

# INSIGHT



---

The Perception and Performance Technical Group Newsletter Vol 27 • No. 2 • June 2005

---

## Chair's Report *Patricia R. DeLucia* Texas Tech University

Greetings to All Members!

I am pleased to announce that the PPTG is co-sponsoring the first **Symposium on Auditory Graphs**, which will be held in Ireland this summer. Bruce Walker, a PPTG member, is chairing the symposium. PPTG sponsorship results in numerous benefits for PPTG members and supports a new and important field of study. Details are provided later in this newsletter.

The Education and Training Committee (of which I am chairperson) will initiate a **new series of special workshops at the 48th Annual Meeting** in Orlando, Florida. The committee will sponsor two half-day workshops on usability presented by James R. Lewis, who has been a usability practitioner at IBM since 1981 and wrote a chapter on usability testing that will appear in 2005 in the third edition of the *Handbook of Human-Computer Interaction*. The morning workshop, "Introduction to Usability Testing," covers the concept of usability, the history of usability testing, various goals of usability testing, and how to run usability tests. In the afternoon, "Advanced Topics in Usability Testing," will cover advanced topics, including sample size estimation for usability tests, computation of confidence intervals, and the use of standardized usability questionnaires. In 2003, the committee conducted a survey to assess the education and training needs of HFES members. Based on the results, the committee identified content and skill areas in which members perceived a need for further education and training. Respondents characterized usability as a top training need. The E&T Committee will continue to sponsor a workshop at each annual meeting to address members' needs. Proposals for future workshops in the identified skill and content areas will be

Continued on page 2

### **IN THIS ISSUE ...**

<i>Chair's Report</i>	<i>Page 1</i>
<i>PPTG Sponsors ICAD Symposium</i>	<i>Page 2</i>
<i>Member Spotlight</i>	<i>Page 3</i>
<i>A Student's Perspective, Part 1</i>	<i>Page 5</i>
<i>A Student's Perspective, Part 2</i>	<i>Page 6</i>
<i>Workload and Situational Awareness...</i>	<i>Page 8</i>

**Chair's Report continued from page 1**

solicited (for a partial list, see the December 2004 issue of *HFES Bulletin*). PPTG members should consider submitting workshop proposals for future meetings. E&T workshop presenter(s) are paid a \$1500 honorarium (for a full-day workshop) rather than the standard full-day workshop honorarium of \$1000.

As promised in the last issue, we have **reprinted** in this issue a **research report from a 1992 issue of *Insight***. The report was written by our very own and venerable **Chris Wickens**. The older issues of our newsletter featured such research reports as a regular column, as well as student papers, and job postings. I would like to encourage members to again submit such items!!

**Winners' Perspectives.** Ernesto A. Bustamante, and Zhonghai Li, our two winners of the HFES Perception & Performance Technical Group Student Research Award each contribute "A Student's Perspective" later in this issue.

**Update on Ballots for Secretary/Treasurer.** All members should have received a ballot to vote for PPTG Secretary/Treasurer in the postal mail. Please mail these back to me at Patricia R. DeLucia, MS 2051, Psychology Dept, Texas Tech University, Lubbock, Texas, 79409-2051.

**PPTG Website Updated.** The PPTG website now has the last issue of *Insight*. Please send Steffen Werner any materials to post or any suggestions to improve the website. Also, if you are interested in help Steffen maintain the website, please contact him at [swerner@uidaho.edu](mailto:swerner@uidaho.edu).

***And finally... please send Shelley columns for *Insight* that describe your research, your background, your place of employment, your educational programs or anything else of interest. We want to hear from you! Contributions should be sent to Shelley at [shelley-home+work@LipmanFamily.org](mailto:shelley-home+work@LipmanFamily.org)***

