RDEC

A full-mission evaluation of a computational model of situational awareness

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Situational Awareness

Problem:

- Various definitions in literature

Goals:

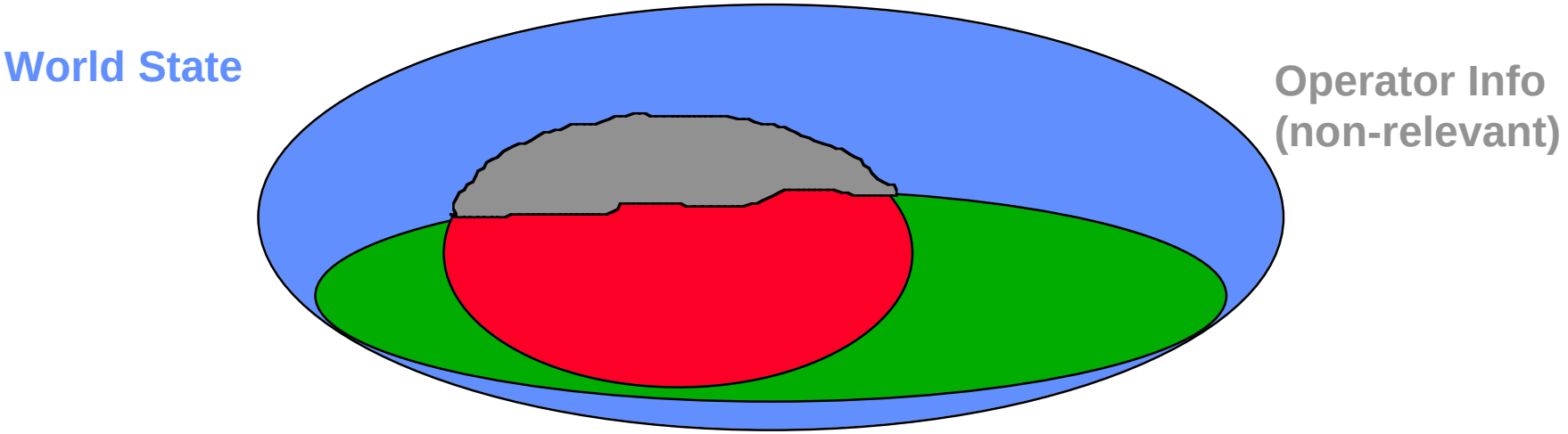
- Develop a computational, clearly defined predictive model of SA
- Distinguish between perceived and actual SA
- Validate in simulation

Situational Awareness (Shively, Brickner & Silbiger)

Ratio of *relevant* knowledge that the user has to the information needed

operator know (context)

info needed (context)



MAN-MACHINE INTEGRATION DESIGN & ANALYSIS SYSTEM (MIDAS)

DESIGN/SPECIFY VEHICLE, CREW, AND MISSION

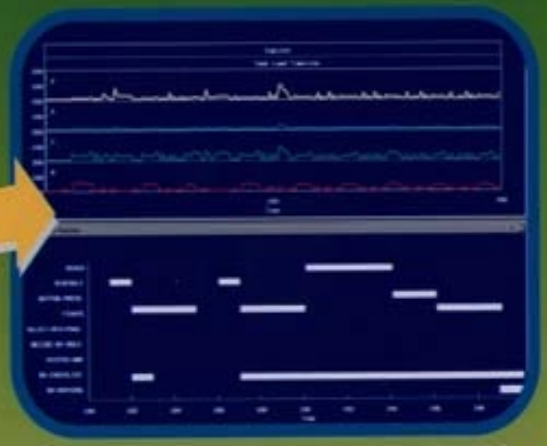
DESIGNER'S WORKSTATION

VISUALIZE SIMULATION OF MISSION SEGMENT

PERFORM INTERACTIVE HUMAN FACTORS ANALYSIS

SUPPORTS INPUT FROM:

- PILOTS
- MISSION PLANNERS
- ENGINEERS
- ANALYSTS
- PSYCHOLOGISTS
- TRAINING SPECIALISTS



ANALYZE RESULTS: INFO REQMTS, TASK TIMELINES, LOADING, ETC.

