VARIATIONS IN "PARTY LINE" INFORMATION IMPORTANCE BETWEEN PILOTS OF DIFFERENCE CHARACTERISTICS

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ABSTRACT

The introduction of digital datalink communications into the ATC may cause a reduction of the situation awareness of Flight Crews due to the reduction of "Party Line" Information (PLI) that can be overheard on the shared voice frequencies. A survey was distributed to determine current PLI use by pilots from different geographic regions, operational groups, experience levels and aircraft equipage. Pilots indicated highest perceived importance for PLI during the phases of flight nearest the airport and lowest importance during Cruise. Several specific traffic and weather information elements were identified as particularly important; traffic and weather information was also cited by pilots as information required for global situation awareness. Some variations in responses were found between pilots from different operational types.

INTRODUCTION

As part of the Federal Aviation Administration's (FAA) National Airspace System modernization plan, digital datalink communications will be introduced as a means of air/ground information exchange between aircraft and ATC facilities. Communications via datalink offer potential benefits in increased system safety and efficiency by reducing transmission and interpretation errors and by allowing more information to be exchanged between aircraft and ground facilities. On the other hand, the transfer of ATC communications from voice to datalink gives rise to numerous human factors issues including a possible loss of flight crew situation awareness. Specifically, the discrete nature of datalink addressing (where each ATC message is directed exclusively to a specific aircraft) may result in a loss of the indirect 'Party Line' Information (PLI) obtained by overhearing communications between ATC and other aircraft. The identification of important PLI elements is necessary to form a basis by which compensatory datalink protocols or strategies can be developed.

BACKGROUND

Previous Work

With the current system of voice ATC communications on shared VHF frequencies, aircraft overhear all conversation on their frequency, thereby having access to a great deal of supplemental information. This PLI is used by pilots to increase their situation awareness with respect to other aircraft, environmental conditions, sector congestion and controller workload.

To determine the significance of PLI, an initial survey was distributed to 1500 American Airline pilots based at Chicago O'Hare. This survey identified the PLI elements judged to be important by air carrier crews, with the most important being *Windshear, Aircraft on Landing/Take-Off Runway, Braking Action* and *Missed Approach Information*. In addition, PLI was indicated as more important during terminal operations and on final approach (Midkiff, 1993).

Research Focus

This research expanded upon the previous survey to determine PLI use by pilots of different operation types, flight experience, aircraft equipage and geographic regions. The number of elements surveyed was expanded to account for the different flight operations and to better determine the importance of specific weather information elements. In addition, free response questions were asked to determine the information required for global situation awareness.

METHOD

Survey Design

The survey was organized into three sections. The first section gathered information about the respondents' characteristics and flight experience. The second section investigated issues relating to datalink implementation and also to the information requirements for global situation awareness by asking "What does the 'Big Picture' mean to you?".

The final and largest section of the survey solicited pilot input on the importance, availability and accuracy of 'Party Line' Information for specific information elements. The elements were categorized into the six phases of flight listed in Table 1; most elements were listed in all Phases of Flight, while others were listed only the Phases of Flight in which they would be applicable. As shown in the sample section in Figure 1, the subjects were asked to rank the importance, availability and accuracy on 5 point scales, where the numbers 1 and 5 represented the extremes Trivial vs. Critical for the importance rating, Non-Existent vs. Common-Place for the availability rating, and Unreliable Vs Reliable for the accuracy rating.

Ground Operations	*Pre-Start, Taxi*
Departure	*Takeoff to Top of Climb*
Cruise	*Top of Climb to Top of Descent*
Descent	*Top of Descent to Approach Control Contact*
Terminal Area	*Approach Control Contact to Final Approach Fix*
Final Approach	*Final Approach Fix to Runway Threshold*

Table 1. Phases of Flight Surveyed

	Importance	Availability	Accuracy
	Trivial — Critical	Non-Existent — Common-Place	Unreliable — Reliable
Cruise: Top Of Climb To Top Of Descent			
Next Communications Frequency	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Weather Situation			
- Over-All	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- TRW Buildups & Deviations	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- Visibility & Ceiling	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- Icing Conditions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- Ride Reports/Turbulence	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- Winds Aloft	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
- Surface Winds	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Traffic Avoidance	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Relative Sequencing Of Other A/C	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Error or Mistake of the Controller	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Other_____	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Figure 1. Sample of Importance, Availability & Accuracy Ratings Section (Cruise Phase of Flight)

Subjects

4375 surveys were distributed, targeting five different operational groups: General Aviation pilots, Commuter Airline Flight Crew, Major Airline Flight Crew, and Military pilots. 710 complete responses were received. The response rate of 16.2% was considered reasonable for a voluntary survey of this type, particularly due to its extensive nature. However, some response bias may be present.

