

By Jon Potts

STABILISING THE SPIN

Academia, industry and end-users must ensure that innovative UAV designs are continuously being proposed at grass-roots level if the UV community is to flourish.

A UAV concept based upon a spin-stabilised flying-disc design offers novel flight characteristics and diverse possibilities for unmanned systems. Universities are the ideal forum for preliminary investigation into innovative concepts and technologies such as this, which are peripheral to industrial research and development.

As UAVs become an increasing focus of future aerospace R&D, Universities will fulfil a crucial support role in the furthering of technology and knowledge applicable to new and innovative UAV concepts.

Academic research in aerospace serves several functions. It supports ongoing research within industry and defence and gives graduates hands-on research experience in preparation for R&D employment within defence, industry or academia.

Additional to the mainstream lines of research, funded by defence research agencies and industrial sponsors, universities tend to breed innovative concepts that are peripheral to industrial R&D. Such institutions hold the ideal format for doing so and good reason for having the initiative.

As an aerospace professor is expected to generate external funding for research, and research agencies are looking to support industry-relevant concepts, so academics are constantly conducting preliminary research to justify funding for further investigation. This is a good system because it encourages excellence and innovation, quality research wins funding which supports more quality research.

COLLABORATIVE RESEARCH

An example of university-industry-defence collaboration is that of the Gryphon UAV. Defence Advanced Research Projects Agency (DARPA) has supported a research program to demonstrate the concept of using micro-actuator technology to provide useful control forces for a large-scale delta-wing UAV. This project is about to reach culmination with an imminent flight-testing programme using micro-electro mechanical systems (MEMS) technology.

The project started with an idea theorising aerodynamic control from vortex shifting over a delta wing. From there, preliminary wind-tunnel-based research demonstrated the theory with experiments and the Gryphon subsequently became a reality. A whole host of MEMS actuator and sensor technology has been integrated into the UAV to provide control and acquire data during flight tests.



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DARPA provides funding and vision; Caltech contributed micro sensor and actuator fabrication; UCLA was responsible for systems integration and wind-tunnel testing; and AeroVironment Inc. designed and maintain the jet-powered delta-wing Gryphon UAV prototype.

This is the ideal way for academic research to work – universities collaborating with industry to maximise the potential of research efforts and further the knowledge base of fluid mechanics and associated technologies.

DISC-WING UAV

A spin-stabilised flying disc UAV concept is under investigation at the University of Manchester, UK. This research is funded by the Engineering and Physical Sciences Research Council (EPSRC) as the initial stage of an ongoing research programme to develop a disc-wing UAV.

This has involved a full aerodynamic study of the disc-wing configuration leading to the demonstration of aerodynamic control methods appropriate for application to a disc-wing UAV. The disc-wing UAV configuration in question is based on the Frisbee™ sports disc shape, typically unstable in pitch and for practical purposes, inertially stabilised by spinning.

A spin-stabilised disc-wing UAV, based on the sports disc shape, requires a power plant and an appropriate method of provision for aerodynamic control. The spinning UAV demands a cyclically pulsed jet thruster of some description and investment from industry to develop the

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necessary small-scale propulsion technology. Aerodynamic control is achieved using flow-control methodologies to generate forces large enough to alter the trajectory and attitude of the disc-wing UAV harnessing gyroscopic precession.

Unconventional active flow control concepts have been tailored to the novel shape and dynamics of the disc-wing. A wind-tunnel-based feasibility study has demonstrated the effectiveness of various fluid-control methodologies such as forced transition strips and flow-obstructing fences. Plans are already in place to extend the study to annular slots for circulation control, global geometric control (bend and twist), surface bumps and variable rim height.

The disc-wing UAV has no predefined flight orientation and offers novel flight characteristics and manoeuvrability. It is potentially suitable for a variety of mission objectives, including surveillance, communications, munitions and/or airborne radar warning systems.

The concept of a disc-wing UAV, although unconventional, offers potential benefits to existing systems. It is ideally suited for delivery by airdrop from larger airborne vehicles or as barrel-launched munitions. It has no protruding parts so could be carried in a backpack over rough terrain until needed and then hand-launched.

Future research and investment could further the development of a flocking myriad of disc-wing UAVs which disperse throughout a designated area to seek and neutralise individual targets, or perhaps as an integrated network of loitering UAVs which together constitute a radar early-warning system capable of monitoring large expanses.

Academic R&D initiatives such as the disc-wing UAV and Gryphon, offer advancements in UAV technology for the furthering of knowledge, with potential application to industry and defence. Aerospace companies and defence research agencies should encourage and collaborate with ongoing research initiatives, within various institutions, whenever possible to maximise this potential. **UV**

