

DR<sup>5</sup>

DR<sup>5</sup>:

Learning Diagnostic For  
Mission Critical Events



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## Intent

The DR5 model was developed through a collaborative inquiry process between the Mission Critical Team Institute, Naval Special Warfare, and the Wharton Neuroscience Initiative (UPENN), as a learning diagnostic to improve performance within immersion events, specifically hostage rescue, and is currently being utilized by teams worldwide. It was initially created to move past the all too common “You Suck! Suck Less!” instructor/student interaction by providing instructors a more precise language to overcome the Tacit Knowledge Transfer Problem (Cline, 2017). This is the problem that experts face when they try to explain, or articulate, their expertise (e.g. Having the skill to ride a bike versus explaining that skill to another). Using research from Psychology, Education, and Neuroscience, the DR<sup>5</sup> model breaks down the immersion event into 5 distinct areas of **Detection, Recognition, Reaction, Response, Reset and Reflection**. While neurologically these stages do not behave sequentially (Gold, 2018), the model provides Instructor Cadres a mechanism for specificity (Ruiz, 2018) to better diagnose and mediate learning within and after immersion events. This version has been written specifically for use in learning medical resuscitation.

## Role of Instructor Cadre

For this diagnostic to be successful the Instructor cadre need to be intentional about how they engage with the learner(s). Different learning profiles will require different interventions and different frameworks. This

Category	Role	Typical Purpose	Example	Style
Training	Instructor	Change Behavior	How to use a tool	Transmission
Education	Teacher	Change Thinking	When, Where and Why to use a tool	Inquiry
Mentoring	Mentor	Increase Cultural Conformity	Our team Standard Operating Procedures for using the tool	Explaining
Coaching	Coach	Optimize Individual Potential	How you can optimize your personal performance with the tool	Individual Inquiry
Facilitation	Facilitator	Increase Collaboration	Optimize entire teams' performance with tool	Reflective Dialogue

table is one example of how different interventions might occur based on the specific observed deficit.

## Phases of the Immersion Event

- Equilibrium: Pre-Immersion Event
- Detection: Sentinel Event
- Recognition: Crossing Event Horizon
  - Reaction
  - Response
- Transition: Crossing Surface Horizon
  - Reset
  - Reflection

## Equilibrium: Preparing for an Immersion Event

While the focus of this paper is on the human factor, all human factors operate within a socio-technical ecosystems with its own variables (Levin, 1998; Svyantek & Brown, 2000).

### Context Variables:

- **Space:** The physical space around a resuscitation is standardized, static, and constrained, but should be designed to optimize performance (Taylor, Brunyé, & Taylor, 2008).
- **Time:** This paper will focus on evolutions of five minutes or 300 seconds or less (Cline, 2017).
- **Technology:** Human machine interaction should optimize, rather than hinder performance (Rasmussen, 1986).
- **Information:** Flow and volume of information need to enable, not overwhelm, dynamic assimilation; the ability to rapidly learn and apply new information (Klingberg, 2009).

### Human Factor Variables:

- **Team Structure:** Initial Resuscitation teams are tactical swarms, or X-teams, which are groups of unfamiliar experts coming together in an ad hoc manner to function with “smart autonomy” against an emergent complex adaptive problem set (Ancona, Bresman, & Kaeufer, 2002); McChrystal (2015, p. 225). A properly matrixed team can ensure that the collective assets of the team can offset any individual deficit.
- **Selection:** With the advent of tactical swarms, variables such as mutual trust, clear closed-loop communication, adaptability, and a commitment to team over self will continue to matter (Eduardo Salas, Sims, & Burke, 2005) to achieve the peer acceptance necessary for high performance (Gifford-Smith & Brownell, 2003, p. 237)
- **Authority:** To optimize speed, Mission Critical Teams have transitioned from directive leadership to empowered membership (Cline, 2017; Mattson, 2016; Yun, Faraj, & Sims, 2005). Meaning that instead of waiting to be told to move, operators take the initiative to move in synchrony until told to stop.
- **Dynamic Assimilation:** Learners need to be capable of assimilating new information and adapting behavior at an acceptable rate (Piaget, 1977).
- **Uncertainty Tolerance:** Learners must be able to manage multiple evolutions sustainably (Grutters, van Asselt, Chalkidou, & Joore, 2015; Hillen, Gutheil, Strout, Smets, & Han, 2017).
- **Flow:** Truly optimal performance requires a “flow state,” a period of effortless calm and focus where solutions seem to emerge as fast as the problem sets (Csikszentmihalyi, 1990).
- **Professional Development:** Effective resuscitation requires adaptive capacity, cognitively and kinesthetically (Bezzola, Mérillat, & Jäncke, 2012; Chiva, Grandío, & Alegre, 2010; G. A. Klein, 2011; Kozlowski, 1998). This requires a combination of training operators to exploit pre-existing contingencies against known, or uncertain, problem sets while also educating them to explore solutions against unknown, or uncertain, problem sets. (Army, 2012; Draude, 2011; Kozlowski, 1998; March, 1991; Snowden, 2005).

