include nitrogen-fixing crops such as alfalfa in the rotation. If such were planted on just 10% of the cropland, the CENR reports stated, nitrogen discharges would decline significantly.

Some farmers say they have already cut fertilizer use and that further reductions would harm their bottom line. But analysts insist that the vast majority could alter their practices without suffering. Changes that cut nitrogen runoff by up to 25%, says agricultural economist Otto Doering of Purdue University, the lead author of the CENR report's economics section, "would not have a severe impact on farmers or on food costs."

The plan would also pay farmers to restore wetlands and plant buffer strips of trees and grasses between farm fields and streams. More vegetation would mean more denitrification, a microbial process in which nitrate is converted into nitrous oxide and nitrogen gases that escape into the atmosphere. This would right a historical wrong. Over the past 150 years, midwesterners have cleared and drained untold millions of hectares of nitrogen-absorbing bottomland forest and wetlands for agriculture, says wetland ecologist William Mitsch of Ohio State University in Columbus.

If it becomes legislation, the action plan would await an uncertain fate in Congress, where it may face opposition from conservatives and must compete for money with scores of other proposals. "I don't think it will be easy," says a Republican Senate aide familiar with the plan.

Luckily for plan backers, farm groups are sending mixed signals. Taking the toughest stand is the American Farm Bureau Federation: "There's simply no way our organization could support" the plan in its current form, says Francl, who says his organization will lobby against it. But the Fertilizer Institute sees merit in aspects of the plan that pay farmers to use fertilizer wisely and plant buffer strips. "You'll see us and many in the [agriculture] community supporting ... policies that will help reduce nutrient loss," says spokesperson Ron Phillips.

Also testifying to the plan's merits are chronicles of other dead zones around the world. Cutting fertilizer use and restoring wetlands in Sweden and Denmark have slashed nutrient inputs into the Kattegat strait, which links the North Sea and the Baltic Sea; oxygen levels are on the rise (see sidebar on p. 969). And a hypoxic zone in the Black Sea even bigger than the Gulf of Mexico's appears to be taking its last gasps. The Black Sea's problems began in the 1960s, after years of being bombarded with heavy fertilizer runoff. When the Soviet Union collapsed in 1990, so did most central support for agriculture, and chemical fertilizer use fell by more than half. By 1996, the Black Sea's dead zone had disappeared for the first time in 30 years.

Aside from those case studies, experts are putting their faith in models that predict the gulf's comeback after less nitrates are fed into it. Using reams of data on everything from oxygen levels and sunlight to temperature and phytoplankton levels, water-quality modeler Victor Bierman of Limno-Tech Inc. in Ann Arbor, Michigan, and his colleagues have predicted that a 20% to 30% reduction in nitrogen levels in the Mississippi would raise oxygen levels as much as 50%, providing enough of the molecule to prevent many hypoxia-related deaths. But it's likely to take more than a decade to see results, Bierman says.

Johnny Glover doesn't know if he can wait that long. Back in the 1970s, when he started out in the fishing business, the waters near the seaside town of Cocodrie teemed with fish. Now Glover manages 10 charter boats, and his captains must travel kilometers farther than they used to to find king mackerel, black drum, and red snapper. "We're working around [the dead zone], but it's getting harder and harder to make a living," he says. For Glover and other hard-pressed fishers, a cure for the dead zone is long overdue. **–DAN FERBER**

AVIATION

Dirigibles to Grace Skies Over Germany Once Again

Companies are betting that giant airships not seen since World War II can pay off in ferrying tourists and heavy objects—and perhaps even doing science

For people who recall images of the zeppelin *Hindenburg*'s fiery demise in 1937, the thought of the cigar-shaped ships—and flying in one—might stir an unsettling feeling. This spring, a company called Zeppelin Luftschifftechnik hopes to wipe away those disturbing thoughts with a new breed of airship to carry tourists in Germany, and eventually to other European countries.

