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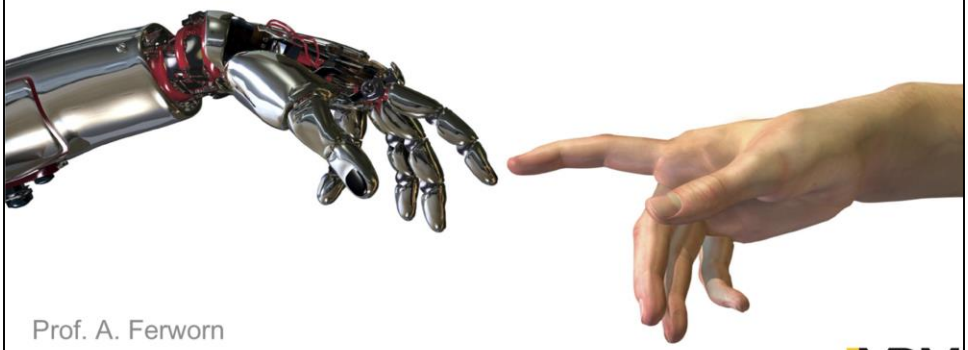
Introduction to Presence, Telepresence and Situational Awareness



Prof. A. Ferworn

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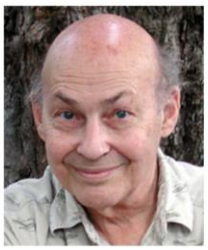
What is Telepresence?

- Term coined by Marvin Minsky in 1980 but attributed to the futurist Patrick Gunkel
- He meant: Manipulation of objects in the real world through remote access technology



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The word “presence” is derived from the term “telepresence,” which was coined by Massachusetts Institute of Technology professor Marvin Minsky in 1980 (Steuer, 1993). His research explained telepresence as the manipulation of objects in the real world through remote access technology (Minsky, 1980). For example, a surgeon may use a computer to control robotic arms to perform minute procedures on a patient in another room. Or a NASA technician may use a computer to control a rover to collect rock samples on Mars. In either case, the operator is granted access to real, though remote, places via televisual tools.

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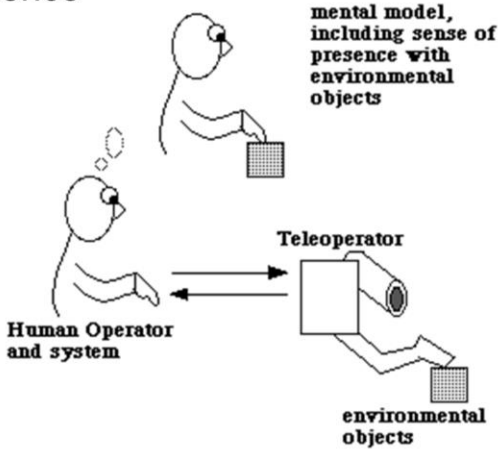
Telepresence



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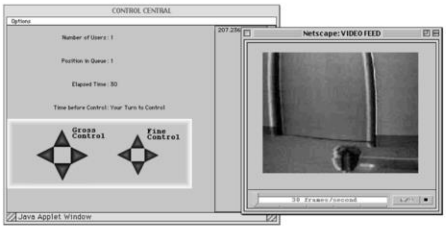
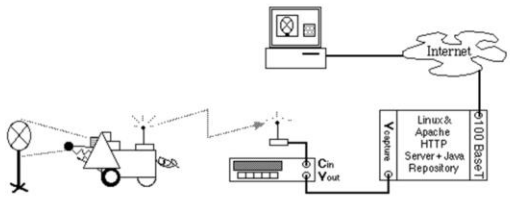
Example: MAX Teleoperated dog on the Web (1998-99)





