MISSION CRITICAL
TEAM INSTITUTE

DR5

DR5 - MED
A LEARNING DIAGNOSTIC FOR MISSION CRITICAL MEDICAL TEAMS

Editors:
Dr. Preston B. Cline, CEO, Preston@missioncti.com
Dr. Dan Dworkis, Chief Medical Officer, Dan@missioncti.com
Mission Critical Team® Institute

Executive Summary

This brief examines the structure and function of the DR5 model, a learning diagnostic tool designed to help instructors better evaluate operators working in mission critical teams and to better teach what "right" looks like. While the DR5 model was originally developed in a military context, it is extended here to work with and for teams operating in mission critical medical capacities. Within this brief, we step through the six processes that comprise the DR5, offer specific criteria instructors can use to evaluate their trainees along each process, and end by identifying a potential set of interventions teams could use after running a DR5 diagnostic.

What are Mission Critical Teams (MCTs)?

A Mission Critical Team ® is a small integrated group of indigenously trained and educated experts that leverage tools and technology to resolve complex adaptive problems in immersive but temporally constrained environments, where the consequence of failure is death or catastrophic loss. Examples of MCTs in medicine include a cardiac cath lab team assembling to work a STEMI case, a mixed emergency and surgical team running a trauma resuscitation, and a difficult airway team responding to a cardiac arrest. Outside of medicine, examples of MCTs include military special mission units, NASA flight directors, search and rescue teams, etc.

What is The Mission Critical Team Institute?

The Mission Critical Team Institute (MCTI) is an applied research organization that serves the needs of the mission critical community. Our goal, in partnering with both researchers and practitioners, is to develop collaborative applied research focused on improving the success, survivability, and sustainability of MCTs.

What is the DR-5?

The DR5-MED (just "the DR5") is a learning tool designed to help instructors successfully teach and evaluate individuals and MCTs operating in medical capacities. Performing at an elite level when working a complex, rapidly adaptive problem set like a managing a difficult airway in a near-death patient requires successfully deploying multiple cognitive and physical skillsets at the individual and team level that are difficult to effectively learn and teach. The DR5 model was designed to offer a more precise and scientifically valid language, and to improve our ability to transfer this tacit knowledge. In the DR5 model, the path an operator takes while working is broken down into six distinct actions: **D**etect, **R**ecognize, **R**eact, **R**espond, **R**eset, and **R**eflect. Using this framework, instructors can more precisely identify the strengths and weaknesses of MCTs, more efficiently address technical, cognitive, and developmental gaps in operations, and more effectively share "what right looks like" with trainees throughout the development pipeline.

Intent

How do you train individuals and teams to perform in high stakes, must not fail "immersion events" like critical resuscitations, difficult airways, and cardiac arrests? **The core challenge the DR5 is designed to address is the "tacit knowledge transfer problem," which experts face when trying to explain to non-experts what "right" feels like** [1]. If you have ever tried to teach someone how to ride a bicycle, you know the tacit knowledge transfer problem—even when you personally already know how to ride a bicycle, explaining how to ride one is extremely challenging. The tacit knowledge transfer problem often provokes frustrated instructors to fall back on the all too common "You suck! Suck less!" or "Just be a better doctor!"

Using research from psychology, education, and neuroscience, the DR5 model breaks down the path an operator takes during an immersion event into six distinct neurological processes: *Detection*, *Recognition*, *Reaction*, *Response*, *Reset*, and *Reflection*. While these stages do not, strictly speaking, occur linearly or sequentially, [2], the model provides instructor cadres a mechanism for specificity [3] to better diagnose and mediate learning within and after immersion events. The DR5 was originally created through a collaborative inquiry process between the MCTI Naval Special Warfare, and the Wharton Neuroscience Initiative (UPenn) to improve the training and education of MCTs by providing the instructor cadre a more effective learning / diagnostic tool. In the period following the outbreak of Covid-19, MCTI was asked to adapt that tool for the training and education of medical resuscitation teams. ***Table 1*** gives an overview of the DR5 model as it applies to mission critical medicine using the example of sudden onset unstable tachycardia.

Target Audience

The DR5 model is designed for individuals operating as part of mission critical teams and for the instructor cadres whose job it is to train, educate, and transform them. All MCTs belong to specific *communities of practice*—teams with their own distinct problem sets, language, and culture [4-6]. Within these communities, three distinct roles typically exist: *leadership, academics*, and *communitas*. In civilian academic medical education, it is often one single group of individuals who fill all these roles rather than multiple distinct sets of individuals. The leadership builds and maintains the mission, structure, and boundaries of the team while also mediating between the academics and the communitas / instructor cadre [7]. The academics (researchers or outsider subject matter experts) uphold scientific rigor in the programs' underlying processes and procedures; ensure consistency, accuracy, and fairness in selection; and keep the communities practicing at the evolving edge of their skillsets. Communitas is a term which describes a group of people who successfully passed a shared crucible or rite of passage experience (e.g., Selection, Medical Residency, Fire Academy) to become a member of the team [8, 9]. The communitas do the work and maintain the sacred parts of the culture—norms, history, stories, rituals, celebrations, losses, and the rites of passage used to assess and select the next generation [9]. The communitas is also the source of the instructor cadre who teach the next generation.

