CARGO DOOR LATCH MECHANISM

B is closed-loop system, now required on all DC-10s.

CLOSED LOOP SYSTEM
CARGO DOOR LATCH MECHANISM

C is detail of closed-loop mechanism.
CARGO DOOR LATCH MECHANISM

A is locking mechanism at time of Windsor Incident.
HENDRIK WOLLESWINKEL heard the news at his home in Amsterdam and said to his wife, “That must be a door.”

It had finally happened, just as they had warned it would—he and his two senior colleagues in the Netherlands Department of Civil Aviation, the RLD. For more than three years, the Dutch had railed at Douglas, at Boeing, at the Federal Aviation Administration and the international aviation community to wake up and act upon the decompression dangers in the wide-body jets.

Wolleswinkel had first been alerted to the potential hazard in the wide-body planes during precertification studies of the 747. Toying with numbers in the terse shorthand of the structural engineer, he had become aware of an alarming fact: Engineers seemed to be ignoring the “size-effect,” the dynamics of the dramatically larger volumes of pressurized air that would fill the big planes. In sudden decompression—if a hole were knocked in the shell when a plane was pressurized—there would be vastly greater volumes of air rushing to get out of the hole, pressing down on cabin floors. If the pressures were great enough, cabin floors could collapse, bending and tearing the control cables that ran through the flors, with the potential for catastrophe for some of the wide-bodies. Fuselages could be punc-
tured any number of ways—by a bomb, a midair collision... a door coming off.

The new planes must be built to withstand a large hole in the shell. They had yelled it to the aviation world—but no one had listened.

Was it the door? Was it that damn door again? This was one of the thoughts that raced through Chuck Miller's mind when he heard that the crash at Paris was a DC-10. Miller had just buckled his ski boots for some Sunday skiing, and was heading for the slopes at Masanatten just outside of Washington, D.C., when his friends called out to him to say they'd heard a radio report of a bad crash in France. Miller was the director of the National Transportation Safety Board's Bureau of Aviation Safety and one of America's most authoritative and concerned watchdogs of air safety. His bureau's job was to investigate all significant U.S. crashes or incidents to determine probable cause and to try, by recommendations to the Federal Aviation Administration and others, to prevent them. There had been only one fatal wide-body crash prior to Paris. When Miller called his deputy, Marion Roscoe, and he had confirmed that it was a DC-10 that had gone in, Miller found his mind jumping to the Windsor Incident more than two years ago... when a DC-10 had lost its aft cargo door in flight. The bureau had investigated the Windsor Incident, made a report and recommendations. Since then, he'd heard very little about the DC-10 cargo door problem. His bureau was always short-staffed, and at the time it was just one of five thousand problems. Now he couldn't get Windsor off his mind. He instructed the GO team to leave for Paris. The GO team are the crash investigation specialists who are always standing by, ready to go. They do not sit around a ready room, like SAC pilots poised for the alarm that blasts them into the skies. They don't wait for accidents. But when on call, they must be reachable at all times via the portable "beeper" they carry with them, ready to depart within two hours, night or day. Many carry
bags in their car, ready to rush to National airport, to the hangar—the closest thing they have to a ready room—that houses the FAA planes they use. Or they go commercial, bumping passengers or sitting in the cockpit, getting to the crash site any way they can, as fast as they can.

This time they’d be on a commercial flight to Paris. Miller knew they would have to have an invitation from the French, “but that doesn’t mean you can’t buy an airplane ticket, and wait in Paris just as well as here.” He ordered the GO team into the air. Senior investigator Doug Dreifus would act as U.S. accredited representative for the American team that would gather in Paris—men from the manufacturers of the plane and engines, the FAA, and the GO team. They were on TWA’s Flight 800—the first available flight to Paris—with their kits, flight suits, and high international reputations. They would be on the scene by Monday morning, French willing.

With every international crash, the men who must be there had to play the delicate game of protocol, pushing the rights they had under the United Nations’ International Civil Aviation Organization (ICAO) to the very limit, hoping they didn’t insult someone, hoping they could break through the pall of secrecy that often fell over a foreign inquiry. With so little crash experience on wide-bodies, it was desperately important for them to be there. Armed with ICAO’s Annex 13, the official crash investigation procedures booklet that defined their rights, they flew off to Paris.

The French were eager for American help, and Dreifus had no difficulty gaining access to the site.

In Paris Monday morning, he had raced so quickly to the forest that he had not even changed into his old flight suit. In sports coat and slacks, he had hiked “the whole distance the first visit. . . Walk a bit, then think about what I’d seen. Rugged terrain. Getting ideas all the way.” He was looking for rational patterns in the wreckage. With information exchanged with the French and the Turks added to their own visual inspection,
he and the team quickly did a tentative analysis of the crash.

The major and initial ground contact was synonymous in a rough area where stone had been quarried. The terrain was subsequently so devastated that precise impact locations were difficult to establish. A tremendous explosion occurred near the initial impact point. Pine trees to the side of the flight path had been uprooted with no mechanical forces evidence. The percussive force of the explosion had blown them out. Tree stubs were discontinuous and irregular, indicating the wreckage had been broken into many pieces during the initial heavy ground impact. The wipeout of trees was essentially complete for an approximate one-half-mile distance.

The pieces were so small that identification of parts was difficult. The tail, usually intact in a crash, had been destroyed almost beyond recognition. The largest chunk of fuselage was only about 10 by 17 feet. Of the thousands of feet of cable that had run the length of the 181-foot-long plane, only one 6-foot length could be found. No instruments were seen. A crumpled boîte noire containing the Digital Flight Data Recorder was found the first day, but the precious Cockpit Voice Recorder could not be located at first. They found floor planking structure but its normal location in the plane could not be identified, and "the only seat structure that remained relatively intact were the seats that separated from the aircraft in flight." The seats that fell over St. Pathus. Because of the tremendous momentum this big plane generated at high speed, a logical sequence of wreckage was hard to distinguish.

Yet even in this shambles, investigators were able to pick up the threads of a logical scenario. There had been momentary explosions and flash fires with a few persisting for a few seconds. But unburned fuel had been found smeared on trees at the point of impact with the wing engines, indicating that the bulk of the fuel on the plane had not burned. The seats that had fallen with their passengers at St. Pathus held valuable
clues. The seats had torn away with small pieces of the metal track at the base of the seats still attached. Structurally a load-bearing part of the floor, the failed track indicated collapse of the cabin floor. The power plant group of the American team found that the engines had not exploded in flight, for there was none of the metal splatter or hot spots that would have indicated “pre-impact distress” in any of the engines. But from the scattered confusion of fan blades, turbine shafts, and compressor sections they were able to deduce that the condition of the rear engine, which is dependent for control on cables running through the floor to the tail, “is as would be expected following the cabin floor failure and resultant destruction of engine control cables.” There was still enough residual heat left in the engine to discolor tree debris, but the temperatures were low, pointing to a shutdown in flight that had left number 2 engine without power, in a “windmilling” condition. It was all consistent with the severing or jamming of engine control cables prior to impact, further supporting the theory of floor collapse.

Enough rotating components were recovered to tell them that the underwing engines, 1 and 3, had been operating at the time of the crash, though perhaps in flight idle. To the relief of General Electric, the engines did not appear to be a causal factor.

The combined investigative groups of all the countries involved started writing up their preliminary evaluations—evaluations that were to be kept confidential until the official French report was issued. “The impact swath was oriented southeast to northwest and was approximately 2,624 feet long and 245 feet wide at its widest part. All personnel were killed.” It was the biggest “non survival accident” yet, a significant new point on the curve.

Late Monday night, Doug Dreifus called Miller with a routine confidential report. He confirmed that bodies and some pieces of “structure” had been found 9 miles from the crash, along the airplane’s flight path. Was the “structure,” Miller asked, a door? They knew it was,
Dreifus reported, but it had not yet been confirmed by the French.

Miller had just learned, too, that McDonnell Douglas had already sent wires out to all DC-10 operators urging them to be sure the cargo doors were fully latched and locked before flight. Douglas clearly feared that the cargo doors *might* be involved. Grasping the chilling implications, Miller ordered out all the files on *Windsor* and told Walt Sweet, the investigator who had handled it, to pack his bag.
dow on the right side, a middle-aged black lady seemed nervous, apprehensive; it was her first flight. An Italian couple was having its concern compounded by a language problem. A black girl soothed a baby. A retired woodworker and his wife were chatting with a friend traveling back to Tonawanda, New York, with them; the wife had carefully stowed a cardboard pretzel box containing an antique cut-glass water pitcher under the seat in front of her. With eight stewardesses patrolling the aisles, they would all be well attended.

It was a wet, gray evening for mid-June. And the 46-minute delay in departure from L.A. had put pressure on the ground crew trying for a fast turnaround—an economic imperative. Brad Reed’s bag and the rest of the escort luggage had been loaded aboard the rear cargo hold, and they were ready to lock up the door. But the ramp service agent was having trouble with the aft cargo door—the door that had reportedly caused two additional delays on American DC-10s on the L.A.–Detroit run within the last three days. As soon as the baggage was stowed, he had pressed the toggle switch that closed the door electrically and had then held it down, listening for the motor to stop running—the sign that the door was properly closed and latched. Then he tried to close the door handle, an act that would guarantee safe flight by locking the latches, sealing the plane, making it ready for pressurization by closing a little vent door—a door within the cargo door—turning off the cockpit light, assuring the flight crew that the aft cargo door was locked.

But he couldn’t get the handle down. And it was eating up seconds. In the cockpit, the initial checklists would have been completed; the crew would be waiting for the cargo door to be closed before firing up the engines. He was holding up the flight—failing in his mission. He put his knee against the handle and shoved. The handle closed flush with the door. But the little vent door looked a little cockeyed. He called a mechanic over to take a look and release the aircraft.
and romantic as "east by nor'east" may be, there's no room for that kind of imprecision in flying, just as the old mariner's "keeping a good look out" is not enough in the three-dimensional environment of the flyer. You can't rely on visual scanning, vital as it is. So control gives you lateral and vertical separation; tells you when other aircraft are on a course that could come near you, and tells you where to look for them.

They got their altitudes and radio frequency. They would fly Airway J-554 to Buffalo, either vectored by ground radars or directed by on-board navigational equipment. They were assigned the transponder code that would identify their aircraft from others on radar. Whitney read back their clearance:

American 96 cleared to...er...Buffalo airport. After takeoff turn right, that's as filed. After takeoff turn right to...er...heading...er...zero six zero for radar vectors J-554. Maintain 5,000...that's maintain 4,000. But expect Flight Level two five zero 10 minutes after departure. One eighteen niner five. And zero 200 transponder.

Not too smooth. He'd messed it up a bit. But he had got it.

On the final pre-takeoff checklists, the amber warning light for the troublesome cargo door was still off. The captain handed over control to his copilot. They rolled and lifted off.

They crossed the Canadian border, swinging over Windsor as they climbed. The climb was so steep that Margaret Innes, whose cut-glass water pitcher clung to its perch under the seat, observed that a stewardess walked up the aisle "as if she was climbing a steep hill." As they broke through the cloud into the shock of brilliant sunlight at about 11,700 feet, her eyes, and the eyes of almost everyone on the plane, were riveted on the spectacle. But as she turned to comment on the "fleecy white clouds" to her husband, Don, and her friend, the calm came apart. With a fury of sound and
motion, the protecting womb was punctured. *Explosive decompression.* One of the most terrifying events that can be experienced in flight. It hit like a hurricane.

The hull shuddered with a series of horizontal jolts, as if it had been kicked in the side by a giant boot. In one furious *whoosh,* the air whipped through the fuselage, sucking and tearing loose anything it could as it roared toward its exit. Ceiling panels the size of table tops fell like lethal blades. Some swung from wires that dangled like intestines from the gaping holes in the ceiling. Smoke—or was it vapor?—poured in through the holes, swirling around Margaret Innes like a smoke-screen. Floor panels leaped up in the aisles between her husband and her friend. The paneled interior of the plane seemed to be collapsing like a house of cards. Thank Heaven there were storage bins—not panels—above the heads of passengers sitting on the sides!

