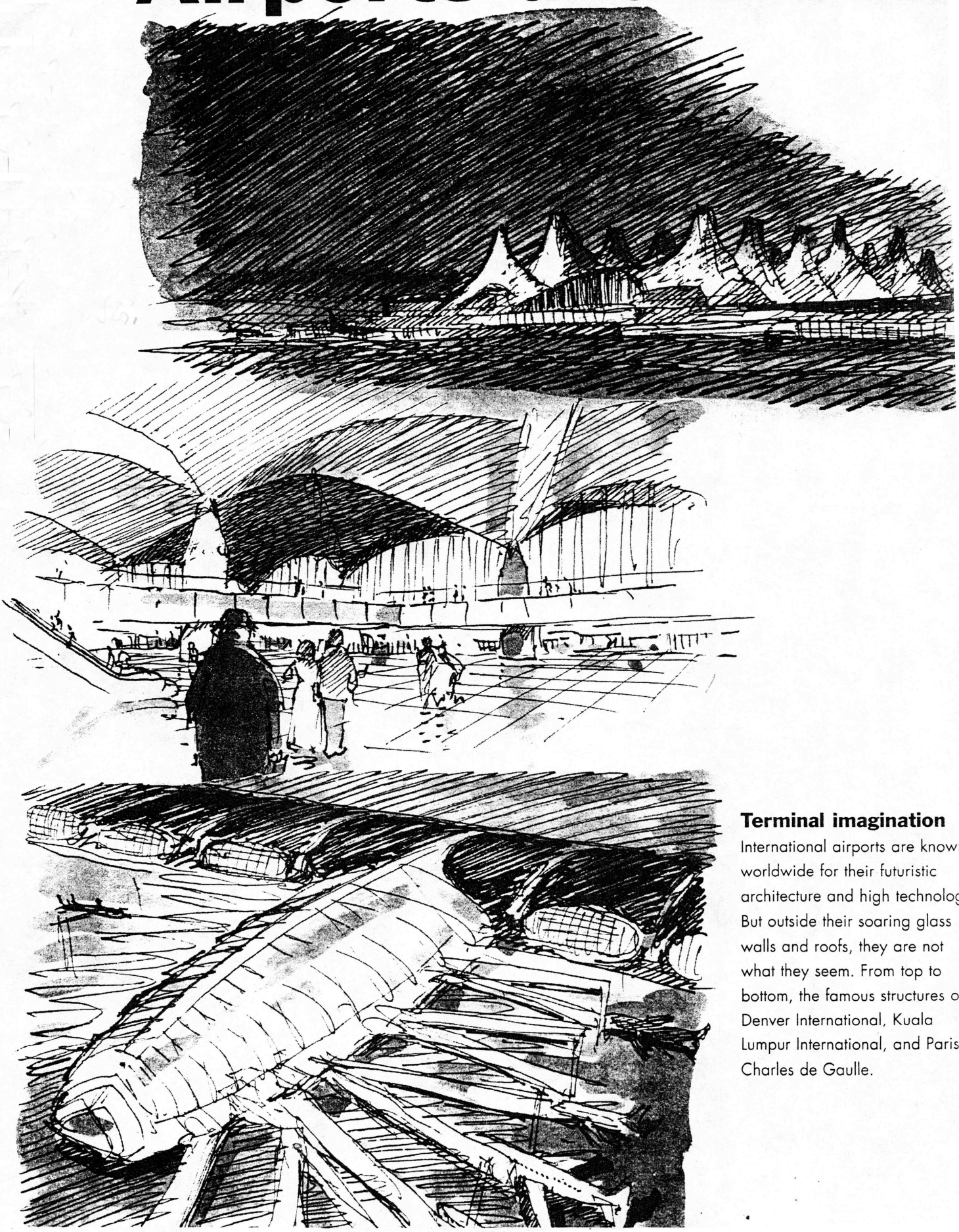
Airports and Cities

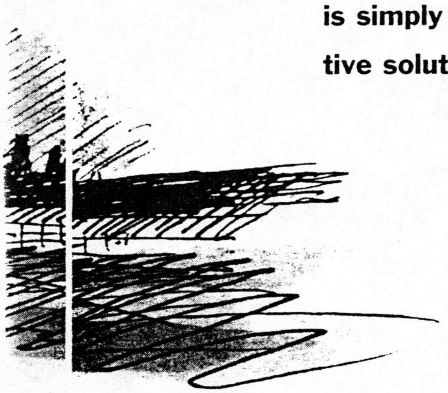


Terminal imagination

International airports are know worldwide for their futuristic architecture and high technolog But outside their soaring glass walls and roofs, they are not what they seem. From top to bottom, the famous structures o Denver International, Kuala Lumpur International, and Paris Charles de Gaulle.

Can They Coexist?

As high-speed global commerce expands, and demand for air transport explodes, airports and cities are invading each-other's space in increasingly hazardous ways. The conventional response is simply to keep expanding airport capacity. But more imaginative solutions are now needed.



by Ed Ayres

"SOME PEOPLE THINK THE WORLD IS FLAT," says the voice on the phone—a voice I have listened to many times in the past year.

At first I hear this as a comment on myopic worldviews, but then I realize it's not just a figure of speech. The man I'm listening to, Jim Starry, is being droll. He really is talking about geometry. But he's not referring to sailors who once worried that their ships might sail off the world's edge. He's ruminating about the people who build airports. Their *runways* are flat, and to Starry, a Colorado-based ecological designer, this doesn't make sense. A flat runway forces the 425-ton jet that is landing on it to throw its engines into reverse and burn a huge amount of fuel to come to a stop, he says. Imagine, instead, a landing strip that is slightly inclined—so that as the plane touches down it decelerates by rolling up a 2- to 3-percent grade.

Imagine that the plane, too, has been given a couple of key design changes. First, just before touchdown, a set of electric motors begins pre-rotating the wheels so that when the plane lands it won't encounter the huge, rubber-pulverizing friction that occurs when a motionless wheel hits pavement at 130 miles per hour. Then, as wing lift is transformed to wheel load, these electric motors begin functioning as generators, using the forward momentum of the plane the way a hydroelectric plant uses a river current. By tapping the energy of the plane's momentum, they slow the plane—without any further reliance on fuel to produce reverse thrust—and recharge the batteries that will later power them as motors at take-off. As the plane rolls up the incline, the gravity-assisted braking brings it to a halt directly atop a 3-kilometer-long, multi-story terminal. Unlike a conventional landing, which typically ends at a place that necessitates a 10-minute, jet-powered crawl to a distant gate, this plane needs only to roll under battery power for a half-minute or so to a gate where its passengers can alight directly into the building below. When it's time to depart, the plane heads back down the other side of the incline, relying initially on its electric motors for acceleration, then switching on its turbines as the slope gently rounds to a level stretch for liftoff.