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Dog Leash metaphor

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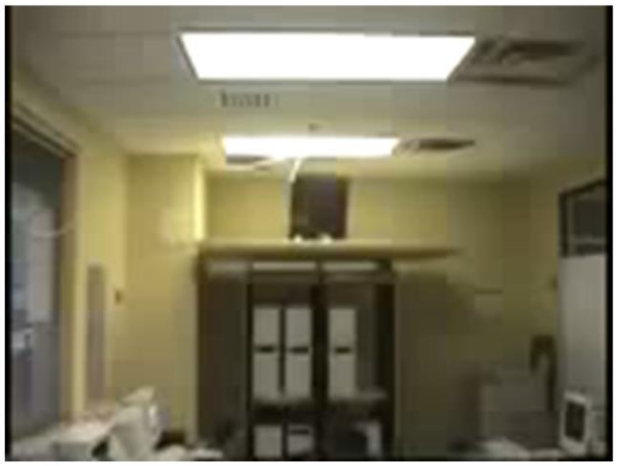
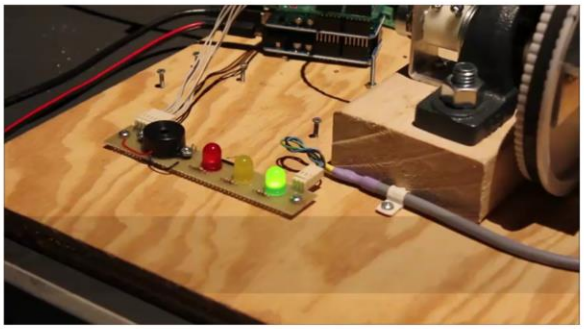
MAX



Telephonic Arm Wrestling

- Norman White and Doug Back
  - 1986



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Presence

- Expanded definition of Telepresence by Thomas Sheridan (1992)
- **Presence** is a theoretical concept describing the effect that people experience when they interact with a computer-mediated or computer-generated environment.

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Roboticist, Editor of Presence journal. Influential at MIT and prof.at Berkley

What is Presence?

- Sense of being present in an environment
  - A physical
  - Virtual
  - Imagined
  - Hallucinated feeling
- Being there is all in your head

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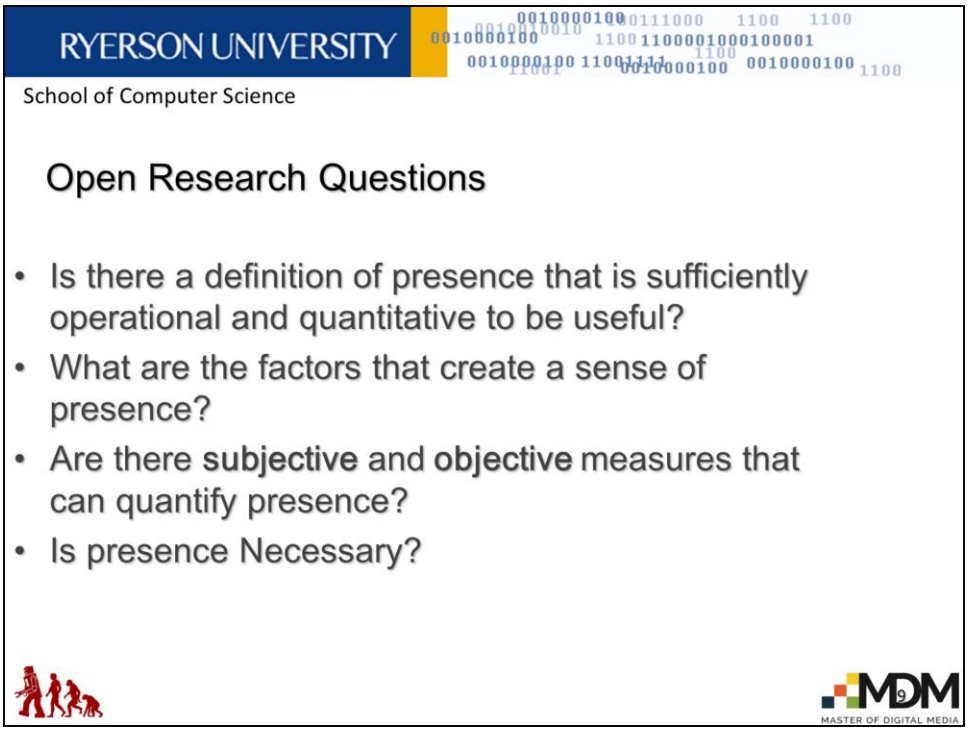
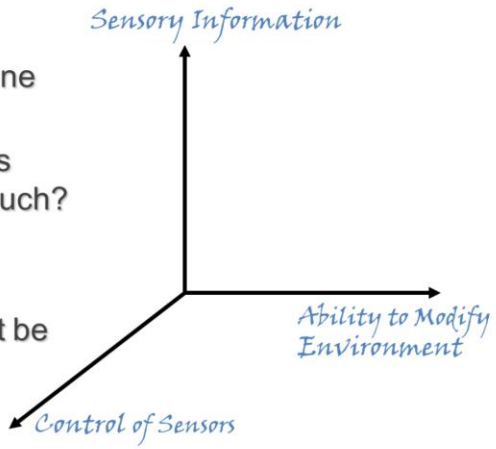


