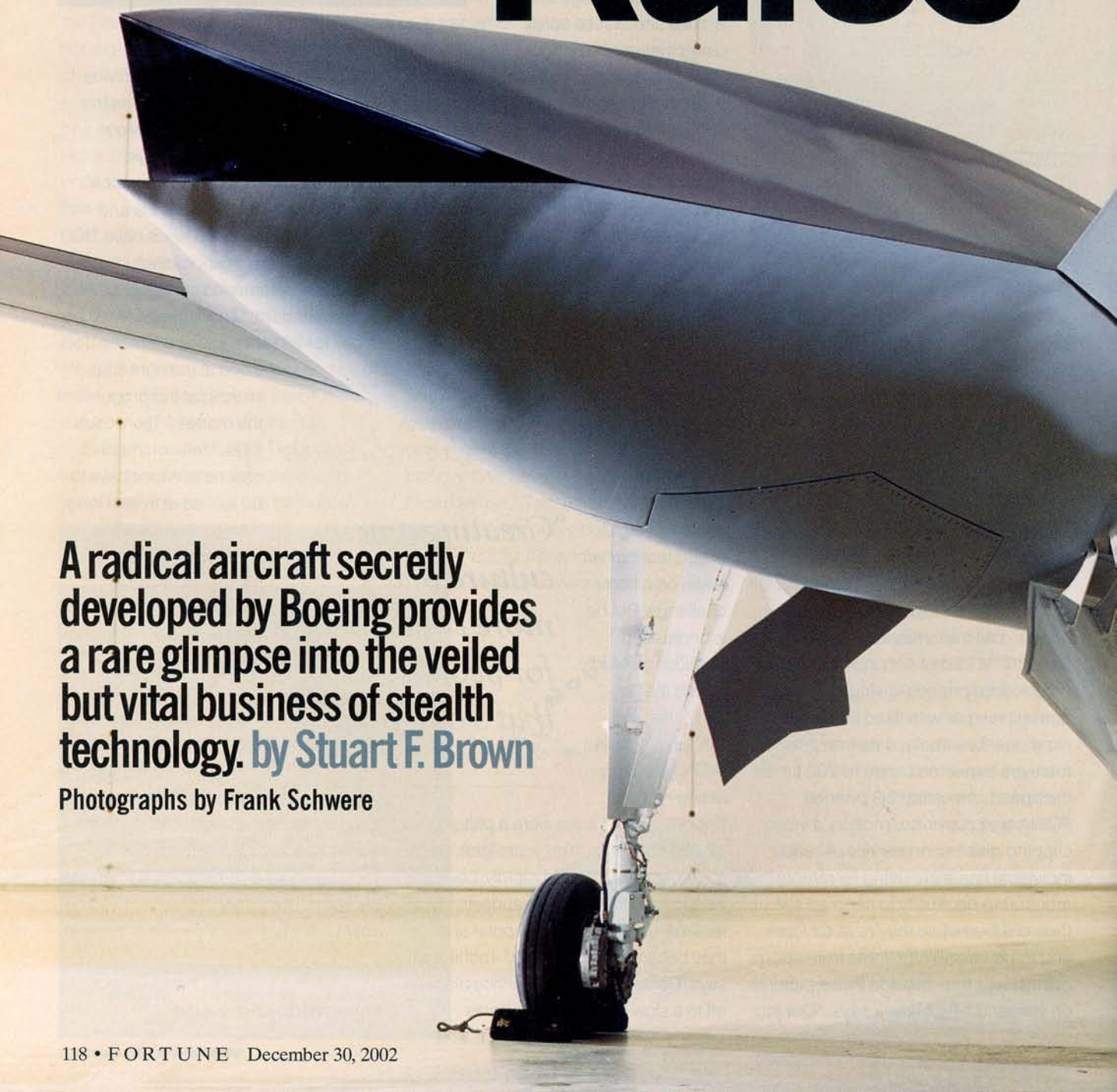