Table 1: Overview of the DR5 Model applied to Mission Critical Medical Teams

Process	Goal	Example
Detect	Identify that a critical event is happening.	A junior doctor notices a change in the cardiac waveform on the monitor coupled with a low blood pressure for and identifies the start of a critical immersion event—the patient in room 10 is actively crashing.
Recognize	The event is (or probably is) X.	The telemetry monitor shows a wide-complex, tachycardia. The intern thinks it looks polymorphic and makes an initial diagnosis of torsade de pointes (TDP).
React	When we see X, we immediately / reflexively do Y.	The intern activates the rapid response team, calls for a code cart to room 10, applies cardiac pads, administers a stat magnesium bolus, and prepares to shock the patient.
Respond	After Y, we slow down, confirm or change our hypothesis of X, then do $Z_1 \ldots Z_n$.	The response team arrives and leadership transitions to a more senior doctor, who adjusts the team's mental model from TDP to ventricular fibrilization. The patient is successfully defibrillated, returns to a normal rhythm, and is transferred to the ICU.
Reset	Transition back to equilibrium after the event and regenerate the ability to work a subsequent problem set.	The response team disbands, the intern slows their own heartrate, takes a drink of water, and returns to their list of other patients. The team restocks the code cart.
Reflect	Post-hoc analysis at individual, team, and system levels.	The senior house staff meet with the intern and nursing team toward the end of the shift to review. Discussion may include teaching on unstable tachydysrhythmias, reflection on team dynamics and communication, review of a new code cart setup, etc. Later, the intern discusses the case with their teammates over dinner and comes up with questions for the following week's teaching sessions.

Equilibrium: Ready and Prepared for an Immersion Event

Before looking at the six processes that make up the DR5 model, we start with "phase zero," the steady state, dynamic equilibrium from which a crisis may arise. [10, 11]. In broad brushstrokes, these are the variables which MCTs must consider prior to the start of a critical immersion event.

Context Variables:

- **Space**: The physical space where a resuscitation takes place—a university hospital trauma bay or the back of a military helicopter—is typically constrained during the event but may potentially be modifiable before / after a crisis to optimize performance [12].
- **Time:** The DR5 model is designed for MCTs working on immersion events of 300 seconds (five minutes) or less [1]. Systems MCTs use *must* be designed to operate effectively (and typically autonomously) for at least this time frame if not longer.
- **Technology:** Human-machine interactions require optimization to improve performance [13].
- **Information:** The flow and volume of information MCTs encounter need to be designed to enable instead of overwhelm. The dynamic assimilation of new and conflicting information that enables medical teams to rapidly learn and change course is a skill that must be practiced [14].

Team Structure:

- **Intact Teams vs Tactical Swarms:** The initial team responding to an acute medical need may be an intact response team that trains and operates together frequently like a cardiac cath lab unit, or it may be a tactical swarm or "X-team"—a group of potentially unfamiliar experts coming together in an ad hoc manner to function with "smart autonomy" against an emergent problem set like a code blue response team [15, 16]. Each team setup requires its own skills and training. A properly matrixed team can ensure that the collective assets of the team can surpass any one operator's skillset.
- **Clearly Defined Roles:** Roles in a critical event—including leadership and followership—are frequently established ahead of time but may change rapidly depending on dynamic demands.
- **Distributed Authority:** To optimize speed, many MCTs have transitioned from directive leadership to empowered membership [1, 17, 18]. Instead of waiting to be told to move, operators take the initiative to move independently until leadership is definitively established.
- **Meaning Making:** MCTs engage in after action reviews both to improve technical skills and make meaning out of complex and often personally challenging events.
- **Adaptive Development:** Effective resuscitation requires the capacity to adapt both cognitively and kinesthetically [19-22]. **Operators must be trained to exploit pre-existing contingencies against known or uncertain problem sets while also educated to explore solutions against unknown or uncertain problem sets.** [21, 23-26].

Human Factor Variables:

- **Trust:** All MCTs working problems in medical environments operate on trust. Swarm teams like a group of potentially unfamiliar doctors and nurses coming together to address an intraoperative cardiac arrest are especially dependent on variables such as mutual trust, clear closed-loop communication, adaptability, and a commitment to the team over self. These variables will continue to matter to achieve the peer acceptance necessary for high performance [27, 28]
- **Uncertainty Tolerance:** **Learners must manage multiple evolutions in parallel and in series, and must do so sustainably, frequently carrying high levels of allostatic load for extended periods of time** [29, 30]. For example, the patient experiencing a cardiac event at the end of a 24-hour shift needs a resident doctor's attention and skill just as much as the patient experiencing one at the beginning.
- **Dynamic Assimilation:** Learners (indeed all of the communitas including the instructor cadre) need to assimilate new information and adapt behavior at an acceptable rate, or optimal rate of learning, despite significant levels of extraneous cognitive load [31].

The Sentinel Event

The sentinel event is the moment when a boundary is crossed and the world around a medical team has changed from the equilibrium state to a critical event. A complex, rapidly adaptive problem set has emerged, and it is up the MCT to identify this new reality and act accordingly. In the medical world, the sentinel event is typically the active or imminent cessation of oxygenation or blood flow posing a mortal or catastrophic threat to the patient [32]. Examples may include the start of cardiac or respiratory arrest, the onset of an ischemic stroke, a shoulder dystocia in labor, a compromised or difficult airway, major blunt or penetrating trauma, etc. The sentinel event may or may not be immediately obvious to junior operators, especially if it is a "negative" event, characterized by the lack of signal where a signal usually exists.

Detection

Human physiology is designed to detect changes in established patterns through sensory cues such as the traditional five senses, but also changes in *neuroception* (environmental threats) [33], *somatosensation* (temperature, body position, balance, pain) and *chronoception* (a change in our perception of time, "this is taking too long!") [34]. If an untrained brain collects enough sensory cues to detect a threat or experiences a "startle response," such as jumping from loud noise [35], it will trigger an acute stress response (ASR) [36], which goes directly into 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 incoming information before reacting. In medical environments, critical problem sets may emerge dramatically in a way that might trigger an ASR—for example, a lacerated artery spraying blood across the room—or they may emerge more "quietly," as when an unmonitored patient loses pulses. In all medical environments, operators need high *situational awareness*, defined as, “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" [37, 38]. 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). Similarly, an experienced operator working in an intensive care unit can pick out a critical change in the sound of a ventilator through a maze of other conversations and alarms. Within MCTs this situational awareness needs to be rapidly shared through what we call distributed cognition, so the team can develop “a group dynamic mental model” [39, 40] which integrates data between the human factor, environment, information, and technology [41, 42]. In chaotic medical environments like active emergency departments, detection is hampered by noise, the presence of simultaneous and ongoing non-emergency operations, and other extraneous factors. Medical operators need to actively and passively scan for certain types of signals in these environments, proactively identify where they are likely to miss signals, and be aware that signals may not take the shape they are used to receiving.