Don Innes looked back toward the rear and saw that the carpeted floor of the cockpit lounge had collapsed. Through the debris and fog he could see “shiny, new-looking cables and wires” in the hole—the plane’s control cables—taut, and exposed like veins.

Something made passenger Cindi Breloff look toward the front of the plane; and as she did, “particles of dust came flying toward me and someone in back of me screamed, ‘Oh, my God!’” The dust flying around was “just like in the movie *Airport,*” and she knew there was a hole in the plane, somewhere.

A galley hatch cover blew up and hit a woman in the cheek, cutting her. The elderly Italian couple who spoke no English were in terror. People counted rosary beads. And Victor Perez prayed to God.

Brad Reed heard a loud rushing noise. He had been watching the sky, too, when “a series of severe jolts occurred—it felt like a violent shudder, sideways, not up and down.... I thought at first it was turbulence, then the front of the tourist section filled with white foglike vapor—very thick—and a panel on the ceiling about six feet ahead of me in the center section came down. The fog was pouring in through the hole where
the panel was missing.” This was not part of the bargain.

Margaret Innes’s first thoughts had been, “A bomb’s gone off... and I hope we aren’t over Lake Erie!”

For most, a bomb or a midair collision were the first thoughts. The stewardesses knew it was decompression, though none had experienced it in their training, as military pilots do. All but two had completed their emergency procedures training within the previous month, and it had at least been graphically described. Most instinctively thought “Oxygen.” But the masks had not come down. One grabbed an oxygen bottle and started up the aisle. Carol McGhee had grabbed for her mask, couldn’t find it, and had realized she was breathing normally. They had been 2,000 feet below the danger level of 14,000 feet, where the masks pop out automatically. She saw the cockpit door burst open, hats fly out, and a sandy cloud come gushing out, murky and different from the fog that was filling the cabin. She started calming hysterical passengers and helping the woman hit by the hatch cover.

“First Lady” Cydia Smith saw the captain’s hat on the floor near the cockpit and felt an urgent need to get up there. Having made one of her major executive decisions on the flight—the bar would not be opened—she had been fixing coffee and had just missed having her face smashed by a service door that flew open. She grabbed a handle to keep from falling. Then, a sensation of weightlessness and, after the wild moments of decompression, an eerie silence—like a vacuum. She raced toward the cockpit.

Scheduled for her regular emergency procedures training the next day, Sandi McConnell had unfastened her shoulder harness and seat belt, but was still in her jump seat at the very rear of the plane, chatting with Bea Copeland, when the jolt hit her. She was thrown from her seat to the divider partition that was behind the circular cocktail bar. What had been the lounge floor was now a gaping hole, and she had the sensation that she was slipping down into it, down into
the cargo hold. Bea was hurled to the floor and found herself trapped, with a piece of ceiling on her head, the upended bar lying beside it, and her foot caught. She was staring into the luggage compartment below the cabin floor. She could not pull her foot free; as she struggled, she could feel the floor give way beneath her. The escaping air had almost taken her with it, and could still succeed.

Brad heard one of the girls scream to a man who'd stood up, "Get back in your seat, please!" and another yell, "Get me out of here!" He didn't know yet that the floor at the back of the plane had caved in with the bar and three of the seats, and that two stewardesses were trapped. Instinct was to get away from the threatening hole, and stewardesses started herding people away from it to the forward seats. Though the stewardesses were generally responding well, most of them seemed frantic to Brad. As passengers were shunted around, he saw one group moved into the very seats that another had just vacated. A man clutching a five-gallon can of antiseize compound like a security blanket was put beside him.

In the cockpit, the flight had been going well. Captain McCormick was so pleased with his plane that he was giving it testimonials. "Whoever designed that thing, I'll tell ya, he... ooooooooh!" They broke out into the sunshine. Flight Engineer Clay Burke thought, "What a beautiful day!" Then there was a loud, thudding bang. A jolt. A whirling sandstorm. The rudder pedals under the captain's and first officer's feet slammed to the hard left position, the left pedals going all the way forward, and the right pedals snapping back with such force that it smashed the captain's leg back against the seat. The three throttle levers flew back, with number 2 whacking hard against its stop. This put the engines into flight idle, killing forward thrust with a lurch, turning the vessel into a massive glider.

The blast was like a firecracker going off in the captain's face. His headset blew off, cutting radio contact; and he got a faceful of flying dirt and debris that
Chapter Ten

The Size Effect

To the Dutch engineers, it was inescapably the door. They had tried to convert everyone. But, like Cassandra, their prophecies had been ignored.

In his office in Amsterdam, Hendrik Wolleswinkel was first confronted with the potential dangers in wide-body jets. He was the youngest of the triumvirate within the Netherlands Civil Aviation Authority, the RLD, whose responsibility it was to certificate any new plane, of any nation, that was to be owned and flown by a Dutch airline. It was precertification studies of the 747 that had begun to raise his fears.

A lean, dark-haired and handsome man in his mid-thirties, he had sat at his desk playing with pencil and paper, toying with numbers. He had played with the new dimensions, with volumes of air, with floor strengths. He worked in a drab bureaucratic environment—pale green vinyl floors, gray-flecked walls, gray metal desk and file case, old radiator under the window. But his mind was intense and alert. And he quickly grasped the alarming fact that engineers were not designing adequately for the larger hull size. Criteria was being met. But criteria itself was not recognizing the "size effect," the dynamics of the dramatically larger volumes of pressurized air that would fill the big planes. They were designing pressurization and venting systems that would allow planes to survive only a very small hole in the shell. And holes could and did
occur—from bombs and midair collisions; from cockpit windshields being shattered by birds; fan blades from a disintegrating engine flung through the fuselage; doors coming off.

Numbers leaped out at him. If a plane's dimensions were doubled, air volumes would be cubed, filling the plane with \textit{eight times as much air as before}. If the shell were punctured, causing sudden decompression, there would be vastly greater volumes of pressurized air pushing to escape through the hole. If a hole occurred in a cargo hold underneath the cabin—from a bomb or door, perhaps—the air in that compartment would rush out to equalize pressure with the ambient air outside. The air in the cabin above the hold would try to rush out, too; massive volumes of air trying to escape would press down on the cabin floor with the weight and urgency of rampaging elephants. \textit{Pressure differential}—the difference in pressure between two adjacent bodies of air, separated by a floor, a fuselage shell, a bulkhead—was a fact of life in any pressurized aircraft. But in the new wide-body breed, it could be lethal. If the pressure differential between the hold below and the cabin above was great enough, the floor would collapse. They must design for it.

But how? Floors could never be strong enough to withstand a high differential; they couldn't be built like trestles or tanks. Catastrophic pressure differentials were normally prevented by letting air escape through venting holes between compartments. And it had to be able to escape fast. To prevent floor collapse, air in the cabin had to escape \textit{almost as fast as the air below was escaping through the hole in the fuselage}. If the hole was large—evacuating the air in the hold almost instantly—and the vents were small, the frustrated air, rushing at the vents like a stampede, would simply burst through the floor. Air was a fluid; it could bottleneck. Only so much could go through at a time.

The vastly increased volumes of pressurized air in the cabins of wide-body planes, enclosed like caged hurricanes, would have to be given more avenues of
escape, more venting between compartments. Though what good would venting and strong floors do if a large door came off at maximum altitude, sending the vital oxygen masks streaming toward the hole, out of passengers’ reach? Doors must be failsafe.

But doors were not the main concern of the Dutchman. It was bombs—terrorist bombs. Bomb holes could be large. *Yet they were designing only for small holes. Venting as if it were the 707 or the DC-8. And worse, they were still routing vital control cables through the floors, floors that could collapse.*

Wolleswinkel could see that “aircraft were complying with and even exceeding existing regulations at the time. But the mistake was that authorities responsible did not recognize that with wide-body aircraft, there are things you can’t extrapolate from experience.” He and his colleagues appreciated the engineering dilemma facing the designers. Where could you put more venting? And could you, in the 1970s, design for every eventuality? Every potential kind of hole? In an uncharacteristic burst of fire, Wolleswinkel threw his arms in the air, and said, “How can you design for a BOMB?”

Venting holes between the cabin and cargo holds were usually put around the periphery of the fuselage at the edge of the floor. But in the wide-body planes, the increase in linear dimensions around the periphery could never catch up with the larger volumes of air. For the volume of air would always increase at a dramatically faster rate. You could not simply riddle the cabin floor with holes and grills, for they could be blocked by carry-on luggage, seats, passengers, and lavatories; or they could weaken the floor. Yet venting was largely the key to the size effect problem. The aviation industry was being confronted with a new kind of problem: The need to vent was outstripping the ability to vent.

By the late sixties, the size effect on structure had become a major concern of the Dutchmen.

They were only three, but they were dedicated men
—Nicolaas Schipper, chief of the Airworthiness Bureau; Casper Falkenhagen, director of the Aeronautical Inspecton Directorate of the Netherlands Department of Civil Aviation; and Wolleswinkel, Falkenhagen's young deputy director. Among them, they had served Dutch aviation for eighty-three years, dominating the certification and airworthiness of Dutch aircraft since World War II.

Somehow, sitting in their low gray building on the edge of Amsterdam's Schiphol airport, they were often able to see the problems more clearly than were the men at the drawing boards. A small organization, they had been forced to become generalists, free of the "tunnel vision" that afflicts those engineers who never have the chance to look beyond one very small aspect of a very large problem. But would anyone listen? They were a handful of men from a small country. Smallness was, as Wolleswinkel knew, "our strength...and our weakness." But they would try.

The crusade had begun publicly in November of 1970, when Schipper made his now-famous statement to ICAO's Airworthiness meeting in Montreal, a statement that has come to be respected for its prophetic vision. But at the time, it had little impact. His comments were not on the agenda. They were not recorded. Nobody was talking about pressures and volumes. Except Schipper, Falkenhagen, and Wolleswinkel.

At a less public level, they asked Douglas to do some testing. And in 1970, Douglas had begun limited research on vents, floors, and pressures.

When, on March 1, 1972, KLM applied to the RLD for certification of the DC-10, the concern of the three men increased. The long-range model, the DC-10-30, would give KLM the capability of flying nonstop and fully loaded from Amsterdam to Curacao, and from Amsterdam to Anchorage, Alaska. Pilots were eager for its sophisticated cockpit. It would have a computerized inertial navigation system that would, when programmed by the punch of a few buttons before takeoff, take over after lift-off and "fly" the plane unaided
to move large control surfaces at the great dynamic pressures of the high-speed jets. Dynamic pressures are best understood by sticking your hand out of a moving car first at 10 mph, then at 50 mph. On a plane, the dynamic pressure at 500 mph is 100 times as great as at 50 mph—a function of velocity squared. Hydraulics were the answer.

With hydraulics, with boosted systems, the pilot had power steering, for a hydraulic system did most of the work, the pilot a little. Then, with fully powered controls, the hydraulic system did all of the work. The pilot still had cables, but the messages he sent down were now fed into servomechanisms that harnessed the power of the hydraulic system. Now, aerodynamic forces on the control surfaces could only push back on the hydraulic system—not on cables as before or on the pilot. It was a one-way street—an irreversible system.

But pilots rely on this feedback to provide important feel cues, cues that instantly tell them the size of the input and the severity of their maneuvers. So with irreversible systems came artificial feel systems—systems that would push back at the pilot in much the same manner as the control surfaces used to. It was easier flying. But every complexity brought new vulnerabilities. The hydraulic system could fail—from a break in the lines that carry the hydraulic fluid or from a failed pump. The fear of failure was real and was met by giving the pilot duplicate systems—redundancy—so that a backup system could be manually or automatically activated if the primary system failed. Redundancy, the failsafe concept, became standard design philosophy in the 1960s. When you couldn't have redundancy—in landing gear struts, for example—you designed for safe life, 100 percent reliability for the life of the plane.

With this complexity, flying a plane had become far more than controlling surfaces. Pilots were becoming "systems managers," responsible for and dependent upon a whole range of complex systems—mechanical, hydraulic, electric, avionic, pneumatic, environmental—
hard you had tried. It was a black/white concept that allowed for no diversionary back roads or philosophical meanderings. The point of a mission was to get from A to B. The mission of the DC-10 was to be better—to do more useful work at lower cost—than the -8 and -9. And, to be realistic, than the L-1011.

