Why are go-around policies ineffective?

The psychology of decision making during unstable approaches

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1. Problem Statement

A lack of go-arounds is the number one risk factor in approach and landing accidents and the number one cause of runway excursions (1). Recent analyses of the past 16 years indicate that 33% of all accidents are runway excursions, the most common type of accident (2). Unstable approaches occur on 3.5% to 4.0% of all approaches, meanwhile, only about 3% of these unstable approaches result in go-arounds while 97% of aircrews in this state continue to land (1). The Flight Safety Foundation (FSF) initiated a 'Go-around Decision Making and Execution Project' (2011) designed to mitigate industry runway excursions due to unstable approaches by achieving a high level of pilot compliance with unstable approach go-around policies. This enhanced compliance will result from answering the research question, "Why are go-around decisions that policy states should be made actually not being made during so many unstable approaches?" and then making recommendations based on the findings. This survey study sought to understand the etiology of compliant versus non-compliant go-around decision making using unique questioning and experimental methodologies. These included assessing pilots' experiences using a series of questions designed to explore the psychological precursors of risk assessment and decision-making.

2. Approach and Methodology

<u>Scenario recall.</u> In this study we asked pilots to recall specific instances of unstable approaches, at or below stable approach heights (SAH), that would be recent (i.e., we asked for the *last instance* they had experienced), and therefore highly memorable to them. The vivid information that this special "situated recall" task would elicit was necessary for what we needed pilots to report to us comprehensively and in detail, namely, their experiences during the minutes leading up to and including a decision whether or not to call a go-around. These experiences include subjective aspects of their own states (e.g., their situational and risk assessments, felt social pressures, fatigue, beliefs about their companies' go-around policies, etc.) as well as their psychological representations of the objective factors characterizing the aircraft and the environment during their approaches (e.g., flight instabilities, visual reference

conditions, environmental and ATC factors, etc.). These variables constitute a full and in-depth recounting of the objective factors and their resulting psychological states during the critical time interval leading up to their decisions, states that were hypothesized to be the highly important precursors of those decisions. In addition, to help refine the analysis pilots also reported a variety of basic demographic information (e.g., rank, time on type, base of operations, etc.) and flight operational characteristics (long versus short haul operations, aircraft type, etc.). The content of the entire survey was thoroughly reviewed, commented upon and amended in accordance with the recommendations made by members of the FSF International Advisory Committee (IAC), the European Advisory Committee (EAC) and other expert advisory team members by which it was vetted.

Among pilots who had experienced both go-around and unstable approach events, we randomly assigned some to recall a scenario in which they had flown an unstable approach (UA) but did not call a go-around, and others to recall a go-around (GA) event. This random experimental assignment would allow us to confidently identify those objective and psychological situational factors associated with non-compliance with GA policies regarding go-around decision making. Pilots who reported they had only flown GAs or UAs recently (i.e., in the last five years) simply recalled their last event of those respective types.

The main set of psychological and psychosocial factors assessed were a differentiated set of nine facets of awarenesses that "unpack" the concept of *situational awareness* in a comprehensive and holistic way, giving a rich phenomenological account of unstable approach landing conditions as they are lived, and providing useful and targeted guidance for mitigations. This set of psychosocial awarenesses (Presage Group Inc.) includes the aspects detailed in Table 1, which comprise an inter-related system of mutual causation. It was hypothesized that greater awareness on each of our nine awareness dimensions would be associated with making better assessments of risk and decisions to go around; in general, greater situational awareness competencies are associated with more operationally compliant decision making.

Table 1. Glossary of Presage Situational Awareness Constructs

Construct Name	Description
Affective Awareness (C1) "Gut feeling for threats"	Pilot's gut feelings for threats; seat of the pants experience, which is characterized by an emotional, sensory experience that triggers further cognitive analysis
Anticipatory Awareness (C2) "Seeing the threats"	Pilot's ability to see and/or monitor real and potential threats as they move and change over time and space
Critical Awareness (C3) "Relying on experience"	Pilot's ability to draw from their personal and professional experience bank as a means to assess here and now events as "normal"
Task-empirical Awareness (C4) "Knowing the limits"	Pilot's expert knowledge of the operational envelope of his/her equipment

Functional Awareness (C5) "Knowing the instruments and equipment"	Pilot's expert knowledge of knowing how to read and translate what his/her instruments are telling them
Compensatory Awareness (C6) "Adjusting to threats"	Pilot's ability to know how and when to compensate or adjust correctly for present and anticipated future operational conditions in order to ensure safe – compliant operations
Hierarchical Awareness (C7) "Knowing the procedures"	Pilot's expert knowledge of operational procedures, their order and correct sequencing
Relational Awareness (C8) "Keeping each other safe"	Pilot's ability to accurately assess and engage crew member relationships in a manner that protects safety and compliance
Environmental Awareness (C9) "Company support for safety"	Pilot's experience of how their company supports and encourages safety and how this in turn shapes his/her commitment to safe and compliant behavior

Go-around thresholds. A second experiment was also included in this survey, about which we report some findings below, but whose details are too numerous to fully describe here.[1] This experiment was designed to uncover the environmental and physical instability parameters that have the most influence on pilots' perceptions of the risks inherent in flying unstable approaches, and to examine when their attention to these parameters affects their judgments about when to call go-arounds. In this study, pilots were presented with a hypothetical flight scenario in which they were randomly assigned to receive variations in the severity of the risk associated with wind conditions, runway conditions/braking action and runway length. They were then asked at what degree of deviation, on five different flight parameters, those variations would cause them to call a go-around. Pilots were instructed to report on their likelihood of calling a go-around based on their own *personal* risk criteria, not those of their companies or of the industry, on this set of five flight parameters, and to do so at different altitudes. This allowed us to infer where on the flight path different risk factors become personally salient and important as drivers of pilots' judgments to go around, and how these factors might interact. The objective was to determine whether or not there was basic alignment between pilots' perceptions about when there is a need to call a go-around and general industry policies about when these instabilities necessitate such a decision. In the case of evidence of any gaps between these two, our goal was to use these data to guide realistic recommendations about changes to policy that might bring them into alignment, while ensuring no compromise to safety. To the extent that pilots' do not see current policies as constituting a set of legitimately unsafe conditions, they are likely to ignore such SOPs and engage in potentially riskier, noncompliant flight behaviors. This was an experimentally-based attempt to explore pilot perceptions of what *should* constitute the conditions to go around, in *their* experienced judgment, and to begin to develop a view about whether such beliefs could or should be incorporated into industry SOPs in a way that would be helpful in ensuring compliant, safe behaviour.