\*\*\*\*\*

### **PPTG Co-Sponsors First Symposium on Auditory Graphs**

Bruce Walker

Displaying numerical or scientific data via sound, or *sonification*, is a relatively new field but one full of promise for a broad range of uses and users. Much remains to be learned in the specific subdomain of creating effective *auditory graphs*, as well as how to train listeners to interpret them for real data analysis tasks. These kinds of issues are certainly of broad interest to the HFES membership; until very recently, this topic has been under-represented at HFES conferences and in *Human Factors*. It

is important to build bridges between the auditory display community and other research fields, including Human Factors and Ergonomics. This is the purpose of the first ever Symposium on Auditory Graphs, which will be held on July 10<sup>th</sup>, in conjunction with the International Conference on Auditory Displays (ICAD), in Limerick, Ireland, July 6-9, 2005. The Symposium will gather researchers from around the world who are experts in the development or study of auditory graphs, and/or experts in various related topics. Example topics include perceptual, conceptual, cognitive, and design issues, as well as implementation issues such

**Continued on page 3**

**Auditory Graph Symposium continued from page 2**

as software tools. Bruce Walker, a PPTG member and faculty member at Georgia Tech University, is chairing the symposium. He hopes to introduce HFES members to the ICAD community and bring the research of ICAD over to the HFES members.

The Perception and Performance Technical Group is co-sponsoring the symposium. Sponsorship will bring several benefits to the PPTG membership. The PPTG has pledged \$400 to produce and disseminate the Symposium Proceedings (printed and on CD). Interested PPTG members will be able to request a free copy of the proceedings on CD (paying only for postage). Members of the PPTG who attend the Symposium will have their registration fee waived. In addition to print and CD, the papers to be presented will be available on the ICAD Symposium website in advance, so that attendees may read them to prepare for the discussions. A link to the symposium website will be added to the PPTG website. Following the Symposium, the participants will co-author a journal article to serve as a summary of the meeting, to introduce the field to a broader audience, and to lay out an agenda for continued research in this

area. A follow-up article is planned for *Insight* which will discuss the event, and point readers to the relevant web sites such as links to articles and the online proceedings.

In addition to providing these tangible benefits to the PPTG membership, we hope that sponsorship will recruit new PPTG and HFES members, foster communications among members of HFES and ICAD and other related organizations, and stimulate discussions at the HFES annual meeting. Several years ago, the PPTG changed its name from the Visual Performance Technical Group and broadened its scope to cover all sensory systems rather than only vision. Sponsorship of this symposium reflects PPTG's commitment to this mission.

The organizers of this meeting are grateful for the encouragement and support of the PPTG, which will be acknowledged at the conference and in the Symposium Proceedings. The organizers look forward to seeing several PPTG faces in Limerick this summer! More details of the Symposium (including the papers to be presented) are available at: <http://sonify.psych.gatech.edu/ags2005/index.html> , or from Bruce Walker ([bruce.walker@psych.gatech.edu](mailto:bruce.walker@psych.gatech.edu)).

\*\*\*\*\*

**Member Spotlight: Harvey Smallman****Pacific Science & Engineering Group**

*Harvey S. Smallman, PhD,*  
[[smallman@pacific-science.com](mailto:smallman@pacific-science.com)]

I'm a Senior Scientist at Pacific Science & Engineering Group (PSE) in San Diego with research interests in the mechanisms of human visual perception and in how perceptual principles can be applied to information visualization.

I've been at PSE for seven years now after moving there from basic science. That academic career saw me earning a doctorate in Psychology on human binocular depth perception at UC San Diego in 1993, pursuing a post-doc at the Smith-Kettlewell Eye Research Institute in San Francisco, and then joining the Psychology faculty of the University of Durham in the UK for a spell. My most fun basic study, which I

**Continued on page 4**

**Member Spotlight, continued from page 3**

published in *Nature* in 2001, was a sight-restoration case in which I showed that human photoreceptors dynamically track where light is coming from, like sunflowers.

PSE has 30 researchers, developers, engineers and support staff working on a variety of different HF/E projects, a dozen of whom have doctoral degrees in the behavioral sciences. The projects span the HF/E spectrum from research-oriented ones, that I'm often involved in, through development efforts, through to the test and evaluation of fielded systems. Many of the projects are sponsored by the Office of Naval Research and some are conducted on contract for the Navy's SPAWAR labs on Point Loma, here in San Diego.

