

# A high-power team

How employees from disparate backgrounds came together to lead Boeing's development of green alternatives to today's jet fuels

By Lauren Penning

**B**ack in 2005, Boeing played only a passive role in jet-fuel development. Now, thanks to the vision of a team of scientists, engineers and strategists across the company, Boeing is on the leading edge and has changed the way the aviation industry looks at alternative fuels.

Boeing's environmental strategy has long been focused on designing fuel-efficient airplanes. Better airplane fuel efficiency means reduced airplane emissions of carbon dioxide, the primary gas linked to climate change concerns. However, fuel efficiency is only half the story. Boeing realized that fuels derived from ecologically sustainable materials, or biofuels, could address not only carbon emissions but also the growing concern of fuel availability and sourcing. According to Billy Glover, managing director of Environmental Strategy for Commercial Airplanes, it's a two-pronged approach: "We continue to focus on improving fuel efficiency, and now we have added a focus on changing the fuel itself."

## CONVERTED TO THE CAUSE

How could jet fuel be changed to reduce carbon emissions? Although biofuels seemed like a natural candidate, initially the biggest hurdle "was our own skepticism," according to Dave Daggett, Technical Fellow for Commercial Airplanes and principal investigator for the biofuels team. Glover and Daggett began looking at sample fuel sources from different vendors back in

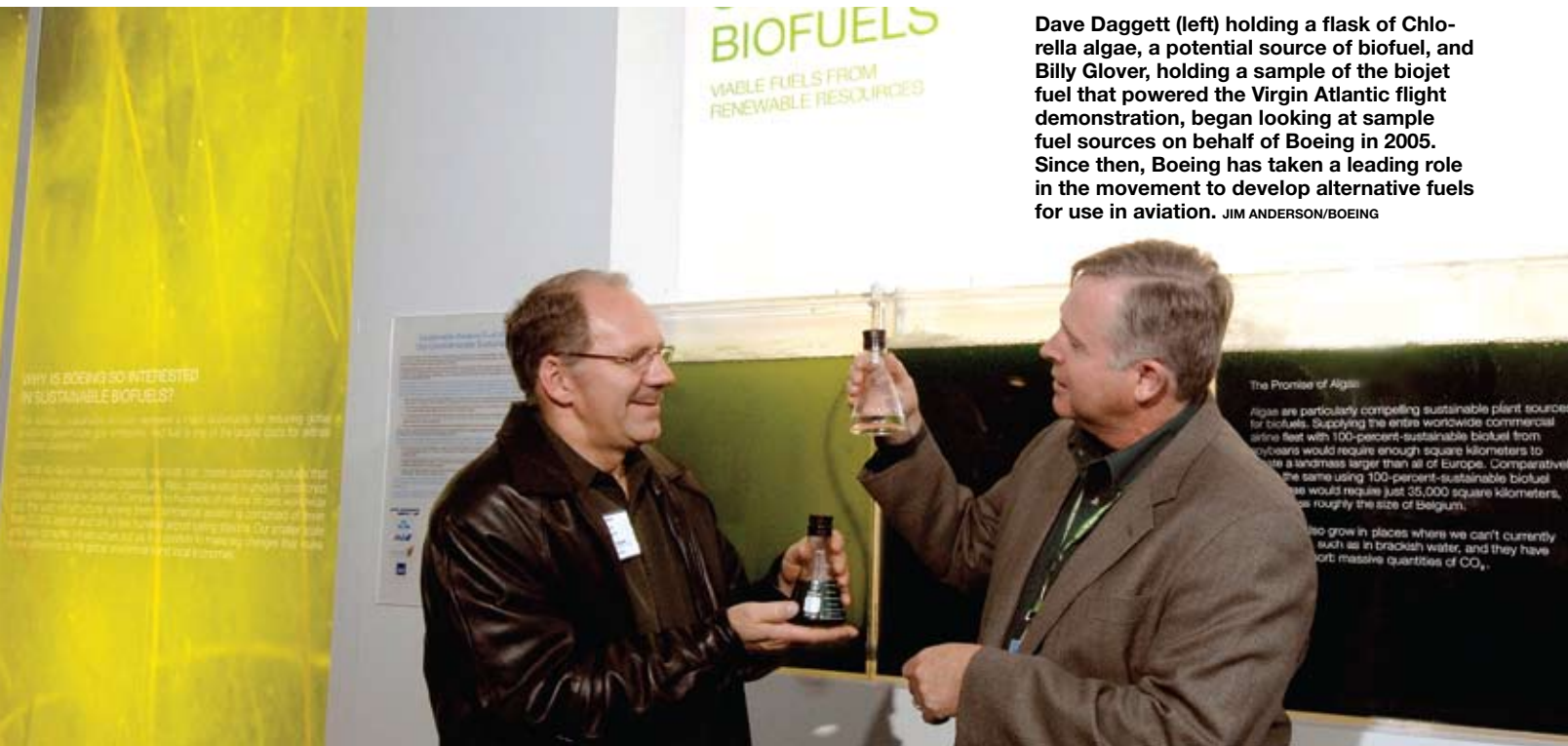
2005, and some looked promising. "Once we started seriously looking at the possibility of biofuels, we became converts," said Daggett. "Now we had to convert the rest of the industry."

