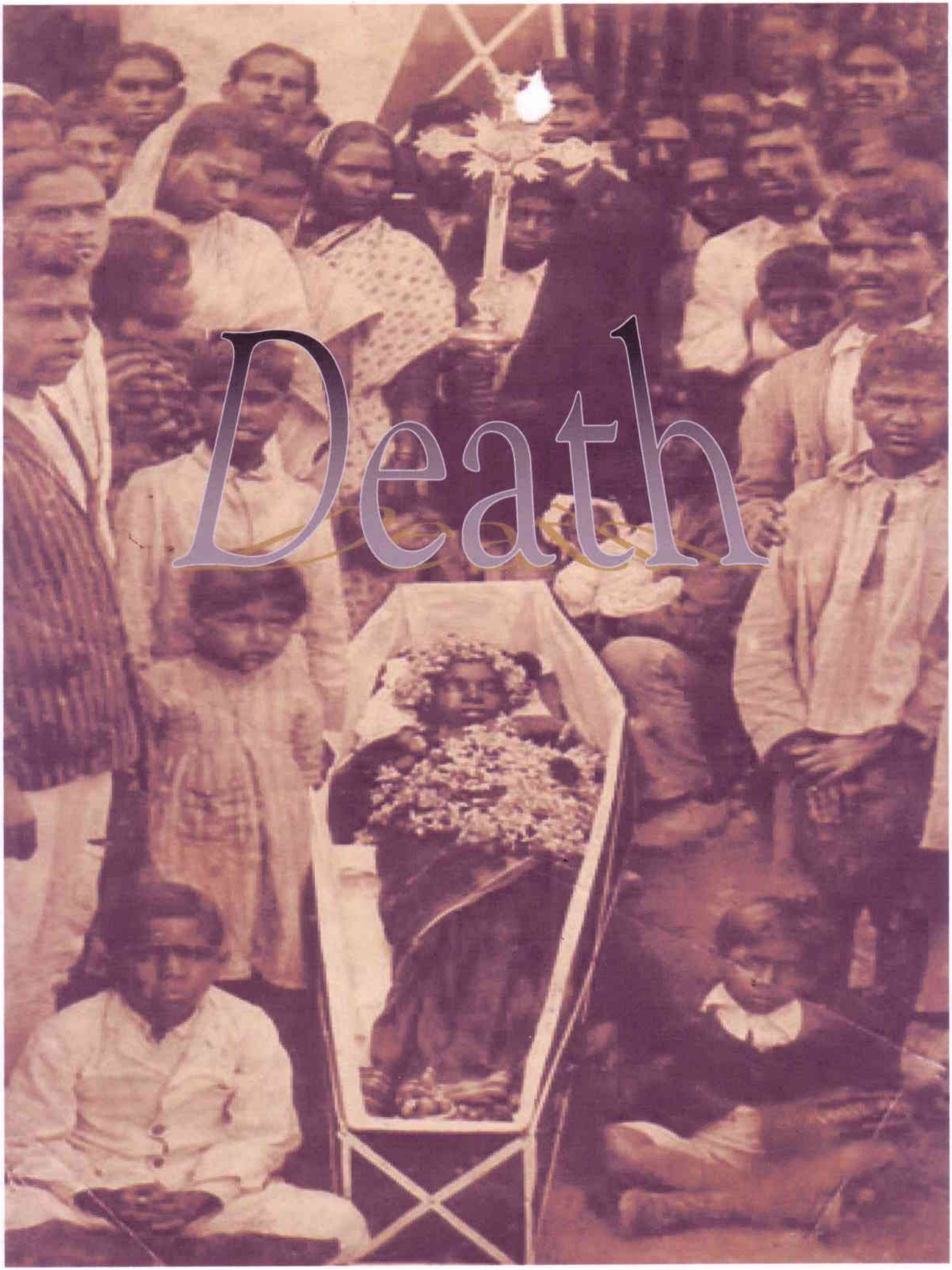
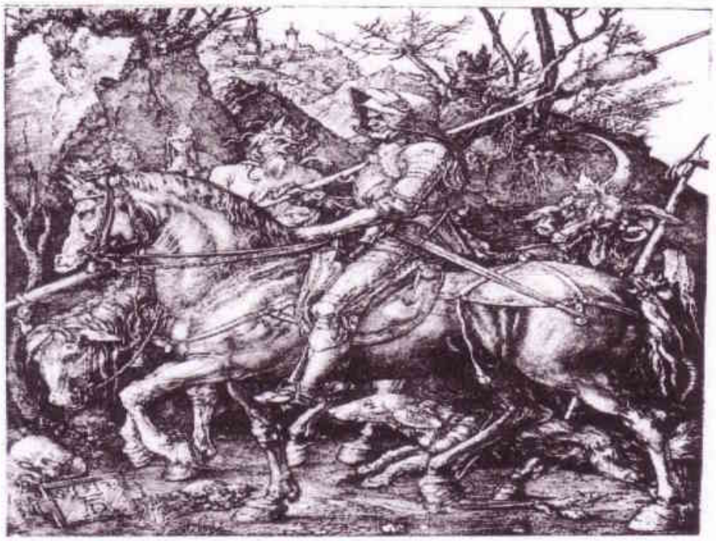