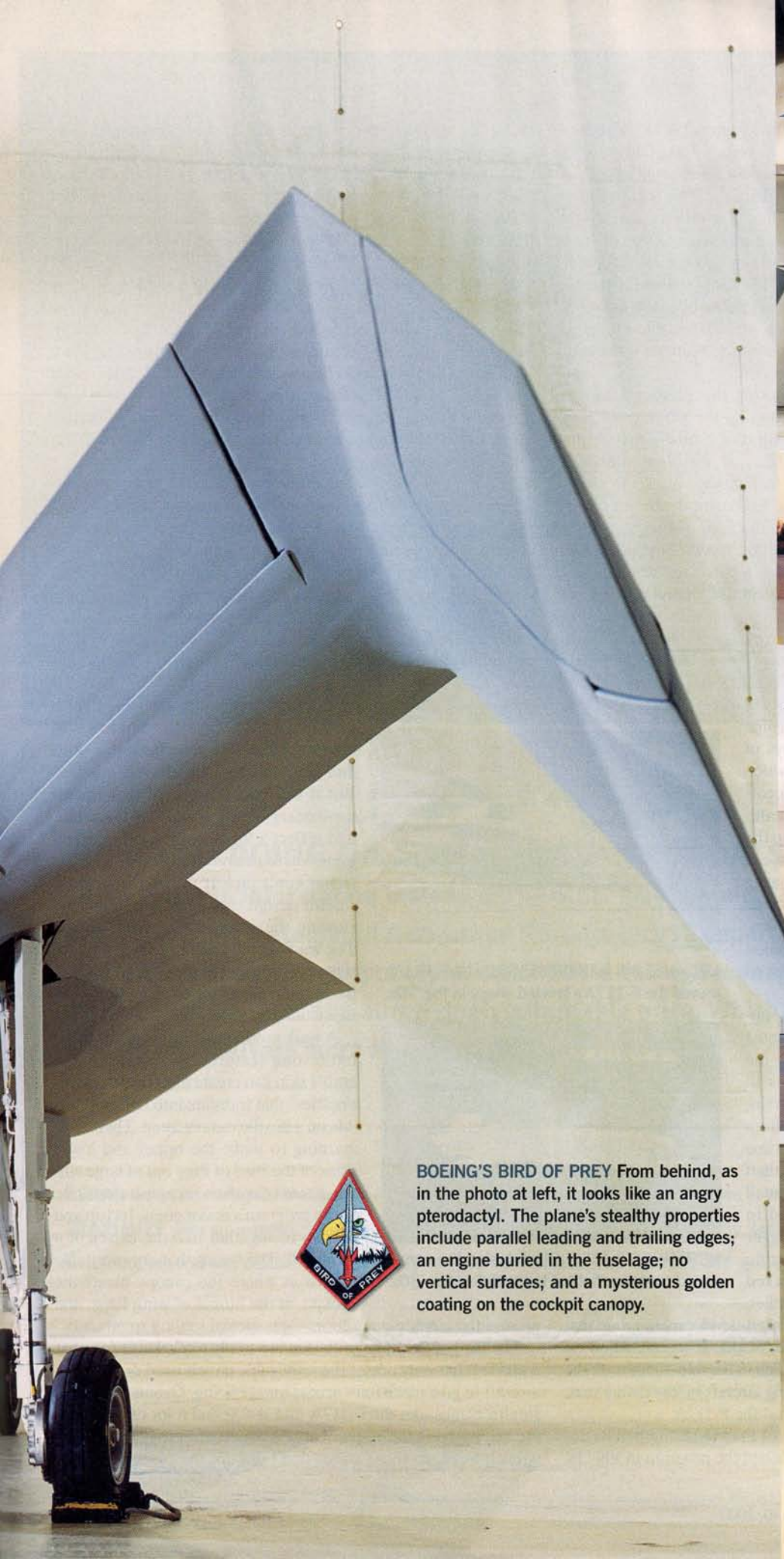
Stealth Rules