## **Detection: The Sentinel Event**

In the context of Resuscitation, the sentinel event will be the cessation of breathing or blood flow which poses a mortal threat to the patient (Wald & Shojania, 2001). This event must be detected by another human in order for there to be a reaction. The human brain is able to recognize immediate threats through sensory cues such as the traditional five senses: sight, hearing, touch, smell and taste, but also changes in Neuroception (environmental threats) (Porges, 2001), Somatosensation (temperature, body position, balance, pain) and Chronoception (a change in our perception of time, “this is taking too long!”) (Ward, 2015). If an untrained brain collects enough sensory cues to detect threat, or experiences a “startle response,” such as jumping from a loud noise (Koch, 1999), it will trigger an instinctual Acute Stress Response (ASR) (Bracha, 2004) which goes directly from detection to instinctual reaction (i.e., fight, flight, freeze). With the appropriate systems, training, and stress inoculation, that same brain can develop the cortical discipline to recognize and categorize the type of threat *before* reacting.

Threat detection is optimized through the increase capacity for Situational Awareness (M. R. Endsley & Garland, 2000), Shared Situational Awareness (Nofi, 2000; Eduardo Salas, Stout, & Cannon-Bowers, 1994), and Joint Cognition (David D. Woods & Hollnagel, 2006). Situational Awareness (SA) is “the perception of the 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, 1988). Shared Situational Awareness (Eduardo Salas et al., 1994), or Collective Intelligence (Woolley, Chabris, Pentland, Hashmi, & Malone, 2010) is the ability of the team to develop “a group dynamic mental model” (Nofi, 2000; E. Salas, Cooke, & Rosen, 2008). Lastly, the design of technical and information systems, to enhance the teams SSA, or distributed cognition, is referred to as Joint Cognitive Systems (Rogers & Ellis, 1994; David D Woods, 1985; David D. Woods & Hollnagel, 2006).

## **Recognition: Crossing the Event Horizon**

The Moment of Recognition or what the Ancient Greeks called “Anagnorisis” is a transformative moment within an ancient Greek theater performance when an agent makes a critical discovery that allows them to understand things as they really are, along with the willingness and motivation to act (Baracchi, 2014). For operators to be able to slow down their reaction to wait for cognition requires both experience, in order to build patterns, or “what right feels like” and the cortical discipline to see dissonance in those patterns (G. Klein, 1993; Monat & Lazarus, 1991). For example, experts know what “normal” radio traffic sounds like and will immediately stop and orient themselves towards the radio if they hear something “weird” (a break in the expected pattern). Recognition can be delayed due to the inability to track weak but important signals in noisy environments (Taleb, 2007) and Cognitive Biases (Kahneman, 2011). Cognitive Biases, or our habitual rules of thumb (heuristics), act to speed our decision making, but can often lead us astray (Gigerenzer & Todd, 1999; Tversky & Kahneman, 1974). For operators to overcome these inherent challenges, while optimizing performance, they need to engage in iterative training evolutions interspersed with periods of intentional stress inoculation (Saunders, Driskell, Johnston, & Salas, 1996). This type of training can diminish the impact of ASR