Detection Diagnostic

Operator

- Did the operator detect the sentinel event?
- What behaviors or communication cues indicated they detected the sentinel event?
- How much time passed between the sentinel event and detection?
- What inhibited the operator’s ability to detect the sentinel event?

Team

- How much time passed between the sentinel event and detection?
- How much time passed between the first operator detecting the sentinel event and team detection?
- What behaviors or communication cues indicated the team detected the sentinel event?
- What inhibited their detection: inexperience as a team, bad habits, flawed principles, trust, credibility, distraction, etc.?

Entering Liminal Space

The team’s choice to engage with a sentinel event immediately immerses them into what is called a liminal space. Anthropologically, liminal space or liminality, is threshold “betwixt and between” equilibrium and the chaos, where space and time take on different properties [8, 43]. Once the team enters liminal space and engages with an event, they are no longer in charge of the clock. For example, when a resuscitation team has pushed paralytics for rapid sequence intubation, they need to secure the patient’s airway one way or another: there is no pause button, or turning back, there is only resolution through performance or catastrophic failure.

Characteristics of a Mission Critical Immersion Event

Whether it is firefighting, hostage rescue, or trauma resuscitation, “immersion events” all share certain characteristics.

- **Immersive:** There is no pause button or ability to safely leave the event and reflect. Operators may experience distortions in their sense of time, space, or both.
- **Urgent:** Multiple things must happen rapidly, simultaneously, and synergistically. These requirements may counteract each other and may necessitate diverting resources from other teams.
- **Temporally Constrained:** The team does not own the clock. **MCTI benchmarks immersion events at 300 seconds because the average human brain has about that amount of oxygen stored at any given time under optimal conditions** [44]. Depending on the team’s actions and the situation, a given event may be shorter or longer than this threshold.
- **Consequential:** Failure to succeed in an immersion event results in catastrophic injury (to person, property, reputation, etc.) or death.
- **Dynamic Leadership:** At the beginning of an event, leadership may be unclear, and the team may need to operate autonomously. During an event, leadership may transition between operators. Communication and active collaboration are key, especially if normal cues like facial expressions and tone of voice are distorted or compromised by equipment or situational demands.

Recognition

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 are, along with the willingness and motivation to act [45]. In the context of mission critical medicine, is the moment that the operator and the team transition from detecting a break in the established pattern to grasping the nature or the emergent problem set. **Recognition may involve an actual diagnosis or simply the generation of a small number of working hypotheses (a streamlined differential diagnosis) for the event**. For example, after detecting a crashing patient, a skilled resuscitation team will rapidly recognize the differences between patients crashing from massive hemorrhage, anaphylaxis, or an acute heart failure exacerbation. As they narrow the list of potential diagnoses, they will “think out loud” and make sure the working mental model is shared with the whole team. **In order for the operators to develop the cortical discipline to disrupt triggering an ASR and to perform the subsequent detection/reaction cascade, they need the right training, experience, and skill development in order to build the tacit knowledge of "what right looks and feels like"** [46, 47]. Recognition can be delayed for numerous reasons, including inexperience, the inability to track weak but critical signals in noisy environments [48], obsolete heuristics, and cognitive biases [49]. *Heuristics* are “‘shortcuts’ that humans use to reduce task complexity in judgment and choice” [50]. *Cognitive Biases* are the gaps which develop between the behaviors which are required to resolve the current problem set and the ingrained habits/behaviors your heuristics want to trigger. It is these gaps where heuristics can lead us astray if the rules have not been updated to new technology, information, or context [51, 52]. For example, a patient having been mis-triaged as an asthma flare will provide barriers to effective problem-set recognition (known as "anchoring bias") when the real underlying diagnosis is acute on chronic congestive heart failure.

Recognition Diagnostic

Operator

- Did the operator correctly recognize the problem set?
- What behaviors or communication cues indicated they correctly recognized the problem set?
- How much time passed between the detection and recognition?
- What inhibited the operator's ability to recognize the problem set (e.g., inexperience, bad habits, flawed principles, incomplete mental models, distraction, etc.)?

Team

- How much time passed between the detection and recognition?
- How much time passed between the first operator recognizing the problem set and team recognition?
- What behaviors or communication cues indicated the team recognized the problem set?
- What inhibited the team's recognition: inexperience as a team, flawed or outdated SOP's, equipment, data, flawed principles, trust, credibility, distraction, culture, etc.?

Reaction

Once the operator has recognized the emergent problem set, this recognition will trigger a cascade of pre-programmed heuristics and behaviors which collectively comprise the operator's *reaction* [53]. For example, when they encounter a patient in active cardiac arrest, medical personnel of all training levels know to start CPR and shout for help, regardless of why the patient is in cardiac arrest. When a rapid response team arrives, they immediately start to achieve vascular access and place defibrillation pads. These behaviors are pre-trained / pre-programmed and activated nearly automatically during an immersion event. In the context of preparing learners to operate in this manner, 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 [54]. This can be especially challenging for experienced operators who have already constructed successful patterns of what "right" looks and feels like, or when critical technology changes without sufficient time to adapt [55]. 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 [56]. Even if the learner possesses high neural plasticity [22, 57]—a measure of a brain's ability to adapt to new information or actions—most training is designed to generate habits [58] using operant conditioning or positive and negative reinforcement [59]. **The strengths and weaknesses of operant conditioning is that it fosters rapid convergent (linear) thinking and problem-solving while expressly discouraging divergent (nonlinear) thinking and problem-solving** [60-62]. 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 [21]. Therefore, operators must develop effective habits and the ability to improvise.