Data Analysis

The principle data consisted of importance, availability or accuracy ratings on a five point scale. The importance of a specific element within each phase of flight was calculated from the mean of all responses for that element. The mean of all elements within the survey sections corresponding to different phases of flight were calculated from all elements within that section. The responses were also subdivided based on respondent characteristics, such as total flight hours or type of flight operations with similar

means calculated for these subdivisions. Standard t-tests were conducted to analyze the differences in the numerical importance data. (Hogg & Ledolter, 1992) Given the discrete number of ratings a pilot could choose, a high importance rating for an element indicates a strong consensus between pilots on its high importance. Therefore, a metric to display and illustrate the relative importance of PLI elements is the percentage of pilots giving a Critical (5) rating, or the next highest rating (4), which is assumed to represent an Important rating.

The questions "What does the 'Big Picture' mean to you?" solicited free responses from pilots. For data analysis, common responses were identified and categorized. These responses were tallied in common categories. Because the pilots were free to mention several answers, the occurrences of all responses sum to a value greater than 100%. Hypothesis tests compared the percentage of free response categories given by different groups of pilots, assuming that the percentage of responses within each category could be given a Bernoulli probability. (Drake, 1967)

RESULTS

Overall Importance Ratings

The pilots overall rate PLI very highly. Across all the information elements, the Critical rating was given 42% of the time and the next highest Important rating was given in an additional 28% of the responses. The individual elements were also rated highly. While the ratings for the elements range from 2.40 to 4.83 on the (1) Trivial to (5) Critical scale, most of the mean ratings were above 4.00 and many of the elements were judged to be Critical by a majority of the pilots.

Importance Ratings by Phase of Flight

An overall comparison of the perceived variations of PLI importance between different Phases of Flight was made by comparing the combined ratings of all PLI elements listed with each, as shown in Figure 2. The highest ratings were give to the Phases of Flight nearest the airports, especially Terminal Area and Final Approach, where over 40% of the combined ratings were Critical. The lowest importance ratings are given in Cruise, where less than 30% of the ratings were Critical. The ratings for each successive Phase of Flight are significantly different from the one preceding (p < 0.01), except between the ratings for Final Approach and Terminal Area.
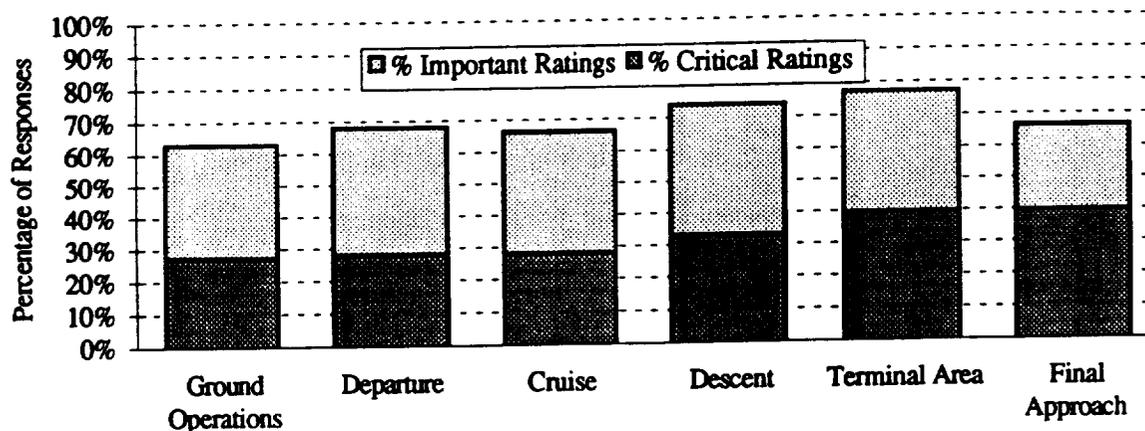

Figure 2. Combined Importance Ratings of All PLI Elements for Each Phase of Flight

In general, the individual weather and traffic PLI elements received importance ratings following the same pattern of higher importance ratings in the Terminal Area and Final Approach, and lower importance ratings in Cruise. However, some weather elements, such as *Thunderstorm Buildups and Deviations* and *Icing Conditions* were consistently perceived as important in all Phases of Flight. Other weather elements, such as *Ride Reports & Turbulence* and *Winds Aloft* received higher ratings in Cruise. This identifies very specific patterns of PLI use by pilots throughout a flight.

Identification of the Most Critical Elements

Many PLI elements were rated as Critical by a majority of the pilots for at least one phase of flight, indicating a strong consensus among pilots that these elements are vital for flight operations during some or all phases of flight. These elements tend to apply to traffic and weather situations which directly affect flight safety. Other PLI elements received ratings of Critical or Important from a majority of the pilots. Elements considered Important by a majority of the pilots include the Traffic and Weather elements useful for flight planning. Some elements are considered Critical by a majority of pilots in some Phases of Flight and Important in other Phases of Flight. These elements and the Phases of Flight in which they received these high ratings are shown in Table 2.

