Unmanned Systems, Vol. 1, No. 2 (2013) 163–164

DOI: 10.1142/S2301385013010024

UNMANNED SYSTEMS
http://www.worldscientific.com/worldscinet/us

Editorial: Special Issue on the 2012 DARPA UAVForge Challenge

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The *UAVForge* exercise, organized by the Defense Advanced Research Projects Agency (DARPA) and the Space and Naval Warfare Systems Center Atlantic (SSC Atlantic), was an ambitious attempt to tap into a broad development community and create an unmanned aerial system (UAS) capable of achieving a difficult mission of interest to the United States Department of Defense (US DoD). The mission for this exercise focused on beyond line of sight (BLOS) communications with an unmanned platform requiring systems to land or hover 2 miles (3.2 km) from a launch point, conduct surveillance for up to 3 hours and then return to the launch point. Having solicited traditional performers in the unmanned systems industrial sector during the *Shrike* program, DARPA wanted to reach out to a new knowledge base and tap into global ideas and design practices to promote innovative unmanned systems, as well as explore non-traditional approaches to developing new technologies.

Following in the path of the *Network Challenge* and *Shredder Challenge*, and succeeded by new crowdsourced programs such as *Adaptive Vehicle Make* and the *Robotics Challenge*, *UAVForge* reached out not only to industrial partners but also to universities, research labs, and the general public to participate in the program. By tapping into more than just the established industrial base, DARPA could search for innovation from new industrial suppliers, hobbyists, and the open source community, as well as the worldwide (*i.e.* non-U.S.) academic community — which are generally regarded as untapped idea sources for DoD-related efforts.

In the end, *UAVForge* had representation from 153 countries; with 144 registered teams, 3,565 registered users on their website, and 45 non-traditional vehicle configurations. But despite this strong worldwide showing, *UAVForge* was unable to declare an official winner. However, the outcome of this provided DARPA with valuable insight into the outstanding technical challenges associated with the surveillance mission proposed. Additionally, by focusing on designs that could be achieved at minimal cost and within one year, *UAVForge* raised the bar for agile unmanned systems prototyping — exposing possible opportunities for improvements in the systems engineering lifecycle for quick reaction capabilities, as was envisioned after successful completion of the program.

In this special issue, the teams will present their unique approaches to the *UAVForge* challenge. Because the crowdsourcing model is both attractive and atypical (though increasingly less so), it is important to consider the success stories, as well as the opportunities for improvement that lie in such a non-traditional approach to engineering a system. The fact that there were so many different solutions to the problem is a testament to the innovation of the teams, and to the fact that a challenging problem often requires multiple solution paths to converge on success.

Moving forward, an important takeaway for organizations running crowdsourced programs is that collaboration and teaming are both essential for the overall success of the program. The teams arguably may not have made such great strides had they not pushed each other with probing questions on the web forum, nor would they have found creative workarounds for issues such as communications dropouts had they not shared the same launch site. With so many innovative solutions to a challenging, multi-faceted event such as *UAVForge*, it may be practical to look for individual strengths across competitors and encourage the exchange of ideas early in the program. Participant down selection could also be made in such a way as to incorporate multiple promising subsystems from different teams in order to select best-of-breed approaches. Regardless, the spirit of collaboration leading up to and during the *UAVForge* event was noteworthy, with teams sharing knowledge, hardware, and even personnel in order to achieve something greater than the sum of their parts. Both DARPA and the participants learned a great deal from the experience, and whilst the

exact mission of *UAVForge* remains an open topic for exploration, the notion of engaging the global community for ideation should be considered a valuable avenue for addressing similar challenges.

DARPA's press release (dated 28 June 2012) stated that: "*UAVForge* concluded with nine finalist teams demonstrating air vehicles in a fly-off event at Fort Stewart, Georgia. The fly-off scenario, conducted on a training site, was a simulated military perch-and-stare reconnaissance mission, requiring vertical take-off, navigation to an area beyond the line of sight from the take-off location, landing on a structure and capturing video, and then returning to the starting point. While some teams were able to reach the observation area, none were able to land on a structure and complete the mission. Persistent, beyond-line-of-sight, soldier-portable perch and stare intelligence, surveillance and reconnaissance (ISR) is a significant mission area of interest that shows promising capability, but hurdles of asset cost and complexity of use must be overcome. Since no team completed the fly-off event, the US$100,000 prize will not be awarded, and a design will not be manufactured for further testing in a military exercise as originally envisaged."

On the face of it, this initiative seems to have resulted in a complete failure, and by and large this was the way it was presented in media reports of the event. However, as we all know, DARPA doesn't do easy! This was a highly ambitious and innovative challenge which sought to showcase what the amateur engineer could develop in comparison to the big defense contractors, such as AeroVironment, Lockheed Martin and Boeing. By far the biggest problem to overcome was the requirement to develop a UAS costing less than US$10,000, whereas most of the commercial systems currently in service cost at least 10 times this amount.

Problems of long-range BLOS communications and the necessity to use commercial-off-the-shelf components in order to reduce costs meant that compromises had to be made, which affected all the fly-off teams.

In this special issue, several of the fly-off teams will present their designs in detail, outlining their strategy and choice of air vehicle configuration which they felt best met the design brief. Each team had something to offer and no team had all the answers to the problem. This issue is an attempt to record the innovative thinking and design developments of each team. At this point, we would like to acknowledge all of the ten selected fly-off teams: Extractor-X (Singapore), Navy EOD (USA), AeroQuad (International), GremLion (Singapore), Phase Analytic (USA), ATMOS (The Netherlands), HALO (UK), SwiftSight (USA), DHAKSHA (India) and icarusLabs (USA) — of which nine made it to the fly-off.

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