Impaired Engagement in High-Reliability Organizing (HRO): 3. Reasoning Impairs Engagement

Daved van Stralen, MD, FAAP, Sean D. McKay, Errol van Stralen, Thomas A. Mercer, RAdm, USN (Retired)

Abstract

We engage contingencies to make them more orderly. Removing context supports objective approaches that are also more orderly. 'Subjective' becomes a derisive term. Preparation for abrupt change includes well-developed plans and people who follow those plans. The event itself is not a part of the planning. This resulting normative stance is transportable and favored by leaders and scholars. An organization or industry institutionalizes competency because generalizable principles can be taught to a high-turnover, novice workforce. Abrupt change makes visible the fundamental gap between reason and action. Cause-and-effect relationships are less visible because nonlinearity allows multiple causes to generate multiple effects. The color of environmental noise, the flow of events, and one's position inside or outside the event benefit from different levels of analysis. Arguing across these different levels creates false debate. The dominant account, relying on classical logic and deductive reasoning, becomes a mistranslation of the environment. Modal logics support inference in situations of incomplete information and can drive action. Paraconsistent logics support contradictions and treat inconsistencies as informative. Paracomplete logics allow continuous change; there is no need to assume "A" or "not-A." The ability to work under uncertainty must not be sacrificed for the tractability of objectivity.

"An organization or industry institutionalizes competency because generalizable principles can be taught to a high-turnover, novice workforce. Abrupt change makes visible the fundamental gap between reason and action."

Introduction

The actual world is messy. From far away, the mess seems in need of organizing. We engage a flux of contingencies to make them more orderly. Coincidentally, distance makes that organizing appear tractable. Engineering models, classical logic, and deductive reasoning support the belief that we can manage a crisis as a technological system from a distance.

Removing context and using objective approaches, independent of context, operates from the image of scientific principles such as thermodynamics and gravity. Principles are true and applicable regardless of the person or situation. The same occurs with the value we place on information or objects; we consider the value we place as objective. (In practice, we also consider the value others place on the information or object as subjective.) Part of the acculturation process into a domain and organization is learning what value to place on information and objects. The acculturation process gives legitimacy to value placement; hence the sense of objectivity and 'objective' becomes a privileged frame.

'Subjective,' then, too quickly becomes a derisive term for what value an individual places on an object or judgment – the value we place is prudent or comes from good judgment, the value they place is 'subjective.' We disregard the immediate environment, natural nonlinear interactions, human perception, and necessary affective judgment. Nevertheless, the adaptive, subjective judgment of many individuals working in concert controls a disruption.

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The authors routinely compare disciplines, domains, and organizations to identify objective approaches that are more likely subjective. Congruity implies an objective basis, while discrepant approaches support subjectivity.

Preparation for an abrupt change includes identifying plausible events, plans created for such events, and how people respond. Though some administrators prefer well-developed plans and people who follow them, the event is not a part of the planning or human response. We cannot know how a person will perceive the event as it emerges, nor what value they will place on that information.

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The human mind developed to think effectively and naturally under stress and fear. However, sometimes even prepared individuals falter at the moment while unprepared individuals rise to the occasion. The authors state this as a shared observation over thousands of incidents, not because the authors wish to undermine knowledge and planning. These are almost micro-local interactions visible only in the immediate vicinity.

Through study, reasoning, and design, we gain a sense of mastery over the causes of and responses to abrupt change. Neverthe-

less, we sacrifice trust and adaptability while creating gratuitous stress and the ecology of fear – "Did I do the right thing?" followed by "What is the right thing?" This program will focus on the situation: identification, specific response, and how did it happen? Unfortunately, "How did it happen?" is more likely to be asked early in the event.

The strength and finality of engineering principles, deductive reasoning, and classical logic give reassurance that success is achievable when we comply with the program and the plans developed from the program. Abrupt events force the formation of gaps between what was planned to work and what will work. Confounding preparation is the misinterpretation of stability and misrepresentations of how HRO can help. It is the individual who engages in these challenges. HRO describes the coherence of individuals engaging across multiple levels of analysis that more effectively brings resolution.

