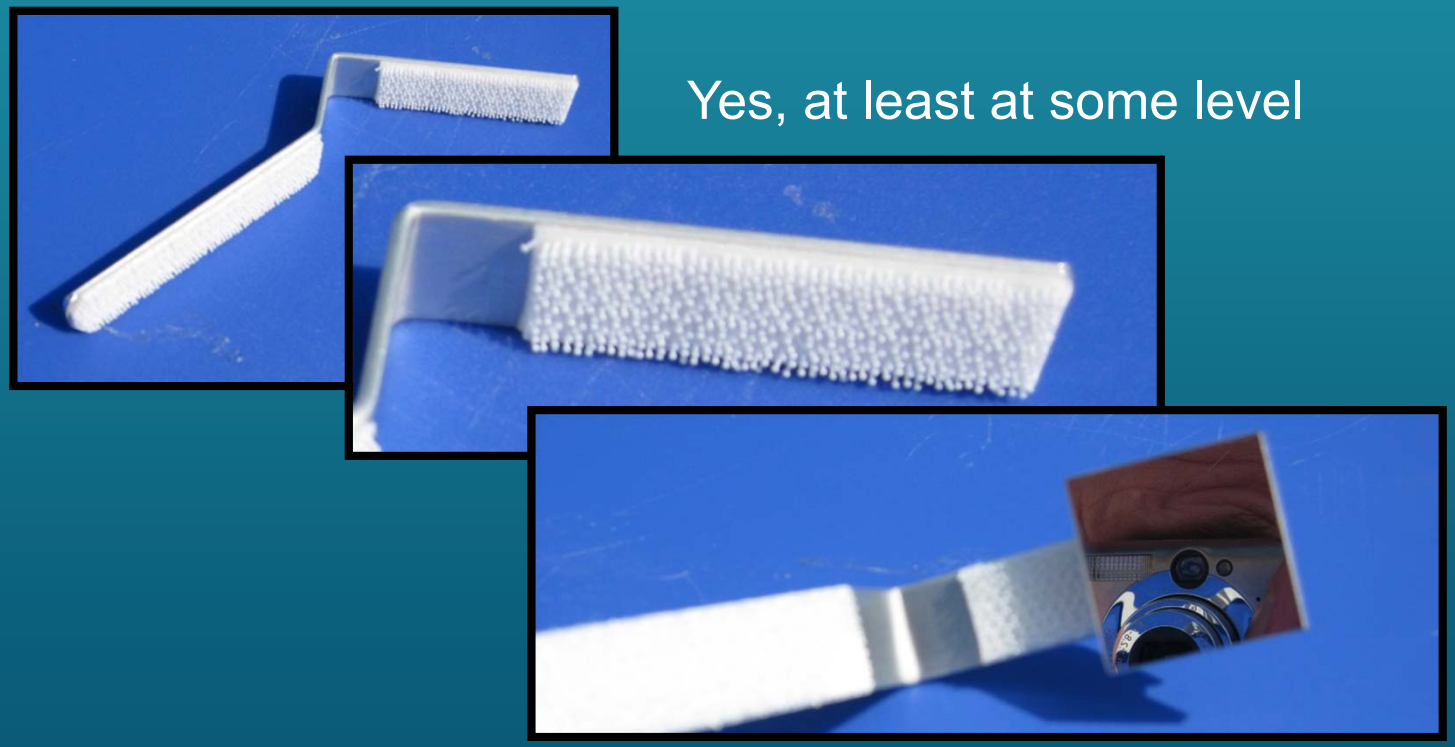
Lessons we've learnt from the lessons #2: technical savvy *vs* science manager

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



Yes, at least at some level

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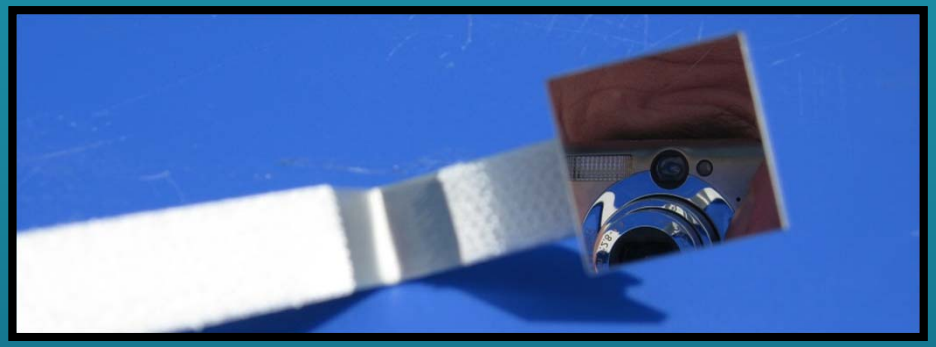
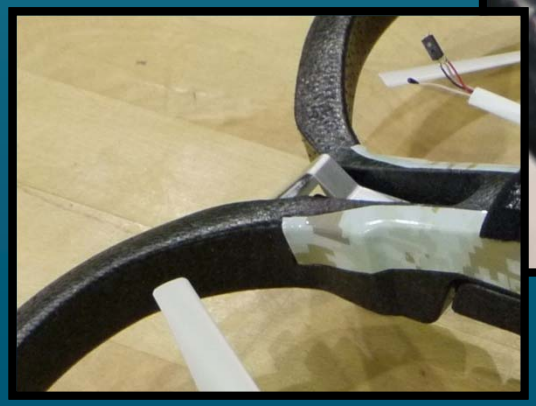
Lessons we've learnt from the lessons #1: technical savvy vs science manager

Introducing the Nadiroscope™



Precise, optically exact positioning every time, converting your FPV AR.Drone into a High Definition mapper!



