



## Anatomy of a Runway Collision

*When the captain relinquished his command authority to the first officer, a chain of events began that ended in tragedy.*

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by

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Two airline aircraft collided on a runway at Detroit Metropolitan/Wayne County (Metro) Airport, Romulus, Michigan, U.S., on December 3, 1990. The U.S. National Transportation Safety Board (NTSB) recently published its findings on the accident in a report, PB91-910405 (NTSB/AAR-91/05). Although the safety issues discussed in the NTSB report include airport marking and lighting, cockpit resource management, air traffic control procedures in low-visibility conditions, flight attendant procedures during evacuations and design of the DC-9 tailcone emergency release system, this article will concern itself specifically with the actions of the captain and first officer who crewed the DC-9 and with issues associated with the concept of cockpit resource management (CRM).

Because the airline did not have a CRM training program in effect at the time of the accident, neither pilot had been exposed to the benefits that such training might have provided to their working relationship. However, the cockpit relationships in that particular DC-9 were such that a question might be raised as to whether CRM training would have addressed the specific circumstances that occurred.

One of the early concepts in the development of CRM training was to show first officers how to cope with a tyrannical, overbearing and authoritarian captain, and to

become assertive in situations where safety might be compromised by the captain's behavior or actions. The purpose of CRM was to improve the understanding of the crew teamwork concept and to utilize all of the personnel resources available in the cockpit.

What happens when there is a role reversal and the first officer somehow assumes the decision-making responsibilities when the captain fails to take charge? This is what happened in the subject accident and leads to questions about the depth of CRM training and whether such training could possibly have prevented this accident.

### The Problem Unfolds

At 1345 hours local time on December 3, 1990, Northwest Airlines (NWA) Flight 1481, a McDonnell Douglas DC-9, and NWA Flight 299, a Boeing 727, collided near the intersection of runways 09/27 and 03C/21C in dense fog at Detroit Metro Airport. At the time of the collision, the Boeing 727 was on takeoff roll and the DC-9 had just inadvertently taxied onto the active runway. The Boeing 727 was substantially damaged but no one was injured. Eight of the 39 passengers and four crew members aboard the DC-9 received fatal injuries and the aircraft was destroyed.

## Role Reversal Cited

The NTSB concluded that the probable cause of this accident was a lack of proper crew coordination, including a virtual reversal of roles by the DC-9 pilots which led to their failure to stop taxiing the airplane and alert the ground controller of the uncertainty of their position in a timely manner both before and after intruding onto the active runway.

Contributory causes included:

- deficiencies in air traffic control services provided by the tower, including failure of the ground controller to take timely action to alert the local controller of a possible runway incursion; inadequate visibility observations; failure to use progressive taxi instructions in low-visibility conditions and issuance of inappropriate and confusing taxi instructions compounded by inadequate backup supervision for the level of experience of the staff on duty
- deficiencies in surface markings, signage and lighting and failure to detect or correct any of those deficiencies
- failure of the airline to provide adequate cockpit resource management training to their line aircrews

## DC-9 Pilot Background Sets the Stage

The captain of the DC-9, age 52, was hired by another airline on August 1, 1966, as a first officer on a Fokker F-27 Friendship. He rose to the positions of check captain, check airman and senior check airman as that airline merged with another airline. He became a DC-9 captain in December 1978 and flew in that capacity until February 1984 (that airline had merged with Republic Airlines), when he was medically disqualified from flying because of kidney stones. Republic merged with NWA in 1986 but, in accordance with merger contracts, the captain's date of employment with NWA was established as 1966.

While off flying status, the captain received regular disability stipends which, according to him, lessened the effect of a financial bankruptcy he experienced during his layoff. His first-class U.S. Federal Aviation Administration (FAA) medical certificate was reissued October 11, 1990. He held an airline transport pilot certificate and had accumulated approximately 23,000 hours, 4,000

of which were in the DC-9. This experience should be kept in mind when the captain's actions on the accident flight are reviewed.

