Professor Tom Scott.

Industrial Use of Drones

(From a nuclear context)

ROYAL ACADEMY OF ENGINEERING

fst

NCNR NATIONAL CENTRE FOR NUCLEAR ROBOTICS

UKRI Engineering and Physical Sciences Research Council

Drones: A significant value opportunity across Industry

pwc

"Drones are becoming an increasingly familiar aspect of life and work in the UK today, playing a growing role in areas from emergency services to construction to oil and gas. But this is just the start"

Recently assessed by PWC, by 2030 the industrial impact of drones in the UK is likely to be economically significant.

£42bn
increase in UK gross domestic product (GDP)

£16bn
in net cost savings to the UK economy

76,000
drones operating in the UK's skies

628,000
jobs in the drones economy

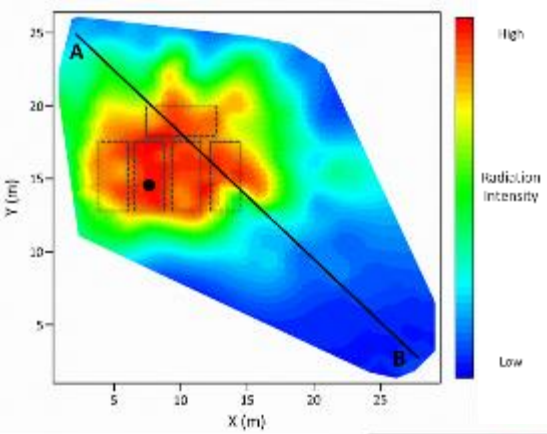
Professor Tom Scott

A UK Nuclear Academic

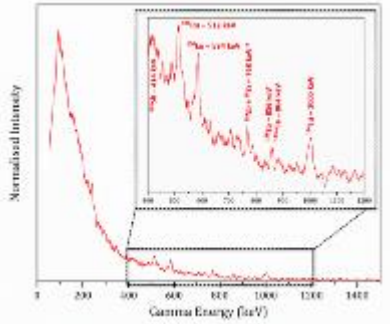
- **RAEng Professor** at the University of Bristol
- **Special advisor to the House of Lords** (2017)
- **Director** of the SW Nuclear Hub (2014-present)
- **Director** of the Interface Analysis Centre (2009-present)
- **Co-Director** Bristol-Oxford Nuclear Research Centre (2011-present)
- Academic lead for the Sellafield Centre of Expertise in Uranium and Reactive metals (2012-present)
- Member of the Programme Advisory Board for Culham Centre for Fusion Energy (UK Fusion programme)

First ever UAV flights at Sellafield in 2014

15 flights over 3 days of operations.



A selection of the results were published in Autumn 2016.



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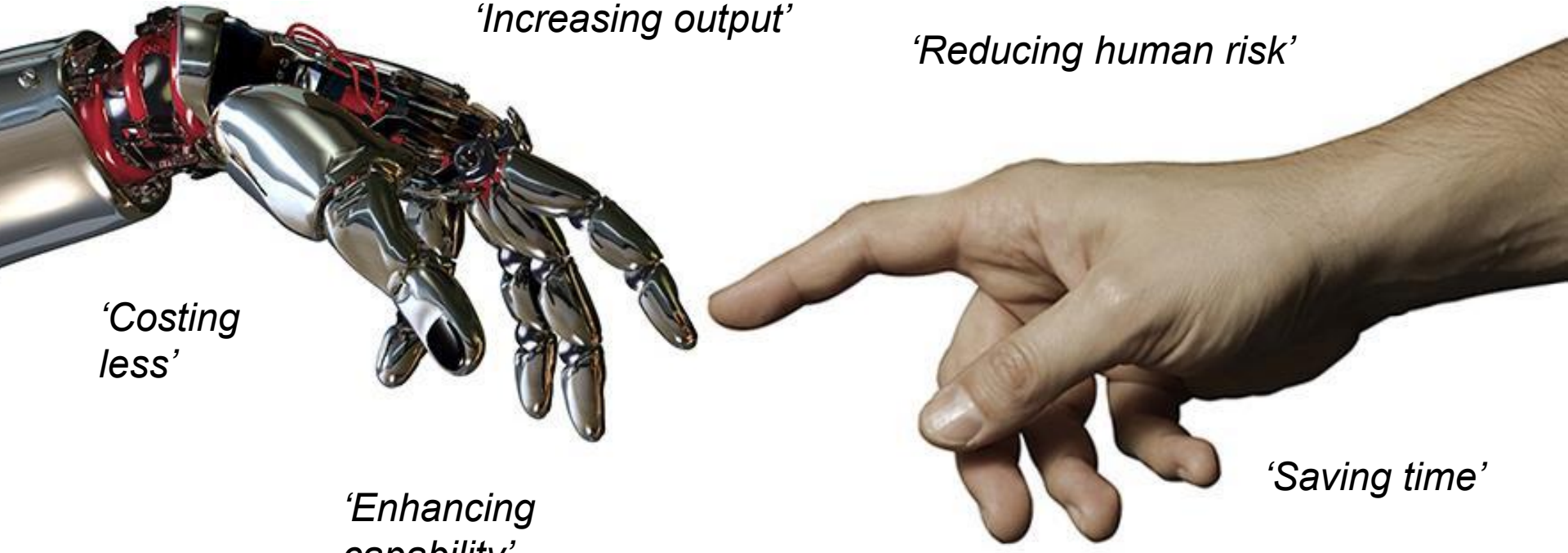
Today, drones are in routine use on site.

