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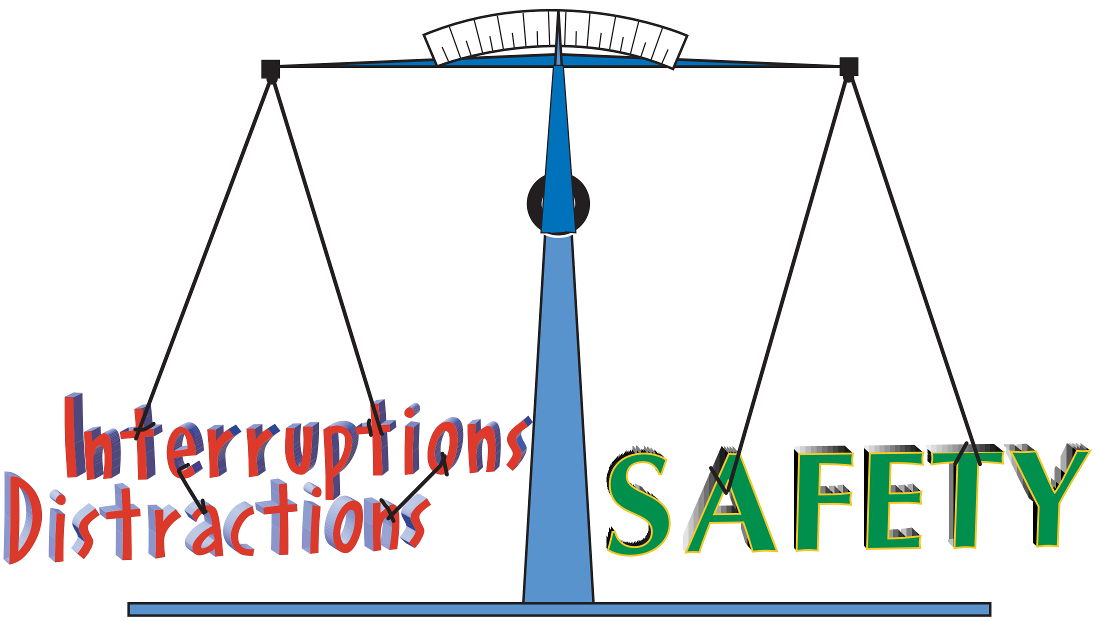

An Introduction to Issue Number 10 — December 1998

Here is Issue Number Ten of *ASRS Directline*. We have presented a summary of two of ASRS's research efforts—*Crossing Restriction Altitude Deviations on SIDs and STARs*, and *Communications-Related Incidents in General Aviation Dual Flight Training*. Both studies were presented at the Ohio State University Symposium on Aviation Psychology in 1997.

Another excellent article, *Cockpit Interruptions and Distractions*, is one of the best reviews of these types of problems we have seen—it may be an effective tool in your training syllabus or perhaps something you might wish to incorporate in your operational procedures.

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Here are the articles for Issue Number Ten:

We hope you enjoy this issue of *ASRS Directline*.

Charles Drew—*ASRS Directline* Executive Editor.

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Cockpit Interruptions and Distractions

Effective Management Requires a Careful Balancing Act[1]

by Key Dismukes, Ph.D., NASA Ames Research Center
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Captain Robert Sumwalt, Battelle[2]

Managing several tasks concurrently is an everyday part of cockpit operations. For the most part, crews handle concurrent task demands efficiently, yet crew preoccupation with one task to the detriment of other tasks is one of the more common forms of error in the cockpit. Most pilots are familiar with the December 1972 L-1011 crash that occurred when the crew became preoccupied with a landing gear light malfunction and failed to notice that someone had inadvertently bumped off the autopilot. More recently, a DC-9 landed gear-up...when the crew, preoccupied with an unstabilized approach, failed to recognize that the gear was not down because they had not switched the hydraulic pumps to high.

NASA has recently begun a research project to study why crews are vulnerable to these sorts of errors. As part of this project we reviewed NTSB reports of accidents attributed to crew error. We concluded that nearly half of these accidents involved lapses of attention associated with interruptions, distractions, or preoccupation with one task to the exclusion of another task. We have also analyzed 107 ASRS reports involving competing tasks; we present here some of our conclusions from this review. The 107 ASRS reports involved 21 different types of routine tasks crews neglected at a critical moment while attending to another task. Sixty-nine percent of the neglected tasks involved either failure to monitor the current status or position of the aircraft, or failure to monitor the actions of the pilot who was flying or taxiing.

Thirty-four different types of competing activities distracted or preoccupied the pilots. Ninety percent of these activities fell into one of four broad categories: (1) communication (e.g., discussion among crew or radio communication), (2) head-down work (e.g., programming the FMS or reviewing approach plates), (3) searching for VMC traffic, or (4) responding to abnormal situations. We will discuss examples from each category and suggest preventive actions crews can take to reduce their vulnerability to these and similar situations. Our suggestions are not perfect fixes, but we hope they will be useful. It is likely that research will ultimately provide more powerful solutions.

Category 1
Communication

✍ *"Copilot was a new hire and new in type; first line flight out of training IOE. Copilot was hand-flying the aircraft on CIVET arrival to LAX. I was talking to him about the arrival and overloaded him. As we approached 12,000 feet (our next assigned altitude) he did not level off even under direction from me. We descended 400 feet low before he could recover. I did not realize that the speed brakes were extended, which contributed to the slow altitude recovery."* (# 360761)

In this example, the Captain was attempting to help the new First Officer, but the combination of flying the airplane and listening to the Captain was too much for the new pilot. Tellingly, the act of talking distracted the Captain himself from adequately monitoring the status of the aircraft.

Thirty-one of these incidents involved altitude deviations or failure to make a crossing restriction.[3] In 17 of these 31 incidents (and 68 of the total 107 incidents) the crews reported being distracted by some form of communication, most commonly discussion between the pilots, or between a pilot and a flight attendant. Most, although not all, of these discussions were pertinent to the flight. However, in many cases the discussion could have been deferred. We later discuss how crews can schedule activities to reduce their vulnerability to distraction.

Research studies have shown that crews who communicate well tend to perform better overall than those who do not. But conversation has a potential downside because it demands a substantial amount of attention to interpret what the other person is saying, to generate appropriate responses, to hold those responses in memory until it is one's own time to speak, and then to utter those responses. One might assume that it is easy to suspend conversation whenever other tasks must be performed. However, the danger is that the crew may become preoccupied with the conversation and may not notice cues that should alert them to perform other tasks. (The accompanying sidebar explores the nature of interference between competing tasks.) Special care is required to avoid distraction when others enter the cockpit, because they may not recognize when the pilots are silently involved in monitoring, visual search, or problem-solving.

Category 2
Head-Down Work

✍ *"…Snowing at YYZ. Taxiing to runway 6R for departure. Instructions were taxi to taxiway B, to taxiway D, to runway 6R.…as First Officer I was busy with checklists [and] new takeoff data. When I looked up, we were not on taxiway D but taxiway W…ATC said stop…."* (# 397607)

In a review of airline accidents attributed primarily to crew error over a 12-year period,[4] the NTSB concluded that failure to monitor and/or challenge the Pilot Flying contributed to 31 of the 37 accidents. In 35 of the ASRS incidents we studied, the Pilot Not Flying reported that preoccupation with other duties prevented monitoring the other pilot closely enough to catch in time an error being made in flying or taxiing. In 13 of these 35 incidents (and 22 of the total 107 incidents), the Pilot Not Flying was preoccupied with some form of head-down work, most commonly paperwork or programming the FMS.

Monitoring the Pilot who is flying or taxiing is a particularly challenging responsibility for several reasons. Much of the time the monitoring pilot has other tasks to perform. Monitoring the other pilot is much more complex than monitoring altitude capture because the other pilot is performing a range of activities that vary in content and time course. Thus, it is sometimes difficult for the monitoring pilot to integrate other activi-

Task Management

Why do activities as routine as conversation sometimes interfere with monitoring or controlling the aircraft? Cognitive research indicates that people are able to perform two tasks concurrently only in limited circumstances, even if they are skillful in performing each task separately.

Broadly speaking, humans have two cognitive systems with which they perform tasks; one involves conscious control, the other is an automatic system that operates largely outside of conscious control.* The conscious system is slow and effortful, and it basically performs one operation at a time, in sequence. Learning a new task typically requires conscious processing, which is why learning to drive a car or fly an airplane at first seems overwhelming: the multiple demands of the task exceed conscious capacity. Automated cognitive processes develop as we acquire skill; these processes are specific to each task, they operate rapidly and fluidly, and they require little effort or attention.