Operational - Repeatable by anyone using the proper procedures.

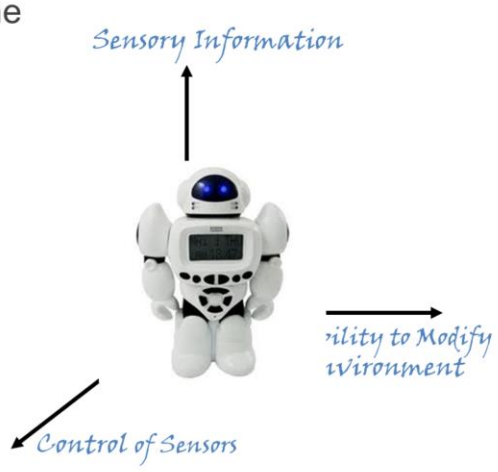
Sheridan (1992)

- Physical aspects of an experience that determine "presence":
  - What Sensory data is available and how much?
  - Can the sensors be controlled?
  - Can the environment be modified?



Why is Presence applicable to Robotics

- One of definition of the word robot might be:
  - Any device that supports
    - Sensing
    - Actuation, and
    - Control



How do we measure presence?

- Well, it turns out, not very well
- Subjective Measurements
  - Questionnaires soliciting opinion about experience
- Indirect Psychological Measurements
  - Relate stimulus magnitude to opinion about the stimulus magnitude
- Objective Measurements
  - Based on
    - Performance measures of tasks
    - Physiological responses

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Questionnaires

- Example:
  - Witmer and Singer Questionnaire
- Questions about reactions to virtual environments
- Hope to create consistency across systems
- General Approach among questionnaires
  - Take assumptions about what presence is and make up questions concerning the assumptions

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Immersive Tendency Questionnaire

Var.	Selected Questions from the Immersive Tendency Questionnaire Item Stems
it3	How frequently do you get emotionally involved (angry, sad, or happy) in the news stories that you read or hear?
it6	Do you ever become so involved in a television program or book that people have problems getting your attention?
it10	Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?
it13	How physically fit do you feel today?
it14	How good are you at blocking out external distractions when you are involved in something?
it15	When watching sports, do you ever become so involved in the game that you react as if you were one of the players?
it16	Do you ever become so involved in a daydream that you are not aware of things happening around you?
it22	How well do you concentrate on disagreeable tasks?
it24	To what extent have you dwelled on personal problems in the last 48 hours?
it25	Have you ever gotten scared by something happening on a TV show or in a movie?
it27	Do you ever avoid carnival or fairground rides because they are too scary?
it29	Do you ever become so involved in doing something that you lose all track of time?

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Physiological Responses

- Theory:
  - The real world changes our physiological responses to it.
  - A remote or virtual world should do the same if we are immersed in it.