The projects that I'm Principal Investigator of are mainly applied research efforts into aspects of visualization and display design; recently, however, I've been awarded a couple of Small Business Innovative Research grants (SBIRs) that will require significant development work. One ongoing long-term research project concerns the human factors of the usage of 3-D perspective view displays. This has been a particularly enjoyable project for me, probably because I've been able to bring to bear, and make contact with, a lot of basic literature about 3-D space perception that I was previously familiar with. In that project, I've been able to develop a couple of theories that I'm excited about. The first was a discovery that 3D space perception seems to entail a simplifying assumption that's used to reconstruct spatial extents from perspective projections. That simplifying assumption leads to a distance underestimation that grows more severe with shallower viewing angles. A second realization was that users' overestimating their ability to extract information from realistic displays, including 3D displays, could result from folk fallacies in their understanding of how perception works. This framework, that we call *Naïve Realism*, accounts for the preference, expressed by users and designers alike, to create realistic displays that mimic the direct visual experience of displayed scenes. I've a

paper, co-authored with my PSE colleague Mark St. John, coming out this summer in *Ergonomics in Design* on Naïve Realism that Mark and I worked very hard on and that I'm particularly pleased with. I'll be discussing the implications of Naïve Realism for display principles at a symposium I've organized for the annual HFES meeting this September in Orlando.

Speaking of the annual HFES meeting, I've found that it has become my primary venue for reporting my research. And my investment in HFES and in that meeting, in particular, has ratcheted up this year by me taking on the role of program chair for the Perception and Performance Technical Group's (PPTG) part of the program. That's been an occasionally hectic but overall satisfying experience that has enabled me to interact directly with a large slice of PPTG's membership. I look forward to seeing all of you at the Florida meeting in September!

Below, I list a few of this year's publications and a couple of older, notable ones.

Smallman, H.S., & St. John, M. (2005) Naïve Realism: Misplaced faith in the utility of realistic displays. *Ergonomics in Design*, in press.

Smallman, H. S. (2005) Overarching Principles of Display Design. Symposium accepted for the *49th Annual Meeting of the Human Factors and Ergonomics Society*. Orlando, FL, Sept 26-30.

Smallman, H. S., & St. John, M. (2005) Improving recovery from multi-task interruptions using an intelligent change awareness tool. Paper accepted for the *1st International Conference on Augmented Cognition and HCI International: 11th International Conference on Human-Computer Interaction* in Las Vegas, Nevada, July 22 – 27, 2005.

St. John, M., Smallman, H.S., Manes, D.I., Feher, B.A., & Morrison, J.G. (2005) Heuristic automation for decluttering tactical displays. *Human Factors*, in press.

St. John, M., Cowen, M.B., Smallman, H.S., and Oonk, H.M. (2001) The use of 2D and 3D displays for shape understanding versus relative position tasks. *Human Factors*, 43, 79-98. **(Winner: 2002 Jerome H. Ely HFES Award)**

Smallman, H.S., Macleod, D.I.A., and Doyle, P. (2001) Realignment of cones after cataract removal. *Nature*, 412, 604-60

---

*A Student's Perspective, Part 1***Bridging the Gap between Human Factors and Correlational Psychology**

**Ernesto A. Bustamante**  
*Old Dominion University*  
*ebustama@odu.edu*

The field of psychology has historically been divided into two separate streams, experimental and correlational psychology. This separation has hindered the development of the field. Taking the strengths of each of these two separate streams and bridging the gap between them is necessary for the understanding of human behavior.

Human Factors (HF) is an interdisciplinary field. HF professionals emphasize the need to incorporate contributions from other fields, such as engineering, computer science, physics, chemistry, biology, law, medicine, education, and business. However, in an effort to expand the scope of the field, HF researchers have overlooked the potential advantages of a different stream within the same field.

The main interest in psychology revolves around the structural relationships between complex theoretical constructs rather than observed indications of such constructs. Although HF researchers recognize the fact that the fundamental constructs of interest in their field, such as stress, fatigue, workload, situation awareness, trust, and even performance, are multifaceted, they very rarely take a multivariate approach for analyzing their findings. One of the main contributions that correlational psychology could make to HF research is the use of sophisticated multivariate quantitative methods.

