Diapositiva 1

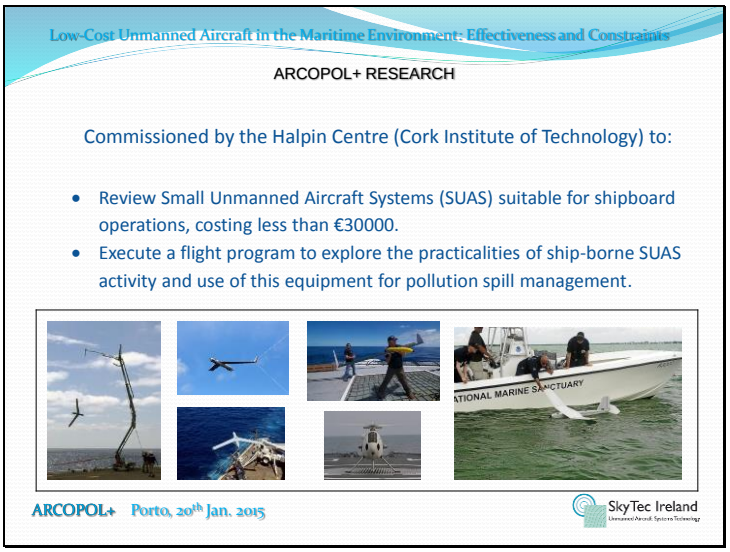
Diapositiva 2

Ladies and gentlemen good morning. I (Mike Griew) represent SkyTec Ireland,

Diapositiva 3

we provide a range of photographic services, run a training facility, and provide consultancy services.

Diapositiva 4

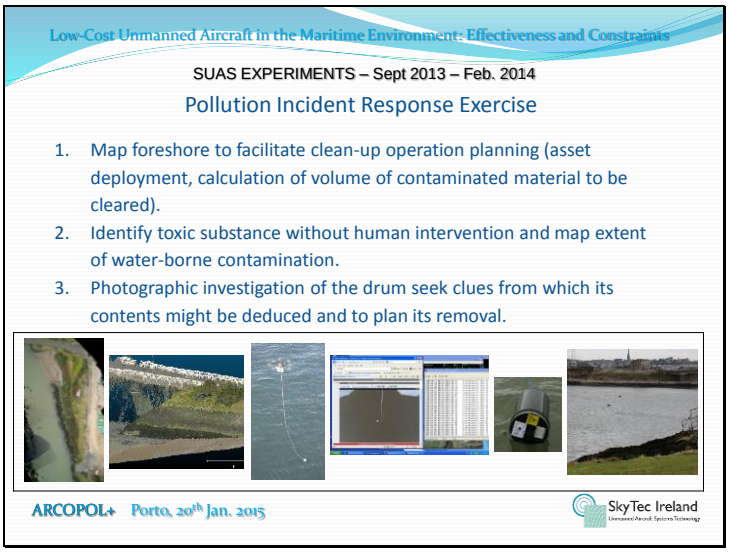


The topic of this presentation is a commission from the Halpin Centre, which is part of Cork Institute of Technology, in which we were asked to review unmanned aircraft systems costing less than thirty-thousand euro capable of maritime pollution support, and to carry out evaluation flights with a suitable aircraft.

Diapositiva 5

For our flight program we envisaged a hypothetical pollution incident in Cork harbor. We imagined a scenario in which a drum, tangled in debris floating in the harbor, had been found snagged on rocks. Water discoloration around the drum and wildlife carcasses found on an adjacent beach prompted a call for robotic investigation prior to human intervention.

