

MMADC Y3 Kick-off Meeting

February 20, 2009

Attendees: Hsiang, Kaber, Kaufman, Kim (NCSU)
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Prinzel (NASA)

Discussion of objectives of MMADC Y3

Extend investigation of clutter measure into a different domain, but using similar display technologies.

- Evaluate visual properties of “Altair” lunar lander displays using VISTAS simulator, with image analysis software (developed by NCSU team).
 - Use as visual properties to predict clutter scores based on models from Y2.
 - Validate predictive models based on observed data from experiment.
- Identify display information features and relevance to V/STOL landing operations (requires cognitive task analysis with expert pilots).
 - Make predictions of display clutter scores based on display information features using models from Y2.
 - May need to consider pilot scan patterns and distances in display use in V/STOL operations (compared with scans when using HUD in commercial aircraft cockpit).
 - Validate predictive models based on observed data from Y3 experiment.
- Develop integrated model for predicting clutter based on display visual properties (bottoms-up) and information features (top-down).
 - Compare with predictive utility of models developed in Y2.
 - Develop generalizable models for space and helo operations.

Operations philosophy (focusing on V/STOL operation)

- Must focus and report on V/STOL operations to NASA management.
 - No reporting of relevance of results to space application.
 - As briefed to management, we cannot say “lunar” - must refer to aeronautics; ok to generalize to space in manuscripts.
 - Dual-use of clutter measures and models for lunar lander design to be limited to publications based on research.
 - Because of the NASA need for aerospace work, we’ll focus on Harrier flight simulation
- V/STOL operation
 - Some similarities between Harrier and 757 operations.
 - Mechanics of controlling harrier are different. (Kaufmann is familiar with landing and approach scenarios but not control mechanics.)
 - Can use autopilot support in hover mode.
 - Allow pilot to control left/right and up/down
 - IMC to VMC at transition to hover – about 50m above surface.

- Prinzel will arrange for team communication with experts on V/STOL operations and control system designers.

Simulator configuration for Y3 study (using Altair display concepts)

- Displays in VISTAS are head down...
 - Could project display on out the window visual scene but not collimated.
 - Probably not necessary because use of out-of-cockpit visuals in Y2 was limited (e.g., look for runway image at published minimums; look for runway out of window at EVS minimums).
- Display conditions / stimuli
 - PFD next to NAV display, with no HUD.
 - ADI ball can be replaced with traditional PFD.
 - Manipulate SVS wireframe
 - Both PFD & NAV
 - PFD or NAV (3 conditions)
 - Manipulate SVS terrain model (rendered) (6 conditions)
 - Tunnel on/off PFD (8)
 - EVS on/off (10)

(Team tentatively agreed to use a HDD setup including a PFD and NAV display.

Content of NAV display will be similar to display in commercial aircraft cockpit and will be held fixed.

Content of PFD will vary, including SVS, EVS, tunnel and symbology features.)

- VISTAS uses joystick instead of yoke.
- Flight simulator is flown in upright, seated position.
- Do not need to model dynamics of specific vehicle.
 - Only need general model of V/STOL operation for measure and model validation. (This may also serve to reduce pilot subject scrutiny of simulation and negative transfer of harrier or helo. mental models.)

Flight scenario development

- Focus on Harrier V/STOL flight.
- Keep the scenario closely tied to the previous experiment (similar type of approach trajectory). However, based on results from Y2 study, remove leg (or phase) of flight as variable in scenario and experiment design.
 - Leg was not significant in Y2, probably due to pilot activity set not varying dramatically across stages of approach.
 - In Y3 study, run more, shorter duration trials to increase power of tests and reliability of results.
- Information that will be relevant for new landing scenario in Y3 study will include...
 - Sink rate
 - Thrust vector, etc.

(This may differ from highly relevant information for landing in Y2 study. Need to do cognitive task analysis with expert V/STOL pilots.)