Death

Death



"On a large enough time line, the survival rate for everyone drops to zero." – Chuck Palahniuk.

Death. It is the one thing that every person on the earth has in common with everybody else. No matter you're race, gender, religion, or monetary standing, you're going to die. It's as simple as that. Death is definitely the great equalizer, so it should come as no surprise that it fascinates us so much. Death is found all throughout our culture – in our movies and music, our books and poems, our sciences, and even our history. Yet most of us probably don't realize how often we deal with this unsettling topic. In this final chapter of *Disciplinary Action*, we'll look at the ways in which the various disciplines tackle themes of death, decay, and finality.

In Literature, there is perhaps no more common a theme than that of death. The literary giants William Shakespeare, Edgar Allan Poe, Emily Dickinson, and Ernest Hemingway utilized this theme extensively throughout their works. For example, Shakespeare's plays *Hamlet, Macbeth, Romeo and Juliet, Julius Caesar,* and *King Lear* all deal with death in some way or another. The great poet Emily Dickinson seems to have been fascinated by death and dying, which is best exemplified by her poem "Because I Could Not Stop for Death." Of course, great literature doesn't begin with Shakespeare and end with Hemingway. When discussing literature, we must also take into consideration the writings of the ancients. The *Epic of Gilgamesh*, an ancient Mesopotamian poem, is one of the earliest known works of fiction. It chronicles the adventures of the hero-king Gilgamesh and his quest for immortality. And for the ancient Greeks and Romans, death was a key component in their mythology. The Greeks explained away the changing of the seasons by the story of Persephone and Hades. Persephone, a goddess of nature, was forced to spend a few months out of every year in the underworld as a consort to Hades, thus leaving the earth barren in winter. This parable for the changing of seasons manages to tie the death of plants and foliage to that of the human underworld. And let's not forget that the number one selling book in the world, the Bible, deals with the crucifixion and resurrection of Jesus of Nazareth. For most people, death could not be more poignant and powerful than in the passion of Christ. Finally, modern day authors such as Stephen King, Dean Koontz, and Ann Rice sell millions of books that center almost exclusively on death.

The argument could be made that science and medicine would not exist if it were not for man's inherent fear of dying. For what is medicine but the attempt of man to extend his own life? Of course, the abating of suffering is an incentive for medicinal practice as well, but the overall concern of any man of medicine –whether he is a witchdoctor, a homeopathic practitioner, or a modern day surgeon – is to delay death. As intelligent creatures with a conscience mind, we understand that our time here is limited. So, it stands to reason that as those intelligent, conscience creatures we try to find ways around these natural inconveniences. As of this time in history, we humans know that death is imminent and unavoidable, yet there are still plenty of thoughtful men and women searching for ways to make this uncomfortable reality a thing of the past. Perhaps, through science, we will one day find a cure for the ultimate disease – death.