Supposing such changes are technically feasible, what would be achieved? First, if the plane is a typical Boeing 747, about 4,000 kilograms less jet fuel would be burned for each landing and takeoff—roughly 300 gallons of fuel for deceleration, 300 for takeoff, and 300-plus for all the taxiing around large expanses of tarmac in between. (Building the runway like an elongated highway overpass, with the terminal underneath it, would eliminate miles of taxiways and cut down on the airport's use of land, as well as of fuel.) This adds up quickly, because a typical major airport accommodates around 1,000 flights a day—meaning a potential daily savings of close to 1 million gallons of fuel from that airport alone. There would also be a substantial reduction of noise, which has become a cause of rising tensions as growing cities and their airports become jammed closer and closer together in the same space.

These differences could turn out to be critical, because airports—often celebrated for their futuristic architecture and technology—have turned out to be surprisingly damaging in their effects on human and ecological health, and in the past few years their

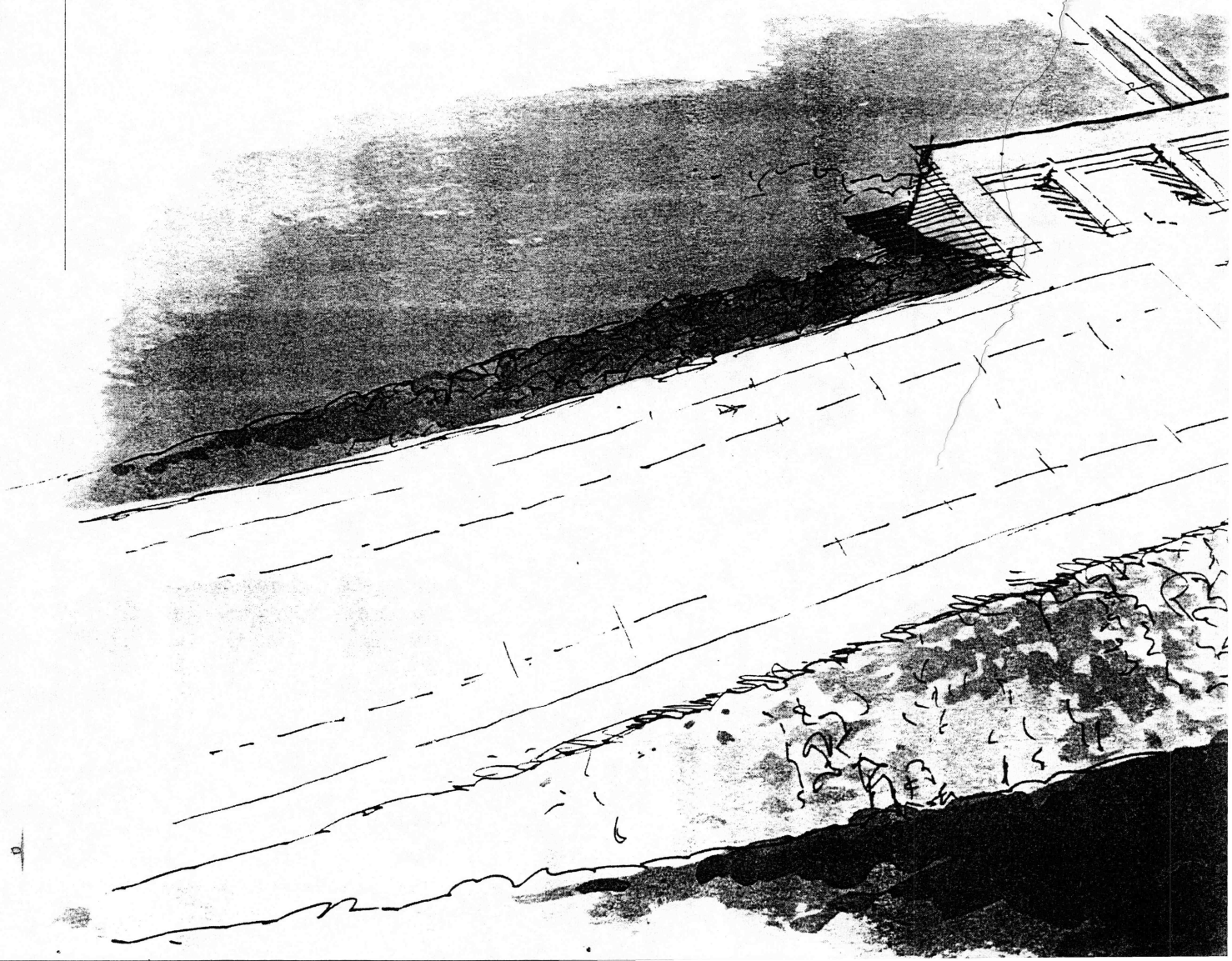
ILLUSTRATIONS BY MALCOLM WELLS

impacts have taken a turn for the worse. In the first two minutes after a 747 takes off, it emits as much air pollution as 3,000 cars, says a study by the Natural Resources Defense Council (NRDC). People living or working near airports have been found to suffer sharply increased rates of psychological impairment, degenerative illness, and mortality. Hundreds of grassroots groups now say it's time to rethink the way we let these giant machines roar in and out of our populated areas.

An Obsolescent Mindset

JIM STARRY ISN'T JUST TALKING about a new kind of runway. To him, the whole mindset that has created the modern major-hub airport doesn't make sense. It's a mindset based on an almost never-questioned assumption—that the solution to rapidly increasing demand for air travel is to provide an ever-increasing supply of land, fuel, and air space. As a result, in its total impact on climate, ecology, and health, today's mega-airport may be one of the most ill-conceived forms of large-scale infrastructure humankind has ever devised—yet it is also one of the least accountable.