The main goal of experimental psychologists and HF researchers has been to identify factors that can be manipulated to causally explain behavior. However, the notion that human behavior can be fully explained by factors outside of individuals while ignoring their internal characteristics is a gross misconception. To fully understand human behavior, we not only need to take into account external factors that we can manipulate, but also individual characteristics, and, most importantly, the interaction between external factors and individual characteristics.

The separation of the two streams has shifted researchers' attention from the primary goal of psychology, understanding behavior. It does not matter whether a phenomenon is due to internal characteristics or external factors as long as researchers can effectively understand it. To accomplish this, researchers need to identify all the factors, internal, external, and their interaction, that can systematically explain why people behave the way they do.

The ultimate goal of HF research should be to develop technology that is adaptable to individuals' characteristics. To accomplish this, we need to expand our minds beyond the traditional experimental approach and take into account how different people interact with different technology.

---

*A Student's Perspective, Part 2***Human Factors: Just "Common Sense"?****Zhonghai Li***University of Toronto**zhonghai@etclab.mie.utoronto.ca*

Recently, during a trip to Ottawa with some friends, we visited the National Gallery of Canada. Among the many fabulous exhibits there, we were most impressed by one demonstration, *The Paradise Institute*, which basically is a simulated miniature theatre. What struck me most about this installation was the "personal binaural surround sound" which could be experienced differently by each visitor. Layered over the visual display is the accompanying soundtrack of the "aural action" of a "virtual audience", such as footsteps from passing audience members, the ringing of someone else's cell phone, the intimate whisper of a close friend in your ear, etc. Through individual headphones, each participant can sense that these sounds are coming from a particular direction inside the theatre. One of my friends even leaned forward to give way to a passing stranger in the audience, only to discover that he was *virtual!*

While my friends were marveling at this unique sound experience and wondering how the artists managed to create such an immersive environment, I understood that this was a wonderful practical application of sound spatialization, illustrating how sound affects visual perception and postural control. This in turn made me realize that this was in fact a perfect vehicle for me to explain human factors research to my friends. As I am sure is common among many HF graduate students, whenever I am asked about what I do at university, I find that my explanations give the impression that human factors either is simply about "common sense" (based on examples from VCRs or stoves, etc.), or is too obscure for them to relate to it (such as when I cite examples about nuclear power plants or airplanes). *The Paradise Institute* was for me a great way to show my friends that human factors neither is "just common sense", nor is it particularly far removed from our daily lives. What we experience every day, in fact every second, through our senses of seeing, hearing, touching, smelling, etc., isn't necessarily self-evident to us, let alone something that can obviously be exploited.

When we continued our trip to Montréal, I encountered another example showing that human factors is not always simple and straightforward. I found that the traffic lights in Montréal are significantly lower and nearer to sidewalk than those in Toronto. While I was driving, it was very easy to miss the lights, and I had to pay a lot of extra attention to detect them. (This was the first time I had ever rented a car!) One of my friends thought that this was just an issue of habit, saying that "people from Montreal probably complain about the traffic lights in Toronto". I can not accept this excuse, however. For such an important display system, there should, in my opinion, be a more consistent standard for specifying signal placement, among other things in terms of limitations of human visual perception and common expectations.

Although we continue to learn about the outside world, we remain relatively ignorant of our inner cognitive world. We frequently overlook our limitations, especially when we overestimate our ability to adapt to changing circumstances. My hope is that, in spite of the difficulty of teaching the world that human factors is more than "common sense," it will at least become common sense to *consider* human factors when developing new technologies. Human factors *can* make a difference, and our world can most definitely benefit from such considerations.

## About the PPTG

This newsletter is a publication of the **Perception & Performance Technical Group** of the **Human Factors and Ergonomics Society**. The PPTG is interested in research and application of all aspects of perception as it affects human performance. The Newsletter is published four times a year. Items for inclusion should be sent to the Editor.