Situational Awareness Model

Key features:

- Situational elements
  - The relevant information in the environment that define the situation.
  - Four Levels of Awareness
- Situation-sensitive nodes
  - Semantically related collections of SE's.

Model Components

Situational Elements

- Relevant elements in the environment that define the situation, i.e. other aircraft, ownship performance parameters, trees, wires
- Weighted by importance in a particular situation
- Acquired through perception; also through experience, pre-flight briefing etc.
- Four levels of awareness give mathematical weights.

Situation-sensitive nodes

- Semantically related collections of SE's
  - e.g. Node NAVIGATION contains all of the waypoints, landmarks and known obstacles on the planned route.
- Nodes are weighted by importance in a particular situation.

Previous study 1
Star Cruiser

- Star Cruiser
  - A video-game style of experiment using college students.
- Results
  - showed a trend to dissociate *perceived* SA (SART) from *actual* SA (SAGAT). Participants who thought they were doing very well rated their SA as being higher even though performance was no different than other participants.

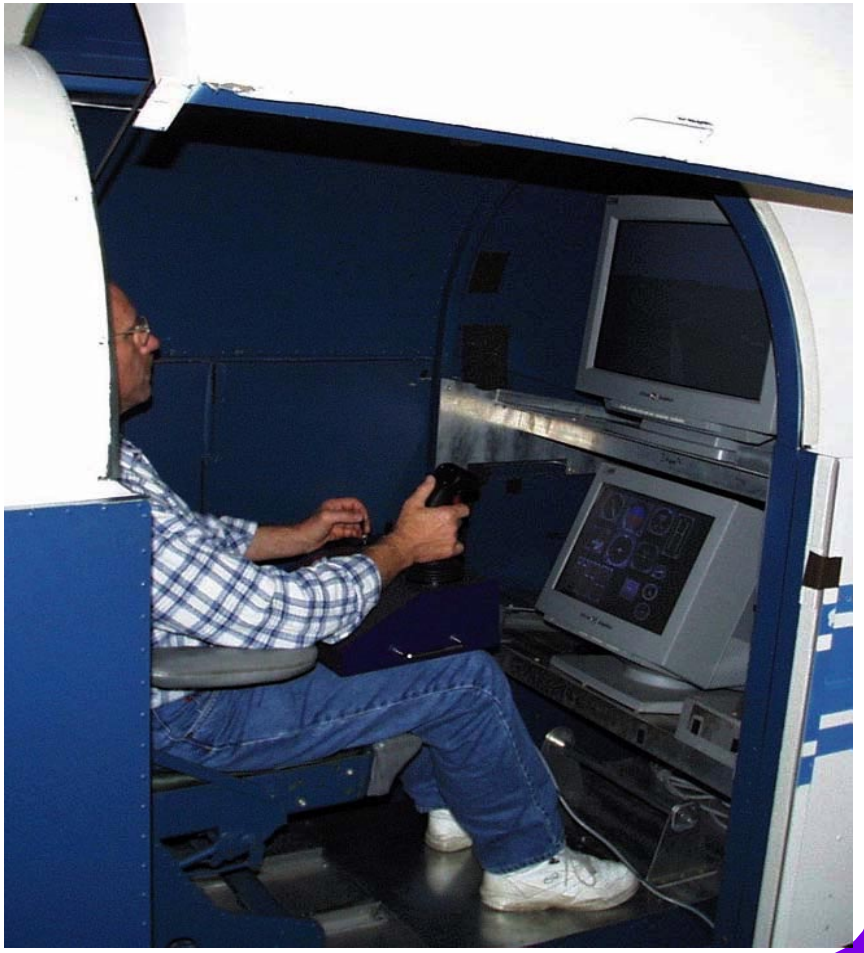
Previous study 2 Window Panes

- Window Panes
  - A low-fidelity flight simulator using GA pilots.
- Results
  - supported the model's predictions of SA based on varying the level of awareness of the SE's across trials. Trials with SE's at a lower level of awareness showed lower SA.
- While both these studies provided support for the model's predictions they were performed in low-fidelity, unfamiliar tasks.