Moreover, airports are both multiplying and expanding at a breathtaking rate. In the past few years, huge new airports have appeared all over the world—from Denver to Abu Dhabi to Bangkok. Constructing such an airport is not on the same scale as building a new office tower or highway; it's more like building a city. In China, 18 new airports are under construction and another 21 will have been built by 2005. In Mexico, 20 new airports are planned just for the Baja peninsula. Major airport expansions, which in some respects create even more urban strains than new "green fields" airports carved out of virgin land, are underway in hundreds of cities or suburbs. In the United States alone, the recently enacted Airport Reform and Investment Act for the 21st Century (so-called AIR-21) will subsidize run-

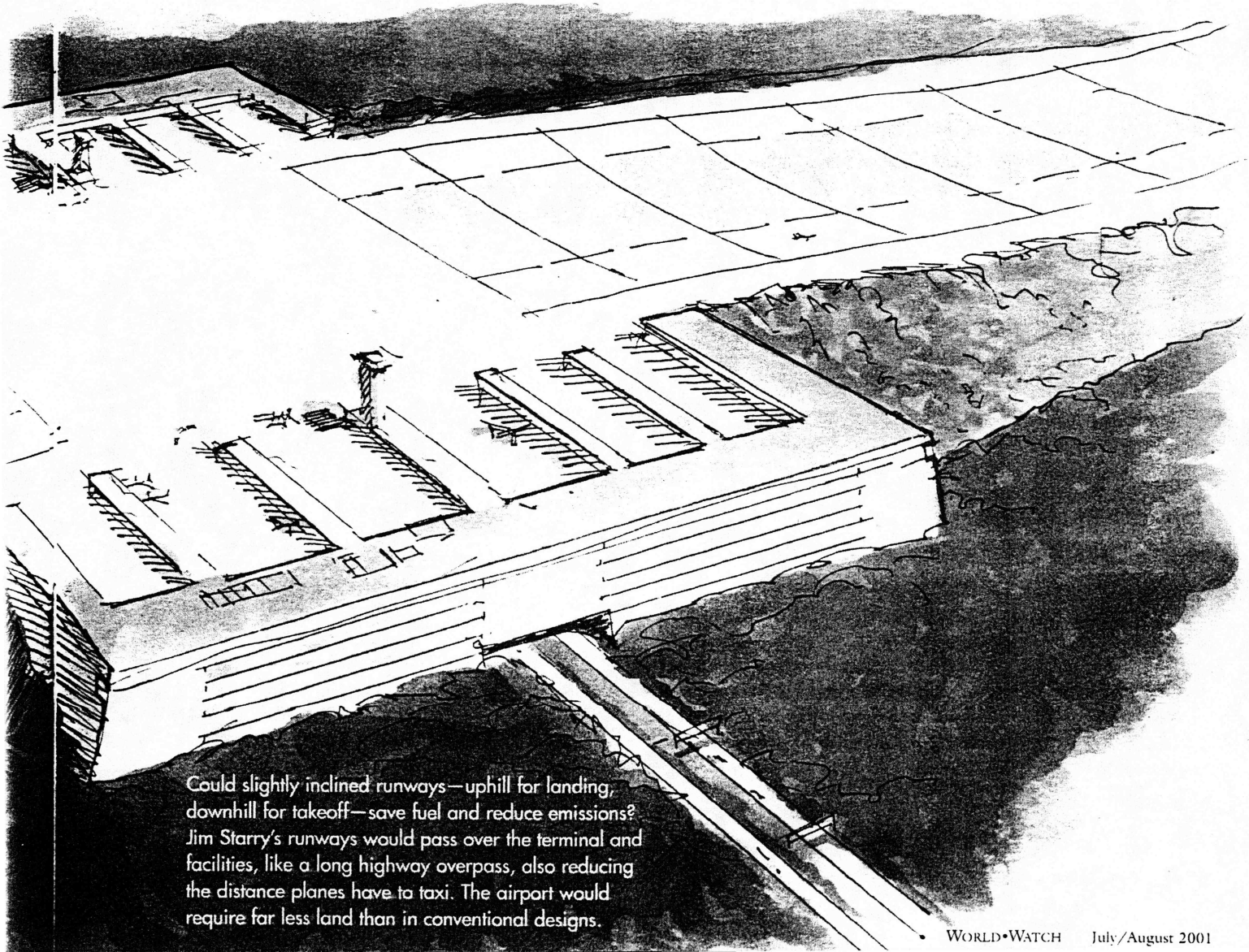


Plane crashes are rare. Disaster is continuous.

- Rates of cancer, asthma, and mortality are sharply higher for people living near some airports.
- Children near airports have higher levels of blood pressure, stress hormones, and difficulty with learning to read.
- Fresh water supplies near airports are often contaminated by de-icing chemicals, cleaning fluids, solvents, and fuel-dumping.
- Construction of a major "outlying" airport can increase automobile traffic by hundreds of millions of vehicle-miles per year, heavily compounding the environmental and health impacts of sprawl.

way expansions or additions at 2,000 airports. New York's heavily congested La Guardia, for example, will increase its capacity by 600 flights per day. And in much of Asia, the pressure to expand is even greater. By 1998, Manila's Ninoy Aquino Airport was operating at twice the capacity it was designed for, and Taipei's Kaohsiung Airport at over three times capacity. Several Pacific Rim governments have embarked on a kind of airport arms race, as they attempt not only to accommodate skyrocketing traffic, but to establish their respective claims to having the pre-eminent "hub" airport of the region.

As Starry ruminates, I become conscious of a distinction I hadn't much thought about before—the difference between air *travel* and *airports*. Over the past decade or so, air transport has been increasingly recognized as an environmental threat. It accounts for an estimated 13 percent of the world's carbon dioxide emissions from all transporta-



Could slightly inclined runways—uphill for landing, downhill for takeoff—save fuel and reduce emissions? Jim Starry's runways would pass over the terminal and facilities, like a long highway overpass, also reducing the distance planes have to taxi. The airport would require far less land than in conventional designs.

tion sources, and its emissions of this primary greenhouse gas are expected to grow sharply in the years ahead. Moreover, carbon dioxide combined with other exhaust gases and particulates emitted from jet engines could have two to four times as great an impact on the atmosphere as CO_2 emissions alone, says a recent U.S. government study. Jet contrails have also been implicated in the development of enormous heat-trapping clouds, which may be escalating the planes' impacts on climate. The exhaust from a single plane may spread to cover as much as 34,000 square kilometers (13,000 square miles). For each passenger on a trans-Pacific flight, about a ton of CO_2 is added to the earth's atmosphere. By 2050, says the Intergovernmental Panel on Climate Change (IPCC), the contribution by contrails may be almost twice as large as the contribution from aircraft CO_2.

But Jim Starry notes that jets are at their worst, by far, when they are *on the ground*—landing, idling, getting de-iced, taxiing, or taking off. Because airports are designed as they are, most airplanes spend a large part of their working life doing those things. At Denver International, for example, up to 23 planes may be running at "high idle" simultaneously, waiting for takeoff, and some wait up to 40 minutes. In the air, planes produce all that CO_2 *because* they're burning fuel so prodigiously. On the ground, jet engines operate at extremely poor efficiency and the fuel is burned very incompletely. Instead of being converted to energy, vapor, and carbon dioxide, huge amounts of fuel are blown into the ground-level air in the form of carbon particulates and volatile organic compounds (VOCs). Starry thinks airports could be designed so that the bulk of that low-efficiency combustion—and pollution—is eliminated.