A note on future reporting. To complete the circle among stakeholders in this research program, we also created a version of the survey for the express use of those responsible for the development, implementation, and quality control of go-around policies and procedures—flight operations management staff. Our goal was to examine the degree of alignment of the perceptual-judgmental reports of this group of managers with pilots' perceptions on similar measures. This study is underway but not yet complete. Its results will be published in a future report.

Respondent sampling. Respondents for this Flight Safety Foundation-sponsored survey were solicited through direct communication with both safety personnel at various pilot associations and FSF-member and non-member airlines globally, as well as through various social media forums. The goal was to invite and administer the online survey to as many pilots as possible from across the world, representing a variety of fleets, aircraft, flight operations, respondent experience levels, cultures, physical geographies, and so on. Anonymity was assured in order to inspire honest and complete self-reports of pilots' experiences, as well as to stimulate participation. Among the 2,340 pilots who completed the survey, we achieved a good range of pilot experience and operational types, as well as wide geographical representation, suggesting our results are generalizable to pilots worldwide (see Table 2).

Table 2. Sample Characteristics (n=2,340)

Variable	Category	% of sample
Gender	Male	97%
	Female	3%
Continent of operations	Africa	1%
	Asia	25%
	Europe	28%
	North America	34%
	Oceania	0%
	South America	12%
First language	Non-English	56%
	English	44%
Initial Training	Non-Military	74%
	Military	26%
Current Position	Captain	66%
	First Officer	33%
	Relief Pilot	1%
Flight Hours (Career)	Median	10,000
	Range	200 - 31,000
Aircraft Operation	Passenger	88%
	Charter	4%
	All cargo	7%
	Corporate	<1%
	Inactive	<1%
Type of Operation	Short-haul	62%
	Long-haul	38%

3. Results and Discussion

Part 1. Analysis Strategy; Overview of Results

The design of this study enabled us to look at the differences between those pilots who were compliant with their companies' policies and those who were not across various objective and subjective measures. Table 3 presents data for the demographic, flight operational, and objective factors present in the unstable approach events reported by pilots. Table 4 shows results for the psychological measures taken, that is, the Presage situational awareness variables, psychosocial factors (fatigue, risk assessment, etc.), and crew interactions. Table 5 illustrates findings for measures, in hindsight, of how pilots evaluated the outcomes of their decisions and what they perceived the main influences to have been on their choices (i.e., personal, interpersonal, operational and organizational).

In these three tables, pilots are divided into four different groups for comparison:

1) GA-only history/GA recall (27% of sample): pilots who reported they had only flown one or more go-arounds in the last five years, but no unstable approaches, and who were therefore asked simply to recall their last go-around event;
2) Mixed history/GA recall (16%): pilots who had flown one or more go-arounds and one or more unstable approaches (past five years) and who were randomly assigned to recall their last go-around event;
3) Mixed history/UA recall (36%): pilots who had flown one or more go-arounds and one or more unstable approaches (past five years) and who were randomly assigned to recall their last unstable approach event; and
4) UA-only history/UA recall (21%): pilots who reported they had only flown one or more unstable approaches in the last five years, but no go-arounds, and who therefore were required to recall their last such unstable approach event.

A comparison of groups 2 and 3 (a combined 52% of total sample) within each table represents one focus of the analysis, as only these pilots were randomly assigned to the two different situated recall conditions. This random assignment controls for chronic pilot factors that would otherwise be "experimentally confounded" with their self-selection into a recall event condition (GA or UA) by virtue of the fact that they had recently only ever experienced that one type of event. Findings from a comparison of these groups are conservative, and represent situationally important factors associated with go-around decision making, not pilot dispositional factors. However, pilot tendencies and preferences associated with flying UAs are of course present in the aviation community, and we will also point out in the data how such pilot dispositional factors may additionally contribute to non-compliance with go-around SOPs.