- Attempt to mimic weather transitions in Y3 experiment
 - Transition from IMC to VMC (NASA has full control of the out-of-window view).
 - Transition to hover in V/STOL will likely happen close to decision height in previous study (Y2).
 - VMC may be compromised by “brownout” or “whiteout” at landing site.
- Manipulate flight task workload
 - Crosswind was not significant in influencing pilot performance in Y2 study, particularly for expert pilots.
 - Need to simulate major differences in flight difficulty among workload conditions in order to assess affect of task-related (top-down) factor on pilot perceptions of clutter.
 - Hsiang suggested presenting wind conditions that varied in multiple dimensions and not pure crosswind.
 - Prinzel suggested using crosswind at high altitude and then simulating wind shear at low altitude.
(Kaufmann will take this approach in drafting initial scenario.)
- Use structured manipulation of environmental factors at landing (like magic fog in Y2 study, which was not balanced) to increase complexity.
 - Consider “brownout” and “whiteout” in harrier landings.
 - Settings could include: 50%, 100% and no brownout.
 - Represents another task-related factor that may be influential in perceived clutter.

Experiment Planning

- Stimuli: Display PFD next to NAV display (with no HUD)
 - SV wireframes on PFD
 - Terrain representation on PFD
 - Tunnel on/off
 - EV on/off
 - Rotate PFD to show ground viewpoint at transition to hover

(Note: Base on cognitive task analysis, we need to specify which tasks are supported by which displays.

May run into experiment confounds if NAV contains similar/redundant info as PFD.

e.g., If PFD is perceived as being too cluttered, pilots may turn to NAV for guidance (even if the display is not intended to serve this function).

- Subjects
 - Use commercial pilots with “glass cockpit” experience and helicopter rating.
 - High experience – only study one group with high sensitivity to display content. (Based on results of Y2 study, experienced pilots were most accurate in terms of classifying displays among defined clutter categories. Low and medium-experience pilots were not accurate or consistent in clutter classifications of displays.)
 - Prinzel suggested getting commercial fixed-wing pilot with helo rating on board – provides expertise, scanning ability, and knowledge of interpreting symbology,

with ability to do transition to landing phases (would be difficult to recruit Harrier pilots).

- Possible IVs (in addition to stimuli)
 - Remove leg IV based on Y2 study (leg did not significantly influence DVs) – increase trial count/power (see above).
 - Given low R-squared values for integrated models of clutter score in bottom-up and top-down factors in Y2, we seem to be missing contextual and/or display factors in model.
 - Increase workload intensity differences – use different wind profiles at different altitudes during hover (use Harry/Mike to confirm difficulty of workload manipulation)
 - Emily and Amy are going to think about other top-down/task-relevant factors to manipulate in the experiment to assess effects on perceived clutter.
 - Need to create opportunities to assess pilot decision making in landing scenarios under varied display conditions.
 - Y2 study revealed presence of EVS in HUD led to reduced bias in decision making on landings.
 - Pilot sensitivity to signals in display was relatively constant across non-EVS and EVS conditions.
 - Prinzel suggested using guidance system failures during harrier landing as one critical event.
 - Aircraft gets off track.
 - Pilot can easily detect and reset.
 - Reset is observable behavior and event can be marked in experiment trials through simulator.
 - We will also explore “go” or “no-go” decisions in landing, based on environmental conditions (e.g., brownout).
 - Structure scenario such that if sink rate is above threshold at minimum altitude, pilot must land vehicle.
(Cannot analyze decision making with displays if there is a period of time after an initial decision in which the pilot may reverse judgment.)
- Possible DVs
 - Expected to be similar to those collected in the Y2 study.
 - If a tunnel is presented, path (center of tunnel) deviation indicators will be included in display as well.
- Training
 - Training regimen will be limited by ensuring that subjects have prior glass cockpit experience.
 - Need to make certain they know typical content of glass PFD and NAV displays.
- Schedule
 - Conduct experiment in early June.

Other issues

- Next step

- Based on meeting, Prinzel will communicate with Bailey regarding support from NASA and secure experiment resources (scheduling VISTAS, arranging for engineering time, etc.).
- We will continue to use project website to share documents and to keep the research on track.

- Publications based on Y2 study.
 - Alexander prepared and submitted a proposal to HFES 09 (2/20).
 - Kaber and Kim are preparing and will submit a paper to ISAP (3/16).