



## Perilog Offers Advanced Data Mining for Aviation Safety Reporting System and the U.S. Airline Industry

*Sophisticated software holds promise of benefiting myriad industries and applications*



Perilog software was developed in 1995 to serve the Aviation Safety Reporting System (ASRS), administered by NASA, and continues to provide advanced data mining capabilities to ASRS's database of more than 110,000 aviation incident report narratives. The software also is benefiting the airline industry, demonstrated by a 2002 Space Act Agreement (SAA) signed with Southwest Airlines that enables the company to use Perilog for its Aviation Safety Action Partnership (ASAP) operations. For both ASRS and Southwest, Perilog helps reduce the cost and effort associated with incident analyses of processed database reports and improves the quality of aviation incident data retrieval—leading to improved aviation and airline safety information.

### **Benefits of Technology Transfer**

- Contributes significantly to the efficacy and efficiency of data mining and analyses for ASRS and the commercial aviation industry
- Saves ASRS and the aviation industry human and financial resources by reducing the costs of data retrieval and expanded incident analyses
- Leads to high quality data analyses that can impact airline policies, procedures, and training for greater overall commercial aviation safety
- Offers text mining possibilities involving language pattern analyses for myriad industries, such as music, literature, and journalism

SUCCESSORS



## Finding use beyond NASA in other industries

While the benefits of Perilog are clearly demonstrated by its success at ASRS and Southwest Airlines, Perilog also offers much promise for the data mining needs of many other industries. Immanuel Barshi, Research Psychologist at NASA's Ames Research Center, demonstrates Perilog regularly to other U.S. airlines (he is Southwest's main point of contact at NASA for Perilog).

Dr. Barshi is keenly familiar with Perilog's capabilities and notes that the software can be used to analyze similarity patterns in myriad applications. "Perilog makes highly relevant contextual associations among words, word pairs, and phrases—but it can be any language," said Barshi. He explained that Perilog could be used to analyze patterns and associations in musical notes, Braille, literature, or journalistic research. "Perilog could be a very powerful research tool for any material that involves textual patterns."

## About the Aviation Safety Reporting System

According to the Federal Aviation Administration (FAA), "The Aviation Safety Reporting System (ASRS) is a voluntary, confidential, and anonymous incident reporting system. It is a cooperative program established under FAA Advisory Circular No. 00-46D, funded by the FAA and administered by NASA. Information collected by ASRS is used to identify hazards and safety discrepancies in the National Aviation Airspace System. It also is used to formulate policy and to strengthen the foundation of aviation human factors safety research." Since 1976, ASRS has processed over 800,000 reports and issued over 4,500 safety alert messages. Alert messages are triggered by reports of significant aviation hazards, reports having significant accident prevention potential, and other incidents of particular concern.

## About Southwest Airlines

Established in 1971, Southwest Airlines is based in Dallas, Texas and is considered a discount airline. It is the largest airline in the world, ranked by number of passengers carried per year (as of 2008), and maintains the third largest passenger fleet of aircraft among the world's commercial airlines. The airline operates approximately 3,200 flights daily and, since August 2006, has carried more customers than any other U.S. airline for total of combined domestic and international passengers, according to the U.S. Department of Transportation's Bureau of Transportation Statistics.

## Technology Origins with ASRS

Perilog initially was developed to benefit ASRS, the national clearinghouse for commercial aviation safety incident reports. ASRS's database remains the largest repository of aviation safety incidents in the world.

Beginning in 1995, Perilog's inventor worked closely with ASRS to ensure that the methods and software addressed ASRS's data mining needs. The very early research work with ASRS data typically involved analyzing no more than 300 narrative incident reports. In 1997, QUORUM (an earlier form of Perilog) was first applied to the entire ASRS database, which at that time contained approximately 68,000 narratives. Since March 2002, Perilog has been used routinely to query the entire ASRS database, which now contains more than 150,000 narratives. Perilog helps ASRS personnel improve the quality of incident database search results while reducing the time and effort formerly needed to produce them. Linda Connell, NASA Director of ASRS since 1997, said that Perilog offers significant time and cost savings for ASRS. "The quality of the data mining capabilities that Perilog provides



is enhanced by streamlined data retrieval and relevance ranking when performing secondary incident analyses every year,” said Connell.

Prior to NASA’s development of Perilog, ASRS had no specific software to find contextual connections between incidents voluntarily reported to ASRS, or to assist in pattern recognition or relevant associations among different incidents. Analyses were performed via simple text search methods and compiled by analysts in frequency charts and graphs.

