Preliminary Results Obtained in Integrated Safety Analysis of NASA Aviation Safety Program Technologies

The goal of the NASA Aviation Safety Program (AvSP) is to develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by the year 2007 and by a factor of 10 by the year 2022. Integrated safety analysis of day-to-day operations and risks within those operations will provide an understanding of the Aviation Safety Program portfolio. Safety benefits analyses are currently being conducted. Preliminary results for the Synthetic Vision Systems (SVS) and Weather Accident Prevention (WxAP) projects of the AvSP have been completed by the Logistics Management Institute under a contract with the NASA Glenn Research Center. These analyses include both a reliability analysis and a computer simulation model.

The integrated safety analysis method comprises two principal components: a reliability model and a simulation model. In the reliability model, the results indicate how different technologies and systems will perform in normal, degraded, and failed modes of operation. In the simulation, an operational scenario is modeled.

The primary purpose of the SVS project is to improve safety by providing visual-flight-like situation awareness during instrument conditions. The current analyses are an estimate of the benefits of SVS in avoiding controlled flight into terrain. The scenario modeled has an aircraft flying directly toward a terrain feature. When the flight crew determines that the aircraft is headed toward an obstruction, the aircraft executes a level turn at speed. The simulation is ended when the aircraft completes the turn.

PRELIMINARY RESULTS SHOWING SAFETY GAIN FROM SYNTHETIC VISION

Turn rate, °/s	Envelope distance, ft	Air traffic control only, $P_{accident}$	Synthetic vision and air traffic control, $P_{accident}$	Safety gain
1.4	17 500	9.50×10^{-1}	8.42×10^{-2}	11.3
1.4	20 000	5.10×10^{-1}	2.90×10^{-3}	175.8
3.0	10 000	8.90×10^{-1}	6.33×10^{-2}	14.1
3.0	12 500	5.10×10^{-1}	2.01×10^{-3}	253.2
5.3	7 500	7.90×10^{-1}	3.78×10^{-2}	20.9
5.3	10 000	4.20×10^{-1}	1.00×10^{-3}	420.0

The preceding table shows preliminary results for SVS, where safety gain is defined as the baseline-case accident probability divided by the variant-case accident probability. Therefore, a safety gain of 420.0 means that the aircraft is 420 times safer with SVS than

without SVS.

The WxAP project was created to address the fact that approximately one-third of commercial aviation accidents are at least partially attributed to adverse weather. Timely and accurate information about weather could reduce accidents caused by weather.

The analyses are aimed at estimating the benefits of WxAP in detecting turbulence and either avoiding it altogether or mitigating its effect if it cannot be avoided. The scenario used to assess turbulence assumes that the aircraft is flying into an area in which there is a turbulence cell. For this scenario, the pilot must perform several actions, including reducing the speed of the aircraft, requesting an altitude change, and beginning to change altitude.

Safety metrics for turbulence are less obvious than those for terrain features, so several results are presented instead of a single-value safety gain. The following three tables show, respectively, encounter probability with and without the WxAP technology and for varying lead times, altitude escape and slowdown probabilities with the WxAP technology for varying lead times, and warning times achieved with the WxAP technology for varying lead times. Although these results are preliminary, it is clear that the AvSP technologies provide significant safety benefits.

COMPARISON OF ENCOUNTER PROBABILITIES

Lead time, s	**No WxAP**	**WxAP**
30	0.210	0.216
60	.219	.212
90	.212	.214
120	.216	.215
180	.208	.191
240	.219	.030
300	.210	.031

ALTITUDE ESCAPE AND SLOWDOWN PROBABILITIES WITH WxAP TECHNOLOGY

Lead time, s	Altitude escape	Full slowdown
30	0.000	0.000
60	0.000	0.000
90	0.000	.169
120	0.000	.875
180	.055	1.000
240	.861	1.000
300	.852	1.000

AVERAGE WARNING TIME

Lead time, s	Warning time, s
30	24.2
60	59.5
90	99.4
120	146.1
180	242.1
240	340.9
300	438.0

Find out more about NASA's Aviation Safety Program http://avsp.larc.nasa.gov/.

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