Episode Book

EPISODE #5558

Landing on the Edge: Cork Fog to Carrier Decks

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SYNOPSIS

Daniel grew up next to Cork Airport's 7,000-foot runway, watching aircraft emerge from fog on a Cat Two ILS. His question: what's it really like to land when you're right up against the safe limits? From Boeing's "fly it onto the runway" technique and a sobering NTSB case where a crew touched down 4,242 feet past the threshold on a 7,001-foot runway, to the terrain quirks that make Cork uniquely challenging, this episode explores the gap between the calculated margin and the flown margin — and what happens when that gap closes to nothing on a carrier deck.

TRANSCRIPT



Corn

Here's the thing I keep turning over. You're in a heavy jet, you're on the glideslope, the fog is sitting on the runway like a wet blanket, and somewhere in the last fifteen seconds somebody has to decide exactly where those wheels touch. Not roughly. Exactly.



Herman

And that's Daniel's question, basically.



Corn

That's Daniel's question. He grew up in Cork, so he grew up next to a runway that's about seven thousand feet. Not eleven thousand. Cork gets fog, it gets wind, and it's got a Cat Two ILS, so he spent his childhood watching aircraft come out of weather that would make most people turn around. And what he wants to know is what it's actually like to land when you're right up against the safe limits. A heavy aircraft. Enough runway, but not a lot of it.



Herman

He asked a few things.



Corn

Whether the touchdown zone is so tightly prescribed that pilots can visually see when they hit the ground. Whether it's harder to land a 737 on a six thousand foot runway than an eleven thousand foot one, or whether once the calculations say it's viable it's just Tuesday for the pilot. And then he goes to the far end of the spectrum. Navy pilots on a carrier deck. He's watched the footage of the aircraft getting yanked out of the air by the arrestor cable, and he says it looks like there's no margin at all. His words: is it really possible to land not a meter past where you should, or a knot over? What do the tolerances actually look like in an environment where mere mortals are doing something that looks impossible?



Herman

That's a good arc, actually. Because Cork and a carrier deck are the same question at two different scales.



Corn

So let's start with the runway Daniel grew up next to, and work our way out to the sea.



Herman

The gap that matters here isn't the runway length. It's the gap between the calculated margin and the flown margin. The calculated margin is what the performance numbers say: this aircraft, this weight, this temperature, this runway, this braking action, and there's a legal number at the end of it. The flown margin is what actually happens in the last fifteen seconds, when a human being with hands and eyes has to put the main gear down in a specific place.



Corn

And those two things can disagree.



Herman

They can disagree badly. The numbers can say a landing is perfectly legal and the aircraft still ends up four thousand feet past where it was supposed to touch. That's not a hypothetical, that's an accident report.



Corn

Give me the Cork numbers, because Daniel's memory of his home runway is actually pretty good.



Herman

It is. Runway 16/34 at Cork is two thousand one hundred and thirty three metres. That's about seven thousand feet, forty five metres wide, grooved asphalt, seven and a half metre shoulders. The crosswind runway, 07/25, is only one thousand three hundred and ten



Herman (continued)

metres. Four thousand three hundred feet. That one's basically a strip by comparison.



Corn

And only one of the main runway directions has the good approach equipment.



Herman

Only Runway 16 has the Cat Two ILS. Runway 34 is Cat One only. The ILS on 16 is a three degree glideslope, reference datum height fifty seven feet. And the low visibility procedures kick in when the ceiling is below two hundred feet and the runway visual range is under five hundred and fifty metres, or visibility under eight hundred.



Corn

So Daniel's memory of "Cat Two ILS" is right, but it's directional. If the wind swings you round to the other end, you've got a much less capable approach.



Herman

Which matters at Cork more than at most places, because Cork is on a hill. Five hundred and two feet above mean sea level. And the aeronautical information publication, the AIP itself, contains a line you almost never see in an official document. It warns that the performance of automatic landing systems may be affected by the profile of the terrain under the approach to Runway 16.



Corn

Say that again, because that's remarkable.



Herman

The airport's own documentation is admitting that the hill under the approach path can degrade the performance of a system that's supposed to fly the aircraft down automatically.