NWA retraining requirements for a pilot who has not received a captain's assignment for more than six years are more stringent than those required by U.S. Federal Aviation Regulations (FARs) and are more comprehensive than those in the NWA training plan for routine captain upgrades. The captain attended a 10-day, 80-hour ground school (twice the normal requirement); accomplished a full six-session flight simulator course and a simulator proficiency checkride; completed 12 initial operating experience (IOE) flights (even though none was required by NWA or FAA); and, during his training, accomplished four departures and arrivals at Detroit Metro Airport. The airline did not offer formal CRM training at the time of the accident but subsequently began requiring a one-day course in CRM for all pilots during training. (The NTSB accident report questioned how much CRM training can be accomplished in one day).

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The NTSB noted that the captain appeared to handle his personal stress problems (layoff, financial bankruptcy, recertification) well and was happy to return to flying. At the time of the accident, the most significant stressor was probably the anxiety caused by his unfamiliarity with current line operations due to the mergers. The manuals, checklists and procedures were all new to him and, noted the NTSB, although he was an experienced captain, he may not have had full confidence in his ability to carry out some of his line flying duties because of the six-year layoff.

The DC-9 first officer, 43, retired from the U.S. Air Force in October, 1989, with the rank of major. He had been a copilot, aircraft commander and instructor pilot in the Boeing B-52 Stratofortress heavy bomber, as well as an instructor in the Northrop T-38 Talon jet trainer. His first line assignment was to a B-52 Squadron in 1971 and he accumulated approximately 3,245 hours in various models of that aircraft, of which 1,380 hours were as an instructor/evaluator pilot. Between B-52 assignments, he was a T-38 pilot, accumulating about 1,025 hours, 780 hours of which were as an instructor.

The first officer was hired by NWA in May 1990, and he held an airline transport pilot certificate and a flight engineer certificate. He estimated that he had accumulated about 4,685 hours, 185 of which were in the DC-9. The airline did not offer CRM training to its first officers.

The first officer told the NTSB that he had flown 22

departures and arrivals at Detroit Metro Airport and that one or two of them had been under instrument flight rules (IFR). He was in a one-year probation period with the airline and he was to be evaluated by each captain with whom he flew. Such evaluations, said the NTSB, were great incentives to perform well but were also stressful because failure to do well might end the chances of flying with a major airline. A captain described the first officer as "maybe a little bit" more helpful than a typical new pilot and noted that the first officer spontaneously tried to assist him with taxiing actions at one airport.

## Unique Command/Leadership Situation Develops

Both pilots arrived at the airline operations facility several hours early. The captain said he wanted to pay a courtesy visit to the airline chief pilot and to review the paperwork for the flight. The first officer made revisions to his flight manual. They completed their prestart activities approximately 40 minutes before the scheduled departure and spent this interval discussing their aviation backgrounds, expected flight duties and briefing for the takeoff.

According to the first officer's post-accident testimony, shortly after he met the captain, the captain asked whether he was experienced in Detroit Metro operations and the first officer responded, "Yes." However, the first officer indicated that what he had meant by his response was that he was familiar with pushback procedures and radio communications changeover points rather than the surface operations and physical layout of the airport.

The first officer also made misstatements about his military accomplishments (mentioned later) and it was the NTSB's opinion that the falsehoods about airport knowledge and military experience could possibly have affected the captain's opinion of the first officer's experience relative to his own. At the time the conversations took place, the pilots probably were still assessing each other's overall ability to perform their respective tasks, and those conversations may have led to a unique command/leadership situation. As a result, said the NTSB, the captain could have become overly impressed by the first officer's capabilities. As an example, the NTSB referred to the first officer's indication that he was familiar with the airport's operations.

The NTSB believed that the first officer's exaggerations about his knowledge of airport operations and the distortions of his military flight experiences and career achieve-

ments demonstrated a lack of professionalism. It was the NTSB's view that ethical conduct among professional flight crew members dictates that they provide accurate information about themselves, and that such information is crucial to the performance of their duties. To deliberately provide less than accurate information, said the NTSB, is contrary to flight safety.