When he first suggested this, I was reflexively skeptical. To begin with, Starry didn't have the credentials one would like to see from someone who's about to challenge a dominant system. He's always been an outsider—a pilot who has flown thousands of hours, to be sure, and a technician who did some inventive work designing high-altitude balloon launching devices for the National Science Foundation's National Center for Atmospheric Research (NCAR). But Starry has never been a prominent player in the world of aeronautic or architectural engineering. It took me a while to decide that this aptly named man might not be just another of those hyper-educated dreamers who live in the twilight between technology and society, trying haplessly to provide world-changing solutions. Eventually, though, I realized he might be on to something I'd been largely oblivious to. When I'm in an airport, I'm in a kind of twilight zone of my own, my thoughts dwelling on either the place I'm coming *from* or the place I'm going *to*. The airport itself doesn't seem quite real. But as I listen to Starry, my focus shifts.

Pollution in High Places

STARRY TELLS ME ABOUT Denver International Airport (DIA)—a subject he returns to again and again in our conversations. When the site was being prepared in the early 1990s, the amount of soil bulldozed off the prairie could have filled a building 10 feet high, 20 feet wide, and 3,000 miles long. The ostensible reason for constructing DIA was to replace Denver's Stapleton Airport, where air traffic was projected to explode from around 35 million passengers in 1985 to 100 million in the early 21st century. During the five years after this rationale was first offered, Stapleton's traffic *declined* by 5 million passengers, but the new airport was built anyway. Today, instead of driving 11 kilometers (7 miles) from downtown Denver to Stapleton, people drive 57 kilometers (32 miles) to DIA. Denver officials estimated that the amount of air pollution generated by the new airport and its added traffic was six to eight times what had been generated before. And this project was not unique. What happened in Colorado is now beginning to happen all over the world. Seoul's new Incheon Airport is about 60 kilometers from downtown, as are the two international airports outside Buenos Aires. Kuala Lumpur International is 66 kilometers out.

Watching the building of DIA got Jim Starry to thinking more seriously about the old assumption that the only satisfaction for fast-rising demand is a

The building under the runways could be several kilometers long, rising as high as eight or ten stories at the center where the terminal gates are located. Radiated heat from the building would warm the runway in winter, improving safety and reducing the use of de-icing chemicals that pollute groundwater.

rising supply. He saw manifestations of this assumption on several fronts of our globalizing economy. In the energy industry, the impulse is to drill for more oil, rather than to use existing supplies much more efficiently. In waste management, the impulse is to find more space to dump. In housing, it's to develop more land, rather than design for higher density on the land already claimed for human use. All these impulses are vestiges of pioneer times, when it was always possible to find more resources by moving on—opening up new territory.

Airports epitomize all three of these resource fronts: they consume land, energy, and dumping capacity at rates rarely equaled anywhere else. Denver is a telling case, because as one of the world's newest mega-airports, it was supposed to be among the most efficient. But instead, DIA seems to have set new standards for excessive consumption. It covers 138 square kilometers (53 square miles), which makes it twice the size of New York City's Manhattan Island. It has greatly increased the region's overall oil consumption; it has increased the time and money travelers spend even before they get on their planes (it has one of the worst on-time records in the nation); and it has accelerated Denver's spread over the Colorado prairie.

As Starry speaks, I'm well aware that this is the kind of thing many people don't like to hear. I'm listening because it's my job to try to keep track of such things. But I'm acutely conscious that we environmentalists have failed, so far, in our mission to halt the accelerating degradation of the planet. In the 30 years since the first Earth Day, every major trend has worsened on a global level. And now I'm hearing about something we have never paid much attention to, because it hasn't fallen into our conventional environmental categories. We study cities and suburbs, agricultural land and wildlife habitat. But airports aren't really any of these. We study green building techniques, but those techniques usually focus on houses and hotels and office buildings, not airports. We've studied the contribution of jet aircraft to air pollution as a function of miles traveled, but not as a result of landing and idling and taking off. Yet, we know these ground-level effects are substantial. Gar Smith, of the Earth Island Institute, reports that in the first five minutes of flight, a commercial airliner burns—turns to CO_2—as much oxygen as 17,000 hectares (44,000 acres) of forest produce in a day.

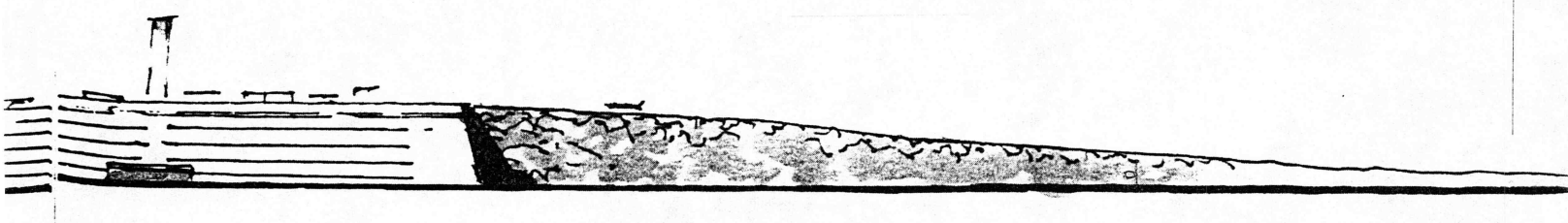
But even more significant than what the plane burns is what it poisons. Studies of neighborhoods near airports such as Chicago's O'Hare and Seattle's Sea-Tac have shown that jet exhaust is subjecting residents to extremely high concentrations of the carcinogens benzene formaldehyde and 1,3-butadiene, and at least 200 other toxic compounds. According to Jack Saporito, president of the Chicago-based U.S. Citizens Aviation Watch, these studies also indicate that significant increases in cancer risk are found among people living near airports with as few as 15 jet flights per day, yet most major cities launch hundreds, and some of them—where there's more than one major airport—launch thousands.

Of course, many of those flights—and their accompanying cargo—have brought important benefits. They've helped bring the world together. But in replacing no-man's lands with busy tarmac, they've brought a new set of threats. For the sake of mental neatness, I divide these threats into five broad categories, though in truth they're not entirely separable—it's a little like trying to separate the risks of overeating, underexercising, smoking, and breathing polluted air in a man who's a heart-attack-waiting-to-happen.