Corn

So even the machine has to work harder at Cork.



Herman

Even the machine.



Corn

So what does it actually take to fly a 737 onto a runway like that?



Herman

Boeing's own technique guidance is refreshingly blunt about it. You aim for the aiming point markers. You keep that aiming point stationary in relation to the aircraft on the windscreen, which means if it's drifting up the windscreen you're going to land short, and if it's drifting down you're going to land long. Then you initiate the flare when the main gear is about fifteen feet above the runway, you increase pitch about three degrees, you bring the thrust to idle, and the manual's words are: do not float, but fly the aircraft onto the runway.



Corn

Fly it onto the runway. That's not a description of a gentle arrival.



Herman

It's the opposite. And this is the first misconception to kill. A smooth landing is not automatically a good landing. Ask any instructor. The line that circulates in training is that a firm landing in the touchdown zone is a good one, and a smooth landing outside the touchdown zone is bad, despite any comments from the cabin crew.



Corn

The cabin crew being the people who will absolutely mention it.



Herman

They will. But the touchdown zone is a defined thing, and that's the answer to Daniel's question about whether pilots can see when they hit the ground. It's not a guess. The touchdown zone is formally the first third of the runway, beginning at the threshold. There are markings for it, there are lights for it, and the aiming point markers sit inside it.



Corn

So the pilot has a visual target painted on the ground.



Herman

A visual target painted on the ground, plus a defined window in which touching down is acceptable. And the technique is built entirely around hitting that window, not around making the arrival feel nice.



Corn

Which is a strange thing to internalise if you're a passenger. You want the greaser. The system wants the firm one.



Herman

The system wants the firm one in the right place. And here's the case that shows why. There's an NTSB investigation into a landing on a seven thousand and one foot runway. Almost exactly Cork's length. The touchdown zone on that runway was two thousand three hundred and thirty four feet, and the touchdown zone markings and lights extended out to three thousand feet. The crew should have used those visual cues. They didn't.



Corn

And where did they touch?



Herman

Four thousand two hundred and forty two feet beyond the threshold.



Corn

On a seven thousand foot runway.



Herman

They used well over half of it before the wheels were on the ground.



Corn

So the calculated margin said the landing was viable. The flown margin ate the entire runway.



Herman

That's the whole episode in one accident report. The numbers were fine. The aeroplane was fine. The runway was fine. And the aeroplane still touched down more than four thousand feet past the threshold, which means the stopping distance available was a fraction of what the performance calculation assumed.



Corn

That answers Daniel's question about the touchdown zone being tightly prescribed. It is prescribed, it's marked, it's lit, and it can still be missed.



Herman

By a wide margin.



Corn

Now the other half of his question. Is it harder to land a 737 on a six thousand foot runway than an eleven thousand foot one, or once the calculations show it's viable, is it just Tuesday?



Herman

I'll be honest with you, I don't think there's a clean answer in the sources, and I'd rather say that than invent one. The evidence points in two directions at once.



Corn

Lay out both directions.



Herman

On the "just Tuesday" side, Boeing's technique manual treats it as a standardised procedure. Aim point, flare at fifteen feet, fly it on. It doesn't read like a special technique reserved for short fields. It reads like the technique, full stop. And the industry does operate short runways routinely. If you're flying into London City, or Florence, or half the regional airports in Europe, you're doing it every day.



Corn

And on the other side?



Herman

On the other side, the NTSB case shows that the flown margin can be blown even on a runway where the calculation was comfortable. And there's the Cork evidence, which is specific. In 2005 there was a public argument about why Cork kept losing flights to fog, and both sides blamed the other.



Corn

Who was arguing?



Herman

The airport director, Joe O'Connor, said Cork has the equipment and the landing aids to keep flights running in fog, and that for that to happen pilots must be properly trained to carry out specialist landings. That's the airport blaming pilot training.



Corn

And the pilots?



Herman

The safety director of the Irish Air Line Pilots' Association, Conor Nolan, said it's highly unlikely that a lack of pilot qualifications is the issue, and that there's a question over whether some aircraft are equipped to make a landing in bad weather. So the pilots' association blamed the aircraft equipment.



