Engineering The Internet of Things: Drones

Unmanned aerial vehicles, or UAVs, have been used by militaries around the globe for a number of years and are now a key technology for intelligence, surveillance and reconnaissance operations. Their role is continually expanding. Recently, interest in lighter-than-air vehicles and commercial and hobbyist drones has grown significantly, with applications in cargo and parcel delivery, internet provision in remote areas, emergency aid, industrial asset monitoring (pipelines) and many more. Drones are a microcosm of the Internet of Things (IoT). For business and technology leaders to realize the potential for drones in their organizations, there are a number of common IoT-related product engineering challenges to overcome.

An example of a military unmanned air vehicle

In February 2016, the Federal Aviation Administration (FAA) announced that there were now more registered drone pilots than manned aircraft in the United States. This quantitative statistic reflects the qualitative data presented on an almost daily basis about new uses for drones; analyst data suggests the civilian drone market will grow at around 19 percent CAGR between 2015 and 2020.[1]

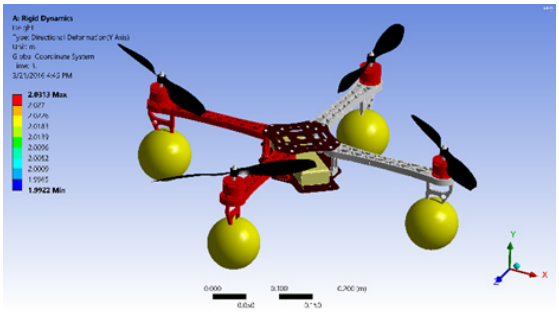
If you are a technology leader in your organization responsible for developing a drone system, or designing components for drones, you are very aware of a number of core drone development engineering challenges.

Addressing Core Engineering Challenges

Our work with UAV and drone companies has highlighted a number of these core engineering challenges. We have worked to deliver simulation-based solutions to their key business initiatives in these areas. Examples include:

Size, Weight, Power and Cooling (SWaP-C)

Back in 2010, this long-standing design challenge was raised at the Association of Unmanned Vehicles Conference by former Chief of Naval Operations Admiral Gary Roughhead, who stated that "while I want to transition the rather mature [unmanned underwater vehicle - UUV] technology to the fleet, we continue to wrestle with UUV energy and power."[2] In the intervening years, as endurance demands and capabilities have increased and the size of drone systems and associated components has decreased, the challenge of SWaP-C has only been heightened. These factors have significantly increased the interdependency of electronic, structural and thermal performance, and therefore demand a tightly integrated design process. In an article in ANSYS Advantage magazine, Amedeo Larussi, Senior Principal Electrical Engineer at Raytheon Corporation, described how "Raytheon engineers took advantage of the integration built into ANSYS...to capture these interdependencies."[3]



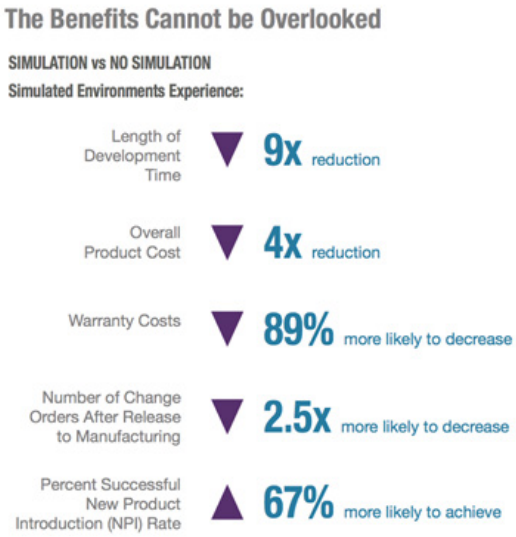
A Virtual Quadcopter Drone

Reliability and Safety – As the pressure to permit drones to operate in commercial airspace increases, non-military applications increase. As personal drones become more capable (and near misses with other aircraft become more common), reliability and safety are headline design considerations for the drone industry. At the core of these issues is the software embedded in the drone and base station systems that controls the drone's response to instructions, and the actions it takes when communication with the base station is lost or interrupted. Brazilian company XMobots is pursuing Equivalent Levels of Safety (ELoS) to manned aircraft for the software in their drones and base stations.[4] By adopting the ANSYS simulation solution for safety-critical embedded software development, the second generation ground control station (GCS) display was developed in six months. This compares with the two years required to develop the first generation GCS using non-simulation, manual code-generation methods. This is a 75 percent time savings.

Durability – Military UAVs are designed to standards that anticipate very harsh environments and that demand durable performance characteristics. While the environment that commercial drones operate in may not be as harsh as those experienced in the military sphere, the business models for commercial drones will only be viable if the drones are robust and have low failure and maintenance rates. Faced with the demands of reducing weight to increase endurance, the drone product engineer must explore a wide design trade space that balances the performance gained through weight reduction with the durability demanded by the business model. Worldwide Aeros Corp, makers of the Sky Dragon Airship platform for its lighter-than-air (LTA) vehicles, used ANSYS simulation tools to consider different physics-based characteristics of the vehicle's design, and to explore the wide trade space in a highly automated fashion to find the lightest possible design that would meet structural and functional requirements. Using this ANSYS multiphysics approach, engineers were able to design a new LTA 40 percent faster than the previous generation.[5]