Diapositiva 6

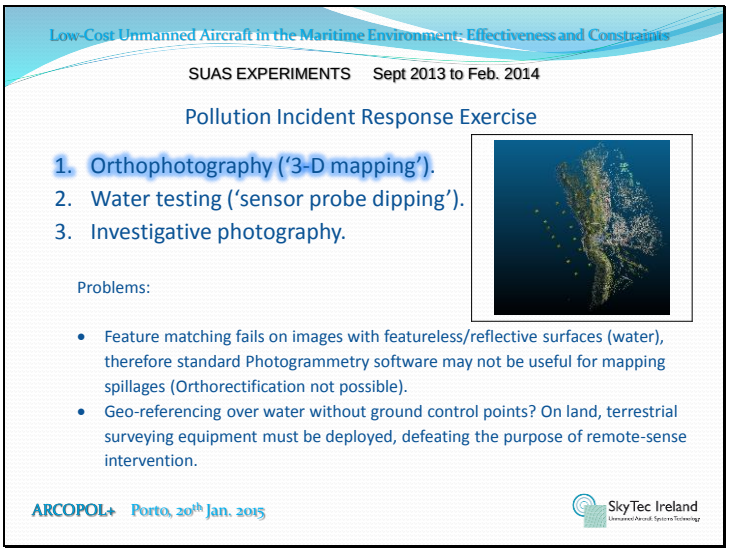


Our first mission mapped the foreshore with photogrammetric software to show how this might provide planning data, such as the width of access points and volumetric data, for the clean-up effort (far left and second from left images).

Our second mission (central two images) simulated mapping the extent of water-borne contamination by dipping a sensor probe. The payload included a downwards looking camera and a wireless computer network system. We can see a screenshot showing sensor data and video feed being viewed on a browser connected to our local network: data could have been distributed onwards via the Internet to computers worldwide. Although our probe measured only temperature, in principle any serial-output device could have been incorporated into the payload.

Our third mission (far right and second from right images) surveyed the drum photographically to simulate the search to determine its contents from labels, and to examine its physical condition and investigate its surroundings in order to plan its removal,

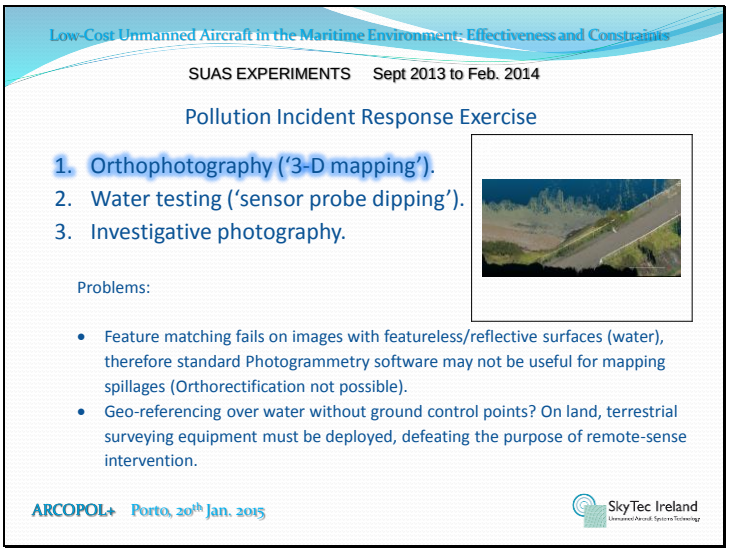
Diapositiva 7



I apologize for including technical explanations in the following review of problems that arose during missions however this knowledge is necessary to understand the challenges faced by those who wish to extend the roles played by low-cost unmanned aircraft and to contextualize our suggestions for future research directions.

We achieved our goal of producing an orthophotograph of the foreshore, but data-set could not have been used to map water. The obvious lack of data points over water seen is on (the left hand side of) this slide leads to erroneous data