History itself is inherently morbid. For when we study history, more often than not, we are reading and writing about people who have long since passed away. Aside from the simple fact that history is the study of the past, thus generally pertaining to death in some form, there are many historical topics that are steeped in morbidity. The violent, bloody, and ultimately deadly topic of war is a main field of research for historians. But war isn't the only gruesome thing of historical importance. Pandemics, natural disasters, murder and assassinations are all areas of historical research in and of themselves. Why? Because we learn a lot about ourselves and our society by studying the effects of traumatic events in the past. For example, many historians believe that the black plague is largely to blame for western civilization's obsession with death. The ideas of memento mori and danse macabre are seen as relics of the devastation of the plague. Our common practice of remembrance for the dead is derived from the concept of memento mori, while danse macabre (literally dance of death) is the notion that everyone is dancing with death at all times. These two concepts on death have had a profound impact on our culture to this very day.

The fields of psychology and sociology also deal with death. For the psychologist, the areas of interest tend to be with the living, however, and how humans deal with grief and loss. The human brain is an interesting thing indeed, and psychologists want nothing more than to learn how to understand and even manipulate this complex organ. In terms of sociology, the effects of death on society as a whole must be considered. The topics of sociological interest that pertain to death are broad; everything from abortion, euthanasia, the death penalty, and murder. Let us not forget that psychologists and sociologists alike have something to say on how violence and death in media (e.g. movies, music, video games, etc) affects our children and teenagers. Of course, psychologists and sociologist study things other than death, but the topic does play a significant role in both disciplines.

In the visual arts and media, death is extremely prevalent. Artists have long since been drawing, painting, and sculpting depictions of violence, war, and death. All one has to do is make a trip to their local museum to see this in action. In modern times though, we tend to shy away from the drawings and paintings that one would find in a museum. However, death is still a significant part of our artistic expressions and entertainment. Movies such as *300* and *Gladiator* glorify death as honorable, whereas films like *Rambo* and *True Lies* imply that killing those who get in your way is just a necessary part of survival. The incidence of death in television shows is just as high as for films. How many soap opera characters have been killed off to provide the viewer with that irresistible twist? The medical dramas such as *E.R.* and *House* present us with death almost every episode. And even the comedy *Scrubs* has rolled a large number of guest stars off to the morgue. As far as music goes, you might think that themes of death are only prevalent among death metal bands – hence the name. But there are plenty of songs in all genres of music that deal with death. Blue Oyster Cult's *Don't Fear the Reaper*, Eric Clapton's *Tears in Heaven*, Blink 182's *Adam's Song,* and Eminem's *Stan,* are just a few examples of the various generations and genres of music that make use of this theme.

So there you have it. Death truly is all around us all the time. It pervades every aspect of our lives, from our entertainment to our education. We read death, we see death, we play death, we even study death. Though we definitely fear it, we just might love it. For why else would we let something we feared consume so much of our time if it were not for the fact that we admire and respect it also? In any case, the fact remains the same. We are surrounded by and incapable of escaping from death. For this reason alone, there is perhaps no more pertinent a chapter to *Disciplinary Action* then this final chapter. Read it if you dare.

When TWA flight 800 blew apart over the Atlantic Ocean in the summer of 1996, there were no survivors left to tell the tale of what happened. Since the plane exploded over water, the black box that was installed to record exactly what happened could not be found. So, as is usually the case with situations like this one, it was up to the scientists to determine, based on the physical evidence, what exactly happened to TWA flight 800. *Beyond the Black Box* is a chapter out of Mary Roach's book *Stiff: The Curious Lives of Human Cadavers*. In the chapter, Roach interviews one of the men responsible for solving the riddle of flight 800, Dennis Shannahan. The selection was chosen because it exemplifies how death and tragedy can be studied in order to help prevent further tragic events.

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BEYOND THE BLACK BOX

When the bodies of the passengers must tell the story of a crash

Dennis Shanahan works in a roomy suite on the second floor of the house he shares with his wife, Maureen, in a subdivision ten minutes east of downtown Carlsbad, California. The office is quiet and sunny and offers no hint of the grisly nature of the work done within. Shanahan is an injury analyst. Much of the time, he analyzes the wounds and breakages of the living. He consults for car companies being sued by people making dubious claims ("the seat belt broke," "I wasn't driving," and so on) that are easily debunked by looking at their injuries. Every now and then the bodies he studies are dead ones. Such was the case with TWA Flight 800.

