

Task 5: Synthetic Vision for Primary Flight and Multifunction Displays (Beringer)

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Project Start Date: 9/1/2008

Anticipated End Date: 9/30/2011

Requirements Statement
<p>Operational Shortfall or Knowledge Gap</p> <p>In accordance with Objective 1 (reduce the commercial airline fatal accident rate) of the agency's Safety Goal (achieve the lowest possible accident rate and constantly improve safety), research is needed to investigate and identify human factors/pilot interface issues with synthetic vision systems (SVS) when used as an integral part of a primary flight display, which has been proposed by a number of applicants (e.g., Universal Avionics, Chelton, and others). Synthetic vision displays are new and novel, being comprised of unique combinations of information on both Primary Flight Displays (PFDs) and Multifunction Displays (MFDs). These presentations will affect pilot performance, workload, and decision-making. Of particular interest is the presentation of dynamic graphical information behind the primary indication of attitude and crewmember decisions based on the presentation. Additionally, few data exist to illustrate how application of this technology to see-through displays, intended to allow a simultaneous view of the synthetic imagery and of the real world, will affect pilot performance.</p>
<p>Benefit in Closing the Shortfall or Gap</p> <p>The results of this research will be used by airplane and, potentially, rotorcraft certification specialists to develop criteria and acceptable means of compliance. The outcome of the requirement will impact on the reduction of Controlled Flight into Terrain (CFIT) accidents/incidents, obstacle-strike accidents/incidents, and address gaps in existing regulations and standards for this new technology.</p>
<p>Description of the Desired Product</p> <p>(1) Listing of recommendations and suggested criteria for accepting SVS, (2) contributions to the Minimum Aviation System Performance Standards (MASPs) for SC-213 and (3) recommendations for and critiques of methods and procedures for the Enhanced Vision System (EVS) and Enhanced Flight Vision System (EFVS) proof-of-concept demonstrations/evaluations.</p>
<p>Schedule</p> <p>(see milestones)</p>

Research Objective

The objective of this project is to determine the potential effects on pilot performance of incorporating synthetic vision system features into primary-flight and/or multi-function displays and, potentially, see-through displays that allow the pilot to see both the synthetic imagery and the real world simultaneously. The intent is to generate data that can be used to formulate appropriate certification criteria across a number of platforms on

which this graphical imagery may be hosted (both aircraft-referenced and pilot-referenced display systems) and to provide data that may be helpful in assessing levels of operational credit that may be granted for the use of such systems.

Background

The FAA is currently tasked to review and approve new synthetic-vision systems. There is very limited experience with Part 23, 27 and 29 certification of synthetic vision systems on primary flight displays and only an emerging knowledge and understanding of this new technology. There are no industry standards for displays incorporating SV and recent design proposals vastly differ from each other. Some applicants combine unique flight symbology with the SV presentation, while others propose only SV with a standard Attitude Directional Indicator (ADI) symbology. The choice of flight symbologies, level of detail, alerts, color, graphics, grids, terrain, water, scaling, field of view, distortion and basic background are unique for each proposed design. Some applicants' designs also provide SV and other pathway symbology on MFD presentations along with the PFD. Since each of the proposals represents new technology, are one-of-a-kind in their appearance, and display non-standard and highly dynamic information in the pilots' primary field-of-view, certification specialists have insufficient data to evaluate these designs such as pilot interpretation and use of the displayed information. Safety may be compromised if the FAA certification effort fails to comprehend factors that affect pilot performance, workload, and decision-making with this new technology. The FAA Transport Airplane Directorate, Small Airplane Directorate, and Rotorcraft Directorate need objective data on the human factors of SVS to develop and publish guidance for certification. Although an Advisory Circular has been published for SVS in Part 23 airplanes, guidelines for application in Part 25 airplanes have not been fully determined. Additionally, the potential benefits of variants of SVS have potential benefit to HEMS operations (as shown in preliminary work in this area), and may be relevant to both equipment/system certification criteria and operational criteria, which may be of use to both Flight Standards and to the Rotorcraft Directorate.

Previous Activity on this Task

CAMI HFRL conducted a literature review in a previous fiscal year along with a summary of the systems available or soon to be made available. CAMI personnel also made, and continue to make, contributions to the ongoing development of the MASPs by SC-213 and have supported the EVS/EFVS proof-of-concept effort. Some preliminary data collected for see-through systems suggested utility for the identification of and guidance to unimproved sites for HEMS operations. CAMI personnel conducted interviews with a small sample of SVS users to determine when and how they used the systems, what they felt were beneficial features, which features were detrimental, and what additional features were desirable. These results were reported to the SAD and were published in the 4th quarter of 2009.