Harold Adams's art was the successful mating of Douglas's philosophies with the facts of life. The cost of building, flying, and maintaining a wide-body plane was astronomical. The DC-10 was going to cost American Airlines more than $1,800 an hour to operate. And sales would be lost or won on a few maintenance dollars saved, or a few extra revenue dollars earned with an extra passenger seat or a few more square feet of usable cargo space. The decision to go with outward-opening latch-type cargo doors in the DC-10 rather than with inward-opening plug-type doors, for example, had been made not only because the door openings were marginally too large for safe and proper operation of a plug-type door, but also because the airline required it for their containerized cargo system—a profit factor.

Suddenly, the mission was in jeopardy. Other crashes haunted the meeting at McDonnell Douglas. The British aviation industry had never fully recovered from the failure of the Comet, the first commercial jet transport. It had lost all public confidence during the desperate months when investigators were trying to find out what was making it disintegrate in midair. The violent and mysterious loss of two Comets had deeply shocked a public just being weaned from propellers. England's prestige as an aviation nation and the survival of commercial jet flight had been at stake. In a painful but courageous decision, the British government had moved in, grounded all Comets, and thrown all of Britain's investigative resources into the most intensive investigation yet mounted. In a remarkable salvage operation, the Royal Navy recovered 80 percent of the wreckage of one of the Comets, the one that had come down in 600 feet of water off the island of Elba.
An entire fuselage was tested in a water tank, put through the pressurization cycle not the limited number of times that had been thought sufficient, but thousands of times. Finally, after the simulated equivalent of 3,060 flights, a tiny metal failure at the corner of a cabin window had been detected. It was determined that the crashes of the two ships had been caused by metal fatigue in the fuselage—fatigue caused by pressurization required for flight in the hostile world of high altitude. Though these were strictly state-of-the-art accidents, almost impossible to have predicted in the trailblazing plane, all the public knew was that Comets had disintegrated into the sea. They didn’t care that subsequent models were safe. And the Comet, though a good plane, was never a successful one.

Then there had been Lockheed’s Electra, a turbo-prop; that transitional stage between propellers and jets that combined the complexity of the former and the power of the latter. There had been a series of crashes in 1959 and 1960, two of which were as inexplicable as the Comets’. A controversy raged over whether or not to ground the plane—a shattering blow to revenues and public confidence. It was not grounded. Pilots slowed the plane as they went through turbulence, and hoped the answer would be found. After months of intensive analyses and tests in an investigation that rivaled the Comet’s in thoroughness, flutter—the whirl mode—was found to be the cause. The whirl mode, which coupled vibration of the structure that sheathes the engine—the nacelle—to a flexing of the wing, reached such an intensity that the wings were literally torn off at their roots. This flutter mode developed quickly and was usually catastrophic. Where the Tacoma Narrows Bridge flutter persisted for a day before failure, finally flailing like a whip, the Electra’s harmonic vibrations ripped the wings off in 30 seconds. Mourning did not become this Electra. And though the engine nacelles and wings were strengthened and the modified Electra 2 went on to earn the admiration of the transport pilot fraternity, its aura of death hurt
sales. Only 174 Electras were sold to the commercial market.

Now, the first crash of a DC-10. Not off in the Everglades, with many survivors like the only other fatal wide-body crash, but fully loaded. Under the eyes of the world. With all aboard dead.

It could be the bomb the Dutchmen had feared. Rumors were already flying. But if something had gone wrong with the DC-10 itself—the doors?—the world’s fleets would have to be alerted instantly and the problem corrected, or the fleets grounded. The cause had to be found.

If it had been a terrorist bomb—or pilot error—any doubts about the DC-10 must be cleared away. Until now, the plane had an almost unblemished public record. No crashes. Some incidents: the bad one over Windsor . . . a passenger sucked out of a window in a bizarre accident over New Mexico when an engine fan disk had pierced the fuselage. But all new planes had bugs to work out during the first year or two of operation. There were no ADs yet, the Airworthiness Directive that is the official hand-slap of the FAA, which is issued if you had a serious safety problem. It had the force of law. And it was public. It could hang around the neck of a new plane like an albatross, adding drag to its image. Was it a door? Was it Windsor all over again?

Cause was still unclear. But, by the end of the day, Douglas sent a telegram to all carriers alerting them to check the cargo doors. Next day, disturbing word arrived from Paris: Wreckage had been found on the flight path, miles from the crash site. It was a door.

How could they have let it get through? Miller wondered. The National Transportation Safety Board had been created to perform a gadfly function, to prick the aviation industry and the FAA into ever higher levels of safety consciousness. As part of the Department of Transport (DOT), it sat in incestuous proximity to both the DOT and the FAA in the DOT’s massive square white marble home at 800 Independence
Avenue. But it had been formed in 1967 as an independent body mandated to investigate nonmilitary crashes and incidents to find the all-important probable cause—which was increasingly found to be a series of interrelated causes—and to send recommendations up to the FAA for implementation. Legally, the NTSB could have sent its recommendations to any body it felt could take action. And Miller was not convinced that the FAA's punitive, regulatory route was the only way to prevent accidents. There were other ways—pilot cooperation, local action at airports. But "prevention through regulation" had become dogma. And the FAA did have the power to get things fixed. The NTSB, and Miller's Bureau of Aviation Safety within it, had not. But the blue-bound NTSB reports were respected and waited for with fear and anticipation by the aviation community.

The NTSB had had to fight fiercely to maintain its independence. Miller had been having in-house battles with what he interpreted as White House interference with his bureau's mission for two years, and they were still going on, taking their toll of his energies. A new general manager, Richard Spears, had been installed at the NTSB, and Miller suspected him of being one of a number of men slipped into agencies by the White House staff to provide a direct line of communication and influence. It seemed part of a disturbing trend to mute criticism of the Nixon administration. Oversight bureaus like his were having their budgets cut, their manpower reduced. The outspoken were being muffled. Long before Watergate, he was becoming convinced that a megalomaniac force was trying to strangle any agency that stood in criticism of the executive branch and the major agencies that were an extension of its power. Or was he wrong? Was he losing his perspective and judgment? Miller had finally been able to air his concerns at public hearings staged by the Senate Commerce Committee's subcommittee on aviation—hearings that spurred the drafting of legislation that would, hopefully, once and for all, depoliticize the NTSB by
making the NTSB independent of the Department of Transport. Legislation was pending at the time of the Paris crash. But the pressures on him within the bureau were still building. Gadflies are not always popular. He had been very alone. Losing his temper with the board, and worse, losing confidence in himself. But how do you measure your own performance? Even now, in March 1974, with the Palace Guard crashing around the king, the clash with the general manager continued to be a constant tension, a conflict he could no longer leave at the office. He was beginning to take it to bed with him. And these chest pains on the tennis court. It was no good. Air safety was a religion with him. But did it demand martyrs? Did you take the pressure until you really blew? His wife had been urging him to quit.

And now, Paris. He had snapped to it, the complete professional. "In the safety business, we have a set of priorities that, in a catastrophe like this, superimpose themselves on everything else."

"I'm going to France," he told John Reed, chairman of the board, "unless you have some objection." Reed did not. So Miller and Walt Sweet flew out Tuesday night.

It was to be Miller's last major crash as head of the Bureau of Aviation Safety.

A stop in Boston gave them a good chance to get a quick refresher course on the cargo door. Locating a DC-10 and a cooperative baggage handler who set up a stand for them, they ran the door through its opening and closing cycle several times. They looked through the tiny peephole that was the result of one of the Windsor recommendations, a small window that let you look through the skin to see if one of the four small lockpins that slipped behind the latches was positioned correctly. The one visible lockpin was only an indication of a safely locked door, for the peephole did not let you see the only real proof—the latches properly hooked over the spools and the linkage properly aligned.
door was simply not urgent enough to work its way up to the top of the pile.

Miller flew on from Boston convinced of three things. "The peephole was a ridiculous thing to expect someone to use. At least one crew didn’t even know what it was for. And any locking system that depended on a baggage handler’s intimate knowledge of its mechanisms was a hazardous system." His alarm would prove to be well founded. More than two years later the official French report of the Paris crash would state that neither Mahmoudi, the baggage handler who had closed the door of TC-JAV, nor the THY mechanic aboard the flight, nor anyone else had looked through the peephole. It was a procedure Mahmoudi had never done himself and did not understand. He had, he said, seen mechanics out with their torches peering in viewports, but, as a baggage handler, felt he should not interfere with engineering matters. The need for looking in the peephole had been made even more critical by the fact, revealed by the French report, that a lock indicating light had not been installed on TC-JAV as recommended by a Douglas Service Bulletin.

Miller’s was the same concern the three Dutchmen had expressed shortly after Windsor when they wrote, concerning the adequacy of the peephole, that "... Douglas took great pains in writing clear instructions. This will not help very much, however, if your freight is handled by untrained personnel. This is a real operational problem that needs considerably more consideration."

They didn’t know for sure yet that it was the door. It wasn’t Miller’s nature to come into a smoking wreck after the fact and shake fingers at the guilty. It was his nature, and his job, to keep incidents from becoming accidents. Prevention was part of the mission. How had they all—McDonnell Douglas, the FAA, his own bureau, the airline—let this one get through? ... After the warning at Windsor?
Chapter Twelve

The Smell of Scandal

Chuck Miller had wanted to have one of his men present at all of the meetings monitoring the DC-10's development. But, with the coming of the new general manager, he had lost control of his bureau's priorities. And he had no manpower.

It had taken a serious incident—Windsor—to bring the developmental problem of the aft cargo door to the attention of the NTSB. He had not known that on March 3, 1972, a log entry for the DC-10 involved in the Windsor Incident had reported difficulty in closing the aft cargo door electrically. Or that, just two weeks before Windsor, McDonnell Douglas, in response to reports by three of the four airlines operating the DC-10 of failures of the electrically driven actuator to latch or unlatch the cargo doors, had issued a service bulletin to operators asking them to install heavier gauge wire to the actuator motor.

Nor had he known that there had even been a rehearsal for the dress rehearsal of Windsor. On May 29, 1970, during a pressure vessel test of fuselage 2 at Long Beach, a cargo door had been blown out as pressure inside had built, and the cabin floor had buckled then, too. The door had blown at less than 3 psi (pounds per square inch), which is equivalent to the pressure differential a plane would have reached at an altitude of less than 7,000 feet. That should have been the shock that propelled engineers back to the drawing boards for a profoundly improved door design and, be-
yond that, to a hard look at the larger problem of size effect.

Instead, the 1970 blowout had initiated a gradual, voluntary program of modification aimed at making the door failsafe. It had to be failsafe for certification. McDonnell Douglas had begun the four-phase DC-10 Cargo Door Improvement Program, which in itself seemed a recognition of imperfection, but that moved only by degrees toward a reliably safe solution. By a series of Service Bulletins, operating airlines were invited to make a series of electrical and mechanical "fixes"—repairs or changes—that only compounded a locking system so inherently unsatisfactory that it would later be described by a senior FAA man as "an inelegant design worthy of Rube Goldberg." It would not be until phase four that the door would finally be free of the possibility, the nagging fear, of human error in closing the door. And even the final solution—the "closed loop" system—was, like all the others, purely voluntary.

The closed loop was a locking system in which the closing of a vent door that permitted pressurization could be achieved only when the lockpins had moved behind the latches and the door was properly locked.

The improvements were issued as Service Bulletins, or SBs, the Douglas in-house directives used to notify airlines and production-line crews of any kind of change that was to be made. A Service Bulletin could alter the wattage of a reading light bulb or the design of a toilet seat, matters so peripheral to safety that a Service Bulletin did not carry with it a sense of urgency—unless specifically issued as an Alert Service Bulletin. Even then, it was only a suggestion, not an order.

The little vent door that went askew during the closing process at Detroit had been the first response—the small door-within-a-door that should never close and permit pressurization unless the latches and lockpins were in their proper, safe position. It was the change that had satisfied the FAA sufficiently for certification.