Bound for Paris from JFK International Airport on July 17, 1996, Flight 800 blew apart in the air over the Atlantic off East Moriches, New York. Witness reports were contradictory. Some claimed to have seen a missile strike the aircraft. Traces of explosives had turned up in the recovered wreckage, but no trace of bomb hardware had been found. (Later it would come out that the explosive materials had been planted in the plane long before the crash, as part of a sniffer-dog training exercise.) Conspiracy theories sprouted and spread. The investigation dragged on without a definitive answer to the question on everyone's

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mind: What—or who—had brought Flight 800 down from the sky?

Within days of the crash, Shanahan flew to New York to visit the bodies of the dead and see what they had to say. Last spring, I flew to Carlsbad, California, to visit Shanahan. I wanted to know how—scientifically and emotionally—a person does this job.

I had other questions for him too. Shanahan is a man who knows the reality behind the nightmare. He knows, in grim medical detail, exactly what happens to people in different types of crashes. He knows how they typically die, whether they're likely to have been cognizant of what was happening, and how—in a low-altitude crash, anyway—they might have increased their chances of survival. I told him I would only take up an hour of his time, but stayed for five.

A crashed plane will usually tell its own story. Sometimes literally, in the voices on the cockpit flight recorder; sometimes by implication, in the rendings and charrings of the fallen craft. But when a plane goes down over the ocean, its story may be patchy and incoherent. If the water is especially deep or the currents swift and chaotic, the black box may not be recovered, nor may enough of the sunken wreckage be recovered to determine for sure what occurred in the plane's last minutes. When this happens, investigators turn to what is known in aviation pathology textbooks as "the human wreckage": the bodies of passengers. For unlike a wing or a piece of fuselage, a corpse will float to the water's surface. By studying victims' wounds—the type, the severity, which side of the body they're on—an injury analyst can begin to piece together the horrible unfolding of events.

Shanahan is waiting for me when I arrive at the airport. He is wearing Dockers, a short-sleeved shirt, and aviator-frame glasses. His hair lies neatly on either side of a perfectly straight

part. It could almost be a toupee, but isn't. He is polite, composed, and immediately likable. He reminds me of my pharmacist Mike.

He isn't at all what I'd had in mind. I had imagined someone gruff, morgue-hardened, prone to expletives. I had planned to do my interview in the field, in the aftermath of a crash. I pictured the two of us in a makeshift morgue in some small-town dance hall or high-school gym, he in his stained lab coat, me with my notepad. This was before I realized that Shanahan himself does not do the autopsies for the crashes he investigates. These are done by teams of medical examiners from nearby county morgues. Though he goes to the site and will often examine bodies for one reason or another, Shanahan works mostly with the autopsy reports, correlating these with the flight's seating chart to identify clusters of telltale injuries. He explained that visiting him at work on a crash site might have required a wait of several years, for the cause of most crashes isn't a mystery, and thus input from the cadavers isn't often called for.

When I tell him I was disappointed over not being able to report from the scene of a crash, Shanahan hands me a book called *Aerospace Pathology*, which, he assures me, contains photographs of the sorts of things I might have seen. I open the volume to a section on "body plotting." Among line sketches of downed plane pieces, small black dots are scattered. Leader lines spoke away from the dots to their labels: "brown leather shoes," "copilot," "piece of spine," "stewardess." By the time I get to the chapter that describes Shanahan's work—"Patterns of Injury in Fatal Aircraft Accidents," wherein photo captions remind investigators to keep in mind things like "intense heat may produce intracranial steam resulting in blowout of the cranial vault, simulating injuries from impact"—it has become clear to me that labeled black dots are as up-close-and-personal as I wish to get to the human wreckage of a plane crash.

In the case of TWA Flight 800, Shanahan was on the trail of

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a bomb. He was analyzing the victims' injuries for evidence of an explosion in the cabin. If he found it, he would then try to pinpoint where on the plane the bomb had been. He takes a thick folder from a file cabinet drawer and pulls out his team's report. Here is the chaos and gore of a major passenger airline crash quantified and outlined, with figures and charts and bar graphs, transformed from horror into something that can be discussed over coffee in a National Transportation Safety Board morning meeting. "4.19: Injury Predominance Right vs. Left with Floating Victims." "4.28: Mid-Shaft Femur Fractures and Forward Horizontal Seat Frame Damage." I ask Shanahan whether the statistics and the dispassionate prose helped him maintain what I imagine to be a necessary emotional remove from the human tragedy behind the inquiry. He looks down at his hands, which rest, fingers interlinked, on the Flight 800 folder.