## Role Reversal is Introduced

The NTSB stated that a nearly complete and unintentional reversal of command took place shortly after taxiing began with the result that the captain became overly reliant on the first officer. In essence, the captain acquiesced to the first officer's assumption of leadership, and this role reversal contributed significantly to the eventual runway incursion.

It all began when the first officer answered "Yes" to the captain's question about his familiarity with the airport. Then the captain asked him to assist with taxi clearances and taxiing. However, the first officer's acceptance without reservation or qualification, coupled with his failure to clarify the extent of his actual knowledge of the airport, placed a considerable burden of responsibility on him.

Although the first officer may have had more familiarity with the airport layout than the captain, said the NTSB, he was not as familiar with it as he led the captain to believe. The NTSB stated that, at this point, the first officer could have clarified what he meant by admitting (as he did after the accident) that he was familiar with pushback and radio changeover procedures rather than the layout of taxiways. The NTSB believed that the first officer did not want the captain to think he was inexperienced. The first officer later stated that this was the first time a captain asked him to actively assist (a responsibility that

he appeared ready and willing to accept). As a result, by the time the crew began to taxi, the first officer had begun to dominate the decision-making in the cockpit.

The NTSB pointed out several examples of this domination that were evident before and during the early part of the taxi sequence as the pilots became lost in the fog:

- At 1317, a nonrevenue passenger entered the cockpit and said that she was a "jump seat rider." Without consulting the captain, the first officer stated, "Are you gonna ride up here or ... ?" The passenger stated her desire to ride in a passenger seat and the captain agreed to permit it. Then, the first officer

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said, “No, it’s up to you but most captains I say fly, fly (sic) first class.” The captain then told the passenger, “Whatever you want to do is fine.”

- About 1322, while the airplane was still parked, the first officer explained to the captain the most accurate way to determine weight and balance.
- At 1325, the first officer told the captain that he had ejected from airplanes twice, once in combat, and a couple of minutes later, that he retired from the Air Force as a Lt. Colonel. Neither statement was supported by the first officer’s military records.
- At 1331, the first officer explained details concerning takeoff data for contaminated runways.
- At 1336, as they were initially searching for the yellow taxiway line, the first officer said, “Just kinda stay on the ramp here.” The captain replied, “Okay. Until the yellow line I guess, huh?” (This exchange, said the NTSB, may have been particularly significant since the airplane was never positioned on the taxiway centerline that paralleled the ramp area and led to the Oscar 6 taxiway entrance — Figure 1).
- Approximately 1338, as the incorrect decision to turn left at the Oscar 6 sign was being made, the captain asked a series of questions about which way to turn. The first officer appeared to convince himself about their location and then told the captain to turn left and that they were on Oscar 6. The airplane was actually on the outer taxiway.

Up to that point, neither pilot appeared to have referred to the directional indicators on the airplane to determine their position. If they had checked the aircraft heading, the fact that they were then taxiing due east for hundreds of feet (an impossibility on taxiway Oscar 6, said the NTSB, because it was oriented northwest/southeast) should have been a sufficient cue to the captain to stop taxiing, determine his position and request instructions from the ground controller as to how to proceed. However, said the NTSB, by the time the airplane was on the outer taxiway, the captain apparently believed that the first officer knew what he was doing and where the airplane was located. As was revealed later, the first officer did not know where he was and did not inform the captain of that.

If the pilots had admitted to themselves that they were lost at that point, said the NTSB, and if they had conveyed

that information to the ground controller at around 1339, they might have prompted the controllers to take appropriate action, which could have prevented the accident.

So the situation was this: the captain believed that the first officer knew where he was and the first officer was not willing to admit, or was not aware, that his assertive directions had placed the airplane in an unsafe predicament.

At 1339, the captain called for the takeoff checklist which occupied the pilots for about one minute and was interrupted at 1340 by the ground controller who asked the crew their position on the ramp. The first officer replied, “Ah, we’re headed eastbound on Oscar 6 here.” This transmission appears to have been the first time that either pilot used a heading indicator to determine the airplane’s position since they began taxiing from the gate and also indicated that the crew was lost because taxiing east on Oscar 6 was impossible.

