IMPACT
research

Bio-Inspired Aerospace Research

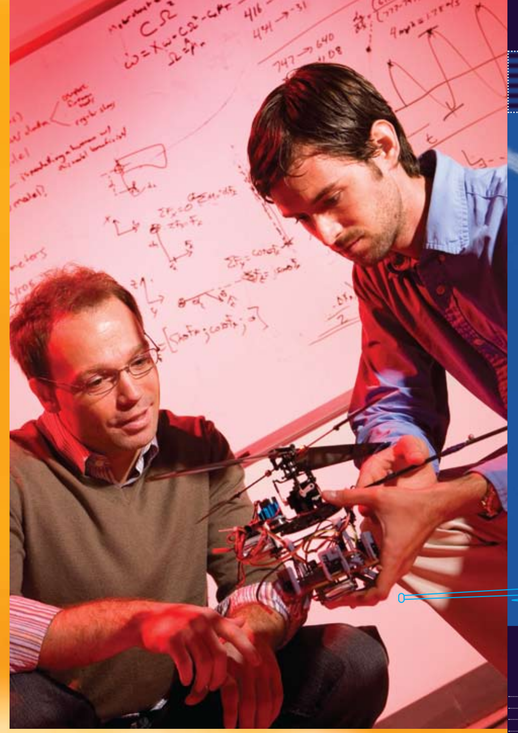
A fruit fly doesn't have anywhere near the processing capability a human does, yet it can easily navigate in and out of a building—all without the assistance of a global positioning system, or GPS.

J. Sean Humbert (at left in photo), assistant professor of aerospace engineering, is investigating why a distributed array of simple sensors like the 2,000 light detectors in a fruit fly's compound eye are so efficient for the insect's navigational needs. Humbert wants to translate the fruit fly's sensory ability to a human-engineered system that is equally efficient, yet not overly complex.

This research will assist Humbert and other scientists who are developing self-navigating microscale vehicles that travel by flapping small, mechanical wings, as well as small ground robots that crawl over terrain and jump over mud puddles to map the ground. These small and relatively inexpensive devices could "swarm" over dangerous enemy terrain on a battlefield—including enclosed structures—where GPS signals that guide current-generation UAVs are unavailable.

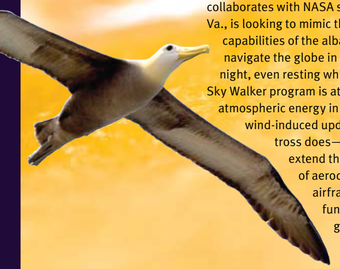
This research is funded by a $12 million grant from the Army Research Lab, with Humbert and **Inderjit Chopra**, professor of aerospace engineering, joining a nationwide group of scientists who are developing new concepts for these microsystems.

"The scientific community is on the verge of being able to design and manufacture a variety of microsystems," Humbert says. "The real challenge, however, is to endow these creations with a sense of autonomy that will enable them to interact with their environments. We believe our study of natural sensory systems at the University of Maryland will provide the insights required for success."



Long-Distance Flight

Other Maryland researchers are taking their engineering inspiration from soaring birds, not insects. **James Hubbard**, a Maryland professor who collaborates with NASA scientists in Hampton, Va., is looking to mimic the long-distance flight capabilities of the albatross, which can circumnavigate the globe in a month, flying day and night, even resting while in flight. Hubbard's Sky Walker program is attempting to exploit atmospheric energy in the form of thermal and wind-induced updrafts—just as an albatross does—in order to indefinitely extend the range and endurance of aerodynamically efficient airframes. The research is funded by an $11 million grant from DARPA.



Rotorcraft Safety

In other flight-related research, **J. Gordon Leishman**, professor of aerospace engineering, is leading a multidisciplinary team of experts studying rotorcraft brownout—a phenomenon that causes a significant risk for helicopter pilots flying close to the ground, as the rotor downwash stirs up blinding dust, causing the pilot to lose visibility. Leishman's team will work to better understand the physics of brownout and develop rotorcraft design improvements to ease or eliminate the condition. The research is funded by a $7.5 million Multidisciplinary University Research Initiative grant.

RESEARCH & EDUCATION
spotlight

University to Train Navy Personnel

Aviation Week & Space Technology magazine recently ranked the University of Maryland third in the nation for aerospace contractors to recruit the best and brightest engineering graduates. The university is expanding this on-campus educational excellence to other areas, including a new research and educational partnership with the Patuxent River Naval Air Station in nearby Lexington Park, Md. "There is a need for an education program that will produce engineers to support the expanding operations at Patuxent River," says Darryll Pines, chair of aerospace engineering at Maryland. The university will provide both on-site and distance-based education, allowing current staff at the Navy facility to earn degrees in aerospace or mechanical engineering. As part of the agreement, the university will also support new programs in flight testing, Pines says, as well as research projects in autonomous vehicles and rotary-wing aircraft. For more information on research and education in aerospace engineering at the University of Maryland, go to **www.aero.umd.edu.**

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IMPACT

RESEARCH AT THE UNIVERSITY OF MARYLAND

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The science of flight has changed dramatically in the past 100 years, reflecting both societal and military needs as well as advances in new technologies. For a glimpse at the latest in aerospace research at the University of Maryland, **take a look inside ...**

Maryland researchers Darryll Pines (far left) and Sean Humbert are leaders in developing new aerospace technologies.

FLYING HIGH

AEROSPACE CHANGES FOCUS ON SMALLER, UNMANNED VEHICLES

Beginning with the Wright brothers in 1903, the last century of aeronautical research has mainly involved manned aircraft designed to soar faster, farther and higher.