Diapositiva 8



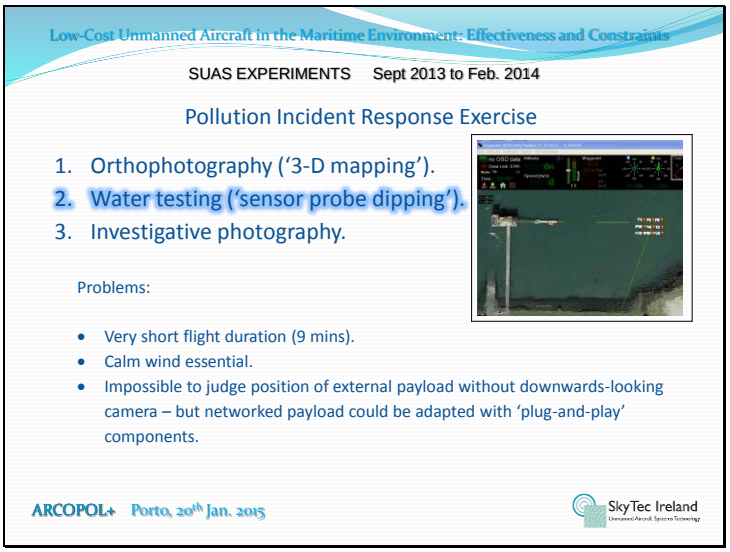
And consequently a sub-optimal 3-D reconstruction.

If standard photogrammetry software cannot cope with over-water imagery, it would not be useful for pollution mapping because scale errors and perspective effects must be removed from low-level aerial images used for Orthophotography. Photogrammetric software needs estimates of camera orientation to orthorectify images, but without surface features to match between adjacent images, software cannot calculate camera orientation.

We must also consider that raw photogrammetric data exists in arbitrary frames of reference. Data must be referenced to real-world coordinate systems: either the camera's precise geographic orientation must be known or ground features must be visible. Without surface features, marine orthophotographs cannot be georeferrenced from imagery alone.

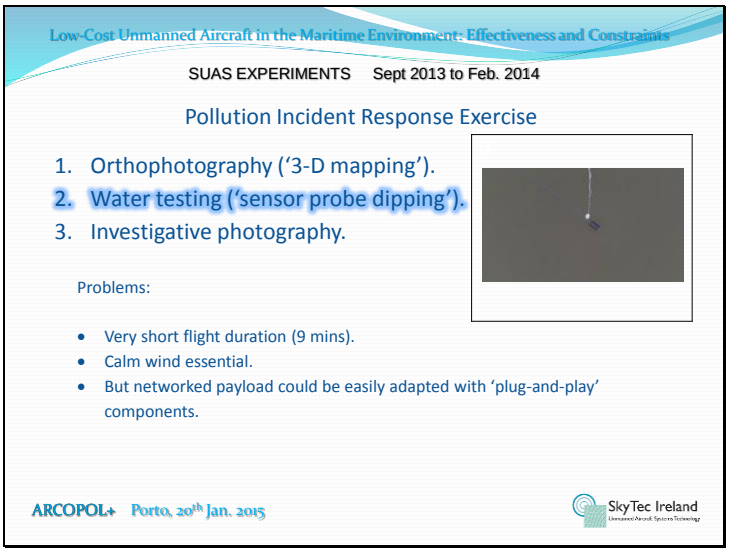
And if photogrammetry is to be used for terrain modeling, as in our foreshore example, we must remember that ground features used for orthorectification must be pinpointed by terrestrial surveyors. The purpose of utilizing remote-sensing as a means to preclude human intervention would be defeated.

Diapositiva 9



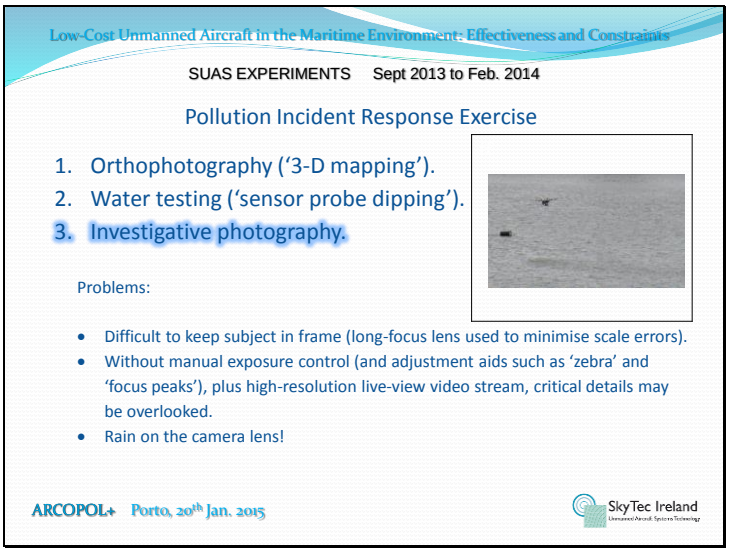
The dipping mission went according to plan, although could only be flown in light winds and lasted only nine minutes, illustrating limitations inherent to drone technology. On a positive note, however, this experiment vindicated our payload design when installed a downwards-looking camera with live video feed simply by adding 'plug-and-play' components. Here you see the pattern of waypoints that had to be centered over the drum