  Cardiovascular, Respiratory,

  Nervous, Sensory,

  Blood Chemistry

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Measure this

- Relax
- Find your Pulse
- Watch this

Performance measures

- Suspension of belief
  - Observable changes in mode of behavior relative to interface
    - Forgetting the interface is there.
- Instinctual responses
  - Ducking at approaching objects
  - Leaning into a perceived curve
  - Vocalizations

The Bottle Test

- While testing for presence is hit and miss, testing for other things can be quite easy
  - Success vs. failure measures
    - Based on individual task performance
- This is the poor man's testing strategy
- When you have nothing else, you can test an operator's concentration and ability to focus with a simple bottle of water

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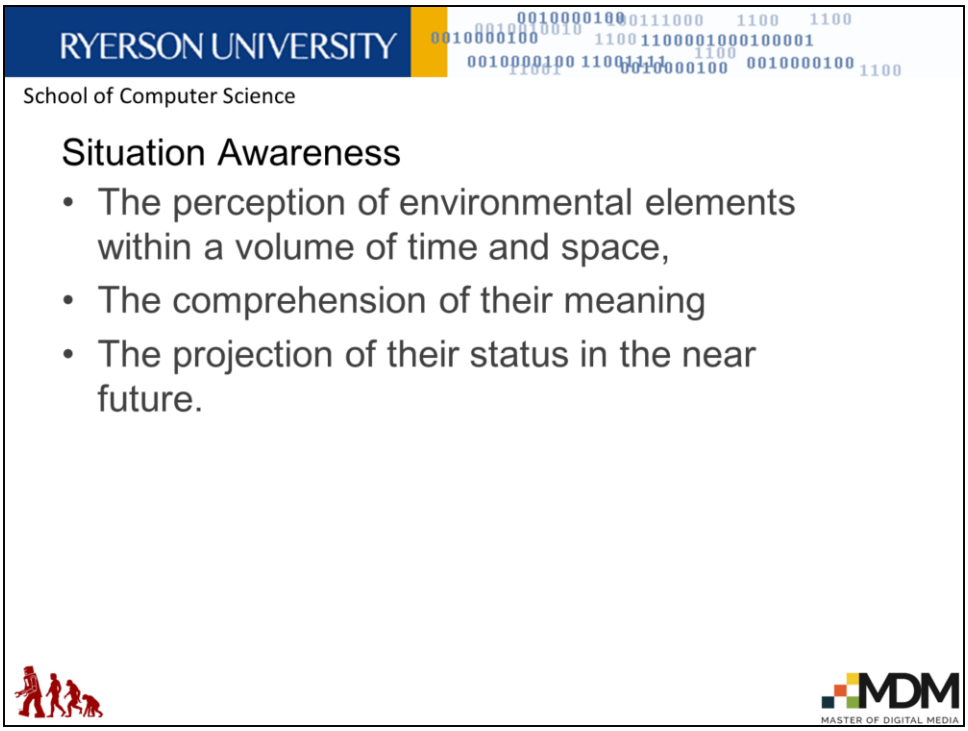

"the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future," Endsley, M.R. (1995). Toward a theory of situation awareness in dynamic systems. Human Factors 37(1), 32–64

Who Cares?

- SA concerned with perception of the environment
- Critical to decision-makers in complex, dynamic areas
  - aviation,
  - air traffic control,
  - power plant operations,
  - military command and control, and
  - emergency services such as fire fighting and policing

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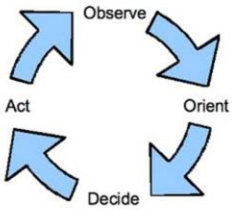
The OODA Loop

- Observe, Orient, Decide, Act
- Attributed to US Fighter Pilot and Theorist John Boyd
- the winning strategy is to "get inside" your opponent's OODA loop,
  - not just by making your own decisions quicker, but also by having better SA than the opponent, and even changing the situation in ways that the opponent cannot monitor or even comprehend.
- Losing one's own SA, in contrast, equates to being "out of the loop."



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Lack of SA can be Troublesome

- 2:30 p.m. on January 15, 2014
  - pilot hits ejection handle.
  - 14 seconds later: "Mayday, mayday, mayday, aircraft in the water."
- According to the Navy's investigation,
  - pilot lost "situational awareness regarding his altitude, airspeed and rate of descent, descending more than 9,220 feet in just 44 seconds."