❶ Land Consumption: The Biggest Sprawl of All

CHICAGO'S O'HARE AIRPORT sits on the site of former apple orchards. The St. Louis airport was once soybean fields. DIA is where winter wheat was once grown. China's Macau International spans two ecologically sensitive wetlands. You'd think that as the human population expands, and development consumes more and more of the world's remaining open land, airport planners would design with increasing efficiency. Instead, as old airports add new runways, planners continue to use the same basic principles they've always used; and new airports tend to be *more* sprawling than the old. Denver's new DIA is 50 times the size of New York's old La Guardia, though they carry comparable traffic. The new Kuala Lumpur International, when finished, will be 30 times the area of the old Osaka Itami. Germany's new Munich Franz Josef Straus is 5 times the area of Norway's old Oslo Gardermoen.

The problem is not just that these huge projects cut sharply into each country's declining environmental assets; they also disrupt existing infrastruc-



ture, which increases the pressure on the surrounding environment still further. The impending expansion of Lambert-St. Louis International, for example, will bulldoze one-fifth of the adjoining neighborhood of Bridgeton, wiping out 2,000 houses. If the relocation of those houses' residents follows recent U.S. patterns, their new homes will take up even more land than the airport is taking from them, as they move farther out to larger, cheaper tracts.

❷ Air Pollution: Autos and Airplanes

FOR THE MOMENT, disregard the emissions of airplanes in flight. Consider just what happens at ground level. According to the U.S. Department of Transportation (DOT), a Boeing 747 spends an average of 32 minutes landing, taxiing, and taking off. In that time, it can generate 87 kilograms of nitrogen oxides (NO_x)—equivalent to over 85,000 kilometers of automobile emissions. In a major international airport, with 1,000 flights a day, that would come to 87 metric tons of NO_x a day, or roughly the amount that might be produced by all the cars in a city of 2 or 3 million people. NO_x, of course, is one of the principal precursors of smog.

Of course, not all of the planes in a big airport are 747s, so actual NO_x totals should be smaller. And indeed, a 1995 survey conducted by NRDC, in which U.S. airports offered their own estimates, reported NO_x emissions topping out at around 5 tons a day for a major airport—though it should be noted that this figure is based only on the data from those airports that responded, which included fewer than half of those contacted. Still, 5 tons equals the NO_x output of close to 5 million kilometers (about 3 million miles) of automobile driving, and the average number of flights handled by a major airport appears likely to have tripled from its 1995 level by 2010. As population growth and globalization continue to drive up air traffic, while competing demands for land continue to narrow the ground-level bottlenecks through which all this traffic must flow, the amount of idling and taxiing time is likely to grow well beyond that 32-minute average. It is during this idling and taxiing that fuel efficiency is poorest, so as traffic rises, pollution can be expected to rise even faster.

Public knowledge of what happens to our air in airports has been blocked not only by a lack of any systematic monitoring, but sometimes also by a lack of candor about the meaning of the few measurements that are made. Consider, for example, the role of particulate matter (PM) measurements in the approval of Denver International. When DIA was being designed, its particulate matter emissions were projected by using a "PM10" standard which counted all the particles that are 10 microns in diameter or larger (a micron is one-millionth of a meter). According to Gerald Rapp, a chemical engineer who works as an air quality consultant, 99 percent of the particulates spewed out by jet engines are *smaller* than 10 microns, meaning that the actual PM output was up to 100 times worse than the measurements suggested. "A 10-micron particle is a *boulder*," Rapp told me. "What's important biologically, for human health, are the really small ones. Tobacco smoke is a tenth to a quarter of *one* micron."

When DIA was first proposed, the city of Denver opposed it. In 1983, the city residents elected a new mayor, Federico Peña, who had said he saw no reason why a new airport was needed. "In terms of access, convenience, and land-use impacts, development of a new regional airport represents an inferior choice," he said. A study by the city projected that with the huge increase in car driving it would bring, DIA would generate 224 tons of air pollution per day,

including NO_x, PM, unburned hydrocarbons, and carbon monoxide. This projection did not include carbon *dioxide*, since global warming had not yet arrived as a political issue.

Shortly after he was elected, however, Peña became an enthusiastic DIA booster. He championed the project with federal authorities, who were interested in supporting a model project to show how new airports could improve urban air quality by dissipating the pollution—by moving the flight paths farther from cities. And the particulate projections for Denver neatly supported that idea. By not measuring the smaller-than-10-micron particles, and disregarding the emissions from the 33 million passenger-miles of daily airport commuting, Peña would later be able to claim that his project had cleaned up the air in Denver, which in a narrow sense it had. But for the region as a whole, DIA made the air worse. Nonetheless, Peña's claim of success helped catapult him into the job of U.S. Secretary of Transportation in the Clinton administration, and DIA, in turn, became a model for airport building around the world.

❸ Water Pollution: Off the Edge of the Tarmac

In the United States, little has been written about the impacts of airports on the surrounding land and water, in part because of the aforementioned "neither-here-nor-there" quality of such projects, and in part because only one major new urban airport (DIA) has been built in the United States since the enactment of the National Environmental Policy Act of 1969, which made environmental assessments mandatory. While a number of "regional" airports have been built since then, their more rural locations have allowed their environmental assessments to largely escape public notice.

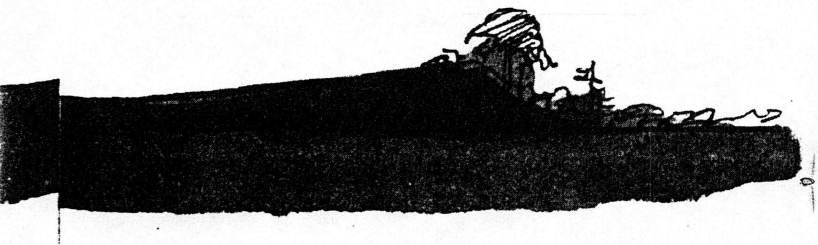
In the assessment for Denver International, it seems there was never any doubt that the project would be approved. In the 550-page book *Denver International Airport: Lessons Learned*, by Paul Stephen Dempsey (McGraw-Hill, 1997), the first reference to any environmental issue appears in this sentence: "By late summer 1989, the first federal funding installment ($60 million) was received, the FAA *approved the final environmental impact statement*, and groundbreaking on the project occurred on September 28, 1989." (Italics added.) The book includes little mention of environmental issues involving DIA, and none at all of water pollution.