Realising the value for robotics in nuclear



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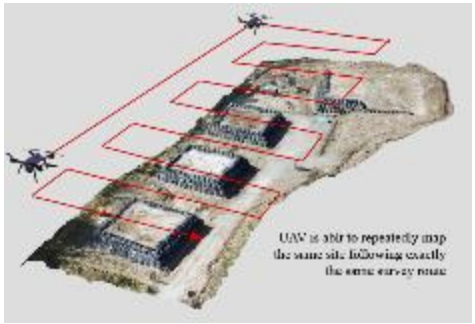
Why use UAVs?

- **Removes operator risk**
- Broad range of uses
- Complimentary new tool
- Rapidly deployed
- Different sensor options
- Wide area & good spatial resolution
- Autonomous & remotely operated

Benefits of UAV radiological inspection

Repeatable



Providing a **repeat survey** following **identical routes** makes **data comparable** when repeated periodically on the same site – spotting temporal variation

Comparable

Human error and **bodily attenuation** prevents easy comparison of results

Sensitive/Accurate

Grand Junction (USA) calibration pads show the ARM system to be sensitive to dose differences **of 0.02 µSv/hr proven.** Comparable with **Ground surveys**.

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Chernobyl

April 26th 1986

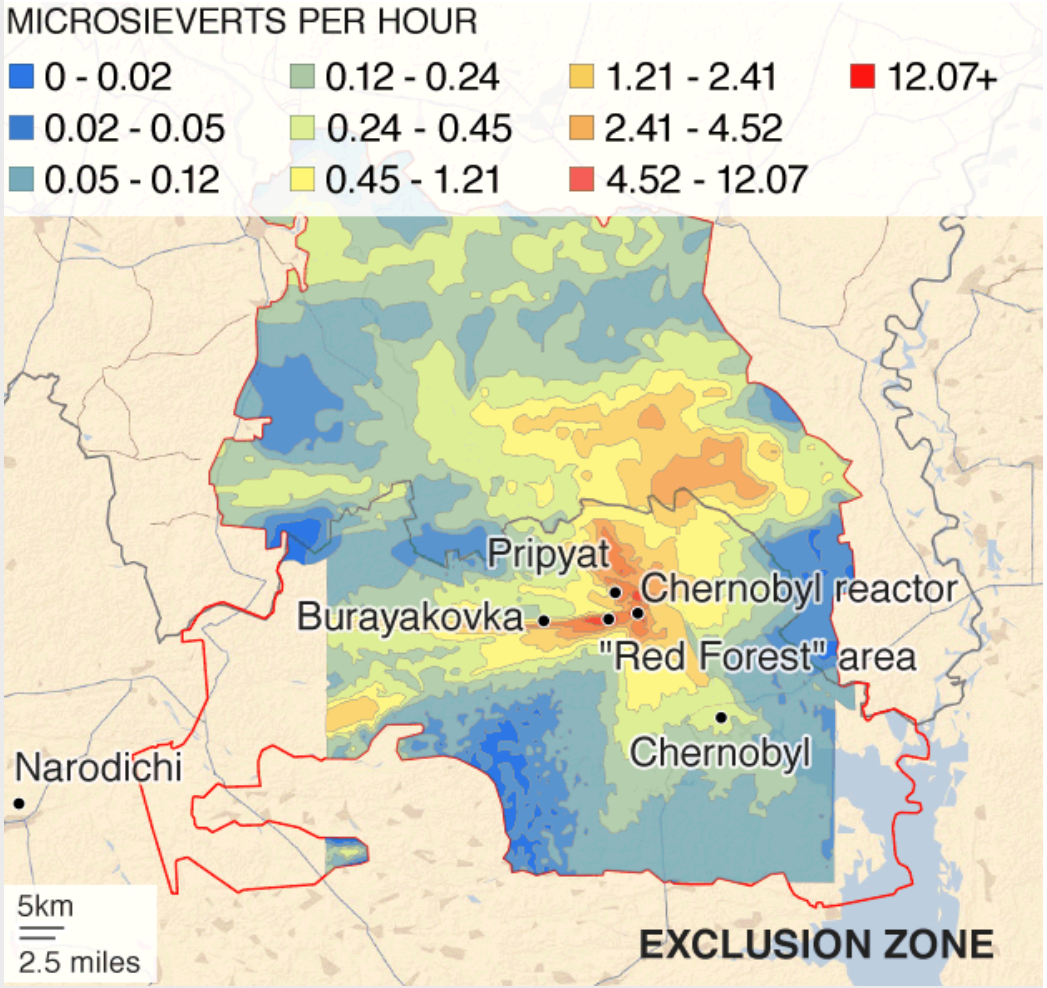
The World's worst nuclear disaster

University of BRISTOL

Source: https://www.history.com/topics/1980s/chernobyl

Mapping the radiation spread in the fallout was performed by men on the ground and in helicopters.

Today we can do it differently..



https://www.bbc.co.uk/news/science-environment-47227767

SOUTH WEST
NUCLEAR HUB

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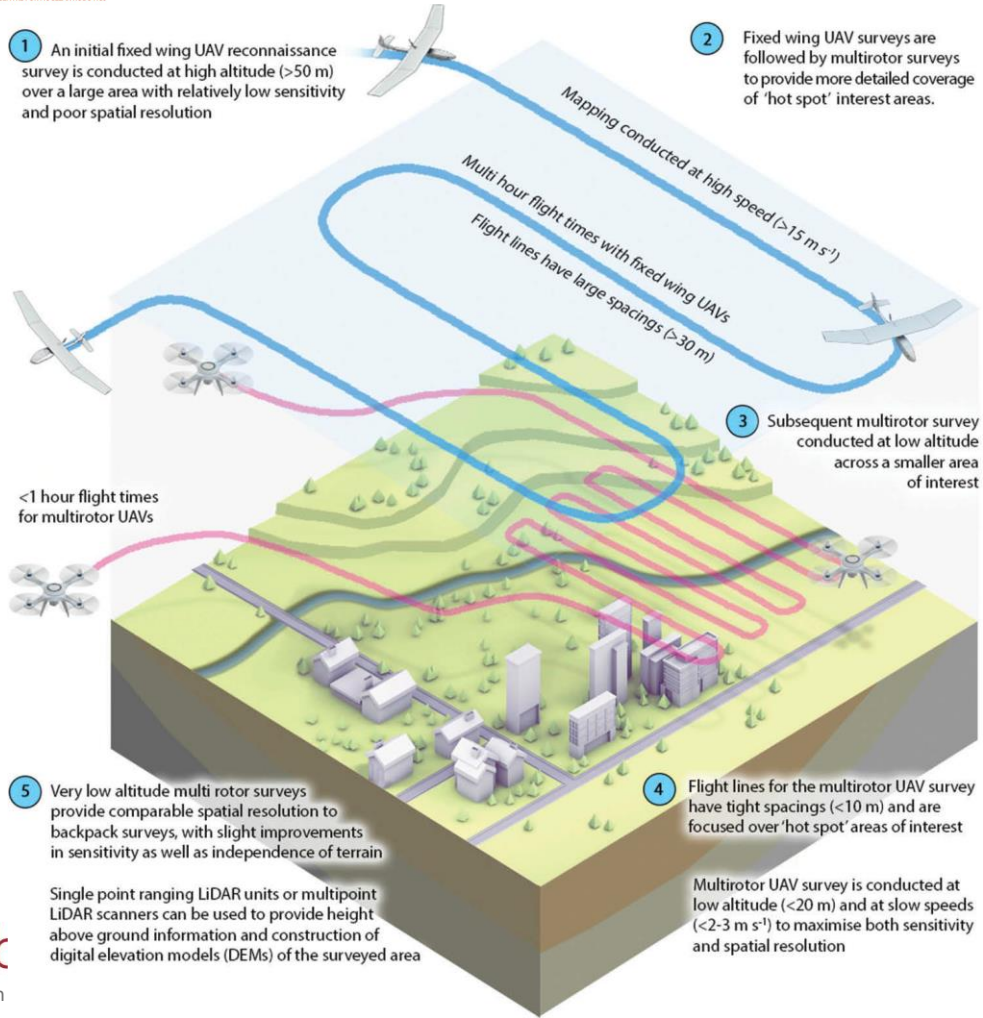