What started out as a group of two grew rapidly in the next few months. "From the beginning, we realized that if only we knew about the potential of biofuels, it would be hard" to move the cause forward, explained Glover. So Glover and Daggett organized a public meeting and started an industry dialogue. "We got calls from people [who were] not originally invited who wanted to attend our first meeting. At the end of the day, we had popular support for doing this," he recalled.

From that first meeting grew the Commercial Aviation Alternative Fuels Initiative, a group that brings industry partners, airlines and regulators together to research and discuss alternative fuels. At an early meeting in October 2006, the industry group drew up a road map that set a biofuel test flight goal of three to five years in the future. "We thought we might be able to do better if we formed a small task team," said Glover, challenging the Boeing team to a test flight on partial biofuel within one year.

## SETTING THE STAGE

Traditionally "the aviation industry has looked at fuel as a given. The fuel industry screens out problems and we were [going to be asking] them to look at bringing something [new] in," Glover explained. For the industry to accept a different type of fuel, Boeing would need to provide the industry with data that



**Dave Daggett (left) holding a flask of Chlorella algae, a potential source of biofuel, and Billy Glover, holding a sample of the biojet fuel that powered the Virgin Atlantic flight demonstration, began looking at sample fuel sources on behalf of Boeing in 2005. Since then, Boeing has taken a leading role in the movement to develop alternative fuels for use in aviation. JIM ANDERSON/BOEING**

proved biofuels were viable.

In January 2007, Glover was named to a new position in Commercial Airplanes—managing director of Environmental Strategy—and brought together a variety of players to form a virtual working group concentrated on sustainable biofuels. Boeing identified fuel experts within the company and hired experts in plant physiology, renewable energy and public policy to help develop an environmental strategy for Commercial Airplanes that included biofuels.

Early on, many offered ideas on what sources Boeing should pursue for biofuel. Weeding out the unfeasible ones was—and remains—a sizable challenge.

“I looked into what [alternative sources] are available and the pros and cons of what can be made available,” Daggett explained. Some were so far out that at one point he referred to himself as the technical fellow of “wacky ideas.”

Algae is one promising candidate that caught Daggett’s attention. “I grew my own algae at home for a while, and it gave me a good understanding of the challenges,” Daggett recalled, such as how best to extract the algae from the water. “Once you get the algae out of the water, then you need to figure out how to extract the oil.”

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Aside from his personal tinkering with potential biofuels, Daggett manages related studies that Boeing commissions with other research organizations. “Once in a while, out of the dozen ideas, I might find one gem [and] take it to the next step,” he said. “Now I’m called the technical fellow of innovative solutions.”

The challenges don’t end with identifying potential biofuel sources. For a new fuel to work, there must be viable suppliers, competent vendors, distribution agreements and, of course, customers for the fuel.

### DRAWING FROM THE EXPERTS

The biofuels group worked closely with Phantom Works to identify possible suppliers and vendors. “We needed to learn from the mistakes of the first generation of alternative fuel in the auto industry—ethanol, or food plant-based fuel,” said Glover.

