

BUSINESS CASE

# UNITED AIRLINES 173

by Jan U. Hagen

## Hint and hope



## UAL flight 173: I told him so

On the afternoon of December 28, 1978, an eight-member-strong United Airlines crew consisting of two pilots, a flight engineer, and five flight attendants was preparing United Airlines 173 (UAL 173) for its flight from Denver to Portland, Oregon<sup>61</sup> (Figure 1.14).



Figure 1.14 Route of UAL 173 from Denver to Portland

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<sup>61</sup> The following facts are based on the report issued by the National Transportation Safety Board, NTSB (1979).



Figure 1.15 **DC-8-61 during takeoff**

The McDonnell-Douglas DC-8-61 (Figure 1.15) was almost full when it embarked on its journey in the early afternoon, only slightly behind schedule. It was carrying 181 passengers, including six children and an off-duty pilot sitting behind the captain on the jump seat.<sup>62</sup> Three and a half hours later, the wreckage of the DC-8 lay in a residential area six miles south of Portland International Airport. Eight passengers and two crew members were killed. A further 21 passengers and two crew members suffered severe injuries. There was a comprehensive investigation into the cause of the crash. It revealed that, even though the plane was under the command of one of the airline's most experienced pilots, this accident was once again attributable to human error. Unlike previous cases, which the US aviation authorities had regarded as isolated incidents, a pattern now started to emerge. This showed that the planes' increasing technical reliability had not in fact led to any decline in the number of accidents.<sup>63</sup>

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62 The NTSB investigation report has no further details about this captain. In particular, there is no information about what types of planes he was licensed to fly.

63 An analysis by Boeing showed that over two-thirds of all air accidents were the result of human error. Some of the particularly spectacular accidents prior to 1979 that confirm this trend include the crash of an Eastern Airlines L-1011 over the Everglades and the previously mentioned collision between two jumbo jets on the runway on Tenerife.

At the end of the 1970s, United Airlines was the largest airline in the Western world. Serving mainly flight routes within the United States, the company enjoyed an excellent reputation. United had a first-class technical maintenance service, and fulfilled the very highest standards, particularly when selecting pilots.

The captain of UAL 173, Malburn McBroom (52), had been flying for 27 years. Of those, he had spent 19 years as a captain with United Airlines. With more than 27,000 flying hours, he was one of United's most experienced pilots. He had been flying the DC-8 for several years. The other two members of the cockpit crew were also experienced pilots. The 45-year-old copilot and first officer, Roderick Beebe, had been flying for United for 14 years, but had only spent four months piloting the DC-8. The flight engineer and second officer, Forrest Mendenhall (41), had been flying with United for 11 years and was just as familiar with the DC-8 as the captain.

Although flight crews fly in different teams due to shift rotations, the cockpit crew of UAL flight 173 had been working together for several days and knew each other relatively well. The five-member-strong cabin crew was led by purser Joan Wheeler (36).

The DC-8-61 had been operated by United Airlines for slightly more than 10 years. During that time, it had notched up a total flying time of 33,114 hours. It was not one of the airline's most modern planes, but it was the typical, reliable workhorse of that era. The period it had been in operation was normal even by today's standards.

In the early afternoon of December 28, the cockpit crew met as usual around 90 minutes before UAL 173 was due to depart from Stapleton International Airport in Denver. The crew would take over the controls of the incoming DC-8 from John F. Kennedy International Airport (JFK) in New York and continue the flight to Portland. According to the weather forecast for Portland, it was going to be a clear evening with visibility of more than 15 miles, a temperature of -2° C, and a moderate northerly wind. The crew did not expect any serious delays. Captain McBroom duly ordered 46,700 pounds of fuel. This amount was sufficient for the expected 2.5 hour flight time, the 45 minute extra flight time required by law, as well as an additional 20 minute buffer, according to United's company policy.<sup>64</sup> McBroom and copilot Beebe agreed that Beebe would fly the plane while McBroom took charge of radio communications.<sup>65</sup> As the third member of the cockpit crew, flight engineer

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64 NTSB (1979), p. 24.

