

Flight Test *Safety* Fact



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In This Issue

Root Cause – Three Big Things about “Root Cause” and Dan Javorsek’s Random Walk
FTSC Announces new Chairman – Huff says goodbye, and Turbo runs with the baton
Subscribe to our Podcast – The last two podcasts got rave reviews from a major OEM

Root Cause

Mark Jones Jr.

“Come into my office” he said. “Let me close the door behind you, because I don’t want anyone to hear me say this.” What I was about to hear about the crash of the A-29 would leave me speechless, sitting with my mouth gaping open.

Since May 15th, four US Air Force fighter aircraft have crashed. As I write this, that’s just over two months ago, since the “surge” began. The first was an [F-22 based at Eglin AFB](#). The second was four days later, [an F-35](#), also at Eglin AFB. An [F-16 crashed near Shaw AFB](#) killing its pilot on June 30. Then on July 14, [an F-16 crashed at Holloman AFB](#). This morning, as I sat with other pilots and considered these events, we wondered aloud what factors may have contributed. Someone mentioned “[Pilot Training Next](#)” and pondered whether or not we could trace any threads from recent accidents to the training pipeline. “Readiness,” or currency or proficiency—pick a word to describe recency and experience—was another obvious suggestion. It’s highly likely that the corona virus had a direct impact on pilot proficiency, as the number of US Air Force training flights have dropped significantly. Some areas have felt the impact more than others, and this is true globally as well: Freight/cargo airlines have continued to fly while many passenger airline pilots are brushing off a lot of dust, for example.

The interesting thing about the conversation was the hypothesis that wound all the way back to the mishap pilot’s initial training. Is it possible that something in the training set off a chain of causal events? Contrast that with the relatively recent effects of coronavirus on proficiency. That temporal antinomy, the recent and the distant, makes me pause and utter an audible “hmm.”

Root Cause

We are all familiar with the term, which is commonly defined something like this: “A root cause is an initiating cause of either a condition or a causal chain that leads to an outcome or effect of interest.” Perhaps this definition is too simple.

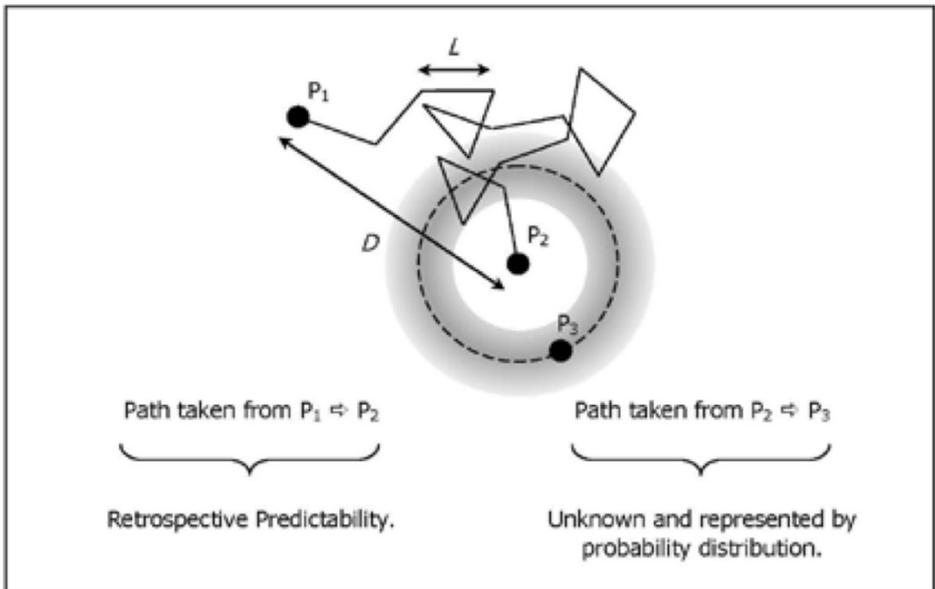
Dan “Animal” Javorsek has something to say about determining root cause. In particular, he believes that we tend to make overly-simplistic conclusions in post-mishap reviews and accident investigations, as he states in his own words below.