For Jim Starry, this is a dumbfounding omission. "Look at what happened with de-icing," he says. "When ice forms on planes, as happens often in Colorado, workers remove it with ethylene glycol. At Stapleton, they were using 51 million gallons a year, and most of it ran off into the ground." By then, Starry had left NCAR and was running his own environmental design firm. When city officials invited him to present his design ideas for the proposed new airport, he suggested building a set of containment ponds to catch the ethylene glycol for recycling. The idea was adopted, though he was never either credited for it or paid for his consulting. (Bill Smith, the assistant mayor who invited him, died before the project got underway, and his successor seems to have pushed Starry out of the picture.) After the ponds were built and the airport began operation, however, a curious thing happened. According to Starry, one of the owners of a major airline company that was being heavily courted by DIA (none of the major carriers *wanted* the new airport), was also the contractor who had been selling ethylene glycol to Stapleton. At DIA, with the ponds catching the fluid for recycling, there was no need to buy so much of it—until one day the ponds were fitted with a 3-foot-diameter pipe that carried the used antifreeze about two miles and dumped it into Barr Lake.

"Now, you can fish in Barr Lake *year-round*, even when all the other lakes in Colorado are frozen," says Starry. He pauses thoughtfully. "But you won't catch any fish."

DIA's antifreeze management, it seems, was not atypical. In the mid-1990s, U.S. Citizens Aviation Watch (US-CAW) sued Baltimore-Washington Airport (BWI) for allowing its de-icing chemicals to enter an aquifer from which the people of Anne Arundel County get their drinking water. In Michigan, state environmental officials recently cited Wayne County for allowing ethylene glycol from Metro Airport to be discharged into a drain that

Starry's idea for an efficient runway also includes a slightly convex shape from side to side—helping both to center the plane as it lands and to protect it from cross-winds. The runway might be wider at the beginning, then narrow gradually as it approaches the terminal stop.

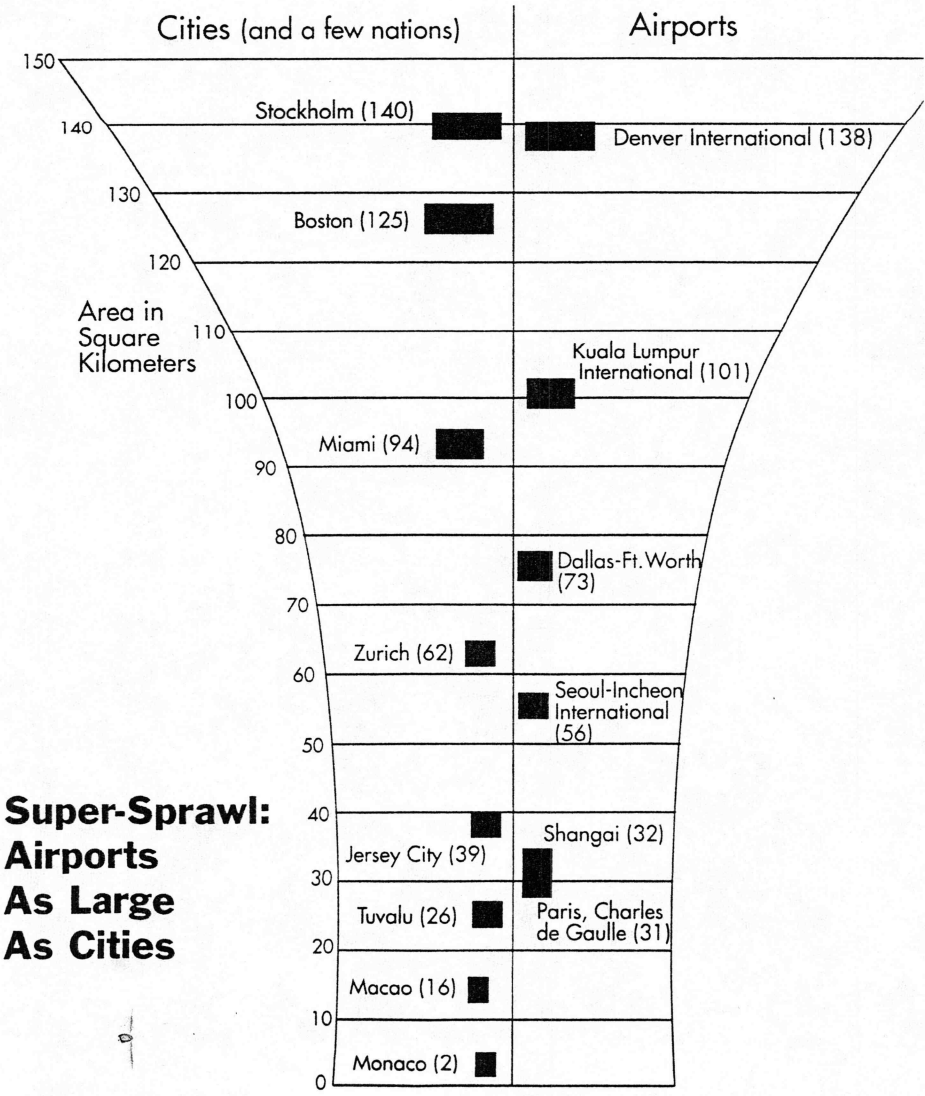


empties into the Detroit River. And it's not just in de-icing country that airports pose threats to water quality. In Florida, Miami-Dade County has just filed the largest environmental awsuit in the state's history, citing American Airlines, Delta Airlines, and 15 other companies for dumping airplane fuel, solvents, and other toxic chemicals into the ground around Miami International Airport, where they have seeped into the county's only drinking water source. But so far, the problem of airports leaking or dumping their multifarious fluids has remained largely below the radar—so to speak—of public scrutiny. Saporito notes that US-CAW won its suit against BWI, but the contamination continues. Holding tanks are still leaking ethylene glycol and other chemicals into the aquifer, and people in Maryland continue to drink it.

❹ Noise: The Psychological Pollution

THE SCREAM OF JETS—of fuel igniting and turbine blades striking the air as planes take off—has become the most noticeable of the environmental impacts of airports worldwide, for obvious reasons. Whereas the effects of contaminated air or water may take years to emerge, airplane noise produces instant irritation. As both cities and airports expand, more and more people find themselves living under the flight paths of ascending jets. Only in the past decade have planners begun to react. In the Netherlands, for example, a 1979 study found that 42,000 homes were being subjected to severe noise from Amsterdam's Schiphol Airport, and in 1990 Schiphol adopted a plan to reduce the impact by noise-insulating some houses and relocating others, and by curtailing night operations. At Paris's Orly, a night curfew has been imposed, and noisier aircraft are required to pay higher taxes. In at least a few places (Osaka, Hong Kong, Seoul), officials have mitigated both noise and land scarcity by filling coastal wetlands or bays so that flight paths go over water instead of homes.