Many real-world tasks require a mixture of automatic and conscious processing. A skillful driver in a familiar car on a familiar road can perform largely on automatic, leaving enough conscious capacity to carry on a conversation. However, if the automatic system is allowed to operate without any conscious supervision, it is vulnerable to certain types of error, especially a type of error called habit capture. For example, if we intend to take a different route home from work, we are prone to miss our turnoff and continue our habitual route if we do not consciously supervise our driving. Also, if we encounter a section of road that is difficult to navigate, we find that we cannot continue the conversation without risking errors in the driving, the conversation, or both. This is because the automatic processes are not adequate to handle the unpredictable aspects of the driving task.

Conscious control is required in four situations: i) when the task is novel, ii) when the task is perceived to be critical, difficult, or dangerous, iii) when an automatic process must be overridden to prevent habit capture, or iv) to choose among competing activities. The required mixture of automatic and conscious processing varies among tasks, and the mixture may vary with the moment to moment demands of a given task. Conversation, for example, generally requires a substantial amount of conscious processing because it involves novelty; we do not know what the other person is going to say and we have to formulate unique responses appropriate to the discussion. In contrast, an experienced pilot can manually fly a familiar aircraft in a largely automatic fashion. However, certain subtasks embedded in the act of flying manually require conscious attention. For example, leveling off at an assigned altitude requires consciously monitoring the

ties with monitoring because he or she cannot entirely anticipate the actions of the other pilot. Furthermore, serious errors by the pilot who is flying or taxiing do not happen frequently, so it is very tempting for the pilot who is not flying to let monitoring wane in periods of high workload.

Periods of head-down activity, such as programming the FMS, are especially vulnerable because the monitoring pilot's eyes are diverted from other tasks. Also, activities such as programming, doing paperwork, or reviewing approach plates, demand such high levels of attention that attempting to perform these tasks simultaneously with other tasks substantially increases the risk of error in one task or the other (see sidebar). Some FMC entries involving one or two keystrokes can be performed quickly and may be interleaved with other cockpit tasks. However, attempting to perform longer programming tasks, such as adding waypoints or inserting approaches during busy segments of flight, can be problematic. It is not possible for the Pilot Not Flying to reliably monitor the Pilot Flying or the aircraft status during longer programming tasks, and it is difficult to suspend the programming in midstream without losing one's place.

Category 3
Searching for VMC Traffic

"PRADO 5 Departure. Cleared to climb (and) received TCASII TA (which) upgraded to an RA, monitor vertical speed. While searching for the traffic we went past the NIKKL intersection...for the turn to the TRM transition. We had discussed the departure before takeoff; special procedures, combined with many step climb altitudes in a short/time/distance, made this a more demanding departure than most. Next time on difficult departures I will use autopilot sooner...will try to be more vigilant in dense traffic areas." (# 403598)

In 16 incidents crews failed to turn as directed by ATC on the SID or STAR they were following. The crews reported various activities competing for their attention; in three cases the activity was searching for traffic called out by ATC or TCAS. Altogether, crews reported searching for traffic as a competing activity in 11 of the 107 incidents. Searching for traffic takes the pilot's eyes away from monitoring aircraft position and status, and also demands substantial mental attention. If the conflict is close the urgency may further narrow the focus of attention.

One of the insidious traps of interruptions is that their effects sometimes linger after the interruption. For example, descending through 4500 feet, a crew might be instructed to report passing through 3000 feet. They might then respond to and quickly resolve a traffic alert, but forget the instruction to report by the time they reach 3000 feet. In this hypothetical example, searching for traffic preempts the reporting instruction from the crew's conscious awareness. The instruction presumably is still stored in memory in an inactive form, and if reminded, the crew probably will recognize that they were given the instruction. However, lacking such a reminder and being preoccupied with other activities, they do not remember to contact ATC as they pass through 3000 feet.

Category 4
Responding to Abnormal Situations

"Large areas of thunderstorms; we had to deviate considerably. Several (equipment malfunctions) in short period...then cabin pressure started climbing slowly in cruise (FL290). Troubleshooting...to no avail. Requested immediate descent. Descending through FL180, both crew members forgot to reset altimeters, putting us 300 feet low at FL130. To prevent this from occurring again during any abnormal, I will: 1) delegate tasks; have one person focus on fly-

ing the airplane while the other trouble-shoots and state clearly who will do what, 2) strictly adhere to company procedures." (# 404306)

In 13 incidents crews failed to reset their altimeters when passing through the transition altitude (18,000 feet MSL in the United States and Canada). It is especially easy to forget to reset altimeters if this action is not linked in pilots' minds to other actions. (For this reason some pilots make resetting altimeters part of a cluster of action items they routinely perform together, e.g., making a passenger announcement and turning on the seat belt sign. Some companies make resetting altimeters part of the descent checklist.) In principle, the problem is similar to that of monitoring for altitude level-off, except more vulnerable to error. In air carrier operations the crew is normally aided with altitude level-off by altitude alerting devices and by the formal procedure of making a thousand-foot call, confirmed by both pilots, before reaching the assigned altitude.

Abnormals = ***Distractions***

Two of the crews reporting to ASRS thought that they forgot to reset their altimeters stated they were preoccupied with an abnormal situation. Altogether, abnormals were a factor in 19 of the 107 incidents. Ironically, it seems that one of the biggest hazards of abnormals is becoming distracted from other cockpit duties. Abnormals easily preempt crews' attention for several reasons. Recognizing the cockpit warning indicators, identifying the nature of the problem, and choosing the correct procedure require considerable attention. Crews have much less opportunity to practice abnormal procedures than normal procedures, so choosing and running the appropriate checklists requires more effort and greater concentration of mental resources than running normal checklists. Also, in situations perceived to be urgent or threatening, the normal human response is to narrow the focus of attention, which unfortunately tends to diminish mental flexibility and reduce ability to analyze and resolve non-routine situations.

altimeter to read the numbers and to match the current altitude with the assigned altitude the pilot is holding in memory.

The framework outlined above allows some general conclusions about the circumstances under which two tasks may be performed concurrently. A task requiring a high degree of conscious processing, FMS programming, for example, cannot be performed concurrently with other tasks without risking error. Two tasks that are largely automated can be performed together reliably if they are regularly practiced in conjunction, for example, flying the aircraft manually and intercepting the localizer. We are less certain how well individuals can combine two tasks, each of which involves a mixture of conscious and automatic processing, for example, searching for traffic while monitoring for altitude capture. We suspect that pilots can learn to integrate two tasks of this sort and achieve reliable performance, but only if they regularly practice the two tasks in conjunction. This, however, is speculation, and requires experimental research for validation.

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* Norman, D. J. and Shallice, T. (1986). Attention to action: willed and automatic control of behavior. In R. J. Deardin, G. E. Schwartz, and D. Shaprio (Eds), Consciousness and Self-Regulation, Advances in Research and Theory (pp 1-18). New York: Plenum.

Strategies for Reducing Vulnerability to Interruptions and Distractions

We suggest several lines of defense against the types of crew errors described above. These are not perfect, but in combination they should, in our opinion, reduce crews' vulnerability to error.

(1) Recognize that conversation is a powerful distracter.
Unless a conversation is extremely urgent, it should be suspended momentarily as the aircraft approaches an altitude or route transition, such as altitude level-off or a SID turn. In high workload situations, conversation should be kept brief and to the point. Even in low workload situations, crew should suspend discussion frequently to scan the status of the aircraft and their situation. This requires considerable discipline because it goes against the natural flow of conversation, which usually is fluid and continuous.

(2) Recognize that head-down tasks greatly reduce one's ability to monitor the other pilot and the status of the aircraft.
If possible, reschedule head-down tasks to low workload periods. Announce that you are going head-down. In some situations it may be useful to go to a lower level of automation to avoid having one crew member remain head-down too long. For example, if ATC requests a speed change when cockpit workload is high, the crew may set the speed in the Mode Control Panel instead of the FMS. An FMS entry might be made later, when workload permits. Also, some airlines have a policy that FMS entries should be commanded by the Pilot Flying and implemented by the Pilot Not Flying. This approach minimizes the amount of attention the Pilot Flying must divert from monitoring the aircraft.