When observing a wide view of the field, we can fit engineering principles, deductive reasoning, and classical logic into our understanding of the situation. Nevertheless, it is in the intimacy of the situation that we experience movement and pressure. What worked before no longer does. What failed before will now ensure success. We cannot change a hypothesis once proven by the rules of logic. The value and meaning of acts change during the flux of events; we can no longer guarantee a hypothesis. In the to-and-fro of action, subjective judgment and the ability to change course ensure effective engagement rapidly.

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Creation of a PICU:

Creating a new PICU in 1989, staff RNs and Respiratory Care Practitioners (RCPs) came from the children's hospital wards, though a few had experience in NICUs or adult ICUs. Responding to a sudden deterioration, one of the authors (DvS) entered the room where a staff member immediately confessed, "I did it!" and quickly recounted their actions leading to the emergency. The author responded, "Great! Now, I know who did it. I know what they did. But I don't know what happened." New PICU staff had brought with them a cultural legacy of blame that developed from the pattern of knowing the situation, doing the right response, and knowing there was a singular cause that could have prevented the event (commonly, this "cause" would be blamed on a human error made by the lowest ranking member in the hierarchy).

The senior intensivist (Ronald M. Perkin) gave these two guiding principles: support the bedside caregiver and do not criticize—these two principles derived from his experience as a US Naval Aviator during the Vietnam War. One of the authors (DvS) brought two action-oriented principles from his experience as a fire rescue ambulance medic: increase the capabilities of staff and the early engagement of any discrepancy or disruption.

The new PICU and its pediatric critical care transport service grew over three years to become the second largest in California while sustaining low rates of mortality and complications. The Institute of Medicine (IOM), conducting a study of patient safety in the nursing environment, invited one of the authors (DvS) for a presentation. They were specifically interested in his experience bringing HRO to the PICU and the similar results in a nearby pediatric subacute care facility.

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Karlene Roberts, one of the founders of the field of HRO, had heard how one of the authors (DvS) taught emergency medical decision-making. She used the OODA Loop, developed for aerial combat decision-making and described elsewhere (1, 2), to outmaneuver rapidly changing physiology during resuscitation. She described the integration of decision-making into a program that increases the capabilities of the individual and team as High-Reliability Organizing, or "HRO" (3).

The greatest difficulty in achieving these accomplishments came from the decontextualization of the consequential incident:

- Situations and problems are like puzzles (Search for the pieces, and you find the answer) (4).
- Criticism and complaints by decontextualizing decisions and actions of PICU staff and residents
- Reliance on engineering models that create and follow plans while conforming to a rigid hierarchy
- The use of classical, linear logic to diagnose and prescribe treatment specific to that diagnosis
- Deductive reasoning is that by gathering facts, we will guarantee our hypothesis.

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This illustrates the fundamental gap created by the abrupt change described above. Administrators, legal counsel, and spectators brought to the PICU and emergency management their mastery of technological systems, 'scientific logic,' and deductive reasoning. The two intensivists contributed their expertise in supporting people who engage in abrupt change; logics we can now identify as modal, paraconsistent, and paracomplete; inductive reasoning; and decision-making with incomplete information during flux.

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Focusing on stress-impaired cognition and fear-circuit behaviors was critical to success. Not only for the care of a child and family but stress and fear originating from colleagues, legal counsel, and administrators – the ecology of fear where a threat causes more harm by its absence than its presence (5).

Vital to the whole enterprise were the efforts of John Mace, chairman of the Department of Pediatrics, and himself, a US Navy Medical Corps veteran. Though a pediatric endocrinologist and well ensconced in clinical practice and administration, Dr. Mace provided much necessary indirect support, deflected opponents, and addressed the friction natural to any novel, rapidly growing program. His interventions continued long after his retirement as department chair and are worthy of a separate review. Except that, because of his diplomatic skills, those in opposition were rarely aware of his support. Diplomacy started early with Dr. Mace. Pursuing a program might terminate as he learns about strategic plans, someone's firmly held beliefs, or another program's overriding interest.