and allow greater focus on actual (vs. potential) threats (Boyer, Bergstrom, & Reviews, 2011) allowing time for the brain to recognize and categorize the threat (Paulus et al., 2010). A recognition of a sentinel event also triggers the crossing of an event horizon into the immersion event. An event horizon is a term describing a boundary in space time that marks the transition between equilibrium and the chaos of an immersion event (Arrow, Poole, Henry, Wheelan, & Moreland, 2004). Anthropologically, the immersion event is referred to as a liminal space (Van Gennep, 2011), or liminality, a threshold “betwixt and between” where space and time take on different properties (Turner, 1995). For Mission Critical Teams Immersion events are benchmarked at 5 minutes, or 300 seconds, because the average human brain has about that amount of oxygen stored in the brain at any given time (Suominen et al., 2002). Trauma Surgeons, Hostage Rescuers, Firefighters, all have to train under the assumption that whomever they are trying to help has stopped breathing or is severely bleeding. Once the event horizon is crossed, there is no pause button, there is only performance or catastrophic failure. Once the threat is recognized, there is no turning back until there is a resolution. Because these are tactical swarms where the individuals may not have met prior to the immersion event, each operator must anticipate how they will accelerate their engagement by anticipating and optimizing their first 30 seconds. In an environment where Personal Protective Equipment (PPE) disguises facial features, efforts at introductions must be intentional, including the stating of names, names/pictures displayed on head or chest, etc. must be anticipated ahead of time (Gawande, 2010; Leach, Myrtle, & Weaver, 2011).

## Reaction

The goal is not just to react, but to react effectively. Once the operator has exerted cortical discipline over their Acute Stress Response, allowing them to recognize the threat, they will then trigger a cascade of pre-programmed heuristics and muscle movements (De Neys & Goel, 2011). In order to improve performance of the operator, Cadre need to be able to diagnose and modify that cascade of behaviors (Lang & Bradley, 2010). In the context of preparing learners to operate within an immersion event, special attention must be paid to reversal learning and building adaptive capacity. Reversal learning is the process of overwriting old habits (what are sometimes called “training scars” by the operators) with the new habits being asked of them by the instructor cadre, within the timeframe required (Kalyuga, Rikers, & Paas, 2012). This can be especially challenging for experienced operators who have already constructed successful patterns of what “right” looks and feels like (Knowles, 1978). As they are asked to learn new things, their hard-won heuristics are now working against them as the “new way” will feel wrong and make them hesitate. It is this reason that older learners will often retreat to prior competence and justify their entrenchment as it is “good enough” and “worked so far” even if they know that competence is flawed because the new information is threatening their identity as an expert (Heifetz & Linsky, 2002). Even if the learner possesses high neural plasticity (Bezzola et al., 2012; Draganski et al., 2004), a measure of a brain’s ability to adapt to new information or actions, most training is designed to generate habits (Grossman & Christensen, 2004) using operant conditioning or positive and negative reinforcement (Skinner, 1937). The strength and weakness of Operant Conditioning is that it fosters rapid convergent (linear) thinking and problem solving, while expressly discouraging divergent

(nonlinear) thinking and problem solving (Cropley, 2006; Csikszentmihalyi, 2001; Woodman, Sawyer, & Griffin, 1993). This can lead to learners always wanting to choreograph, or anticipate, a future contingency plan, rather than building their capacity to adapt to whatever problem set emerges (Kozlowski, 1998). Therefore, operators must develop effective habits, as well as the ability to improvise.

## Response

During the immersion event the operator will need to constantly engage cortical discipline to rapidly transition between reacting to threats, to responding to the larger mission (G. Klein, 1998). It is this ability to rapidly and smoothly transition between reaction and response that make MCT operators unique (Drakos, 2018). As the problem set grows in complexity, however, the operator will need to overcome Hick's Law, which states that as the number of options increase, the time required to make a decision increases logarithmically (Roberts, Beh, & Stankov, 1988). To diminish the impact of hicks law Mission Critical Teams have sought to increase their Adaptive Capacity by distributing information processing, through Joint Cognitive Systems, to speed Dynamic Assimilation (the ability to learn new information and apply it to emerging problem sets) (Folke et al., 2002; David D. Woods & Hollnagel, 2006).

## Transition: Crossing Surface Horizon

The team will remain in Recognize/React/Respond evolutions until either the problem is resolved or transitioned to a new team. When transitioning out of an immersion event operators need to anticipate changes in roles, responsibilities and communication (Meleis & Trangenstein, 1994). Once the problem set has been resolved or transitioned to a new team, the original team needs the ability to both immediately reset, in case a new event emerges, while also reflecting and making meaning of the immersion event they just experienced.