“...when viewed in reverse, the event appears straight forward to predict. To best demonstrate this...it is convenient to consider a single particle of pollen floating in a glass of still water. After several hours of random collisions with adjacent water molecules, the pollen will have traveled about an inch under normal conditions.”

Most of us are aware that the Brownian motion Javorsek describes is the result of many, many “random” collisions of microscopic particles, and it is known as a random walk. Still, he believes we tend to look at what happened (the path from P1 to P2 in the figure below) and “explain” each of these collisions, but predicting future collisions of these molecules and the subsequent path is impossible. Javorsek expounds:

“In contrast, an attempt to predict the future location of the pollen must account for all possible paths and collisions. Prediction becomes impossible due to an unrealistic number of calculations far greater in scope than those associated with the aforementioned observation assessment.”

It would require us to evaluate all possible random walks in the area contained within the dotted line (P3). There are an uncountably infinite number of such random walks. That’s a really big number.



I think Javorsek’s most powerful statement is one that gets buried in his discussion: “As a result, mishap boards often dissect events that happened and forget to consider those events that could have happened but did not. This artifact of the determinism

mindset can result in the loss of clues that may be extremely vital to our assessment of overall system robustness and fragility.” Perhaps, when an investigation identifies “root cause,” it has merely found a cause common to all flights, those that end in a mishap and those that don’t. Or it conflates correlation and causation. In both cases, we tend to accept preponderance of the evidence rather than proof beyond a reasonable doubt.

To connect this statement with the events mentioned in the introduction, I would ask this: “What’s wrong with the system—why are we still crashing airplanes at such an alarming rate?” But this question only scrapes away the topsoil and does not get to root cause. If we believe Javorsek, who says, “Fatal catastrophic mishaps are, by definition, not the result of well-behaved variables,” then what can we do to dig deeper? How many times must we ask “why,” and where do we go from here?

Route Cause

There are three things to which I want to draw your attention, three paths I hope you explore after reading this very, very brief introduction to Javorsek’s ideas. The first is to steer you towards Animal’s corpus of safety papers. The second item directs you to a recent series of newsworthy events in “urban mobility” that may not have caught your eye, and the final journey is a wandering one that explores the wreckage of an A-29 crash in New Mexico and the subsequent accident report. Each appears below.

I. Read Animal’s Papers

The quotes in this article come from “Cultivating the Assertive Skeptic: A Proposal for Modernizing Flight Test Safety to Address Human Agency” (SETP Cockpit, January-June 2016, pages 75-95), but Javorsek has presented several times and written several compelling, stand-alone articles about flight test safety: 1) another in SETP Cockpit, “Test Planning and Risk Mitigation Strategies for Complex Aircraft Systems” by Dan Alix and Dan Javorsek (July-December 2018, pages 16-36); “Modernizing Flight Test Safety to Address Human Agency” in [ITEA Journal of Test and Evaluation, 2016, pages 325-332](#). He has some fascinating critiques of the two-dimensional risk matrix as well.

II. Going Places with Urban Mobility

The second scenic route I hope you explore is the recent news in Urban Air Mobility—or as Starr would call it, Advanced Air Mobility—some of which directly affects at least one of our readers in New York. According to [Aviation Today](#), “Though much progress has been made toward creating and testing unmanned traffic management systems that will enable safe integration of drones into the national airspace, little work has been done to identify and prepare for potential system faults outside of aircraft malfunctions.”

