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**Founded in 1996, NEXTOR (National Center of Excellence for Aviation Operations Research)** is a consortium of research scientists from five universities. Housed at UC Berkeley's Institute of Transportation Studies (ITS), NEXTOR's focus is air traffic problems, air traffic management and control, airline operations, aviation systems planning, safety data analysis, and aviation economics.



## Leaving on a Jet Plane

Jasenka Rakas' airport design students grapple with real-world, real-time aviation issues in her popular CE 153 class



On her early morning walks down from the hills to her office, Berkeley CEE lecturer, aviation researcher, and **NEXTOR Deputy Director Jasenka Rakas'** mind is never far from the sky—which is

home at any given moment, she reminds us, to five or six thousand aircraft—and source for what she calls "the magical world of aviation."

Rakas begins her CE 153 class with a kind of ode to the color blue. "Blue is the color of the aviation world, but blue is a color with no dimension," she says quoting one of her favorite artists, Yves Klein. "Blue is beyond dimension, while other colors are not."

Already we're hooked.



Rakas and her students pose under the belly of an American jetliner at LAX

"Aviation is driven by innovation, risk, and passion and has always attracted enthusiastic people who were very much adventurers. And that spirit still exists today," she says. The timeless allure and peril of flight, she tells her students, begins with the Greek myth of Daedalus and Icarus, the infamous father and son who, to escape their exile on Crete, fly off the island with feathered wings

fastened with wax. Warned not to fly too close to the sun, Icarus, in his reckless joy, ignores his father's warning, melts the wax that secured his wings, and falls into the sea.

Rakas relishes the stories of the so-called flight "chauffeurs," who in the 19th century, looked at powered flight in a brute force thrust and lift manner—"build an engine, slap it on an airframe strong enough to withstand the forces and generate lift." But those who followed, including aviation pioneer Otto Lillienthal, says Rakas, "were the real airmen. They were the ones who recognized the need to get up in the air, fly around in gliders, and understand the *feel* of flying. It was this philosophy, and the airmen's concern with flight control, that ultimately led to successfully-powered flight."

The historical context sets the stage for the tangle of issues that challenge the aviation industry today. It's here that Rakas gets to the core of her teaching: to intrigue students with the nuts and bolts of major airports' current dilemmas, and perhaps, to bring a fresh influx of ideas and talent into the field.



**Jasenka Rakas** is deputy director of NEXTOR, vice-chair of the Transportation Research Board Committee for Airfield and Airspace Capacity and Delay, and founder of the UC Berkeley Advanced Aviation Educational Program, the National Airspace System Infrastructure annual conference, and the Airport Design Studio. A classically trained pianist, Rakas also composes music, plays guitar, paints, and is a passionate sailor.

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"The U.S. accounts for about 30 percent of the world's aviation, yet our current system can't absorb the increased demand," says Rakas. "There's a fundamental need right now to improve our future aviation workforce. If we're not careful, we will run out of aviation engineers very soon."

And this at a time when airports face enormous challenges as they transition toward modernization. This huge effort, shepherded by the FAA and other agencies, began in response to an army of problems—poor visibility in bad weather, staggering increases in flying demand, aging navigational equipment, and the current "hub-and-spoke" system, which adds to delays by forcing large numbers of aircraft to arrive at busy airports within short periods of time for passenger transfers.

But real-world crises are fodder for fine teaching and CE 153 is no exception. Last fall semester's 30 students, many of whom were new to aviation, drilled into those issues considered pivotal to modernizing today's airports. They explored airport noise pollution, new technologies, airspace structure, and environmental code conformance to upgrade terminal buildings, gates, taxiway and runway exit designs to meet increased traffic demands.

Take airport noise pollution. You can read all about it, study the decibels, frequencies, and sound wave projections, but it tingles in your ears only when you hear it, even if it's from an instrument simulating a few aspects of noise pollution. Rakas picks up her guitar (she's also a musician) to illustrate how sound can turn into noise, asking students to differentiate between pitch, frequency, and sound intensity in order to "get" what bothers residents who live in the wake of active airport runways. Getting it is part one; designing noise mitigation systems is part two and crucial to Rakas' notion of analyzing aviation problems and designing workable solutions.

"We use some traditional mathematical techniques in the class, but I'm against letting students rely only on mechanical equations to calculate their answers or feel finished after a quick glance at Wikipedia. Here we use mechanical equations in a larger context to design complex systems. I try to inspire my students to come up with new design concepts and new ways of operating so they perceive problems in completely different ways."

Early in the semester, Rakas invites a group of professionals from NEXTOR's industry partnership program who work at high-level airports to participate in labs and lectures. Industry partners are often instrumental in the one-day field trip the class takes to a major airport (see story below). As the semester winds down, this same group of professionals act as the panel of experts as students present their final projects—comprehensive master plans for a large-scale airport renovation system.

"This is a very dynamic design class," says former CEE undergrad Justin Bychek, who took Rakas' class last year and now serves as the class's special assistant. "Rather than being a completely technical structural design class, we're creating a comprehensive report designed to be released to a 'virtual' client. The class ties together all that you learn with a deliverable project that prepares you for real work."

— Nancy Bronstein

### SFO to LAX: Ticket To Ride



A central piece of aviation researcher Jasenka Rakas' airport design class is a one-day field trip to a major airport, the past two years to LAX and underwritten by Virgin America Airlines. Not only does the experience give students hands-on access to the airside, landside, and commercial jet operations of a modern-day airport, it ties their observations to their ongoing airport master plan projects. During a five-hour tour led by one of LAX's top planners, students observed airport layout problems, runway capacity, airline, cargo and security operations, and baggage handling.

"The field trip is an exercise in critical thinking, creativity, and engineering judgment," says Rakas. "LAX is an excellent, almost scholarly example of a large, complex hub-and-spoke international airport that is undertaking

major renovations as a result of reaching maximum capacity. By far the largest airport on the west coast in terms of passenger volume, LAX is also the largest airport in the world in terms of origin/destination passengers, and had to be prepared to accommodate the largest aircraft in the world."

In fact, the A380, the relatively new double-decker airbus, accommodating more than 800 passengers in economy class, is expected to have the largest number of daily operations at LAX, the most of any North American airport.

Students reacted enthusiastically to the field trip, waxing ecstatic about Virgin America's leather seats, individual interactive computer system, and the mood lighting: "more like a nightclub" than an airline cabin, wrote one. But they also noted significant problems at LAX: long taxi times, high noise levels in nearby residential areas, the lack of mass transit to LAX, and the ensuing back-up after an airliner went out of service on a runway. In papers they wrote after their return, they postulated possible solutions, which they detailed more thoroughly in a final project presented in the form of professional-looking reports on topics ranging from runway and taxiway design and LAX ground access to the landside impacts of a midfield satellite terminal.

"If we return to LAX fall semester," says Rakas, "we'll look at it from an entirely different perspective, that of green airports, and explore how to run an airport that size in the most environmentally friendly, emission-free, noise-free, energy-efficient ways."

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