At 1340, the first officer transmitted, “Okay, I think we might have missed Oscar 6. See a sign here that says, ah, the arrows to Oscar 5. Think we’re on Foxtrot now.”

These statements, said the NTSB, should have made it evident to the captain that they were lost on the airport. “The arrows to Oscar 5” statement clearly referred to a taxiway identification sign (Figure 2), and taxiway 5 is not near taxiway Foxtrot. That should have prompted the captain to stop, determine his position and call for progressive taxi instructions (step-by-step routing directions).

At 1340, the ground controller transmitted, “Northwest 1481, continue to Oscar 4, then turn right on Xray.” In retrospect, stated the NTSB, this transmission may have confused the crew and adversely affected their subsequent actions because they did not have to go as far as the centerline for taxiway Oscar 4 to turn right onto taxiway Xray.

At 1341, said the NTSB, the pilots abandoned their attempts to compare the Jeppesen airport diagram with what they saw from the cockpit and relied totally on the airfield signs and markings seen through the fog to comply with the ground controller’s instructions. The captain could have been fully occupied maintaining the centerline and looking for taxiway signs. Within about 12 seconds, the first officer saw a sign that indicated Outer/Xray and a sign that indicated Oscar 4. The Oscar 4 sign could have only been observed after the airplane was actually on that taxiway by looking to the left, behind the airplane.

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The NTSB stated that the aircraft then taxied forward a short distance as the pilots convinced themselves that they had taxied onto taxiway Oscar 4, in compliance with the ground controller's instructions. The next task was to cross runway 9/27 on taxiway Xray, which would have led them to the takeoff position for runway 3. However, the DC-9 had not turned right enough to enter taxiway Xray, but was proceeding along Oscar 4 toward the intersection of runways 9/27 and 3C/21C. The first officer confirmed permission to cross runway 9/27, and the captain then taxied the airplane through a right turn a short distance on Oscar 4 and unwittingly crossed the single,

angled hold line for both runways 3C/21C and 9/27 and was headed for the runway intersection.

About 1342, the first officer said, "Well, wait a minute. Oh, (expletive), this, uh, ah. . ." The NTSB thought that it was at this time that the first officer may have realized he was not sure of their position. His next comment was, "I think we're on, ah, Xray here now" in a last attempt to convince himself that nothing was amiss. At this point, just prior to entering the active runway, the captain apparently stopped the airplane but did not set the parking brake.