Corn

Two professionals, same airport, same problem, opposite diagnosis.



Herman

And that's the honest state of the "is it routine" question. Even the people inside the industry don't agree on whether the difficulty lives in the training or the hardware.



Corn

What does the terrain argument say? Because Daniel grew up there and he'd know the hill.



Herman

An Aer Lingus pilot, Michael McLaughlin, described it precisely. He said Cork airport is on a hill and its runway is seven thousand feet long, so the ground falls away very rapidly when you are landing, and the aircraft is going to think it is landing at a much more rapid rate than it actually is.



Corn

Unpack that, because it's not obvious.



Herman

A radio altimeter measures height above the ground directly beneath the aircraft. It doesn't know about the runway ahead. If the terrain under the approach falls away steeply, the aeroplane is descending through air that's a normal distance above a surface that's dropping. The geometry changes. And the automation, and the pilot's own read of the picture, are both being fed a rate of closure that doesn't match what's actually happening relative to the runway.



Corn

So the hill isn't just scenery. It's an input to the landing.



Herman

It's an input to the landing, and the AIP says so in writing. That's why Cork is such a good case study for Daniel's question. It's not just short. It's short, on a hill, in fog, with a Cat Two ILS on one end only.



Corn

And the disruption numbers back up that it's not a theoretical problem.



Herman

Met Éireann records for March 2005 show Cork and Knock had fourteen days of heavy fog. Dublin had one. Shannon had three. In 2004 Cork recorded one hundred and sixteen cancellations out of fourteen thousand two hundred and seventy arrivals, which is eight tenths of a percent. But in March alone, two point one percent of flights were disrupted.



Corn

So the bad month is nearly three times the annual rate.



Herman

Which tells you the problem is concentrated in exactly the conditions Daniel remembers. Fog and wind.



Corn

So that's the runway Daniel grew up with. Now let's go to the extreme end of the spectrum. The carrier deck.



Herman

The carrier is where the flown margin gets compressed to the point where it stops looking like a margin at all. There's a description in a Lehigh engineering thesis that calls a carrier landing essentially a precisely controlled crash on a small moving target. And the Skyhawk Association puts it even more plainly: in reality, it isn't even a landing. The aircraft is flown onto the deck.



Corn

Flown onto the deck.



Herman

There's no flare in the airline sense. There's no gentle settling. You're establishing a descent rate and you're putting the aeroplane on the steel, and the arrestor gear does the rest.



Corn

Now the thing Daniel actually asked about, which is the tolerances. He wants to know if it's really possible to land not a meter past where you should.



Herman

The answer is that the vertical tolerance is defined, and it's tiny. The optical glideslope, the meatball, the Fresnel lens on the left side of the deck, gives the pilot a vertical window of only plus or minus zero point seven five degrees from the optimum glideslope. That's the T-45 carrier qualification manual.



Corn

Three quarters of a degree doesn't sound like much.



Herman

It isn't. But here's the number that makes it real. The lens cell, the individual light bar in the meatball, subtends a certain thickness at a given distance. At three quarters of a mile out, one cell is about twenty seven feet tall in the pilot's view. At the ramp, it's two point two feet.



Corn

Two point two feet.



Herman

So near touchdown, being one cell off the ideal path means being roughly two feet off. That's the answer to Daniel's question. It's not that there's no margin. It's that the margin is measured in feet at the point where it matters.



Corn

And the glideslope angle itself changes depending on conditions.



Herman

The basic glideslope is three and a half degrees. It goes to four degrees for high wind over the deck, thirty eight knots or more, or for small decks where the hook-to-ramp clearance is getting close to the ten foot minimum.



Corn

Hook-to-ramp clearance. Explain that.



Herman

That's the gap between the tailhook under the aircraft and the back edge of the deck, the ramp, as the aircraft crosses it. If the hook is too low, you hit the ramp instead of the deck. On the old Essex class small decks, the twenty seven C configuration, they used a four degree glideslope to get about ten feet of hook-to-ramp clearance. On the Forrestal class big decks, three and a half degrees, about fourteen feet.



Corn

Ten feet is the floor.