Hot on its heels is a company designing the world's largest airship, a dirigible for transporting heavy machinery that could make its debut in about 2 years. Fueling the dirigible's renaissance is what appears to be a healthy demand from sightseers and a niche market in the cargo world. Research trips could soon follow. "This is just the starting signal for the development of new airships," says aviation engineer Ingolf Schäfer, a consultant based in Lahnau, Germany.

Dirigibles hit the comeback trail in 1988, when the company Luftschiffbau Zeppelin, which had long since gotten out of producing dirigibles and into producing radar aerials and silos, asked staff engineers Klaus G. Hagenlocher and Florian Windischbauer to study whether airships had the potential to fly again. The duo reviewed the safety and flying records of all 119 zeppelins produced before the airships were shelved in 1940. They concluded that dirigibles could offer a safe alternative to hot-air balloons and other sightseeing vessels—but that there would be too few customers to make transatlantic crossings pay.

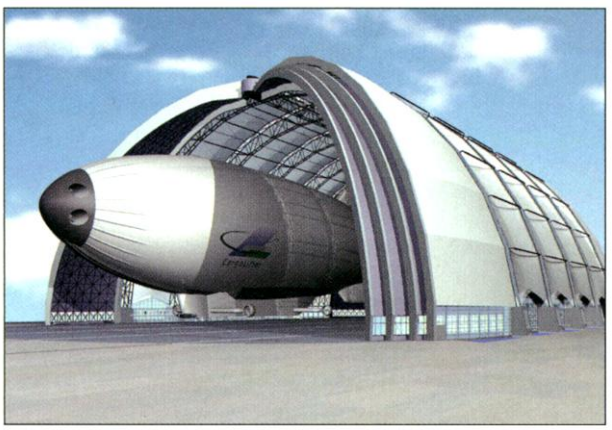
Not just hot air. Zeppelin is back in the dirigibles business with a craft that atmospheric scientists are hoping to catch a ride in.

CREDIT: ZEPPELIN LUFTSCHIFFTECHNIK GMBH

In 1993, Zeppelin Luftschifftechnik was established to make dirigible tourism a reality. The firm was situated in a nostalgic location: Friedrichshafen, where Count Ferdinand von Zeppelin made his dirigible dream come true when he took his LZ 1 into the air on 2 July 1900. Exactly 100 years later, the count's

granddaughter, Elisabeth Veil, baptized the modern prototype "Friedrichshafen."

The project Zeppelin NT ("New Technology") has exploited a host of recent advances in materials science to make the modern zeppelin a better airship than its ancestors. The craft's skin is Tedlar foil and polyester textile, weatherproof fabrics that give the company the option of not having to keep the zeppelins in a hangar. Modern materials give the new breed a big advantage over last century's zeppelins, the cotton-based skin of which would suck up a lot of water, making the dirigibles heavier and sometimes rupturing during flight—forcing daring midflight repairs.



Thinking big. CargoLifter has plans for a huge dirigible that could carry heavy objects to remote locations.

The new ship's aluminum and carbon fiber–strengthened plastic frame has a triangular geometry, making the helium-filled dirigible more compact and lighter by volume than its progenitors. Dirigibles also have a big advantage over blimps, famous for hovering over U.S. football games. If a blimp were to lose gas, the skeletonless airship could crumple and become unsteerable. A dirigible's frame allows it to be steered even when deflated.

The prototype Zeppelin NT has completed more than 800 hours of test flights in Germany. Initially, it and a twin to roll out this spring will be confined to German airspace; indeed, dirigible tours will not stray far from Lake Constanze. But the company hopes to launch flights to other countries after getting regulatory approval.

The dirigibles will be used for advertising, and Zeppelin Luftschifftechnik is exploring other markets, including measuring airborne pollutants. The airships could also provide a vibration-free and steerable platform for scientists. "A plane is too quick for some instruments," says Markus Quante of the Institute for Atmospheric Physics in Geesthacht. He studies how greenhouse gases move through the atmosphere. "Our particle detectors work much better at low speed, and they are very complex instruments, so you need an operator at their side," he says. "You can't do this in a balloon."