A team of companies and the FAA have begun to explore the range of possible outcomes and attempt to predict the path of pollen particles, as it were. In this case, I mean the complex system that supports UAM and its possible failure modes. That announcement followed the [recent release of the UAM ConOps by the FAA](#). You can read more here:

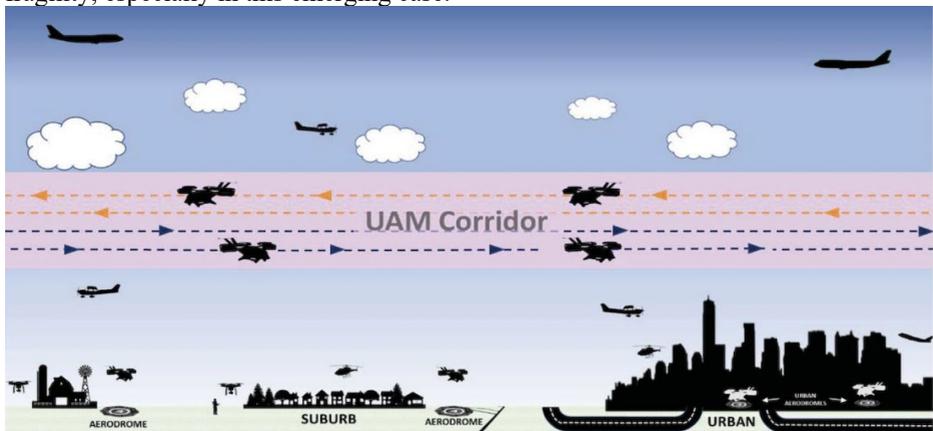
1) FAA publishes first concept of operations for urban air mobility
<https://evtol.com/news/faa-conops-urban-air-mobility/>

2) Direct link to the document:

https://utm.arc.nasa.gov/docs/2020-03-FAA-NextGen-UTM_ConOps_v2.pdf

3) FAA's New Urban Air Mobility ConOps Raises Questions
<https://www.ainonline.com/aviation-news/general-aviation/2020-07-15/faas-new-urban-air-mobility-conops-raises-questions>

This is a rapidly evolving topic, and as I mentioned, we have colleagues in these spaces. So I hope you get the chance to dig into those stories. As we navigate the days ahead, we have an awesome responsibility, and our understanding of the concepts Javorsek describes may be extremely vital to our assessment of overall system robustness and fragility, especially in this emerging case.



An image from FAA's Concept of Operations for Urban Air Mobility

III. What should “we” do when we fail to find Root Cause?

The question stands on its own, but I want to link it back to the introduction, to the conversation I had behind a closed door. That wasn't the only time I was dumbfounded—I've had many conversations like the one described. So many people that I've spoken with admit that the Root Cause of the A-29 crash has not been determined, and, more importantly, that we have not taken any steps to prevent it from happening again.

According to the accident report, “One of the major findings was as follows: ‘Wrong Choice of Action During an Operation (AE206) is a factor when the individual, through faulty logic or erroneous expectations, selects the wrong course of action (Tab BB-50). The [mishap crew] made a wrong choice of action when they decided just prior to the initial weapon delivery to accept a slower than normal airspeed and proceed with the

planned weapon release followed by a 180-degree turn in the direction of the heavy right wing, without compensating for the asymmetry (Tab GG-3 to GG-5).”

We should agree that compass heading has nothing to do with this accident. A turn of 180-degrees should not result in a fatal accident.

I sought further clarification from the convening authority about the mishap. He indicated that the aircraft was within the flight manual envelope when it began the maneuver described above. The lateral asymmetry was normal. The airspeed was above stall speed. No limitations were exceeded.

The question that remains unanswered is this: “Why did the aircraft depart controlled flight?” To my knowledge, the US Air Force has taken no additional steps to answer this question. An airplane should not depart controlled flight in the normal part of the flight envelope. We can speculate that perhaps the flight envelope is not adequately described, but shouldn’t that raise more questions in our minds? If I were asked to fly an A-29 today, how do I know that the risk has been addressed?