Table 3. Results for Pilot and Flight Scenario Characteristics

	Pilot Types / Recall Conditions				p < .05	
Pilot Demographics	**(1) GA-Only History / GA Recall**	**(2) Mixed History / GA Recall**	**(3) Mixed History / UA Recall**	**(4) UA-Only History / UA Recall**	**(1) and (2) vs. (3) and (4)**	**(2) vs. (3)**
% Male pilots	97	95	96	96	ns	ns
% Captains	64	64	58	46	Y	ns
% First officers	34	35	39	52	Y	ns
Average total flight hours at time of event (h)	9005	10077	9495	8557	ns	ns
Average total time on type at time of event (h)	3163	2757	3099	2830	ns	ns
% Respondents whose first language was same as crew	82	**78**	**85**	86	Y	**Y**
% Base of operations: Asia	24	**27**	**14**	20	Y	**Y**
% Base of operations: Europe	20	20	26	33	Y	ns
% Base of operations: North America	17	43	42	42	Y	ns
% Base of operations: South America	35	**2**	**11**	2	Y	**Y**
Flight Characteristics						
Recency of Event (Mean months in past)	26	38	37	32	ns	ns
% Short haul	76	82	78	76	ns	ns
% Long haul	24	18	22	24	ns	ns
% VMC approaches	68	**73**	**85**	86	Y	**Y**
% IMC approaches	17	**17**	**8**	7	Y	**Y**
% Precision approaches	48	36	38	39	ns	ns
% Non-precision approaches	20	16	12	11	Y	ns
% Approaches with active instrument reference	33	32	35	33	ns	ns
% Approach without active instrument reference	7	**12**	**6**	12	ns	**Y**
% Manual approach to recognition of instability	37	49	44	42	ns	ns
% Automated approach to recognition of instability	39	22	29	25	ns	ns
% Combined manual and automated approach	24	29	26	32	ns	ns
% Unstable at stable approach height	68	**77**	**85**	88	Y	**Y**
% Unstable after stable approach height	32	**23**	**15**	12	Y	**Y**
% Respondents who were flying	54	56	53	52	ns	ns
% Respondents who personally made the decision to go-around	84	73	NA	NA	NA	NA
% Respondents who made the decision to continue unstable	NA	NA	59	50	NA	NA
% Respondents who discussed a go-around	NA	NA	46	41	NA	NA
Mean altitude at which decision was made (ft)	772	713	843	763	ns	ns
Incidence of instability factors (%):						
Flight path deviation	64	**70**	**49**	55	Y	**Y**
Aircraft speed exceeded V_{REF} +20 knots	50	58	63	64	Y	ns
Aircraft speed was less than V_{REF}	9	**9**	**4**	5	Y	**Y**
Sink rate exceeded 1,000 feet per minute	48	47	47	53	ns	ns
Power setting was not appropriate for the aircraft	42	47	51	57	Y	ns
Aircraft was not in the correct landing configuration	30	24	29	24	ns	ns
Briefings and checklists were not complete	16	13	14	16	ns	ns
Incidence of environmental factors (%):						
Tailwind	39	33	32	25	Y	ns
Windshear	25	**20**	**13**	8	Y	**Y**
Turbulence	34	23	20	16	Y	ns
Insufficient visual reference	21	**19**	**10**	8	Y	**Y**
Contaminated runway	14	**12**	**6**	3	Y	**Y**
Incidence of ATC factors (%):						
Occupied runway	8	4	5	5	ns	ns
Inadequate separation on approach	12	10	11	13	ns	ns
Wake turbulence	9	2	3	3	Y	ns
Late clearance or poor approach vectoring	35	43	35	44	ns	ns

Notes: 1) 'ns' = 'non significant'; 2) 'NA' = 'non available comparison'; 3) numbers bolded for the two Mixed Groups represent statistically reliable effects

Table 4: Results for Psychosocial Factors

	Pilot Types / Recall Conditions				p < .05	
	(1) GA-Only History / GA Recall	**(2) Mixed History / GA Recall**	**(3) Mixed History / UA Recall**	**(4) UA-Only History / UA Recall**	**(1) and (2) vs. (3) and (4)**	**(2) vs. (3)**
Mean scores on Presage situational awareness constructs (6-pt; high=higher awareness):						
Affective Awareness (Gut feel for threats)	4.39	**4.30**	**3.29**	3.36	Y	**Y**
Functional Awareness (Knowing the instruments & equipment)	4.83	**4.36**	**3.28**	3.41	Y	**Y**
Critical Awareness (Relying on experience)	4.22	**4.28**	**3.90**	3.68	Y	**Y**
Anticipatory Awareness (Seeing the threats)	4.13	**3.74**	**3.37**	3.25	Y	**Y**
Task-Empirical Awareness (Knowing the limits)	5.04	4.72	4.77	4.78	Y	ns
Compensatory Awareness (Adjusting to threats)	3.69	**3.28**	**2.43**	2.50	Y	**Y**
Relational Awareness (Keeping each other safe)	4.57	**4.49**	**4.24**	4.10	Y	**Y**
Hierarchical Awareness (Knowing the procedures)	4.73	**4.42**	**4.19**	4.22	Y	**Y**
Environmental Awareness (Company support for safety)	5.28	5.08	5.05	5.08	Y	ns
Mean scores on key psychosocial factors (6-pt; high=higher score on dimension):						
Presence of fatigue	2.85	2.75	2.92	2.74	ns	ns
Proper fatigue management	4.14	**4.08**	**3.75**	3.61	Y	**Y**
Ability to listen to / understand gut feeling warnings about risk	4.86	**4.50**	**4.17**	4.19	Y	**Y**
Ability to anticipate a GA	4.22	**4.11**	**3.29**	3.03	Y	**Y**
Confidence in GA performance abilities	5.36	5.29	5.34	5.28	ns	ns
General willingness to challenge crew	5.04	4.92	4.96	4.85	ns	ns
Event challenges to authority	3.02	2.83	2.93	2.92	ns	ns
Appropriate crew influence on GA decision making	4.98	**4.95**	**4.79**	4.56	Y	**Y**
Passenger pressure to land	4.26	3.61	3.80	3.78	ns	ns
Agreement with company UA/GA policies and procedures	4.78	4.29	4.24	4.37	Y	ns
Intolerance for deviance from GA policy and procedures	5.11	**4.59**	**4.32**	4.28	Y	**Y**
Anticipated company support for a GA decision	5.25	5.06	4.95	5.03	Y	ns
Assessment of the instability as risky/unmanageable	4.53	**4.20**	**2.36**	2.39	Y	**Y**
Company incentivization:						
% Who say their company reprimands pilots for performing UAs	46	50	45	43	ns	ns
% Who say their company reprimands pilots for performing GAs	3	7	4	4	ns	ns
Incidence of active consideration/discussion of instability factors (%)						
Flight path deviation	77	**81**	**69**	69	Y	**Y**
Aircraft speed exceeded V_{REF} +20 knots	86	**83**	**71**	66	Y	**Y**
Aircraft speed was less than V_{REF}	65	69	73	73	ns	ns
Sink rate exceeded 1,000 feet per minute	77	**73**	**62**	66	Y	**Y**
Power setting was not appropriate for the aircraft	73	61	59	58	Y	ns
Aircraft was not in the correct landing configuration	82	**81**	**64**	64	Y	**Y**
Briefings and checklists were not complete	71	44	57	54	ns	ns
Incidence of active consideration/discussion of environmental factors (%)						
Tailwind	66	65	71	68	ns	ns
Windshear	73	73	80	88	ns	ns
Turbulence	55	**75**	**49**	58	ns	**Y**
Insufficient visual reference	59	69	71	59	ns	ns
Contaminated runway	64	**88**	**60**	43	ns	**Y**
Incidence of active consideration/discussion of ATC factors (%)						
Occupied runway	65	**100**	**50**	91	ns	**Y**
Inadequate separation on approach	62	67	62	80	ns	ns
Wake turbulence	42	100	60	83	ns	ns
Late clearance or poor approach vectoring	70	70	71	64	ns	ns

