Trip Report MITRE CAASD: 1/6/2003 and 1/15/2003
Human Factors Simulations of Runway Entrance Lights (RELs)

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During the past two weeks, on January 6th and January 15th, Maria Picardi Kuffner traveled to MITRE CAASD in McLean, VA first for a planning meeting of RWSL human factors simulations and then for real-time observation of two transport pilots being tested in the ATM cockpit laboratory simulator.

RWSL Pre-Experiment Briefing

Representatives from the FAA RWSL program office and flight standards, ALPA, and CAASD human factors staff attended the planning meeting. We began with a discussion of the runway entrance lights configuration that was demonstrated by FAA technical center staff at ACY last month to several pilots.[1] The chosen configuration comprises a longitudinal array of red RELs alternating with green lead-on lights along the taxiway centerline, extending from just before the hold line to the runway edge plus two elevated RELs at the hold line, bracketing the in-pavement Runway Guard Lights and two in-pavement RELs at the runway edge transverse to the runway. This choice was based on the participants' concern that pilots would confuse transverse RELs with the low visibility SMGCS red stop bars and taxi to the runway edge if a bar of RELs were placed there.

The FAA has added one additional in-pavement REL directly on the runway centerline, in-line with the taxiway centerline, to this "I bar" configuration, i.e. "dotting the I". The additional REL is a further response to MIT Lincoln Laboratory's recommendation, based on analysis of DFW traffic data, that the effectiveness of RELs against the most severe category of runway incursions is optimized when pilots can see the REL from the runway edge.

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[1] The FAA program office briefed preliminary results from the REL demonstration held at ACY last month. A list of the pilot subjects comments regarding the REL configuration is documented in a separate memorandum.

Dick Temple of flight standards and Pete Hwoschinsky of the program office referred to this configuration as having four lines of defense:

1. Three RELs at the hold line
2. Multiple RELs along the taxiway centerline
3. Three RELs at the runway edge
4. One REL on the runway centerline

The ALPA pilots concurred with this thought process and were pleased the FAA had heard their concerns. After a briefing on the experimental design by CAASD, we proceeded to the ATM cockpit laboratory and reviewed CAASD's ground traffic scenarios. I observed from behind the subject ALPA pilot and CAASD co-pilot/experimenter seated at the controls and viewing a panoramic out-the-window display. ALPA recommended the RVR be decreased from 2000 to 1200 and this was immediately done. FAA insisted that the runway centerline REL be added and CAASD incurred a two-day schedule delay to have that done for the actual experiment.

RWSL Human Factors Simulation Observation

I joined Pete Hwoschinsky and Dick Temple at the FAA's first opportunity to observe the experiment. We observed transport pilot subjects number 3 and 4 from an observation room within 15 feet of the cockpit simulator. CAASD has tentative plans to run GA pilots in simulations upon completion of testing with a total of 12 transport pilots. We saw either the subject pilot's view out the cockpit window or a plan view. We heard the voice communications of the co-pilot to the ground/local controllers and pseudo pilots.

Human Factors Simulation limitations:

No low visibility SMGCS lights were displayed (i.e. no yellow RGLs and no red stop bars), an important omission because RELs must be implemented an operate "in conjunction" with SMGCS. According to the experimenter, 2 out of 3 subjects have asked about the SMGCS. One subject recommended the RELs be shown as a bar, a configuration option that was rejected because it is not unique from the SMGCS stop bar. We suggested that the pilots be asked if they have ever experienced stop bars and that future simulations include RGLs certainly and stop bars ideally.

The CAASD simulator is more a training device than a motion-based simulator and does not have any brakes of rudders. The pilot subject pushes forward on the stick to "stop." We were unable to hear the pilot and requested an area microphone be placed in the cockpit. We were unable to verify the pilots scan and suggested adding an oculometer (or pupilometer). We also suggested an observer and/or videotape be supplied to record the pilots communications but were assured the experimenter co-pilot was taking notes after each scenario was completed. We noted that there was a dearth of "chatter" on the frequencies and DFW in reality has much more party-line voice communications. Our suggestions to increase realism and provide an appropriate level of tension included having all participants speak more rapidly and perhaps dubbing in actual recorded communications.

The airport simulated was Memphis because CAASD did not have time to adapt DFW. Memphis has some curved taxiway centerlines that have very short straight (perpendicular to the runway edge) segment. The FAA decided to place RELs along the curve and extend them to the leading end of the runway (i.e. up to the chevrons) instead of along the short straight segment. There are two issues with this REL placement. First it looks peculiar to a pilot who does turn onto the straight segment and therefore sees a diagonal line of RELs off to the side. Second, the newly added runway centerline REL would be placed in the chevrons. This is under discussion.

We asked Steve Estes, the CAASD experimenter if the pilot subjects are paid and if they are told not to let other pilots know the RWSL concept so their naivety is preserved. Pilots are being paid $150.00 to participate.