(3) Schedule/reschedule activities to minimize conflicts, especially during critical junctures.
When approaching or crossing an active runway, both pilots should suspend all activities that are not related to taxiing, such as FMS programming and company radio calls, until the aircraft has either stopped short of the runway or safely crossed it. Crews can reduce their workload during descent by performing some tasks while still at cruise, for example, obtaining ATIS, briefing the anticipated instrument approach, and inserting the approach into the FMS (for aircraft so equipped). Also, it may be useful for companies to review their operating practices for optimal placement of procedural items. For instance, could some items on the Before Takeoff Checklist be moved to the Before Start Checklist, since the latter is performed during a period that usually has lower workload?

(4) When two tasks must be performed concurrently, set up a scan and avoid letting attention linger too long on either task.
In some situations pilots must perform two tasks concurrently, for example, searching for traffic while flying the airplane. With practice, pilots can develop the habit of not letting their attention linger long on one task, but rather switch attention back and forth every few seconds between tasks. This is somewhat analogous to an instrument scan, and like an instrument scan it requires discipline and practice, for our natural tendency is to fixate on one task until it is complete. Pilots should be aware

that some tasks, such as building an approach in the FMC, do not lend themselves to time-sharing with other tasks without an increased chance of error.

(5) Treat interruptions as red flags. Knowing that we are all vulnerable to preoccupation with interruptive tasks can help reduce that vulnerability. Many pilots, when interrupted while running a checklist, place a thumb on the last item performed to remind them that the checklist was suspended; it may be possible to use similar techniques for other interrupted cockpit tasks. One of us has developed a personal technique using the mnemonic "Interruptions Always Distract" for a three-step process: (1) Identify the Interruption when it occurs, (2) Ask, "What was I doing before I was interrupted" immediately after the interruption, (3) Decide what action to take to get back on track. Perhaps another mnemonic for this could be "***Identify***-Ask-Decide."

(6) Explicitly assign Pilot Flying and Pilot Not Flying responsibilities, especially in abnormal situations. The Pilot Flying should be dedicated to monitoring and controlling the aircraft. The Pilot Flying must firmly fix in mind that he or she must concentrate on the primary responsibility of flying the airplane. This approach does not prevent each pilot from having to perform concurrent tasks at times, but it does insure that someone is flying the airplane and it guards against both pilots getting pulled into trying to solve problems.

End Notes

[1] We thank ASRS staff members who assisted in this study.: Dr. Rowena Morrison and Mr. Vince Mellone helped design the search strategy for reports; Mr. Bob Wright screened reports; Capt. Bill Richards made callbacks to reporters and consulted with NASA on selected incidents; Capt. Charles Drew reviewed the paper; and Dr. Rowena Morrison reviewed and edited the paper.

[2] Captain Sumwalt is employed by a major U.S. air carrier, and has served as an ASRS research consultant since 1993. He has also published a number of articles on pilot error and human factors issues in professional aviation publications.

[3] The relative frequencies of different types of neglected activity reported probably do not reflect the relative frequencies actually occurring in line operations. Pilots may be more likely to report incidents observable to ATC, for example, altitude deviations, than to report incidents not observable outside the cockpit, for example, omitting a checklist item.

[4] National Transportation Safety Board (1994). A review of flightcrew-involved major accidents of U.S. air carriers, 1978 through 1990. Safety study NTSB/SS-94-01. Washington, D.C.: NTSB.

Crossing Restriction Altitude Deviations on SIDs and STARs

by Jeanne McElhatton, Paul Buchanan, and Charles Drew

"The FMS was programmed for [a] Runway 8 arrival. [The] flight attendant came forward. I...started reprogramming the FMS for a Runway 26 arrival and the new crossing restriction. After I had completed this, I noticed that the FMS was not in VNAV—we had overflown the descent point. I made every effort but crossed 6,000 feet high." (# 298266)

A History of Ups and Downs

Throughout 21 years of operation by the Aviation Safety Reporting System (ASRS), approximately 35 percent of all incidents reported to the ASRS have been altitude deviations. Previous ASRS reviews of altitude errors have identified multiple contributing factors for these events. A 1982 ASRS study, *Probability Distributions of Altitude Deviations*, found that altitude deviations reported to ASRS were exponentially distributed with a mean of 1,080 feet, and that deviations from ATC-assigned altitudes were equally likely to occur above or below the assigned altitude.[1] Another ASRS review of altitude deviation problems, *One Zero Ways to Bust an Altitude*,[2] looked at the percentage of altitude deviations by altitude pairing, (i.e., confusing one altitude for another) and found that 35% of all paired deviations occur at 10,000 and 11,000.

More recently, ASRS analysts have noted that approximately 15 to 20 percent of the altitude deviations reported to ASRS involve crossing restriction errors on Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). SIDs and STARs are published instrument routings whose primary purpose is to simplify ATC's clearance delivery procedures.

Altitude crossing restrictions associated with SIDs and STARs may be published on navigation charts or assigned by ATC. Crossing restrictions exist for two primary purposes: 1) to provide vertical separation from traffic on different routings that cross the same fix, and 2) to contain traffic vertically within a given ATC controller's sector in cases where other sectors within the same facility, or sectors in another facility, are layered above and below. ATC-assigned crossing restrictions (as opposed to published crossing altitudes) may be temporary requirements imposed to meet changing operational conditions, including facilitating traffic hand-offs to another sector. Pilot compliance with SID and STAR altitude assignments is important, for if a controller permits traffic penetration of another sector either laterally or vertically without prior coordination and approval from the controller in that sector, an operational deviation results.

No previous ASRS review of SID- and STAR-related altitude deviations has been conducted. Thus we undertook this review to determine the causes and contributors to altitude deviations that occur during SID and STAR procedures, and to compare the results of this analysis with selected findings of the 1982 ASRS study.

Looking at Reports

The objective of this review was to categorize the types (i.e., undershoot or overshoot) and frequency of crossing restriction altitude deviations, and to determine the types of human performance errors that contribute to crossing restriction altitude deviations. Additionally, we looked at how and by whom these deviations are detected and corrected, and compared the number of deviations for traditional versus glass cockpit technology aircraft.

Reports selected for review in this study involved Part 121 or 135 aircraft in scheduled or non-scheduled air carrier operations conducting Standard Instrument Departure (SID) or Standard Terminal Arrival Route (STAR) procedures under Instrument Rules, where the flight failed to level at or cross a specified crossing restriction altitude as instructed by ATC or as required by a published procedure. Two hundred full-form records, from December 1988 through February 1996, were extracted from the ASRS Database and reviewed. Of these, 172 met the criteria for inclusion in this study. A five-page coding form was developed to extract pertinent information from the data set.

What Doesn't Matter

Of the 172 air carrier reports in the study, 159 involved turbojet aircraft and 13 involved turboprop aircraft. We found no evidence that the day of the week, time of day, aircraft type or configuration, or weather factors played a role in these altitude deviations. Similarly, it did not intuitively appear that crossing restriction altitude deviations were more likely to occur at any given ATC facility.

Finally, altitude crossing restriction errors were detected by ATC and the flight crew in approximately equal proportions: 53 percent were detected by flight crews, and 41 percent by ATC controllers.

ATC-Assigned vs. Charted Requirement

Where the required crossing restriction altitude was assigned by ATC, the flight failed to meet a crossing restriction on a SID or a STAR in 66 percent of events, while in 34 percent of events the crossing restriction was a charted requirement. The preponderance of incidents in which ATC assigned the crossing restriction altitude may be attributable to diminished time for climb or descent planning and to breakdowns of communications.

The following report excerpt demonstrates a communication problem:

✍ *"We had assumed that while in radar contact…we could safely descend to the cleared level of Flight Level 70—apparently Santiago Approach intended for us to observe the arrival procedure altitude restrictions, even though they had us in radar contact and had cleared us to descend to Flight Level 70. We both feel that this incident was in part due to communications misunderstanding."* (# 294836)

And now for one that illustrates the problems of reduced time for descent planning:

✍ *"ATC deviated from the expected CIVET 1 Arrival. [We received an] unusual crossing restriction not normally used or expected during an approach into LAX. Too many short-notice clearances issued, with very little time between each of them."* (# 304840)

Deviations Up—Going Down

Only 23 percent of altitude deviation events in the data set occurred on occurred on SIDs (climb), while a full 77 percent occurred on STARs (in descent). One possible explanation for this variation may be workload: in the descent (STAR) phase of flight, flight crews have a large number of tasks and issues to contend with, including obtaining ATIS, adjusting or planning for changing weather conditions, conducting company communications, confirming gate assignments, planning for terminal procedures and runway configurations, traffic watch, configuring the aircraft, or alerting and communicating with cabin crew.

