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How Pilots Represent Risk

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Pilots are front-line operators in a system, civil aviation, which is inherently risky. For good reasons, much effort has been devoted to the tasks of creating objective measures of risk and of devising systems of risk management in aviation as well as other process industries. It is commonly assumed that risk perception and risk management are elements of pilot decision making. But what do we know about how pilots represent risk? An understanding of how pilots make decisions in the presence of risk or under conditions of uncertainty could surely benefit from a better understanding of how pilots represent risk.

It may seem that the risks of flying are obvious, but risk is intangible. The perception of risk therefore implies the construction of representations of risk. Mostly we do not notice the work that goes into the creation of representations of intangible entities such as risks. What counts as reckless behavior? How do operators judge that a course of action is risky or prudent, cautious or over-cautious? These judgements are not made by reference to the properties of the event alone, but in relation to community standards and to the outcome of a course of action. Institutions provide the context within which behavior of the culturally appropriate level of caution/riskiness can be exhibited and justified. Culture provides the resources to make the intangible tangible, the invisible visible. Different pilot communities, i.e., scheduled flag carriers (FAR part 121), general aviation (FAR part 91), and military aviation have different cultures, different regulations, different standards of recklessness/cautiousness, and different perceptions of acceptable risk. In this paper I use interviews with airline pilots as evidence about the ways that professional pilots represent risk.

In collaboration with a major U.S. airline we[1] are conducting a longitudinal study to investigate the processes by which pilots acquire expertise in the operation of the Airbus A320 airplane with particular emphasis on the operation of the autoflight and flight management computer systems. We are particularly interested in discovering how pilot's understanding of flight deck automation develops over the course of initial training and through early stages of operating experience.

[1] The project described here is conducted by myself in collaboration with Dr. Barbara Holder, a postdoctoral researcher in my lab.

We interview pilots flying the A320 for a major U.S. airline at regular intervals. The initial interview was conducted during the pilot's the first week of training. The second interview occurred after the pilot's initial operating experience (IOE, an evaluation period flown with specially qualified check airmen[2]). Subsequent interviews were conducted at 6 months, 12 months, and 18 months of operational experience (also called flying "on the line").

The initial interview questions were designed to probe for the preconceptions about the airplane that pilots bring to training. We also collected experience data and asked pilots about their impressions of the first few days of training. In Post-IOE interviews we probe specifically for training issues, particularly what they thought was lacking in their training and areas they didn't understand. In subsequent interviews we probe for how they use the automation when they fly and how they use the automation to handle difficult flight situations. We ask pilots to describe the last leg they flew and how they used the automation in all phases of flight. We found that reviewing the last flight flown provides the pilots with a rich context for talking about automation use and areas of difficulty. We also observe pilots in the cockpit (from the jumpseat) during normal revenue flights to assess how pilots use the automation in flight. The jumpseat provides an opportunity to talk with the pilots while they fly[3] and it provides a rich setting for discussion about autoflight functioning. We use field notes from jumpseat observations to complement pilot descriptions in the interviews.

While the interviews were conducted to collect data about how pilots represent the behavior of the autoflight system, they also present an opportunity to examine how pilots represent risk. I examined 10 normal line interviews with pilots learning to fly the Airbus A320 (four after 6 months of experience flying the airplane, four at 12 months, and two at 18 months). I also examined and gave special attention to four other interviews. The first of these is a 6th month interview with a pilot who experienced indications of cargo fire, followed by an in-flight engine shutdown while diverting to an unfamiliar airport. The second and third are two interviews (at about 9 months of experience) with a pilot who encountered a high-altitude shear (mountain wave) that caused the airplane's automatic overspeed protection to engage[4]. The fourth is an 18th month interview in which the pilot describes a bird strike on takeoff followed by excessive engine vibration with an immediate return to landing. I gave these four interviews special attention because the events described in them involve much higher levels of risk than normal operations.

In order to find representations of risk in the interviews, I created the following procedure and applied it to the interviews:

1. Read the interview and use my expertise as a pilot[5] to identify statements that contain implicit or explicit reference to risk.
2. Change the font color (to red) of the statements identified in step 1.
3. Copy the statements one at a time into a new file, sorting them into groups on the basis of the type of risk being described.
4. As the risk topic groups are being formed, identify and describe the risk condition and the possible dangerous consequences of that condition.
5. Highlight (in **black bold**) the risk conditions and use them as section headings for the collections of statements from the interview.
6. Re-read the statements and highlight (in **red bold** font) key words that refer to elements of risk or concepts that are used in the construction of the risk concept.

[2] The IOE period ends when 25 hours of operational flight time or six legs have been logged.
[3] All in flight conversations abide by the constraints of safety and sterile cockpit rules.
[4] An analysis of the mental models used by this pilot to construct an understanding of the behavior of the automatic protections is presented in Hutchins & Holder, 2000.
[5] I hold a commercial pilot certificate for single and multiengine airplanes, instrument airplane, and a type rating in the Cessna Citation business jet. I have also completed training programs for the Boeing 747-400 and the Airbus A320.

7. Review the statements and the highlighted words and phrases, creating a commentary that explicitly describes the resources that are used in the construction of representations of risk. (An example of the output of this procedure for the first mountain wave interview is included as appendix A.)

Represented Risks:

The table below describes the risks that are represented in some form in the interviews. Since the interviews were not focused on risk, these are all what we might call ‘incidental’ description of risk. When I began the analysis I had no strong expectations about the extent to which the interviews would contain representations of risk. I was quite surprised by the quantity and richness of these representations. I should emphasize that this paper is about how pilots represent these risks, not about the risks themselves. In this paper, I can only present a small sampling of the observed representations.

Where several conditions lead to the same sort of risk, I have collected the risks into categories. For example, a number of conditions may lead to an unstable approach. An airplane may come to harm during an unstable approach by stalling or impacting the terrain short of the runway. The unstable approach may also lead to a range of unwanted landing outcomes including landing short, landing long, hard landing, tail-strike, loss of control in the flare, and loss of control on rollout. Because the pilots did not explicitly describe these particular outcomes, I have used the umbrella heading ‘unstable approach’ to label the risk associated with the described conditions.

