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DI News

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The DI Story

Kay Stanney

Design Interactive (DI), Inc. was founded in 1998 to provide consultation and usability design services to private industry clients and the military. Our first project was a usability analysis of the Conning Officers Virtual Environment (COVE). From there our early project efforts grew modestly, with just a few employees and one project – **usability lead on ONR's Virtual Technologies and Environments (VIRTE) Program**, where we collaborated for many years with Dr. Dylan Schmorrow and Dr. Joseph Cohn, both enthusiastic believers in our formative years. Through the VIRTE program we learned how to effectively insert usability into military program efforts. VIRTE provided the opportunity to work directly with warfighters in the field to jointly design and evaluate training systems that best meet their needs. Such collaborative field work has become a passion within the company.

Inside This Issue

Over the last five years DI has seen tremendous growth. We have gone from two employees to 17 and counting! We have expanded from one project to dozens and from meeting the needs of one funding agency to supporting multiple agencies, as well as Fortune 500 companies.

DI brings on board individuals who are truly passionate about enhancing technology to empower users. Through their vision and enthusiasm, **DI has developed many cutting edge techniques to enhance system usability**. We hope you enjoy learning more about us through this first edition of *DI News*.

The Early Years: Transforming Usability Engineering

Kay Stanney and Laura Milham

During the early years at Design Interactive (DI) we broke new ground in usability engineering. Until the late 90's, usability had largely been focused on consumer products and computer interfaces, with intuitiveness, efficiency, and satisfaction the foremost concerns. Thus, when the Navy commenced efforts to adopt virtual environments (VEs) as training systems, the usability field was ill prepared. No longer was the user interface something detached from the user, with its greatest impending danger being a bad case of frustration from poor interface design. With immersive VEs, issues of cybersickness, lingering aftereffects, and sense of presence all became of paramount importance, thereby requiring a transformation of the usability field. DI jumped in, reformulating usability assessment techniques to account for the intricacies of human-virtual environment interaction.

DI's early VE usability efforts commenced with an evaluation of the **COVE – Conning Officer Virtual Environment**; a contract awarded to DI by what was

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Training and HSI

Kay Stanney

The main focus of DI's efforts is to empower users through the application of **highly effective usability engineering principles**. The Company has two main subdivisions, **Training Systems Design and Evaluation** and **Human-Systems Integration**. The Training Systems Division is headed up by Dr. Laura Milham, while the HSI Division is led by Dr. Kelly Hale. Under Laura's visionary leadership, the Training Systems Division has developed unique approaches to **user-centered requirements analysis**, **human performance measurements**, and **training effectiveness evaluation**. Kelly empowers the imaginative minds within her group as they work

The DI office, Oviedo, FL

to extend the computing paradigm into **multimodal interaction**, explore cutting edge techniques of leveraging **physiological measures** to evaluate system and product effectiveness, and **work with Fortune 500** companies to evolve their usability practices to the cutting edge. Together, the DI divisions work as advocates for system users to **get the system or product right the first time!**

Technology Goes Multimodal

Kelly Hale

Today, humans are inundated with information from a variety of sources, and are expected to make timely decisions taking into account vast data sets. For example, command center operators have status information provided from numerous sensors that cover multiple ongoing operations, and are tasked with maintaining 'the big picture' and making key decisions that impact their organization. To best aid operations in information-rich environments, **human factors engineers are faced with the challenge of how to organize and present vast amounts of available data** to operators so they can effectively and efficiently complete their tasks. While visualization techniques have advanced in an attempt to optimize visual presentation of data, to truly "amplify cognition" **designers must move beyond information visualization and look towards multimodal display techniques**.

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"…designers must move beyond information visualization and look towards multimodal display techniques."

Multimodal Fun Fact

Humans have seven primary odors that help them identify objects.

Odor	Example
Camphoric	Mothballs
Musky	Perfume
Floral	Roses
Peppermint	Mint Gum
Etheral	Dry Cleaning Fluid
Pungent	Vinegar
Putrid	Rotten Eggs