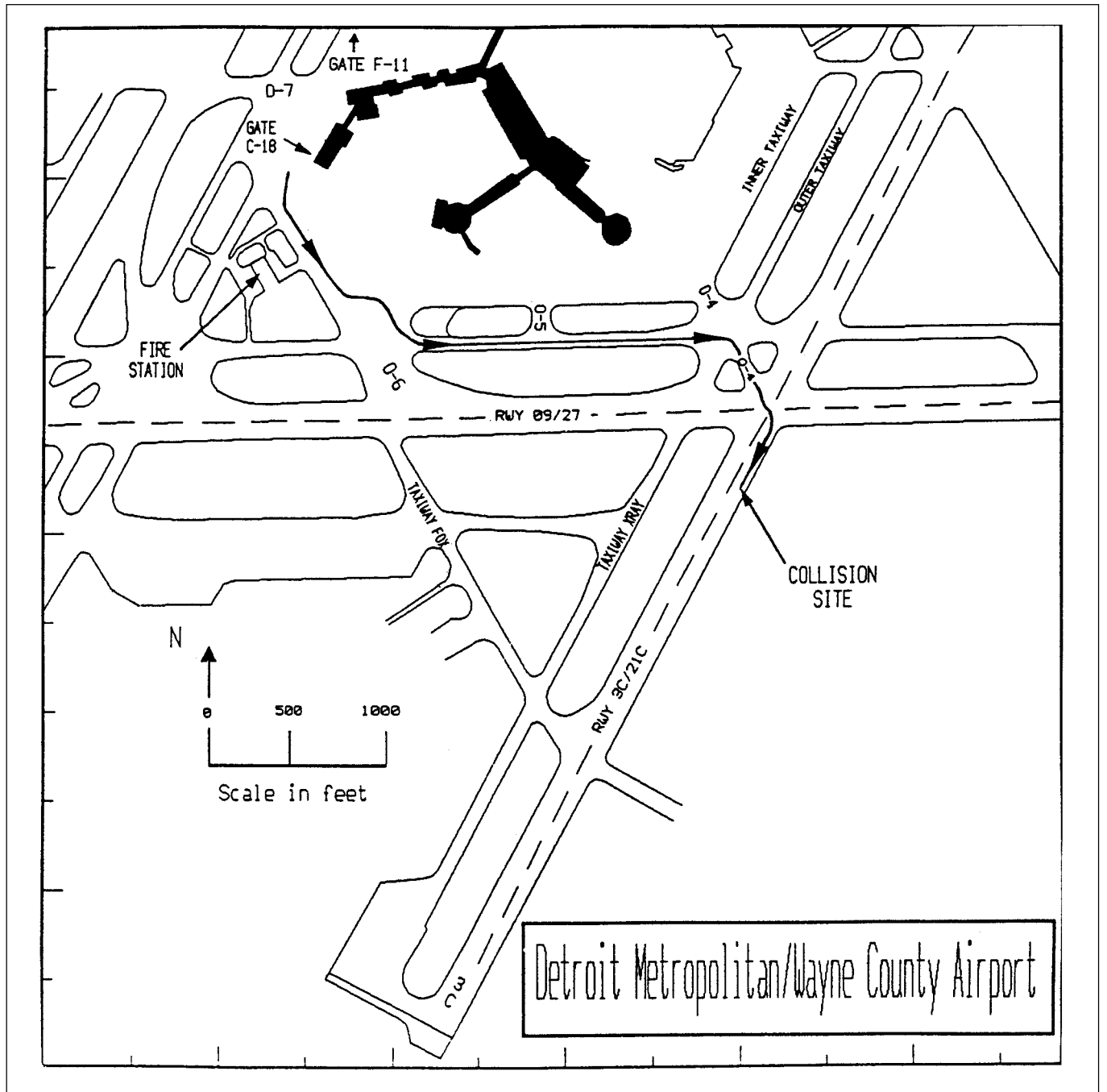


Figure 1. Detroit Metropolitan/Wayne County (Metro) Airport layout and DC-9 taxi route.

At 1342:35, apparently for the first time, the captain started to issue a command about taxiing and their precarious position. "Give him a call and tell him that, ah ... ." This may have been the first time that the captain realized they were confused and needed help. He was apparently not aware that they were approaching the active runway and danger. Immediately after this comment, the first officer stated, "Yeah, this is [runway] 9.

We're facing 160 [degrees], yeah. Cleared to cross it."

The only taxiway segment in the Oscar 4 area having a heading of 160 leads directly to the intersection of runway 9/27 and the active runway 3C/21C. Neither of the pilots noticed this fact. The captain, his doubts somewhat eased by the first officer's confidence, then asked, "We're cleared to cross?" and he received a confident