Some of the risk conditions listed below were described by pilots as having actually happened to them or to pilots they knew. Others were presented as counterfactual conditions that did not occur, possibly because they were prevented from occurring by risk management measures. Counterfactual conditions are indicated with a ‘*’ in front of the locator tag[6]. For example, the notation

- Ground-speed mini thrust surges [102:3:13]

indicates that pilot 102 reported in an interview after 18 months on the line that he experienced thrust surges while using ground-speed mini mode. The notation,

- Speed target too low followed by TOGA lock *[102:3:13]

indicates that in that same interview pilot 102 described the risk of, but did **not** experience, low speed targets on approach followed by TOGA lock leading to an unstable approach.

The right hand column of table 1 presents some of the key words used by pilots when representing these risks. These words are not the full story on how pilots represent risk, but they do give a sense of the sort of language pilots use.

[6] The location of the risk representation in the corpus is indicated as follows: [pilot-id: interview: transcript page].

Risk	Representation key words
Unstable approach due to:	
Autothrust engages wrong speed target on single-engine approach [111:2:10]	Already a handful of airplane. No reason to put up with that extra monster
Ground-speed mini thrust surges [102:3:13]	It’s a pain in the butt
Speed target too low followed by TOGA lock *[102:3:13]	It’s gonna do weird things to you
False glideslope intercept [113:1:7]	Glad I saw it in IOE, versus on my own
Unexpected thrust increase on approach in bad weather [114:1:10-11]	What!? Why’s it doing that?
Overrun on landing due to speed too high at touchdown *[102:3:12-13], *[110:1:7]	Gets a little hairy, We were high, hot, and heavy
Loss of control due to:	
Late response by pilot to autothrust malfunction *[109:2:2],	Would’ve been on top of it sooner. Red flag raised sooner
Autothrust commands idle thrust in managed climb *[102:3:7]	I use OP CLB since then
Overspeed in mountain wave conditions [103:mtnwav:1ff]	Went crazy, pegged, we were exposed, rare, not my idea of a good time, last card
Unnoticed disengagement of autopilot [103:mtnwav:1ff]	Kicked on, tripped of, nobody’s flying this thing, learned the hard way
Setting a very low climb speed in order to expedite a climb *[107:1:7]	I take..a nice safe speed
Distraction in critical phase of flight:	
FMS GPS position disagree warning on takeoff [102:3:5]	Oh crap! What was that?
Transfer of controls on approach *[107:1:7]	Seemed like the smart thing to do
Reengagement of autothrust on approach *[114:1:10-11]	Not the time to start messing with [it]
Cargo fire [110:1:2ff]	Oh shit! crazy, Valuejet, fear
In-flight engine shutdown [110:1:6ff]	I’m not believing this, worse than any sim[ulator session].
Impact with terrain *[110:1:3ff]	Mountainous, not familiar, oh my god!
Midair collision:	
with airplane on parallel departure *[109:2:7]	Out of step, visibility was good
with airplane on parallel approach *[102:3:12]	30° off heading, may cause problems
due to two heads down in terminal area *[102:3:4], *[107:1:5]	I’m not gonna be heads down
Flight into adverse weather *[111:2:4], *[114:1:6]	use the automation, ‘till I see runway
Loss of protections due to autothrust remaining off after manual disconnect *[102:3:9], *[114:1:11]	Why take it off and run the risk of having something happen and take your protections away?
Operational errors due to:	
Fatigue *[111:2:4], *[107:1:5,7]	Use automation, exhausted
Tempo of events [103:mtnwav:3ff], [110:1:6ff], [111:2:10]	happened so fast, gets so accelerated
Automation confusion [102:3:1]	Screwing up and getting bit
FAA action against pilot due to:	
Exceed 250 KIAS speed limit below 10,000’ [102:3:9]	Make sure it doesn’t exceed 250
Missed altitude constraint in descent [110:2:2]	Miss an altitude by less
Unnecessary shutdown of a usable engine [110:1:6]	FAA’s gonna have my license
Airplane on wrong heading due to FMGC programming [110:2:11-12], [110:2:16]	Violated, Holy smokes! Oh shit! Let’s fill out one of those little white forms.
Unable to hold cleared descent path going into Los Angeles, [113:1:8], [114:1:2]	Gotta be on top of it, gonna end up high.
Sudden change in descent path forecast [110:2:14]	Why’s it doing that? Hell if I know.

Representations of risk

Pilots do not appear to represent risk in terms of probabilities or utilities. Instead, they use a wide range of discursive practices (Goodwin, 1996) to construct the perception of risk associated with specific events. Here is a partial list of the discursive practices observed in these interviews:

- Risk is represented in terms of the behavior of flight instruments.
- Risks are constructed by embedding activities in widely shared cultural models that imply risk and sometimes risk management.
- Situations are marked as risky by reporting specific physiological and psychological responses to the situations. This includes the use of a folk model of the mind (D'Andrade, 1987).
- Risk is constructed by employing metaphors from inherently risky endeavors such as gambling.
- Current risky events are conceptually blended (Fauconnier and Turner, 199X, 2001) with historical events known for their high levels of risk or disastrous outcomes.

Representation of risk in flight instruments

In the case of the encounter with a mountain wave, the pilot provides detailed descriptions of the behavior the airspeed indicator (see appendix A). The regions of risk are depicted on the instrument in red. The nature of the risk is not represented on the airspeed indicator. In the long term, designing instruments that provide good representations of the risks that matter to pilots will be an important strategy for reducing risk in aviation.

Using cultural models to construct representations of risk

Two models stand out in the data: an "experience/ability" model and a "risk as exposure" model.

Lack of experience as an element in the perception of risk

The Airbus A320 is not only new to the pilots participating in our study, it is new to the airline as a whole. Given that these pilots are learning to fly a new airplane it is not surprising that a cultural model relating experience to ability organizes much of their discourse. This model has two main parts. In the first part, lack of experience is associated with lack of ability. This model is extremely widespread, appearing in non-Western as well as Western cultures. The second part of this model is more specific to flying or to inherently risky activities. This part holds that lack of ability is a component of the construction of risk. This is believed to be true for individual pilots and for the community of pilots as a whole as well. This model is built into the aviation regulations in that individuals are required to have certain amounts of experience, measured in hours, or legs flown, in order to be fully qualified. Collectively, a crew must have a certain amount of cumulative experience before they are permitted to fly together. Pilots in our study explain the fact that they found themselves in risky situations by reference to their lack of experience. "I'm fairly new on the airplane.."[103:mtnwav-II:3] "I was too new to the aircraft to know that it shouldn't have gone off." [110:1:8] "my first officer was ***not*** experienced. he was one of the guys who had had four or five years off and there's a couple of things most of us have // we use as backup and stuff and he wasn't up to speed or hadn't seen that stuff, and I think maybe he might've known where I was coming from some of the things I asked" [110:1:8]. In this last case, the first officer is represented as lacking knowledge required to establish intersubjective understanding of the shared activities with the captain.