"Number 1 Flight Attendant came into the cockpit asking for gate connections and giving a cabin write-up. Managed to get distracted and forgot to reset altimeters to the proper setting below 18,000 feet." (# 306840)

It is also possible that on STARs there is greater ambiguity about ATC expectations, that is, *when* or *where* ATC expects the flight to initiate descent.

Undershoots and Overshoots

A majority of altitude deviations—75 percent—were altitude undershoots (failure to reach the assigned altitude—usually on descent). This indicates that flight crews may have been late in planning or execution of the procedure.

"The Captain began programming the FMC when we should have started down to Flight Level 190. Afterwards, the Captain commented that he always tells new copilots to begin the descent before programming the FMC if there is any doubt as to meeting the crossing [restriction], and he was upset that he had tried to program the FMC first." (# 112925)

Point of Detection

In over half of all events in the data set (51 percent), the error was detected before reaching the required or specified altitude. In 28 percent of events, the error was discovered at the required or specified crossing restriction altitude. In 17 percent of events the error was discovered after passing the required altitude.

In those events where the error was discovered at or before the required crossing altitude, climb or descent rates may have been sufficiently high to preclude recovery before the deviation occurred.

How Much Did We Miss By?

1. **Point of Detection:** The magnitude of the altitude deviation at the point of detection averaged 2,400 feet, with a median of 1,500 feet.
2. **Point of Maximum Excursion:** The altitude deviation magnitudes at the point of maximum excursion were examined using methods employed by the 1982 ASRS study, and were found to be exponentially distributed, with a mean deviation of approximately 2,500 feet. The mean for crossing restriction deviations at point of maximum excursion was substantially larger (approximately 1,400 feet greater) than the mean for undifferentiated altitude deviations (1,080 feet) reported in the 1982 ASRS study on altitude deviations. The median for the point of maximum excursion was 1,500 feet.

Controller Actions

ATC did not intervene, or was not required to intervene in order to avoid airborne conflict in 43 percent of incidents in the data set. (This supports the research team's subjective assessments of incident severity.) In 60 percent of incidents (100 of 168), the flight continued the climb or descent, with ATC concurrence.

"We were given descent clearance from Flight Level 230 to 13,000 feet by ATC, on the MINEE 1 Arrival (MCA). We read back 'Descending out of Flight Level 230 for 13,000 feet' and dialed 13,000 feet in the altitude select and began the descent. ATC then told us to contact Approach. We checked in with Approach and stated we were descending to 13,000 feet. As we passed through 14,700 feet, Approach asked us if we were level at 15,000 feet, we replied 'Negative, we are descending

through 14,700 feet for 13,000 feet.' We also said we would stop the descent and return to 15,000 feet, if necessary. Approach replied, 'No, descend and maintain, 13,000 feet.' We then advised them we were given 13,000 feet by ATC and had checked in with him stating we were descending to 13,000 feet. Approach then said 13,000 feet was O.K." (# 297750)

Advanced and Traditional Cockpits

There were slightly more (61 percent) advanced cockpit (EFIS and/or NAV control) than traditional cockpit aircraft in the data set. This compares to 51 percent advanced cockpit versus 49 percent traditional cockpit air carrier aircraft in the entire ASRS database for the same time period.

It was expected that advanced cockpit aircraft would be more likely to be involved in crossing restriction altitude deviations due to the greater complexity in programming descents and descent crossing fixes. While we did see this pattern, the difference in numbers between advanced and traditional cockpit aircraft was not large.

Human Performance Errors

Reporters of incidents in this data set referenced human errors as shown in Table 1.

Table 1—Human Errors
Based on 233 Citations from 171 of 172 Reports

Human Errors	Citations	Percent
Exercised poor judgment	43	25.1
Neglected to cross-check data	42	24.6
Delayed implementing procedure	41	24.0
Misunderstood clearance	35	20.5
Other (unspecified)	32	18.7
Forgot clearance	15	8.8
Did not read, or mis-read chart	14	8.2
Not stated or ambiguous	9	5.3
Did not hear clearance	1	0.6
Looked at wrong chart	1	0.6
TOTALS	233	136.4%

Note: Multiple citations are possible in this category, thus the total number of citations exceeds the number of reports.

An example of poor judgment is flight crew failure or reluctance to use speed brakes to meet descent profile requirements:

"Flight plan called for a (SIE CAMRN 2) STAR to JFK. ATC instructed us to cross CAMRN at 11,000 feet, 250 knots. At 19,000 feet, I told Captain we would not make restriction unless he used speed brake to increase rate of descent. He responded there would be no problem. I informed him I would tell ATC we were unable to comply with restriction. ATC responded, 'give us the altitude first and then the airspeed.' We crossed CAMRN at 13,000 feet and 290 knots. We were handed off to Approach for a normal continuation of flight to JFK with no comments made to us by ZNY or Approach Control reference the CAMRN crossing. The Captain's comment to me was that he did not like using the speed brake and thought he would be able to make the restriction." (# 315639)

Flight crews failing to cross-check data typically resulted in use of the wrong waypoint:

"Inbound to SLC at Flight Level 310. We were cleared the OGDEN 5 Arrival with a descent clearance to cross BEARR (25 nm NW Ogden VOR) at 17,000 feet. STAR path tracks outbound Burley VOR 117 degree radial to Ogden VOR 302 degree radial, then radar vectors. The STAR depicts the Ogden VOR very close to the Salt Lake City VOR. I (Captain) was flying the aircraft outbound on the Burley VOR radial, First Officer had switched his VOR to Salt Lake City for distance to the field. However, he did not verbally announce that he had switched to SLC—I thought he was on Ogden. Because of unfamiliarity with arrival (only second time into SLC), I switched over to SLC VOR inbound (should have been Ogden). We discussed the fact the outbound and inbound radials did not match up but nei-

ther of us discovered my mistake. I therefore tracked off course and, because [I was] looking at the wrong DME, started the descent too late to make the crossing restriction." (# 300912)

Cockpit Workload

Reporters cited cockpit workload on SIDs and STARs as a factor in 44 percent of reports. The most commonly noted workload issues are shown in Table 2.

✍ *"I tried unsuccessfully to enter the restriction in the FMS. After three attempts, the Captain tried unsuccessfully and tried to explain why it wouldn't take. Meanwhile, no descent was started…we are flying an airplane, not a computer. My focus on the FMS got in the way of doing a very simple descent profile. I will be focusing on flying first, programming second."* (# 259889)

SID and STAR Charts

In 88 percent of reports, there were no complaints about chart graphic depiction or procedures. There were, however, some complaints regarding chart text narratives, specifically that the font size was small, and that text blocks were sometimes not placed sufficiently close to the appropriate area of the graphic depiction. In one event, the flight crew of a turbojet transport followed instructions specific to turboprop aircraft, thus deviating from an altitude requirement.

Event Resolution

Table 3 provides event resolution information:

Incident Severity

In more than 95 percent of incidents in the data set, the analysts' subjective assessment was that there was minimal impact on flight safety or efficiency. While there was no direct evidence of loss of separation in the majority of these events, there may have been implications for ATC, such as sector penetration, of which the pilot reporters in this study were unaware.

Table 2 — Cockpit Workload Issues
Based on 97 Citations from 171 of 172 Reports

Workload Issues	Citations	Percent
FMS Programming (automation issues)	18	24.0%
High quantity radio communication with ATC	17	22.7%
Lack of planning on the part of the flight crew that led to time-compression (such as cabin attendant in cockpit)	17	22.7%
Other (misread altimeter, company com, etc.)	15	20.0%
Flight attendant call or cockpit-cabin interphone communication	12	16.0%
A change in clearance	10	13.3%
Weather factors	8	10.7%
TOTALS	97	129.4%

Note: Multiple citations are possible in this category, thus the total number of citations exceeds the number of reports.

Summing Up

Crossing restriction altitude deviations occur more often on STARs than SIDs, but traffic separation was known to be compromised in only a small portion of these events. Aircraft configuration or type did not appear to play a role in these incidents. Most deviations were altitude *undershoots*. An altitude undershoot on a STAR may indicate a flight crew's failure to adequately plan for the STAR, or their distraction from effectively monitoring the descent.

In instances of altitude overshoots, the flight crew or ATC often detected the error *before* the altitude deviation occurred; however, climb or descent rates may have been sufficiently high to preclude recovery before a deviation occurred. Crossing restriction altitude deviations occurred more often when the crossing altitude was assigned by ATC.