Miller knew that it was only with jet aircraft and
high-altitude flight that the reliability of doors had become so critical. Before, a door coming off or flying open was inconvenient and embarrassing, but not generally catastrophic, because the air pressure was approximately the same inside as out. And it had been difficult to break the "set" of the engineer and pilot minds that still saw doors as "just doors." But with pressurization, doors had become the gateways to disaster. With the air pressing insistently against the shell from inside, it had become vital to maintain the integrity of the pressure vessel in flight. All openings—doors, windows—were suddenly vulnerable.

Engineers had followed their instincts to plug the holes by doing just that. They had created plug-type doors and windows that were stuck in from the inside. As pressure built up inside, they were pressed even harder into the hole, like a bathtub plug, making the seal even tighter. But, as always with airplane design, there were tradeoffs. The plug-type door, which opened inward, took valuable, revenue-producing space, especially in the cargo holds. On large doors there could be sealing problems. And it lacked the structural advantages of the latch-type door.

Douglas had been using outward-opening latch-type doors for the cargo doors of its pressurized aircraft since the DC-6 in the early fifties. Opening out, they did not take up any room in the holds; and closed and locked, they became part of the stress-bearing structure of the vessel. Curved to conform perfectly to the shape of the hull, and secured by powerful latches, they became aerodynamically, as well as structurally, part of the hull. The tension stresses created by pressurization passed through the latches into the door, letting the door itself share the load. In contrast, tension stresses could not flow through but had to circumvent the plug-type door or window, concentrating stress loads around the openings, particularly at points of sharp curvature. Strengthening added weight. The Comet mystery had finally been traced to metal fatigue at the top of a window—a point of stress concentration.
Once you were committed to a latch-type door on the DC-10 there was no turning back; for it became an integral part of the structure, and the fuselage structure in the vicinity of the door was designed accordingly. You could not simply substitute a plug-type door. You had to live with it and hope you could correct any genetic defects. Mainly, you had to make it failsafe.

As Detroit papers dramatized the Windsor Incident with breathless detail and explicit diagrams of the door, McDonnell Douglas and American Airlines had come to its defense like protective parents. "There's no way the craft could take off if the hatch wasn't properly closed. There are too many safety devices aboard to indicate an open hatch. If those devices showed it closed, then it was closed," American's Walter Boyd was quoted as saying. A McDonnell Douglas spokesman said that the only way the jet could possibly have taken off with an open or improperly closed hatch would be if the hatch warning light in the cockpit was burned out. "But that's a very remote possibility." They admitted that there had been some problems in closing the doors. There had been some binding of the series of rollers, or spools, that are gripped by the latches like a fist clamping around a metal bar. But "we feel the problem has been corrected by the addition of lubricating devices on the latching mechanisms."

But tests made at Douglas under the eyes of the NTSB and FAA investigators had turned their statements into empty whimpers. Hidden under the skin, in the door's latching mechanism, was a design defect that had not been discovered in precertification testing. It was possible, they found, to have the door appear closed, latched, and locked when, in fact, it was not. If the door was operating correctly, the pressing of an electrical switch would close the door. Holding the switch down for an additional four to seven seconds would position the clawlike latches on the door around spools on the door jamb, linking the bottom of the door to the fuselage. Then, pulling a locking handle down slipped small lockpins in behind the latches. The move-
ment of the lockpins and the lock tube to which they were attached tripped a switch that turned out the warning light on the flight engineer’s annunciator panel. The closing of the handle also closed the little vent door, allowing the plane to pressurize. Unless the latches were fully engaged around the spools and the latching mechanism was “overcenter”—the act that truly “locked” the door—the lockpins could not be driven home, and the closing of the vent door, which was simultaneous with the movement of the lockpins, could not occur, preventing pressurization. It seemed to guarantee safety.

But the design engineers had forgotten Moose Jaw. Or Murphy. It was possible, by releasing the switch on the outside of the door a second or two too soon, to leave the latches only partially around the spools and the latching mechanism not “overcenter.” Also, binding of the spools or insufficient power to the actuators could result in the same problem. But the most disturbing finding was that even though the latches were not fully closed, the locking handle could still be stowed by applying approximately 120 pounds of force, closing the vent door and letting you assume the lockpins were in place. The baggage handler in Detroit had done it with his knee. And inside, the force that should have pushed the lockpins into behind the latches had been deflected back into a flexible linkage of metal rods—the vent door torque tube and push rods that connect the handle with the vent door and lockpins—that had taken up the slack and tolerances, twisting or bending just enough to get the handle stowed. This deflection of the metal also forced the vent door closed and pushed a small striker against the cockpit light indicator switch, turning off the warning light. The warning light—the flight crew’s only indication of the door’s integrity—gave them a false signal.

The NTSB had blamed the “improper engagement of the latching mechanism” as the probable cause and had been able to explain the mystifying sequence of events experienced aboard Flight 96.

As the aircraft had climbed, it had pressurized nor-
mally. At 11,750 feet, the pressure differential acting on the improperly latched cargo door had built to 4.5 psi, a force of approximately 5 tons. That had been enough to push the door open and fling it violently into the 260-knot slipstream where, torn off its hinges, it struck the horizontal stabilizer—the tail.

The hole in the fuselage allowed the aft cargo compartment to depressurize in a rush of air that hurled out the coffin. And now, with too little venting between the cargo hold and the cabin to equalize pressure, the huge volume of compressed air trying to burst out of the cabin pushed down on the floor with 4.5 psi. The floor could only take about 3 psi. It could not take the load, and collapsed, taking three seats and the cocktail bar with it. The cabin air escaped, like a tire blowout, and peripheral air, equally wild to escape containment, rushed into the cabin from above the ceiling, knocking down the panels . . . from the other cargo holds, hurling the galley hatch open, bursting through the service lift door, and throwing up the dust and grit that collects in any cockpit, creating the brief sandstorm that had blinded the captain. The cockpit door blew open. Air, sand, and hats gushed into the cabin. Air from everywhere raced down the cabin to escape through the hole in the shell. And as the air rushed out, the pressure and temperature dropped, and water vapor condensed, forming fog. Explosive decompression. Alarming, but not lethal. Yet.

What had threatened the flight was the jamming and severing of the control cables that ran through holes in the floor beams.

After Windsor, NTSB member Isobel Burgess had flown to the scene and had come home shocked by the extent of the damage, and by the close call. A special meeting of the board had been called to act on recommendations made by the Bureau of Aviation Safety, and these were sent out within ten days. The board recommended that the door be modified so that it would be "physically impossible to position the external locking handle and vent door to their normal door locked posi-
tions unless the locking pins are fully engaged." Chuck Miller, concerned with the more serious problem of floor collapse, added a recommendation that Douglas undertake a study of more venting between the cabin and cargo hold to preclude catastrophic pressure differentials in case of explosive decompression. The board, aroused, went further and recommended that Douglas do more than a study, that they install adequate venting.

It would be expensive. The industry claimed it might cost $250,000 to retrofit each plane and would keep planes out of service while it was being done. Miller had fundamental concerns about the whole door/floor/pressure relationship in the DC-10; but, in the real world, he knew the major modifications would not be made. He was right; they were not.

But he assumed the FAA would issue an AD to force correction of the immediate problem—the door. The NTSB waited for the AD that never materialized. He still didn't understand why the FAA had let Douglas get away with simply a Service Bulletin on something so vitally safety related. If his bureau had followed up more vigorously, could they have forced the issue? Questions were always easier in hindsight.

The first response to Windsor had been the peephole—the one-inch diameter peephole, subject of Service Bulletin 52-35, with caution placards, stenciled on in English near the operating panel beside the door, beside the locking handle and beside the peephole. The placards told the operator not to force the vent door handle. One read: "CAUTION: VERIFY LATCH LOCK-PINS ENGAGED." The placard by the peephole said, rather primitive: LOCKPINS ENGAGED—SYSTEM SAFE; LOCKPINS NOT ENGAGED—SYSTEM UNSAFE. Placards did not inspire confidence in safety professionals. And neither the peephole nor placards corrected the problem. They still left lots of room for Murphy.

Miller's awful fear now was that Windsor might have been a dress rehearsal for a tragedy that should never
have been staged. If it was the door... then, in the Windsor Incident report his own bureau had produced, they had all held the script for Paris in their hands.

When Miller and Sweet arrived in Paris Wednesday morning, March 6, they made a courtesy call to the U.S. embassy, then spent the morning at the offices of the French civil investigative group, their Gallic counterparts. They listened to the air traffic control tapes, then Miller told them about Windsor.

Early in the afternoon, he and Dreifus visited René Lemaire, who, as chief of the Inspection General of Civilian Aviation, had been named president of the Commission of Inquiry—the Enquête. They were told that the cargo door found at St. Pathus was now being kept in the gendarmerie headquarters at Le Bourget airport, under heavy guard, but that the Americans might see it. Briefly.

Immediately, the entire American team rendezvoused at Le Bourget for a swift examination—men from the NTSB, the FAA, McDonnell Douglas, and General Electric, the builder of the engines.

The door had been broken into two pieces as it had been flung upward on its hinges against the side of the hull, and there was "much deformation of the door structure." But trained eyes had been able to pick up some startling information. The latches were not locked overcenter, and at least one lockpin was against the side of the latch, rather than behind it in the locked position. Like Windsor. And something important was missing: a small metal plate.

Bill Weston was the first of the NTSB team to spot it, and he told Doug Dreifus. The plate should have been attached to the vent door torque tube that, coupled with rigging adjustments, increased the force required to close the handle from 120 to 440 pounds, making it virtually impossible for the handle to be stowed by force, as the Detroit baggage handler had done. It should have been installed on the Turkish hull in the Douglas plant, before delivery. It had been the subject
of Douglas’s Service Bulletin 52-37, which had been issued three weeks after, and in direct response to, the Winsor Incident. Following hard on the heels of the peep-hole, it was a far more positive modification than a dollhouse window.

Could the support plate have come off in the crash? Eyes narrowed to the point where three bolts should have attached the plate to the torque tube, to see if they had been sheared off. There were no signs of bolts. There were no signs, even, of bolt holes. They had never been drilled. The plate had never been attached!

They did spot some mysterious file marks, though, where the plate should have been. Had someone started, then stopped? Why? And who?

That Wednesday night, the American team met to discuss the status of their investigation. Doug Dreifus had pulled Miller aside earlier to tell him about the missing plate. With Dreifus chairing the meeting, Miller sat back and waited for the McDonnell Douglas men to report on the missing plate. They didn’t mention it. But he knew that “it’s normal for people to get a little bashful about admitting what’s wrong.” He had done the same thing for Chance Vought when he went out on crashes of navy planes his company had built. They had put “a hell of a lot of blood, sweat, and tears into this thing,” and with product pride and corporate loyalty so strong at Douglas, he was not surprised at the reticence, and saw no conspiracy in it. But this was too vital to hide. He began to prod a bit. A Douglas representative finally admitted that, yes, the plate was missing. The plate that could have prevented the door from being improperly closed.

In Washington, in the offices of the Senate Commerce Committee in the baroque Old Senate Building, Robert Ginther knew about the missing plate almost as soon as Miller did. A handsome young ex-TV newscaster who had been plucked from Seattle by Senator Warren Magnuson, the committee chairman, Ginther was the staff man who drafted new legislation and staged public hearings on aviation issues. His job, the job of all the
look forward to it. He believed that, with the shock of Watergate, "people, and in large part the media, are looking for villains." And he recognized the impact of it on "our reputation . . . our customers have to have absolute confidence in the integrity of our product. That's part of what's made this transportation system what it is—innate confidence people have in our transportation system, and Douglas is part of that. The reason I came to work for Douglas was simply that I thought they work on a little higher plane than, maybe, other companies." Now, a tiny, inexpensive piece of metal was bringing this "integrity of product" and the entire system of inspection and delegation under fire. He made his statement to the senators.

"It has been reported from Paris that a key part of one of the modifications of the aft cargo door . . . was found missing upon inspection of the aft cargo door located at the accident site. According to our manufacturing records, all Service Bulletins that had been issued to improve the cargo door latching mechanisms had been incorporated in the Turkish Airlines [plane] prior to its delivery. At this time we are unable to satisfactorily explain this discrepancy, but we are continuing to investigate this matter."