Notes: 1) 'ns' = 'non significant'; 2) 'NA' = 'non available comparison'; 3) numbers bolded for the two Mixed Groups represent statistically reliable effects

Table 5: Results for Hindsight Judgments

	Pilot Types / Recall Conditions				**p < .05**	
	(1) GA-Only History / GA Recall	**(2) Mixed History / GA Recall**	**(3) Mixed History / UA Recall**	**(4) UA-Only History / UA Recall**	**(1) and (2) vs. (3) and (4)**	**(2) vs. (3)**
GA-UA outcomes (6-pt; high=agree):						
Our go-around was well executed	5.45	5.25	NA	NA	NA	NA
Our go-around was well coordinated among the crew	5.41	5.26	NA	NA	NA	NA
Our go-around was well coordinated with ATC	5.21	5.21	NA	NA	NA	NA
Our go-around was flown as expected	5.43	5.18	NA	NA	NA	NA
Our landing was normal	NA	NA	4.74	4.76	NA	NA
Our landing was long	NA	NA	2.42	2.67	NA	NA
We experienced reduced control on the runway	NA	NA	1.45	1.39	NA	NA
We were off the centreline on touchdown	NA	NA	1.43	1.46	NA	NA
We had a hard/rough landing	NA	NA	1.55	1.49	NA	NA
We had negative passenger reactions	NA	NA	1.34	1.36	NA	NA
Post-flight evaluations of the decision and its outcomes (6-pt; high=agree)						
I felt we made the right decision to GA/continue the landing while unstable	5.77	**5.74**	**3.51**	3.50	Y	**Y**
If had made opposite decision, would not have altered the risk	2.89	**3.03**	**3.41**	3.18	Y	**Y**
Should not have made the decision we did	1.40	**1.43**	**4.15**	4.08	Y	**Y**
Called go-around (GA) / engaged in risk (UA) needlessly	1.99	**1.84**	**3.26**	3.42	Y	**Y**
We got support from our company for the decision to GA/land in an UA	5.47	**5.17**	**2.18**	2.25	Y	**Y**
We got criticism from our company for the decision to GA/land in an UA	1.40	**1.48**	**2.22**	2.02	Y	**Y**
Company's SOPs for initiating go-arounds served us well (GA) / poorly (UA) that day	5.26	**4.77**	**2.91**	3.07	Y	**Y**
Changing views of GAs and UAs (%)						
% My views on calling go-arounds changed after experiencing this event	14	**21**	**43**	45	Y	**Y**
% My views on flying unstable approaches changed after experiencing this event	17	**21**	**43**	45	Y	**Y**
Beliefs about degrees of influence on decision for (4-pt; high=strong influence):						
Aircraft instabilities	2.88	**2.98**	**1.57**	1.52	Y	**Y**
Weather	2.36	2.15	1.95	1.77	Y	ns
Fatigue	1.77	1.64	1.77	1.67	ns	ns
Crew coordination	1.82	**1.87**	**2.10**	2.12	Y	**Y**
Crew communication	1.74	1.88	1.96	2.09	Y	ns
Experience	2.44	2.61	2.68	2.85	Y	ns
Crew competency	1.88	2.09	2.18	2.35	Y	ns
Aircraft configuration	2.04	**1.96**	**1.74**	1.72	Y	**Y**
Company pressure to land	1.15	1.27	1.25	1.23	ns	ns
Commercial pressure to land (passenger connections, scheduling, etc.)	1.30	**1.43**	**1.60**	1.48	Y	**Y**
Peer/professional pressures to land	1.29	**1.55**	**1.81**	1.96	Y	**Y**
ATC pressure to land	1.29	1.36	1.37	1.30	ns	ns
Critical aircraft system(s)	1.25	**1.27**	**1.10**	1.06	Y	**Y**
Communication with ATC	1.57	1.54	1.52	1.55	ns	ns
Fuel levels	1.29	1.25	1.38	1.33	ns	ns
Personal resistance to managing the demands associated with a go-around	1.29	**1.44**	**1.63**	1.61	Y	**Y**

Notes: 1) 'ns' = 'non significant'; 2) 'NA' = 'non available comparison'; 3) numbers bolded for the two Mixed Groups represent statistically reliable effects

It is our belief that the best way to present the findings is to describe how pilots' non-compliant behavior is a function of a decision making process influenced by: 1) the in-flight aircraft and environmental factors that shape their decisions; 2) their situational awareness competencies in encoding and making meaning of the cues they receive about these aircraft and environmental factors; 3) their personal perceptions of risk and risk tolerance that then result; and 4) their appetite for appropriate crew collaborative conversation around risk during the approach as an input to decision making. It is from both the pilots' responses within each of these four classes of variables, as well as the interactions between them, that a complete descriptive, psychological profile for non-compliance emerges.

Part 2. The Optimal Situational Awareness Profile

Situational awareness of his or her environment, in all its facets, is the psychological prerequisite state for a pilot to judge risk and then for them to make a decision to maintain compliance and safety in light of that judgment. This study employed The Presage Group's Situational Awareness Model for measuring and interpreting the psychological and social factors that collectively make up situational awareness. Recall that within this model, situational awareness comprises nine distinct but interconnected and seamless aspects of awareness. Much of our discussion will be framed around how each of these aspects influences a pilot's decision making processes, singly and in concert with one another, to remain compliant versus non-compliant. (We note in passing that the Presage model classifies with an average 85% accuracy whether pilots are describing an unstable approach and landing or a go-around—88% for UAs and 82% for GAs—based only on its psychosocial measurements and excluding any knowledge of the objective factors present in the unstable approach scenarios reported. This means that our assessment of the lived experience of awareness, as we have measured it, does a very good job of predicting pilots' decision making behaviour—far beyond a 50% chance level of prediction).

