A Spy on the Wall
A composites option in micro air vehicle technology

By Melinda Skeat

Thanks to Wright State University (WSU), your wish to become the proverbial fly on the wall may soon be a reality. With funding from the U.S. Air Force, WSU is developing micro air vehicles (MAV) the size of an insect.

More Than Meets the Eye
The Air Force wants to deploy bird-sized vehicles by 2015 and insect-sized by 2030. These small automatons, classified as 15 cm total dimension or less, can be useful in applications ranging from national security to other microscopic life-saving jobs.

"The Department of Defense would like to use it as a spy bug," says Robert Michelson, principal research engineer at Georgia Tech Research Institute. "If you think about it, it's the stuff going on inside a building that we need to know about. Using a MAV would save lives and money because you don't have to send anyone into unknown territory. Not only would MAVs be useful in enemy territory during war time but also in other instances such as drug raids. "You can send a fly buzzing down a corridor virtually unseen and leave it perched on top of a cabinet. Maybe a few days later a guy comes in and starts making a drug. The MAV has it on tape and you can organize a sting," says Michelson. MAVs would also be useful in civilian rescue, says Hibo Dong, assistant professor of Mechanical Engineering at WSU. "You can send a MAV into a burning building to determine if there are people inside, where they are, the source of a fire or, even more alarming, the source of a virus or biological bomb," he says. "Or, it also could be used in outdoor wooded areas and be hand-launched by troops in the field."

Dong's team began researching the potential of insect MAVs after doing his graduate research for the Navy to develop underwater vehicles that resembled swimming fish.

"I came to WSU with a goal to develop a flying vehicle. We began studying flight kinetics of various birds and insects with the idea to not only discover how it works, but understand and mimic it," says Dong.

"After three years of study, we developed a dragonfly prototype that can hover and swoop under the guidance of our researchers," A dragonfly is unique among insects because it has four individual wings that are separate from each other. It can therefore control each one separately, shifting each wing to get more strength ranging from a 54 to 100 degree angle. A dragonfly also can hover with its wings at a 180 degree angle, whereas a fly only has two wings and butterflies, while having four wings, have to flap them all together. WSU's final goal is to have a fully controlled, autonomous, functioning vehicle that can be programmed to look for something and function on its own.

WSU is the first to build a MAV based on a dragonfly in the U.S. According to Dong, there is a Japanese team that has done studies on the insect but hasn't made any MAV's based on their biological studies. There are also a few other universities within the U.S. that are funded by the Air Force as well. Harvard is developing a fly MAV and Georgia Tech University, with the help of Michelson, began work on a bird-sized MAV. However Michelson's team recently put their project on hold due to funding. WSU however continues to move forward.

"The Air Force wants to deploy bird-sized vehicles by 2015."

——— Hibo Dong, assistant professor of Mechanical Engineering, Wright State University, Dayton, Ohio

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In the drive to develop micro air vehicle (MAV) technology, Georgia Tech Research Institute partnered with Cambridge University in England and took a different approach than other competing schools. "I took a different approach on how to create a MAV that could actually function outside a lab and could be manufactured," says Robert Michelson, principal research engineer and adjunct professor. Instead of finding a power source that could lift a MAV we created, I started with a power source and developed wings around that power source.

Georgia Tech's entomopter has flapping wings and is inspired by biology, but unlike Wright State University and Harvard, it doesn't mimic biology in the strictest sense. "Developing flapping wings that twist around are impossible to control," says Michelson. "Instead we developed a wing that can beat at a constant rate. The mechanical insect is based around a new development called a Reciprocating Chemical Muscle (RCM) which is capable of generating autonomic wing beating from a chemical energy source. Through direct conversion, the RCM also provides small amounts of electricity for onboard systems and further provides differential lift enhancement on the wings to achieve roll, allowing a steered flight.

The RCM uses the Coanda Effect to almost hover in a spot while staying airborne. "The Coanda Effect allows you to change the lift. The decomposing fuel used by the entomopter creates gas, which is vented out by the wings and used to modulate the wing lift," he explains. "Normally air flows in a horizontal pattern, but there is a small tornado-like effect that eventually breaks from the wing. By using the Coanda Effect we can keep the tornado attached to the wing longer than normal, allowing for increased wingspread without a shift in direction."

"The Department of Defense would like to use the Entomopter as a spy bug," says Robert Michelson, principal research engineer at Georgia Tech Research Institute.