65 It is normal practice for the captain and copilot to take it in turns to fly the plane. However, overall responsibility always remains with the captain.



Figure 1.16 **Cockpit with captain, copilot, and flight engineer**

Mendenhall was responsible for operating and monitoring the plane's technical systems. He sat behind the two pilots in the cockpit (Figure 1.16).

The cockpit crew then discussed details of the flight with the cabin crew. Like the cockpit crew, the flight attendants and Wheeler had agreed on their respective roles within the cabin. Once the briefing was complete, the crew made their way to the DC-8 arriving from New York. Due to their clearly defined roles, each member of the crew knew exactly what his or her tasks were.

In this post-Christmas period, UAL flight 173 was almost fully booked. At 2:33 p.m. Pacific Standard Time,<sup>66</sup> the plane was pushed back from the gate in Denver and taxied to the runway. Fourteen minutes later, copilot Beebe got the DC-8 off the ground and set course for Portland. After a routine flight, captain McBroom contacted Portland air traffic control at 5:05 p.m. before the plane was cleared for visual approach to runway 28 left. The flight attendants gathered up the last remaining glasses and prepared the cabin for landing. Beebe already had a good view of the runway. Five minutes later, he set the flaps for landing and gave captain McBroom the order to extend the landing gear.

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66 Time according to the place of the later accident.

During this process, the crew and the passengers all heard a loud noise and felt a powerful jolt. Captain McBroom assumed that the landing gear had deployed more quickly than usual. He also noticed that, of the three landing gear indicators, only the green light for the nose landing gear showed it was down and locked. Due to the flow noise, the pilots knew that part of the landing gear was deployed. However, they did not know if the main landing gear under the wings was fully extended and properly secured. McBroom reported that the plane was pulling to the right, indicating an asymmetrical configuration. As the air traffic controller in Portland instructed UAL 173 to contact the tower in preparation for landing, McBroom answered, “Negative, we’ll stay with you. We’ll stay at five [thousand feet]. We’ll maintain about a hundred and seventy knots. We got a gear problem. We’ll let you know.” The controller told the crew to stay at 5,000 feet and set a course of 220°. “I’ll just orbit you out there ‘til you get your problem [solved].”

As the plane still had enough fuel to fly for more than an hour, the crew focused on the problem with the landing gear. If it was deployed only partially or not at all, there was a danger that one of the wings might touch the ground during landing. That would make it impossible to control the plane. Consequently, the cabin crew would have to prepare the passengers for a possible emergency landing and evacuation.

At 5:14 p.m. (the time at which the plane was scheduled to land in Portland), the controller put the plane into a holding pattern southeast of Portland. While the cockpit crew went through the checklists for landing gear faults, purser Wheeler entered the cockpit. Captain McBroom explained the problem to her. He said that he would tell her what he planned to do next, once he had carried out a few more checks. Meanwhile, copilot Beebe went into the cabin and tried to see the visual indicators on the wings. If these were extended above the wing surface, it would show that the main landing gear had been extended and secured. However, it was already too dark to tell.

At 5:38 p.m., around 23 minutes after entering the holding pattern, McBroom contacted the United Airlines maintenance center in Portland to explain the problem. When the flight service advisor asked whether McBroom could confirm an estimated landing time of 6:05 p.m., McBroom replied, “Yeah, that’s good ball park. I am not going to hurry the girls. We got about a hundred-sixty-five people on board and we want to take our time and get everybody ready and then we’ll go. It’s clear as a bell and no problem.”<sup>67</sup>

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67 NTSB (1979), p. 3.

Let us take a closer look here at the people who make up the cabin crew. Operational responsibility lies with the purser. The purser and his or her team of flight assistants take care of the passengers and, in an emergency, are responsible for the emergency exits and evacuating the plane as quickly as possible. Like the cockpit crew, they receive regular training to ensure they can cope with emergency situations.

As the cockpit crew has basically no contact with the cabin, they rely on the flight attendants to pass on relevant cabin information. In the 1970s, the hierarchical structures between the cockpit and cabin crews meant communications were more or less always between the purser and the cockpit.