A radical aircraft secretly developed by Boeing provides a rare glimpse into the veiled but vital business of stealth technology. by Stuart F. Brown

Photographs by Frank Schwere



BOEING'S BIRD OF PREY From behind, as in the photo at left, it looks like an angry pterodactyl. The plane's stealthy properties include parallel leading and trailing edges; an engine buried in the fuselage; no vertical surfaces; and a mysterious golden coating on the cockpit canopy.

Sharply outlined against the sky, a pair of dull-gray, downturned fins glide through the door of an unmarked beige hangar. A few moments later the fins are revealed to be the wingtips of a tailless, single-seat aircraft being pushed backward by a bright-yellow tug attached to its nose landing gear. The spooky shape of the 47-foot-long aerial Batmobile is right out of science fiction, and so is its name: Bird of Prey, inspired by the Klingon spacecraft on TV's *Star Trek*.

Every so often the Pentagon and its contractors let slip the cloak of secrecy and permit a peek into the black world of exotic hardware development. It may be no coincidence that Washington okayed this technological tease, staged at the Phantom Works, Boeing's advanced-development group in St. Louis, on the eve of a possible confrontation in Iraq. Though the Bird of Prey can fly, it is not a fully fledged warplane performing secret missions somewhere, nor even a prototype of one. Rather, the dramatically sculpted craft is a one-off aeronautical and organizational experiment that Pentagon types refer to as a "technology demonstrator." It cost a mere $67 million to design and build but could be worth a whole lot more to Boeing: Its success in test flights between 1996 and 1999 put the $58-billion-a-year aerospace giant on the Pentagon's short list of stealth aircraft suppliers.

Stealth has emerged as the big game in military aviation. Since the days of the SR-71 Blackbird spy plane, which in the early '60s was the first to incorporate radar-cheating features, stealth has moved from the techy fringe into the mainstream of the $22-billion-a-year military aircraft industry. Today knowing how to build so-called low-observable features into aircraft is essential to winning contracts to supply next-generation warbirds, be they piloted or unpiloted planes or cruise missiles.

Historically, Boeing played only a supporting role in the stealth world, most importantly as a subcontractor on the B-2 bomber. The hot nameplates in stealth have been Lockheed Martin, builder of the angular F-117A medium bomber, and Northrop Grumman, prime contractor on the batlike B-2. More than a decade ago, executives at McDonnell Douglas (which Boeing acquired in 1997) decided that they wanted a bigger piece of the action. Stung by hearing from Air Force officials that they lacked the stealth chops to be a major supplier, McDonnell execs launched the advanced-development group that came to be known as the Phantom Works. It was modeled on Lockheed's fabled Skunk Works, which in the mid-1950s took the U-2 spy plane from an idea to a flying aircraft in less than a year, and later built both the Blackbird and the F-117A.

McDonnell dreamed up the Bird of Prey to strengthen its design and prototyping muscle. It launched the program in 1992 by recruiting stealth experts from rival aerospace companies. The design they developed was so unorthodox that the Bird of Prey went through dozens of iterations over four years before it was ready to fly. Nobody wants to say this on the record, but the Bird of Prey made 38 flights during its three-year testing career in the skies above Area 51, the mysterious base in the Nevada desert originally established for flight-testing the U-2.

McDonnell's rivals had been down this trail: The Bird of Prey is the third strange-looking stealth technology demonstrator the U.S. is known to have flown over the past 25 years. Lockheed, in the late '70s, built two examples of a demonstrator called Have Blue, a two-thirds-scale predecessor to the F-117A. It established that a plane with a faceted shape was flyable and did indeed have the desired radar-eluding traits. Both Have Blues ultimately crashed, but not before yielding enough knowledge to keep the F-117A program moving.

In the early '80s, Northrop secretly built and flew a demonstrator code-named Tacit Blue and nicknamed "the Whale." Tacit Blue was butt-ugly; it looked like the product of a marriage between a loaf of French bread and a snow shovel. But it flew and, importantly, proved the viability of compound-contour stealth shaping and materials that Northrop later incorporated into the B-2. Like Have Blue and Tacit Blue, the Bird of Prey will lead to actual warplanes—aspects of its design are already visible in Boeing's X-45, a prototype attack drone now flying at Edwards Air Force Base in California's Mojave Desert.

Eerie as the Bird of Prey looks, it isn't magic. Like any stealth plane, it can't erase the microwaves emitted by radars searching the skies and guiding lethal antiaircraft missiles. But it can eat up some of that microwave energy using absorbent materials, and reflect a lot of the rest off in directions where the radar dish that sent the signal can't pick it up. An important stealth design trick is visible to anyone viewing the Bird of Prey from above: The leading and trailing edges of its fuselage and wings are parallel, which limits its radar reflections to directions unlikely to be detected.

COURTESY ERIK SIMONSEN

LOCKHEED'S EXPERIMENTAL HAVE BLUE proved the F-117A's faceted shape in the '70s.

NORTHROP'S TACIT BLUE tested the compound contours that led to the B-2 in the '80s.

