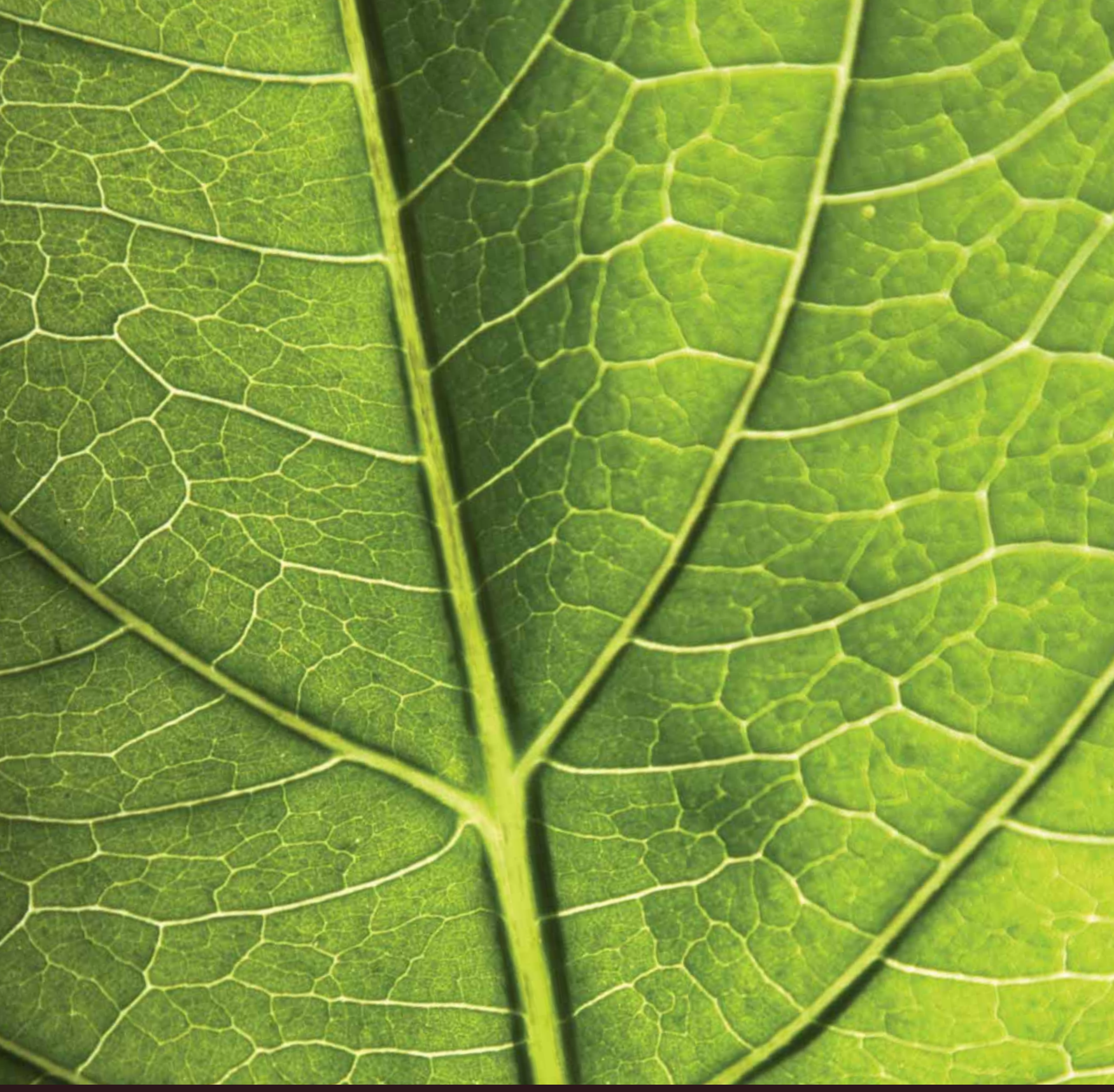

AVIATION, ENERGY ENVIRONMENT

"Flying — the worst thing to do … The dirtiest industry in the world"

B. SEWILL, *FLY NOW, GRIEVE LATER*, **2005**[11]

"… unrelenting carbon-efficient improvement is business as usual for commercial airlines … We are the greenest form of mass transportation."

J. C. MAY, *AIR TRANSPORT ASSOCIATION PRESIDENT AND CEO,* **CONGRESSIONAL TESTIMONY, 2007**[12]

Aviation, environment, and energy: the debate is intense and intensifying. What are the facts? How should we address aviation's contribution to climate change, local air quality impacts and community noise? Is there a role for alternative fuels for aviation? Do technological and operational solutions exist to reduce aviation's impacts in absolute terms, notwithstanding growth? What policies should be implemented to best balance economy and mobility, environment, and security? How do we reconcile the contribution that aviation makes to our society and way of life with what we are all taught in kindergarten: clean up your own mess?