It is good practice to advise ATC of any altitude change, specifically the altitude being vacated and the destination altitude, and to confirm with ATC the point of anticipated or expected initiation of descent.

Flight crews anticipating or experiencing difficulty adhering to crossing restriction requirements should advise ATC as soon as practical.

Cockpit workload was commonly cited as a contributing factor in altitude deviations on STARs. Therefore, flight crews may wish to complete checklists early (mid-cruise or before descent), and review STAR charts before descent initiation.

Table 3 — Incident Resolution
Based on 172 Citations from 172 Reports (Categories are Mutually Exclusive)

Event Resolution Categories	*Citations*	Citations	Percent
Controller Actions		68	39.6%
Controller Intervened	*52*		
Controller Issued New Clearance	*16*		
Flight Crew Action		84	48.8%
No Action Taken / Anomaly Accepted	*26*		
No Action Taken / Detected After the Fact	*23*		
Flight Returned to Original Clearance / Course	*14*		
No Action Taken / Insufficient Time	*13*		
Flight Crew Overcame Equipment Problem	*4*		
Flight Crew Became Reoriented	*3*		
Avoidance Maneuvers / Evasive Action	*1*		
Unspecified		20	11.6%
Not Resolved / Unable / Other	*17*		
Other	*3*		
TOTALS	*172*	172	100%

End Notes

1 Ralph E. Thomas and Loren J. Rosenthal, *Probability Distributions of Altitude Deviations* (NASA Contractor Report 166339), Ames Research Center: Moffett Field, California, p. 32.

2 Don George, *One Zero Ways to Bust an Altitude*, ASRS Directline Issue No. 2, 1991.

Communications-related Incidents in General Aviation Dual Flight Training

by Kamil Etem and Marcia Patten

A recent survey of the Aviation Safety Reporting System (ASRS) database on incidents involving General Aviation (GA) aircraft revealed that one third of the GA incidents were associated with communications difficulties. These problems included failure to comply with ATC clearances, communications equipment malfunctions, and poor radio technique. The results of this survey suggested to our research team that GA communications issues were an appropriate topic for further ASRS research. We were also aware that past ASRS research has not focused on this subject.[1]

The 1996 Nall Report, published by the Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation, further focused our attention on dual instruction.[2] Although flight instruction, overall, is one of the safest operations in General Aviation, according to 1995 accident statistics, there was a notable concentration of fatalities and accidents during dual instruction: the only fatal go-around accident, four of the five fatal maneuvering accidents, and five out of seven non-fatal maneuvering accidents occurred during dual instruction.[3] This cluster of accidents and fatalities in dual flight instruction raised the question of whether problematic communications, both inside and outside the aircraft, might have played a role.

A final motivation for this study was research by NASA and others which has shown that in shared decision-making situations similar to those that occur in GA dual flight instruction, there is often a failure of individuals to take responsibility for actions, including communications. At the 1995 OSU Symposium, Prince and Stout presented the results of interviews with professional aviators from the military, air carriers, and GA. They reported that 30 percent of the GA instructors surveyed stated that they trained students to perform independently, as single pilots, and believed their task as flight instructor was to encourage independence, not team awareness.[4] An exaggerated emphasis on pilot independence during training arguably may exclude development of sound cross-cockpit communications procedures, and impair communications awareness and effectiveness.

Defining the Task

Our research goal was to examine a representative set of ASRS reports referencing communications-related incidents that occurred during GA dual instruction, with the following specific objectives:

- To identify the airspace, location, and operational context in which GA dual instruction communications incidents occurred (external factors);
- To determine the nature of problematic communications interactions that occurred (or did not occur) in the cockpit between instructor and trainee (internal factors);
- To identify contributing communications equipment and operational factors;

- To suggest strategies for improving communications management during GA dual flight instruction.

This research effort was limited to ASRS incidents involving powered aircraft with a maximum gross takeoff weight less than or equal to 14,500 pounds. Incident reports selected for the study had to directly reference the presence of a flight instructor onboard who was actively conducting dual flight instruction or a flight review.

Although we had no means of identifying database reports in which communications (or the lack thereof) between instructor and trainee contributed to an incident but were not reported, it was possible to retrieve reports in which communications factors were explicitly referenced as a contributing factor. Therefore a further requirement was that reports selected for the study contain specific references to verbal interactions between the flight instructor and trainee which contributed to the incident. Examples included directives or instructions; questions; recognition or announcements of a problem; predictions or warnings; status reports; information acquisition; statements referring to planning or goals; explanations; and non-pertinent conversations. (See the sidebar on the Properties of ASRS Data.)

Initial query of the ASRS database revealed 582 incident occurrences from January 1988 through December 1996 which had the potential to meet the scoping criteria for this study. We screened a random sampling of these reports to aid in hypothesis generation and the development and refinement of a coding instrument.

A final data set of 200 incidents were selected that met the scoping criteria for the study. Eighty-four percent of these reports were submitted by instructors; sixteen percent were submitted by trainees. This reporter distribution is almost identical to that of the ASRS database for all GA dual instruction incidents.

Findings and Discussion

External Factors

Environment for GA Communications Incident Occurrences

A strong pattern emerged from our analysis of the environment in which dual instruction communications-related incidents occurred: Half or more of the incidents occurred within the airport environs and airspace, within 10 nautical miles of the airport, at altitudes less than 1,000 feet.

As depicted in Figure 1, almost half of the dual instruction events occurred in Class D airspace, with Class E airspace next in the number of occurrences.[5] This concentration of incidents within Class D airspace was not surprising, as both primary and more advanced types of instruction are airport-centered: primary instruction involves recurrent landing practice and pattern work, while more advanced flight instruction often involves approaches to an airport or related navigational aid, and takeoff/landing practice. In slightly over half of all events, the incident also occurred within a 10-nautical mile range of the airport (Figure 2) and at altitudes less than 1,000 feet AGL (Figure 3).

Consistent with the numbers of incidents in the study set that occurred on or near airports, and at low altitudes, communications-related incidents were most prevalent during the approach/descent phases (167 citations, 47 percent) and landing phase (103 citations, 29 percent) of flight.[6] The concentration of incidents in these flight phases is doubtless due to the fact that more approaches and landings are performed in dual instruction than in other types of GA operations.

Properties of ASRS Data

ASRS data have certain limitations. Reporters to ASRS may introduce biases that result from a greater tendency to report serious events than minor ones; from organizational and geographic influences; and from many other factors. All of these potential influences reduce the confidence that can be attached to statistical findings based on ASRS data. However, the proportions of consistently reported incidents to ASRS, such as altitude deviations, have been remarkably stable over many years. Therefore, users of ASRS data may presume that incident reports drawn from a time interval of several or more years will reflect patterns that are broadly representative of the total universe of aviation safety incidents of that type.

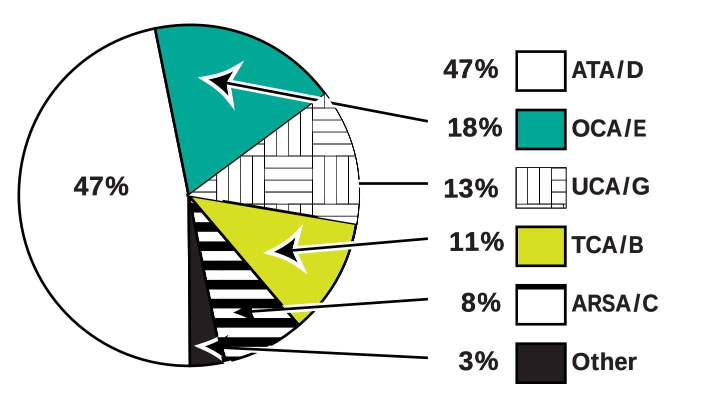

Figure 1 — Airspace Involved

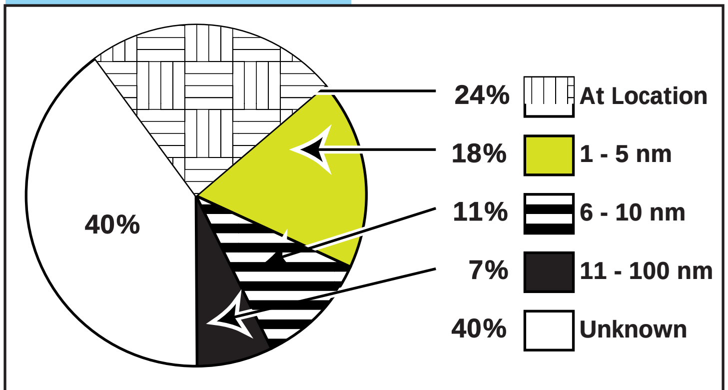

Figure 2 — Distance from Airport (miles)