This is the meat on the bones of this third item. Perhaps, one could argue, we have an ethical obligation to ask these questions until they are answered. Is there a formal way to request additional inquiry, additional investigation, additional reporting? Is there a formal way to request a correction to the accident report? This line of questioning applies to all flight test—including the woefully inadequate accident report on the crash of the Kitty Hawk Heaviside. I hope that we can, as a community, work towards satisfying answers to unanswered questions about root cause.

Conclusions and Recommendations

If you do nothing else, I hope you conclude that reading Animal’s papers and news about version 2.0 of the FAA UAM ConOp are both useful activities.

If you also conclude that we have much to talk about, that we ought to explore these ideas more, I recommend that you send me an email, and we will share your thoughts with readers of the Flight Test Safety Fact. I’m always open to input and suggestions.

FTSC Announces new Chairman

On 16 July 2020, the Flight Test Safety Committee bid farewell to outgoing Chairman Tom Huff and welcomed incoming Chairman Art Tomassetti. Tom served from 4 May 2017 to 16 July 2020 and will now move into the role of Executive Advisor. Art “Turbo” Tomassetti joined the FTSC in 2019. He is a Past President of the Society of Experimental Test Pilots. Turbo’s served 28 years in the USMC and worked six years as a program manager at Lockheed Martin. You can see Turbo in his Superman shirt and read his full bio on the Flight Test Safety webpage: <http://flighttestsafety.org/about-ftsc/directors/77-about-ftsc/board-of-directors/193-art-tomassetti>.

FTSC – A Chairman’s Journey

Tom Huff

It was a distinct honor to take the reins of the Flight Test Safety Committee (FTSC) in 2017 from Mr. Jerry Whites, a household name in transport aircraft development and flight test safety advocacy. There were big shoes to fill from a trusted mentor, one that truly cared about the flight test community and making flight test safer. The august group that comprises the FTSC represents the spectrum of flight testing to include defense, commercial and general aviation. We even have a consistent NASA and FAA presence. Collectively, we thought it important to reaffirm our heritage as a tri-organization that includes Society of Experimental Test Pilots (SETP), Society of Flight Test Engineers (SFTE), and the American Institute of Aeronautics and Astronautics (AIAA), just as it was when the FTSC was conceived in 1994. Hence, we include all three organizations on our logo and maintain our longstanding partnership and collaboration with these key entities.

The Flight Test Safety Workshops (FTSW) are considered the marquee event for the FTSC, and boosting content quality was a strategic focus. Recent North American Workshops have seen excellent attendance and yielded positive feedback that we are providing relevant and impactful information that testers can apply within their respective organizations. We also set a goal to resurrect the European FTSW that has been dormant since 2015. As we started 2020 with great momentum from the 2019 FTSW in Charleston, who could have imagined the impact of COVID-19? Feeling the need to sustain FTSC outreach and safety promotion, the FTSW for 2020 shifted to a virtual event, with attendance numbers double that we typically see in-person. Clearly, we missed the comradery, networking and lesson sharing at a face-to-face event, but unprecedented times require adaptable response. The European FTSW also fell victim to COVID-19 right behind the difficult decision to scrub the SETP Symposium and Banquet. Disappointingly, kick-starting this important workshop “across the pond” will have to wait until 2021.

The committee was also dedicated to providing useful resources and guidance material on the flighttessafety.org web site. Sadly, many of these resources evolved from tragic accidents and were in response to NTSB recommendations. In my view, one of the most important references hosted on the web site is the operational guidance document – developed after the fatal G VI flight test accident in 2011. This concise guide covers the waterfront in terms of recommended practices to establish necessary safety functions and processes for a test organization. Most recently, we completed the airshow guide that captures all the previous work of the SETP airshow working group and adds further considerations for test organizations that may be called upon to perform these high-risk public events. And we even included COVID-19 operational consideration references that can aid organizations in sustaining or resuming operations with the latest health guidelines adopted to our unique environment.