Douglas had discovered that the inspector who should have checked to make sure the plate had been attached—the support plate that should have made it physically impossible to close the door by force—had put his stamp on the inspection sheet, guaranteeing that the modification had been done, *when, in fact, the plate had never been attached*. Nor had it been attached to a DC-10 owned by Laker Airways in England, which had gone through the predelivery modifications at the same time. The inspector had been subsequently identified, reprimanded, and removed from inspection duties. But his error could never be withdrawn. When the two planes had been delivered in December of 1972, the inspection sheets had gone along as part of the planes' pedigree of airworthiness. Airlines relied on those sheets. The only other way the defect could have been spotted would have been to take the door apart, strip
off the fiber glass panel covering the locking mechanisms, and look.

News of the missing plate had stunning impact. It was one of those screaming admissions for which there could be no answer, no excuse, no escape. To lawyers, this was gross negligence—the stuff of massive lawsuits. Letting revelation build on revelation, the senators picked up the scenario and probed in to the more basic problem—the integrity of the floors. The vents and floor strengths that had nagged the Dutch since the late sixties. Brizendine reported that venting studies had been done as early as 1970 at the request of the Netherlands. They had done additional studies after Windsor and had continued to work at a “modest low level of intense activity” ever since. Now, under pressure from the FAA, the press, Congress, the level of activity had increased.

No one—not the industry, the FAA, or NASA, which could have done basic research on the volumes and pressures in the new generation of jets—had fully recognized the serious implications of the size effect. When the FAA had asked Douglas to reassess the jumbo jet design with regard to fuselage holes, Douglas had replied, just a week before the Paris crash, that they felt it was a burden that should be shared by the entire industry. The FAA, they suggested, should fund the study. It was clear that, even after Paris, the aviation industry would have to be pried, like an abalone from a rock, from what had become a compulsive attachment to failsafe doors as the only solution to the size effect. “Douglas’s primary efforts,” Brizendine confirmed, “have been to insure the integrity of the pressure vessel.”

That they had finally achieved, to the infinite relief of all those who had read about the door and who flew DC-10s.

Within months of the Paris crash, the door would be as safe as it was possible for Douglas engineers to make it and, by general consensus, failsafe at last. Two weeks after the crash, the FAA had issued an AD forcing air-
lines to incorporate the "closed-loop" system, which had been phase four of Douglas's door improvement program, the subject of a generally neglected Service Bulletin SB 52-49. It was a locking system in which the closing of the vent door could only be achieved by proper movement of the locktube—a system in which the closing of the vent door did mean that the lockpins were properly engaged. July 1, 1974, was the date set for completion of the closed-loop system for every DC-10, with foreign airlines eagerly and voluntarily complying.

At last they had fixed the door, but they still hadn't fixed the plane. Floors had not been strengthened; more venting had not been installed. Yet floors had collapsed twice in flight. And now 346 had died.

Watching the hearings from his Wichita hotel room, Sterns had sensed a burgeoning scandal, sure now that this would be the biggest product liability case in history. And what had been revealed in the hearings—the Gentlemen's Agreement, the Windsor Incident, the missing plate, the vulnerable floors—was only the tip of the iceberg, he knew, compared to what discovery would bring out. The public case had been made. But the legal case was still hidden in California, in documents. He could taste it.

That was a month ago. Then the Wright case had come in. And the call from Engler. Now he was on his way to England to receive his instructions.

Sterns met the English solicitors in Mitchell's offices on the Thames. Below them, in full view, Denmark's Queen Margrethe's visit was coming to an end; royalty were saying good-bye with full ceremonial pomp. Flags waved. Plumed guards saluted. And as the whistle of the Danish royal yacht blew, Sterns felt powerfully moved by this persistence of tradition. The Tower Bridge loomed in the background, adding its weight of history to the scene. He was a western boy who never felt completely comfortable in New York. But here, strangely, he felt very much at home.
Chapter Nineteen

The Great Birthday Card Debate

Like a housewife who’s just heard twenty unexpected guests are coming for dinner, Thelma Alden, Judge Hall’s court clerk, was scurrying around getting the house in order. The federal courthouse in Los Angeles. On June 6, the Judicial Panel on Multidistrict Litigation had transferred the case to California and assigned it to her boss, Judge Peirson M. Hall, senior judge in the U.S. District Court for the Central District of California. By mid-June, twenty or thirty lawyers would be jetting into town for hearings on the class action and the start of depositions on In Re: Paris Air Crash MDL No. 172. But unlike dinner guests, they’d be hanging around the house for at least a year. And the place was still bustling from previous crashes. There were still three hundred deaths pending in Hall’s other crash cases. Air Canada, General Dynamics, and Air Alaska were still hanging on, clogging the calendar with court hearings. Pago Pago, already being referred to as “Pango” by the insiders on the case, had just arrived. The Pan Am 707 had crashed in western Samoa just a month before the Paris crash and had been MDLd to Judge Hall’s court, too. She would now have to find space for both Pago Pago and Paris without overtaxing the judge.

With the major aviation cases flowing into Hall’s hands, it was hard for Thelma to give him enough time
The efforts of thousands of men, all working on different elements of the design, came together in Harold Adams’s design meetings, held, now, every day. It was here, over engineering drawings, that Adams earned the commanding respect of his engineers with his ability to scan complex designs from any department, to send engineers back to their drawing boards with a simpler solution, and have then return an hour later muttering, “By God, he’s right. It’ll work that way.” Discarding, adding, changing, the form of the plane was rapidly coming together into a body of numbers that defined the new airplane. Weights. Speeds. The dimensions of wings, fuselage, tail, doors. Center of gravity limits. Altitudes and cabin pressures. Fuel capacity. Tires, wheels, and brakes. Engines. The number and placement of passenger seats, galleys, and lavatories to suit the customer airline’s needs. Some of the numbers defined years earlier, some changing daily. Documents revealed a story of decisions. Three or four engines? Three . . . But where was the third engine to go? It was decided to hoist it up onto the vertical tail, moving the air straight through rather than into an S duct that “bent” the air twice, with a loss of energy. The design would give them 3 percent greater efficiency than the L-1011 and provide “a better environment for the engine.” Though it was a purely functional decision, that mighty sheathed power plant, apparently speared by the tail fin high above the ground would become the most distinctive visual characteristic of the DC-10. Clean, male, massive, the aesthetic of engine number 2 had evolved, like any well-engineered product, out of the job it had to do. By the mid-1970s, Douglas’s great silver cigar would be clearly visible above the sprawling terminal buildings of many of the world’s airports. Some of the numbers that would cast the fate of 346 people had been established by July of 1968. Pressures. And doors. The plane would fly at a maximum altitude of 42,000 feet, with the cabin altitude kept to a maximum of 7,610 feet—like sitting in Aspen, Colorado. The cabin pressure, in normal operation, would be 8.6
psi higher than the air pressure outside with pressure-relief valves preventing pressures in excess of 9.1, though the fuselage could withstand still higher pressures. The bulk cargo compartment door would be on the left-hand side of the plane, at station 1811. It would close over an opening 44 inches wide and 48 inches high, and would be the smallest of the lower cargo doors in the plane—18.5 square feet, much larger than the .9 square foot fuselage hole that the plane must be able to sustain to satisfy the FAA.

The choice of a potential hole size in the shell was one of the most significant in the development of the plane. It was the number that allowed engineers to proceed with designing the venting that would protect the floor. They already knew the other vital numbers. The normal operating pressure would be 8.6 psi and, in flight, would be the same in all pressurized compartments. The same pressure that pressed down on the cabin floor would press up on it from the cargo holds beneath. But the floor was designed to withstand a pressure differential of only 3 psi, which meant that it would be safe as long as pressures were roughly equal on both sides of the floor, pressing on it like two hands pushing with equal force on either side of a piece of plywood. But if a compartment on either side of the floor—a cargo hold or the cabin—lost pressure, it would be like one hand suddenly being pulled away. When the pressure differential rose to 3 psi, the floor would collapse into the vacuum on the other side. It was venting that would allow the air to flow from one compartment to another, to prevent an excessive pressure buildup on either side of the floor. And the amount of venting depended on the size of the hole through which air would evacuate.

But what size hole? There were meetings. Discussions. What might cause decompression? Bombs. Volatile cargoes exploding, or being thrown around in turbulence. A turbine blade flung from an engine. A bird through the cockpit windshield. Migration season sent over four million ten-pound Canada Geese flying in
close formation at altitudes of up to 20,000 feet. And one hundred million ducks! There were lightning strikes. A door coming off. How big was the hole likely to be? Who knew?

John Brizendine, the -10’s program manager at that time, knew that “the experience with jet aircraft and pressurized aircraft was quite good with regard to the puncturing of the pressure vessel, so there was nothing in the experience that said that the probability of puncturing this pressure vessel was anything to worry about.” The FAA had established an industry standard for hole size that seemed to make sense—the area between two frames and two longerons, which was just under one square foot. The size of a writing tablet. The frames and longerons were the aluminum skeleton that gridded the plane. Skin was laid over the skeleton and riveted on, creating thousands of small rectangular areas, or panels, defined by the crisscrossing members. If the fuselage were pierced, or if it cracked from fatigue, the skin might fly back in the rush of decompression; but the rivets would contain the ripping of the skin.

It was a Douglas design tradition to design enough venting to handle the loss of two panels, doubling the roughly one square foot industry standard. And there were other factors that helped them determine the hole size. The air outflow valve, if it failed, would open up a hole significantly larger than one square foot. And they had to cover “all loading and rigidity conditions.” The hole size they came up with was between 3 and 8 square feet, depending on location. The front of the plane could withstand an 8 square foot hole; the rear of the plane where the bulk cargo door was located could withstand a hole of only 3 square feet—much larger than the minimum criterion. But it was still far smaller than the smallest door. “Doors,” said Brizendine, “were not considered. _Doors are supposed to stay closed!_” Even the Dutch agreed. The numbers were locked up with the rest of the design load criteria in November 1967, and subsequently certificated by the FAA.

And what kind of cargo doors would they design?
Would they be outward opening latch type? Or inward opening plug type? Would they open and close hydraulically . . . or electrically? Significant choices, in hindsight, but in the overall scheme of things, these were not global decisions. They were just doors. Douglas had been designing doors for pressure vessels for thirty years and, as John Brizendine had said, they had never been much of a problem. Doors were a small element in the total complexity of a big jet. The DC-10 was about five times as complex as the DC-9. It was the innovations in a new plane that you worried about. The Electra’s powerful new turbo props had torn her wings off. The Comet’s skin, not fully designed and tested for the pressures of high altitudes, had cracked with fatigue. The DC-10 must not have an Achilles heel. To Harold Adams, its longitudinal controls, fully powered for the first time in a Douglas aircraft, seemed far more critical than the cargo doors.

And underlying the design was always the broader philosophical worry, too, over the fixed “set” of engineers’ minds. They measured systems by their strengths, not their weaknesses, and reveled in the perfection of a design on paper. Adams always pushed his engineers to take the human factor into account. But it was distasteful for them to let human frailty “torque” their designs. Murphy compromised mathematical purity. It was Adams’s last chance to crack minds open before he retired.

But a small cargo door with a fatal susceptibility to human error had slipped through. In spite of an admirable pedigree, a door had been bred that was a bad seed. Lawyers grabbed memos on the doors, hoping to find answers or at least hard questions to ask witnesses. As they read the documents, they began to grasp General Dynamics’ role in the DC-10 saga—a connection the Senate hearings and the press had not even touched, and only Sterns of the plaintiff lawyers had considered it seriously enough to name in his complaints. He had learned from his Air Force T-29 case against General Dynamics that the company was involved in the DC-10,
but he could only guess at the depth of their involvement.

The Convair Aerospace Division of General Dynamics Corporation had been awarded a contract in early August 1968 to design and build four sections of the fuselage, including floors and doors, to Douglas's general specifications. The section that attached to the wings had been designed by Douglas, though built by Convair. Douglas had decided such things as type and placement of control cables, cabin pressures, and the type of door.