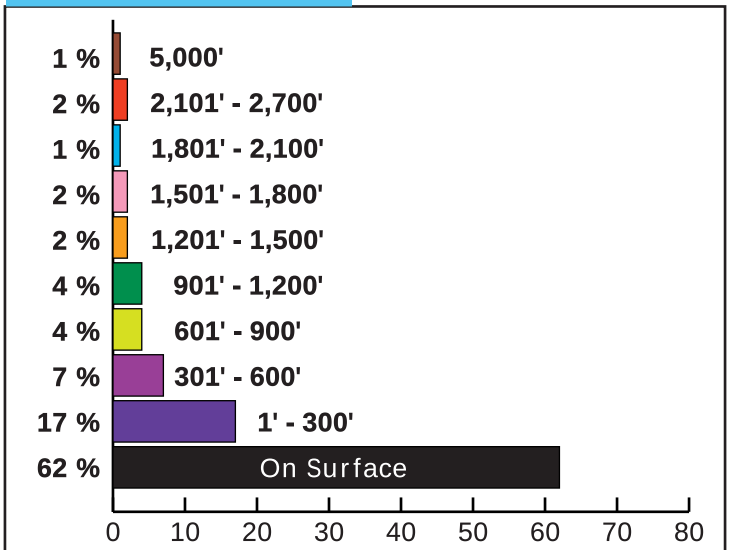

Figure 3 — AGL Altitude Range
(113 of 200 Total Reports)

Surface Versus Airborne Communications Incidents

One third of our data set (66 reports) described incidents involving aircraft operating on an airport surface, and conducting external radio communications. In our extensive experience as flight instructors, the amount of time spent on the airport surface in any type of dual instruction is generally small–usually 15 percent (or less) of an instructional period, even in primary instruction. The occurrence of more GA dual instruction incidents on the airport surface than expected suggests that airports may be a problematic environment for communications-related incidents.[7]

For both surface and airborne incidents that involved external radio communications, control tower communications were reported the most frequently. Of the 66 surface-based incidents, 47 (71 percent) cited communications with a control tower. Another 117 reports that involved airborne operations cited ongoing ATC communications. Of these, 52 incidents (44 percent) cited communication with towers, 39 incidents (33 percent) referenced communication with TRACONs, and 21 incidents (18 percent) cited communications with UNICOM or Centers. The prevalence of tower-communication reports in our study set reinforces the notion that effective management of instructional communications while monitoring Tower frequencies is crucial to the effective and safe conduct of dual training operations, both while on the surface and airborne.

Internal Factors

All reports included in our study set were classified into broad groupings of verbal communication anomalies that occurred within the cockpit. Drawing on explicit references from the study reports, we classified the types of instructor/trainee statements, determined whether these statements were heard by the intended recipient, and evaluated the timeliness and appropriateness of responses these statements elicited. Additionally we sought to identify the equipment, and task or workload-related (operational) factors which played material roles in the events.

Cockpit Communications Anomalies

Figure 4 (right) depicts the three most frequently occurring combinations of instructor/trainee verbal interaction problems.

Confusing, erroneous, or misleading statements were the leading type of instructor communications anomaly (30 percent of citations).[8] Delayed or withheld communications by instructors were the next most frequent instructor anomaly (16 percent of citations), and a leading cause of delayed or inappropriate actions on the part of trainees. It is a common technique of flight instructors to allow the trainee to make mistakes in an attempt to develop independent actions and observe the trainee's level of awareness. However, especially during IFR operations, or when compliance with an ATC directive is doubtful, corrective verbal comments by the instructor have a significant impact on flight safety.

Regardless of the type of communications anomaly displayed by instructors, the effect on trainees most often was a delayed or inappropriate verbal or control response (39 percent of citations). Several reports indicated a lack of assertiveness on the trainee's part, and a failure to challenge the instructor even when the trainee believed the instruction was wrong. The following study report excerpt exemplifies how confusing and vague communication by both instructor and trainee can result in a safety incident:

✍ *"Instructor said...'Uh, you can have control if you, uh, want it.' I probably replied 'OK' rather than the usual 'I have control.' I began to pull the nose up slowly when I thought I felt my instructor push forward on the wheel [and] relaxed...Nosewheel touched down first and we bounced...Fortunately we walked away...with an undamaged aircraft. 'Wishy washy' coms played a major role in this."* (# 240165)

Figure 4 — Cockpit Communications Anomalies
Top 3 Combinations of Communications Anomalies
• Instructor made confusing or misleading statements *and* trainee delayed action or acted inappropriately.
• Instructor heard but misinterpreted intra-cockpit coms *and* trainee delayed action or acted inappropriately.
• Instructor withheld or delayed comment *and* trainee delayed action or acted inappropriately.

Communications Equipment Factors

We expected that a number of reports in the study set would describe problems with onboard communications equipment that contributed to incidents. One in five reports (21 percent) did identify such problems. The most frequently reported problems involved malfunctioning or improperly operated headsets, microphones, and installed radios. The following instructor's report illustrates both a pilot-induced headset problem, and a preoccupation with training that led to complete lack of situational awareness:

✍ *"We had started flying using headsets, with the radios being monitored through the headsets. After the first landing the student stated he would prefer to continue without the headsets as he didn't feel comfortable wearing them. I said OK. We got involved in doing touch and goes (5) and I failed to notice that we had not heard from Tower during this time. When I did notice that the speaker button was not in the proper position, I made contact with the Tower. They (Tower) terminated the flight and I was instructed to call the Tower."* (# 290210)

Operational Factors

In addition to our analysis of cockpit communications anomalies, we examined the types of operational factors that were present during dual flight training, and identified the leading combinations of factors associated with incident occurrence. We found that instructor critiques during ongoing maneuvers were the most frequent operational pattern (27 percent of citations), closely followed by maneuvers during ongoing communications with Tower (26 percent), and instructor critiques during ongoing Tower communications (20 percent of citations). The following description of a wrong-runway takeoff illustrates how an instructor's perception of task priority may have been distorted by the desire to critique the student:

"We took off on [Runway] 24 instead of 30, as the Tower subsequently informed us. As I reviewed the event later, with my student and in my own mind, I realized how I may have added to the uncertainty. I was busy pointing out airport markings and critiquing the flight to this point. The priority should have been communications with the Tower and standard procedure." (# 137322)

Event Consequences

More than three-fourths of all the GA communications incident citations involved some ATC-related infraction or violation of FARs. Most often this was non-compliance with a clearance (51 percent of citations), but more than a third of all citations also involved clearance-related ground hazards, such as runway incursions (22 percent) and ground conflicts (10 percent). Aircraft damage was reported in 13 percent of citations.

Although the study's report selection criteria had required that there be direct reference to verbal communications between instructor and trainee, no such requirement existed regarding ATC communications. The large number of ATC-related consequences was therefore unexpected. We believe that the high incidence of missed ATC clearances in the study set, and reporters' failure to comply with various clearance requirements, directly relate to several other patterns observed in the data: (1) the concentration of dual instruction incidents on or near airports, especially tower-controlled airports with their demanding communications requirements; and (2) the operational context in which dual instruction often occurs, specifically, the simultaneous occurrence of internal verbal or external radio communications with aircraft maneuvers and demonstrations.

It is clear that dual instruction places heavy demands on the attention management and communications skills of both instructor and trainee, and that lapses in concentration may result in reduced situational awareness and safety consequences.

Summary and Conclusions

General Aviation flight instruction presents an environment with unique external and intracockpit communications requirements. This research identified key communications factors that contributed to incidents in the study set. The research team also developed some possible approaches to resolving the communications problems identified.

Situation

Almost half of all communications-related dual instruction incidents occurred within, or near, an airport environs, at an altitude less than 1,000 feet AGL. Ongoing communications with Tower were a prominent element of both ground and airborne incidents.

Suggestion

- In preflight briefings and ground instruction, instructors may wish to raise trainees' awareness that airport surface operations are vulnerable to safety incidents during dual instruction. They should also consider emphasizing the importance of standard phraseology in communications with ATC, and the active monitoring of ATC frequencies—especially Tower frequencies.