Reaction Diagnostic

Operator

- Did the operator react correctly?
- What were the specific behaviors which indicated optimal reaction?
- How much time passed between the recognition and reaction?
- Did anything inhibit the operator's ability to react to the problem set (e.g., inexperience, bad habits, flawed principles, incomplete mental models, distraction, structure, rules, culture, status, etc.)?

Team

- Did the team react correctly and congruently?
- How much time passed between recognition and reaction? Between the first operator reacting and the team reacting?
- What specific behaviors indicated the team reacted optimally?
- Did anything inhibit an optimal reaction by the team: inexperience as a team, flawed or outdated SOP's, equipment, data, unclear roles, trust, credibility, distraction, culture, etc.?

Response

Once the operator and the team have effectively reacted to the initial part of the problem set and gained some control over the situation and the clock, they need the cortical and cultural discipline to take a tactical pause and respond more deeply to the changing strategic problems set [63]. The ability to rapidly and smoothly transition between reaction and response is one of the skills which makes MCT operators unique [64]. For example, even after a rapid response team working a patient with a major trauma involving an arterial bleed has successfully placed a tourniquet, they still have a critically ill patient in front of them that needs advanced medical care and sophisticated teamwork. This patient may immediately decompensate again unless the team performs optimally in the following moments and may decompensate even if they do so. As the problem set grows in complexity, the operator will also need to overcome Hick's Law, which states that as the number of options increase, the time required to make a decision increases logarithmically [65]. To diminish the impact of Hicks law, MCTs need to optimize their adaptive capacity through optimizing both their *distributed cognition* and their *dynamic assimilation*, respectively defined as the ability to share mental models across a team and the ability to learn new information and rapidly apply adaptive solutions to emerging problem sets. [42, 66]. Optimal team response requires clear roles and responsibilities as well as a clear understanding of routine and critical communication and when to apply each [67, 68].

Response Diagnostic

Operator

- Was the operator able to appropriately transition between reaction to response?
- What were the specific actions which indicated optimal response?
- How much time passed between the reaction and response?
- Did anything inhibit the operator's ability to transition between reaction and response? (e.g., Inexperience, bad habits, flawed principles, incomplete mental models, distraction, structure, rules, culture, status, etc.)?

Team

- Was the team able to appropriately transition between reaction and response?
- How much time passed between reaction and response?
- What specific actions indicated the team was updating their plan and changing their actions based on trends and meta data?
- Did anything inhibit an optimal response by the team: inexperience as a team, flawed or outdated SOP's, equipment, data, unclear roles, trust, credibility, distraction, culture, etc.?

Exiting Liminal Space

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—so called "re-entry" phenomena [69, 70]. **Once the problem set has been resolved or transitioned to a new team, the original team needs the capacity and skills both to immediately reset in case a new event emerges and also to reflect and make meaning out of the immersion event they just experienced.**

Reset

Mission Critical Teams need to be prepared to exit one immersion event only to have to cross the event horizon into the next immersion event immediately. For example, an ER team working a traumatic arrest from a motorcycle accident may have hours before the next sick patient arrives, or they may need to move immediately into the adjacent room to treat a pediatric respiratory arrest. **The goals of a successful reset phase are to (1) put out any existing fires and make sure team members themselves don't require immediate medical attention, (2) rapidly regenerate the ability to act again at as close to 100% as possible, and (3) lay a solid foundation that favors future growth over dysfunction.** Implicit in this is the challenge of how to let go of any negative feelings (regret, remorse, rumination, frustration, etc.)[71, 72].

Reset Diagnostic

Operator

- Was the operator able to appropriately reset between immersion events?
- What were the specific actions which indicated the operator has reset?
- How much time passed between the end of the event and the operator regenerating the capacity to act again?
- Did anything inhibit the operator's ability to successfully reset? (e.g., Inexperience, bad habits, flawed principles, incomplete mental models, distraction, structure, rules, culture, status, etc.)?
-

Team

- Was the team able to appropriately reset between immersion events?
- What were the specific actions which indicated the team has regenerated its ability to act again?
- How much time passed between the end of the event and the team having successfully reset?
- Did anything inhibit the team's ability to successfully reset? (e.g., inexperience, bad habits, flawed principles, incomplete mental models, distraction, structure, rules, culture, status, etc.)?

Reflection

Japanese Buddhists use the word "Shoshin" to mean the "Beginner's Mind"; "[I]n the beginner's mind there are many possibilities; in the expert's mind there are few [73]." To be effective within an MCT, operators must remain adaptive, and the key way humans adapt is through learning. To learn, we must overcome our reluctance to talk about one of the greatest threats to mission success, survivability, and sustainability: human error. In other words, we cannot fix what we cannot talk about. The key to overcoming the reluctance to talk about an error is the understanding that learning is dependent upon making mistakes; without error, there is no reason to adapt [74, 75]. **We need to understand that an operator cannot be exceptional in all domains—therefore to achieve high performance, when we identify an error, we need to spend our resources on developing our strengths (assets) rather than focusing on our weaknesses (deficits) [76, 77]**. Errors will occur. Mistakes will happen. Losses will be suffered. The goal is to make meaning of those errors, to learn from them. To never let the team or the patient's suffering go to waste [78].

All MCT's engage in a post evolution review to formally deconstruct their last learning cycle, whether they call it an after action review (AAR), hot wash, debrief, morbidity and mortality conference, post mortem, or post evolution meeting [79]. In most cases, these reviews are built around three questions: an *opening* question, "What happened?"; a *guiding* question, "Why did it happen?"; and a *closing* question, "Now what?" **Successful reflection merges technical learning, meaning making, and virtuous improvement.** For example, a medical team debriefing a challenging pediatric arrest may work on a combination of individual skills and communication issues, reflect on how witnessing the death of a child effects them as human beings, and identify systems that could be improved to enable faster delivery of elite quality care for the next sick child. To be successful, the AAR has to be what ancient Greeks called *parrhesia*, or the "courageous conversation" [80] that serves to help the team reveal each other's blind spots [81]. **All debriefs need to be grounded in the question of how the process will influence the operator and the team's narrative: what story will the operators and the team tell about the event and themselves on Monday? [82]** By taking the time to make meaning of the immersion event collectively, 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 [83].