On the day of UAL flight 173, the problem with the landing gear did not initially appear to be a major issue. Between 5:14 and 5:45 p.m., the captain and copilot switched roles. McBroom was now flying the plane while Beebe operated the radio. In addition, McBroom was still talking with United's maintenance center.

At 5:45 p.m., purser Wheeler came into the cockpit again. She reported that the cabin crew was ready to announce the planned emergency landing. Shortly after, Beebe asked flight engineer Mendenhall how much fuel was left. He replied that there were still 5,000 pounds.

McBroom probably failed to hear this update as he was discussing the emergency landing with the pilot flying with them behind him on the jump seat.<sup>68</sup> The off-duty pilot then went into the cabin to help the flight attendants. Two minutes later, Beebe asked for another fuel update. This time McBroom replied that there were 5,000 pounds left and pointed to the flashing warning lights that would show if the remaining fuel fell below 5,000 pounds. In other words, it should have been clear to everyone in the cockpit at this point that there was enough fuel for another 20 minutes; together, the four engines consumed around 220 pounds per minute.<sup>69</sup> A little later, McBroom asked the flight engineer to calculate the landing weight – based on the zero fuel weight<sup>70</sup> of the plane and the remaining fuel – in “about another fifteen minutes.” Mendenhall repeated, “Fifteen minutes?” Brushing this off, McBroom simply added that Mendenhall should factor in three or four thousand pounds on top of the zero fuel weight. It is worth taking a closer look at that calculation. Together, the four engines would consume 3,300 pounds in the space of 15 minutes. If the plane were to land in 15 minutes' time, the

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68 He was only flying in the cockpit as a passenger.

69 NTSB (1979), pp. 18–19.

70 Empty weight of the plane plus passengers and cargo.

amount of fuel remaining would be 1,700 pounds, certainly not 3,000–4,000 pounds.

“Not enough,” murmured Mendenhall. Raising his voice a little, he said, “Fifteen minutes is gonna really run us low on fuel here.” He made it no clearer than that. Shortly after, he notified the captain of the plane’s landing weight. Still, McBroom was assuming a fuel reserve of 3,000–4,000 pounds while Mendenhall was working with a reserve of just 1,700.

By now, the plane was 18 miles south of Portland Airport and flying in a curve toward runway 28. The United flight service advisor requested the plane’s estimated landing time.

At 5:53 p.m., Mendenhall asked McBroom if they would land at “about five after” [i.e., 6:05 p.m.]. McBroom said yes. Three minutes later, Beebe asked Mendenhall about the fuel situation. “Four, four – thousand – in each [tank] – pounds,” Mendenhall replied vaguely. “Okay,” said Beebe, even though Mendenhall’s answer could have meant 4,000 pounds overall or 4,000 in each tank. Naturally, neither Beebe nor McBroom would have thought there were still 16,000 pounds left at this point. For that reason, let us assume that they were basing their calculations on an overall fuel reserve of 4,000 pounds.

McBroom said to Mendenhall, “Walk back through the cabin and kinda see how things are going. Okay? I don’t want to hurry ‘em, but I’d like to do it in another, oh, ten minutes.” Mendenhall went into the cabin to check the situation there while McBroom and Beebe discussed the landing and evacuation. The air traffic controller put the plane into the next holding pattern. A moment later, Mendenhall returned to report that there were around 3,000 pounds of fuel left. The controller asked how much waiting time the crew needed. Copilot Beebe responded, “Yeah, we have indication our gear is abnormal. It’ll be our intention in about five minutes to land on (runway) two eight left. We would like the (fire) equipment standing by. We’ve got our people prepared for an evacuation in the event that should become necessary.”

When Portland air traffic control asked for details of the number of people on board and the volume of fuel upon *landing*, McBroom answered, “One seventy two and about four thousand, well, make it three thousand pounds of fuel and you can add one seventy two [passengers] plus six infants.”<sup>71</sup> However, this figure represented the fuel remaining at

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71 This information was incorrect in terms of not only the fuel volume but also the number of passengers. There were 181 passengers and eight crew members and, at the time the report was made, the fuel had already dropped to 3,000 pounds.

that time, not on landing. As it was, the figure of 4,000 was already an overestimate. There were at least another 10 minutes to go before landing. The figure quoted by McBroom should have been 2,200 pounds less, indicating a remaining reserve of not even 1,000 pounds.