The design of the cargo doors was still in flux when the contract was signed. There was a tug-of-war over the tradeoffs in the plug-versus latch-type door. A compelling argument for latch-type doors was the airline’s requirement for a containerized cargo system. It gave you more cubic feet in the cargo hold for payload and allowed the uninhibited movement in and out of containers. To an engineer, the outward-opening latch-type door was structurally superior. For large doors, it gave you a better seal. And when it was properly closed, it was integrated into the surrounding structure, behaving as if there was no door there; it became part of the shell, sharing the load. Beautiful. If you could forget the human factor, it had to be closed right. That was the tradeoff. The latch type would open under pressure, if not quite closed. The plug door would close tighter, like a bathtub plug. Inherently safer. And the plug door weighed less—another vital factor in its favor. And yet outward-opening latch-type doors, hydraulically operated, had been used successfully on the DC-8 and -9 cargo doors.

In the atmosphere of growth and change, of reviews, revisions, meetings, no one seemed to remember precisely when or why the tradeoffs tipped the decision in favor of the outward-opening latch-type door. Or who tipped the scales. But once chosen for the two large cargo doors, it was selected for the small bulk cargo door mainly for consistency—an important operational factor.
As with the entire Convair relationship, the exchange of data, ideas, and design responsibilities between the two firms was so constant and so complex, the communications with direct phones, shuttle planes, and exchanged personnel so close that it was impossible to trace all the millions of threads of thought back to their points of origin. For the lawyers, the tiny fragments of decision and responsibility tended to tangle into a great gummy ball.

The moment of decision to operate the doors electrically was equally elusive, but was one of the most significant decisions in the design of the doors. The doors were originally to have been powered hydraulically like the cargo doors on the DC-8 and DC-9. That had been the early understanding between Douglas and General Dynamics. Hydraulics had some inherent safety advantages. If improperly latched and under pressure, a hydraulic door oozed open, bleeding air gently, preventing the plane from being fully pressurized inside, thus keeping the buildup of pressure to less than a normal level. On the other hand, an electrically powered door, if only partially latched, would not ooze open. Once closed, it would grip the fuselage tightly, allowing the pressure inside the plane to build up to the point where it could hold on no longer—until a failure occurred. But looming above these considerations was one vital factor. Weight. There would be a 28-pound weight-saving per door using electrical actuators, an 84-pound saving per plane. In the DC-10, as in any commercial transport, “Every pound’s worth its weight in gold.” For the DC-10 a $100 a pound weight tradeoff was established, which meant that if you could make a technically sound change that would save a pound at an extra cost of less than $100, you were to do it. The decision was made to go with the electrical system, a decision that may have been one of the major steps toward Paris.

As they plunged toward the “off-board” design deadlines, weight began to hover over the drawing boards as tyrannically as certification. On December 5, 1968,
fastened with two and a half million fasteners; they were being riveted and bolted together. Engineers were bandying about the old joke about a plane being "a million small parts flying in close formation" as the excitement built.

On March 30, the wings and all fuselage sections of the first DC-10 had been mated, readying for the first test flight. After three intensive years, the marvel of creation was becoming dramatically apparent. On the assembly line, the parts were fitting together like a three-dimensional jigsaw puzzle. Wings from Canada, Fuselage sections from San Diego, Vertical stabilizer and rudders from Italy. They fit. They worked. Wires, cables, hydraulic and pneumatic lines were all mated, connected together in a multicolored network of veins and arteries that would bring the plane to life by flicking a series of switches in the cockpit. A product of management techniques that were virtually born in the aerospace industry, the mission was being accomplished, as a Douglas engineer explained it with uncharacteristic flippancy, "the same way you eat an elephant—a bite at a time."

As the plane came together on the assembly line, a new weekly deadline was putting pressure on the program, giving a new rhythm to life at Douglas. At 2:30, every Tuesday afternoon, the whole assembly line moved forward one step. Each immense aircraft section was physically moved, from station to station, from the periphery toward the center of the hangar, coming closer to completion with each step. Finally they would be mated to other sections that had been moved through the same relentless series of Tuesday deadlines.

Through the spring, memos reflected the countdown atmosphere. "As of this date, there are 130 days to first flight." By May 29, the day of the pressure vessel test, there were only ninety-three days.

The pressure vessel test of fuselage number 2—a standard functional test of the air conditioning and pressurization systems conducted by the structural engineering group—was held outside hangar number 54.
Because there was no electrical power yet on the plane, a door—the forward cargo door—was cranked closed by mechanics unfamiliar with the nuances of the closing mechanism. They did not crank long enough to move the latches all the way around the spools, however, and did not make the proper visual check. Between 3 and 4 psi the forward cargo compartment door blew out with a violence that tore the door off its hinges and buckled the floor adjacent to the door.

It was a shock to both Douglas and Convair. They reacted with a flurry of meetings and extra engineers working overtime, searching for ways to solve the problem. A basic decision had to be made: whether to make the consequences of losing a door less catastrophic, or to make the probability of losing the door less likely. To change the airplane? Or the door.

They considered the plane. They believed they had a “safe and sturdy” floor.

Rerouting the control cables that went through the floor had been considered, but rejected as impractical and as a possible compromise of the control system that had been integrated into the plane from the initial design phase. They did contemplate more venting between the cabin and cargo holds, but because of the placement of the lavatories and other factors, more venting to the aft cargo compartment, where the most critical problem existed, was considered impractical.

The flight-test program was pressing. Structures and environmental control brainstormed at design meetings. By September, a vent door had risen above all other possibilities as the most probable solution. A tiny door cut into the cargo doors. Boeing had used it. A door within a door that would stay open if the door was improperly latched, preventing pressurization.

In retrospect, the DC-10 cargo door problem might have ended right there. Had they returned then to the originally specified hydraulic actuators, the whole problem of pressure buildup behind an improperly locked door might have been eliminated. Instead, they added a
new element—a little vent door—to the problem they already had.

In the air, the DC-10 was amassing hours in its test flights. It had made its maiden flight on schedule on August 29, 1970, taking off from Long Beach Airport and landing at Edwards Air Force Base three hours and twenty-six minutes later.

On the ground, with the failure of the pressure vessel test and the decision on the vent door, the mood of the General Dynamics-Douglas relationship changed as abruptly as if clouds had suddenly covered the sun.

Vent doors would have to be put in fuselage number 1, now flying; in fuselage number 2, being prepared for tests; and in all subsequent cargo doors. The job of building and installing the vent doors on the first three hundred planes would cost, by early “guesstimate,” $2.6 million—a figure later moved up to over $4 million. Who was going to pay? By November 1970, the two companies had taken the defensive positions which they would hold so staunchly that they would become part of the baggage of intransigence and rancor that would be carried into the Paris case.

The dispute hinged on interpretation of the contract between them. Douglas maintained that the vent door was a design change that should be considered “normal and anticipated” as part of Convair’s responsibility; that the failure of the door and the floor collapse had been the result of a design flaw Convair should have recognized; and that the FAA would probably require the change before certification. The contract obligated Convair to provide a satisfactory and safe design, under Douglas’s direction, or to specifically advise Douglas if the direction was unsafe or unsatisfactory. To avoid paying, Convair would have to prove that the vent door was a “significant” change; that the original design was sound; that it had complied with FAA requirements; and that the vent doors were a voluntary product improvement by Douglas.

To protect themselves, Convair’s stance would be that the door was just fine, and that Douglas's obsession
with vent doors was simply “overkill.” And if a fix were needed, there were other, better ways to accomplish it.

Meetings, letters, phone calls tried to solve the dilemma. But the disagreement only grew deeper. Through the winter of 1970–1971, it gradually emerged on paper as a battle between two men. For Douglas, it was Steve Dillon, director of special procurement programs; and for Convair, J. B. Hurt, Convair’s DC-10 program support manager. Convair continued to insist that the vent doors were an “out-of-scope” product improvement, not a correction; that there was no way that they could reasonably have known the design would be deficient—and they denied that it was deficient—with the successful history of the DC-8 and -9, and Douglas’s clear design authority. They wanted proof that the FAA required the change. They were sure that that was just a verbal threat Douglas had dreamed up to add weight to the argument that there had been a design flaw. Convair smoldered that, as subcontractors, they were denied direct contact with the FAA. They had not been allowed to discuss the damning FMEAs directly with the FAA but had had to hope that Douglas would transmit the worrisome message to the FAA. And they were restrained now from discussing the need for a vent door with the FAA. They were caught in the dilemma of doubting the door, but having to defend it.

Douglas tossed out a veiled threat that they would return all cargo doors to Convair as unacceptable. They claimed that Convair owed them a new floor to replace the one that had collapsed.

The fight over who would pay for the vent doors went on even as vent doors were designed, incorporated into the cargo doors, and submitted to the FAA for certification. The plane was ahead of schedule and might beat the original October 1971 deadline by two months. As they pressed toward a new certification and first delivery date of July 29, the vent door issue reached an angry stalemate, in which Dillon told Hurt that “I suppose we will be seeing you in court. . . .”
On July 29, 1971, the DC-10 was certificated and delivered to American and United Airlines in a joint ceremony. It had met all of its criteria, with more payload than promised. Vying to be first in the air, American scooped United a week later by sneaking a DC-10 onto a morning flight from Los Angeles to Chicago. As it landed in Chicago, a mission begun in the mid-sixties was completed. The DC-10 had entered scheduled airline service.

That same week, the Guppy freighter flew in section E and the main landing gear of fuselage number 29, the hull that would eventually be sold to Turkish Airlines. It had already been sold to Mitsui, a giant Japanese holding company that was speculating on DC-10s. They had contracted to buy six, which would be sold at a profit to All-Nippon Airlines.

The dispute over the vent doors was no closer to settlement by May 1972 and was now being referred to in Convair's in-house memos as the "Cargo Door Vent Door Issue." Neither firm had budged. And then, within a month, Windsor.

F. D. Applegate, Convair's director of product engineering, sat down and poured out his frustrations over the cargo door and his concerns for Convair's position. In a memo titled "DC-10 Future Accident Liability," he gave the lawyers precisely what they had been looking for. The Applegate memo would become to the litigation what the Gentlemen's Agreement had been to the Senate hearings. Lawyers stroked through the key phrases with yellow felt-tip pens. "The fundamental safety of the cargo door latching system has been progressively degraded since the program began in 1968... The airplane demonstrated an inherent susceptibility to catastrophic failure when exposed to explosive decompression of the cargo compartment in 1970 ground tests." Applegate regretted the change from hydraulic to electric actuation, which he believed was "fundamentally less positive." Fundamentally less positive—a superb new weapon in the legal battle. Though Douglas and Convair had jointly pursued a
suitable "fix" following the pressure vessel blowout, Applegate was convinced that "since 'Murphy's law' being what it is, cargo doors will come open sometime during the twenty-plus years of use ahead for the DC-10... I would expect this to usually result in the loss of the airplane." And, to Applegate, the vent doors had been "a 'Band-Aid fix'" that had "not only failed to correct the inherent DC-10 catastrophic failure mode of cabin floor collapse, but the detail design of the vent door change further degraded the safety of the original latch system by replacing the direct, short-coupled and stiff latch 'lock' indicator system with a complex and relatively flexible linkage." It was the flexible linkage that had been overpowered by the baggage handler's knee on the handle at Detroit. Applegate criticized the peepholes then being designed as "more Band-Aids." Even if the door were finally made "foolproof," it would not "solve the fundamental deficiency in the airplane"—the vulnerability of the floor to catastrophic collapse. Why then, he posed, had Convair "not originally detail designed a cabin floor to withstand the loads of cargo compartment explosive decompression"? Or designed adequate venting? Because Douglas had supplied the pressure loads and criteria to which floors, vents, and doors had been designed. He believed that nothing in the "experience history" of either Convair or Douglas would have led either to suspect the catastrophic failure mode of the cabin floor in explosive decompression. "My only criticism, therefore, of Douglas in this regard is that once this inherent weakness was demonstrated by the July 1970 test failure, they did not take immediate steps to correct it."