Membership in the PPTG is open to all. Dues are \$5 per year (\$7.00 US for outside USA and Canada), which includes a subscription to the Newsletter. Single newsletter copies, including back issues, are available for \$2 each. Please send requests to the Editor, with a check payable to the Human Factors and Ergonomics Society.

Questions about advertising in **Insight** should be addressed to Shelley L. Rosenbaum Lipman, editor of INSIGHT.

Rates are  
 Quarter page \$ 75.00  
 Half page \$125.00  
 Full page \$200.00

\*\*\*\*\*

### Membership Application: HFES PPTG

*Please print your name and mailing address:*

Name:  Dr.  Mr.  Ms.

\_\_\_\_\_

Address: \_\_\_\_\_

—

\_\_\_\_\_

email: \_\_\_\_\_

Check appropriate box:  New Member  
 Member Renewal

Organization/Affiliation: \_\_\_\_\_

—

**Submit this form along with \$5 (\$7 outside USA and Canada)**

**Check payable to:**  
**Human Factors and Ergonomics Society**  
**Box 1369**  
**Santa Monica, CA 90406**

## PPTG Officers

**Chair:**

Patricia R. DeLucia  
[Pat.Delucia@ttu.edu](mailto:Pat.Delucia@ttu.edu)

**Chair Elect:**

Elizabeth T. Davis  
[etdavis6@earthlink.net](mailto:etdavis6@earthlink.net)

**Secretary/Treasurer:**

Mike Miller  
[mnmiller@frontier.net](mailto:mnmiller@frontier.net)

**Program Chair**

Harvey Smallman  
[Smallman@Pacific-Science.com](mailto:Smallman@Pacific-Science.com)




**Electronic Information Editor:**

Steffan Werner  
[SWerner@UIdaho.edu](mailto:SWerner@UIdaho.edu)

**Editor:**

Shelley Rosenbaum Lipman  
[shellEy-home+work@LipmanFamily.org](mailto:shellEy-home+work@LipmanFamily.org)

### CONFERENCE CALENDAR:

	<p><b>HFES 49<sup>th</sup> Annual Meeting and 2005 Conference</b>                  Meeting of the Human Factors and Ergonomics Society: 26-30 September; Orlando, Florida.</p>
	<p><b>HPEE 2<sup>nd</sup> Annual Meeting</b>  <a href="http://www.hpee.org/meeting3.php">http://www.hpee.org/meeting3.php</a>                  Meeting of the Human Performance in Extreme Environments: 24-25 September 2005; Orlando, Florida. Contact Jason Kring (<a href="mailto:jkring@HPEE.org">jkring@HPEE.org</a>) for details.</p>
	<p><b>First Symposium on Auditory Graphs</b>                  July 2005: University of Limerick; Limerick, Ireland. Contact Bruce Walker (<a href="mailto:bruce.walker@psych.gatech.edu">bruce.walker@psych.gatech.edu</a>) for details.</p>

# INSIGHT

The Visual Performance Technical Group Newsletter

Volume 14 • Number 4 • December 1992

## WORKLOAD AND SITUATION AWARENESS: AN ANALOGY OF HISTORY AND IMPLICATIONS

*Christopher D. Wickens*  
*Aviation Research Laboratory*  
*University of Illinois Institute of Aviation*  
*Savoy, Illinois*

### WORKLOAD

Workload, and particularly pilot workload, was the "hot issue" of the 1980s. Everybody tried to define it; however no one was truly satisfied with anyone else's definition, yet everyone also knew that the construct was very important, and had important implications for performance, accident investigation, training and aviation display design.

In general the workload concept was assumed to refer to the interaction between a pilot and his or her task, insofar as the pilot's limited information processing capacities (resources) were concerned. When workload was exceeded, performance declined, sometimes catastrophically so. What made the concept so intriguing, and at the same time so fuzzy and frustrating, particularly to engineers, was the fact that it was an *inferred mental construct*. You could not see it in behavior (necessarily), yet it had very strong manifestations in the *potential* to carry out that behavior. The inferential characteristics, and its dependency upon nonobservant mental phenomena, which made it sometimes so frustrating to engineers, at the same time made it a naturally intriguing area of study for psychologists. Because pilots could also themselves experience high and low workload, the concept had a great deal of face validity and appeal to the operational community.