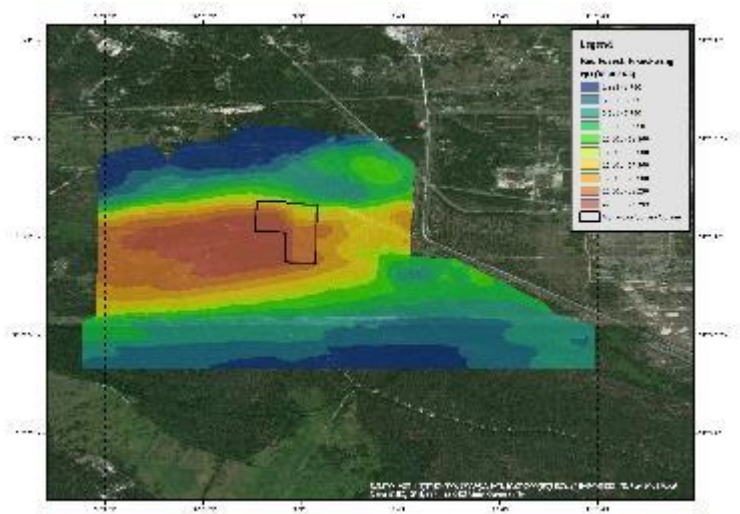

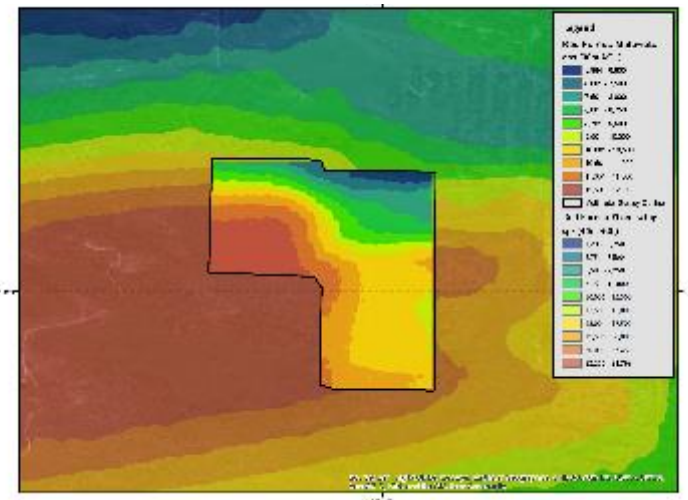

Different Drones for different tasks

Different size/weight classes pose different risks……

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A convergence of technology, societal acceptance and regulation

- For widespread industrial drone usage to be realised, the current regulations **must evolve** to allow further drone use cases.
- Drones differ from other emerging technologies such as artificial intelligence (AI) in that the government **is responsible for the safety of its airspace**, so all uses of drones will need to comply with regulation to ensure airspace safety.
- Other limitations related to flying in **congested areas** and **collecting personal data**, for example by flying near buildings and people or over roads, also need to be considered. **Especially if we start to use flying cars!**

Strongly supported by the UK Government, trials (including Bristol University) are already being run with the aim of proving '**beyond visual line of sight**' (BVLOS) flying is possible while protecting people and property.

Operating Beyond Line of Sight

CCA definition of BVLOS

- 'Beyond the Visual Line Of Sight (BVLOS) of the person flying the aircraft'
- 'If the person flying the aircraft is unable to maintain direct unaided visual contact with it while it is airborne, then an alternative method of collision avoidance must be employed in order to ensure that it can still be flown safely.'

CCA definition of BVLOS

- ***So the definition of BVLOS might be binary but the solution is not!***

- BVLOS flight will normally require either:

    1. a technical capability which is equivalent to the ability of a pilot of a manned aircraft uses to ‘see and avoid’ potential conflictions - this is referred to as a Detect and Avoid (DAA) capability
    2. a block of airspace to operate in which the unmanned aircraft is ‘segregated’ from other aircraft - because other aircraft are not permitted to enter this airspace block, the unmanned aircraft can operate without the risk of collision, or the need for other collision avoidance capabilities

    Note Tom’s note – how do you monitor and ensure the airspace remains segregated during operations?