Herman

Ten feet is roughly the minimum. The Lehigh thesis notes the landing signal officer will insist on much tighter bounds than the published ones, including clearing the ramp by at least seven feet.



Corn

Seven feet of clearance between the hook and the back of the ship.



Herman

And that's the LSO's job. He's standing on the deck watching the approach, talking to the pilot on the radio, and he can wave the aircraft off if it's going wrong.



Corn

Now the target. Where are they actually trying to put the aeroplane?



Herman

The target is the three wire. Pilots aim for the middle of the wires, which is two or three depending on the ship's configuration. The one wire is dangerous, because catching the one wire means you were low and close to a ramp strike.



Corn

So being short isn't a small error. Being short is the thing that kills people.



Herman

And every landing is graded on a competitive scale. There's a grade called OK Underline, which is a perfect pass, worth five points. It's so rare that naval aviators often go hundreds of carrier landings without ever receiving one.



Corn

Hundreds of landings.



Herman

Not one.



Corn

What does the human side of that look like?



Herman

There's a former EA-18G Growler pilot, Adam Daymude, who also served as an LSO. His line is that they need quite a bit of margin for error because it is god-damned difficult to keep the plane on a perfect glideslope. And he describes a ramp strike he witnessed. It ripped the main landing gear off, but by some miracle the aircraft still stopped on deck. And he says there were three LSOs on the radio with the pilot, all of them screaming power, power, power.



Corn

Three landing signal officers screaming the same word at the same time.



Herman

Because there's nothing else to say. If the aircraft is sinking toward the ramp, the only correction available is more thrust, and it has to happen now.



Corn

What happens after the wheels touch?



Herman

The throttles go to military power, essentially full, and they stay there for about three seconds. The pilot is holding full power in case the hook misses every wire and the aircraft bolters, or in case a cable snaps. You're ready to fly away the entire time you're decelerating.



Corn

So the landing isn't finished when the wheels touch. The landing is finished when the aeroplane stops.



Herman

And the aeroplane is being flown, not parked, right up to that point.



Corn

Now Daniel's actual question about the tolerance. Can they land not a meter past where they should?



Herman

I want to be careful here, because I don't think we can answer it with a number, and I'd rather flag that than make one up. The plus or minus zero point seven five degree window and the two point two foot cell at the ramp tell you the visual tolerance is measured in feet. But the exact touchdown dispersion, the figure that says pilots land within X feet of the target wire, that isn't in anything I could find.



Corn

So the honest answer is that the tolerance is defined in degrees and in feet of clearance, and the touchdown scatter itself is something we'd have to guess at.



Herman

I'd rather not guess. What we can say is that the grading system exists precisely because the scatter is real. If every pass were identical, you wouldn't need an OK Underline.



Corn

You'd just have landings. I want to go back to something. Daniel asked whether the touchdown zone is so tightly prescribed that pilots can visually see when they hit the ground. On the carrier, the answer is almost inverted. They can see when they hit the ground because the ground arrives.



Herman

The deck arrives. And there's no flare to soften it. The aircraft is flown into the steel at a defined descent rate, and the hook does the arresting.



Corn

Which brings the two halves of this episode together. Cork is a seven thousand foot runway on a hill in fog, and the pilot has a marked zone and a defined technique and a legal calculation. The carrier is a moving deck in the ocean, and the pilot has a meatball and about two feet of visual tolerance at the ramp.



Herman

Same problem, different scale. In both cases the calculation is the easy part. The flown margin is where it lives.



Corn

Hilbert, you've been quiet back there. You've actually done some of this, haven't you?



Hilbert

I spent two years on the ramp at a regional field. Smaller. We had one runway, and it was short enough that the pilots coming in on the mail run used to talk about it before they even started the approach.



Corn

What did they say about it?



Hilbert

Nothing dramatic. One of them would just say the number. Seven thousand and forty feet, and then he'd say the wind, and then he'd go quiet. That was the whole conversation.



Corn

You watched them land.



Hilbert

I watched them land in fog more times than I can count. And here's the thing that stays with me. After one of them, a bad morning, visibility down near the minimums, the aircraft came off the runway and taxiied in, and I was standing by the marshalling point. The pilot shut down, and I saw his hands on the yoke.