## Short Term: Reset

Mission Critical Teams need to be prepared to exit one immersion event, only to have to immediately cross the event horizon into the next immersion event. The challenge then, is how to “Reset,” in order to let go of any negative feelings (regret, remorse, frustration, etc.) in order to fully engage in the next evolution and re-achieve flow state. Sports research indicates that specific psychological skill training, such as Goal Setting, Arousal Regulation (mindfulness), Mental Imagery and Positive Self Talk have all been shown to be very effective in helping operators drop back into the flow (Barwood, 2006; Kee & Wang, 2008).

- **Goal setting:** Having clear personal goals in which to focus, providing purpose.
- **Arousal Regulation:** The use of box breathing to get centered and suppress arousal.
- **Visioning:** Mentally recreate the positive and negative visual, auditory, sensory, and kinesthetic experiences. Then visualize a successful evolution.
- **Positive self-talk:** Identify the negative inner monologue and create counter arguments and positive statements.

## Long Term: Reflect

The word “Shoshin” is used by Japanese Buddhists to mean the “Beginner’s Mind”; “...In the beginner’s mind there are many possibilities; in the experts mind there are few (Suzuki, 2010).” To be effective within a Mission Critical Team, operators must remain adaptive, and the way humans adapt is through learning. In order to learn, we must overcome our reluctance to talk about the greatest threat to Mission Success, Survivability and Sustainability: human error. In other words, we cannot fix what we cannot talk about. Key to overcoming the reluctance to talk about error, is the understanding that learning is dependent upon making mistakes, without error there is no reason to adapt (Kable, 2018; Schultz, Dayan, & Montague, 1997). We then need to understand that an individual cannot be exceptional in all domains, therefore when we identify an error we need to spend our resources on developing our strengths (assets), rather than focusing on our weaknesses (deficits), in order to achieve high performance (Chamorro-Premuzic, 2016; Green & Haines, 2011, p. 7). Errors will occur. Mistakes will happen. Losses will be suffered. The goal is to make meaning of those errors, to learn from them.

All MCT’s engage in a post evolution review, whether they call it an After Action Review (AAR), Hot wash, Debrief, M&M, post mortem or post evolution meeting, to be a formally review their last learning cycle (Morrison & Meliza, 1999). In most cases, they are built around three questions: An Opening question: “What happened?”, a Guiding question: “Why did it happen?”, and a Closing question: “Now what?” To be successful, the AAR has to be what ancient Greeks called “Parrhesia,” or the courageous conversation (Foucault, 1999), that serves to help the team reveal each other’s blind spots (Luft & Ingham, 1961).

By taking the time to collectively make meaning of the immersion event, we are more likely to process the residue of the experience into the meaningful building blocks of our character, rather than the regrets that weigh us down (Cline, 2020).

## Optimal Individual and Team Behaviors within an Immersion Event

### Crossing the Immersion Event Horizon

- **Detection:** Also known as “Threat Detection,” is an ongoing automatic process of collecting sensory (sight, sound, smell, etc.) and pattern cues, to identify imminent threats (Boyer et al., 2011; Neuberg, Kenrick, Schaller, & Reviews, 2011; Öhman, 2005; Paulus et al., 2010).
  - **Individual Behavior:** Does the learner rapidly detect and orient toward the threat or opportunity?
  - **Team Behavior**
- **Recognition:** Also known as “Moment of Recognition” is the accumulation and analysis of sensory cues resulting in pattern identification (G. Klein, 1993; Ploran et al., 2007). Note: untrained personnel might go directly from detection to reaction due to an Acute Stress Response, or “Amygdala Hijacking” (Bracha, 2004).
  - **Individual Behavior:** Is the learner able to differentiate between threat or opportunity prior to reaction?
  - **Team Behavior:**
- **Reaction:** Is the amount of time between the detection of stimulus and action.
  - **Individual Behavior:** Is the learner moving with the team in a fluid, coherent and congruent manner?
  - **Team Behavior:**
- **Response:** This is the moment of choice, where the operator asserts cortical discipline (Monat & Lazarus, 1991) and transitions from reacting to threats to responding to the larger mission (G. Klein, 1998). Within an Immersion Event, this needs to happen in under 5 minutes (Cline, 2017).
  - **Individual Behavior:** Is the learner able to dynamically assimilate new information and adapt their behavior and/or communicate behavior change to their team?
  - **Team Behavior:**

### Crossing the Surface Horizon

- **Reset:** How does the operator quickly reset to the next problem set, even after error or failure? (Kee & Wang, 2008).
  - **Individual Behavior:** Is the learner able to rapidly assimilate prior mistakes so that they can completely refocus and engage with the next problem set?
  - **Team Behavior:**
- **Reflection:** AAR – A note about residue
  - **Individual Behavior**
  - **Team Behavior**



## Lexicon

**Complex Adaptive Problem Sets:** Are non-linear, unpredictable, and adaptive groups of problems which require new learning to resolve (Heifetz & Laurie, 1997).