Aerospace engineers today are still intent that humans slip the surly bonds of earth, yet some—including a cadre of researchers at the University of Maryland—are exploring the next generation of *unmanned* aerial vehicles, or UAVs.

"The biggest change in aerospace engineering in the past decade, fueled mostly by military designs and requirements, is a switch to autonomous aerial vehicles and the reduction of manned vehicles and manned development programs," explains **Darryll Pines**, chair of aerospace engineering at Maryland.*

Pines and other faculty in the A. James Clark School of Engineering are at the forefront of UAV research, addressing scientific challenges in flight navigation, "sense-and-avoid" technologies, propulsion configurations and the use of smart materials and smart structures to increase rotorcraft capabilities and reduce aerodynamic drag.

The Maryland researchers are particularly adept at developing UAVs at the micro- and nanoscale level. Microscale UAVs are about six inches tall, while vehicles less than two inches high and weighing about 10 grams are termed "nanoscale."

The military may soon use these small, unmanned machines for surveillance and intelligence-gathering missions in dangerous settings, while other agencies are interested in them for search-and-rescue efforts or patrolling the nation's borders.

Aviation researchers are also interested in designing UAVs on the opposite end of the spectrum: large, unmanned cargo carriers that will one day operate in the same airspace as commercial airlines. "This will fuel technologies related to reducing the possibility of collisions—developing sense-and-avoid technologies that are very reliable," Pines says.

Ultimately, scientists will need to perfect the engineering needed for an unmanned vehicle of any size to take off on its own, safely fly in a crowded airspace, and then land on its own—all with minimal human oversight.

Other new aerospace initiatives

Four key thrusts of aerospace research at Maryland—space systems, hypersonics, rotorcraft and microsystems robotics—all fit within emerging trends in aerospace engineering.

One new trend is a booming private space-launch industry, with companies sending satellites into orbit and a space tourism industry steadily booking passengers for future flights.

These private space ventures are fueling improvements in rocket-based propulsion technology and other propulsion technologies, Pines says. More importantly, the private entities are infusing significant amounts of research funding for commercial and civilian applications, not government-related or military projects.

"These companies obviously want to make things very safe and very efficient, but they also have futuristic technologies they want to explore that perhaps the government doesn't need to invest in, or isn't willing to invest in," Pines says.

Where the University of Maryland can play a key role, Pines believes, is in developing new spacesuit technologies and providing expertise in areas of guidance technology and autonomy. NASA's Constellation program, tasked with building a next-generation fleet of spacecraft to send humans back to the moon, recently selected the university's Space Systems Laboratory to develop concepts on how astronauts will live and work on the lunar surface.

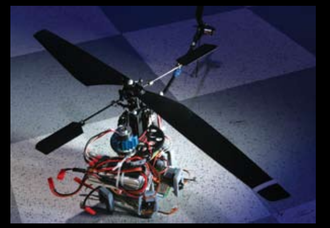
Other timely research at Maryland also involves developing hypersonic air vehicles that will fly at speeds greater than Mach 5 (more than 3,500 mph), allowing coast-to-coast travel for U.S. airline passengers in under two hours.

Clark School engineers are refining new technologies for air-breathing propulsion systems, known as "scramjet" engines, with **Mark Lewis**, professor of aerospace engineering and senior scientist for the U.S. Air Force, and **Ken Yu**, associate professor of aerospace engineering, leading the effort.

Clark School faculty and graduate students are at the forefront of designing microscale aerial vehicles that mimic nature. Here, a graduate student in the laboratory of Darryll Pines assembles a small aircraft with a wing structure based on a samara leaf (shown at top).

** As this publication was going to press, Pines was named dean of the A. James Clark School of Engineering, effective January 2009.*

Four Key Areas of Research



MICROSYSTEMS

ROTORCRAFT

SPACE SYSTEMS

HYPERSONICS

research CAPABILITIES

These assets enhance on-campus research and stimulate collaborations with non-university scientists, particularly those within the federal government.

Location
NASA Goddard Space Flight Center is less than five miles away, advancing research between Maryland faculty and NASA scientists in areas like flight navigation and control. Other nearby government agencies include the Defense Advanced Research Projects Agency, or DARPA, the Office of Naval Research, the Army Research Lab and the Patuxent River Naval Air Station testing facility.

Connectivity to Government Agencies
Two aerospace researchers at Maryland, department chair **Darryll Pines** and professor **Mark Lewis**, have valuable experience within the federal government. Pines was assigned to DARPA from 2001–2003, leading efforts in microscale UAV research; for the past four years, Lewis has had a joint appointment as chief research scientist for the U.S. Air Force. Another Maryland aerospace engineer, **Alison Flatau**, was a program manager at the National Science Foundation.

Glenn L. Martin Wind Tunnel
The university has a wind tunnel for testing in areas of rotorcraft design, hypersonic drag efficiency and smart materials and smart structures.

Neutral Buoyancy Tank
The Space Systems Laboratory, under the direction of **David Akin**, uses its neutral buoyancy tank (shown at left) to test new spacesuit technologies and tools for working and living in space. Maryland is the only university in the world with such a facility.

Alfred E. Gessow Rotorcraft Center
Now in its 25th year, the university's rotorcraft center, under the direction of **Inderjit Chopra**, is a leader in fluid dynamics, rotorcraft design, smart materials and smart structures. These core research areas directly complement new designs in microscale UAVs.

Autonomous Vehicle Laboratory
This lab, under the direction of **J. Sean Humbert**, conducts research in all aspects of autonomy, flight dynamics, stability and control of biological and microrobotic systems, including replicating the sensory ability of the fruit fly.