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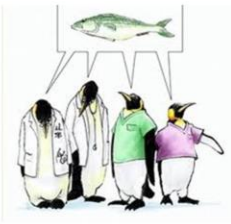
Mental Models

- Accurate mental models needed to achieve SA
- mental model:
  - Set of well-defined, and dynamic knowledge structures developed over time from experience
- Too much data overwhelms the capabilities of novice decision makers
  - Resut ==information overload and worse outcomes.
- Experienced decision makers – faster and more accurate using models
  - Use long-term memory
- Cues in the environment activate these mental models, which in turn guide their decision making process.



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Accurate mental models are one of the prerequisites for achieving SA (Endsley & Jones, 1997; Sarter & Woods, 1991). A mental model can be described as a set of well-defined, highly-organized yet dynamic knowledge structures developed over time from experience (Glaser, 1989; Kozlowski, 1998). The volume of available data inherent in complex operational environments can overwhelm the capability of novice decision makers to attend, process, and integrate this information efficiently, resulting in information overload and negatively impacting their SA (Endsley, 1997). In contrast, experienced decision makers assess and interpret the current situation (Level 1 and 2 SA) and select an appropriate action based on conceptual patterns stored in their long-term memory as "mental models" (Serfaty, MacMillan, Entin, & Entin, 1997). Cues in the environment activate these mental models, which in turn guide their decision making process.

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Team SA

- Must consider SA of the team as a whole.
- A team can be defined as:
  - "a distinguishable set of two or more people who interact dynamically, interdependently and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life span of membership."

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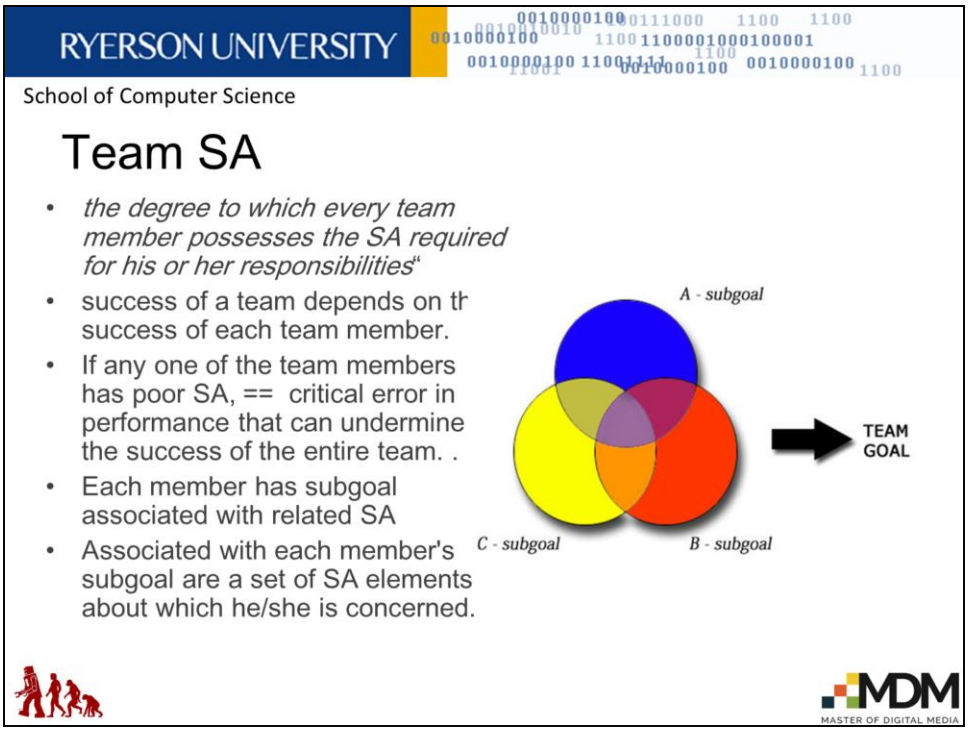
n many systems and organizations, people work not just as individuals, but as members of a team. Thus, it is necessary to consider the SA of not just individual team members, but also the SA of the team as a whole. To begin to understand what is needed for SA within teams, it is first necessary to clearly define what constitutes a team. A team is not just any group of individuals; rather teams have a few defining characteristics. As defined by Salas et al. (1992), a team is:

"a distinguishable set of two or more people who interact dynamically, interdependently and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life span of membership."