Diapositiva 10



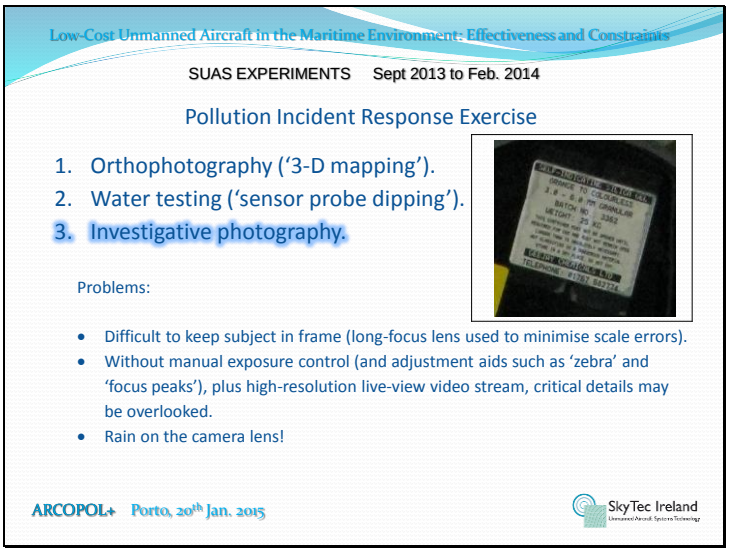
and the frame grabbed from video footage at the moment we recorded the drum's co-ordinates.

Diapositiva 11



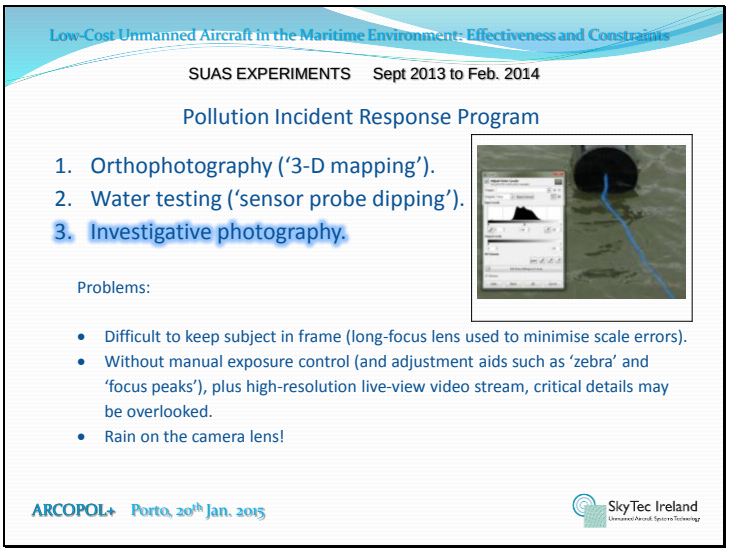
The photographic reconnaissance mission was successful, however lack of precise control over the aircraft's flight path made it difficult to hold station in close proximity to the drum whilst centering the drum in the camera's viewfinder. But flying as close to the drum and the water as we dared