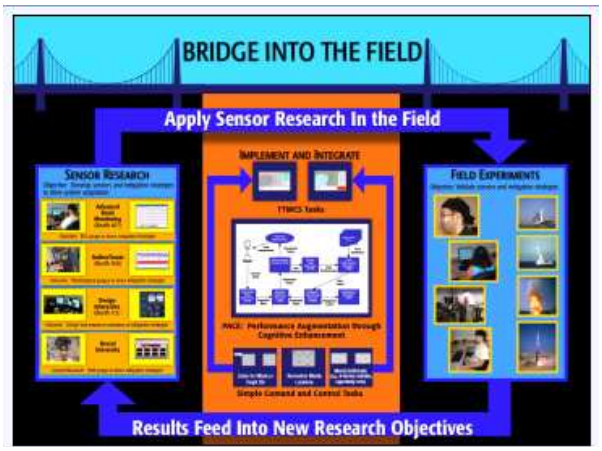
Source: http://library.thinkquest.org

Next Generation: Computing with Assistive Neurotechnology

Sven Fuchs

There have been many attempts throughout the years to create systems that make the computer a "team member." Many such efforts failed to consider that there is more to human-computer interaction than predefined guidelines and design principles can account for: Interaction between two people is always adaptive. For example, we speak louder when somebody does not hear well, we use a more basic vocabulary when talking to people who don't speak our language well, and we interrupt the conversation when something more important comes up. To realize the vision of a human-computer symbiosis, computer systems must adapt to the human operator in a similar way. Unlike other humans, however, they cannot "sense" the human's cognitive or operational state on a meta level (e.g., through facial expressions or body language). Thus, the information to base adaptation on is limited to objective information exchange.

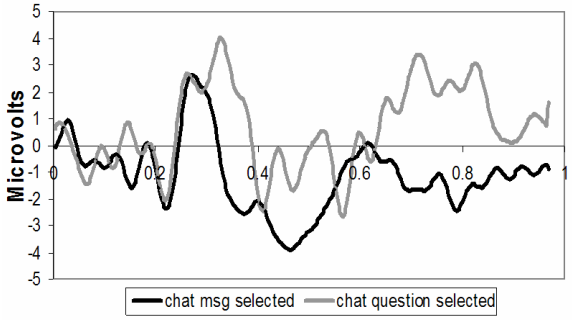
Augmented Cognition (AugCog) attempts to resolve this shortcoming by employing physiological sensors to create systems that can monitor their operators' cognitive activity and derive a real-time assessment of cognitive state, which adaptation can then be based on. DI's early AugCog efforts, which were in partnership with the Lockheed Martin Advanced Technology Laboratories (LM-ATL), focused on developing AugCog technology for the Tactical Tomahawk Weapons and Aegis Simulation Environments. The DI team next engaged in AugCog research under a DARPA Phase I SBIR that explored how to use physiological indicators to measure and enhance situation awareness in command-and-control environments in real time. In partnership with Advanced Brain Monitoring, Inc., **DI broke new ground by introducing a revolutionary approach to cognitive assessment**, despite project duration of



Early AugCog research in partnership with LM-ATL.

only 9 months - EEG event-related potentials (ERPs), unique signatures within the stream of EEG waves that appear time-locked to certain cognitive activity, were used to assess the neurophysiological reaction to key task events. The figure below provides an example from this effort, showing how ERP patterns are different when a chat message contained a statement (black line) versus a question (gray line). With this event-based paradigm, a new level of

Please see *Next Generation* on page 4



ERP signatures in response to a visual-textual chat message.

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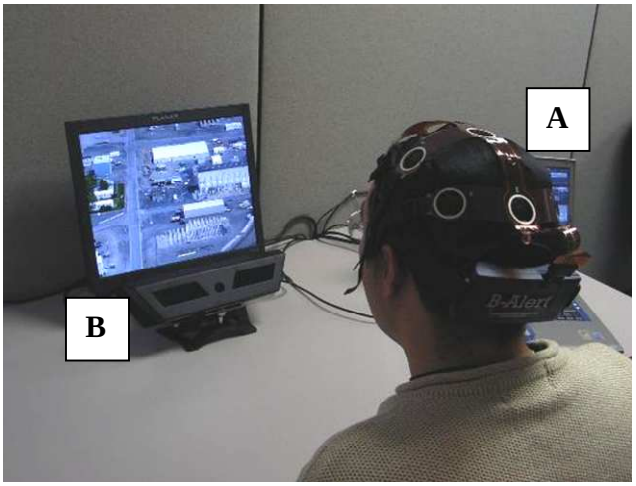
context-sensitivity was reached that not only accounts for when adaptation of an information display is necessary, but also provides indicators where and how it should be applied. A mitigation framework was conceptualized that – for the first time – did not just address the symptom, but also the cause of the cognitive state problem. This **"considerate mitigation" allows selection of adaptation strategies that optimally account for an operator's cognitive limitations with regard to system state and task context**.