Team SA is defined as "*the degree to which every team member possesses the SA required for his or her responsibilities*" (Endsley, 1995b, p. 39; see also Endsley, 1989). The success or failure of a team depends on the success or failure of each of its team members. If any one of the team members has poor SA, it can lead to a critical error in performance that can undermine the success of the entire team. By this definition, each team member needs to have a high level of SA on those factors *that are relevant for his or her job*. It is not sufficient for one member of the team to be aware of critical information if the team member who needs that information is not aware.

In a team, each member has a subgoal pertinent to his/her specific role that feeds into the overall team goal. Associated with each member's subgoal are a set of SA elements about which he/she is concerned. Team SA, therefore, can be represented as shown in Figure 2. As the members of a team are essentially interdependent in meeting the overall team goal, some overlap between each member's subgoal and their SA requirements will be present. It is this subset of information that constitutes much of team coordination. That coordination may occur as a verbal exchange, a duplication of displayed information, or by some other means.

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Royal Navy Field Gun Competition

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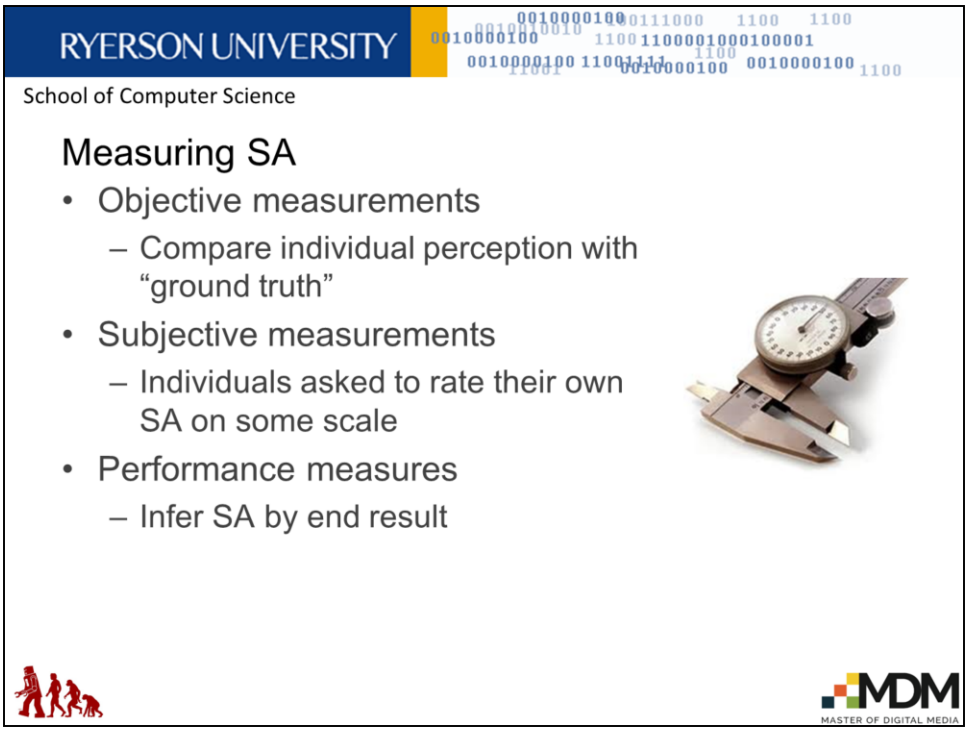

Measurement of situation awareness

While the SA construct has been widely researched, the multivariate nature of SA poses a considerable challenge to its quantification and measurement (for a detailed discussion on SA measurement, see Endsley & Garland, 2000; Fracker, 1991a; 1991b). In general, techniques vary in terms of *direct* measurement of SA (e.g., objective real-time probes or subjective questionnaires assessing perceived SA) or methods that *infer* SA based on operator behavior or performance. Direct measures are typically considered to be "product-oriented" in that these techniques assess an SA outcome; inferred measures are considered to be "process-oriented," focusing on the underlying processes or mechanisms required to achieve SA (Graham & Matthews, 2000). These SA measurement approaches are further described next.