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Lessons we've learnt from the lessons #2: technical savvy *vs* science manager

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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).

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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.

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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?

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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.

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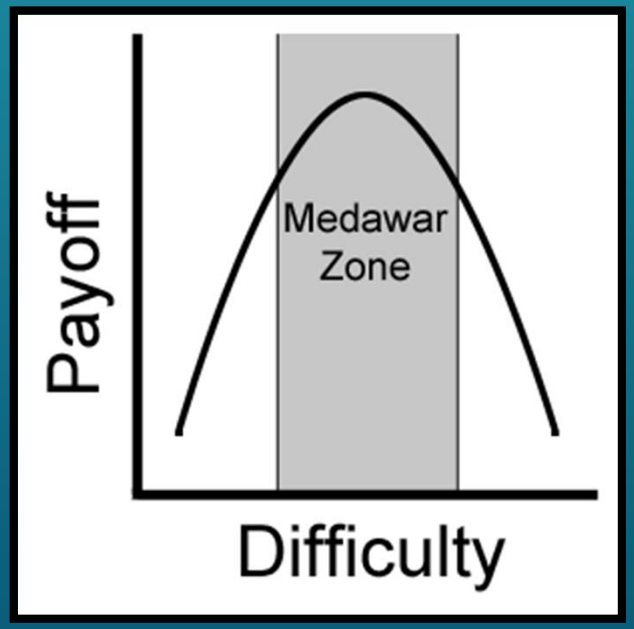
Reflection

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:



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.

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.

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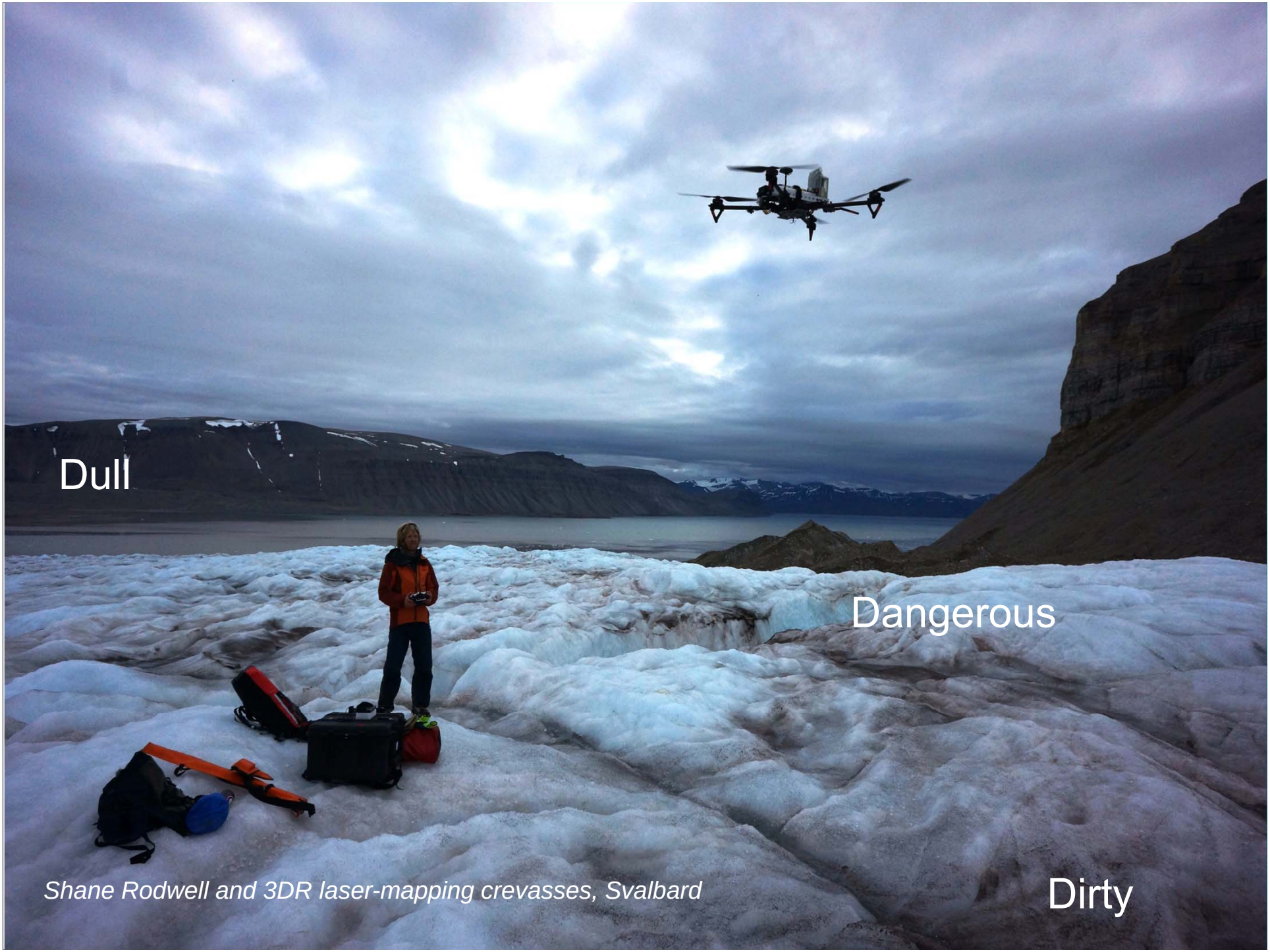

Shane Rodwell and 3DR laser-mapping crevasses, Svalbard