At around 6:06 p.m., Wheeler entered the cockpit and said the cabin was now ready. “Okay we’re going in now, we should be landing in about five minutes,” replied McBroom.

At the same moment, Beebe said to McBroom, “I think you lost [engine] number four, Buddy,” before turning to the flight engineer: “Better get some crossfeeds open there or something.”

McBroom, however, had failed to notice the engine failure. He was still talking to Wheeler. Beebe turned to him again. “We’re going to lose an engine, Buddy.”

“Why?”

“We’re losing an engine.”

“Why?”

“Fuel.”

Beebe turned back to Mendenhall. “Open the crossfeeds, man.”

At nearly the same time, McBroom said to Mendenhall, “Open the crossfeeds there or something. [My fuel gauge is] showing a thousand or better.” “I don’t think it’s in there,” answered Beebe.

Pilots and flight engineers each have their own tank indicators, which can display slightly different values. When the fuel level is very low, technical issues can affect the accuracy of the tank indicators.<sup>72</sup> “Okay, it, it’s a ...” started McBroom. Beebe said, “It’s flamed out.”

McBroom asked Portland air traffic control to issue immediate instructions for landing and was given permission for a visual approach to runway 28 left. Flight engineer Mendenhall reported that engine number three was also on the brink of failing. “It [the fuel gauge] is showing zero.” McBroom answered, almost pleadingly, “You got a thousand pounds, you got to. ...” In response, Mendenhall said, “Five thousand were in there, Buddy, but we lost it.” “Okay,” replied McBroom, while he and Beebe tried to restart engine number three.

McBroom told Mendenhall to give the cabin the signal for an immediate landing and asked the air traffic controller how far it was to the airport. “I’d call it eighteen flying miles,” the controller replied.

“Boy,” said Mendenhall, “that fuel sure went to hell all of a sudden. I told you we had four [thousand pounds].” “There’s a kind of an interstate

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72 The reliable range of deviation is between +/-200 and +/-400 pounds.

highway type thing along that bank on the river in case we are short,” said McBroom. “That’s Troutdale [a small airport] over there...”<sup>73</sup> “Let’s take the shortest route to the airport,” said Beebe.

At 6:13 p.m. Mendenhall stated, “We’ve lost two engines, guys. We just lost two engines, one and two.” “You got all the pumps on and everything?” asked Beebe. “Yep” was Mendenhall’s brief reply. “They’re all going. We can’t make Troutdale,” said McBroom. “We can’t make anything,” replied Beebe. “Okay, declare a Mayday,” ordered McBroom.

Beebe called Portland tower. “United 173 heavy, Mayday, the engines are flaming out, we’re going down, we’re not going to be able to make the airport.” It was the last radio transmission from United 173 (Figure 1.17).