The relation of experience to ability is also held to be true of the community of pilots as a whole. Commenting on the general low level of experience in the fleet, one of the first officers said, "I have not flown with a lot of guys who have flown the airplane for a long time, we have so many people that have **not** been able to establish techniques. I've flown with guys on their first trip, so **I** was the old guy. That sucks, that's not the best thing in the world." [114:1:7]. This pilot delayed bidding the Airbus airplane so that other pilots would "learn it" first so that they could "help me on the line when I get to it." [114:1:7] Pilots also believe that the insurance premiums paid by their company are based on the overall level of experience of the flight crews.

If inexperience is constructed as a risk factor, experience is the obvious counter-measure. Our interview questions presupposed that experience would lead to new skills. We explicitly asked the pilots if they had learned anything "on the line" that they did not know in training. We got many answers to this question. For example, one pilot said, "the biggest thing that experience gives is it allows you the time to start actually bringing some of that stuff out of your subconscious into the conscious and understanding what it actually all meant." [111:2:4] Another pilot called it a sorting out process and described "rehearsing the dance steps" so that "you can deal with the situation as it comes up, and then your habit patterns just take care of business." [109:2:4,12] Yet another said that experience allowed him to "conduct business in an orderly manner" [109:2:3]. One of our captains experienced a false glideslope intercept during his IOE, under the supervision of a specially qualified IOE captain, and then experienced it again when he was "on his own" he said, "Glad I saw it in IOE, versus on my own the first time." [113:1:7]

Perhaps the biggest experience issue on a highly automated airplane like the A320 is the concern about the pilot's ability to fly the airplane by hand if the automation fails. There are two main parts to automatic control: the autopilot/flight director system, and the autothrust system. Hand flying refers to manipulation of the sidestick providing manual control inputs that would otherwise be provided by the autopilot/flight director system. According to company policy, the other major part of the automation, autothrust, is to remain engaged at all times in flight[7]. An indication of the company risk management strategy here is that the aircraft is not permitted to dispatch with autothrust inoperative. Virtually all of our pilots reported hand flying as a specific risk management procedure, the concern being, "are you gonna be up to speed?" [110:2:10] , [114:1:12] Or, " you need to keep your proficiency up . if you just kept it on the autopilot all the time, and it failed or something, then you'd be in, uh, you know, a little bit of a problem." [113:1:4] The pilots in our study report routinely flying by hand up to 10,000' or more on the departure and down from 3,000' or more on the arrival. The extent of hand flying reported by the pilots in our study is surprising to airline management and to the training department at Airbus Industrie.

Another risk perceived by pilots is the lack of familiarity with the operation of manual thrust. To the pilots, the most obvious way to manage this risk is to occasionally try out manual thrust control. However, this is specifically forbidden by company policy. One of our pilots suggested that manual thrust usage "should [happen] once on IOE or once somewhere, so you have an idea," arguing that "it would be good to have a little bit under your belt prior to having to use that." [114:1:11]

The pilots construct their sense of the value of the training simulator as a place to prepare for real-world events in terms of this experience model. Several pilots mentioned the need to practice autothrust disconnect. [113:1:4] For example, the pilot who hit the mountain wave said, "we don't spend enough time with a quick disconnect and so, instinctively there's gonna be … a delay in disconnecting the autothrust" [103:mtnwav-II:2]. One pilot also wished to have more experience with crosswind landings in the simulator. [110:2:x] However, they are not always permitted to practice these events and they see this as adding to their risk.

While the simulator can provide some kinds of experience, according to the pilots, the simulator cannot capture the emotional aspects of dealing with real emergencies. [111:2:10]

Exposure model

The notion of risk as something to which one may be exposed is a second widespread cultural model used in the construction of risk. This model has been formalized in some approaches to risk management and one version of it is taught to the pilots in this airline as part of captain upgrade training.

Just as the lack of experience model has experience or practice as the obvious countermeasure, the representation of risk as exposure implies that ways to reduce exposure are barriers that stand between the operator and risks.

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[7] Autothrust is normally engaged shortly after takeoff when the thrust levers are placed in the climb detent. It remains engaged until the thrust levers are brought to idle during the landing maneuver.

The pilot who experienced the encounter with high altitude shear used this model to organize important aspects of his construction of the risks involved in the event. He said,

> "at the very least, we would've re-significantly **reduced our exposure** to the overspeed condition, 'cause we were **in** the **overspeed condition** you know for **quite a few seconds**. [103:mtnwav:3]
> this one to two second // delay (1.5) uh **exposed** us to that overspeed condition **longer** than we should've been. [103:mtnwav:5]

Exposure to risky conditions is a common metaphor in aviation. In these excerpts, overspeed condition is something one goes into. A containment metaphor is used to construct a condition of exposure (uncontainment) to risk. Exposure has duration. Perceived risk is proportional to the duration of the exposure. Greater duration implies greater risk. There are two partitions constructed here. One partition distinguishes being in and out of the overspeed condition. The other partition separates the airplane/crew from risk. Imagine a wall between the pilots and risk. Now imagine a hole in the wall. The overspeed condition is the hole in the wall. It is something that one can go into or out of. When contained within it, one is no longer contained by the wall, and so is exposed to risk. Cumulative risk is constructed as being proportional to the duration of exposure.

A related containment metaphor is provided by the concept of flight envelope. Flight envelope is an aerodynamic concept describing a region in parameter space (defined by Airspeed and G-load) within which controlled flight can be maintained and the airplane will not suffer structural damage. The shape of the envelope changes with pressure altitude. In the mountain wave event, the crew had selected a speed slower than normal cruise speed in anticipation of the turbulence that accompanies mountain wave conditions. At the altitude of 36,000' the one-G flight envelope was approximately 40 knots wide. The selected speed (.75 MACH) fell roughly in the middle of the speed range. The pilot said, "we had about a **forty knot envelope**? We had about twenty knots above and twenty knots below where you know still-maybe a little less where we could-you know stay in a // a you know a **safe speed** zone" [103:mtnwav:3] The notion of a **safe speed** zone captures both the top and the bottom of the flight **envelope**. It implies that the speeds out of this zone are unsafe or exposed to risk.