He wrote with the disciplined style of the engineer. But his words gave a sense of the intercorporate conflict that, even after Windsor, was preventing a satisfactory fix. "This fundamental failure mode has been discussed in the past and is being discussed again in the bowels of both the Douglas and Convair organizations. It appears however that Douglas is waiting and hoping for government direction or regulations in the hope of
passing costs on to us or their customers... If you can judge from Douglas's position during ongoing contract change negotiations, they may feel that any liability incurred in the meantime for loss of life, property, and equipment may be legally passed on to us." Applegate recommended "that overtures be made at the highest management level to persuade Douglas to immediately make a decision to incorporate changes in the DC-10 which will correct the fundamental cabin floor catastrophic failure mode," changes that were "more expensive every day as production continues." It might still be less expensive, he believed, "than the cost of damages resulting from the loss of one plane load of people."

J. B. Hurt read Applegate's memo and on July 3, 1972, wrote his own memo to Convair's DC-10 general manager, M. C. Curtis. In it he said, "I do not take issue with the facts or the concern expressed in the referenced memo. However we should look at the 'other side of the coin.'" He had considered recommending more floor venting as a better fix, he said, but had not done it because "I am sure that Douglas would immediately interpret such recommendations as a tacit admission on Convair's part that the original concurrence by Convair of the design philosophy was in error and that therefore Convair was liable for all problems and corrections that have subsequently occurred... We have an interesting legal and moral problem, and I feel that any direct conversation on this subject with Douglas should be based on the assumption that, as a result, Convair may subsequently find itself in a position where it must assume all or a significant portion of the costs that are involved."

Laid out on a table, removed by time and distance from the corporate environment in which it is written, the letter was perhaps the most incriminating document to emerge from discovery. To the lawyers, it was the kind that shines out from the others like the first nugget found in a gold rush.

Hurt would claim much later in depositions that his
memo had not expressed his personal opinion but had been an attempt to air both sides of the issue. No rational man consciously conspires to kill 346 people. But Convair was boxed in, apparently convinced that they were trapped by a contract that could force them to pay if they admitted the DC-10 had flaws in the door/floor/vent design.

When Hurt sent his memo recommending inaction on the Applegate memo to his general manager, Curtis, the letter apparently stopped there. Hurt would later tell lawyers of a meeting at Convair called to discuss Applegate’s memo, but he would not be able to remember that any conclusive actions were taken. The issue was not taken to the “highest management level” at Douglas. Disclosure of the memo had been “a surprise” to Brizendine. And questioned by Sterns in depositions, he claimed, in fact, that he would have expected Convair to come to him with a serious safety problem. Convair did not. Why? With the two memos before them—one warning of lost dollars, the other posing the chilling alternative to corrective action—Convair would seem to have had no choice. Clearly, it was the time to sit down and work out a compromise that both companies could live with, technically and financially. It might have been a painful swallowing of pride. But it might have saved an airplane.

What held them back? What are the dynamics that let common sense get lost in rationales; that permit loyal company men to make decisions that ultimately undermine the corporate mission? For the mission, most basically, had to be to build safe airplanes. Was it a misplaced obligation to stockholders; a belief that capitulation on the vent doors would look bad on the balance sheet? Perhaps the three events—Applegate’s memo, Hurt’s memo, and the corporate silence—are a rare view of the dynamics of the “company line,” the remarkable forging of disparate opinion into one view. It is what lets two groups of engineers with the same training and background examine the same data for different companies and arrive at totally different conclu-
way that, if the cargo door is improperly locked, the vent door will open to relieve the cargo compartment pressure and to forestall subsequent blowing open of the cargo door.”

Clearly, the FAA had believed that the vent door was an active pressure-relief mechanism that would open to relieve pressure. But, with Sterns pressing the point hard in depositions, it was confirmed that that was precisely what it was not. Once closed, it became a plug-type door, tightening its seal as pressure differential built up. It was not a relief valve. In a copy of the same documents produced from the FAA’s files, the word remain had been penciled in, so that the line read “the vent door will remain open. . . .” Under questioning, an FAA man, Richard Sliff, who was chief of the western region’s aircraft engineering division, admitted that he had penciled the word in at some later date. The guess was that he had penciled it in immediately after Windsor, or Paris, in an inept attempt to cover evidence that the FAA had certificated a vent door it did not understand. Douglas had seen the letter and had not enlightened the FAA. Kreindler and Sterns went wild, for this smacked of fraudulent certification!

Plaintiff lawyers watched with satisfaction as McDonnell Douglas offered Turkish Airlines’ head on a plate. FitzSimons had suggested privately to several plaintiff lawyers that they should put Marchall Caldwell, member of Douglas’s investigative team in Paris, and Robert LaCombe, who had been part of the support team assigned to THY before the crash, in the deposition chair to give evidence that seemed to shift the blame to the airline. The plaintiffs were delighted. It was part of tactics to keep the pressure on as many defendants as possible. And without physical evidence—the door or any of the wreckage—the testimony of a Douglas expert who had been on the scene might be as authoritative as any evidence they would get. They might never see the cargo door—they didn’t even know where it was—and Caldwell’s testimony could be vital in court. They questioned him and drew out the “misrigging”
theory that was to become the basis of McDonnell Douglas's counterattack.

On the shattered door that had fallen in St. Pathus with the six bodies, there was evidence that adjustments to the lockpin mechanisms had been done—but done wrong. On examination, almost imperceptible scoring, or scuff marks, had been detected on the tiny lockpins, telling them that, as the handle was stowed, the lockpins had not moved as far as they should have, making it possible to close the handle with very little force and to turn off the warning light too soon, before the door was properly locked. In an effort to make it impossible for a baggage handler to close the handle on an improperly locked door, as had been done in Detroit, Douglas had issued SB 52-37 recommending the infamous missing support plate, and rigging changes (adjustments) that, even without the support plate, would have required approximately 250 pounds of force on the handle to overpower it.

But Caldwell reported that Douglas tests after the crash confirmed what the scoring on the lockpins had suggested—that the mechanism could be overpowered with very little force, perhaps as little as thirteen pounds—the amount of force a child could easily exert. Even if there had been a support plate, it would only have taken 33 pounds to overpower the handle, he said, well within the capability of a baggage handler and so close to the normal 15 to 35 pound force required to close a properly latched door that it would not have been noticed.

There was a stir of surprise, pencils scratched, and lawyers listened, absorbed, as he led the case into a whole new dimension, describing the minute but vital factors that may have actually let the baggage handler close the door improperly. Caldwell explained that the force required to close the handle of an improperly latched door could be altered by adjusting the lockpins—by turning an adjusting rod on its threads. In the crashed plane, the adjustment had been made in the wrong direction. The rod had been turned 3 revolutions
the wrong way, shortening the distance of lockpin travel .407 inches from where SB 52-37 had said it should have been, and reducing the force required on the handle to the perilously light 13 pounds. The implication was that the Turks had made the negative lockpin adjustment. And that they had added shims, tiny metal washers, to the striker on the lockpin tube that turned off the cockpit warning light. The shims contacted the switch too soon, turning off the warning light before the door was locked. Another shim—a crumpled, paper-thin shim not of Douglas stock or of aeronautical quality—was also found, defective installation. LaCombe testified that it was common practice for the Turks to put on their own shims to turn off the warning light in the cockpit. The Turks were accused, too, of ignoring the peephole and with removing the factory-installed actuator and installing their own.

ImPLYING that through inept maintenance the Turks had brought the crash on themselves, McDonnell Douglas was hanging its case—and millions and millions of dollars—on fractions of an inch and a paper-thin metal shim. But it was to be a wildly controversial theory. Had the Turks misrigged the plane? Sterns speculated that if Douglas could make one mistake in the factory on SB 52-37, why not two. More important, in Kreindler's view, was why Douglas had produced a door that could be misrigged, especially since rigging of the door in the field was a regular procedure.

Others were ready to believe the Turks had done it, rightly or wrongly, in response to operational problems with the plane. DC-10 program manager William T. Gross confirmed in depositions that from the beginning of operations, airlines had reported difficulties with the cargo door. Actuators working too slowly... hooks binding on spools... troubles that had inspired Douglas's Field Service Representative in Turkey and Germany, D. Y. Krug, to write just two months before the crash, "If there was need to Murphy-proof the cargo doors on DC-10-10s, there is also a need to Murphy-proof the doors on the -30s." And the Turks had been
told to use shims by SB 52-55, which said, "The operators have reported numerous instances of false cargo door warning indications. These nuisance indications are attributed to the flexing of the fuselage. . . . Shimming the light switches . . . will alleviate this condition . . . If not corrected, flight delays and cancellations may result." Was the bastard shim that Douglas had disowned a Turkish response to this economic pressure?

There was controversy, too, over the force on the handle. How many pounds of force had Mahmoudi used to close the door? Thirteen pounds? The NTSB had written it up as 31 pounds. The French investigators would finally say 50 pounds, finding the lockpin travel in error by .312 of an inch, not the .407 of an inch reported by both Douglas and the NTSB. Exasperated, lawyers tried to pin down the numbers, for it was on just this kind of technical minutiae that aviation cases were won or lost.

It had all come out by late autumn. The altered FMEA. The Applegate and Hurt memos. The misrigning theory. The FAA's lack of vigor and understanding. And more, much more. The elite group of lawyers carrying the world's largest crash case had had a rich banquet of incriminating facts laid before them. Corporate fingerprints seemed to be everywhere. The story seemed to be one of staggering engineering achievement brought down by human failure. A story without real criminals but of decent men whose personal destinies had become so merged with the corporate goal that they had not always followed—or perhaps had not even been able to define—the rational path. It was a story of corporate disputes magnified by personality clashes into great stubborn schisms.

To the plaintiffs, it was, more than ever, an open and shut case of product liability. But the defendants were not crawling to the settlement table. The principals had gathered in New York for a preliminary settlement meeting, but it had been futile. The two sides were obviously too many millions of dollars apart to even talk at this early stage. But the sense of stalemate was com-
And Gene Barrow had had her own job, providing some 2,000 pounds a year to the family, with a promotion due in three years. She clearly played a large role in running the home, though the fact that she had a housekeeper four days a week would reduce that value. It began to look as if, even with England's lower wage levels, the case might be worth half a million dollars.

Reading the interrogatories and looking at the happy face, even Jim Murray, who had never met the Barrows, sensed that putting a dollar value on Gene Barrow was going to be like catching sunbeams in a jar.

Sterns and his staff kept working at the figures. For Gene Barrow, economic loss worked out to $212,405, using the actuary's calculations. Applying the formula for loss of society, noneconomic loss was $447,433.50. A total loss of $659,838.50. The defense would never buy it. As a compromise, Sterns would put $425,000 on the bottom line—a starting point.

What was a good wife worth?
Chapter Twenty-Four

Settlement!

"FUNDAMENTALLY LESS POSSITIVE!" Applegate had said that electrical actuation was "fundamentally less positive" than hydraulic actuation of the cargo doors. The phrase from the infamous memo rang in their ears, as Sterns and Marshall Morgan dug through documents trying to find out why. And why had the decision been made to change to electrical from hydraulic closing of the doors, as originally planned? As they dug, the two lawyers began to sense that they might be on to the decision that, more than any other, had doomed the plane. They had found a basic and highly significant difference between the two systems. A hydraulically closed door, if closed but not properly locked, would back off and ooze open under pressure, bleeding off the pressurized air. The electrically actuated door did not. It relied on two actuators: one to close the door and one to drive the hooks over the spools, locking it. The vulnerability lay in the fact that a baggage handler did both operations—close and latch—by pressing one toggle switch. He held the switch down while the door closed, then, counting out the proper number of seconds, held it down a little longer while the hooks engaged over the spools. If he was impatient—if he held it down for too few seconds—or if the second actuator wasn't working properly, the hooks, unknown to the baggage handler, would not be fully engaged over the spools. And here was where the difference between the
two actuating systems could become lethal. The electrical system was irreversible. As pressure differential built, the electrically closed door could not back off and bleed. If improperly locked, it held on until it blew. It appeared to Sterns and Morgan to have been the unreliability of the actuator that had led to most of theifies—heavier gauge wiring, the vent door, peepholes, placards, a new indicating light on the operating panel beside the door—one compounding the other until Paris.