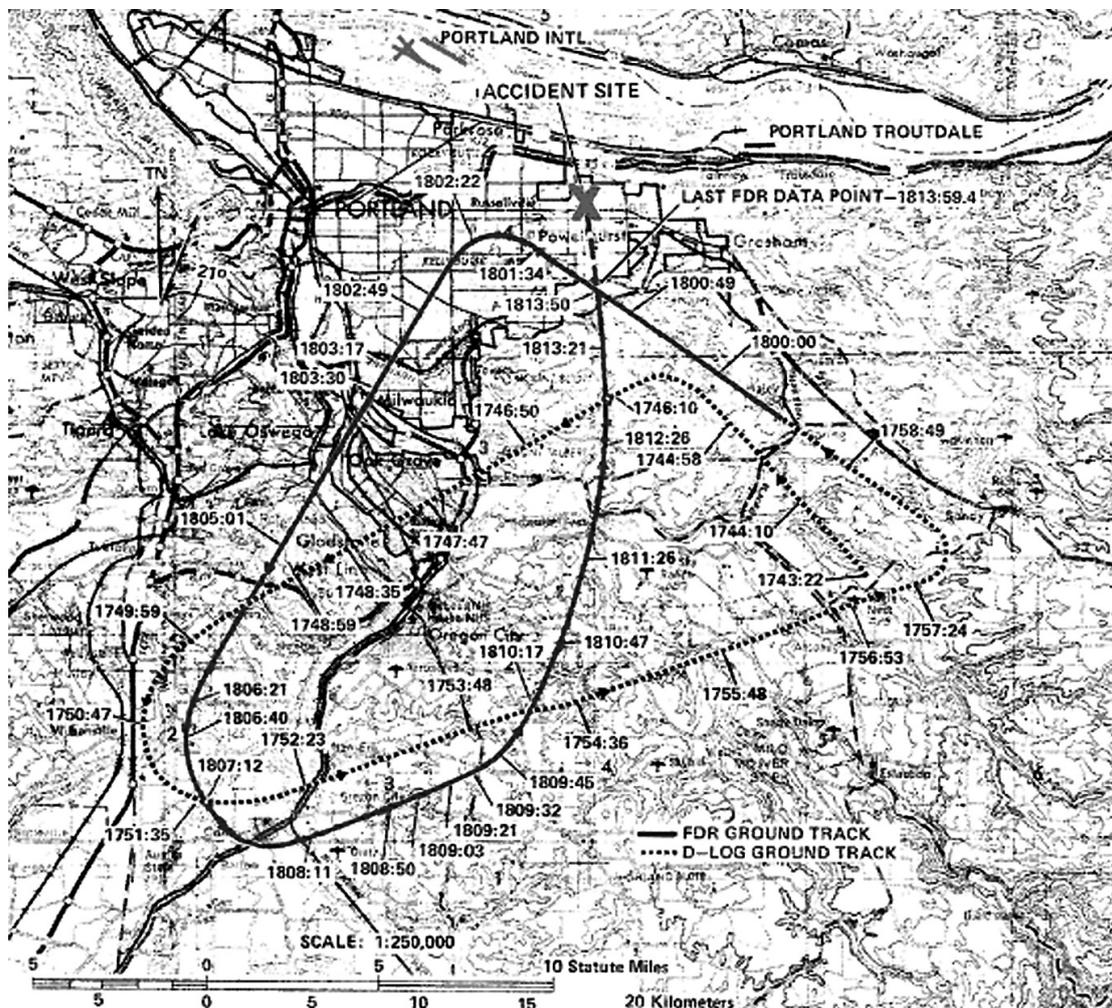


Figure 1.17 Flight path of UAL 173

<sup>73</sup> A small airport that was not suitable for landing a large passenger jet and was only considered as an option in the event of an emergency landing.

McBroom and his crew managed to make an emergency landing. At around 100 feet above the ground, the DC-8 struck a wooded area six miles southeast of Portland Airport. Slowed by the trees, it came to a halt on the ground after 1,230 feet (Figure 1.18). Eight of the 181 passengers on board were killed by the impact. A further 21 were seriously injured. Mendenhall and Wheeler were also killed.

The NTSB published its accident report six months later. In essence, the report found<sup>74</sup> that the captain was responsible for the accident. He failed to heed information from his crew and check the fuel levels properly. The report also criticized Beebe and Mendenhall for failing to ensure McBroom was fully aware of the limited fuel supplies. Ironically, the investigation also revealed that the main landing gear was fully extended and ready for landing at the time of the impact. However, regardless of the responsibility borne by captain McBroom, the NTSB decided the true cause of the crash lay elsewhere. Two experienced crew members had failed to communicate a simple message to their superior, namely that the fuel was running low and the plane had to land.



Figure 1.18 **UAL 173 after the emergency landing**

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74 NTSB (1979), p. 29.

We all, including the NTSB, see everything better in hindsight. For that reason, we should take a closer look at some of the key situations in this scenario. Among other things, it reveals one of the most treacherous causes of errors: misinterpretations based on assumptions and silent misunderstandings. In this case, we have McBroom, an experienced captain, who knows that if there are 5,000 pounds of fuel remaining, the plane will have to land within 20 minutes. He also knows that the flashing warning lights mean fuel is running low. In addition, we have Mendenhall and Beebe, two equally experienced crew members, who theoretically can assume their captain is fully aware of all aspects of the situation.

