Situational Awareness

Have we thought about our designs?
Situational Awareness

“Being aware of what is happening around you and understanding what that information means to you now and in the future to achieve a particular job or goal” (Endsley & Jones, 2012)

• Information relevant to the task at hand

• The picture or mental representation of the situation
Technology-Centered Design

- Approach most commonly used by our engineers in response to new technology.
- New sensor or system = another computer = another screen = more operator alarms or exception screens

But
- Our operators can only pay attention to a certain amount of information at one time

Our operators must, find sort, integrate and process virtually all of the incoming information for what is required to make a decision.

People only process a limited amount of information at one time
Results Technology-Centered Design

- Design-induced error, not human error in many cases
  - Ex. Multiple monitors, Bhopal

- The attempt to automate our way out of so-called human error has only led to more complexity, more cognitive load and catastrophic errors associated with losses of situational awareness (Endsley & Kiris, 1995)
User-Centered Design

• Make the interface compatible with the capabilities and needs of the operator
• Optimize the overall human-machine interface (HMI)

It is not:

• Asking the operator what they want and giving it to them
  • Include them in design but filter ideas based on objective interface testing
• Presenting the operator with just the information they need now
  • Difficult for system to detect changing conditions and predict what information is required for decision making.
• Systems that make decisions for the operator
  • Ambiguous information hinders human decision quality
• Doing things for the operator
  • Operator may fight the system for control

HAL 9000 “I can’t let you do that Dave”
User-Centered Design Principles

• Human Factors Analysis – suitable for linear, repetitive tasks
• User-centered Design – complex systems with multiple and competing goals

Principles:

1. Situational-awareness is goal-oriented
2. Create system interfaces to support cognitive process of the operator
3. Keep the operator in control
Steps to Achieving Situational Awareness

- Level 1 SA: **Perception** of the status, attributes, and dynamics of relevant elements in the environment
  - Visual, auditory, tactile, taste or smell
  - Very difficult for a machine/sensor to do as well as human
  - Confidence level is critical
  - 76% of pilot errors in SA

- Level 2 SA: **Comprehension** of the current situation
  - Synthesis (comprehension) of L1 SA relevant to current goals and objectives
  - Ex. Warning lights on take-off
  - 19% of SA errors

- Level 3 SA: **Projection** of future Status
  - Mentally demanding – complicated by information overload
FIGURE 2.5  Mechanisms and processes involved in SA. (From Endsley, M.R., Theoretical underpinnings of situation awareness: A critical review, in M.R. Endsley and D.J. Garland (Eds.), Situation Awareness Analysis and Measurement, pp. 3–32, LEA, Mahwah, NJ, 2000b.)
Why is achieving good SA difficult? (Endsley & Jones, 2012)

- Attention tunneling (fixating on a problem)
- Requisite Memory Trap (short-term memory limitation)
- Workload, anxiety, fatigue, and stressors
- Data overload
- Misplaced salience
- Complexity creep
- Errant Mental models
- Out-of-the-loop syndrome
Unmanned and ROV’s

Unmanned or Uninhabited vehicle – operator exists just off-board
  • Operators still need good SA

Classes of control
  • Exocentric teleoperation – direct line of sight
  • Egocentric teleoperation – no LOS but camera view
    – Attempt to duplication of experience of on-board operator
  • Egocentric semi or automated control – auto-tramming for drill
  • Exocentric semi or automated control
Human Error in UAV/UGM

- UAV’s have accident rates 10 to 100 times higher than manned aircraft
  - More dangerous situations or automation of landing features
- UGV have fewer accidents but have problems with localization, orientation, confinement
What are the challenges for remote control drilling?

- Must be able to be used in our manned operations
  - Conflict resolution, coordination, and safety
- Usually lose direct sensory information or over-compensation with video and visual displays (impact on network and SA)
- Latency issues – duration and variability
- Disorientation or inability to localize the vehicle mentally
- Demanding tasks and poor visual cues (bandwidth for cameras)
- Low level data overload and interface design
- Multi-tasking and multi-vehicle operation task mental capability
- Humans make poor monitors of automated functions
Design Factors

Displays
• Multiple cameras or picture in picture
• Increase FOV to 60° and slightly behind vehicle for navigation
• Best spatial resolution or higher frame rate
• Add auditory cues or vibrotactile feedback

Controls
• Speech input control versus manual inputs
• Pre-set coordinates for camera tilt, pan, and zoom

Multiple Machine Controls
• Avoid simultaneous performance (all drills tramming)
• Auditory alerts for system failures

Team Coordination & Collaboration
• One to many allocation will required support and coordination manpower (RC driller, multiple drills, drill field support, & controller)
Summary & Conclusions

1. We have a lot to learn about machine autonomy in our business, but let’s learn from our collective mistakes.
2. The enabling technologies are still evolving rapidly and change will require agility.
3. Like computer memory, we will use all of the bandwidth that our IT process can deliver, but we need more now.
4. We need to press our OEM’s and OTM’s to make system/sensor outputs available to developers to facilitate rapid innovation and integration.
5. The Science of situational awareness is new to mining, and understanding it relative to autonomous and tele-remote mining will take some education.
6. We can use the experience that the “Nintendo” generation is bringing to the industry, if we can attract them with our technology.
Questions?