As General Dynamics' J. B. Hurt took the deposition chair, Sterns couldn't wait to get at him. And Morgan was waiting to follow up. For Hurt was not only the man who had squelched the Applegate memo. As project engineer on the DC-10, he had been involved in decisions on the doors. It was time to put pressure on General Dynamics, they felt, for the dispute between General Dynamics and McDonnell Douglas had invaded the lawsuit, with General Dynamics refusing to contribute a share of the pot acceptable to Douglas.

As he came into the deposition room, Sterns had a strange feeling that something had changed, that something was going to happen. Mid-morning, he was called from the room by a phone call from Fred Lack, General Dynamics counsel, who asked Sterns what he was planning. Sterns responded, "Fred, we’ve really got the goods on this actuator, and this morning we’re going to hurt Hurt!" Lack asked him to take it easy on Hurt today, because a deal was in the wind. Ask him anything—where he went to high school, what his favorite color is—but cool it, because if he gets hurt, the deal may be off. Sterns returned to depositions and began to redirect his questions, exploring McDonnell Douglas's role in the actuator decisions.

The depositions ended at noon. The lawyers flew home. There were no depositions scheduled the following week, but they kept closely in touch, comparing rumors. Then, on the morning of May 27, ten days after the Hurt deposition, FitzSimons stood in court and in a terse, four-line statement announced that the defen-
dants would “not contest liability.” The defendants had reached a sharing agreement secretly among themselves and were ready to start settlement negotiations.

It was the climax of the case to date. The point of transition between the liability phase and settlements. But what did it mean? The defense would not contest liability. But they did not concede it. Normally, the defense accepted liability, then settlements got under way. Kreindler and Sterns were confused and suspicious. The inconclusive statement was wreathed in unacceptable conditions. Kreindler flatly refused the precondition that he waive punitive damages, since he regarded the claims as part of the strength of his case. There seemed too many loose ends. Sterns was concerned about how the volume of cases was to be processed. Which cases would be first . . . and last? And he was reluctant to see the momentum of discovery stopped. With Hurt, Sterns felt he had been at the brink of insights into the cause of the crash that, now, might never be disclosed. He still wanted a trial date. He, like Kreindler and Morgan, believed that the hovering threat of a jury trial on liability and punitive damages was still the best negotiating tool.

The judge, too, faced a critical decision. If it was a good-faith offer, the case was well on its way to completion. It would bring the contentious liability phase to an end—a phase that threatened to go on forever and to bury the court under a blizzard of paper and an unrelenting flood of third-party claims, cross claims, counter claims, causes of action, and defenses. In addition to the 205 filed complaints, there were 600 third-party complaints, cross claims, or counterclaims—a total of over 800 pleadings. Choosing the Backhouse case, No. 74-1993, as a random sample, his law clerk Delphine Ruman counted causes of action for negligence in design and construction, negligence in operation and maintenance, for strict product liability, breach of warranty, willful misconduct, vicarious liability, breach of contract of carriage, and for fraud, oppres-
case. If it had not been for the death of a beautiful redhead in the forest, he would still be in the Lloyd's camp. Forced to cross the line, he had seen the shocking unwillingness of English judges to deal with the needs of families struck by an air crash. But his had never been a moral crusade. Though he had shepherded over eighty British cases across the sea, he was still heartsick that “the personal loss can only be compensated in terms of money,” still saddened by what they had all felt compelled to do. He hoped that the Kween verdict could speed peace and finality. For the crash would never be fully behind him until the litigation was over.

Mitchell watched the calm movement of river traffic along the Thames. Something had been achieved. There had been a breakthrough in public awareness of the insurer's role in liability cases, a healthy bit of education. But the profound questions of moral values had still not been resolved. He knew that somewhere lay the balance between British and American values, settlement sums that would have the effect of “avoiding thalidomide, without discouraging the discovery of penicillin,” as The Economist had put it after the Kween verdict; a balance between abandoning technology's victims and encouraging everyone who stubs his toe to run for a lawyer. Mitchell spoke out. "Lloyd's have an honourable reputation to live up to and I feel that they must see the sense, now that we have the first feel of California juries' views, that it would be better to get around a table and see what kind of money we can agree upon. The American lawyers acting for our clients are quite prepared, with myself, to get together tomorrow—preferably somewhere away from the heat of the action. . . ."

Bermuda perhaps, which though still comfortably British was, symbolically, closer to the United States than to England. Though he and Sterns had been able to forge their close friendship under fire, neutral ground might be needed to soften the defense and attack modes that had become conditioned reflexes. When he and Sterns had flown to hear Peter Martin speak in Dallas, the academic setting away from the battlefield had
someday helped them bridge the distances. In Paris, Martin was their adversary. But there, he had dropped his shield and poured out with unaccustomed passion the frustrations he felt as he dealt with crashes around the world. The dismal record of 1974 had cast its gloom as he had spoken. There had been 1,657 transport crash deaths worldwide, up from 1,569 the previous year. Yet it was still just a few hundred more than were drowned annually around Britain’s coasts, and a small fraction of the nearly 60,000 killed annually on America’s and U.K.’s roads. Martin knew that statistically, a businessman could fly ten trips a year—12,000 miles a year—for 38,000 years without the risk of death. The grandmother flying only one 2,500-mile trip a year to visit her married daughter could fly it for 12½ million years before the odds would catch up with her. The lawyers who came to Los Angeles to attack the industry lived in planes and flew without fear. Fatal accident rates had been declining steadily for the past ten years, were still declining. Yet some airlines were better than others. Accidents did occur, leading to the widening flood of litigation that so concerned Martin, raising “nightmare anxieties about the wickedness of big business, and the inefficiency of governments.” Damaging public confidence in flying. Compromising air safety, in his view. Yet he had recognized that American litigation served a needed function. The U.S. tort and criminal law systems did sometimes “serve as a deterrent to unsafe behaviour . . .” Warsaw’s inadequacy had made litigation inevitable “if injustice and hardship are to be avoided.” Martin had pleaded then—as Mitchell did now—for the humane middle road. “Accidents are about death and destruction, not litigation, and ought to be looked at in this way by those with the power to influence change for the better. Just for once, could not the divided parts of our profession combine to produce a major change in the law instead of feeding on the inadequacy of the existing system?”

It had seemed possible in Dallas. It must be possible now, for the second anniversary was almost here.
There was no way to see or to feel that, with every foot of altitude, the air trapped in the fuselage was growing more frustrated by containment. It was roiling with eagerness to expand, to escape. And as it responded to the suck of the partial vacuum outside, it pressed out, putting stress on every rivet, latch, and window, every square inch of the thin, silvery skin. Pushing against the shell with several times the force of a hurricane, it searched for a way out.

The plane climbed through 11,500 feet, sprinting up at 2,200 feet a minute toward its assigned flight level, with the pressure differential between the cabin and the air outside building rapidly.

At 12:39 and 56 seconds*—a moment frozen in time by the plane’s cockpit voice recorder—the air found its escape route. In one explosive microsecond, the caged hurricane burst through the rear cargo door, shearing off the bolts that held it to the fuselage, and flinging it—with six passengers still in their seats—down to the quiet French countryside.

On radar, stunned controllers watched, helpless. A battery of radar screens had been monitoring the moving blip that was Flight 981. At the instant the door came off, the image on the screens changed. On secondary radar, the blip simply vanished, leaving for several seconds the imprint of its altitude—13,000 feet. On the primary radar screen, the controller watched in horror as the image of Flight 981 split in two and became a double image. He had “seen” the door come off. As he watched, the two blips separated from each other on the screen. One stayed fixed at 24 miles northeast of Orly, frozen on the screen for two or three minutes. It was the door and the bodies free falling to the freshly plowed fields of St. Pathus. The second image followed a trajectory to the left, reached a heading of 280 degrees, to the northwest, and vanished.

*There is a 30-second discrepancy between this time taken from the cockpit voice recorder and times taken from the flight data recorder. Both, however, are in agreement on duration of flight and crisis.
It disappeared from his screen 77 seconds after the image had split.

Shortly after the image split, there were alerts by radio, too, that something had gone wrong with Flight 981. At 12:40 and thirteen seconds, Paris Control heard a garbled transmission of Turkish voices above the blaring of the depressurization alarm and, then, the overspeed klaxon. All transmissions ceased as the blip disappeared from the screen.

The controller tried to reach Flight 981. "981, come in... 981 do you read me?... Come in, 981... 981..." Eight times he tried to reach them. There was no response. After 9 minutes of flight, she had vanished.

In the cockpit, the crisis had hit the crew like a lightning strike. There was the sudden, thunderous noise of decompression as the air evacuated and violent jolts kicked the plane sideways. An explosive burst of dust and debris flew up into the cockpit, temporarily blinding them. From a climb of 3 or 4 degrees, the nose pitched down violently into a dive. The plane yawed hard left because of a 10 degree rudder deflection, forcing the left wing down. The autopilot disengaged instantly and the crew grabbed for control. Scanning instruments with ferocious speed and intensity, they had no idea what had happened, though Ulusman snapped out, "The fuselage has burst!" They did not know that the cabin floor had collapsed, severing and jamming the control cables that ran through the floor from cockpit to tail—their lifeline. They knew they were yawing hard left. And that elevators were forcing the nose down, jammed, inoperative—their prime means of pitch control. Within 22 seconds, the nose was down 20 degrees. They had to get the nose up. Berkoz yelled, "Bring it up... pull her nose up!" Ulusman pulled back with all his strength on the controls. But he could not overpower the dive. "I can't bring it up. She doesn't respond!"

Speed, increasing with pitch, had risen viciously from 300 to 362 knots. Number 2—the mighty engine on the tail—was already out. Dead. Windmilling uselessly. Now they cut the power on the underwing engines 1
Near-catastrophic failure of an American Airline’s cargo door in flight over Windsor, Canada, did extensive damage to door area, control cables, and surfaces, presaging Paris.

NATIONAL TRANSPORTATION SAFETY BOARD

The -10’s mighty tail, showing vital control surfaces, and containerized cargo system that influenced choice of outward-opening cargo doors. MC DONELL DOUGLAS
By strange coincidence, a few weeks before the Paris crash, British solicitor Bernard Engler photographed the commanding sight of a Turkish Airlines DC-10 at Heathrow Airport. He would later become actively involved in the litigation.

BERNARD ENGLER

This section of fuselage was the largest remaining section of the plane. JAMES ANDANSON/SYGMA
lines to incorporate the “closed-loop” system, which had been phase four of Douglas’s door improvement program, the subject of a generally neglected Service Bulletin SB 52-49. It was a locking system in which the closing of the vent door could only be achieved by proper movement of the locktube—a system in which the closing of the vent door did mean that the lockpins were properly engaged. July 1, 1974, was the date set for completion of the closed-loop system for every DC-10, with foreign airlines eagerly and voluntarily complying.

At last they had fixed the door, but they still hadn’t fixed the plane. Floors had not been strengthened; more venting had not been installed. Yet floors had collapsed twice in flight. And now 346 had died.

Watching the hearings from his Wichita hotel room, Sterns had sensed a burgeoning scandal, sure now that this would be the biggest product liability case in history. And what had been revealed in the hearings—the Gentlemen’s Agreement, the Windsor Incident, the missing plate, the vulnerable floors—was only the tip of the iceberg, he knew, compared to what discovery would bring out. The public case had been made. But the legal case was still hidden in California, in documents. He could taste it.

That was a month ago. Then the Wright case had come in. And the call from Engler. Now he was on his way to England to receive his instructions.

Sterns met the English solicitors in Mitchell’s offices on the Thames. Below them, in full view, Denmark’s Queen Margrethe’s visit was coming to an end; royalty were saying good-by with full ceremonial pomp. Flags waved. Plumed guards saluted. And as the whistle of the Danish royal yacht blew, Sterns felt powerfully moved by this persistence of tradition. The Tower Bridge loomed in the background, adding its weight of history to the scene. He was a western boy who never felt completely comfortable in New York. But here, strangely, he felt very much at home.