Three primary issues were paramount in workload research of the 80s: How to measure it, via subjective, physiological or performance-based scales; how to predict it, via computational models; and what are the consequences of excessive workload: How does performance break down when workload crosses some "red line". The issues of model-based prediction is still very much of a hot topic, and is joined by more recent concerns of modeling the human operator as a strategic manager of his/her own workload.

### SITUATION AWARENESS

In the same way that the seed of workload research were planted and nourished in the late 70s and grew to full bloom in the 80s, so, a decade later, the seeds of applied interest in

*situation awareness* were planted in the mid 80s, and, I forecast will grow and bloom in the 90s (I'll leave the "withering and dying on the vine" part of my analogy for others to speculate). There are other features of situation awareness (SA) that make it analogous to workload. It too deals with a hypothetical or inferred "mental construct", that cannot be directly observed in behavior, but which we know has many important consequences for the potential of that behavior to succeed or fail. Just as important performance consequences follow when workload becomes excessive, so important performance consequences are assumed to follow when SA is lost. Furthermore, issues of both prediction and assessment have been very much at the forefront of SA research. Finally, while the engineer may sometimes feel uncomfortable with such a purely "mental" construct as SA, both the psychologist *and* the operational pilot realize the important validity of the concept.

*Definition.* While several authors have offered definitions for SA (See Sarter and Woods, 1991, for an especially good treatment), I prefer the following:

(continued on page 3)

**Call for  
nominations for  
Chair-Elect**

(see page 5)

**...ask what you can  
do for *Insight***

(see page 9)

**The Data Challenge**

(see page 11)

**Max's Last  
Column**

(see page 5)

### CONTENTS

COTG Corner

Chair's Report

Piet's and Pieces

Student Paper

Student's Corner

High Definition

CSERIAC Search

Editorial

2  
4  
5  
6  
7  
7  
8  
9

Situation Awareness refers to the ability to rapidly bring to consciousness those characteristics that *evolve* during a flight.

Notice that the "evolve" part of this definition excludes other information, like declarative and procedural knowledge, that may be rapidly brought to mind. Notice too that "the ability to bring" allows SA to refer to things that may not *at that moment* be in consciousness (or working memory, if you choose). But you have to be able to grab them when you need them.

The following are the kinds of information that evolve during a flight, and therefore are within the domain of SA:

*1. Navigation awareness.* Where am I with regard to other aircraft, the terrain, and local weather conditions? A loss of navigation SA was, in part, responsible for the mid air crash of the PSA 737 and the Cessna over San Diego, in 1987.

*2. Systems awareness.* What autopilots are in effect, and how are they managing systems under their control? This

of course has been a major concern of pilots with the new generation of highly automated aircraft. The automation "hides" the true state of aircraft systems. Hence the near disaster of the China Airlines 747 over the Pacific was said to result from loss of systems SA.

*3. Task awareness.* What tasks need to be completed, and in what order of priority? What has been accomplished already, and by whom?

*4. Temporal awareness.* How much time remains before deadlines (in order to accomplish tasks in time? This then relates closely to task awareness), and what will happen in the future, given the present *evolving* conditions.

*Assessment.* There are essentially three qualitatively different assessment techniques, discussed in more detail by Fracker (1989).

*1. Subjective.* There has been a good deal of recent work by Taylor of RAF, and Endsley of General Dynamics, on developing subjective scales, whereby pilots rate their feelings of awareness of the current situation. These have

many analogies with the subjective measure of workload, and suffer from many of the same pitfalls.

**2. Explicit performance.** An example used by Marshak and his colleagues is to stop a pilot in the middle of a simulated mission, blank the screen, and ask him to reconstruct the location of various aircraft and other threats. This has the advantage of measuring the same construct that you are inferring (i.e., high construct validity). However, it has the problem that if subjects become aware that you will be explicitly assessing these features, they may begin performing the task differently than they normally would be doing. Besides, this technique can be quite disruptive to the general flow of the simulated mission.