"Maureen will tell you I coped variably with Flight 800. It was emotionally very traumatic, particularly with the number of teenagers on board. A high school French club going to Paris. Young couples. We were all pretty grim." Shanahan says this isn't typical of the mood behind the scenes at a crash site. "You want a very superficial involvement, so jokes and lightheartedness tend to be fairly common. Not this time."

For Shanahan, the hardest thing about Flight 800 was that most of the bodies were relatively whole. "Intactness bothers me much more than the lack of it," he says. The sorts of things most of us can't imagine seeing or coping with—severed hands, legs, scraps of flesh—Shanahan is more comfortable with. "That way, it's just tissue. You can put yourself in that frame of mind and get on with your job." It's gory, but not sad. Gore you get used to. Shattered lives you don't. Shanahan does what the pathologists do. "They focus on the parts, not the person. During the autopsy, they'll be describing the eyes, then the mouth. You don't stand back and say, 'This is a person who is the father of four.' It's the only way you can emotionally survive."

Ironically, intactness is one of the most useful clues in determining whether a bomb has gone off. We are on page 16 of the report, Heading 4.7: Body Fragmentation. "People very close to an explosion come apart," Shanahan says to me quietly. Dennis has a way of talking about these things that seems neither patronizingly euphemistic nor offensively graphic. Had there been a bomb in the cabin of Flight 800, Shanahan would have found a cluster of "highly fragmented bodies" corresponding to the seats nearest the explosion. In fact, most of the bodies were primarily intact, a fact quickly gleaned by noting their body fragmentation code. To simplify the work of people like Shanahan who must analyze large numbers of reports, medical examiners often use color codes. On Flight 800, for instance, people ended up either Green (body intact), Yellow (crushed head or the loss of one extremity), Blue (loss of 2 extremities with or without crushed head), or Red (loss of 3 or more extremities or complete transection of body).

Another way the dead can help determine whether a bomb went off is through the numbers and trajectories of the "foreign bodies" embedded within them. These show up on X-rays, which are routinely taken as part of each crash autopsy. Bombs launch shards of themselves and of nearby objects into people seated close by; the patterns within each body and among the bodies overall can shed light on whether a bomb went off and where. If a bomb went off in a starboard bathroom, for instance, the people whose seats faced it would carry fragments that entered the fronts of their bodies. People across the aisle from it would display these injuries on their right sides. As Shanahan had expected, no telltale patterns emerged.

Shanahan turned next to the chemical burns found on some of the bodies. These burns had begun to fuel speculation that a

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missile had torn through the cabin. It's true that chemical burns in a crash are usually caused by contact with highly caustic fuel, but Shanahan suspected that the burns had happened after the plane hit the water. Spilled jet fuel on the surface of the water will burn a floating body on its back, but not on its front. Shanahan checked to be sure that all the "floaters"—people recovered from the water's surface—were the ones with the chemical burns, and that these burns were on their backs. And they were. Had a missile blasted through the cabin, the fuel burns would have been on people's fronts or sides, depending on where they had been seated, but not their backs, as the seatbacks would have protected them. No evidence of a missile.

Shanahan also looked at thermal burns, the kind caused by fire. Here there was a pattern. By looking at the orientation of the burns—most were on the front of the body—he was able to trace the path of a fire that had swept through the cabin. Next he looked at data on how badly these passengers' seats had been burned. That their chairs were far more severely burned than they themselves were told him that people had been thrown from their seats and clear of the plane within seconds after the fire broke out. Authorities had begun to suspect that a wing fuel tank had exploded. The blast was far enough away from passengers that they had remained intact, but serious enough to damage the body of the plane to the point that it broke apart and the passengers were thrown clear.