Based on the success of this phase I AugCog endeavor, DI is now working on two projects for the intelligence community in which ERP cognitive signatures and oculo-motor indices will be used to detect an intelligence analyst's level of interest in reviewed materials. Under the CASE (Collaboration and Analyst/System Effectiveness) program funded by the Disruptive Technology Office, **DI is developing a tool that supports analysts in rapidly detecting items of interest in geospatial imagery data**. Employing eye tracking and EEG sensor hardware, relevant ocular fixations will be detected and the respective ERP response evaluated. Preliminary results show **strong potential for physiological detection of interest that could soon accelerate the analysis process by eliminating the need for a manual response**. Furthermore, ERPs may exist that can be used to **detect instances where cognitive biases disturb the objective analysis outcome**. For example, analysts may 'explain away' potential targets because they don't integrate well with their mental model. By identifying and mitigating these shortcomings, analysis performance will be further increased. The product of this research will ultimately be integrated with other systems developed under the CASE program to form a tool suite that is expected to increase information throughput by an order of magnitude while improving analysis accuracy.



Experimental AugCog setup with EEG headset (A) and eye tracker (B).

> *"The DI team … explored how to use physiological indicators to measure and enhance situation awareness in command-and-control environments in real time."*

Under a DARPA-funded SBIR Phase II directed by Dr. Kendra Moore, DI is currently investigating if a similar approach can be used to **determine analyst interest during the analysis of text sources** (such as documents, intercepted messages, communication transcripts and web content). The **Advanced Neurophysiology for Intelligence Text Analysis (ANITA) system** will attempt to create a 'Virtual Shoebox' in which items of interest (that were automatically detected and extracted during the analysis) will be stored and organized. This two-year project, which commenced in May 2007, is particularly challenging due to the unstructured nature of the text analysis task and because complex cognitive phenomena such as deception must be considered. But the DI team is up to the challenge!

Team Diversity: The Key to Success

David Jones

Team diversity and passion for the user are what have led to DI's overwhelming success to date and what we believe will ensure success in our future endeavors.

DI embraces diversity in that we truly recognize, appreciate, value, and utilize the unique talents and contributions of all members of our team, which comprise a kaleidoscope of nationalities (natives of 6 different countries) and languages – English, Spanish, Swedish, Arabic, and German. These diverse backgrounds bring a multitude of unique perspectives to the DI team.

DI's employees are trained engineers and cognitive psychologists. Each brings distinctive skills to the team, thereby allowing tremendous flexibility during project execution. The multimodal design efforts conveyed on Page 2 are prime examples of projects that require this team diversity. For our multimodal design and evaluation efforts, **Dr. Kelly Hale** brings to bare her kinesiology background and experience designing haptic interfaces, while **David Jones** adds expertise in the field of audio design, **Angela Baskin** brings her background in situational awareness, **Par Axelsson** provides strengths in user testing and system evaluation, and **Sven Fuchs** compliments the team with his media and UI design experience. In order to ensure the precision of algorithms, such as those used to calculate and optimize workload levels within multimodal interfaces, **Dr. Ali Ahmad**, a Six Sigma blackbelt, provides expertise in quantitative methods and computational modeling. **Matthew Johnston** and **Dr. Adams Greenwood-Ericksen** are our most recent additions to the HSI Division. Matthew brings prior haptic design experience from Ford Motor Company, while Adams has tremendous field experience and background in scenario development.

On the training side of the Company, diversity has also been key to success. **Dr. Laura Milham**, has leveraged her past experience from the University of Central Florida's Team Performance Lab and Institute for Simulation and Training, to develop training-centric user centered design methodologies. DI's Training System Design and Evaluation projects are ever expanding. Our most recent forays into team training and intelligent training systems design have brought **Meredith Bell Carroll, Susan Eitelman**, **Tiffany Parrish,** and **Dervon Chang** to the DI team. Meredith came to DI from The Boeing Company with experience in human/team performance and training in complex systems, while Susan, an artificial intelligence engineer, brings skills in developing and evaluating intelligent interactive training systems. Tiffany is expanding the capabilities of the Training Systems group with her background in team-based naturalized decision making. Dervon combines her technical expertise with domain knowledge to provide the team with operationally-relevant training solutions.

No projects benefit more from DI's team diversity than our usability efforts. Many members of the DI team have experience performing usability projects with Fortune 500 companies. This experience provides a diverse set of tools and techniques at the team's disposal, which empower the group to conquer the challenges of any usability project. Of recent interest to our usability clients are the cutting-edge emotional design tools, which one of our usability engineers, **Roberto Champney**, has added to the DI usability toolkit.

Although a number of team members have programming experience, all DI efforts would be at a loss without the skills of **Malachi Lawson**, our software/systems engineer.