Objective measures of SA

Objective measures directly assess SA by comparing an individual's perceptions of the situation or environment to some "ground truth" reality. Specifically, objective measures collect data from the individual on his or her perceptions of the situation and compare them to what is actually happening to score the accuracy of their SA at a given moment in time. Thus, this type of assessment provides a direct measure of SA and does not require operators or observers to make judgments about situational knowledge on the basis of incomplete information. Objective measures can be gathered in one of three ways: real-time as the task is completed (e.g., "real-time probes" presented as open questions embedded as verbal communications during the task – Jones & Endsley, 2000), during an interruption in task performance (e.g., Situation Awareness Global Assessment Technique (SAGAT) – Endsley, 1995a, or the WOMBAT Situational Awareness and Stress Tolerance Test mostly used in aviation since the late 1980s and often called HUPEX in Europe), or post-test following completion of the task.

Subjective measures of SA

Subjective measures directly assess SA by asking individuals to rate their own or the observed SA of individuals on an anchored scale (e.g., Participant Situation Awareness Questionnaire (PSAQ) – Strater, Endsley, Pleban, & Matthews, 2001; the Situation Awareness Rating Technique (SART) – Taylor, 1989). Subjective measures of SA are attractive in that they are relatively straightforward and easy to administer. However, several limitations should be noted. Individuals making subjective assessments of their own SA are often unaware of information they do not know (the "unknown unknowns"). Subjective measures also tend to be global in nature, and, as such, do not fully exploit the multivariate nature of SA to provide the detailed diagnostics available with objective measures. Nevertheless, self-ratings may be useful in that they can provide an assessment of operators' degree of *confidence* in their SA and their own performance. Measuring how SA is *perceived* by the operator may provide information as important as the operator's *actual* SA, since errors in perceived SA quality (over-confidence or under-confidence in SA) may have just as harmful an effect on an individual's or team's decision-making as errors in their actual SA (Endsley, 1998).

Subjective estimates of an individual's SA may also be made by experienced observers (e.g., peers, commanders, or trained external experts). These observer ratings may be somewhat superior to self-ratings of SA because more information about the true state of the environment is usually available to the observer than to the operator, who may be focused on performing the task (i.e., trained observers may have more complete knowledge of the situation).

However, observers have only limited knowledge about the operator's concept of the situation and cannot have complete insight into the mental state of the individual being evaluated. Thus, observers are forced to rely more on operators'*observable* actions and verbalizations in order to infer their level of SA. In this case, such actions and verbalizations are best assessed using *performance* and *behavioral* measures of SA, as described next.

Performance and behavioral measures of SA

Performance measures "infer" SA from the end result (i.e., task performance outcomes), based on the assumption that better performance indicates better SA. Common performance metrics include quantity of output or productivity level, time to perform the task or respond to an event, and the accuracy of the response or, conversely, the number of errors committed. The main advantage of performance measures is that these can be collected objectively and without disrupting task performance. However, although evidence exists to suggest a positive relation between SA and performance, this connection is probabilistic and not always direct and unequivocal (Endsley, 1995b). In other words, good SA does not always lead to good performance and poor SA does not always lead to poor performance (Endsley, 1990). Thus, performance measures should be used in conjunction with others measures of SA that directly assess this construct.

Behavioral measures also "infer" SA from the actions that individuals choose to take, based on the assumption that good actions will follow from good SA and vice-versa. Behavioral measures rely primarily on observer ratings, and are, thus, somewhat subjective in nature. To address this limitation, observers can be asked to evaluate the degree to which individuals are carrying out actions and exhibiting behaviors that would be expected to promote the achievement of higher levels of SA (see, for example, the Situation Awareness Behaviorally Anchored Rating Scale (SABARS) – Matthews, Pleban, Endsley, & Strater, 2000; Strater et al., 2001). This approach removes some of the subjectivity associated with making judgments about an individual's internal state of knowledge by allowing them to make judgments about SA indicators that are more readily observable.

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Test Your SA