I ask Shanahan why the bodies would be thrown from the plane if they were wearing seat belts. Once a plane starts breaking up, he replies, enormous forces come into play. Unlike the split-second forces of a bomb, they won't typically rip a body apart, but they are powerful enough to wrench passengers from their seats. "This is a plane that's traveling at three hundred miles per hour," Shanahan says. "When it breaks up, it loses its aerodynamic capability. The engines are still providing thrust, but now the plane's not stable. It's going to be going through hor-

rible gyrations. Fractures propagate and within five or six seconds this plane's in chunks. My theory is that the plane was breaking up pretty rapidly, and seatbacks were collapsing and people were slipping out of their restraint systems."

The Flight 800 injuries fit Dennis's theory: People tended to have the sort of massive internal trauma that one typically sees from what they call in Shanahan's world "extreme water impact." A falling human stops short when it hits the surface of the water, but its organs keep traveling for a fraction of a second longer, until they hit the wall of the body cavity, which by that point has started to rebound. The aorta often ruptures because part of it is fixed to the body cavity—and thus stops at the same time—while the other part, the part closest to the heart, hangs free and stops slightly later; the two parts wind up traveling in opposite directions and the resultant shear forces cause the vessel to snap. Seventy-three percent of Flight 800's passengers had serious aortic tears.

The other thing that reliably happens when a body hits water after a long fall is that the ribs break. This fact has been documented by former Civil Aeromedical Institute researchers Richard Snyder and Clyde Snow. In 1968, Snyder looked at autopsy reports from 169 people who had jumped off the Golden Gate Bridge. Eighty-five percent had broken ribs, whereas only 15 percent emerged with fractured vertebrae and only a third with arm or leg fractures. Broken ribs are minor in and of themselves, but during high-velocity impacts they become sharp, jagged weapons that pierce and slice what lies within them: heart, lungs, aorta. In 76 percent of the cases Snyder and Snow looked at, the ribs had punctured the lungs. Statistics from Flight 800 sketched a similar scenario: Most of the bodies displayed the telltale internal injuries of extreme water impact. All had blunt chest injuries, 99 percent had multiple broken ribs, 88 percent had lacerated lungs, and 73 percent had injured aortas.

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If a brutal impact against the water's surface was what killed most passengers, does that mean they were alive and aware of their circumstances during the three-minute drop to the sea? Alive, perhaps. "If you define alive as heart pumping and them breathing," says Shanahan, "there might have been a significant number." Aware? Dennis doesn't think so. "I think it's very remote. The seats and the passengers are being tossed around. You'd just get overwhelmed." Shanahan has made a point of asking the hundreds of plane and car crash survivors he interviews what they felt and observed during their accident. "I've come to the general conclusion that they don't have a whole lot of awareness that they've been severely traumatized. I find them very detached. They're aware of a lot of things going on, but they give you this kind of ethereal response—'I knew what was going on, but I didn't really know what was going on. I didn't particularly feel like I was a part of it, but on the other hand I knew I was a part of it.' "

Given that so many Flight 800 passengers were thrown clear of the plane as it broke apart, I wondered whether they stood a chance—however slim—of surviving. If you hit the water like an Olympic diver, might it be possible to survive a fall from a high-flying plane? It has happened at least once. In 1963, our man of the long-distance plummet, Richard Snyder, turned his attention to people who had survived falls from normally fatal heights. In "Human Survivability of Extreme Impacts in Free-Fall," he reports the case of a man who fell seven miles from an airplane and survived, albeit for only half a day. And this poor sap didn't have the relative luxury of a water landing. He hit ground. (From that height, in fact, there is little difference.) What Snyder found is that a person's speed at impact doesn't dependably predict the severity of his or her injuries. He spoke with eloping bridegrooms who sustained more debilitating injuries falling off their ladders than did a suicidal thirty-six-year-old who dropped seventy-one feet onto concrete. The latter walked away needing nothing more than Band-Aids and a therapist.

Generally speaking, people falling from planes have booked their final flight. According to Snyder's paper, the maximum speed at which a human being has a respectable shot at surviving a feet-first—that's the safest position—fall into water is about 70 mph. Given that the terminal velocity of a falling body is 120 mph, and that it takes only five hundred feet to reach that speed, you are probably not going to fall five miles from an exploding plane and live to be interviewed by Dennis Shanahan.

Was Shanahan right about Flight 800? He was. Over time, critical pieces of the plane were recovered, and the wreckage supported his findings. The final determination: Sparks from frayed wiring had ignited fuel vapors, causing an explosion of one of the fuel tanks.