In a perfect response to an unstable approach, the "Optimum Situational Awareness Profile" (OSAP) for a pilot flying an aircraft so as to maintain compliance to their company's SOPs, might look something like the following. (Note: while we serialize the description in steps here for ease of exposition, the reader should not lose sight of the fact that these awarenesses exist in a mutually inter-dependent whole of causation, with rapid feedback loops and interactions connecting each to the other). Imagine a late-developing instability below SAH and consider the pilot's phenomenological experiences of it, *as it is lived*:

Example OSAP Experience:

1. At a point immediately above stable approach height (SAH) the pilot's "gut", or what we refer to as their ***affective awareness,*** subtly signals to him or her to confirm that the aircraft's flight characteristics and profile are normal. In a near-instantaneous and seamless fashion, this should be followed by…..

2. A visual check, or what we refer to as a ***functional awareness***, which would be made where the pilot's expert knowledge and their ability to understand their instruments play a key role in confirming that the cue from their gut was, in fact, correct or not. Simultaneously, there is an….
3. Immediate and confirmatory statement from the pilot's network of past experiences, or ***critical awareness*** as we have termed it, in which their professional experience confirms the presence of a "normal" flight profile. Seconds later, however, imagine that in continuing its descent below SAH the aircraft encounters significant in-flight turbulence with headwinds shifting to tailwinds and downdrafts altering V_{REF} by +21 knots, accompanied by a vertical descent now greater than 1100 feet per minute. Instantly….
4. The pilot's ***anticipatory awareness,*** his or her ability to see these threats, registers in harmony with the reactivated gut, expert instrument knowledge, and experience, which are now signaling a non-normal event, and there arises an immediate need for a signal from….
5. ***Task-empirical awareness,*** the pilot's expert knowledge of the safe operational envelope limits, which confirms that although the aircraft is now unstable it perhaps still remains within the safe operational envelope. However before concluding that parameters are now safe or unsafe, this developing event requires immediate input from another competency….
6. ***Compensatory awareness,*** or the ability to understand how to compensate correctly for non-normal events, by referencing through *functional awareness* whether or not the instruments will direct back to a normal condition if acted upon. Whether the answer, not yet fully formed, is likely to be 'yes', 'no' or uncertain, the pilot is also simultaneously receiving….
7. Through ***relational awareness***—the pilot's knowledge of how they use their relationships to protect safety—input that re-enlivens a memory trace of a prior verbal signal from a conversation and agreement earlier in the approach, initiated by the PNF, that a go-around was possible should the aircraft become unstable at or below SAH, which….
8. Informs and motivates the pilot to engage ***hierarchical awareness,*** or their expert knowledge of operational procedures under specific operational conditions, so as to confirm their ability to safely fly a go-around if necessary. Finally, with the crew in agreement and….
9. Confident that their company will support their decision to initiate a go-around, an expression of their ***environmental awareness***, the PF puts all of these elements together to judge that the risks confronting them are not fully manageable, and so decides to call for a go-around.

The results of this study revealed, as hypothesized, that on all nine of these inter-related situational awareness factors, UA pilots scored significantly less aware than GA pilots in the moments leading up to and including their go-around decision making (see Table 4)—that is, they were less aware of their emotional responses to threat, and less able to anticipate risk, and more over-confident in their ability to compensate for the instability, and in less agreement with company SOPs, etc.. In other words, when measured against the optimum situational awareness profile (OSAP), the UA-recall pilots scored much lower than did the GA-recall pilots on every facet of situational awareness assessed. Seven of these nine differences held up statistically to the more situationally rigorous analysis that compared just the experimentally assigned GA and UA pilots with one another. And eight of the nine differences between the experimentally assigned GA and UA pilots were even more pronounced when comparing the GA-only and UA-only groups—groups which add back into the situational mix more enduring pilot predispositions/behaviors as assessed by their more chronic tendencies to have flown only unstable approaches or go-arounds in the last five years.

It is meaningful to ask, "How do these awarenesses shape a pilot's perception of risk?" Put simply, a pilot's situational awareness competencies directly affect their perceptions and assessment of risk. The lower the degree of threat pilots associate with instability and environmental factors, whose perception is directly informed by their situational awarenesses, the lower the significance pilots will place on the contributing factors present and the less risky they will perceive the situation to be. Table 4 shows just this result, with UA-recall pilots reporting much lower assessments of the riskiness and unmanageability of their instabilities than GA-recall pilots.

Part 3. The Spreading Activation Effect of Situational Awareness Competencies

We have asserted that the inter-dependent nature of the facets of situational awareness means that a decline in one will produce a rapid deleterious effect on the others. This statement becomes very clear when we consider the data relevant to this "spreading activation effect" of situational awareness facets. For example, this cross contamination effect is evident among the UA pilot groups, whose lower scores on their gut feel for threats (**Finding 1**) (see Table 4), as well as on seeing the threats (**F2**), leaves them vulnerable to minimizing both their assessment of the potential threat of aircraft instability, as well as their ability to see the threat of instability as a risk to be managed correctly. The natural outcome of this is that more UA pilots are unstable at SAH (Table 3). A corollary effect of these lower awareness scores is that UA pilots also score lower in their ability to leverage crew relationships to maximize compliance and safety; Table 4 shows that UA pilots are more likely to minimize efforts to consider and/or discuss with their crewmembers both instability factors (**F3**) (i.e., flight path deviation, aircraft V_{REF}+20 kts, sink rate, and landing configuration), and environmental factors (**F4**) (i.e., turbulence, contaminated runway, occupied runway).