Information Elements Rated Critical

- Aircraft on Landing Runway
  (Final Approach)
- Traffic - Uncontrolled Airports
  (Departure, Descent, Terminal Area & Approach)
- Traffic - Controlled Airports
  (Departure, Descent, Terminal Area & Approach)
- Traffic Avoidance
  (Cruise)
- Windshear
  (Final Approach)
- Missed Approach - Weather
  (Final Approach)
- Visibility & Ceiling
  (Terminal Area & Final Approach)
- Thunderstorms
  (All Phases of Flight)
- Surface Winds
  (Final Approach)
- Braking Action
  (Final Approach)
- Icing Conditions
  (Departure, Descent & Terminal Area)
- Aircraft Crossing Active Runway
  (Ground Operations)
- Approach Clearance
  (Terminal Area)
- Terminal Routing
  (Terminal Area)
- Missed Approach - Other
  (Final Approach)
- Error of Controller
  (Ground Ops, Terminal Area & Final Approach)

Information Elements Rated Important

- Holding Situation/EFC Validity
  (Descent & Terminal Area)
- Relative Sequencing of Other Aircraft
  (All Phases of Flight)
- "Hold Short" of Runway
  (Ground Operations)
- Taxiway Turnoff
  (Final Approach)
- Routing to (Take-Off) Runway
  (Ground Operations)
- Weather Overall
  (All Phases of Flight)
- Visibility & Ceiling
  (Ground Operations, Departure & Descent)
- Ride Reports & Turbulence
  (All Phases of Flight but Ground Operations)
- Surface Winds
  (Ground Operations, Descent & Terminal Area)
- Icing Conditions
  (Ground Operations, Cruise & Final Approach)
- Error of Controller
  (Departure, Cruise & Descent)
- Next Communications Frequency
  (Descent, Terminal Area & Final Approach)

Table 2. PLI Elements Rated Critical or Important by a Majority of Pilots

Variance in Importance Ratings Between Pilots of Different Characteristics

To study possible variations between importance ratings given by pilots from different operational types, the responses of General Aviation, Commuter Airline, Major Airline and Military pilots were compared. Several significant differences in perceived PLI importance were found.

First, General Aviation pilots rated PLI as consistently important in all Phases of Flight, without a significant drop in PLI importance during Cruise. This differs from the other pilots who perceive PLI to be more important in the busy Phases of Flight nearest the airport. This effect can be seen in Figure 3.
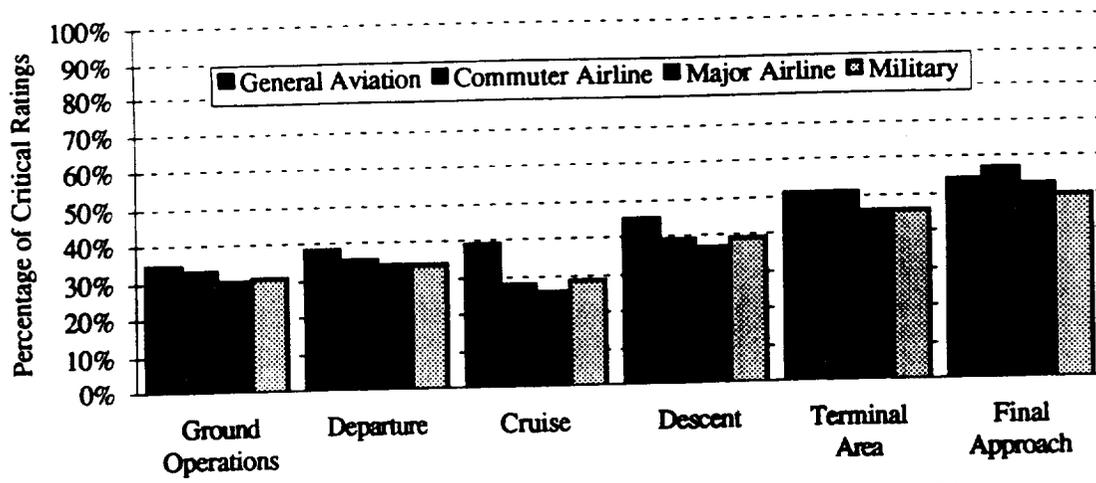
Figure 3. Combined Importance Ratings of All PLI Elements for Each Phase of Flight, Broken Down by Pilot Type

Second, certain PLI elements were rated significantly higher by specific groups of pilots. These results are summarized in Table 3.