Situation

Trainees often delayed actions or acted inappropriately because instructors made confusing or misleading comments, misinterpreted trainees' comments, or delayed or withheld feedback on maneuvers.

Suggestion

- Our study data suggest the need for additional curriculum and training to improve the clarity, economy, and judgment of priority of verbal communications in dual training, especially for flight instructors. Trainees need to be able to express doubt or uncertainty, and also to admit mistakes. But it is also helpful for instructors to remember that every word counts–as well as the timing of training-related critiques. For example, it is more effective for an instructor to say "turn left 90 degrees," than to ask, "where are you going?" as the aircraft enters controlled airspace without a required clearance.

- Instructors should consider delaying critiques until after tiedown, whenever possible. This will allow maximum attention to be given to other aircraft operations, compliance with taxi clearances, runway and taxiway markings and signs, pedestrian activity (at non-tower fields), and aircraft equipment operating procedures. Instructors may make summary notes in-flight for use in post-flight debriefings. These notes may be reviewed prior to the next lesson's flight to reinforce instructional focus.

Situation

One in five study reports noted problems with communications equipment that contributed to the incident.

Suggestion

- The detection during preflight of aircraft equipment problems, especially with "renter installed" communications equipment such as intercoms and push-to-talk switches, can serve as a caution to delay the flight until qualified assistance can be found to ensure normal operation.

- Instructors may want to establish specific radio usage procedures to ensure that volume levels for ATC communications are louder than intercom volume levels, and that radio equipment is operating normally with periodic equipment tests (i.e., "radio checks").

- To enable quick recognition of external communications problems (i.e., stuck mike or volume level misset), an instructor may minimize intracockpit communications, especially at controlled airports during pattern operations.

Situation

A large majority of all incidents involved non-compliance with ATC clearances, or other ATC-related infractions and violations.

Suggestion

- In order to advise ATC and other aircraft of the instructional nature of a flight, the word "trainer" (e.g., Cessna trainer 54321) may be added to flight plans and radio broadcasts. The use of "trainer" can also serve as an attention cue that helps guard against missed clearances and readbacks. ATC already employs enhanced callsigns with suffixes such as /R (RNAV) and /H (Heavy).

References

Drew, Charles, A. Scott, and R. Matchette. 1993. Delayed Pilot Recognition of Lost Communications Events. In Proceedings of the Seventh International OSU Aviation Psychology Symposium, 318-323. Columbus, Ohio: The Ohio State University.

Morrison, Rowena, K. Etem, and B. Hicks. 1993. General Aviation Landing Incidents and Accidents: A Review of ASRS and AOPA Research Findings. In Proceedings of the Seventh International OSU Aviation Psychology Symposium, 975-980. Columbus, Ohio: The Ohio State University.

The 1996 Nall Report: Accident Trends and Factors for 1995. 1996. AOPA Air Safety Foundation.

Orasanu, Judith. 1995. Situation Awareness: Its Role in Flight Crew Decision Making. In Proceedings of the Eighth International OSU Aviation Psychology Symposium, 734-739. Columbus, Ohio: The Ohio State University.

Prince, Carolyn and R. Stout. 1995. Situation Awareness From the Team Perspective. In Proceedings of the Eighth International OSU Aviation Psychology Symposium, 740-744. Columbus, Ohio: The Ohio State University.

End Notes

1 ASRS research on General Aviation issues largely has been confined to weather-related topics, such as single-pilot IFR; pilot judgment issues; and flight phase-specific problems such as landing incidents.

2 For the purposes of this study, dual instruction is considered primary or advanced flight training that involves a student or rated pilot who actively handles the aircraft controls (usually from the left seat of the aircraft, except in tandem configurations), and a certified flight instructor who observes the trainee's actions (usually from the right seat of the aircraft) and has the capability of intervening in control and communications actions.

3 The 1996 Nall Report: Accident Trends and Factors for 1995, AOPA Air Safety Foundation, 1996, 21.

4 Carolyn Prince and Renee Stout. "Situation Awareness From the Team Perspective." In *Proceedings of the Eighth International OSU Aviation Psychology Symposium*, Columbus, Ohio: OSU, 1995, 744.

5 There were a total of 300 airspace citations for the 200 incident reports in the data set.

6 There were a total of 356 flight phase citations for the 200 incident reports in the data set.

7 To provide a context for this study finding, we searched for statistics on the numbers of total GA ground operations that occur daily and/or annually in the U.S. We discovered that the Boeing Company has done a study for insurance purposes of the amount of time an air carrier aircraft spends on the ground in maintenance. However, we were unable to find comparable data on the numbers of GA ground operations for any time period.

8 192 out of 200 reports (96 percent) described one or more communications anomalies that occurred within the cockpit during flight (as opposed to preflight, or post-tiedown, communications anomalies).

ASRS Services on the INTERNET

The ASRS Web Site, started in late 1995, has become increasingly popular with the aviation community. To the end of September 1998, there have been 435,763 "Hits"[1] in 154,904 "User Sessions."[2] The most popular pages, other than the ASRS Home Page are *CALLBACK* (ASRS's award winning Monthly Safety Bulletin), ASRS Reporting Forms, ASRS Database Information, and *ASRS Directline*. Since April, 1997, 14,888 NASA Incident Reporting Forms (in PDF[3]) have been downloaded by pilots, controllers, maintenance personnel, and cabin crew. There were 25,114 ASRS Database Report Sets downloaded from February 15 through the end of September, 1998 (see pages 25 and 26).

New Features in 1998

Ongoing .... We will continue to add *CALLBACK* and *ASRS Directline* issues in HTML[4] and PDF format as they are published.

January 15 .... Selected ASRS Database "Report Sets" were added to the ASRS Web Site. We have provided twenty individual sets of reports on various issues of topical interest. Report Sets are available in Rich Text Format[5] (RTF). The file size for each Report Set will be small, averaging less than 200K, thus download time for users will be minimal.

Each Report Set consists of fifty ASRS Database records, preceeded by a note of introduction, caveats on use of ASRS data, and standard abbreviations and definitions used in ASRS Database records. All Report Sets have been pre-screened to assure their relevance to the selected topic. The Report Sets will be updated quarterly. New topics will be added—and outdated topics removed—in response to input from the ASRS user community, and analysis of Web site usage.

Your comments on the usefulness of the "ASRS Database Report Sets" feature would be appreciated, and may be directed to ASRS's Web Site Administrator at webadmin@olias.arc.nasa.gov

Upcoming Features in 1999

- **Research Products**

  ASRS Research Papers will be provided in HTML and PDF.

- **Web Pages**

  The general appearance and functionality of all ASRS pages will be upgraded, and navigation will be made simpler and more intuitive.

- **Electronic Report Submission**

  We are planning to introduce a new method for electronic dissemination, and ultimately submission, of ASRS aviation safety incident reports.

*Definitions

1 Hit: An action on a web server, such as when a user views a page or downloads a file.

2 User Session: A session of activity (all hits) for one user of a web site. A unique user is determined by the IP address or domain name. By default, a user session is (considered) terminated when a user falls inactive for more than 30 minutes.

3 PDF: Adobe's Portable Document Format, quickly becoming a standard where there is need to transfer exact image documents between various computer platforms.

4 HTML: Hyper Text Markup Language—the common cross-platform language for web browsers.

5 RTF: Microsoft's Rich Text Format, a format which can preserve formatting between various applications, most notably word processing packages. RTF can be read by almost all word processors, and by many spreadsheet and database programs.