It is the culminating effect of the aforementioned reduced awareness competencies that leaves the UA pilots vulnerable to adopting a mental model which minimizes the risk of instability and in so doing reduces their attention to details (**F5**). As the results for "knowing the instruments and equipment" and "knowing the procedures" indicate (i.e., functional and hierarchical awareness, in Table 4), UA pilots are more tolerant of deviations from operational limits and procedures (**F6**), as well as less compliant with performing all checklists and standard calls (**F7**). Moreover, as these pilots commits further to continuing with an UA they minimize what their professional experience could offer (**F8**) in terms of executing what the SOP states (Table 4, "relying on experience" or critical awareness). In other words, when an UA pilot is not tuned into salient information from his/her experience bank, they increase the risk profile of the operation and deny themselves the opportunity to correctly adjust or compensate for the operational threat (Table 4, "adjusting to threats" or compensatory awareness). The finding that UA pilots more often than GA pilots report being unstable at SAH confirms this missed opportunity to remain compliant (Table 3).

In concert with the former pattern is the finding that UA pilots were more comfortable in operating on the margins of the safety envelope (**F9**) (Table 4; lower scores on "knowing the limits" or task-empirical awareness), which translates to a greater tolerance for risk, which is seen to be manageable (**F10**) (see Table 4, assessment of the instability as risky/unmanageable). Once a pilot has turned down the volume on his or her situational awareness competencies they would likely also shut themselves off from available resources, such as by using their interpersonal relationships to protect operational safety and remain compliant (**F11**) (Table 4, "keeping each other safe" or relational awareness). There are a number of significant findings at the granular level of this construct which tell a very meaningful story in this regard. Most notable among these is that UA pilots are relatively more likely than GA pilots to: feel crew pressure to land; perceive a lack of crew support for a possible GA decision (**F12**); feel discomfort in being challenged and in challenging others (**F13**); and feel inhibited to call a GA because of the authority structure in the cockpit (**F14**). Also, GA pilots are almost four times more likely than UA pilots to report recalling (56% vs. 13%) that an individual was prompting the crew to initiate a go-around (**F15**). The evidence is clear here that rather than leveraging the crew relationships as a tool for safe decision making, crew roles, expectations and communications had a suboptimal, even deleterious, effect. Finally, compounding this risk profile are the findings that UA pilots score lower on "company support for safety (**F16**) (Table 4), that fewer than 50% of UA-recall pilots believed they would be reprimanded for landing unstable while, at the same time, maintaining that their company's criteria for when to execute a GA is not realistic (**F17**) (Table 4). In the end, for the UA pilots there is less buy-in to company SOPs, and an incentive structure that "encourages," or is at least not seen to discourage, unstable approaches when landing.

These results describe a situation that creates internal conflict for the UA pilots, at least in hindsight, where they express regret for the decision they made to continue unstable and land (see Table 5). Specifically, compared with GA pilots, UA pilots rated their flight outcome less positively, felt less often that they had made the right decision, felt much more strongly than GA pilots that they should not have taken the decision they did and, finally, agreed more strongly that they had engaged in needless risk.

Part 4. Interpretation of "Conflicting" Results

The results appear to imply a conflicting message from the UA pilot group. On one hand, UA pilots feel regret about their decisions to continue unstable and land knowing that they have engaged in taking risk, and yet at the same time they don't feel the company's criteria for a GA is realistic (**F18**) (see Table 4, where their agreement with their companies' SOPs is middling). The latter may be, in part, a rationalization of their non-compliant decision, and one that they carry forward into the next such unstable approach situation. At the moment of decision, the potential for non-compliant behaviour based on these beliefs is very present, while the chance that pilots may anticipate post-decisional regret for a non-call to go around and have that cue act as an inhibitor of their tendency to continue to fly unstable seems remote.

Consider the ingredients present in the psychosocial safety stew of these UA pilots at the time they need to make an appropriate decision whether or not to go around: they have a lowered sense of situational awareness across most facets, which has led them to minimize the importance of objective threats in their assessment of risk (**F19**) (Table 4). Further, their decision making process finds little failsafe in protective crew norms and processes (**F20**) and there is no real disincentive to fly in unstable based on the expected company response to that decision. These are the ingredients of a recipe for the "normalization of deviance" to contaminate this component of aviation safety culture. Essentially, this term refers to the development of a "new normal" mode of operation, which is passively supported, tolerated and/or approved by its stakeholders (pilots), owners (company management), and in some cases, regulators. Once entrenched within a given culture this new mode's power and authority can be overwhelmingly influential on behavior, as evidenced in the Challenger and Columbia space shuttle tragedies (3). There is supportive evidence from the results of this study indicating that in their acceptance of the new normal, UA pilots have surrendered a level of situational awareness competency that directly impacts accurate risk assessment and full compliance with SOPs as published. In short, new norms, roles and incentives have come to displace some of the influence that situational awareness should have in proximity to risk assessment and decision making (**F21**).

Part 5. Pilot Thresholds for Going Around

Another area remaining for brief discussion is the second experimental part of the survey, wherein pilots were asked to provide their risk tolerance thresholds for various in-flight parameters, given a set of flight and environmental conditions[1]. We found that braking action (good vs. poor) had a particularly large impact on a pilot's perception of the degrees of instability that warrant calling a go-around. On the whole, however, pilots' thresholds for calling go-arounds varied as a function of both height above ground level (agl) and the instability parameter they were considering as a reason to go around. For several of these instability factors, the perceived threshold occurred well below 1000' agl (see Figures 1 to 3) (**F22**). In particular, pilots felt they should be on profile at roughly 800' agl (Fig. 1), and that they could compensate for instabilities for V_{REF+} and sink rate later on in the decent, at around 500' agl (Fig. 2, 3) (**F23**).