Physiological and psychological responses

The pilot who faced the most dangerous situation, a possible in-flight fire, spoke candidly about the experience of fear. "fire puts a fear that I have never experienced before in my life" [110:1:5]
"both of us said that is a fear that we have never ever known in our lives, luckily have never had to experience, I think maybe if you got mugged you may have had that fear or something" [110:1:8]

Speaking of the cargo smoke light, the pilot said, "if it had stayed on I think I would've had a heart attack" [110:1:8] Looking back on the entire experience, the pilot said, "You just don't know when you get an aft cargo smoke at altitude, in the mountains, after Valuejet and SwissAir, what it kinda does to your heart" [110:2:1]

Another common model of a response to extreme stress is loss of bladder or bowel control. Pilots use this model to construct representations of circumstances in which the "pucker factor" is high. These are risky situations in which effort is required to flex the sphincters and avoid having to "change one's pants." In a jumpseat interview, a pilot reported having urinated in his pants following a lightning strike to the nose of his airplane.

A wince is a bodily reaction to the anticipating of pain. The pilot who had to shut down an engine in flight used this idea to construct the riskiness of the action, saying, "I winced I think as I turned the engine master switch for the-you know fuel o-off." [110:1:6]

The pilots believe that their bodily responses to stress add to risk. The pilot whose engine ingested a bird on takeoff explains his failure to activate and confirm the approach to the emergency runway by saying, "the biggest enemy at that point in time is adrenaline" [111:2:10] The pilot who had the cargo smoke indication reported that he was attempting to enter data to the FMGC faster than the computer could accept it because “the adrenaline was going” [110:1:6] He reported abandoning the attempt because he could not get the computer to work at his pace.

Contrasting his ability to think about the airplane’s behavior over lunch with the experience of flying it when things go wrong, the pilot who hit the mountain wave said,

> “but to be **in the seat** (1.5) and **be exposed to** this condition you’re g-you know **here you go here’s** your speed increase you’ve **never seen anything like this before**, you’re communicating with the first officer, the flying pilot, you know how you want him to handle it or whatever, you’re // calling altitudes you know performance numbers out it was sort of you know kinda like when we do a windshear uh training m-manuever? you know a lotta communication going back and forth. you **got all these things going there (at) once”** [103:mtnwav:3]

Here, the pilot uses a **model of the mind** to account for his own behavior. The mental processes as experienced in the cockpit are contrasted with those in a more relaxed setting. In this model, the mind works best with the slow presentation of clear indications of simple familiar ideas. The rapid tempo, novelty and complexity of the situation are seen as factors that impede clear understanding. Ambiguous indications of autopilot disconnect made correct interpretation difficult. The pilot constructs these cognitive effects as being very important. The relation to risk is not made explicit, except to say that this is a big deal and a big concern.

Disbelief is also a response to risky situations. The pilot facing the cargo fire and engine shutdown represents the situation as unbelievable, “I just went oh shit I couldn’t believe it.” [110:1:5], and “we got indication to shut an engine down. and I go I’m not believing this.” And “we kinda stared at it in total disbelief” [110:1:6].

The three pilots who encountered abnormal in-flight conditions all describe some sort of cognitive overload which rendered them unable to process and understand everything that happens. They see this as an element of risk. The pilot who had the cargo smoke indication and engine shutdown gave the most detailed description. He said,

> “but **things were happening so fast**, and we only had seventy miles to descend from thirty five thousand feet, down to where Reno was, and that’s ***really really*** busy and we’re trying to do checklists, divert, tell the company, and everything else like this” [110:1:4-5]
> I’m trying to focus on okay what’s the minimum vectoring altitude for the mountains, what direction is the runway, what’s the length of the runway, what’s the field elevation, and honestly to tell you the truth I didn’t even hear what the wind was. you know it was just like system overload at that point. [110:1:6]

This pilot represents the risk of combining rapid pace of events with excessive quantity of information. The pilot who encountered a mountain wave said, “I mean it**-everything happened so fast** but (I’d say) in probably less than one to two seconds. that all this is happening.” [103:mtnwav:1] and the pilot whose engine ingested a bird said, “everything gets so **accelerated**” [111:2:10]. Rapid tempo can be added to unfamiliarity and complexity as a perceived element of risk.

The primary strategy for managing the risk of rapid pace of events it to “stay ahead” of the airplane. This means doing as much as possible to in low tempo phases of the activity to prepare for the rapid tempo phases. The converse of staying ahead of the airplane is “getting behind” the airplane [111:2:10]
As a final example of the representation of risk in psychological terms, one pilot described ground-speed mini thrust changes as “**disconcerting”** [110:2:9]

Gambling metaphors

Gambling provides a source of metaphors for the creation of expression of uncertainty. The pilot who encountered the mountain wave used the construct of a last card to describe the automatic protections. He said, "uh // my idea of a good time is not letting these protections // um come about. you know that's your last card." [103:mtnwav:2] And "the airplane was doin' its thing ***exactly*** as advertised. but again that should be my last card." [103:mtnwav:7]

The **last card** metaphor implies that there are other cards to be played and that the pilot would prefer not to be down to his last one. This is part of the wider notion in flying of layers of planning and procedures. If plan A fails, plan B should already be in place. (Alternate airports, missed approach procedures, V-speeds, multiple engines, dual controls, redundant computations, clearance read-backs, challenge/response checklists, etc., are examples of this principle at work).

Risk is controlled by having many cards available to play. The card metaphor is related to the notion of exposure to risk via the barriers to risk concept. Risk is heightened when one is down to one's last card because when that card is played one is directly exposed to risk. Other gambling metaphors include the notion of what is "on the line" (not the same notion as flying "on the line") The pilot dealing with the cargo smoke indication said he thought to himself , "I really have a-a crisis here and this had better be good, because there's a lotta lives on the line." What is on the line is what is wagered in a game of chance. It is close in meaning to what is "at stake".

One more expression deserves mention here. When the pilot deliberates and then finally decides to shut down the engine in flight, he reports saying to himself, "okay, here goes" [110:1:6]. This phrase marks the uncertainty of outcome or entry into more risky situation. The pilot adopts a speech act of someone embarking hopefully on an uncertain course of action.