ASRS Web Site Features (December, 1998)

Here is what is available on ASRS's Web Site:

ASRS Publications

- ✔ *CALLBACK* (December, 1994 through present, in HTML and PDF)
- ✔ *ASRS Directline* (All Issues, in HTML and PDF)

Operational Issues Bulletins

- ✔ Operational Issues Bulletin 96-01 (new bulletins will be added as they are issued—in HTML and PDF)

Reporting Forms (In PDF)

- ✔ General Reporting Form (for pilots, dispatchers, ground personnel, etc.)
- ✔ ATC Reporting Form (for controllers)
- ✔ Maintenance Reporting Form (for mechanics)
- ✔ Cabin Crew Reporting Form (for flight attendants)

Immunity Policies

- ✔ Advisory Circular 00-46D
- ✔ Federal Aviation Regulation (FAR) 91.25
- ✔ Facility Operations and Administration Handbook (7210.3M), Para. 2-2-9

ASRS Database

- ✔ ASRS Database Report Sets (in Rich Text Format), including:
  - Automated Weather Systems
  - Cabin Attendant Reports
  - Checklist Incidents
  - Commuter and Corporate Flight Crew Fatigue Reports
  - Commuter and GA Icing Incidents
  - Controlled Flight Toward Terrain
  - CRM Issues
  - Fuel Management Issues
  - Inflight Weather Encounters
  - Land and Hold Short Operations
  - Mechanic Reports
  - Multi-Engine Turbojet Aircraft Upsets Incidents
  - Non-Tower Airport Incidents
  - Parachutist / Aircraft Conflicts
  - Passenger Electronic Devices
  - Pilot / Controller Communications
  - Rotary Wing Aircraft Flight Crew Reports
  - Runway Incursions
  - TCAS II Incidents
  - Wake Turbulence Encounters
- ✔ Information on the ASRS Database on CD-ROM (available from Aviation Research Group/U.S.)
- ✔ Requesting database searches from ASRS

Program Overview (a quick summary of ASRS function and products)

Program Briefing (a slightly more in-depth examination of the ASRS)

Contact ASRS (e-mail addresses for major ASRS programs)

Website: http://olias.arc.nasa.gov/asrs

Web Site Usage—Some Interesting Numbers

ASRS Publications

HTML and PDF versions of *CALLBACK* and *ASRS Directline* complement the printed versions of these publications. CALLBACK, posted monthly to the Web Site, is extremely popular—an average of 1,200 users every month read the most current "online" version.

NASA Aviation Incident Reporting Forms

In April of 1997, ASRS introduced Adobe Acrobat versions of the Reporting Forms. (Users download a PDF version of the Reporting Form of their choice, a free copy of Adobe Acrobat Reader, and then print, fill out and mail their completed report.) Here are the downloads for NASA Reporting Forms:

- General (Pilot) Forms 9,560
- Maintenance (Mechanic) Forms 2,417
- Cabin Crew Forms 1,566
- ATC (Controller) Forms 1,345

Total 14,888

Overall Access to the ASRS Web Site

Figure 1 (below) shows both "Hits" and "User Sessions" from December, 1995 though September, 1998. (See the "Definitions" sidebar on page 23 for an explanation of "Hits" and "User Sessions.")

ASRS Database Reports Sets

Rich Text Format versions of frequently search requests were introduced in January of 1998. As can be seen in Table 1 (facing page), these have generated a lot of interest.

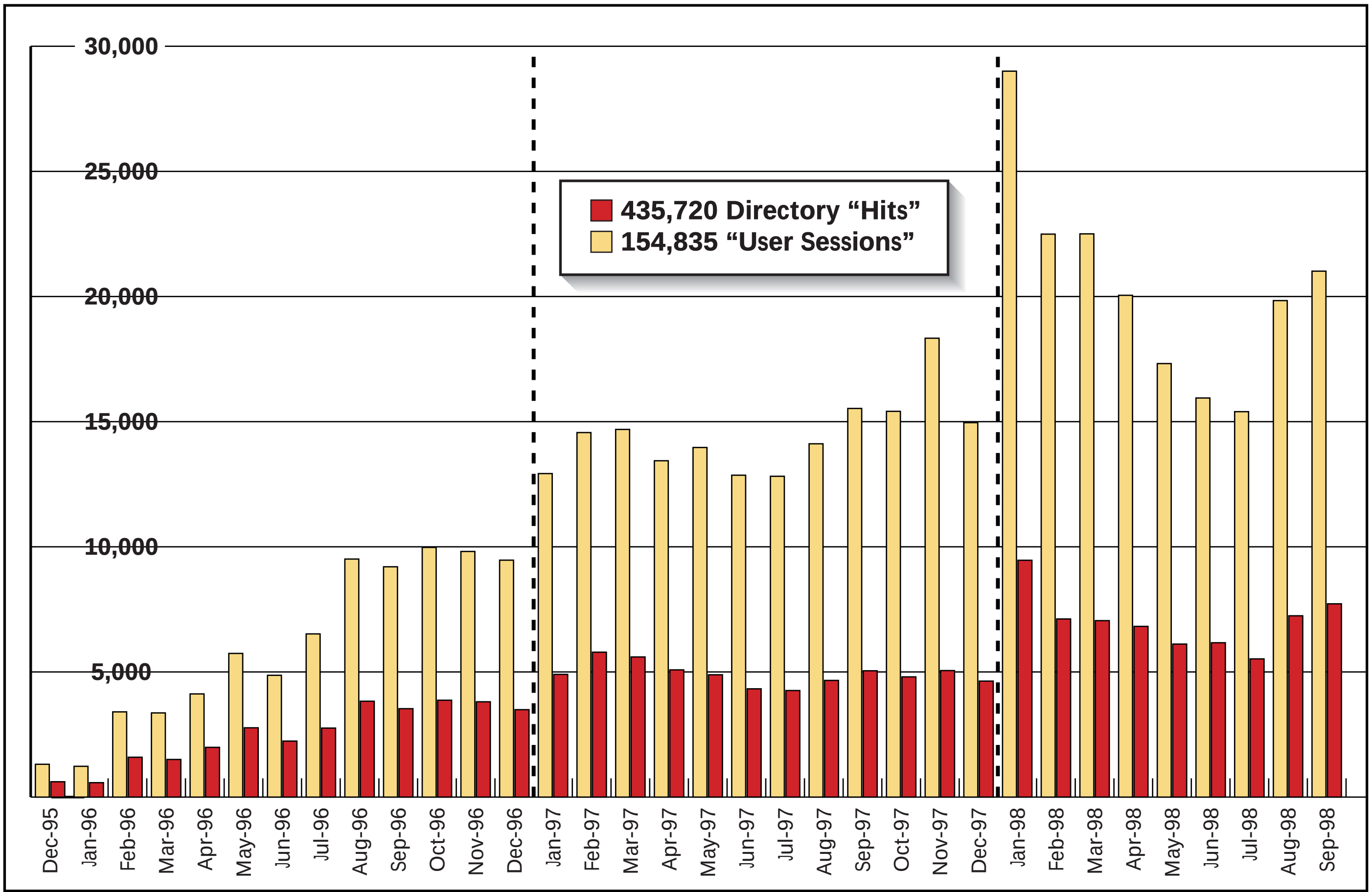

Figure 1—ASRS Web Site "Hits" and "User Sessions," December, 1995 through September, 1998

Table 1—ASRS Database Report Sets Downloaded (in RTF)
(25,114 Report Sets downloaded from January, 1998 through September, 1998)

Set / Month	01/98	02/98	03/98	04/98	05/98	06/98	07/98	08/98	09/98	Total
Cabin Attendant Reports	615	300	249	248	239	204	166	329	221	**2,571**
Pilot / Controller Communications	503	305	190	194	175	156	129	182	150	**1,984**
Controlled Flight Toward Terrain	456	253	218	169	166	123	110	175	153	**1,823**
Checklist Incidents	389	303	207	189	154	127	101	182	160	**1,812**
CRM Issues	423	267	223	203	158	136	101	153	148	**1,812**
Mechanic Reports	274	182	112	151	125	107	102	149	148	**1,350**
Parachutist / Aircraft Conflicts	357	177	115	106	78	109	94	136	121	**1,293**
Automated Weather Systems	333	172	116	99	94	100	64	147	98	**1,223**
Inflight Weather Encounters	278	138	124	104	109	95	67	104	97	**1,116**
Runway Incursions	247	121	130	121	76	120	87	106	93	**1,101**
Commuter/Corp. Crew Fatigue	205	182	131	82	92	69	67	106	102	**1,036**
Commuter/GA Icing Incidents	359	151	103	80	67	79	49	67	73	**1,028**
Non-Tower Airport Incidents	296	118	78	72	74	71	48	99	102	**958**
Multi-Engine Turbojet Upsets	200	147	93	82	85	76	85	102	86	**956**
TCAS II Incidents	203	119	120	104	86	69	70	95	89	**955**
Passenger Electronic Devices	78	173	129	104	63	48	34	139	132	**900**
Wake Turbulence Encounters	204	127	87	89	79	63	67	88	75	**879**
Land and Hold Short Operations	243	124	94	68	69	52	56	78	75	**859**
Fuel Management Issues	221	108	116	75	65	63	52	76	67	**843**
Rotary Wing Crew Reports	139	85	53	56	34	48	47	86	67	**615**
Totals	**6,023**	**3,552**	**2,688**	**2,396**	**2,088**	**1,915**	**1,596**	**2,599**	**2,257**	**25,114**