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This is not a trite digression. One of the authors (DvS) identified a similar problem introducing HRO into two pediatric subacute care facilities. Bedside staff resisted in one facility, and hospital administration resisted in another. Similar to the efforts of Dr. Mace, a respiratory care supervisor mediated efforts with bedside caregivers (6), and a nursing supervisor did the same for administrators. These are three examples of the necessity for an outside leader to assist in bridging the theory and practice gap.

The Color of the Environment:

The messiness an outsider observes is deceiving. Noise is an intrinsic property of an open system. This is compatible with the concept that noise is a signal that carries no information that has meaning to the receiver. The flow of energy (dissipation) is the thermodynamic principle of entropy. Noise energy entering a system generates nonlinear feedback. The response within the system is autocorrelation – past events impact current events to produce long-period frequencies ("red" after the longer wavelengths of red light). Longer frequencies carry more energy, the power of red noise as a forcing function on the environment, "forcing" a response (7).

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Energy, having frequencies, flows into and out of an open system. When all the frequencies are equally represented, we are in a white noise environment (similar to sound canceling "white noise"). In the actual world, not all frequencies are equally represented due to entropy. Longer wavelengths, or frequencies in the red spectrum, have more power. Note that shorter wavelengths from the blue spectrum carry higher energy. Infrequent events carry more power and can force people and the environment to respond – the forcing function of red noise.

- White noise is the "noise" of everyday activity.
- Red noise is the noise of sudden unanticipated events.

When energy enters the system, white noise can cancel the intruding energies like noise-canceling earphones, giving stability. These environments are sufficiently stable that data distribution forms a Gaussian distribution. We can make statistical calculations and probability predictions.

In white noise, a convergent, deductive, analytic approach makes sense. We search for facts and information because that guarantees our hypothesis—the structures we create and our actions reinforce the normative frame and the security they offer. The linearity and stability, however, impede generating stochastic resonance for stability (8). Rigid structure and linearity narrow and increasingly confine our responses.

Abrupt change creates a gap between the event and how people respond. People imagine and plan for a serious event. Engineering design and materials science is embedded for structural stability. We have sacrificed adaptability from subjective judgment for the security of objective structures.

Nuclear power plants on the northeast coast of Japan have seawalls constructed for protection from post-earthquake tsunamis. Engineers determine the seawall's height from the tsunami's predicted height. Yanosuke Hirai, an engineer for one of the nuclear

power plants, used his subjective interpretation of the data to insist on a higher seawall than predicted and the use of specific cooling pumps should a tsunami reach the power plant (9).

On March 11, 2011, tsunamis from Great East Japan (Tōhoku) Earthquake reached the Fukushima Daiichi and Onagawa nuclear power plants. The failure of the Daiichi power plant, 150 km from the epicenter, was the world's third most severe nuclear power plant failure. With relatively little damage, the two fully operating reactors at the Onagawa plant reached a cold shutdown the next morning (10). The Onagawa plant was 80 km from the epicenter of the earthquake. The Onagawa plant had a higher seawall due to Yanosuke Hirai's insistence (personal communication, Najmedin Meshkati, Professor of Civil Engineering, University of Southern California).

How people respond is on both sides of the gap and can be the same – which is adaptive or maladaptive depending on the source of the behavior. Modeling behaviors from the white noise environment prepares the organization for unrecognized, confusing failure from disruptions of any magnitude. Modeling behaviors from red noise or pink noise environments embeds the capabilities for adaptive change into the organization. HRO supports the sensitive detection of discrepancies and disruptions for early intervention.

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Gaps from Structure and Behavior:

Abrupt change makes the gap between reason and action visible, but circumstances supported reasoning as the preferred approach long before the abrupt event. Long periods give the impression of stability and linearity. As discussed above, long-period red noise has the behavior of white noise, producing the belief that the organization is fully prepared for abrupt change – plans are in place.