Conceptual blending of present with past

Of course, an inflight fire is one of the most dangerous of all flight conditions. It can lead to damage to airframe, complete loss of control, and loss of life. In the past 5 years two major airline disasters have been caused by in-flight fires: the Valuejet crash in 1996, and the SwissAir crash in 1998. The pilot who experienced an indication of a cargo hold fire said of himself and his co-pilot, "and uh you know we're both thinking **Valuejet**." [110:1:5]

On May 11, 1996 Valuejet flight 592 crashed in the Florida Everglades killing all on board. Shortly before the accident, the crew reported smoke and fire in the forward cargo hold. While the airplane was maneuvering back to Miami International airport, the fire rendered the airplane impossible to control. Valuejet is an economical expression for a conceptual blend in which the current flight and the Valuejet flight are blended. The blended space has the emergent properties that the present flight should land as soon as possible, and that the current flight could end in a crash that kills all on board.

Risk management measures

In addition to the risk management strategies implied by the experience model, the exposure model, the 'stay ahead of the airplane' model and the model of the mind, pilots construct a general risk management strategy grounded in company procedures and conservative behavior. They also construct local strategies to deal with specific perceived risks. In many cases, the representation of risk is implicit in the claimed need for risk management measures.

The interviews contain many statements of the importance of reliance on standard operating procedures and habits for risk management. For example, "I pretty much try to stay within the rules, …I haven't tried to become creative [111:2:2]." Or consider, "I've followed – I try to follow procedures precisely, how they taught em to us." [107:1:3] When asked in the initial interview if he expected to hand fly the airplane, one of the pilots said, "I'm sure I'll (2.0) fly it the way I was trained. it's their airplane they just hired me to fly their airplane. I'm not gonna in-reinvent the wheel. you know there-there are other guys that are a whole heck of a lot smarter than me and they've put a whole lot more brain power into this than I have, so you kinda go with the experts." [106:init:5] The idea of creativity as a risk factor seems to me **not** to be shared with the general aviation and military aviation communities. Another pilot said, "I stick to SOPs. "I'm not hotdogging the airplane at all. I hotdog in the sense I like to fly it, and I do make it perform… Ninety eight percent of the time, I'm right within their profile." [111:2:9] The notion of "their profile" refers to the company policies for handling the airplane. Another pilot implicitly invokes the flight envelope notion by talking about "the edge",

"I try not to do everything at – right on the edge. I always save a little bit in case there's more needed." "I'm a very conservative pilot. I try not to test my limits., but I always try to know what they are. [107:1:8]

Many of the pilots in our study see standardization of policies as an important risk management measure. For example, referring to the highly automated, so-called 'glass cockpit' airplanes, one said, "once you get in to the glass, with the FMCs and FMSs, and everything, you need the standardization." [113:1:3]

In general, the pilots think that company procedures should provide protection against risk. However, they also believe that this is not always the case. The pilot who experienced the overspeed condition said,

> if I had to do it all over again knowing what I know now (2.0) at the first indication of the overspeed, I would've just // you know disconnect the autothrust go to idle and uh and then control the autothrust manually ***but*** // that **conflicts with *((airline #2))* procedures**.
> I looked it up [in the manual] and it said well it's a mountain wave and there's really nothing you can- you know there's-there's a little blurb but nothing that really // gives you a technique or (catch) the things you need to think about.

The pilot believes that the procedures in place for use of autothrust in encounters with mountain wave conditions are not adequate to avoid events such as the one reported[8]. Autothrust is also at the center of a risk management disagreement. Airline management has chosen to manage the risk of inappropriate thrust settings and loss of automatic protections by forbidding manual control of thrust. Pilots would prefer to control the same risk by practicing manual control of thrust in conditions where other risk factors are low.

Other specific risk management strategies include the following:

- Requesting a block altitude in mountain wave conditions [103:mtnwav:1].
- Preparing the cabin in an emergency diversion. "I just said it was a precautionary divert for safety, get the cabin ready, and if anything went crazy at the last minute, or as I put it to hell in a handbasket, I'd give her the emergency six bell signal, and then they could brace for landing. otherwise it would be a normal landing." Talking to flight attendants is a risk management measure. The manageable risks in the cabin are primarily injuries to passengers from passengers or baggage becoming projectiles in high-G conditions. [110:1:5]
- Forming the practice of activating and confirming the approach below 10,000' after experiencing an inappropriate approach speed target.[109]
- Using OP CLB mode above FL240 after hearing a rumor about uncommanded thrust reductions in CLB mode. [102]
- Deliberately keeping the speed low during taxi operations with steer-by-wire, "I move at a slow pace when I'm taxiing the airplane just to uh// until I get a little bit better at what I'm doing." [107:1:6] This reasoning is a direct consequence of the experience/ability model.
- Using ILS guidance on visual approach [107:1:6] This is very common practice, which is shared by the general aviation community.
- Having the FO do appraoch briefing [107:1:7] "that way I didn't have to distract myself or change who was flying the airplane, and at five thirty in the morning after you've been up since seven o'clock the previous day with a short nap in there someplace, seemed like the smart thing to do."

[8] Recent discussions between the author and Airbus engineers indicate that other steps could be taken to get better performance from the automated systems. The Airbus engineers also acknowledge that in the manuals provided to the airlines by the manufacturer there is no specific guidance for encounters with mountain wave conditions.

Nobody in control

The so-called "hard" protections in the Airbus airplanes create the possibility of a new kind of flying risk. This is the situation in which the airplane disregards inputs from the pilots and takes control of itself. In normal operating configuration, the airplane has protections for pitch attitude, angle of attack, overspeed, and g-load. If certain limits on these parameters are exceeded via either manual input or autopilot command, the airplane will disregard the inputs and restore the airplane to the operating envelope. The designers intend these protections to make the airplane robust in the face of pilot errors that might lead to an unusual attitude, a stall, an overspeed, or excessive g-loads. If the airplane was on autopilot when the protection engaged, the autopilot will be disengaged. The risk is that the disengagement of the autopilot could go unnoticed by the crew. This risk theme is also constructed in passive terms with respect to the engagement of protections. This passivity shows up explicitly in the use of the phrases '**we were along for the ride**' and '**nobody's flying this thing**' (see appendix A for details).

In representing operational risks, pilots indicate that they see risk factors as roughly additive. Their descriptions of challenging flight conditions include lists of factors. For example, indication of fire, engine out, mountainous terrain, no charts, insufficient time to get everything done, and no support from company. When risk is constructed in terms of exposure, the amount of risk increases with increasing duration of exposure.