Corn

Shaking?



Hilbert

Shaking. Just enough that he put them in his lap rather than on the yoke. And he sat there for a minute before he got out.



Corn

You'd expect a pilot who'd just done something difficult to look pleased with himself.



Hilbert

He looked like a man who'd been holding his breath. And I'd say this, if it's worth anything. The hosts have been talking about the calculated margin and the flown margin, and I agree with all of it. But I'd push back on one small thing.



Herman

Go on.



Hilbert

The idea that the pilot is just doing their job. The calculation is the job. The landing is the performance. Those are two different things, and the second one costs something. The shaking hands are the cost. That's not a malfunction. That's the job working.



Corn

Say more about that.



Hilbert

We could see the touchdown zone markers from the ramp. Painted on the asphalt, right where the manual says they should be. And we knew, standing there, when a pilot had floated past them. You can see the wheels come down late. You don't need a report to tell you. The aeroplane is still in the air when it should be on the ground, and everybody on the ramp knows it at the same moment.



Herman

The pilot knows it too.



Hilbert

The pilot knows it first. That's why the hands shake.



Corn

The routine is the calculation, and the landing is the thing you can't fully rehearse.



Hilbert

You can rehearse it. You can rehearse it a thousand times. And on the thousand and first, the fog is a little lower than forecast, and the runway is a little wetter than the report said, and you're still doing it for the first time.



Corn

That's the thing the numbers can't carry.



Hilbert

The numbers are fine. The numbers were always fine. Somebody still has to put it on the asphalt and then sit in the seat afterwards until their hands stop.



Herman

The touchdown zone markers. You said you could see them from the ramp.



Hilbert

Every day. They're painted on the surface. And you learn to read them the way you read anything else on a ramp. You know where the aiming point is. You know where the zone ends. And when an aeroplane comes down late, you see it before the tower says anything.



Corn

There's something in that. The touchdown zone isn't an abstraction. It's paint on asphalt, and there are people standing at the edge of the runway who can see whether you hit it.



Herman

Which is exactly why the instructor line lands the way it does. A firm landing in the zone is a good one. It's not a compromise. It's the objective.



Corn

The smooth landing outside the zone is a failure that happens to feel nice.



Herman

That's the whole inversion. The passenger's metric and the aeroplane's metric are opposites.



Corn

Let's land this properly. There are two things we couldn't answer. The first is the carrier touchdown dispersion. We've got the glideslope window, we've got the two point two foot cell at the ramp, we've got the seven to ten foot hook-to-ramp clearance, and we still don't have the figure that says how far from the target wire a pass typically ends up.



Herman

The second is the "is it just Tuesday" question. Boeing's manual says it's a standard procedure. The NTSB case says the flown margin can still be blown. The Cork argument in 2005 had the airport blaming training and the pilots blaming equipment. That's not a settled question, and I don't think it settles just because we'd like it to.



Corn

What I'd watch is where the margin moves next. As automation gets better, the calculated margin and the flown margin get closer together, because the machine does the flying. But Cork's own documentation already warns that the terrain profile can degrade the automatic landing system. So the automation doesn't remove the problem. It relocates it. It moves the risk from the pilot's hands to the terrain model inside the box.



Herman

It moves the question of who's responsible when it goes wrong.



Corn

Right. Because if the machine flies it and the machine gets it wrong, there's no pair of shaking hands to point at. There's just a line in a manual about terrain profiles.



Herman

Which is the thing Hilbert handed us. The margin isn't a number on a page. It's a person sitting in a seat afterwards, waiting for their hands to stop.



Corn

The next time you're on an aeroplane coming down through fog, and you feel that firm arrival and the cabin crew do that little intake of breath, remember that the firm one in the right place is the one they were aiming for. And remember the two point two foot cell, and the seven feet of clearance between a tailhook and the back of a ship, and the man on the ramp who could see from the ground whether you made it.



Herman

Thanks to Hilbert Flumingtop, our producer. This has been My Weird Prompts.



Corn

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Herman

We'll be back soon.