Human Factors Simulation method:

Each pilot is initially given two tasks, taxi according to ATC clearance and maintain a constant taxi speed of 15 knots. For the initial trial, no explanation of runway status lights is given to the pilot. This constitutes the "naïve" trial type and is counterbalanced such that every other pilot is exposed to either an REL or THL scenario first. After the first scenario trial is completed, the experimenter says something like "you may have noticed some red lights…" and takes about five minutes to explain the RWSL concept and proper piloting procedure upon encountering red status lights. The remaining eleven trials are a variety of incursion or non-incursion REL and THL scenarios.

Human Factors Simulation results:

As expected, all of the pilots taxied through red status lights during the naïve trials. I observed the first subject (#3) taxi through all "four layers of defense" red RELs. He later also departed through all three rows of THLs. I observed the second subject (#4) takeoff through all THLs during the naïve scenario. Later the experimenter told me that this was the only pilot so far to inquire about the "red lights" after he completed the naïve trial. I did not observe any more busting through red lights after the initial naïve trials were completed.

Steve Estes reported that so far the first three pilots like the RWSL concept but are not sure about the REL configuration. Some suggested the RELs should form a bar, some suggested the RELs should flash. None liked the curvilinear asymmetrical RELs that diverged from the taxiway centerline. I noted that one of the runway edge RELs was still unrealistically far outboard to the taxiway centerline point but Pete responded that CAASD did not have time to fix that and add the runway centerline REL so they did only the latter.

The pilots liked the THLs but asked why there were three rows of them (not really necessary on the scenarios shown because the three consecutive taxiway entrances to the runway ala DFW was not depicted). Steve is gathering these comments and data via an automated survey on a dedicated web server.

Suggestions and concerns:

As we watched the simulations we simultaneously fit in many side discussions about the human factors issues of RWSL. Since unfamiliarity with the RWSL concept can lead to dire consequences, we worked on the idea of announcing that status lights are operative and "stop on red" via the ATIS. The idea of developing appropriate "escape maneuvers" such as reversing away from the runway edge was considered as well. It would improve the simulation to have standard phraseology developed instead of different variations of a rather casual announcement from the co-pilot to the controller like "Tower we got red lights." There should definitely be more chatter on the party-line to increase the fidelity of voice communications and inherent distractions in the sometimes tense surface traffic environment. Different piloting techniques must be noted in the simulations, for example the United pilot did a 40% check on takeoff. We did observe anticipated separation in use but the timing should be validated by ATC for fidelity of this procedure.

New THL configuration:

We also discussed the THLs and the reason for multiple rows of THLs proposed for 18L/36R at DFW. Dick Temple expressed concern about mixing the THL red lights in between and amongst the existing white touch down zone lights that appear as several rows of three lights per row on either side of the runway centerline in the same vicinity as the THLs would be located. He also was concerned with protecting possible intersection takeoffs by turboprops or others that might use the former starting point of the runway at taxiways Y, YA and Z on 18L. At first, we talked about moving some of the six rows of THLs so that for 18L there would be two rows at the new starting point and two rows at the former starting point plus just two rows at the starting point of 36R.

We then considered a longitudinal configuration of THLs placed on the runway centerline from near the starting point out for approximately 1000 feet. The human factors advantages of a runway centerline configuration include being located exactly where pilots are looking when they start a takeoff roll, being consistent with the look of RELs placed longitudinally on the taxiway centerline, and allowing for immediate feedback (and hopefully instantaneous reaction) under all visibility conditions. Dick Temple said this idea has merit. He was pleased with the potentially practical implementation of dual cans for lamps on the runway centerline, one the existing white and one red for THLs. Also it keeps the THLs away from the white touchdown zone lights and protects the entire space where the THLs might be turned on during the first moments of departure. Pete raised the possibility that the red THLs could appear to look pink when next to the white runway centerline lights but we agreed that this remains to be seen and tested.

Conclusions:

We concluded that this new THL configuration is to be demonstrated at the upcoming activity being planned at ACY. We concluded that although there is room for improvement in the human factors simulations methodology, there are no showstoppers and CAASD will continue to test more transport pilots in the next two weeks.

Next Steps:

Peter Hwoschinsky, the RWSL human factors manager, has requested my presence at another demonstration of RWSL airfield lighting configuration at ACY sometime soon. This demonstration in coordination with the William J. Hughes Technical Center (WJHTC) will include adding the runway centerline REL to the REL configuration seen there in November. In addition, the THLs will be demonstrated for the first time on the airfield. Dick Temple stressed that actual taxiways and runways be used for this demonstration, rather than again using the ramp area.

Attendees of January 6th planning meeting included:

David Domino, Steven Estes, Jason Giovannelli, John Helleberg and Matthew Pollack of MITRE CAASD; Pete Hwoschinsky, Dick Temple and Terry Stubblefield of the FAA, Bill Phaneuf of ALPA and Maria Picardi Kuffner of MIT/LL

Attendees of January 6[15h] human factors simulation included:
David Domino, Steven Estes, Jason Giovannelli, John Helleberg and Matthew Pollack of MITRE CAASD; Vincent Chu, Peter Hwoschinsky and Dick Temple of the FAA, and Maria Picardi Kuffner of MIT/LL