Rotorcraft Part-Task Simulator RPTL

Mid-fidelity rotorcraft simulator consisting of:

- Out the window view
- instrument panel
- flybox
- fixed-based, one seat cab
- external experimenter station



Current study overview

Objective:

- To provide a more stringent test of the model's predictions of participant SA using a more realistic flight environment

Approach:

- Participants flew simulated Medevac scenarios consisting of an ingress to an accident site, followed by an egress to a pre-designated hospital or airport site.

Method

- Participants
  - Six GA pilots were trained on the RPTL simulator.
  - Training consisted of a two hour session allowing for familiarization with the handling characteristics of the simulator.
  - Training scenarios were designed to expose the pilots to appropriate rate of turns, r/c acceleration, route following, and to maximize exposure to low altitude flying.

Design

- Within-subjects design. Each pilot flew three Medevac scenarios, (consisting of an ingress and an egress) under three different conditions.
- Conditions varied the level of awareness of the Situational Elements in the scenario, thus resulting in model predictions of High, Medium or Low predicted SA for each trial.
- Pilots were tasked to fly between 80-120 knots at an altitude of between 200'-400' for all trials. Trials were counterbalanced to avoid order effects.

Manipulations

Manipulation	Pred High SA	Pred Med SA	Pred Low SA
Pre-trial briefing	Extensive	Moderate	Brief
Detail of map	Path, type, loc, hdg, time, divert	Faint path, loc, hdg, divert	loc, time, divert
Visibility	CAVU	Hazy	Fog, < 1 mi vis
Contrast	High contrast	Good contrast	Poor contrast
Clutter	Isolated wp	Objects near wp	Clutter near wp
Air Traffic	Single, on legs	Single, near wp	Groups, near wp
Ownship instruments	Gauges easy to read	Gauges harder to read	Gauges difficult to read

Weighting of nodes and SE's

- Nodes weights were assigned based on a task analysis of the scenario in conjunction with experienced operator input. Pilot subjects are unaware of the experimental weights.

- Mathematical weights of SE's were assigned based on the level of awareness of the SE in the trial. The current values associated with levels of awareness are arbitrary and subject to validation.

Higher Order Nodes and SE's for an Ingress

- Navigation (weight of .5)
  - SE's: briefed flight path, WP1, WP2, WP3, WP4, WP5, landmark1, landmark2, accident site
- Ownship (weight of .3)
  - SE's: A/S, AGL, ASL, Heading, V/S, Fuel Quantity and Consumption, Engine and Oil Temps, Engine power, Percent Torque.
- Air Traffic (weight of .2)
  - SE's: A/C1, A/C2, A/C3

Calculation for predicted HI SA trial

SE	LOA	Value	Node
Flight Path	Comp	1.00	Nav
WP1	Comp	1.00	Nav
WP2	Ident	.75	Nav
WP3	Ident	.75	Nav
LM1	Comp	1.00	Nav
LM2	Ident	.75	Nav
Site	Comp	1.00	Nav
RadAlt	Ident	.75	Ownship
Airspeed	Comp	1.00	Ownship