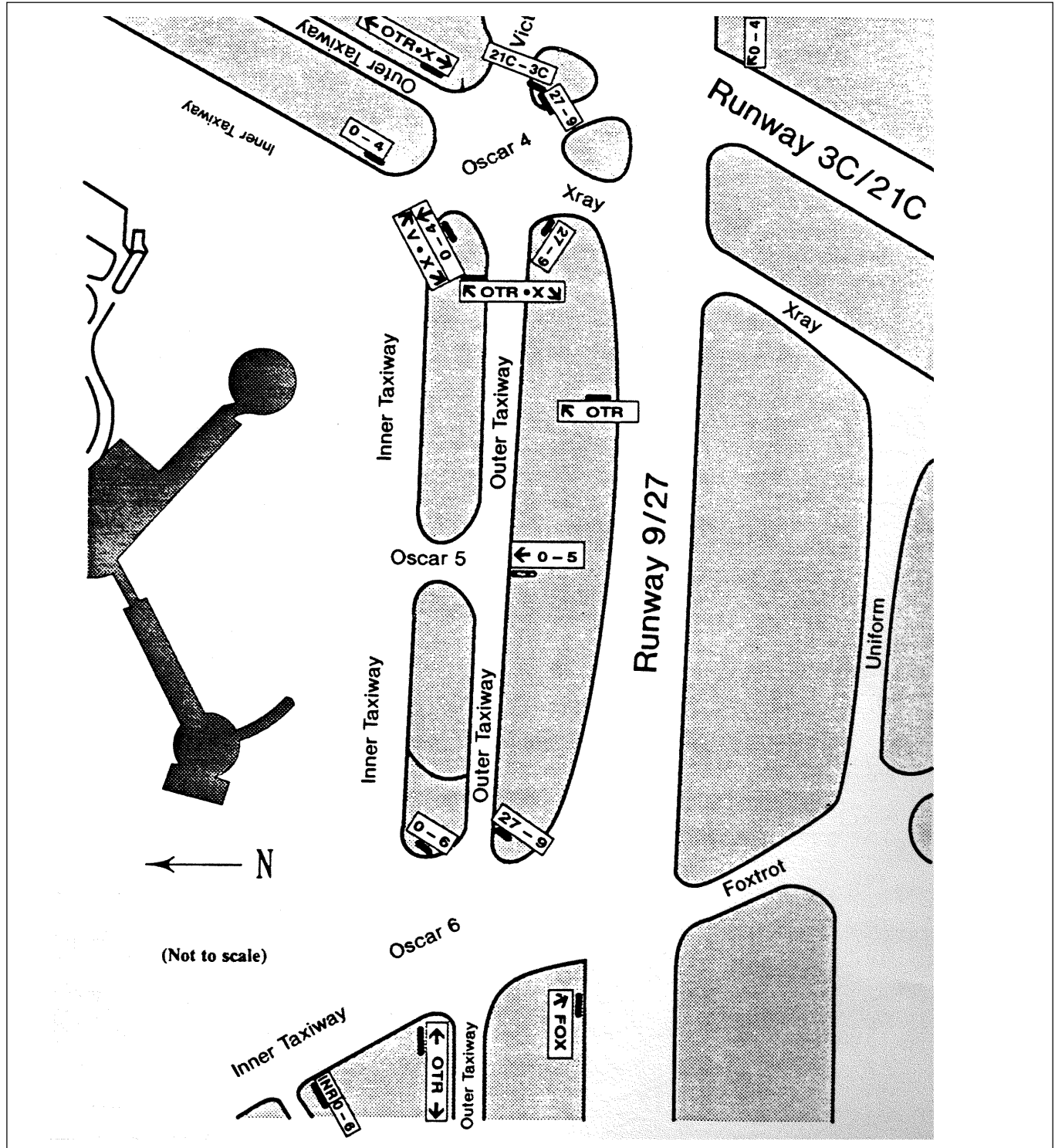


Figure 2. Detroit Metro taxiway signs in the Oscar 4, Oscar 5 and Oscar 6 areas.

reply, “Yeah, we’re cleared to cross.” The captain then asked, “Which way do I go? Right?” The first officer responded, “Yeah.”

The NTSB said that this conversation was representative of the entire taxi sequence — the role reversal in the cockpit. The captain was about to complete a direct order to the first officer to make a radio call to the tower concerning their predicament. Instead, the first officer interjected his statement that they were on runway 9. The captain believed him and resumed a subordinate role when he asked the first officer more questions as he taxied the airplane southeasterly toward the active runway.

At 1342:56, the captain evidently began to have real doubts about their location and said, “This, this is the active runway here, isn’t it?” The first officer, now a little less confident, said, “This is, should be 9 and 27. It is. Yeah, this is 9/27.” The NTSB report indicated that about this time, 1343:08, the airplane first entered the active runway although it had crossed the hold line for the runway earlier. Shortly thereafter, the captain apparently saw white lines that convinced him that they were not on a taxiway. He stopped the aircraft and set the parking brake.