**3. Implicit performance.** Here we develop tasks which the pilot would perform differently if she didn't have SA than if she did. Hence we are *inferring* SA (or lack thereof) from behavior rather than measuring it directly. Examples are the techniques used by Aretz (1991), and by Andre, Wickens, Moorman, and Boschelli (1991), and by Wickens, Haskell, and Harte (1989) to assess navigation awareness.

When SA is lost, the subject becomes unexpectedly disoriented. Those with high SA will more rapidly and accurately turn themselves back to their original course, than those without. The main pitfall here is that the *inability* to respond appropriately may result from poor SA; but it also may result from poor execution of the correct intentions based on good SA.

#### WHY SITUATION AWARENESS?

Research on the measurement and prediction of situation awareness as well as on the consequences of loss of SA has had and will continue to have important practical implications. The following are examples of the influence of SA research:

**Displays.** Recent developments in advanced flight deck displays have come partially as a result of concerns that traditional nonintegrated displays provide poor SA. SA can therefore be improved by effective display integration. How then do we assess the effectiveness of display support for SA?

**Training.** Many flight instructors have the sense that, while their students may be going through all the right moves at a local level, they really don't grasp the "big picture" in a way that would allow them to respond appropriately if things suddenly go wrong. At issue is both how to measure this absence of the "big picture SA", and how to train it.

**OOTLUF.** This refers to "Out-of-the-loop-unfamiliarity" and is a symptom of high levels of automation, when something goes wrong, but because of lack of systems SA, the pilot does not jump in with the appropriate, timely corrective action. Concern for this form of SA has led design-

ers to both worry about displays that can preserve systems SA and to consider procedures that may reduce OOTLUF and thereby enhance systems SA (e.g., recommendations about staying in the loop at critical times, or design of sticks that move as the autopilot does).

**Cockpit Resource Management.** Much of the recent emphasis on CRM training has addressed SA in two ways: (a) by teaching pilots to seek, solicit and process information from subordinates, in a way that will maintain the pilot's SA, and will not intimidate the subordinates from providing unsolicited, but critical, information, (b) delegating tasks and responsibilities for monitoring key variables in a way that will maintain task SA.

Where this will all lead is uncertain. But it is clearly a domain in which psychology can make many critical contributions to understanding.

#### REFERENCES

- Andre, A.D., Wickens, C. D., Moorman, L., & Boschelli, M. (1991). Display formatting techniques for improving situation awareness in the aircraft cockpit. *International Journal of Aviation Psychology, 1*, 205-218.
- Aretz, A. (1991). The design of electronic map displays. *Human Factors, 33*, 85-101.
- Endsley, M. R. (1988, May). Situation awareness global assessment technique (SAGAT). Paper presented at the *National Aerospace and Electronic Conference (NAECON)*, Dayton, OH.
- Fracker, M. L. (1989). Attentional allocation in situation awareness. In *Proceedings of the Human Factors Society 33rd Annual Meeting* (pp. 1396-1399). Santa Monica, CA: Human Factors Society.
- Marshak, W. P., Kupeman, G., Ramsey, E. G., & Wilson, D. (1987). Situational awareness in map displays. In *Proceedings of the Human Factors Society 31st Annual Meeting* (pp. 533-538). Santa Monica, CA: Human Factors Society.
- Regal, D. M., Rogers, W. H., & Boucek, G. P. (1988). *Situational awareness in the commercial flight deck: definition, measurement, and enhancement* (SAE Technical Paper No. 881508). Warrendale, PA: Society of Automotive Engineers.
- Sarter, N. B., & Woods, D. D. (1991). Situation awareness: A critical but ill-defined phenomenon. *International Journal of Aviation Psychology, 1*, 45-57.
- Wickens, C. D., Haskell, I., Harte, K. (1989). *Perspective flight path displays*. University of Illinois Technical Report (ARL-89-2/Boeing-89-1). Savoy, IL: Aviation Research Laboratory.