At some point, though, Beebe seems to become unsure as to everybody's awareness of their fuel situation. Yet, instead of voicing his concerns and pressing McBroom to land the plane, he asks Mendenhall about the amount of fuel remaining. Ten minutes later, he asks the same question. In both cases, he already knows the answer because, as copilot, he has his own fuel tank indicator. Yet again, he does not take the matter up with McBroom. Perhaps he hoped McBroom had overheard the conversation and interpreted everything correctly.

We are already familiar with this type of behavior from the case of JAL 8054. In that instance, flight engineer Yokokawa felt unable to address the mistakes made by captain Marsh and simply made general statements. Recall his phrase "Usually on yaw damper." This principle of hinting and hoping is a type of defense mechanism. It is a way of indirectly addressing errors made by a superior in the hope that he or she will get the message without taking umbrage.

However, McBroom's request for the landing weight and the given amount of fuel shows that he did not have a clear picture of the fuel situation at all. That is perhaps understandable in view of the imminent emergency landing. Instead of calculating the consumption for 15 minutes based on the existing 5,000 pounds – giving a reserve of around 1,700 pounds – he came up with a residual amount of 3,000–4,000 pounds, which he probably felt was a comfortable buffer. In an ideal world, when talking about their reserve, Mendenhall would have contradicted McBroom and stated the correct figure. Instead, he makes a series of vague comments. "Fifteen minutes is gonna really run us low on fuel here," he says. A little later, he notifies McBroom of the landing weight (i.e., the zero fuel weight of the plane plus fuel). However, the two men are basing their calculations on different fuel volumes – Mendenhall on the correct volume, McBroom on an incorrect one. Nevertheless, they assume they are in agreement. Shortly thereafter, when asked again about the fuel situation, Mendenhall

gives the current figure of 4,000 pounds. Although Mendenhall's response is a little confused, McBroom could have understood the message. After all, Mendenhall was now talking about a figure that McBroom already had fixed in his head, namely something in the region of 4,000 pounds. After that, McBroom becomes distracted and starts discussing the emergency landing with his copilot. The next figure Mendenhall gives is 3,000 pounds. McBroom does not fully register this and seems to remain fixated on his figure of 4,000 or "make it three thousand pounds of fuel," mistakenly quoting this figure for the fuel reserve upon landing to the air traffic controller in Portland – even though it was the current amount and, for their landing reserve, far too high. The engine failures and the necessity of an immediate emergency landing – all within the space of a few minutes – must have come like a bolt from the blue.

So what went wrong? This time, fear of the captain cannot have played a role in what unfolded. Unlike in other cases we have examined, McBroom is not a man who insists on observing strict hierarchical distances between himself and those under his command. His tone is informal and his colleagues address him as "Buddy." He stays calm when a problem arises. There is very little age difference between McBroom, Mendenhall, and Beebe. Mendenhall calls Beebe and McBroom "boys." The atmosphere between the three men is relaxed. Nevertheless, shortly before the planned landing, both Beebe and Mendenhall must have noticed that McBroom no longer had an overview of the fuel situation. Even so, it did not occur to them to educate or correct him – and then it was too late to do anything and the fuel was gone. The question we inevitably have to ask is why did the pair – Mendenhall in particular – not speak up in time to ensure that McBroom was fully aware of the problem? After all, they were in the middle of an emergency situation that was getting more serious by the minute, plus the lives of everyone on board were hanging in the balance. Granted, there was not much to be done at the start of the problem. If two people are silently convinced of two different things – yet believe that they are in agreement and that what they think is right – then it will not, and actually cannot, occur to either of them to clarify, debate, or attempt to improve the situation. Such situations resolve themselves either by chance or are never actually identified. For that reason, it is more interesting to examine why the first information flow blockage occurred. After all, it triggered the subsequent series of vague, unhelpful communications.