Administrative risk:

An important class of risk faced by pilots is administrative risk. Pilots are at risk of losing their flying privileges if they violate the federal aviation regulations. They refer to this as being violated[9] by FAA. " I also had a friend of mine violated 'cause of his first officer." [107:1:8] The pilot's principal risk management measure in the face of administrative risk is vigilance. "If you're not right on top of it, you're going to have a lot of trouble." [113:1:8] and "keep an eye on it" [114:1:9]. In describing a case in which the crew misspelled the name of a waypoint and went the wrong direction, a pilot gave the following account: "and all of a sudden they [ATC] go, 'hey ((airline #2)) where you goin'?' [we said] 'Avere' They said, 'no you're not.'" Because the airplane deviated from an accepted clearance, the pilots faced the possibility of administrative action by the FAA. The pilot then reported that he said, "Oh shit! Okay, let's fill out one of those little white forms, Okay?" [110:2:16] The "little white form" is a NASA Aviation Safety Reporting System form. Pilots can complete a form describing any circumstance they feel represents a threat to the safety of flight. In return for honest reporting, they are granted limited immunity from administrative actions.

The most severe administrative action is the revocation of the pilot's license. If that happens, the pilot's flying career would be ended. When considering the decision to shut down the engine in flight, the pilot said, "if I shut this down and it's a good engine, if I'm getting bad readings, the FAA's gonna have my license" [110:1:6]

The company also presents administrative risks to the pilots. Pilots are expected to conform to company procedures, even when deviating from company procedure would not be a violation of the FARs. In a discussion of the widespread desire among pilots to fly the airplane using manual thrust, a pilot described the perception of administrative risk as follows:, "I think all the guys are scared that this airplane takes records so much that they can pull it up and look at it. We don't want to get into trouble by doing it." [114:1:8] Modern commercial transport category aircraft are equipped with digital flight data recorders (DFDR). The data from the DFDR is accumulated and reviewed by management to identify operational problems. This is actually a small threat to the pilots, however, since the data are 'deidentified' by a union representative before they are seen by management.

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[9] I'm not sure if the fact that this term can also refer to rape is a factor in its choice to represent this relation to the FAA.

Finally, pilots also manage the risks of litigation for the company in a number of ways, including by handling medical emergencies in a conservative way, “We call medlink now since they tell us to, to cover our financial rear ends.” [107:1:6] Of course, the ‘cover your ass’ model is such a commonplace in American culture that it is recognized by the initials, CYA. It is also a statement of risk management in a variant of the ‘risk is exposure’ model.

Discussion

Pilots use a variety of resources to construct representations of risk. They describe the behavior of flight instruments where those instruments provide the raw materials for the construction of risk representations. They use a wide range of cultural models, some of which are quite general, and some of which are more specific to aviation. Of the four models, the model of mind and experience/ability are extremely widespread, possibly even cultural universals. The ‘risk as exposure’ model probably originated in the business world but it now comes to the pilots via colloquial expressions such as CYA, or via training provided by the airline. The ‘ahead of the airplane’ model may have originated in flying culture. It is certainly widespread there today.

Pilots use commonplace notions (e.g. ‘going to the edge’) for risky activities and for risk management concepts (e.g., cover your ass). They draw freely from popular American culture and American slang in constructing representations risk. For the most part, the resources they use to construct representations of risk are informal and taken for granted.

Pilots increase the represented intensity of risks by reference to physiological responses to stress. These can take the form of clinical language (e.g., adrenaline) or cliché (e.g., pucker factor). Finally, they use powerful blends of current activity with well-known historical events to construct representations of risk in the present.

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Appendix A
Representations of risk in an interview with a pilot about an encounter with a mountain wave:

Description of the risk condition: Possible dangerous consequences.

Overspeed: Mach tuck – high altitude upset – loss of control
Airspeed indications as indications of risk
the speed trend arrow **pegs off the scale**
here comes MMO, or **maximum** you know the **redline**
we're well into the **redline**, right at the uh (1.5) where the-you know the **maximum** for the airplane
we entered with an updraft, and it was you know very **abrupt**. and you know that's why the speed trend arrow **went crazy.**
it took all we had. it // it **pegged out** right at you know there's an equal sign on the airspeed tape, and it pretty much stayed there, and that's where the airplane flew it.
Interesting use of the notion of 'peg', which comes from analogue instruments and is not a property of digital speed display. It implies reaching the limit of the instrument to display the value. **"off the scale"** refers to the speed scale which is a constant 120 knot window around the current speed. The speed trend arrow indicates the speed that will be achieved in 10 seconds at the current rate of acceleration. If it went off scale, that implies that a speed 60 knots greater than current speed will be achieved in 10 seconds. Since the overspeed condition was only about 20 knots above current speed, this is a dramatic indication of a problem. The description of the speed going 'crazy' makes use of a common cultural resource: the notion that craziness is deviant and unpredictable.
Redline is displayed as a region on the digital display. Maximum mach is an aerodynamic consideration. Above maximum mach, swept-wing jet airplanes tend to exhibit a nose-down pitch attitude that may be so powerful that it cannot be countered by stick-back control inputs. Pitching down increases speed, which makes the so-called 'Mach-tuck' worse. This can lead to loss of control and structural damage. The consequences for control are not explicitly represented anywhere in this interview. These are things that 'go without saying' among jet pilots. (Many aspects of flying airliners are the same in small airplanes. This is not one of them.)
The equal sign on the airspeed tape shows the speed at which the overspeed protection will become active.
Notice the use of spatial language in the description of the speeds. "Here comes MMO" and "We're well into the redline." This use of language provides evidence that airspeed is conceived in a conceptual blend that is anchored in the physical properties of the airspeed indicator. That is, the abstract quantity of airspeed and it's relation to aerodynamic concepts is one input to the blend. The physical structure of the airspeed indicator tape (speed indication line, redline, Vls, speed trend arrow) provides the other input. The compression of the blend is so effective that the speed tape becomes the airspeed. The location of the current airspeed is taken as an implicit point of view of the pilot,and the movement of the tape, scrolling down to current airspeed line (which remains fixed in the middle of the tape) is described using the deictic verb 'come'. Come implies motion toward the speaker's implicit point of view. In the phrase, "We're well into the redline.", the frame of reference for motion is changed, and now it is the crew (and via metonomy, the airplane) that has gone "into the redline". The pilot reasons about the speed in terms of spatial relations in the conceptual blend formed in the airspeed indicator. The tightness of the compression in this blend gives the instrument great power as a representational device. However, there can also be a down-side to such tight compressions (see the discussion of the example of turn in the wrong direction for a heading change).

Summary: Risk is represented in terms of the behavior of the airspeed indicator. The regions of risk are depicted on the instrument in red. The nature of the risk is not represented on the airspeed indicator.