Proposed or Planned Research

Continued activity on this project will be to follow through with the MASPs development to a final draft, to support the Ops Concept document, and to continue support of the EVS/EFVS proof-of-concept effort. Recommendations and criteria will be contributed to SC-213 for inclusion in the documents in preparation. Initial research will be performed on which of the display variables being examined transfer directly to the use of synthetic vision/synthetic cues on pilot-view-referenced display devices, and how use in that medium may or may not affect likely certification standards.

Complete thorough listing, in brief form, of items covered in SC-213 MASPS, determine which are supported, fully, by empirical research, which are industry convention or best practices, and which items are either disputable according to extant research or which contradict empirical findings and may compromise pilot performance (workload, errors, etc.). Derive "research needed" by comparison of MASPS and empirical findings. Create list of recommended research thrusts.

CAMI is working with outside support to update the literature review to document what is known about unique human factors/pilot interface issues associated with SVS and hybrid SV/EV integration to increase the FAA's knowledge and understanding of this new technology. Within the report, there is a need for a summary of the sensitivity of pilot performance, workload, and decision-making on a variety of design parameters (e.g., symbology, level of detail, alerts, color, graphics, grids, terrain, water, scaling, field of view, distortion and symbology overlay on dynamic multi-color background, SV/EV integration) that can be used to develop issue papers and certification guidance for SV and SV/EV hybrid integration. Task analysis required to define pilot decision-making tasks, information needed, and how technology available can support these tasks. Ultimately the report must make recommendations and identify outcomes for addressing needs for updates in FAA regulations and lack of knowledge regarding SVS and hybrid technology.

Research Question(s)

1. Are the certification/credit issues different depending upon the platform on which SVS hosted (display orientation reference)?
2. What are the differences between the Part 91 applications and the Part 121 applications and do they materially affect certification/credit criteria?
3. Where are the gaps in existing knowledge regarding standards for SVSs?
4. What are the most salient variables that should be considered during certification applications?
5. Can a working set of condensed guidelines be developed for use by Aircraft Certification Service evaluators?
6. How do criteria differ between head-down versus see-through formats of display?
7. How are design and performance criteria affected by major task types?

Technical Approach

Current Year

The outcomes of a workshop on Synthetic Vision, hosted by the Transport Airplane Directorate (February, 2006), have been used to define what the remaining germane issues are for the certification of SVSs in both Part 25 and Part 23 airplanes and for Part 121, 135, and 91 operations. The output from that workshop and the output of RTCA SC-213 are being used by the sponsor and the performing organization to define (1) what the outstanding issues are regarding granting certification of and operational credit for SVSs, (2) what data are immediately available, through additional compilations from the literature, that bear on the certification and operational credit issues, and (3) what additional data need to be collected through empirical research to fill in gaps in the extant data. Data gathered are being used to contribute to the SC-213 MASPs writing and to inform responses to requests for additional operational credit for use of SVS/EVS/EFVS.

Out-Years

Additional research comparing requirements of head-down versus see-through formats is expected to separate criteria for each of these types of display (this question is currently being considered in SC-213 and corresponding support activity may be moved earlier to correspond with this), and to provide insight into the combination of sensor-derived information and database-derived information within a display.

Air Traffic Resources Required

None

Information Technology Resources Required

Assist with integration of hardware and software

Calibration

None

FY10 Milestone Schedule		
Description	Proposed Start Date	Proposed Completion Date
Initiate contract support of literature review and product overview	FY10 Q1	FY10 Q2
Generate preliminary report from these reviews	FY10 Q2	FY10 Q3
Initiate follow-on simulator research if warranted	FY10 Q3	FY10 Q4
Preliminary report on follow-on research and status review	FY10 Q4	FY10 Q4
Contractor will provide quarterly updates	FY10 Q1	FY10 Q3

FY10 Deliverables		
Description	Proposed completion date	Actual completion date
Support of R.T.C.A Special Committee 213 (Synthetic Vision Systems) in the writing of MASPS and Ops Concept.	Ongoing	
Support of EVS and EFVS Proof-of-concept demonstrations/evaluation (AFS)	Undetermined	
Report of additional experimental research findings	FY10 Q4	
Complete literature review of human factors research and FAA and industry guidance related to SVS/EVS design and implementation (K. Lemos)	FY10 Q3	Partial FY' 10 Q1
Complete an SVS/EVS industry review/inventory, including hands-on evaluations by human factors specialists (K. Lemos)	FY10 Q3	Partial FY' 10 Q1
Recommended items for incorporation into an "EVS/SVS human factors certification and approval checklist" for use in certification and approval of EVS/SVS systems for new intended functions	FY10 Q4	
A report describing the pilot decision-making tasks and associated information cues that must be supported by EVS or SVS technologies	FY11 Q1	
Draft report associated with SVS and hybrid SV/EV integration	FY11 Q2	