At the level of individual experience, we may identify short-time segments that appear linear because of minimal change. We "linearize the curve," consciously or unconsciously converting red noise to white noise to gain tractability. For example, residents in the PICU report urine output for a time segment of 24 hours. Changing to an eight-hour time segment revealed new meaning for a report of 1 mL/hour for 24 hours: 0.5 mL/hour, 1 mL/hour, 1.5 mL/hour or 1.5 mL/hour, 1 mL/hour, 0.5 mL/hour. The former could represent increasing blood volume and the latter decreasing blood volume. Each set has 1 mL/hour for a 24-hour time segment. Changing time segments identified an otherwise occult information gap for blood volume or kidney function.

Linearization of the curve can support the belief that the actual world is stable or that the planners' program has maintained stability. We lose the sense of anticipation, a necessary attribute while working in dangerous contexts. Unconscious conversion from red to white noise risks the loss of subtle or nuanced signals. Similarly, we forgo tractability when we mislabel the meaning of changes, overemphasizing their significance. Conscious linearization of the curve reduces gaps, facilitates the use of classical logic, and enables deductive reasoning. In high-risk circumstances, linearization can be deadly.

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This produces what we describe as *the normative stance* that an 'outside' leader has a complete view of the actual world. Objective and decontextualized, the normative stance aligns with theory and *scientific rationality* (11, 12). The normative frame is orderly, measurable, amenable to experimental study, and can be mastered. Abrupt events allow rapid application of response processes while leaders demonstrate mastery of command and problem-solving skills.

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The appearance of mastery in leadership and problem-solving creates an identity for the individual. But it is an identity derived from scholastic achievement, years in the field, and/or the person's position in the hierarchy. Social order develops as the leader organizes responses with commands from *outside* the event. Subordinates *within* the event, carrying out these commands, gain a sense of security. The leader's sense of mastery increases as subordinates more closely follow commands. The subordinate's sense of security increases as they "do the right thing."

These leaders act with the certitude of Tetlock's hedgehog, moving employees to submit to the leader. A Confucian social order develops as the leader becomes the guarantor of employee welfare, sometimes misconstrued as the "servant leader." Employees carry out the leader's plan without disagreement or question. The leader becomes stronger. Information flow becomes impeded by suppression of disconfirming information and "shooting the messenger." These subtle changes create what Ron Westrum (13) describes as the "pathological organization."

Philip E. Tetlock (14) found the worst success rate for forecasters from those with the greatest certitude and higher rates from those who entertained the most doubt. He turned to Isaiah Berlin's essay *The Hedgehog and the Fox* for an explanation.

> *Hedgehogs* will extend their one theory to many domains with great confidence. When they are wrong, they focus on

justifying their decision.

Foxes, the 'superforecasters,' know many things but to a far lesser degree. They use a point-counterpoint thinking style to sustain doubt and understand how opposing and contradictory forces yield stability, a feature that confounds prediction. Superforecasters pursue and update information, revising conclusions as information becomes available.

Cause-and-effect relationships are less visible; their nonlinearity allows multiple causes to generate multiple possible effects. From the inside, reactions generate a meaningful trajectory described using qualitative continuous measures of position and pressure. Individuals moving within the trajectory can influence the system's movement without knowing causation. Oscillations from nonlinear feedback generate stochastic resonance. Weak or relatively small noise can create and sustain significant oscillations (15).

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As the situation becomes contextualized, subjective interpretations and affective judgment increase error. In practice, decisions exist as processes of incremental self-correcting interactions giving the appearance of instability to those outside the event. This is the *practical rationality* of the *pragmatic stance*, the stance of HRO (11, 16).

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The normative stance is transportable, making it favored by leaders and scholars who will more likely move to areas with different circumstances and different people. From the normative stance, we identify the situation or diagnosis which allows a specific response or treatment, respectively. "First, do no harm," the treatment will have greater effectiveness with minimal complications.

The pragmatic stance is local, vigilant for consequences, and ready for early intervention. The pragmatic stance effectively prevents failure by not allowing a disruption to cascade toward irreversible failure. This stance, however, creates the circumstances for its failure – the dramatic drop in consequential failure leads people to question the reason for the intervention. It would seem obvious that people will remember the reasons for the program. The baseline for knowledge is the experience that is reset to the time the member joins the system (17). Knowledge and experience are lost.