Controlling exposure to the risky condition
at the very least, we would've re-significantly **reduced our exposure** to the overspeed condition, 'cause we were **in** the **overspeed condition** you know for **quite a few seconds**.
I really think that if I had had manual control of the thrust levers, that I think **I could've done a little better**. I'm not saying that we probably would not have // **gone into** overspeed but I-I'm pretty sure that // it-it would not have uh **gone to** a **full overspeed** condition.
this one to two second // delay (1.5) uh **exposed** us to that overspeed condition **longer** than we should've been.
Exposure to risky conditions is a common metaphor in aviation. In these excerpts, overspeed condition is something one goes into. Thus, there is an underlying containment metaphor used to construct the concept of the condition. Exposure has duration. Perceived risk is proportional to the duration of the exposure. Greater duration implies greater risk. The overspeed condition can be partial or full.

Summary: A containment metaphor is used to construct a condition of exposure (uncontainment) to risk. There are two partitions constructed here. One partition distinguishes being in and out of the overspeed condition. The other partition separates the airplane/crew from risk. Imagine a wall between the pilots and risk. Now imagine a hole in the wall. The overspeed condition is the hole in the wall. It is something that one can go into or out of. When contained within in, one is no longer contained by the wall, and so is exposed to risk. Cumulative risk is proportional to the duration of exposure. The notion that something can stand between the crew and risk is a common metaphor that has been developed into formal systems of risk management. Some such systems represent barriers between operators and risk. I believe our airline is using a model of this sort in captain upgrade training.

Unnoticed autopilot disconnect: loss of control

the airplane's protections **went ahead** and **kicked on**. the autopilot **tripped off**, the flight directors **tripped off**,

we **got** the **overspeed** condition, and the indication for that was a master caution-uh I'm sorry a master ***warning*** (it's) a red light, and then on ecam, we had an ecam message, overspeed, and then the audible warning was the uh CRC? The continuous repetitive // um // what do they call it // anyway // um chime, (continuous) repetitive chime, so (1.5) those things are all fine and good, the only **problem** is that // all those warnings are the same for the autopilot disconnect.

but to be **in the seat** (1.5) and **be exposed to** this condition you're g-you know **here you go here's** your speed increase you've **never seen anything like this before**, you're communicating with the first officer, the flying pilot, you know how you want him to handle it or whatever, you're // calling altitudes you know performance numbers out it was sort of you know kinda like when we do a windshear uh training m-manuever? you know a lotta communication going back and forth. you **got all these things going there (at) once**, and the most obvious warning is the overspeed because you see that on your speed tape (already) been reported to you, then you see it on ecam, you know (1.5) my response was to an **overspeed condition**, and secondary // **seconds later**, was to the fact that the autopilot **had tripped**.

but in my opinion it s-still took him roughly one to maybe two seconds to recognize the fact that **it had tripped** and in my opinion that is **a long time** to be flying around and realizing hey wait a minute **nobody's flying this thing**.

I didn't tune in to the autopilot disconnecting till sometime after he had [and] that-that's where my **single biggest concern** is is that // the warnings would've been the same so // you know my you know if you were asking me // you know what I don't like about the Airbus? I'm gonna tell you there-right there. [that's it], and **I learned that the hard way.**

ask [Airbus] 'em-ask 'em for me what is-what are the possibilities to make // you know an autopilot disconnect warning uh exclusively-**exclusive** to the autopilot and **unique** from **any other** indication that you can have to ***me***, **that is a big deal**.

when that autopilot disconnects it **should be in my face**, either visually, 'cause I may not be looking at my PFD, in this case I wasn't (at) the time. uh I may not be // able to read because of turbulence or otherwise you know the autopilot off on ecam. um so the only other option is I-I need a sound that **tells me uniquely**, you know **(it's) autopilot man**, you-**you got a problem here**. ask 'em that for me. I-I'm interested in in knowing what they say.

Protections are thought of as waiting to 'kick on' (kick in?). They 'went ahead' and did that. Autopilot and flight directors 'trip off'. The 'trip' concept comes from electrical device models, circuit breakers trip, as do generator controllers. This implies a sudden and complete rupture.

The issue of the level of control of the pilot with the autopilot engaged or the protections engaged requires some knowledge of the operation of the system. Autopilot works for the pilot to achieve performance targets (trajectories, speeds, etc.) as specified by the pilot. The protections are the most local sort of control and override or disregard all other targets. They maintain certain critical parameters in safe ranges when some other process threatens to take those parameters out of the safe range. That is why when the protections are engaged the pilot says, "Nobody's flying this thing." Notice that the airplane becomes a thing in this construction. This is an expression of the increased distance between the pilot and the airplane. It indicates that the special relationship that existed between the pilot (by virtue of his training as a pilot) and the airplane (by virtue of its character as a thing controlled by a pilot) has been broken.

Here we see the overspeed condition as something they 'got' rather than something they went into or were exposed to. Why? This is an expression of the passivity of the crew. Such passivity is itself an indication of risk. The condition is something they got, that is, something received from an outside process. The passivity of the crew is represented at many levels. For example, the passive voice is used to describe the pilot's situation, "to be **in the seat** (1.5) and **be exposed to** this condition". The seat is a metonomy for the authority and responsibility of the crewmember. When asking whether one is a captain or first officer, one asks about the seat. The crew does not enter this condition, they are exposed to it. The phrase, "**here you go here's** your speed increase**"** also signals the passivity of the crew. These are things that happen to the pilot rather than things the pilot controls. (Last words of Alaska Airlines captain as out of control plane plunges into the sea, "Here we go.") All of these constructions of passivity on the part of the crew are indications that they are not the active agents in control of this course of actions. A crew that is not in control implies an airplane at risk.

The lack of familiarity (**never seen anything like this before**), complexity (you **got all these things going there (at) once**), and tempo (see below) of the situation make it difficult for the pilot to understand what is happening.