Boeing is committed to finding alternatives to fossil fuels that have a smaller carbon footprint and do not compete with food sources (unlike ethanol). This means finding suppliers that support this model and harvest energy sources that use minimal land, water and energy.

One such vendor is UOP Honeywell, which has been “maturing its process to create a bioderived jet fuel, and we were fortunate to apply that process to several sustainable plant sources in a large enough scale to supply fuel for airline flights and engine tests,” said Tim Rahmes, emissions engineer for Commercial Airplanes and manager of the biofuel flights.

UOP Honeywell is producing fuel for the next biofuel test flight, scheduled for early 2009 with Air New Zealand. That flight follows a February 2008 test with Virgin Atlantic and GE Aviation, which

marked the first time a commercial jet flew on a sustainable plant-based fuel mixture. In that case, the fuel was 20 percent plant oils, including indigenous Brazilian plants and coconuts from the Philippines, and 80 percent traditional jet fuel.

The Virgin Atlantic flight not only provided solid data on flying on biofuels, but it also helped overcome industry skepticism. "With these flights we captured the imagination of the industry and the public," said Glover.

airport uses a million gallons of fuel per day [including some biofuel], it can't juggle blends. This has to be seamless," said Jean Ray, Associate Technical Fellow in Fuels and Lubrication Technology for Commercial Airplanes.

To that end, the Material and Process Technology fuel testing group puts new biofuels through the same rigorous testing as for traditional fuel ("Jet A"). Boeing

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With each additional biofuels test flight, Boeing and its industry collaborators take a step closer to making commercial flight on biofuels a reality. The Air New Zealand flight will increase the biofuel mixture to 50 percent.

"The aviation industry is cautious—as it should be," noted Jim Kinder, a senior engineer in Commercial Airplanes and a chemist on the biofuels team. "We are taking these test flights as a step approach, but we are very confident in the biofuels we have identified for our next three test flights—the fuel is as good as or better than traditional jet fuel."

### TESTING, TESTING

Before flight, the fuel testing team rigorously researches the chemistry of each fuel candidate. "Thematically, these are new sources of fuel, but chemically they contain the same types of molecules that are in traditional petroleum jet fuel," explained Darrin Morgan, director of Business Analysis and Biofuel Strategy for Commercial Airplanes.

Chemical compatibility is essential because a new fuel won't be commercially viable if it can't be dropped into the existing aviation infrastructure. "When a large

Flight Test engineer focal Mike Henry works closely with each airline to collect appropriate data and return the airplanes and engines to revenue service after a test flight. Candidate biofuels for the next test flights have all performed as well as or better than traditional fuels in Boeing and engine manufacturers testing and are not expected to have an adverse effect on the airframes, engines or systems.

The next step is testing to ensure that there are no negative effects over the life of an airplane and its servicing. "Filling hoses, storage tanks, pipelines that supply some airports, the airplane fuel tanks—they all need to be looked at," said Ray. The team will continue that testing over the next three to five years.

### TO MARKET

Although the group's progress has been remarkable, the strategic driver hasn't been surprising, according to Morgan: "Before, aviation didn't have other options. Now that these fuels look promising, newly discovered alternative fuel will allow our customers to diversify their fuel portfolios."

It's not just airlines that are looking to diversify. Tim Vinopal, chief engineer for



**Jean Ray, an Associate Technical Fellow in Fuels and Lubrication Technology for Commercial Airplanes, examines test specimens after exposure to a candidate biofuel. Ray noted that biofuels must be chemically compatible with today's aviation infrastructure. JIM ANDERSON/BOEING**

Environment, Health and Safety for Integrated Defense Systems and the person responsible for developing IDS' environmental strategy, engages Boeing's military customers about biofuels. "Historically, our [IDS] customers haven't been concerned with carbon footprint, but that's starting to change," Vinopal explained. Recently, Boeing Phantom Works received a contract from the U.S. Air Force to evaluate greenhouse gas life-cycle models for military fuels and explore how the military aircraft Boeing produces could also work with the biofuels Boeing is identifying for commercial airplanes.

The Boeing biofuels group continues to be aggressive. "I would rather have very aggressive goals and fail to meet those goals occasionally, rather than step through at a slow pace," explained Glover. "If we are not failing occasionally, we are not trying." ■

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