Figure 1. GA thresholds for flight path deviation

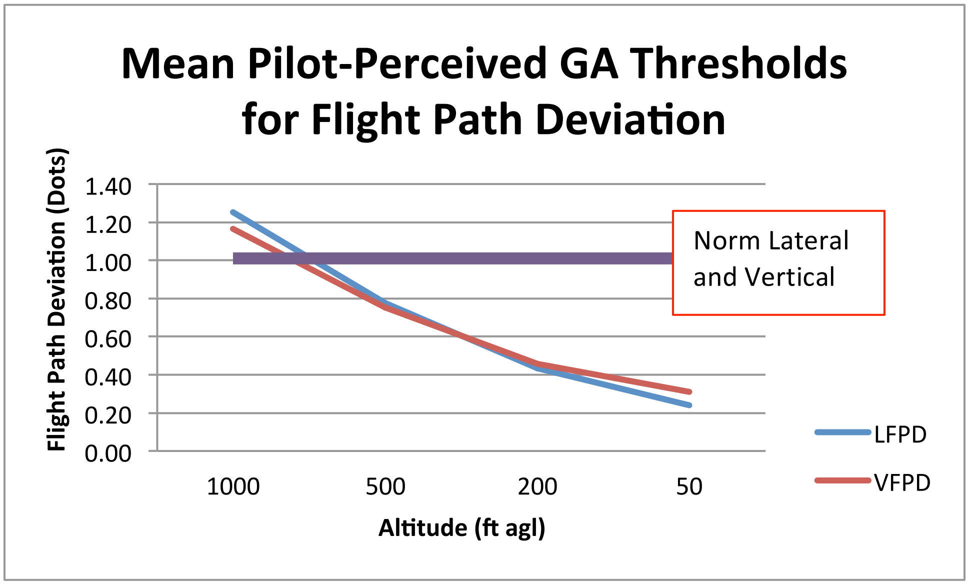


Figure 2. GA thresholds for velocity deviation

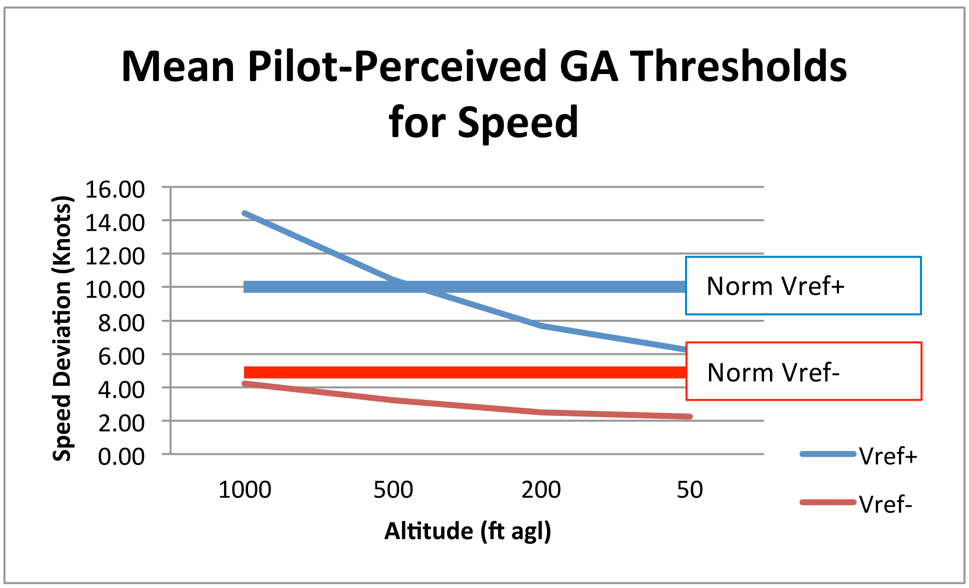
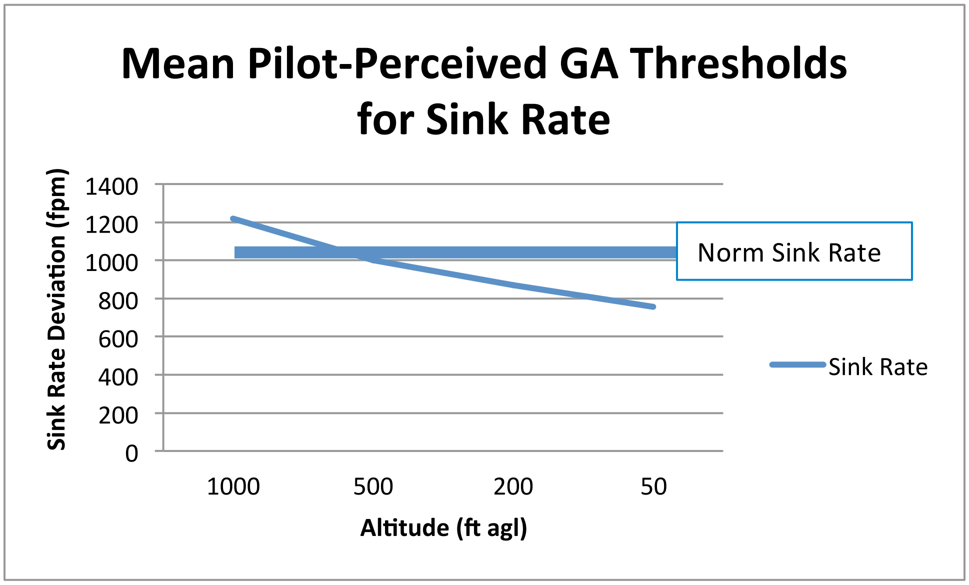