A walk around the bird exposes other interesting features. Seams in an aircraft's skin can create electrical "discontinuities" that translate into hot spots visible on a hostile radar screen. Therefore, learning to make the upper and lower skins of the Bird of Prey out of large single pieces of carbon composite was one of the program's major goals. Its top and bottom fit together like the halves of a clamshell. The seams that are inevitable —such as where the canopy meets the cockpit, at the hinges of wing flaps, and around the landing-gear doors—get special sealing treatments.

The Bird of Prey's smooth skin is equally remarkable for what it lacks: It has only one of the removable panels used on all other aircraft to give mechanics access for servicing. Ground crews on stealth planes like the F-117A and B-2 spend a lot of time taping and puttying the edges of access panels after they finish their wrench work, so those edges don't disrupt the plane's stealthy

properties. The Bird of Prey's designers figured out a better way: They simply positioned most of the access panels within the landing-gear wells.

Behind the cockpit is a top-mounted engine-air inlet, and at the tail a diamond-shaped exhaust opening—the only evidence you'll see of the Bird of Prey's engine. Like most stealth planes, this one masks the highly radar-reflective front of its engine by burying it deep within the fuselage, where prying radar waves have no direct path to the power plant.

In this instance the engine itself is nothing special—it's a small turbofan pilfered from a business jet. Using an off-the-shelf engine was a practical way to get the test plane off the ground quickly and at reasonable cost. The Bird of Prey's spindly landing gear and ejection seat are also scavenged from other planes.

The aircraft's uncanny curves, though, are anything but hand-me-downs. Engineers hatched them using three-dimensional solid-modeling software coupled with highly classified computer codes that predict the radar reflectivity of shapes. Those enabled McDonnell to define the initial contours. The company also invested in one of the stealth designer's indispensable tools—an anechoic chamber where components and aircraft models can be tested for radar reflectivity. By repeatedly testing and refining the aircraft, the engineers perfected the pterodactyl-winged design that took to the air.

The military wants stealthy, unmanned craft for "dull, dirty, and dangerous" missions.

BOEING'S X-45 drone incorporates features from the Bird of Prey.

The Bird of Prey also expanded McDonnell's knowledge about building very large sections of carbon-composite skin. Rapid progress in composites is making it cheaper and quicker to fabricate large skin sections. New resins that cure at room temperature are rendering obsolete large and costly autoclaves, which cure parts under high pressure and temperature in an atmosphere of inert gas. Doing away with heat curing also eliminates the need for exotic steel tooling to support the composite shapes until they harden. Instead, the Bird of Prey's skin sections were formed on plywood frames supporting glass-fiber molds, bargain-basement technology familiar to boatmakers.

The materials that make up the airframe have better, more consistent electrical properties than those of earlier stealth aircraft, minimizing "hot spots." That innovation could pay off handsomely for Boeing. Before it forks over the sticker price, the Pentagon requires each individual stealth plane to pass extensive radar-reflectivity testing; variations in the reflectivity of B-2 bombers created huge headaches for Northrop. Says George Muellner, Boeing's senior vice president for Air Force systems: "When you build stealthy vehicles, you need repeatable material characteristics or else they fail their acceptance tests. It's easier to build planes onesie-twosie than to build 50 of them. Then the planes can be like Aston Martins—every one is different."

There's plenty more about the Bird of Prey that Boeing says it's not allowed to discuss. The cockpit canopy, for example, has a vaguely golden cast that has something to do with stealth. Then there's that odd little lip that partly covers the flap hinges. It looks as if it might be flexible, but a visitor is allowed to go no closer than 20 feet from the plane, and his escorts are instructed not to respond to questions. All this secrecy persists even though the aircraft is officially now retired—in fact, it is destined for the Air Force Museum in Dayton, where it will join Tacit Blue.

Hatchlings of the Bird of Prey, though, could be flying in combat missions within the decade. Much of what McDonnell (now Boeing) learned about design and prototyping has already spilled into the X-45, the stealthy UCAV (that's an uninhabited combat aerial vehicle) it is developing for the Defense Advanced Research Projects Agency and the Air Force. The Defense Department, which has embraced a fast-forward concept called spiral development, is hungry for knowledge about how to design and prototype stealthy aircraft rapidly. Tired of seeing development programs that stretch on for 15 years or more and planes that are outdated by the time they get into production, Defense wants to have new Batplanes flying every few years, with upgrades and revisions incorporated as they become available. The Bird of Prey has given Boeing methods it needs to play that game.