Taking a different tack is CargoLifter, a Berlin-based company that hopes to revive dirigibles as titanic airborne mules. "We're really creating a new industry," says Charles H. W. Edwards, president of CargoLifter's U.S. holding company. Edwards predicts his firm will have more demand than it can handle for the 50 airships it hopes to build over the next 15 years. Major customers could include the heavy machine and construction industries, oil-exploration firms, and humanitarian missions. Gigantic machines, such as turbines or air liquefiers, are usually moved from factory to customer by truck for shipment out of a port or an airport. "A ship has to end [its journey] at the wharf," says Edwards, and not every airport can handle a cargo jet. So a truck often must complete the journey. "We can go point to point," he says. Like a flying crane, CargoLifter's CL 160—still on the drawing board—would be able to grab its freight—up to 160 tons, equal to 27 full-grown African elephants—while hovering and without disassembling it.

But CargoLifter still must obtain regulatory clearances from air traffic authorities. The cumbersome airships might be excluded from airspace near airports, and regulators have not yet decided whether to treat the CL 160 as a plane or as a container ship, which would affect the number of hours that crews would be allowed to work and thus the duration of CL 160 flights. The uncertainty hasn't stopped CargoLifter from building a hangar at a former Russian military airport 60 kilometers south of Berlin for a prototype it hopes to fly in 2003. Potential competitors are popping up: The U.K.'s Advanced Technologies Group has recently tested a model of a jumbo dirigible designed to carry 1000 tons.

Experts are thrilled that these anachronisms may find a place in the modern world. Within 5 years, predicts Schäfer, German skies will be filled with dirigibles.

–OLAF FRITSCHE

Olaf Fritsche is a freelance writer in Sandhausen, Germany.

MILLIMETER ASTRONOMY

U.S.–Mexican Telescope Gains Firmer Footing

After a shaky start, the Large Millimeter Telescope is taking shape in the mountains of central Mexico. It's Mexico's biggest splash in global research

AMHERST, MASSACHUSETTS—A narrow sand-and-gravel road studded with hairpin turns is the only way to reach the future site of the Large Millimeter Telescope (LMT), atop a 5000-meter mountain in eastern central Mexico. The road is too treacherous to transport the 1000-ton, 35-meter-long pieces of steel, now being manufactured in the lowlands below, that will form the telescope's 50-meter dish and supporting structure. But work on a wider, safer, and long-overdue road has stopped because of lack of money. That problem is just one of several obstacles in the way of a 12-year quest by U.S. and Mexican scientists to construct Mexico's most expensive scientific facility and its largest cooperative R&D effort with its northern neighbor.

Operating at wavelengths as short as 1 millimeter, the $80 million telescope is designed to generate important new data on the nature of early galaxy formation and many other objects in the universe. But despite the road and a host of other challenges—ranging from design headaches to an uphill battle for scientific respect—the project's future suddenly seems bright. The new Mexican government appears favorably disposed to the project, and the U.S. National Science Foundation (NSF) is poised to provide the first chunk of U.S. government support obtained through accepted scientific channels.

A lot is riding on a successful outcome. The telescope would vault Mexico into the elite ranks of countries with world-class observatories. "This is very, very important for us," says Alfonse Serrano, director of the National Institute of Astrophysics, Optics, and Electronics and the Mexican midwife of the effort. For its U.S. partner, the University of Massachusetts (U Mass), the new telescope means a chance to remain in the top ranks of U.S. astronomy departments. And for the community at large, LMT represents a new and valuable tool. "We're happy to have it," says Martha Haynes, a Cornell astronomer who chaired last year's radio astronomy panel that fed into the National Research Council's (NRC's) influential decadal report on the future of U.S. astronomy.

Work on its foundation began last month

CREDIT: CARGOLIFTER AG