Diapositiva 12



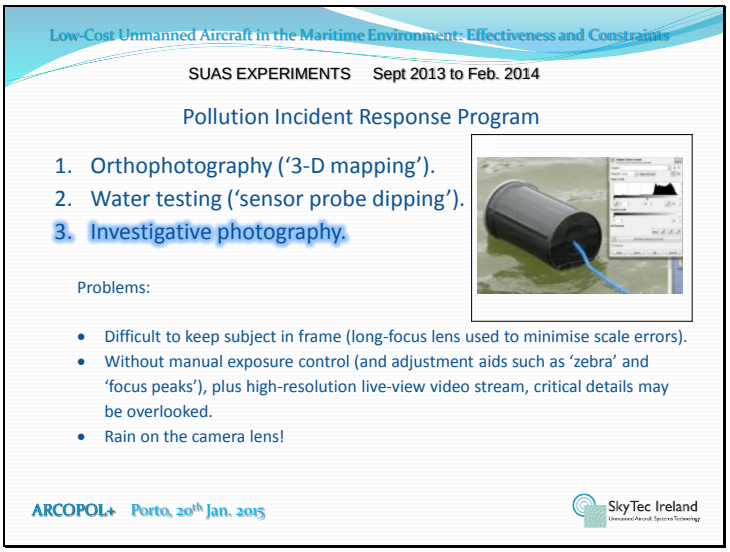
it was just possible to reveal lettering on the label.

Diapositiva 13



And despite being able to remotely-control the camera's exposure settings we found it difficult to extract details given ambient light conditions, the drum's dark reflective surface, and levels of water brightness that varied depending on viewing angle. In this slide, contours of the drum's base and rope attachment are hidden,

Diapositiva 14



until we intentionally over-expose the image.

Diapositiva 15

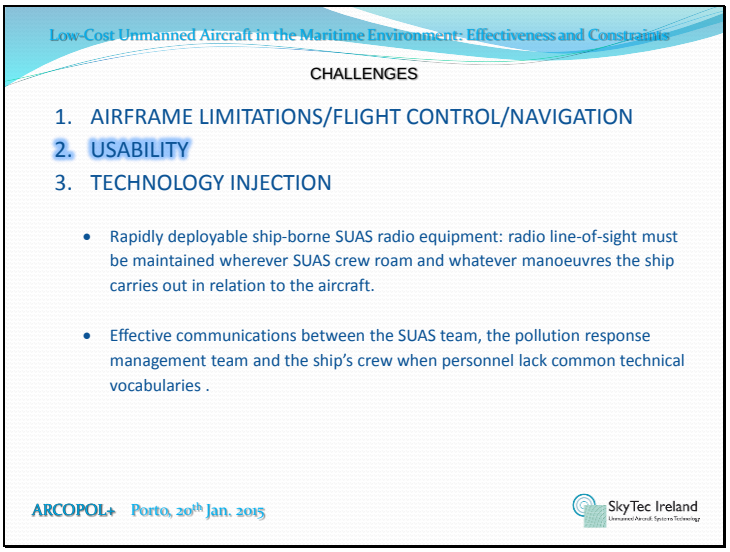
Technological challenges follow logically from these experiments, for example:

•we need affordable aircraft with long flight-times and weather tolerance, yet designs that can take off and land in close proximity from to people on small boats.

•To overcome the problems we encountered orthorectifying and geo-referrencing marine imagery, precise navigation data is needed.

•To simplify control of aircraft when missions must be remotely piloted, better human-machine interfaces, proximity detection, avoidance systems, and non-gps navigation aids are needed.

Diapositiva 16



In regards to deployment of unmanned aircraft in real world incidents we would expect to mobilize vessels of convenience with little time to set-up equipment, but systems depend on unbroken line-of-sight between the aircraft and ship-borne antennae and the pilot being maintained at all times. A means to eliminate cables would permit equipment to be rapidly deployed yet optimally distributed. Furthermore, ad-hoc teams with dissimilar backgrounds and technical jargons might struggle to communicate effectively. Qualification standards should be laid down and operating procedures specified so operators who intend to conduct ship-borne UAS operations can plan appropriately training.