MIT is a leader in this complex, rapidly evolving area of aerospace engineering. We lead the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), the FAA/NASA/Transport Canada Center of Excellence with 12 universities, 50 organizations on the advisory board, and linkages throughout the world. On behalf of the U.S. Secretary of Transportation and the NASA Administrator, PARTNER drafted the Report to the U.S. Congress on Aviation and the Environment: A National Vision Statement, Framework for Goals and Recommended Actions. The vision calls for absolute reduc-

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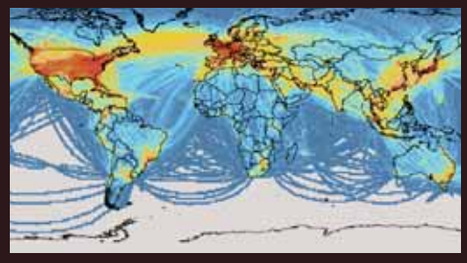
tions in significant impacts notwithstanding anticipated growth, reducing uncertainty regarding aviation's contribution to climate change, particulate matter, and hazardous air pollutants, and greater coordination and communication among stakeholders.

We are leading the development of tools that the U.S. Federal Aviation Administration has committed to use to evaluate the health, welfare, and economic impacts of aviation in order to inform domestic and international policy making. Working with the U.S. DOT Volpe National Transportation Systems Center and the Logistics Management Institute, we developed the tools that the United States uses for reporting its aviation emissions inventories under the United Nations Framework Convention on Climate Change. We designed and flight-tested new arrival procedures that are being implemented around the world to reduce noise, emissions, and fuel burn. We have characterized the fundamental physics and chemistry of aircraft particulate emissions and evaluated their health impacts. With Cambridge University, and a number of industry and government partners, we created the Silent Aircraft Initiative, a collaboration aimed at developing the con-



Distribution of aircraft carbon emissions for 2000 from the FAA System for assessing Aviation's Global Emissions developed by Aero-Astro, US DOT Volpe Center, and the Logistics Management Institute.

"Noise complaints about Logan International Airport exploded during the first six months of the year, with a wave of protests about the roaring jet engines coming from outraged ... residents and politicians." [13]

BOSTON HERALD, AUGUST 12, 2007

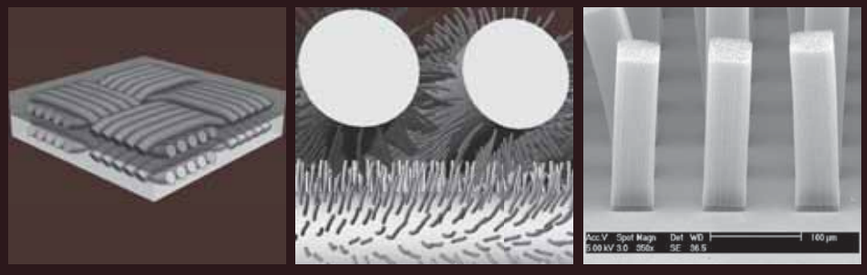
"In the last 30 years the number of people impacted by aviation noise has been reduced 95% despite a 6-fold growth in people-miles traveled by air." [14]

REPORT TO CONGRESS ON AVIATION AND ENVIRONMENT, 2004

The Aero-Astro/Cambridge University Silent Aircraft Initiative was conceived to make a substantial reduction in aircraft noise. The plane could also reduce fuel consumption by 25 percent compared to current aircraft.

ceptual design of an aircraft that would be inaudible outside the boundary of an urban airport. The technologies and operations conceived for this new, unique aircraft may enable not only a dramatic reduction in aircraft noise, but also a 25 percent reduction in fuel burn compared to current civil engines.

Such improvements in energy efficiency are critical. Although aircraft account for less than three percent of total non-renewable energy usage, their contribution is anticipated to grow. Further, the economics of commercial and military aviation are strongly influenced by fuel availability and price. We are continuing our long-standing efforts to develop energy efficient aircraft and operations, but we have recently expanded these into new areas. We have established a collaboration with the MIT Laboratory for Energy and Environment and a team of international university and industry partners to evaluate the challenges and opportunities for alternative fuels for aviation. We have also formed an aerospace industry consortium to develop a new class of mass-efficient nano-engineered materials which offer efficiency through multi-functionality, and which take advantage of the outstanding mass-specific properties of carbon nanotubes. Many of the technologies we are studying for advancing aircraft propulsion also have direct application in energy systems associated with land-based gas turbine power generation.



Aligned carbon nanotube (CNT) multi-scale hybrid advanced composite architecture developed by Professor Brian Wardle, Dr. Enrique Garcia, and colleagues, as part of MIT's Nano-engineered Composite aerospace STructures (NECST) Consortium: (left) illustration of woven fabric with in situ grown CNTs, (middle) illustration of aligned CNTs on fabric fibers, and (right) scanning electron micrograph of aligned CNT pillars. There are 10-100 billion aligned CNTs per square centimeter.

In sum, dozens of MIT Aero-Astro students, researchers, and faculty members are engaged in advancing the science, policy, economic, and engineering aspects relating to the interaction of aviation, environment, and energy. The department is seizing the opportunities to replace rhetoric with scientific and engineering analyses and rational judgment, to invent and implement new technologies and operations for vehicles and the air transportation system, and, thereby, to advance a sustainable aviation system that contributes to the betterment of society in all dimensions of economy and mobility, environment, and national security.