**Cortical Discipline:** To be able to maintain the ability to intentionally, rather than reactively, move along the system 1 & 2 continuum we need to be able to better screen out and calibrate noise/stimulus/threats.

**Critical Environment:** A liminal environment characterized by time (300 seconds or less) and criticality (high threat or loss potential) that has the potential to trigger a limbic response. In an untrained mind this would manifest as a stress (fight, flight, freeze) response. In a trained mind this would manifest as a preprogrammed choreography of action (the ABC's for a medic, or Move, shoot, communicate for special operations).

**Joint Cognitive Systems (Joint Cognition):** The combination of human problem solver and automation/technologies which must act as co-agents to achieve goals and objectives in a complex work domain (David D. Woods & Hollnagel, 2006).

**Liminal (or Liminality):** Greek for a transitional or initial stage of a process, or threshold. The perceptual changes in space and time reported by firefighters, emergency medical professionals, and special operations units when immersed in criticality (Turner, 1995; Van Genneep, 2011).

**Mindfulness:** Is a state where the Individual is constantly engaged in updating 'how' to achieve the mission in the face of evolving stressors (i.e., you avoid the hit by getting out of the way).

**Mission Critical Teams:** are defined as a small (4-12 agents) integrated group of indigenously trained and educated experts that leverage tools and technology to resolve rapidly emergent complex adaptive problems in an immersive, but constrained (five minutes or less) temporal environment, where the consequence of failure can be catastrophic loss (Cline, 2017).

**Resilience:** Being able to recover quickly or easily from experiencing a stress (i.e, you quickly get up after being hit and knocked down).

**Reversal Learning:** Reversal learning is term used to describe the process of overwriting old habits (what are sometimes called "training scars") with the new habits (Kalyuga et al., 2012).

**Robustness:** A property that allows a system to maintain its momentum in the face of stress (i.e., you can take the hit).

**Routine Environment:** This is what most people think of as a normal, non-threatening environment. It is primarily characterized as an environment that does not trigger the startle or stress response, often shorthanded by the "fight, flight, Freeze" reaction, to the perception of threatening stimuli.

**Shared Situational Awareness:** (Eduardo Salas et al., 1994), or Collective Intelligence (Woolley et al., 2010) is the ability of the team to develop "a group dynamic mental model" (Nofi, 2000).

**Situational Awareness:** is "the perception of the 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, 1988)

**Technical Problem Sets:** Are linear, predictable, and fixed problem sets that can be solved by the existing knowledge of experts (Heifetz & Laurie, 1997).

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## About the Mission Critical Team Institute

Founded in 2018, after a three-year pilot at the Wharton School, University of Pennsylvania, the MCTI is a collaborative inquiry research and professional development Institute aimed at improving the success, survivability and sustainability of Mission Critical Teams, through invitational only collaborative inquiry programs and onsite engagements. In partnership with our current Mission Critical Team collaborative inquiry community, within Military Special Operations (within the 5 eyes), Tactical Law Enforcement, Urban and Wilderness Fire, Emergency and Trauma Medicine and NASA, we work with Instructor Cadres and Team Leadership to improve the human factor through exposure to current research and dialogue about current challenges and opportunities. identify and support select organizations. Our effort includes:

- **Applied Collaborative Research Community:** To support our partners to develop more rigorous methods to solve current problems in a collaborative environment.
- **Instructor Cadre Development Programs:** Focused on sharing the theories and techniques related to the selection, teaching and learning of future Mission Critical Team Operators.
- **Custom Small Team Leadership Programs:** This program would be aimed at MCT operators who are entering positions of leadership.
- **Mission Critical Team Summit:** held once a year and aimed at bringing the entire collaborative community together once a year to explore emerging ideas, tools and techniques related to further develop the Human Factor.
- **Learning Observations and Review:** Onsite visits to our partners to observe and discuss current and future practice.

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## Contributors to this Paper

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