ANSYS: The Value of a Consolidated Simulation Platform

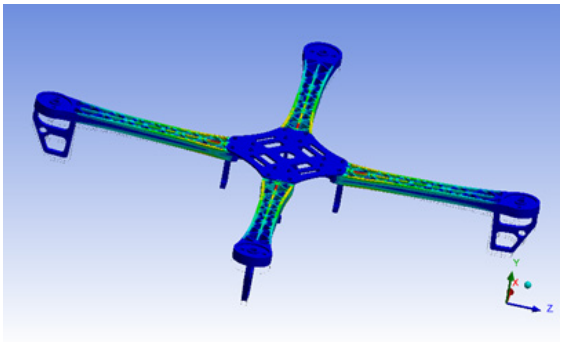
As the company stories shared above have shown, engineering simulation is playing a key role in the development of the drone industry. This was confirmed by Dr. Michael Ruith, Computational Fluid Dynamics and High-Performance Computing Manager at General Atomics Aeronautical Systems (makers of the Predator and related UAVs), who stated that "Today, engineering simulation plays a fundamental role in the development of the leading UAS [unmanned aircraft systems] in areas such as aerodynamics, structural performance, electronic systems, propulsion and thermal management. As UASs continue to develop, for example with increased autonomy, engineering simulation will become ever more critical due to the need for more detailed understanding of the aerodynamic and integrated system-level performance."



The increased difficulty of overcoming the core engineering challenges created by the complexities of making products IoT-ready is highlighting weaknesses in existing design processes. Independent research has shown that successful development of these products requires an increase in communication and collaboration between functional engineering teams. Without this, product delays, reliability issues and cost overruns are likely. A product made without collaboration can lead to integration issues, especially when subsystems are built and over-designed because each team added their own safety margins.

Companies with a strong culture of collaboration are leapfrogging their competition through the use of engineering simulation. Best-in-class companies use a consolidated simulation platform to analyze component and system-level behavior, as well as subsystem interactions, before physical prototyping. Designers at these companies are able to quickly explore the performance of numerous design alternatives. This allows them to optimize the design for cost, quality or performance. The metrics below highlight just some of the benefits of a simulation-based design approach executed on a consolidated platform that enables cross-functional engineering interaction.

With the ANSYS integrated simulation platform, applications critical to the success of drones can be addressed. These include:



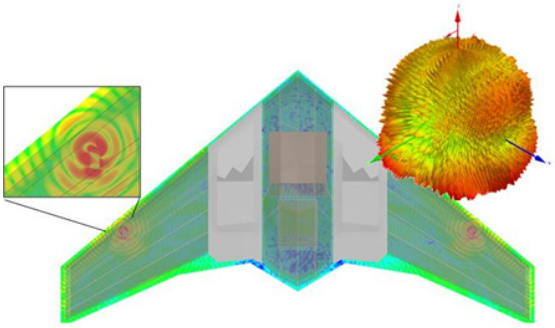
An example of a military unmanned air vehicle

Antenna Design & Placement
You can rely on ANSYS for accurate results regarding the performance of your antennas, both as components and when integrated into an operating environment. Depending on the scale of the problem and results desired, you can select from a range of solver technologies.

Chip-Package-System Design
Power integrity and signal integrity simulation for any integrated circuit (IC) should be performed with the proper noise model of the IC, along with the channel model of the package and board.

Power Management
ANSYS provides simulation tools to address a broad spectrum of power management challenges. These include optimizing power consumption and integrity in the system. As Brad Bryant, ASIC Design Manager at L3 Communications stated when referring to one of ANSYS simulation tools for power management "The power estimate provided by the tool came very close to what was measured in the lab. All in all, the tools worked as advertised. What more can you ask for?"

Embedded Software
Some industry leaders claim that every 1,000 lines of embedded software contain eight bugs. To manage this quality risk, as well as to meet tighter standards for software certification, embedded software engineers need to leverage software simulation tools and certified code generators. ANSYS provides a model-based embedded software development and simulation environment with a built-in automatic code generator to accelerate embedded software development projects.



Antenna design and placement on a UAV

ANSYS: Your Trusted Partner

ANSYS does not manufacture drones, but companies large and small across the drone supply chain rely on ANSYS to realize their product promise. ANSYS will remain your trusted partner — delivering the proven simulation capabilities you've come to rely on, along with new capabilities that support your continued product development success in a transformed world.

References:

[1] *The Drones Report*, BI Intelligence, March 2016

[2] *AUVSI Update: Power Issues Hamper Deployment of Robotic Underwater Vehicles,* National Defense Industries Association, January 2012

[3] Larussi, A. Hot Wire, *ANSYS Advantage*, 2014, Vol. VIII, Issue 3, pp. 20-23

[4] de Assis, F. *The Use of SCADE for UAV Ground Stations*, ANSYS SCADE User Group Conference, 2013

[5] Amirian, A. Air Power. *ANSYS Advantage*, 2015, Vol. IX, Issue 3, pp. 10–12

[6] *The Impact of Strategic Simulation on Product Profitability,* Research Brief by the Aberdeen Group (June 2010)

[7] *Achieving Product Development Success Through a Consolidated Simulation Platform,* Research Brief by the Aberdeen Group, January 2015

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