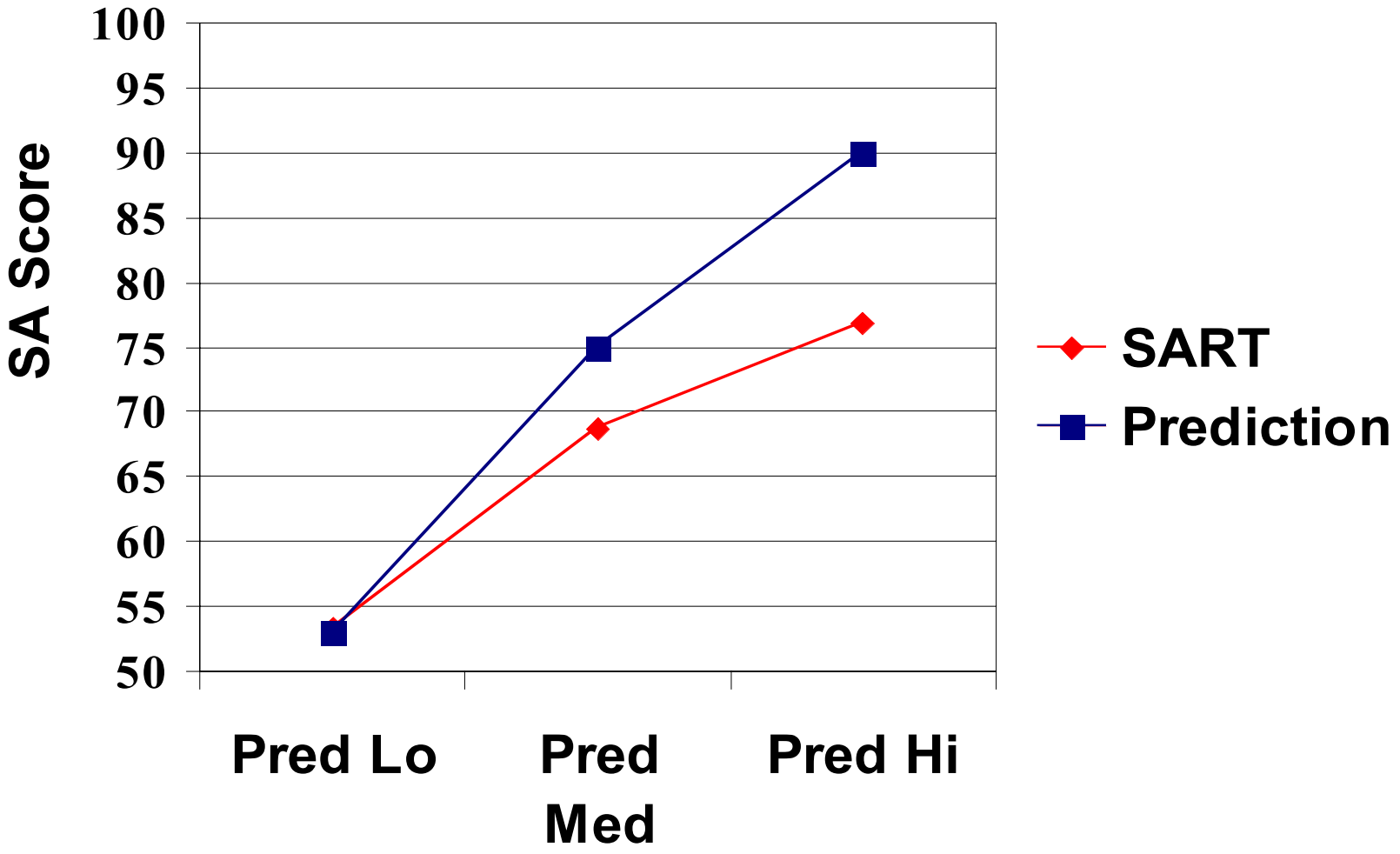
Predicted HIGH SA cont.

SE	LOA	Value	Node
Heading	Comp	1.00	Own
AC1	Comp	1.00	Aircraft
AC2	Ident	.75	Aircraft
AC3	Ident	.75	Aircraft