One of the things I'm most proud of is the Flight Test Safety Fact newsletter. Our editor, Mark Jones Jr., deserves the credit for launching the monthly editions to extend our safety promotion communications and stimulate discussion on complex and perhaps controversial subjects. Mark has done an incredible job keeping the creative juices flowing and soliciting content that is fresh and relevant. Complementing the newsletter is the Flight Test Safety Podcast hosted and produced by Art "Turbo" Tomasetti. Turbo brings interesting topics each month with the convenience of easily accessible podcast channels. Of course, all of this is archived on the flighthttestsafety.org web site in addition to videos of all the workshops. Feel free to consume all this goodness, at your leisure.

You might be thinking: how are we doing in flight test safety? That certainly was on my mind when I started my FTSC Chairman journey. In preparation for one of the workshops, I catalogued accidents starting with the G VI in 2011. Full disclosure: I'm quite familiar with this accident and even escorted the families of our deceased colleagues and friends to the NTSB public meeting in Washington, DC. I started with this accident so no one could accuse me of bias... Over the next 7 years (up to the 2018 FTSW), the news wasn't good at all: thirteen test-related accidents; seven fatal, with 22 lives lost. We needed a call to action! We briefed this abysmal safety record at every flight test event we could, including SETP's Symposium and Banquet. Things got worse over just 18 months, adding nine more accidents, four fatal, with an additional 7 lives lost. A safety stand-down was certainly in order...

These avoidable tragedies provided ample stimulus for the FTSC to consider a renewed focus on the basics as well as amplifying safety promotion and outreach. Nothing was off the table when debating the operational guidance mentioned earlier and other recommended practice resources that were developed and offered to the test community. Let me not forget to mention these resources are FREE. I wish I could say the hard work is done but the bread won't rise without the leadership yeast. None of these recommended practices and tools – including Safety Management System (SMS) - will yield satisfactory results unless organizational culture is established that is "positive." Hopefully, no explanation is needed to characterize "positive safety culture."

I distinctly remember former SETP president and one of the original FTSC founders Billie Flynn declaring: "there are no new lessons to be learned in flight test." After nearly two decades of attending SETP symposia and workshops, I can't help thinking he's right. Certainly, the accidents and incidents since 2011 didn't produce any new revelations. With the NTSB taking an interest investigating flight test accidents, you can count on unpleasant discoveries about supervisory and organizational factors if you "bend metal." These are correctable and the operational guidance section on SMS says it best: "The primary challenge is to ensure company top management is fully supportive of the SMS and embraces the necessity of establishing a safety culture which provides the focus and stimulus for continual safety performance improvement."

Let me step off my soapbox to highlight that there are lots of exciting new developments in technologies, air vehicle design, and system capabilities that are underpinned by test teams executing with safety and precision. Perhaps we've turned a bit of a corner?

I'm pleased to announce that Turbo will be taking the helm as the next FTSC Chairman. The committee couldn't be in more capable hands. I salute my FTSC colleagues and offer a heartfelt "thank you" for the extraordinary support and dedication in achieving our objectives. I'd be remiss if I did not mention the incredible support provided by SETP/SFTE headquarters staff. Susan Bennett, Laurie Balderas, Paula Smith (now retired), and Claude Pasquis; the motive force for success, second-to-none. An incredible journey it was....

In your service,

Tom Huff

Subscribe to our Podcast

Over the past two months, you heard Turbo interview Nancy Leveson, the brains behind STPA. If you still don't know what STPA is, listen in. At least one member from a major OEM shared rave reviews, as they try to educate and implement in their operation.

I also know for a fact that at least one Board member took advantage of the STPA workshop too. During his review of this edition, he mentioned that STPA talks about Root Cause as well. So the seeds are getting planted and being watered in many ways.



Also, please subscribe to the Flight Test Safety Podcast on the [Apple](#) or [Google podcast app](#). You can also navigate directly to the recording in [a web browser](#). You can leave comments on these platforms. Last, but not least, tell a friend: Help us *Reach Everyone*. Read [here](#) about Reach Everyone.



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