Representations of the severity of the threat:
It may seem surprising that without describing any dire consequences, the pilot says this event embodies his **single biggest concern** about the airplane. This event is taken as an exemplar of a more general class of events that involve subtle changes in airplane state that may be missed by the pilot leading to a misunderstanding of the situation and thence to risk. The consequences of this event are implicit and apparent to any jet pilot. The duration of the exposure was **a long time.** The pilot expresses the implicit cost of this experience, (**I learned that the hard way**) and the magnitude of the risk, (**that is a big deal**) implied by the fact that neither crewmember knew that the autopilot had disengaged. Learning the hard way is another cultural resource. Out of a range of ways to learn, some are less costly than others. Big deal is a frozen cultural form representing importance.
The final excerpt represents a plea for salient cues and the importance of the notification that the autopilot is disengaged, **(it's) autopilot man**, you-**you got a problem here.**

Summary: The overspeed condition is constructed as something that happens to the passive crew. Protections are seen as waiting to engage. The trip concept frames a sudden rupture of the pilot/airplane relationship. The exposure to risk lasted seconds, which is too long. The pilot uses a **model of the mind** to account for his own behavior. The mental processes as experienced in the cockpit are contrasted with those in a more relaxed setting. In this model, the mind works best with the slow presentation of clear indications of simple familiar ideas. The rapid tempo, novelty and complexity of the situation are seen as factors that impede clear understanding. Ambiguous indications of autopilot disconnect made correct interpretation difficult. The pilot constructs these cognitive effects as being very important. The relation to risk is not made explicit, except to say that this is a big deal and a big concern. Of course, it is part of the idea that an airplane flying without a pilot in control is an airplane at risk.

Engagement of protections: Pilot not in control,
a nose up command occurred, (notice passive construction)
uh // **my idea of a good time** is not letting these protections // um come about.
so uh you know we're just **along for the ride** at this point.
hey wait a minute **nobody's flying this thing**.
you know that's your **last card**.
Again, that should be **my last card**.
This risk theme is also constructed in passive terms with respect to the engagement of protections. This shows up explicitly in the use of the phrases '**along for the ride**' and '**nobody's flying this thing**'. As long as the airplane is doing OK, why should the pilots care? Because the pilots are responsible for the control of the airplane. They are the ones who should anticipate the coming conditions and ensure that the airplane remains in a safe condition.

It is also present in the use of the passive construction, 'a nose up command occurred' without a specification of who or what issued the nose up command. There is a classic case of pilot understatement (an important value in pilot culture) in the phrase, '**my idea of a good time** is not letting these protections // um come about'. The **last card** metaphor implies that there are other cards to be played and that the pilot would prefer not to be down to his last one. This is part of the wider notion in flying of layers of planning and procedures. If plan A fails, plan B should already be in place. (Alternate airports, missed approach procedures, V-speeds, multiple engines, dual controls, redundant computations, clearance read-backs, challenge/response checklists, etc., are examples of this principle at work). Risk is controlled by having many cards available to play. The card metaphor is related to the notion of exposure to risk via the barriers to risk concept. Risk is heightened when one is down to one's last card because when that card is played one is directly exposed to risk.

Underspeed: Stall – loss of control
the speed now is at VLS, which would be the **minimum** speed right?
Vls (V lowest selectable) is the lowest speed that can be selected by the crew as a target for the autopilot. It is normally the minimum safe speed (includes a margin above stall speed). If the speed falls below Vls, the airplane could stall. This is especially dangerous in turbulent conditions, since turbulence imposes momentary g-loads, and stall speed increases with increasing g-load. An airplane that is flying fine at a low speed could stall at that same speed with an increase in g-load induced by turbulence. A high altitude stall can lead to loss of control. There is no need to make this explicit in a discussion among pilots. On the first telling of the event, it was not clear whether the FO or the airplane make the control response to the low speed condition. In later descriptions of the event in this interview and in a second interview, it became

clear that the airplane protections commanded nose down pitch to increase speed on the first oscillation of the wave.

Flight envelope – airspeed range at high altitude: loss of control or structural damage if airplane exceeds the boundaries of the envelope.

I didn't think that **twenty knots one way or the other** was gonna be ***that*** bad. that's why I got the block altitude, I figured if I fly the wave we'll be just fine. So well **surprise**.

we had about a **forty knot envelope**? we had about twenty knots above and twenty knots below where you know still- maybe a little less where we could-you know stay in a // a you know a **safe speed** zone

Envelope is an aerodynamic concept describing a region in parameter space (defined by Airspeed and G-load) within which controlled flight can be maintained and the airplane will not suffer structural damage. The shape of the envelope changes with pressure altitude. The crew had selected a speed slower than normal cruise speed in anticipation of the turbulence that accompanies mountain wave conditions. At the altitude of 36,000' the one-G flight envelope was approximately 40 knots wide. The selected speed (.75 MACH) fell roughly in the middle of the speed range. The notion of a **safe speed** zone captures both the top and the bottom of the flight **envelope**. It implies that the speeds out of this zone are unsafe or risky.

Tempo of events: pilot unable to process and understand everything that happens.

I don't know I mean it-**everything happened so fast** but (I'd say) in probably less than one to two seconds. that all this is happening.

This can be added to unfamiliarity and complexity as a perceived element of risk.

Company procedures: should provide protection against risk but do not

if I had to do it all over again knowing what I know now (2.0) at the first indication of the overspeed, I would've just // you know disconnect the autothrust go to idle and uh and then control the autothrust manually ***but*** // that **conflicts with *((airline #2))* procedures**.

I looked it up [in the manual] and it said well it's a mountain wave and there's really nothing you can**-** you know there's-there's a little blurb but nothing that really // gives you a technique or (catch) the things you need to think about.

The pilot believes that the procedures in place for use of autothrust in encounters with mountain wave conditions are not adequate to avoid events such as the one reported. Recent discussions between the author and Airbus engineers indicate that other steps could be taken to get better performance from the automated systems. The Airbus engineers also acknowledge that in the manuals provided to the airlines by the manufacturer there is no specific guidance for encounters with mountain wave conditions.

Other airplanes did **not request block altitude**: altitude busts and speed excursions

> everybody else // tried to stay at their altitude so their **speed excursions** were // bigger and then-yeah. and then
>
> // after that then they had the **altitude bust**. because they've **exceeded** I don't know three, five hundred
>
> whatever they may have had. So // that really **shocked** me.
>
> I just-it **surprises** me that nobody's-[requesting a block altitude].

The pilot expresses surprise that other pilots encountering the same conditions that night did not take the step of requesting a block altitude which would permit them to control the risks of **speed excursions** while remaining within the assigned altitude range. A speed excursion is deviation of speed from the speed target. An excursion that takes the speed outside the flight envelope may result in loss of control. An **altitude bust** occurs when an airplane deviates by more than 300' from its assigned altitude. A pilot could be suspended from duty for an altitude bust. This represents at least a risk of loss of flying privileges and at worst a risk of collision with airplanes flying at adjacent altitudes.