

Tiny flying machines inspired by nature will revolutionize surveillance work

July 28 2011



Ready for take-off: a locust awaits its turn to fly

Tiny aerial vehicles are being developed with innovative flapping wings based on those of real-life insects.

Incorporating micro-cameras, these revolutionary insect-size vehicles will be suitable for many different purposes ranging from helping in [emergency situations](#) considered too dangerous for people to enter, to covert [military surveillance](#) missions.

Supported by the Engineering and Physical Sciences Research Council, world-leading research at the University of Oxford is playing a key role in the vehicles' development.

Dr Richard Bomphrey, from the Department of Zoology, is leading this

research, which is generating new insight into how [insect wings](#) have evolved over the last 350 [million years](#). "Nature has solved the problem of how to design miniature flying machines," he says. "By learning those lessons, our findings will make it possible to aerodynamically engineer a new breed of surveillance vehicles that, because they're as small as insects and also fly like them, completely blend into their surroundings."

Currently the smallest of state-of-the-art fixed-wing unmanned surveillance vehicles are around a foot wide. The incorporation of [flapping wings](#) is the secret to making the new designs so small. To achieve flight, any object requires a combination of thrust and lift. In manmade aircraft, two separate devices are needed to generate these (i.e. engines provide thrust and wings provide lift), this limits the scope for miniaturising flying machines.

But an insect's flapping wings combine both thrust and lift. If manmade vehicles could emulate this more efficient approach, it would be possible to scale down flying machines to much smaller dimensions than is currently possible.

"This will require a much more detailed understanding than we currently have of how insect wings have evolved, and specifically of how different types of insect wing have evolved for different purposes," Dr Bomphrey says. "For instance, bees are load-lifters, a predator such as a dragonfly is fast and manoeuvrable, and creatures like locusts have to range over vast distances. Investigating the differences between insect wing designs is a key focus of our work. These ecological differences have led to a variety of wing designs depending on the task needing to be performed. It means that new vehicles could be customised to suit particular uses ranging from exploring hostile terrain, collapsed buildings or chemical spills to providing enhanced TV coverage of sports and other events".

Dr Bomphrey and his team lead the world in their use of both cutting-

edge computer modelling capabilities and the latest high-speed, high-resolution camera technology to investigate insect wing design and performance.

Key to the work is the calculation of air flow velocities around insect wings. This is achieved by placing insects in a wind tunnel, seeding the air with a light fog and illuminating the particles with pulsing laser light – using a technique called Particle Image Velocimetry.

The team's groundbreaking work has attracted the attention of NATO, the US Air Force and the European Office of Aerospace Research and Development. The research is expected to produce findings that can be utilised by the defence industry within 3-5 years, leading to the development and widespread deployment of insect-sized flying machines within 20 years.

"This is just one more example of how we can learn important lessons from nature," says Dr Bomphrey. "Tiny [flying machines](#) could provide the perfect way of exploring all kinds of dark, dangerous and dirty places."

Dr Bomphrey is using his EPSRC-funded Fellowship to pursue this research. The fundamental aim of the work is to explore how natural selection has impacted on the design of insect wings and how these designs have been affected by the laws of aerodynamics and other physical constraints. "Evolution hasn't settled on a single type of insect wing design," says Dr Bomphrey. "We aim to understand how natural selection led to this situation. But we also want to explore how manmade vehicles could transcend the constraints imposed by nature."

Provided by Engineering and Physical Sciences Research Council

Citation: Tiny flying machines inspired by nature will revolutionize surveillance work (2011, July 28) retrieved 20 March 2024 from <https://phys.org/news/2011-07-tiny-machines-nature-revolutionize-surveillance.html>

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