The unjolly science of injury analysis got its start in 1954, the year two British Comet airliners mysteriously dropped from the sky into the sea. The first plane vanished in January, over Elba, the second off Naples three months later. In both crashes, owing to the depth of the water, authorities were unable to recover much of the wreckage and so turned for clues to the "medical evidence": the injuries of the twenty-one passengers recovered from the surface of the sea.

The investigation was carried out at Britain's Royal Air Force Institute of Aviation Medicine in Farnborough, by the organization's group captain, W. K. Stewart, in conjunction with one Sir Harold E. Whittingham, director of medical services for the British Overseas Airways Corporation. As Sir Harold held the most degrees—five are listed on the published paper, not counting the knighthood—I will, out of respect, assume him to have been the team leader.

Sir Harold and his team were immediately struck by the uni-

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formity of the corpses' injuries. All twenty-one cadavers showed relatively few external wounds and quite severe internal injuries, particularly to the lungs. Three conditions were known to cause lung injuries such as those found in the Comet bodies: bomb blast, sudden decompression—as happens when pressurization of an airplane cabin fails—and a fall from extreme heights. Any one of them, in a crash like these, was a possibility. So far, the dead weren't doing much to clear up the mystery.

The bomb possibility was the first to be ruled out. None of the bodies were burned, none had been penetrated with bomb-generated shrapnel, and none had been, as Dennis Shanahan would put it, highly fragmented. The insane, grudge-bearing, explosives-savvy former Comet employee theory quickly bit the dust.

Next the team considered sudden depressurization of the passenger cabin. Could this possibly cause such severe lung damage? To find out, the Farnborough team recruited a group of guinea pigs and exposed them to a sudden simulated pressure drop—from sea level to 35,000 feet. To quote Sir Harold, "The guinea pigs appeared mildly startled by the experience but showed no signs of respiratory distress." Data from other facilities, based on both animal experimentation and human experiences, showed similarly few deleterious effects—certainly not the kind of damage seen in the lungs of the Comet passengers.

This left our friend "extreme water impact" as the likely cause of death, and a high-altitude cabin breakup, presumably from some structural flaw, as the likely cause of the crash. As Richard Snyder wouldn't write "Fatal Injuries Resulting from Extreme Water Impact" for another fourteen years, the Farnborough team turned once again to guinea pigs. Sir Harold wanted to find out exactly what happens to lungs that hit water at terminal velocity. When I first saw mention of the animals, I pictured Sir Harold trekking to the cliffs of Dover, rodent cages in tow, and hurling the unsuspecting creatures into the seas below, where his companions awaited in rowboats with nets. But Sir Harold had more sense than I; he and his men devised a "vertical catapult" to achieve the necessary forces in a far shorter distance. "The guinea pigs," he wrote, "were lightly secured by strips of adhesive paper to the under surface of the carrier so that, when the latter was arrested to the lower limit of its excursion, the guinea pig was projected belly first, about 2½ feet through the air before hitting the water." I know just the sort of little boy Sir Harold was.

To make a long story short, the catapulted guinea pigs' lungs looked a lot like the Comet passengers' lungs. The researchers concluded that the planes had broken apart at altitude, spilling most of their human contents into the sea. To figure out exactly where the fuselage had broken apart, they looked at whether the passengers had been clothed or naked when pulled from the sea. Sir Harold's theory was that hitting the sea from a height of several miles would knock one's clothes off, but that hitting the sea inside the largely intact tail of the plane would not, and that they could therefore surmise the point of breakup as the dividing line between clothed and naked cadavers. For in both flights, it was the passengers determined (by checking the seating chart) to have been in the back of the plane who wound up floating in their clothes, while passengers seated forward of a certain point were found floating naked, or practically so.

To prove his theory, Sir Harold lacked one key piece of data: Was it indeed true that hitting the sea after falling from an airplane would serve to knock one's clothes off? Ever the pioneer, Sir Harold undertook the study himself. Though I would like nothing better than to be able to relate to you the details of another Farnborough guinea pig study, this one featuring the little rodents outfitted in tiny worsted suits and 1950s dresses, in point of fact no guinea pigs were used. The Royal Aircraft