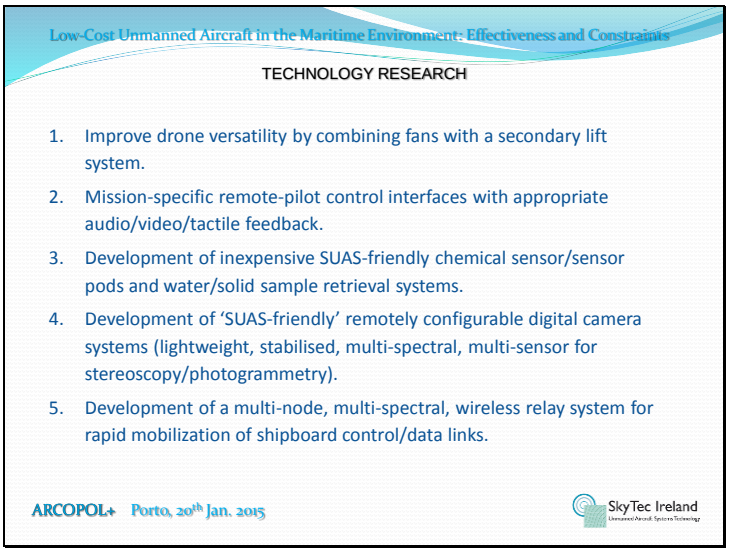
Diapositiva 17

Finally, there are practical and economic barriers to overcome that may otherwise prevent unmanned aircraft technology penetrating niche fields such as pollution management or emergency services support.

Compliance with aviation regulations may discourage State and Semi-state data end-users from becoming directly involved with unmanned aircraft. But can support be successfully out-sourced? Judging from what candidates who have passed through our Academy told us about their business aspirations, we believe end-users may find it impossible to find operators with sufficient manpower to guarantee call-out availability, with access to the variety of aircraft needed to cater for specialized missions, and who possess appropriate technical expertise.

The ongoing dominance of the UAS market by just two manufacturers, whose products are priced in line with recreational model aircraft, must be addressed. Bespoke aircraft designers and sensor designers cannot expect to recoup development costs and run profitable businesses when they are forced to match the low prices of mass-produced equipment. Moreover, incentives that might have enticed investors to back manufacturers of specialist equipment have eroded as profit-making opportunities from an already small customer pool shrink further.

Diapositiva 18



Our reservations regarding the commercial viability of specialist products notwithstanding, we suggest the following ideas for future projects.

An investigation into airframes that combine lifting fans, for safe and convenient vertical takeoff and landing, with auxiliary lift systems, such as wings or unpowered rotor systems, for efficient extended flight, in order to develop versatile yet weather tolerant aircraft for maritime applications.

Optimization of remote control human-machine interfaces for missions that demand precise remote piloting.

Programs to develop affordable alternatives to commercial off-the-shelf chemical sensors and consumer camera systems, and water sampling systems.

Research into systems that could be used to eliminate wiring between disparate equipment.

Diapositiva 19

A review of potential end-users for environmental SUAS packages, quantifying equipment procurement budgets and out-sourced services budgets. A clearer picture might encourage investment in mission-specific technology and encourage the pool of potential service providers to grow.

Evaluation of a plan to introduce an European Aerial Work scheme to reduce the burned of regulation compliance on State and semi-State agencies who wish to take up Unmanned Aircraft tools. The scheme would provide Operations Manual templates, specify standardized operating procedures and would provide training syllabi in a format that could be adapted for use in any European country.

Implementation of a shared or collaborative commercialization scheme to encourage development of SUAS technology in a manner that does not depend on a volume-sales model or private backers. In this scheme Academics participate in an 'umbrella' project, such as development of a versatile aircraft, exchanging dormant research deliverables or expertise for shares in future profits, other than the proceeds of sales to State-funded customers. By targeting research products for which spinout cannot be justified, or that lies dormant because originators lack entrepreneurial desires, taxpayers recover, in the form of improved environmental protection, return on research funds that currently are written off.