Reflection Diagnostic

Operator

- Is the operator adapting their behavior in response to lessons learned?
- Are the operator adaptations generative (positive growth) or maladaptive (negative growth)?
- Is the operator able to talk about what they adapt about themselves?

Team

- Is the team able to talk about their strengths and weaknesses?
- Is the team adapting their behavior in response to lessons learned?
- Are the team adaptations generative (positive growth) or maladaptive (negative growth)?

Learning Interventions

For the DR5 diagnostic to be successful, the instructor cadre needs to be intentional about how they engage with the learner(s) to improve performance after a training evolution. Different learning profiles will require different types of interventions using different principles. Table 2 shows one example of how different interventions might occur based on the precisely observed deficit, and the section below describes potential learning interventions in more detail.

Table 2: Learning Intervention Roles

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 Operator Potential	How the student can fully optimize their personal performance with the tool	Operator Inquiry
Counseling	Counselor	Optimize Protective Factors	Developing the student’s protective factors in the face of emotional stressors	Dialogue & Teaching
Guiding	Guide	Guide Students though transitions of Identity	Guide the students through transitions of identity throughout their career.	Inquiry, Dialogue and Teaching
Facilitation	Facilitator	Increase Collaboration	Optimize entire teams’ performance with the tool	Reflective Dialogue

Appropriate use of Cadre Roles in Learning Interventions

- **Fixed Behaviors:** If a learner is struggling with a behavior or principle which is fixed in time and space (e.g. “This is how you approach an airway with a hyper-angulated vs a Mac-3 blade”) than they need an *instructor* who can focus on correct and iterative practice to develop the students optimal muscle memory and heuristics. To be successful, the learner needs to know *why* the behavior is fixed and needs to understand what right looks and feels like.
- **Adaptive Behavior:** If the learner is struggling with how to navigate problems where the answer depends on context (e.g. “Depending on the type of trauma, you may need to start with the pericardial view instead of the RUQ view during your e-FAST exam.”), then they need an *educator* who can ask the

right questions to shape the students working principles and mental models. This needs to be done Socratically, using inquiry and dialogue.

- **Cultural Behaviors:** If the student is struggling to adapt to the team and fit in, (e.g. "When the senior triage nurse tells you to come see a patient, you go immediately," or, "Here's why we don't run in the ER."), then they need a *mentor* who can help explain the historical reasons and provide the stories, to explain the team's norms and taboos.
- **Deficit of Protective Factors:** If the student is struggling to manage emotional regulation or coping skills, (e.g. they are crushed by the death of a patient and are failing to regenerate their ability to perform), then they need a *counselor* who can help them build up the relevant protective factors.
- **Challenges with Transitions and Identity:** If an individual is challenged by important transitions such as moving from student to operator, operator to leader, or leader to instructor (e.g. their leadership in the trauma bay is compromised by feelings of inadequacy or imposter syndrome), then they need a *guide*. All transitions come with questions about identity and belonging and this need should be expected as normal rather than viewed as pathological.
- **Team Behavior:** If an entire team or set of teams is struggling to operate successfully together (e.g. there are frequently conflicts between the ER and ICU teams over a particular set of issues), then the teams need a *facilitator*. This person (typically outside the team but versed in the team's reality) can lead reflective conversations and guide collaborative inquiry that can help teams identify solutions to these types of consistent problems.

Next Steps

There are multiple ways for MCTs to start applying the DR5 to their training, all of which are designed to address the core issue of exploring and teaching what "right" looks like in mission critical environments. MCTs may choose to adopt any or all of these measures and may find that where and how they apply the DR5 changes over time. MCTI stands ready to support MCTs in working with the DR5 as it applies to their unique situation.

- **Exploring Optimal:** The DR5 can be the source of exploration and discovery by communitas / instructor cadre members around what "right" actually is for a given situation. Frequently, there is no objective gold standard for how to operate in a particular environment or work a particular problem set—when faced with a difficult airway in a decompensating patient, elite-level experts will frequently disagree about the best way to run the case. In these situations, the DR5 can help experts identify where they agree (this frequently becomes training), and where they differ (this frequently becomes education). For example, a group of skilled doctors debating a case can walk through the processes in the DR5 in front of more junior learners to showcase the skills and mental models they would use and focus their discussion where it is most useful.

- **Guided Self Reflection:** After a complex case, particularly one with a suboptimal outcome, medical operators frequently do a 1:1 debrief with a senior instructor (or a peer operator if no seniors are available). This tends to occur in addition to a more formal group AAR, and frequently is more of a conversation than an official debrief. Applying the DR5 to this 1:1 discussion can provide a much-needed structure to these conversations, drastically improving their yield. The scoring / scoping questions provided with each process can be particularly useful for this. For example, when reviewing performance after a trauma resuscitation, the senior instructor could start by asking the junior operator, “tell me about when you identified this was a critical event,” then walk with the junior through the other processes in the DR5 framework.
- **Formal Evaluation:** The DR5 framework can be adopted as a formal scoring mechanism to provide structure for difficult to assess events like objective structured clinical examinations (OSCEs), boards-style oral review cases, simulated exercises, or think-out-loud exercises. Discussing the scoring framework before the event, then again when reviewing the score can provide needed repetition to drive learning and focus future educational resources. For example, many resident physicians need to pass simulated clinical exams before being authorized to perform certain procedures or lead certain teams on their own—using the scoring / scoping questions provided with each process, the instructor cadre can explain to junioroperators more specifically what went well and what needs to change.