November's lethal missile attack by a Predator drone on a carload of al Qaeda men in Yemen made the UCAV concept crystal clear. Now the military wants bigger and better unmanned craft like the X-45 to tackle the "dull, dirty, and dangerous" missions such as patrolling no-fly zones, flying through areas where chemical or biological weapons may have been used, and jamming and attacking air-defense networks. Air-to-air dogfighting is seen as a job best left to human pilots, whose brains, eyes, and hands still constitute a better quick-reaction package than any drone can hope to emulate.

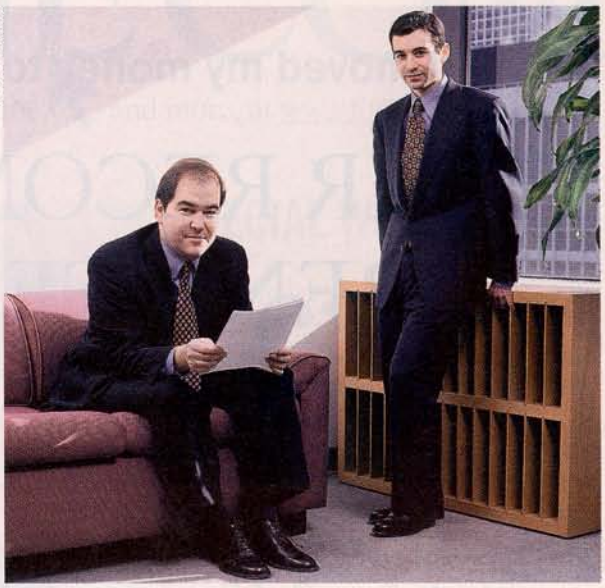
There is a debate about whether the invisible world of black projects is a good deal for the taxpayer. Historians tend to view the U-2 program as a model for getting great work done quickly, with its small, cloistered staff and limited interference by the customer—in that case, the CIA. On the other hand, in the 1980s the Navy, General Dynamics, and McDonnell managed to squander an astounding $5 billion without making a single aircraft in the bungled A-12 stealth attack plane program. The A-12 was finally canceled in 1991.

Boeing's Muellner, a retired Air Force three-star general with a background in aircraft development, knows what he likes about black projects. "You don't get as much quote-unquote 'help' from the customer, which means you get fewer straphangers coming through. Because there are fewer levels of scrutiny, the government usually picks their smartest guy to be the liaison," he says. "The other big benefit of a black program is that generally you have greater funding stability. Budgets that go up and down are the No. 1 inducer of cost increases and missed schedules." Other unrevealed stealthy aircraft surely exist, some of them test items, others perhaps operational in modest numbers. And now one thing is clear: We know there are three major makers tooled up to build these things. F

FEEDBACK *sbrown@fortunemail.com*

EDITOR'S DESK

ANDREA MORINI



It's been a miserable year for Wall Street. Pummeled by falling stocks, big layoffs, and endless scandals—and corralled by Eliot Spitzer and other regulators—the raging bull of yesterday is becoming a different animal. But how much will investment banking really change, and what will that mean to you? For answers we turned to the deceptively youthful-looking duo above. Nelson Schwartz (seated) is a six-year FORTUNE veteran who's been a mainstay of our investing coverage. Though he's expanded into new territory with stories on Israeli security, steel, and Kmart, Nelson's first love is how Wall Street works, especially, he says, "when things are in turmoil." Since 1997, Jeremy Kahn, who studied history in college, has made himself one of our experts on the arcana of accounting. Needless to say, he's never been busier.

ANDREA MORINI

His editor Tim Smith calls him a "poet of the inanimate." An old college buddy tagged him an "intellectual hardhat." You get the point. Writer Stuart Brown's specialty is what happens when science meets metal. Don't miss his latest story, "Stealth Rules," a crisp, lively look at what Boeing and its rivals are doing to make U.S. warplanes even more invisible. Oh—that piece of junk he's holding? It's a part from one of the first F-117A stealth fighters, which crashed at Area 51 in Nevada. (He could tell you more, but he'd have to kill you.)

Rik Kirkland

MANAGING EDITOR