Amongst the diversity, common ground exists between the team members in their deep passion for the user – whether it be a warfighter, information analyst, business analyst, or consumer – the DI team strives in every endeavor to capture and analyze the voice of the client and the target domain in order to provide direct insight into user needs, capabilities, concerns, and priorities. **Even if the user cannot sit at the design table, with DI on the team their presence will be not only be felt but their needs will be consciously and deliberately integrated into the design solution.**

The Early Years from page 1

then the Naval Air Warfare Center – Training Systems Division (NAWC-TSD, Orlando). Our evaluation uncovered that the Navy was definitely on to something in their efforts to tap the technological potential of VEs – as trainees were excited and intrigued by this new training medium. Not only did trainees believe the COVE could be used to teach basic conning skills, man overboard, flight quarters, and other bridge drills such as casualty control, **they also felt the technology had great potential in a recruiter's office to lure in new recruits!**

The COVE evaluation revealed firsthand that designing usable and effective VE training systems was a new challenge for the usability field. For example, when it came to assessing how effectively trainees could maintain orientation during the underway replenishment maneuver conducted in the COVE, how well they could manipulate the field-of-view, or how to assess the impact of the lack of vestibular stimulation from the sea on human performance, traditional usability techniques fell short. To fill this gap, DI created a novel usability evaluation tool called the **Multi-criteria Assessment of Usability for Virtual Environments (MAUVE) System**. MAUVE expands the capabilities of usability practitioners to carry out systematic evaluations of VE training systems and may be used at various stages in the usability engineering lifecycle. Deborah Hix and Joseph Gabbard, also pioneers in VE usability, provided a source of expert validation of the MAUVE system and reported that the MAUVE system "presents an unprecedented collection of usability heuristics and characteristics for Virtual Environments … and supports thorough and systematic heuristic evaluation of VEs, allowing expert evaluators to work quickly and efficiently."

"These efforts led to the development of several … tools, including the Multi-sensory Task Analysis Battery, Training System Fidelity Battery, Team Responsibility Requirements Battery, and Scenario Manipulation

Based on our groundbreaking VE usability work, DI was next challenged to serve as the Training Effectiveness Evaluation (TEE) lead for the Office of Naval Research's **Virtual Technologies and Environments (VIRTE) Program**. During VIRTE Demo I, our efforts focused on defining user centered design (UCD) requirements for the initial VIRTE testbeds, the Virtual Environment Landing Craft Air Cushion (VELCAC) and Virtual Environment Helicopter (VEHELO). As we set out to address the UCD requirements for these training systems, we identified that one critical component missing from the UCD toolkit was an understanding of how to extend the traditional UCD model to that of an interactive training system. With our background in training systems design and evaluation, DI identified a number of methodologies that could be extended to support UCD of training systems. These efforts led to the development of several methodologies and tools, including the **Multi-sensory Task Analysis Battery, Training System Fidelity Battery, Team Responsibility Requirements Battery, and Scenario Manipulation Battery**. Taken together, this toolkit empowers system designers to follow a methodical user-centered design process that is grounded in science, yet field-tested for reliability and validity. The Multisensory Task Analysis Battery walks a designer through the process of determining targeted training goals, identifying tasks steps, and specifying multimodal cues required in the training system to support training goals. The Training System Fidelity Battery takes that information and facilitates selection of appropriate levels of fidelity for those multimodal cues. The Scenario Manipulation Battery assists designers in identifying which scenario variables provide direct practice on skills related to training goal attainment.

Years later, and several more VE TEEs behind us (VE MOUT, MSAT, MOTIVE…), we continue to improve upon our **training-centric UCD methods**, which aim to ensure that trainees not only have optimized interfaces, but also that training systems are cost effective and designed to ensure a desired level of operational readiness.

Multimodal from page 2

Future operations will benefit from multimodal systems that provide the right information in the right format at the right time to the right user. Using a variety of display modalities – from visual to auditory, haptic and olfactory – there is potential for more information to be presented to users. More importantly, more information can be perceived and comprehended by users when systems are designed using sound multimodal design science due to human's innate ability to take in and process information presented in different modalities.

Designers need to push information smarter, rather than just pushing more information. DI has developed design techniques that get more of the brain on task and optimize distribution across human capabilities. These techniques have lead to substantial improvements in information throughput and decision accuracy. Specifically, the HSI team at **DI has developed the Multimodal Information Design Support (MIDS) system** that systematically examines C4ISR task environments, predicts times of operator overload, and provides design guidance to alleviate identified problems by distributing information across available modalities. The MIDS tool incorporates proven multimodal design guidelines that are tied to design issues specific to the system under evaluation. Consideration for multitasking and task criticality is included.

The MIDS system has been **successfully applied to a variety of domains, including TTWCS, simulated TAO watchstations, and simulated IVA/EVA space operations**. Implementing system changes based on MIDS output has resulted in substantial gains – for example in one application we realized a **23% increase in communication response accuracy and 30-35% reductions in reaction time**.

Looking to the future – advances in technology capabilities will lead to larger capacity for multimodal information presentation. Of great potential are haptic and olfactory modalities, both of which are largely untapped in current systems. As technologies advance, **Design Interactive will continue to lead interaction design R&D of complex information systems**.

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