References:

1. Cline, P., *Mission Critical Teams: Towards a University Assisted, Mission Critical Team Instructor Cadre Development Program*, in *Dissertation for Doctorate in Education*. 2017, University of Pennsylvania Graduate School of Education.
2. Gold, J., *Personal Communication Review of Learning Framework*, in *Professor, Department of Neuroscience University of Pennsylvania*, P. B.Cline, Editor. 2018.
3. Ruiz, c., *Mechanism for Specificity*, P.B. Cline, Editor. 2018.
4. Bishop, R., *Collaborative research stories: Whakawhanaungatanga.* Unpublished PhD thesis, University of Otago, Dunedin, 1995.
5. Wenger, E., *Communities of practice and social learning systems.* Organization, 2000. **7**(2): p. 225-246.
6. Wenger, E., R.A. McDermott, and W. Snyder, *Cultivating communities of practice: A guide to managing knowledge*. 2002: Harvard Business Press.
7. Butler, D.L., L. Schnellert, and K. MacNeil, *Collaborative inquiry and distributed agency in educational change: A case study of a multi-level community of inquiry.* Journal of educational change, 2015. **16**(1): p. 1-26.
8. Turner, V., *The ritual process: Structure and anti-structure*. 1995: Transaction Publishers.
9. Van Gennep, A., *The rites of passage*. 2011: University of Chicago Press.
10. Levin, S.A., *Ecosystems and the biosphere as complex adaptive systems.* Ecosystems, 1998. **1**(5): p. 431-436.
11. Svyantek, D.J. and L.L. Brown, *A Complex-Systems Approach to Organizations.* Current Directions in Psychological Science, 2000. **9**(2): p. 69-74.
12. Taylor, H.A., T.T. Brunyé, and S.T. Taylor, *Spatial mental representation: implications for navigation system design.* Reviews of human factors and ergonomics, 2008. **4**(1): p. 1-40.
13. Rasmussen, J., *Information Processing and Human-Machine Interaction. An Approach to Cognitive Engineering.* 1986.
14. Klingberg, T., *The overflowing brain: Information overload and the limits of working memory*. 2009: Oxford University Press.
15. Ancona, D., H. Bresman, and K. Kaeufer, *The comparative advantage of X-teams.* MIT Sloan Management Review, 2002. **43**(3): p. 33.
16. McChrystal, G.S., *Team of Teams: New Rules of Engagement for a Complex World*. 2015, New York, NY: Penguin Publishing Group.
17. Mattson, D.P.J., *Interview with FBI Agent*, in *Federal Bureau of Investigation Special Operations Unit*, P.B. Cline, Editor. 2016.
18. Yun, S., S. Faraj, and H.P. Sims, Jr., *Contingent leadership and effectiveness of trauma resuscitation teams.* J Appl Psychol, 2005. **90**(6): p. 1288-96.
19. Chiva, R., A. Grandío, and J. Alegre, *Adaptive and generative learning: Implications from complexity theories.* International Journal of Management Reviews, 2010. **12**(2): p. 114-129.
20. Klein, G.A., *Streetlights and shadows: Searching for the keys to adaptive decision making*. 2011: MIT Press.
21. Kozlowski, S.W., *Training and developing adaptive teams: Theory, principles, and research.* 1998.
22. Bezzola, L., S. Mérillat, and L. Jäncke, *Motor training-induced neuroplasticity.* GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry, 2012. **25**(4): p. 189.
23. Snowden, D.J., *Multi-ontology sense making: a new simplicity in decision making.* Inform Prim Care, 2005. **13**(1): p. 45-54.

24. Army, U.S. *Principles of Command and General Staff College*. 2012 January 4, 2012; Available from: http://usacac.army.mil/cac2/cgsc/principles.asp.
25. Draude, T.V., *Brigadier General U.S. Marine Corps (Ret), President and Chief Executive Officer U.S. Marine Corps University Foundation.* 2011.
26. March, J.G., *Exploration and exploitation in organizational learning.* Organization science, 1991. **2**(1): p. 71-87.
27. Gifford-Smith, M.E. and C.A. Brownell, *Childhood peer relationships: Social acceptance, friendships, and peer networks.* Journal of School Psychology, 2003. **41**(4): p. 235-284.
28. Salas, E., D.E. Sims, and C.S. Burke, *Is there a "Big Five" in teamwork?* Small group research, 2005. **36**(5): p. 555-599.
29. Hillen, M.A., et al., *Tolerance of uncertainty: conceptual analysis, integrative model, and implications for healthcare.* Social Science & Medicine, 2017. **180**: p. 62-75.
30. Grutters, J.P., et al., *Healthy decisions: towards uncertainty tolerance in healthcare policy.* Pharmacoeconomics, 2015. **33**(1): p. 1-4.
31. Piaget, J., *Problems of equilibration*, in *Topics in cognitive development*. 1977, Springer. p. 3-13.
32. Wald, H. and K.G. Shojania, *Root cause analysis.* Making health care safer: a critical analysis of patient safety practices, 2001. **51**.
33. Porges, S.W., *The polyvagal theory: phylogenetic substrates of a social nervous system.* International Journal of Psychophysiology, 2001. **42**(2): p. 123-146.
34. Ward, J., *The student's guide to cognitive neuroscience*. 2015: Psychology Press.
35. Koch, M., *The neurobiology of startle.* Progress in neurobiology, 1999. **59**(2): p. 107-128.
36. Bracha, H.S., *Freeze, flight, fight, fright, faint: Adaptationist perspectives on the acute stress response spectrum.* CNS spectrums, 2004. **9**(9): p. 679-685.
37. Endsley. *Design and evaluation for situation awareness enhancement*. in *Human Factors Society, Annual Meeting, 32nd, Anaheim, CA*. 1988.
38. Endsley, M.R. and D.J. Garland, *Situation awareness: analysis and measurement*. 2000, Mahwah, NJ: Lawrence Erlbaum Associates. xxiii, 383 p.
39. Nofi, A.A., *Defining and Measuring Shared Situational Awareness*, C.f.N. Analyses, Editor. 2000: 4825 mark Center Drive, Alexandria, Virginia 22311-1850.
40. Salas, E., R. Stout, and J. Cannon-Bowers, *The role of shared mental models in developing shared situational awareness.* Situational awareness in complex systems, 1994: p. 297-304.
41. Woods, D.D., *Cognitive technologies: The design of joint human-machine cognitive systems.* AI magazine, 1985. **6**(4): p. 86.
42. Woods, D.D. and E. Hollnagel, *Joint cognitive systems: patterns in cognitive systems engineering*. 2006, Boca Raton: CRC/Taylor & Francis. ix, 219 p.
43. Arrow, H., et al., *Time, Change, and Development: The Temporal Perspective on Groups.* Small Group Research, 2004. **35**(1): p. 73-105.
44. Suominen, P., et al., *Impact of age, submersion time and water temperature on outcome in near-drowning.* Resuscitation, 2002. **52**(3): p. 247-254.
45. Baracchi, C., *The Bloomsbury Companion to Aristotle*. 2014: BLOOMSBURY PUBLISHING.
46. Monat, A. and R.S. Lazarus, *Stress and coping: An anthology*. 1991: Columbia University Press.