Figure 3. GA thresholds for sink rate deviation



Part 6. Varying Objective Levels of Unstable Approach Risk

Finally, a full analysis of the objective levels of risk present in each event our pilots recalled is warranted to fully explain the phenomenon of broad noncompliance with go-around policies and SOPs. The inherent risks associated with the 97% of approaches that continue unstable can only be indirectly inferred from the present methodology, based on pilot self-reports. This study mainly assessed the psychological characteristics and attributes, *in situ*, of pilots who choose to continue unstable approaches to landing versus those who make decisions to go-around. It does not segregate the various unstable approach scenarios described into classes of environments presenting high risk versus low objective risk. While it is understood that not all unstable approaches carry the same level of inherent risk, within the 97% of unstable approaches that are flown to completion exist the highest-risk approaches and these can, and have, resulted in runway excursions. In the absence of a definition of the objective level of risk associated with a given approach, all pilots have at hand is but one set of criteria, one definition of the instabilities and environmental threats that is expected to trigger a go-around choice. Beyond this single definition, it is up to the pilot to further determine what they perceive as a safe and manageable level of risk to entertain. This determination flows directly from their levels and kinds of situational awareness and the mental models of risk they construct based on those awarenesses. To the extent that a pilot has lowered situational awareness, whether caused by acute aspects of the situation such as a high workload or chronic aspects of the cultural environment such as lessened acceptance of their company's GA SOPs or generally few challenges to cockpit command, they will be less sensitive to relevant situational awareness cues and therefore be more likely to continue their unstable approaches irrespective of the inherent objective risks associated with their approach. These inadequately informed mental models of risk less accurately and sensitively represent the objective levels of threat present. As a result, they will not track "reality" sufficiently well and will tend to produce an over-occurrence of non-compliant decision making.

4. Recommendations

As the FSF Go-around Decision Making and Execution Project is ongoing, and as results of other survey work and go-around analysis is pending, the following recommendations are preliminary and based upon the results of this portion of phase 1 work. We offer the following recommendations with three essential strategies in mind.

S1. Enhance situational awareness (psychosocial awareness) through policy and procedural enhancements and communication improvements, to heighten flight crews' situational awareness throughout the approach, through the SAH, and beyond - until landing.

S2. Optimize the stable approach definition and height to maximize its relevance to flight crews and its manageability by flight managers/supervisors.

S3. Minimize the subjectivity of UA vs. GA decision making for the decision maker (e.g., PF, Captain as per company policy) to mitigate those specific components of situational awareness that directly compromise the pilot's risk assessment and decision making ability, so as to be able to more accurately assess operational risk and remain compliant.

It should be stressed that the above strategies cannot be addressed in isolation. In doing so one could increase rather than decrease the relative risk level of an unstable approach. For example, lowering a stable approach decision altitude (S2) without increasing the flight crew's risk situational awareness (S1) to compensate could increase risk.

Moreover, particular attention will be paid to the types of communication recommended. Of the three types of communication, passive, progressive and active, the latter two will be the focus of our recommendations as they are designed specifically to eliminate subjective factors and focus on only objective information, which ensures maximum situational awareness.

The following table lists preliminary recommendations, the corresponding finding(s) that support them and the strategy and psychosocial construct(s) they address.

Table 6. Recommendations

Recommendation		Finding(s)	Strategy(s)	Construct(s)
R1.	Re-define the stable approach criteria and stable approach height(s). In redefinition there is a valid argument to separate the profile (vertical and lateral) from the other stable approach criteria.	F9, F10, F16, F17, F22, F23	S2	C4, C9
R2.	Develop SOPs to discuss instability factors during approach briefings prior to descent.	F1, F3, F4, F11	S1	C1, C2, C7, C8
R3.	Develop SOPs to state critical instability factors (briefly) just prior to approach commencement, e.g. 5000 feet.	F2, F5	S1, S3	C2, C4, C6, C7
R4.	Develop 'active' communications procedures for each approach that are 'objective', 'progressive', and 'sequential', similar on concept to EGPWS or TCAS systems. E.g. at 1000 feet; "on profile/off profile", at 500 feet; "stable/unstable", at SAH; "stable/unstable"	F12, F13, F14, F15	S1, S3	C2, C7, C8
R5.	Separate the active 'objective' communications from the 'decision' communications. E.g. the PNF would verbalize the objective call, and the PF verbalize the decision call. This is particularly important for the case of junior PNF first officer paired with a senior PF Captain. Avoid the junior PNF pilot having to make a directive call, e.g. "go around".	F8, F11, F15	S3	C3, C8
R6.	Ensure UA and GA policies are clear, concise, and unambiguous, including follow up procedures for non-compliance.	F7, F17, F18	S1	C3, C8, C9
R7.	Develop automated stable approach monitor and alerting systems.	F1, F2, F6	S3	C1, C2, C5, C9
R8.	Avoid directive or suggestive calls that may compromise ongoing decision making, e.g. "Landing" at minimums.	F2, F9, F20	S1	C2, C3, C4, C8

R9.	Provide ongoing training to enhance psychosocial awareness and management, the components and their contribution to non-compliance during the approach phase.	F19, F21	S1	C1, C2, C3, C4, C5, C6, C7, C8, C9

5. Conclusions

This research and analysis set out to help determine if there exists, from a psychological point of view, an answer to the question "Why are go-around decisions that policy states should be made, actually not being made during so many unstable approaches?" and to then make preliminary recommendations based on the findings. It should again be noted that more work continues within the project scope to assess decision making of flight operations management, and the risk of executing go-arounds.

The results demonstrate that there are clear differences in situational awareness, crew interaction, risk assessment and decision making between flight crew who elect to continue with an unstable approach versus those who opt to go around. These psychological differences in the moments leading up to the point where a go-around decision might be made are robust and variegated, and imply a series of targeted mitigations that can be instituted to better ensure that go-around decision making will be compliant with companies' policies and procedures.

6. References

(1) Flight Safety Foundation Year In Review, IASS 2011.

(2) Flight Safety Foundation 2012.

(3) Vaughan D. (1996). The Challenger Launch Decision: Risky Technology, Culture and Deviance at NASA. Chicago: The University of Chicago Press.

7. Endnotes

[1]The interested reader is referred to a more comprehensive report of this study available on our website at www.presagegroup.com, where further details of the methodology of this second experiment and its results are described. Additional analyses and interpretations are also presented for the scenario recall experiment.