In the United States, where suburbanization has caused the most extensive friction, irritation over noise has spurred the formation of scores of grassroots groups opposing airport expansion projects. In Seattle, a citizens' group called the Regional Commission on Airport Affairs has mobilized to stop the building of a third runway at Sea-Tac Airport, claiming that "the only plan for mitigation of noise from the new runway is to buy more nearby houses," and that "this provides no relief for the tens of thousands who will be newly exposed to overflight noise in neighborhoods miles from the airport." In California, a group called Citizens Against Airport Pollution (CAAP) is suing to stop expansion of San Jose International Airport because the project "would cause traffic gridlock and lead to more air and noise pollution." Similar groups have formed to fight noise at New York's La Guardia, Chicago's O'Hare, Los Angeles International, and St. Louis's Lambert-St. Louis International, among others. It was a national coalition of such groups that gave rise to Saporito's



Super-Sprawl: Airports As Large As Cities

organization, which now has 1.5 million members. "There are expansion plans coming up everywhere, and you just can't roll over the objecting communities anymore," says Dennis McGram, who heads a national coalition called NOISE—the National Organization to Insure a Sound-controlled Environment.

⑤ Impacts on Health

THERE'S A NOMBYISH (not over my back yard) quality to the political battles being fought over airports and their adjacent communities; many people like the commercial boost an airport can bring, and like the convenience of having ready access to air travel—but don't want planes roaring over their homes. Many of the battles have featured accusations by one neighborhood that it is being used as a dumping ground for noise being diverted from another, more politically connected and vocal neighborhood. "They Complain, We Get the Planes!" read one recent website headline. "How Our Neighbors to the North Screwed Us," said another. In some cases the tug-of-war has become an environmental justice issue, with flight paths tending to be located over the city's poorest neighborhoods. But in the long run, these local concerns may be subsumed by a more pervasive one: the emerging realization that airports may affect the health of anyone living within about a 20-mile radius. In the United States today, 70 percent of the population lives within 20 miles of a major airport.

As reported by Sharon Skolnick of the Earth Island Institute, the State of Washington's Health Department Census, which compared 1991–1995 health data for people living near SeaTac Airport with those of Seattle residents overall, found that "infant mortality near the airport was 50 percent greater, heart disease was 57 percent greater, cancer deaths were 36 percent greater." For people living near the airport, overall life expectancy was found to be 5.6 years shorter. That's not to say we know airport-generated pollution was the cause (or more likely one of several causes), but it suggests that far more attention to that possibility is now warranted. In Chicago, a similar pattern was found, as people living near O'Hare Airport had cancer rates 70 percent higher than those for Chicago overall.

One of the newer and more alarming findings concerns the effects of noise. Apparently, the complaints of groups like NOISE are not just matters of frayed nerves or disrupted sleep. In Germany, when the new Munich airport went into operation, a study of third- and fourth-grade children living in the flight path found significant increases in blood pressure and stress hormones, compared with a similar group of children living in the same area before the airport began operation. "These hormones are linked to adult illnesses, some of which are life-threatening, including high blood pressure, elevated lipids and cholesterol, heart disease, and reduction in the body's supply of disease-fighting immune cells," noted the report.

The Munich study, conducted by the Cornell University College of Human Ecology, also found that the children subjected to flight-path noise did not learn to read as well, because they tended to tune out speech. "This is probably the most definitive proof that noise causes stress and is harmful to humans," said Gary Evans, a professor of design and environmental analysis at Cornell.

The Physics of Catching a Ball

LISTENING TO JIM STARRY talk about ethylene glycol in Barr Lake, I feel a certain frustration, because I have come to empathize with the public reaction: "*Everything* causes cancer now, and *everything* is killing the environment. What can *I* do about it?" I sense that Starry is frustrated too, but not because of a lack of solutions. He has a solution that makes intuitive sense and is clearly worth pursuing—getting funding for feasibility studies, and perhaps pilot projects—but people aren't taking it seriously.

I question him more closely about his central concept—the inclined runway. Has the idea ever been tried?

He laughs. "Lots of airports have runways that are inclined because that was just the lay of the land when they built them," he says. "Telluride, Colorado has a 4-percent grade. Aspen has a 112-foot dip. Oh, yes—a big airport in Nepal has a 15-percent incline. We've just never done it on purpose, taken advantage of what it could save in fuel, if we did it systematically."

How about the pilots? Do they have a problem with it?

"No. But pilots are not allowed to have input into runway design. Pilots would actually find it easier, because as you land, you can see the whole runway ahead, like when you're driving and you see the road ahead going up a hill. On a flat, the heat waves often distort visibility—you get that shimmer, and sometimes you can't see all the way down the runway."

He recalls the time a captain at Gurnsy airbase in Wyoming invited him to video a C130 landing on an incline. It went smoothly, although Starry was so transfixed by what he was seeing through the camera that he almost got run over by the plane.

What about the terminal? I understand that having the runway pass over it eliminates most of the taxiing, but are there any other advantages—or disadvantages?

"Think again about the de-icing," he replies. "With the whole airport complex built under the runways, the fuel could be kept underground, at 58 degrees. Instead of filling the wing tanks with fuel

that's been stored in freezing trucks, it would go into the planes warm, so the wings would usually have no need to be de-iced in the first place. Then think of ice on the runway. The heat radiating from the terminal's roof melts the ice on the runway overhead, which is good for safety. Then there's the energy conservation of a complex where all the buildings are combined into one, and where it's all insulated by earthen embankment. The whole airport could be built on one-third the land, at one-half the cost, with lower operating cost, and a cleaner environment—which also means the airlines and other airport-related businesses could operate a lot more profitably. It's like designing a city, really; the more compact design is more energy-efficient, more materials-efficient, and more pleasant to be in."

Starry has clearly thought this concept through, and I feel a growing curiosity about its implications. As an editor at Worldwatch, I've long been wary of technological solutions to problems caused primarily by poor judgement or confused values. There are the sobering lessons we've learned about pesticides—the 1950s PR photos of kids smiling happily as they play, free of fear from mosquitos, in a protective cloud of DDT. There's the PR mail I get every week or so from Los Alamos National Laboratory, about its latest proposed technological fix for humankind. But Starry's proposal intrigues me, not because it's new technology but because it seems to be a more intelligent way of using techniques we humans have had all along. I wondered how long it has been since *Homo sapiens* has known how to cup his hand to catch a ball instead of trying to catch it with the hand held flat.