47. Klein, G., *A recognition-primed decision (RPD) model of rapid decision making.* Decision making in action: Models and methods, 1993. **5**(4): p. 138-147.
48. Taleb, N., *The black swan: the impact of the highly improbable*. 1st ed. 2007, New York: Random House. xxviii, 366 p.
49. Kahneman, D., *Thinking, fast and slow*. 1st ed. 2011, New York: Farrar, Straus and Giroux. 499 p.
50. Gonzalez, C., ed. *Decision-Making: A Cognitive Science Perspective*. The Oxford handbook of cognitive science, ed. S.E. Chipman. 2016, Oxford University Press. 249.
51. Tversky, A. and D. Kahneman, *Judgment under Uncertainty: Heuristics and Biases.* Science, 1974. **185**(4157): p. 1124-31.
52. Gigerenzer, G. and P.M. Todd, *Fast and frugal heuristics: The adaptive toolbox*, in *Simple heuristics that make us smart*. 1999, Oxford University Press. p. 3-34.
53. De Neys, W. and V. Goel, *Heuristics and biases in the brain: Dual neural pathways for decision making.* Neuroscience of Decision Making, 2011.
54. Kalyuga, S., R. Rikers, and F. Paas, *Educational implications of expertise reversal effects in learning and performance of complex cognitive and sensorimotor skills.* Educational Psychology Review, 2012. **24**(2): p. 313-337.
55. Knowles, M., *The adult learner: A neglected species*. 1978: Gulf Publishing.
56. Heifetz, R.A. and M. Linsky, *Leadership on the line: Staying alive through the dangers of leading*. Vol. 465. 2002: Harvard Business Press.
57. Draganski, B., et al., *Neuroplasticity: changes in grey matter induced by training.* Nature, 2004. **427**(6972): p. 311-312.
58. Grossman, D. and L.W. Christensen, *On combat: the psychology and physiology of deadly conflict in war and in peace*. 1st ed. 2004, Illinois: PPCT Research Publications. xxiv, 395 p.
59. Skinner, B.F., *Two types of conditioned reflex: A reply to Konorski and Miller.* The Journal of General Psychology, 1937. **16**(1): p. 272-279.
60. Woodman, R.W., J.E. Sawyer, and R.W. Griffin, *Toward a Theory of Organizational Creativity.* The Academy of Management Review, 1993. **18**(2): p. 293-321.
61. Csikszentmihalyi, M., *A systems perspective on creativity.* Creative Management, 2001: p. 11-26.
62. Cropley, A., *In praise of convergent thinking.* Creativity Research Journal, 2006. **18**(3): p. 391-404.
63. Klein, G., *Sources of power: how people make decisions*. 1998, Cambridge, Mass.: MIT Press. xviii, 330 p.
64. Drakos, N., *Personal Communication Review of Learning Model*, in *U.S. Army Emergency Physician*, P.B. Cline, Editor. 2018.
65. Roberts, R.D., H.C. Beh, and L. Stankov, *Hick's law, competing-task performance, and intelligence.* Intelligence, 1988. **12**(2): p. 111-130.
66. Folke, C., et al., *Resilience and sustainable development: building adaptive capacity in a world of transformations.* Ambio, 2002. **31**(5): p. 437-40.
67. Edmondson, A.C. and J.-F. Harvey, *Cross-boundary teaming for innovation: Integrating research on teams and knowledge in organizations.* Human Resource Management Review, 2018. **28**(4): p. 347-360.
68. Falk, D., et al., *A Novel Framework for Routine Versus Critical Communication in Surgical Education—Don't Take It Personally.* JAAOS-Journal of the American Academy of Orthopaedic Surgeons, 2023. **31**(3): p. 115-121.
69. Meleis, A.I. and P.A. Trangenstein, *Facilitating transitions: redefinition of the nursing mission.* Nurs Outlook, 1994. **42**(6): p. 255-9.

70. Dhingra, K.R., A. Elms, and C. Hobgood, *Reducing error in the emergency department: a call for standardization of the sign-out process.* Annals of emergency medicine, 2010. **56**(6): p. 637-642.

71. Samaie, G. and H.A. Farahani, *Self-compassion as a moderator of the relationship between rumination, self-reflection and stress.* Procedia - Social and Behavioral Sciences, 2011. **30**: p. 978-982.

72. Johnson, E.A. and K.A. O'Brien, *Self-compassion soothes the savage ego-threat system: Effects on negative affect, shame, rumination, and depressive symptoms.* Journal of Social and Clinical Psychology, 2013. **32**(9): p. 939-963.