“Before Perilog, if we had a question like, ‘Of all the 747 aircraft incident reports we received, how many of those had an engine problem and also were found to have problem X?’, we would do a basic search on both engine types and problem X,” said Connell. “Depending on the specific question, we might get 5 reports or 5,000 reports.”

Connell explained that for a large number of reports, further qualitative analyses are needed to determine which reports are most relevant to the original question. “We need to look for more details and context—like what was going on with the pilot and the weather, etcetera—so we can try to make more relevant assessments,” said Connell.

But prior to Perilog, such contextual analyses were complicated, time consuming, and relatively expensive. Two or three expert analysts would develop a more specific set of questions to analyze the initial search result, and then would perform a secondary coding analysis to determine a more detailed level of relevance. According to Connell, ASRS could evaluate about 300 reports in this way. “But if I had 5,000 reports from my first search result, I then had to decide how to choose the 300 to evaluate for more information,” said Connell. At the time, analysts often had to make a random selection or choose the 300 most recent reports.

“Perilog changed all that,” said Connell. Now, she said, an analyst can run a search on specific selection criteria, get

5,000 reports as a result, and then run those 5,000 reports through Perilog. “And it’s going to tell you which are the most relevant,” said Connell. “So, rather than guessing, now we can really tailor our searches down to 300 quality reports that really get to the heart of what we’re investigating. It’s so much more defined. That’s been the biggest advantage to us.”

### **Finding Use Beyond NASA at Southwest Airlines**

Beyond NASA and ASRS, Perilog has found a place in the larger airline industry. Southwest Airlines’ SAA, signed in 2002, led the company to use Perilog to improve the efficiency and relevance of queries to its ASAP database, a repository of pilot self-disclosures about aviation incidents—similar to ASRS. According to Captain Jeff Hamlett, Senior Manager of Flight Safety at Southwest, the airline uses Perilog to find nuances in the language of pilot narratives—details that may not immediately seem to tie different events together—but present a common thread among occurrences that, when understood by expert analysts, can help reduce problems on a broad scale, often leading to policy changes that can enhance safety.

“When a pilot submits a report, an expert analyst will glean details from the narrative about why the pilot is disclosing an event,” said Captain Hamlett. “We spend a lot of time categorizing the things that we understand and are important to the analyst, but humans can’t pick up every factor. That’s where Perilog comes in.”

Captain Hamlett explained that Perilog helps analysts find words associated contextually, such as all words or phrases that can be associated with an event involving a ‘distraction’ or an ‘unstable approach’. So, even if the pilot who authored the report does not use the specific words of interest to the analyst, Perilog will search according to context to help retrieve all reports that can be related to such events. For example, a pilot may say something about a distraction, without actually using the word ‘distraction’ or words like ‘attention’ or ‘interruption’.

## On the Record

“The quality of the data mining capabilities that Perilog provides can save us thousands of hours of expensive incident analyses every year.” — *Linda Connell, Director, NASA/ASRS*

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So, Perilog goes beyond querying the database for known patterns among topics and actually discovers information in the data that the analyst didn’t know to ask about. “Our Flight Data Analysis Program will tell us that certain types of events occurred, but it doesn’t tell us why,” said Captain Hamlett. “But we can query the ASAP database using Perilog, and it will search by example and find reports that are similar to the event we are investigating—even if the reports don’t have any similarities on the surface.”

In this way, Perilog can help analysts find all contributing factors that may lead up to a problem. And it also can find all of the major event types that are influenced by those contributing factors, leading to safer airline policies, procedures, and training. “Perilog lets the database talk to us,” Captain Hamlett said. “It’s not just a word search but a very sophisticated concept mining tool.”

## Technology Transfer Process

Ames Research Center’s Entrepreneurial Initiatives Division (formerly the Technology Partnerships Office), part of NASA’s Innovative Partnerships Program (IPP), helped coordinate the SAA among technical contacts, personnel at Southwest, and the Intellectual Property Office at Ames. Ames made technical contacts available who provided consultation on Perilog to Southwest.

## Looking Ahead

ASRS has relied on Perilog since 1997, and NASA has no plans to change that, as the system’s database continues to grow and Perilog continues to provide a robust means to mine that data. “I get approached constantly about data mining, and I simply haven’t found anything that comes even close to what Perilog does,” said Connell.

Hamlett echoed this view. “We’ve done a lot of practical application of text mining, and I have seen several text mining tools, but I’m not personally aware of one that’s as powerful as Perilog,” he said. Southwest continues to use Perilog to mine its ASAP data and also is considering to expand use of the software to its irregularity reporting program.

## For More Information

If you would like more information about Ames’s Perilog technology, or about other technologies available for license or transfer, please contact:

Fuentek, LLC  
919-249-0327  
ARC14512@fuentek.com

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