This brings us to next situation in the cockpit of UAL 173. What we are talking about here is a commonplace internal attitude of lower-ranking individuals and the curious paradox whereby they believe that their bosses

know better – but that they do, too. In everyday business environments, this type of attitude leads to an interminable cycle of statements such as “I could have told him that,” “I knew that from the start,” “The boss doesn’t have a clue,” and “I’m not surprised it hasn’t worked.” Yet, in the next moment, this can flip over into “He should know, he is the boss,” “I’m not getting involved, that is above my pay grade,” and “It has nothing to do with me.” This behavior is not indicative merely of mental confusion. Rather, we are dealing with signs of silent antagonism between superiors and subordinates, signs that are sometimes papered over but can easily resurface. In this relationship, a superior – even someone as easygoing as McBroom – may on occasion consider his own knowledge to be privileged, his findings smarter, or he may not be greatly interested in what his next-in-command thinks. But maybe on the next occasion, the very next in command – even someone as friendly as Mendenhall – may let their superior take the fall because of this.

I am not suggesting that either Mendenhall or McBroom were intentionally behaving in this manner during the flight. However, when Mendenhall is instructed to calculate the landing weight in “about another fifteen minutes,” he asks – whether to confirm the order or for no real reason at all – if McBroom means “fifteen minutes.” McBroom does not respond to this. Perhaps he did not hear Mendenhall’s question. Perhaps he felt no response was necessary or he was simply irritated by the question. All of us will be able to understand all three of these possibilities. This exchange is followed by McBroom’s imperious order that Mendenhall should calculate 3,000–4,000 pounds on top of the zero fuel weight of the plane. In other words, just seconds after giving Mendenhall a task, McBroom effectively does it for him. With this in mind, it is possible that Mendenhall is left a bit annoyed. After all, not only has his question been ignored, but he also may feel McBroom has just treated him like a child by doing his job for him. It is also possible that – whether intentionally or semi-intentionally – he tries to punish McBroom later by not communicating the necessary information as clearly as required. “Not enough,” he murmurs, almost to himself, regarding their fuel reserve. His comment “Fifteen minutes is gonna really run us low on fuel here,” is slightly louder, but still falls short of making a concrete statement.

Of course, this possible sequence of behavior – disappointment/resentment/punishment – applies not only to the relationship between a first and second (or in this case a third) in command, but also to the way we generally deal with and react to other people. In the case of minor issues, we manage to swallow our annoyance. However, if we were in the

shoes of Mendenhall, our subsequent reactions may be tinged with resentment. If we pursue this train of thought further, Mendenhall's sense of vindication – and even triumph – shortly before the emergency landing becomes more plausible. *That fuel sure went to hell all of a sudden.* This is accompanied by a reflection on that earlier moment that now provides him with satisfaction and a perfect alibi: *I told you we had four.* Mendenhall had tried to give McBroom the right information, but the captain failed to listen. Now, McBroom will have to answer for the consequences.

In business environments, the rule that “facts” should dominate our behavior is often cited, as if facts were sacred and should take preeminence over the emotions or feelings of the individual. If we follow this train of thought, Mendenhall should have forgotten his feelings and focused on the factual situation as being the only thing which counted. But he did not, independent of what he should have done. There are situations where the postulate of subordinating one's feeling to the rule of fact and reason is too simplistic a doctrine, particularly so, as it will not help in understanding human behavior. Undoubtedly, it is possible to suppress resentment, disappointment, anger, and irritation and swallow it down in the face of the “facts” (or at least appear to do so). Yet we can only guess what inner state of affairs these frustrated feelings may trigger; at least, we know fairly well what they trigger in ourselves and how long we choke on the feelings we have swallowed for the sake of so-called facts. In this respect, Mendenhall's behavior offers a nice example of the influence these emotions can have when we are under their spell and shows us how impotent reason or common sense may be at the times both forces compete.

The NTSB, too, began to think that new training requirements alone (such as constant monitoring of fuel indicators and clear distribution of tasks within the cockpit) would not be enough to prevent similar accidents in the future. After all, the pilots of UAL flight 173 had all received exactly these training courses and instructions on a regular basis. What was needed was a different, clearer mindset that even though it would put “the facts” at the forefront, it would do so in an emotionally secure environment, where all team members communicated as equals.