    1. clear evidence that the intended operation will have ‘no aviation threat’ and that the safety of persons and objects on the ground has been properly addressed.

Segregated Airspace

- Press Release by BBSR - 21st October 2019
  - **Blue Bear conducts BVLOS flights in UK segregated airspace using 5G communications**
  - Blue Bear demonstrated the first long-distance command and control of drones over 5G, controlling the drones in Cumbria from over 200 miles away in Bedford and 300 miles away in London. *A safety pilot in visual line of sight with the drone was always in the loop, but this paves the way for future BVLOS operations in remote areas from a centralised mission control centre*.

BLUEBEAR

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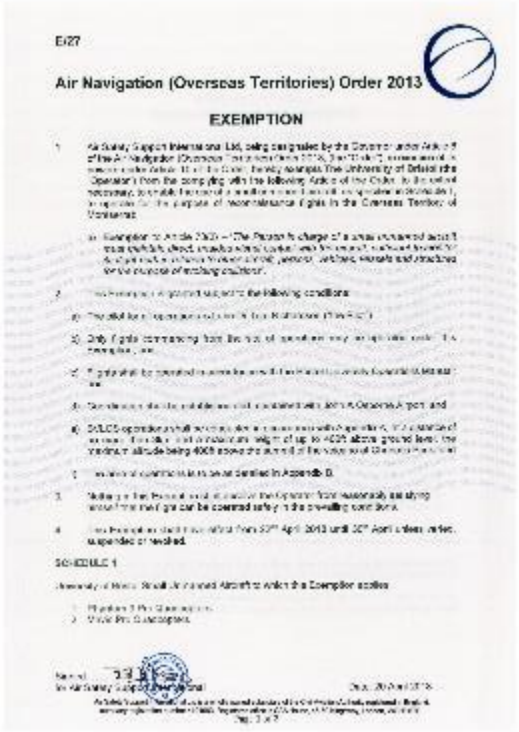
University of Bristol BVLOS permissions
Montserrat, ASSI (CAA)



EI27

Air Navigation (Overseas Territories) Order 2013

EXEMPTION

e) BVLOS operations shall be conducted in accordance with Appendix A, at a distance of no more than 3km and a maximum height of up to 400ft above ground level, the maximum altitude being 400ft above the summit of the volcano at Chances Peak; and

And one from 2014 for Ascenion Island

Regulation of Small Unmanned Aircraft

1. Air Safety Support International Ltd, being designated by the Governor under Article 6 of the Air Navigation (Overseas Territories) Order 2013, (the "Order"), in exercise of its powers under Article 10 of the Order, hereby exempts **The University of Bristol** (the "Operator") from the complying with the following Articles of the Order, to the extent necessary, to enable the use of a small unmanned aircraft, as specified in Schedule 1, to operate for the purpose of collecting air samples up to an altitude of 10,000ft above the United Kingdom Overseas Territory of Ascension Island:

   a) Article 73(3)

Ascension – segregated airspace (1)
Montserrat – shared with limited monitored manned air traffic (3)

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What would it take for BVLOS flight of Drones in (Unmonitored) Unsegregated Airspace to be approved by the CAA?

(*Tom's view*)

a) Absolute minimum
- Proven Detect & Avoid System – approved specifically for airspace type, application and airframe.

b) Very likely to be required
- Electronic Conspicuity. CAA – *Electronic Conspicuity (EC) is an umbrella term for a range of technologies that, in their most basic form, transmit the position of the host aircraft to other airspace users operating compatible equipment*.

c) Expected to have
- Good communications. Standard radio telemetry, 4G/5G and/or satellite coms. The problem here is that there must be approved behaviors / protocol for loss of communications. You cannot rely on guaranteed communications as underpinning the safety case.

d) Nice to have
- UTM. (USA definition) Unmanned Aircraft System Traffic Management is a "traffic management" ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA's Air Traffic Management (ATM) system.

Engaging children in STEM

- Drones are a very popular gift for children.
- They provide a low-cost way to unlock their interest in STEM subjects.
- If we remove access to drones through overly draconian regulations then we remove this STEM engagement opportunity

Summary

- Drones offer a **significant benefit** to many different industries including nuclear.
- Evolution in regulation and legislation **is required** to ensure **safe and responsible drone use.** It must be well considered and appropriate.
- Drones also provide an **excellent way to encourage children into engineering**.
  Lets not take their drones away unnecessarily!

Any Questions?

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Manam Volcano Vent, Papua New Guinea
Photo taken by Bristol University drone under BVLOS conditions
May, 2019

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