73. Suzuki, S., *Zen mind, beginner's mind*. 2010: Shambhala Publications.

74. Kable, J., *Personal Communication Review of Learning*, in *Baird Term Associate Professor of Psychology at Univeristy of Pennsylvania*, P.B. Cline, Editor. 2018.

75. Schultz, W., P. Dayan, and P.R. Montague, *A neural substrate of prediction and reward.* Science, 1997. **275**(5306): p. 1593-9.

76. Chamorro-Premuzic, T., *Strengths-based coaching can actually weaken you.* Harvard Business Review, 2016.

77. Green, G.P. and A. Haines, *Asset Building & Community Development*. 2011: SAGE Publications.

78. Dworkis, D., *The Emergency Mind: Wiring Your Brain for Performance Under Pressure*. 2021: Sangfroid Press, Los Angeles, CA, USA.

79. Morrison, J.E. and L.L. Meliza, *Foundations of the after action review process*. 1999, DTIC Document.

80. Foucault, M., *The meaning and evolution of the word parrhesia.* Discourse and truth: The problematization of parrhesia, 1999. **28**: p. 2014.

81. Luft, J. and H. Ingham, *The johari window.* Human Relations Training News, 1961. **5**(1): p. 6-7.

82. Fletcher, A., P. Cline, and M. Hoffman *A Better Approach to After-Action Reviews*. Harvard Business Review, 2023.

83. Cline, P., *Residue*. 2020, Mission Critical Team Institute: Philadelphia.

84. Gawande, A., *The checklist manifesto: how to get things right*. 1st ed. 2010, New York, N.Y.: Metropolitan Books. x, 209 p.

85. Leach, L.S., R.C. Myrtle, and F.A. Weaver, *Surgical teams: role perspectives and role dynamics in the operating room.* Health Services Management Research, 2011. **24**(2): p. 81-90.

86. Boyer, P., B.J.N. Bergstrom, and B. Reviews, *Threat-detection in child development: An evolutionary perspective.* 2011. **35**(4): p. 1034-1041.

87. Paulus, M.P., et al., *Differential brain activation to angry faces by elite warfighters: neural processing evidence for enhanced threat detection.* PLoS One, 2010. **5**(4): p. e10096.

88. Öhman, A., *The role of the amygdala in human fear: Automatic detection of threat.* Psychoneuroendocrinology, 2005. **30**(10): p. 953-958.

89. Neuberg, S.L., et al., *Human threat management systems: Self-protection and disease avoidance.* 2011. **35**(4): p. 1042-1051.

90. Ploran, E.J., et al., *Evidence accumulation and the moment of recognition: dissociating perceptual recognition processes using fMRI.* The Journal of Neuroscience, 2007. **27**(44): p. 11912-11924.

91. Saunders, T., et al., *The effect of stress inoculation training on anxiety and performance.* J Occup Health Psychol, 1996. **1**(2): p. 170-86.

92. Lang, P.J. and M.M. Bradley, *Emotion and the motivational brain.* Biological psychology, 2010. **84**(3): p. 437-450.

93. Kee, Y.H. and C.J. Wang, *Relationships between mindfulness, flow dispositions and mental skills adoption: A cluster analytic approach.* Psychology of Sport and Exercise, 2008. **9**(4): p. 393-411.

94. Barwood, M.J., *Breath-Hold Performance During Cold Water Immersion: Effects fo Psychological Skills Training.* Aviation, Space, and Environmental Medicine, 2006. **77**(11).

95. Rogers, Y. and J. Ellis, *Distributed cognition: an alternative framework for analysing and explaining collaborative working.* Journal of information technology, 1994. **9**(2): p. 119-128.

96. Woolley, A.W., et al., *Evidence for a collective intelligence factor in the performance of human groups.* Science, 2010. **330**(6004): p. 686-8.

97. Heifetz, R.A. and D.L. Laurie, *The work of leadership.* Harvard business review, 1997. **75**: p. 124-134.

98. Edmondson, A.C., *Managing the risk of learning: Psychological safety in work teams*. 2002: Citeseer.

99. Edmondson, A., *Psychological Safety and Learning Behavior in Work Teams.* Administrative Science Quarterly, 1999. **44**(2): p. 350-383.

100. Taormina, R.J. and R. Sun, *Antecedents and outcomes of psychological insecurity and interpersonal trust among Chinese people.* 2015.

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 FVEY's), 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.

Contributors to this Paper

First developed in 2016, in partnership with Instructor Cadre of Naval Special Warfare in Community and key academic partners, the DR5 model remains a living evolving document. Teams and Operators within the International Mission Critical Team Collaborative Inquiry continue to provide feedback and suggestions as they use the model to better support their instructor cadre. Key partners in the model's development have been:

The Team at the Wharton Neuroscience Initiative at the University of Pennsylvania, and specifically, Dr. Elizabeth "Zab" Johnson, who introduced me to the research on detection (where the D came from) and Dr. Josh Gold, whose feedback critical to key sections of the model.

Dr. Dan Dworkis, the MCTI Chief Medical Officer, led the effort to adapt the model for those medical teams engaged in Trauma Resuscitation. Dr. Al'ai Alvarez at the Stanford University School of Medicine, Department of Emergency Medicine was instrumental in providing feedback.

Shaun Huls, a noted professional in human performance, is currently with the Cleveland Browns.

MCTI core staff, including Dr. Art Finch, Harry Moffit, Clare Murphy, and Janese Jackson.

Eric Karp: NSW retired, currently with Axiom Space

In addition, I want to thank the support from Operators (many who prefer not to be named) within, Naval Special Warfare Training Command, U.S. Army Special Operations Command, FBI Critical Incident Response Group, the Australian Special Operations Command, New Zealand Special Operations Command, Canadian Special Operations Forces, United Kingdom Special Forces, and NASA Flight Operations. Each iteration will be further informed and modified in response to feedback from the MCTI Collaborative Inquiry Community.

Comments for Version 6 can be sent to Preston@missioncti.com.