Operational Type	Elements Rated Significantly Higher by This Type
General Aviation	Icing Conditions, Visibility & Ceiling, Winds Aloft, Relative Sequencing, Next Communication Frequency
Commuter Airline	Traffic Avoidance -- Uncontrolled Airports
Major Airline	Ride Reports & Turbulence, Routing to Runway, "Hold Short", Braking Action
Military	Traffic Avoidance -- Controlled Airports & (Cruise) Traffic Avoidance

Table 3. Elements Perceived More Important by Pilots of Different Operational Types

Attempts were made to isolate differences between pilots based on flight experience, as estimated by total flight hours. However, different experience levels corresponded closely with different types of operations -- for example, the General Aviation pilots, on average, had significantly few flight hours than any other group of pilots and the Major Airline pilots had significantly more flight hours than any other group. Therefore, the variations in importance between pilots of different experience correlated strongly with the variations found between the different user groups. Within each the responses from each operational group, no differences could be found between pilots with different experience, suggesting that operational type is the strongest determinant in pilots perception of PLI importance.

Few significant differences could be found between pilots from different geographic regions, or between pilots flying aircraft equipped or not equipped with weather radar or TCAS.

Availability and Accuracy Ratings of PLI

Unlike the Importance ratings where the extreme rating of '5' was common, pilots generally did not give the maximum value for the Availability and Accuracy ratings. Instead, these ratings were indicated that pilots consider PLI generally reliable and accurate without giving any significantly higher ratings to any PLI elements.

The Availability and Accuracy ratings for most PLI elements were strongly correlated to their Importance ratings. However, some PLI elements, *Next Communications Frequency, Controlled Traffic, Approach Clearance, Terminal Routing* and *Surface Winds*, were found to have high Availability and Accuracy ratings compared to their importance ratings, possibly indicating their continuous presentation by Party Line communications. Conversely, the PLI elements *Error of the Controller* and *Uncontrolled*

Traffic were found to have disproportional low Availability and Accuracy ratings, possibly indicating that Party Line Communications is not an adequate information source for these elements.

Information Requirements for Global Situation Awareness

To ascertain the information required for Global Situation Awareness, pilots were asked for free responses to the question "What does the 'Big Picture' mean to you?". Their responses were categorized and the percentage of responses in each tally was recorded. These results are shown in Figure 4. Traffic is named significantly more often than any other information ($p<0.01$); the next item, Weather, is also cited significantly more often than any of the less mentioned items.
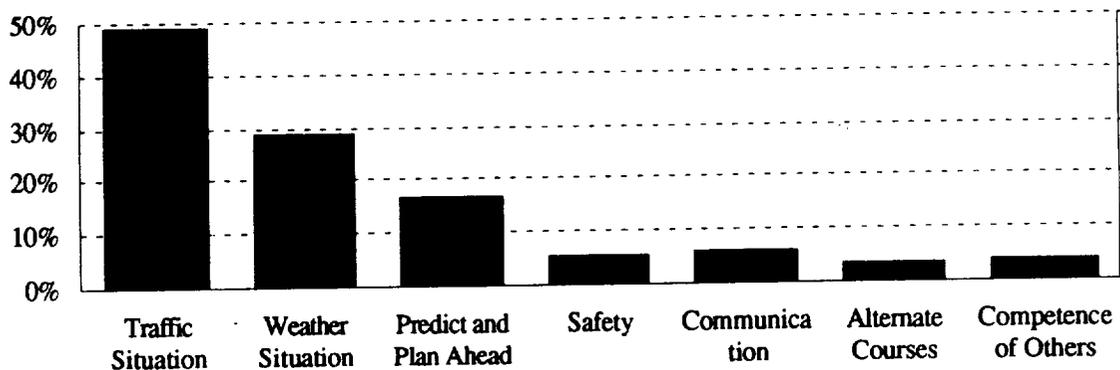

Figure 4. Percentage of Responses to "What does the 'Big Picture' mean to you?"

CONCLUSIONS

PLI currently provides pilots with information considered to be very important. However, given the ambivalent accuracy and availability ratings given to PLI, better transmission and display modalities may be found. The presentation of information currently available from PLI must be a consideration during implementation of datalink communications. The importance of PLI was found to be significantly higher in the busier and higher density Phases of Flight near the airport, suggesting any initial implementation of datalink communications in Terminal Area control sectors will need to be well compensated for PLI loss.

Specific Traffic and Weather PLI elements were identified as Critical. These results, combined with the common citing of these two types of information as necessary for 'The Big Picture', suggest Traffic and Weather information is required for pilot Global Situation Awareness.

The implementation of TCAS and the availability of better, less expensive weather displays may enhance PLI use and help compensate for its loss in the datalink environment. However, little is known about these effects, suggesting further studies in these areas.

ACKNOWLEDGMENTS

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