At 1343:35, the captain gave a complete order to the first officer to, “Give him a call and tell him that, ah, we can’t see nothin’ out here.” The first officer did not comply with this order and, after a lapse of about 13 seconds, responded incorrectly to another ground control request for their position. If the first officer had obeyed the captain immediately, said the NTSB, the air traffic controllers might have taken more timely action to stop the Boeing 727 from taking off.

According to the CVR transcript, the captain then released the parking brake and began to angle off to the left of the runway as he began to have more doubts about their location. At 1344:35, for the third time, he told the first officer to call the tower for assistance saying, “Well, tell him we’re out here. We’re stuck.” The first officer still did not comply but he did respond inaccurately (again) with, “That’s 09.”

At 1344:47, 53 seconds before the collision, the captain finally asserted his authority. After two unsuccessful attempts on some unknown frequency or on interphone, he succeeded in informing the ground controller that they were on an [unidentified word on CVR] runway. Less than one minute prior to the collision, the captain had exercised his command responsibility. By 1345:14, the first officer was apparently convinced that they were

not only on a runway but that it was the active runway and so informed the captain. The captain relayed this information to the ground controller at 1345:17. It was not until 1345:33, seven seconds prior to the collision, that the ground controller ordered the flight off the active runway.

When the captain transmitted, at 1345:17, “Yeah, it looks like we’re on 21 Center here,” he was asked to confirm by the ground controller. The captain then stated, “I believe we are, we’re not sure.” Following the accident, the captain said that if he had been positive that he was on an active runway and that another airplane was bearing down on him, he would have taxied off the runway onto the grass. In this instance, he was sufficiently aware that something was wrong and he intentionally taxied to the edge of the paved surface of the runway.

In this accident, the NTSB thought the captain was correct in using the first officer for assistance but that overreliance on the first officer without using other available resources,

such as the compass and the airport diagram, amounted to a relinquishment of his command responsibilities.

Neither pilot had been provided with CRM training. Further, said the NTSB, it is unclear whether the airline’s CRM training (if it had been provided to this crew) would have properly addressed the CRM deficiencies displayed by this crew. To be effective, said the NTSB, CRM training should strike a balance between an appropriate manifestation of a captain’s command authority and leadership abilities in delegating responsibilities; a first officer’s ability to communicate effectively and carry out such duties; and the use of suitable resources to conduct a safe flight. The NTSB concluded that if these pilots had been exposed to a proper CRM training program, the captain might have taken sufficient action, including stopping the aircraft before reaching the runway and asking for help from the ground controller, after he recognized that the first officer was usurping his command authority.

## Preventive Measures Considered

Without giving any consideration to the ground controller’s activities, airport markings or other contributing factors, a review of the behavior of this crew traces a deadly chain of events. As in the case of so many other aircraft accidents, any action that would have interrupted and stopped that chain from continuing its growth could have prevented the accident.

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It is not difficult to understand how and why the captain allowed the first officer to usurp his authority given the facts that he was new to the airline's operations and somewhat unfamiliar with its procedures, or to understand the first officer's desire to demonstrate his competence by exaggerating his experience. What is more difficult to comprehend is why, as they approached the final minutes of their taxi route, the first officer failed to obey the captain's commands to call for assistance not once, but three times and why the captain did not immediately take the initiative.

The NTSB correctly questioned whether, if provided to both pilots, the airline's CRM training would have covered what appears to be a unique and peculiar cockpit situation. As stated earlier, most CRM programs appear to be designed around the concept that it is the captain's assumed overbearing behavior that must be addressed and not the first officer's attitudes and actions. This accident suggests that existing CRM programs should be reviewed so that use of role models and role-playing include overbearing, or overconfident, first officers.

With all of the variables involved in CRM, it is not likely that a one-day program can do anything more than pro-

vide a basic definition of what cockpit resource management is. To be more effective, CRM training programs need not only more time initially but periodic review to keep from drifting back to the older and less effective ways of managing the cockpit. ♦

### *About the Author*

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