But if his concept has real potential, why *don't* people listen? Starry is a gentle person, and doesn't like to blame. He prefers to say the problem is that no-one is in charge of the airport system, and it turns out there's some truth in this. On a micro level, someone controls every movement—the air traffic controllers directing the planes in the air, the security guards monitoring your luggage and your pockets. But on a macro level, when it comes to planning and building, there seems to be no place where the buck stops. In the United States, FAA guidelines tell builders to limit runways to a maximum slope of 1.58 percent, but no-one seems to be able to explain why. It's like the "least common denominator" standards of product safety or quality in commerce, which provide a level playing field for all jurisdictions, but which some jurisdictions complain about because it may prevent them from adopting their own, higher, standards. Airplane pilots, wherever they may be landing, understandably like some degree of uniformity in runway design. And because airports are used by all nations, governments can't impose unilateral regulations on them to the extent they might on their strictly domestic operations. So airport administrations have become worlds unto themselves—quasi-independent, and fully accountable to no-one. I find myself wondering if this lack of accountability isn't a manifestation of the same mental compartmentalization that shackles so much of our thinking—so that, for example, public health agencies enforce no-smoking rules in airport terminals, but have no say in runway design, which may account for vastly larger differences in the amounts of carcinogens to which people in airports are subjected. According to NCAR, each gallon of jet fuel burned pollutes over 8,400 gallons of air to a level of toxicity that would be dangerous, if not lethal, to breathe. The only reason we're not seeing it kill anyone is that it's so rapidly dispersed through the atmosphere. But how long can a finite atmosphere continue to absorb it?

In any case, jet pollution isn't regulated the way car exhaust is. In the United States, legal loopholes have left airports exempt from either reporting to the Toxic Release Inventory or regulation under the Clean Air Act. And when U.S. Aviation Watch sued Baltimore-Washington International for its contamination of drinking water, Saporito says that "EPA was so out-of-the-loop that they had to come to *us* to find out what was going on. That's scary."

The Boy Who Flew Backward ... But Remembered to Keep Looking Ahead

STILL, IT SEEMS THAT the biggest reason why people don't pay attention to the environmental damage done by large airports—and to the kind of remedies proposed by people like Jim Starry—is neither administrative buck-passing nor corruption. Rather, it's that blind spot about supply-side solutions. For most people, airport dysfunction still seems to be just a matter of passenger crowding and delays. Even in terms of passenger capacity, the usual view is narrow—considering only how to expand the numbers of runways and flights, not how to either reduce demand or make supply more energy- and land-efficient.

Two recent accounts illustrate this tunnel vision. A 2000 *Consumer Reports* review of U.S. airports, ostensibly considering all major factors in consumers' interests, concludes that the solution is to build more outlying airports. Noting that 635 million passengers flew on U.S. carriers in 1999, with a projected increase to 1 billion by 2010, the authors argue that the answer is "public policy that equitably provides easier access to the skies," and that as new airports are planned for locations farther and farther from city centers, "the increasing availability of alternative arrival and departure points for air travel doesn't come a moment too soon."

A front page article in *USA Today* (September 12, 2000) comes to essentially the same conclusion. "Can gridlock be cured by expanding airports?"

asks the headline. And a sub-head answers: "Using alternative sites may be a better solution." The story goes on to suggest that the money being spent to add new runways to large hub airports would be better invested by building more new airports in outlying areas "where land is cheaper and the population more welcoming." Both publications thus echo the prevailing 19th-century notion that the way to get rid of any kind of congestion—whether of people, traffic, or waste—is simply to remove it to a more open space.

But this is the same primrose path that led to suburban sprawl. By looking only at the profitability of new tracts, versus the redesign of cities, we missed the costs of destroying habitat, paving over farmland, increasing per capita energy consumption, and so on. But the proliferation of new runways and access roads isn't just a parallel phenomenon; it's an *escalation* of sprawl. New airports almost invariably mean major new roads and additional developments along those roads.

Breaking this kind of vicious circle will require looking at efficiency not just in the narrow way airlines do when they try to fly without empty seats, but in the broad way that considers how much energy is consumed by the whole system. An airport that reduces congestion on the runways and in the air by moving out from the city isn't necessarily more efficient if it requires hundreds of millions of passenger miles of added driving each year, as does DIA. A project that makes people use more energy may boost local business and add to GNP, but ecologically it moves us backwards.

Jim Starry says he knows what it's like to fly backwards—and it's a scary feeling. Here, again, he's not speaking figuratively. One time when he was in high school, he deliberately slowed the plane he was flying—a J3 cub that he and a friend had rebuilt—to stalling speed, as part of a training exercise. The stalling speed of the J3 is 30 miles per hour. Flying into a head-wind of 50 miles per hour, "I was actually flying backwards at 20 mph," he recalls. "I was 18 years old—what can I say?" Now older and more circumspect, he doesn't like the idea of unnecessary risk on either a personal or societal level. There are better ways to find thrills, and one of the best is to allow for more imaginative, more out-of-the-box thinking about how to solve some of the world's most threatening problems.

Starry's solutions don't solve the problem of sprawl, but they help to redirect consciousness in an important way. They show that innovative design—in runways, terminals, and airplanes—can provide non-destructive substitutes for new jet fuel supplies or numbers of flights. In doing so, they may also help attune us to the idea that airport design is becoming an increasingly important part of the larger issue of urban design. That, in turn, is critical to determining how our increasingly congested and restless human population can adapt successfully to the limitations of its fast-shrinking planet.

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For Further Information

Paul Stephen Dempsey, *Airport Planning and Development Handbook*, McGraw-Hill, 1999 — provides perspectives on land-use impacts of major airports worldwide.

Paul Stephen Dempsey, et al., *Denver International Airport: Lessons Learned*, McGraw-Hill, 1997 — tells the story of the world's most severe case of airport sprawl.

Natural Resources Defense Council, "Flying Off Course: Environmental Impacts of America's Airports," October 1996, surveys 125 of the busiest U.S. airports. Contact: www.nrdc.org.

Cornell University College of Human Ecology — studied impacts of airport noise on children's health and development in Munich, Germany. See *Psychological Science*, January 1998.

The Ozone Secretariat, United Nations Environment Programme, "Special Report on Aviation and the Global Atmosphere — 19th OEWG," June 1999 — assesses current and projected impacts of aircraft emissions. See www.unep.org/ozone/19oewg-2-add1.shtml

US Citizens Aviation Watch – is a coalition of regional citizens' groups concerned with the noise, pollution, and land-use impacts of airport expansions. Contact: www.us-caw.org; or call Jack Saporito, (847) 506-0670