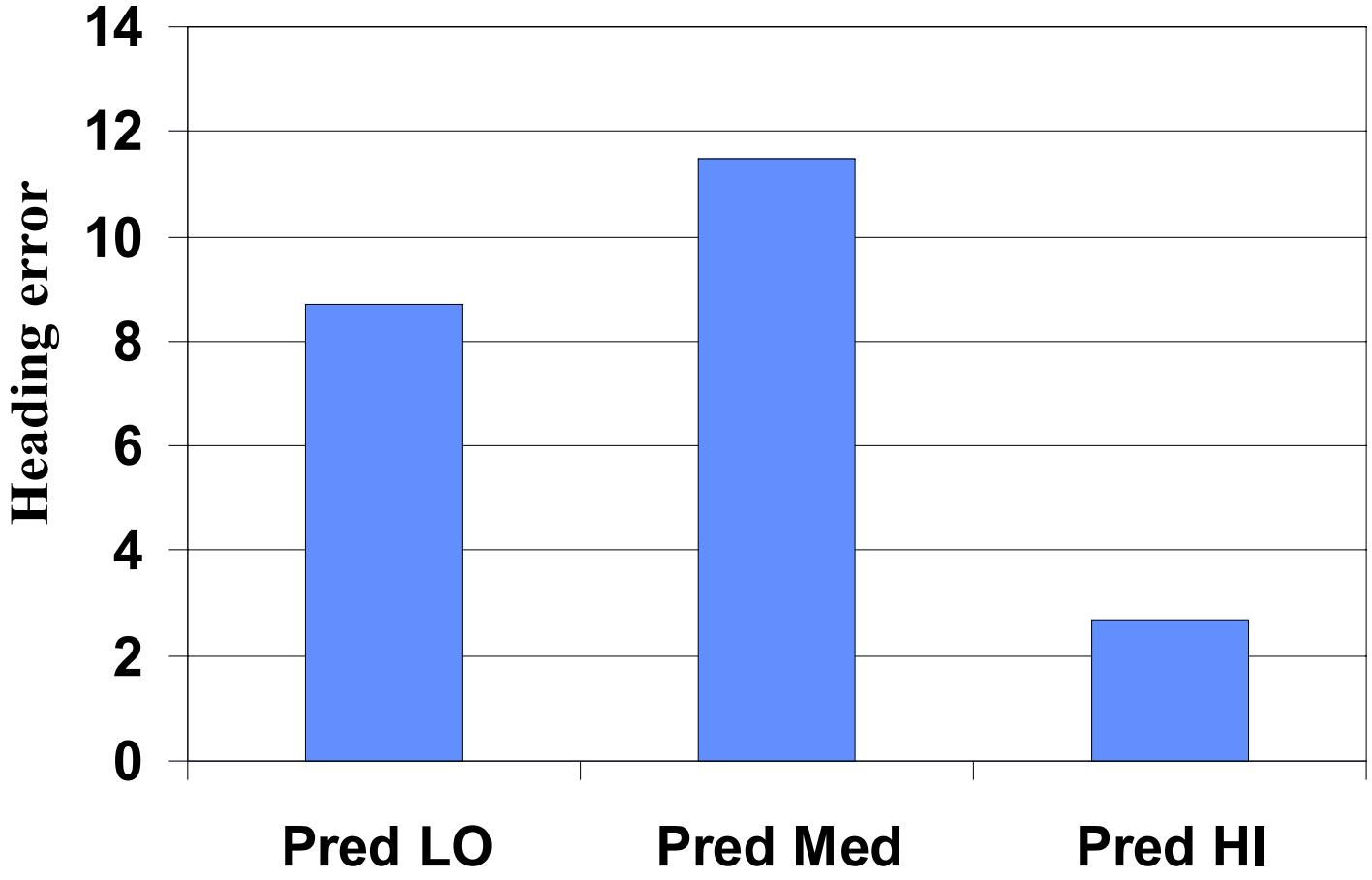
- Predicted SA

[((1.00+1.00+.75+.75+1.00+.75+1.00)/7)*.5] +
[((.75+1.00+1.00)/3)*.3 + [((1.00+.75+.75)/3)*.2] = .45 +
.28 + .17 = .9

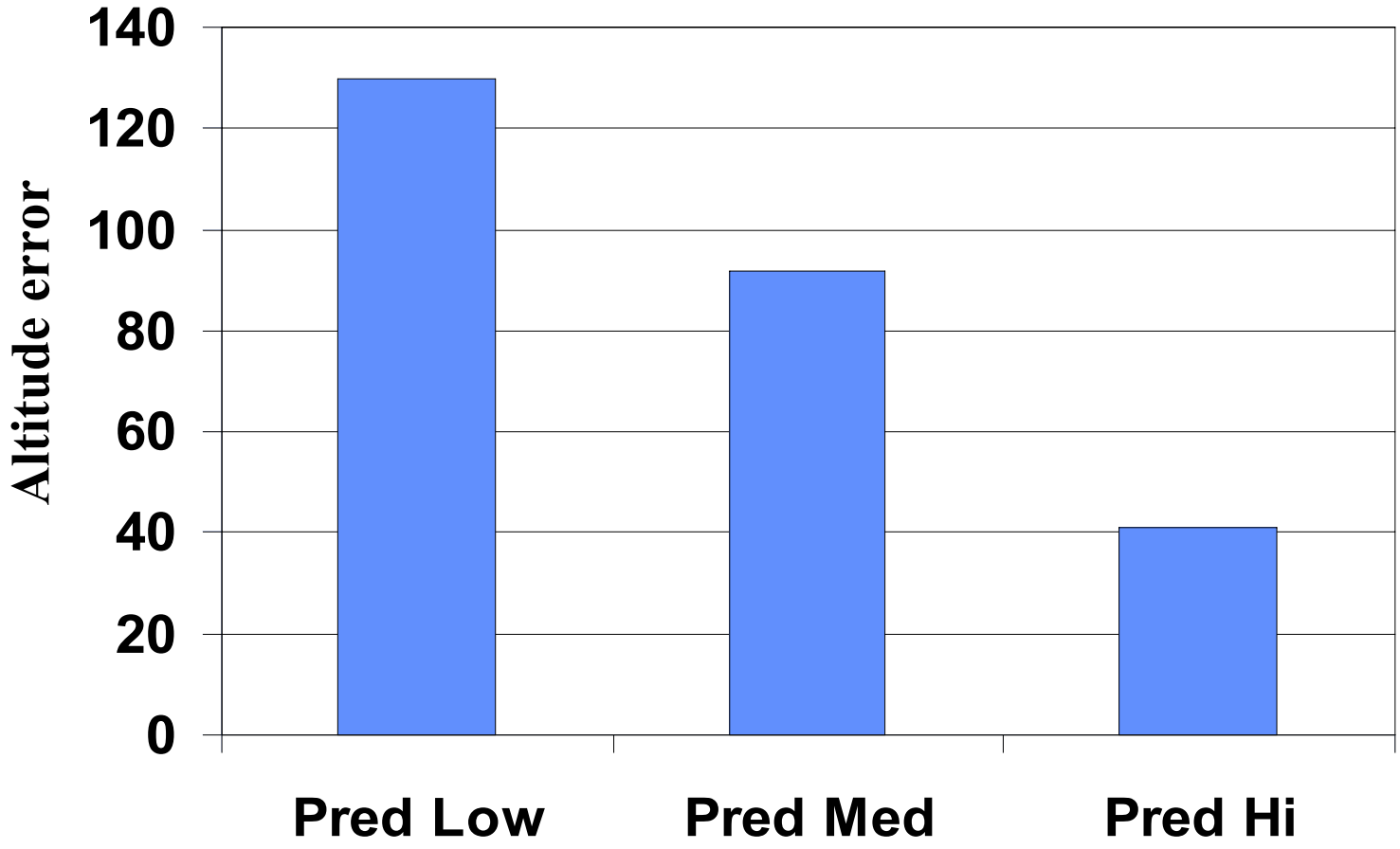
SART SA Results



SAGAT Heading



SAGAT AGL


Altitude error
140
120
100
80
60
40
20
0
Pred Low
Pred Med
Pred Hi

Summary

- SART and SAGAT data support the model's predictions.
- Further SA measures forthcoming from post-task questionnaire analysis and performance data.
- Future
  - diagnostic testing of the model using actual Medevac pilots and the introduction of errors.