Stability:

A pragmatic frame with stochastic resonance enhances our capability to solve problems emerging from deeper, unidentifiable structures (18). The stabilizing benefits of stochastic resonance come from greater degrees of freedom and complex interactions between nonlinearities. This stochastic randomness, rather than a particular frequency, ensures stability (19).

Besides stochastic resonance, we can organize and sustain stability by commands from the outside, a technological system we describe above. Or a system becomes structured from internal processes with order emerging from local nonlinear processes in a self-organizing system. As described in an earlier *Neonatology Today* article (11), when fire rescue ambulance medics went 'on scene,' they become part of the problem: they may need to rescue themselves; their presence alone changes the scene, and you can only solve these problems from within the problem. This is the gap between those who offer commands outside the system and those operating within the event.

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The use of a rigid, *linear response* to a *nonlinear forcing function* is driven by the certitude of deductive reasoning (the facts guarantee the hypothesis), the explanatory power of statistical analysis, the predictive power of probability calculations, the linearity of cause-and-effect, and the finality of a hypothesis derived using classical logic. We can then form a codifying framework of guiding principles. However, the emphasis gets misplaced when those principles are seen as the core to producing reliability (11).

The difficulty lies in translating the knowledge and experience gained in new or dangerous contexts to those routine operations with only the potential for serious harm. An engineering approach with the cognitive domain aligns well with classical logic and deductive reasoning. With a well-circumscribed body of knowledge, the individual has the proficiency to engage in commonly encountered situations. We can engineer solutions, but we cannot engineer judgment.

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An organization or industry may institutionalize competency rather than proficiency because generalizable principles can be taught to a high-turnover, novice workforce (20). Moving to proficiency requires using specifics, the particular, and case reports. It demands more time, training, shared insight, and modeling of senior, more

experienced people. Competency-based programs form the rule-based system of Jens Rasmussen's skills, rules, and knowledge (SRK) framework in his ecological interface design system (21). James Reason (22) adapted this framework for his model of error management now used in healthcare. This is almost institutionalization to impair institutional extension.

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Unrecognized in this training and education approach is the neglect of judgment as a means to gain stability. Patricia Benner (20) described the discontinuity between the competent level of performance obtained in preparatory education and the proficiency necessary for more independent professional functioning. The student moves from what can be taught by precept to what can only be learned through experience. In dangerous contexts, skill acquisition occurs as semi-autonomous engagement under the watchful supervision of veterans, all of whom share the duty to ensure that the novice learns appropriately (23).

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The demonstrated reciprocal feedback used to improvise solutions was vital to such engagement – a clear demonstration of HRO as natural human actions when freed from convention and central authority. Visible in the commentary of those who maintained engagement despite repeated failures was the development and reward of moral agency. Patricia Benner (20) described the moral agency as a result of the individual acting independently, then observing that the actions made someone's life better. Benner placed the development of moral agency at the crossing of the gap between simple competence and the richness of expertise. The *moral agency* gives meaning to one's actions, either internalized by the individual or interpreted for the individual by a leader. *Meaning giving* can reduce the effects of stress that may develop into post-traumatic stress (24).

The risk lies in mistranslation by those inexperienced in dangerous contexts or by those who lack a vocabulary that is familiar or readily accessible to spectators (11, 23). The salience and meaning spectators could use to expand their cognitive, affective, and behavioral repertoires are missing or not recognized (25). Knowledge and experience reduce the bravado that comes from the influence of movies and television (5), the substitution of the abstract for the contextual (26, 27), or understanding of what lies beyond the grasp of outsiders (11). The authors have organized a series of articles in *Neonatology Today* that combines the primary sciences, primary experience, and practical ways to overcome mistranslations while bridging this gap.

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Levels of Analysis:

There are differences in analysis for the color of the environment, the flow of events, and one's position inside or outside the event. Arguing across levels of analysis creates false debate. We do not argue against engineering models, deductive reasoning, or classical logic (28). We argue that people and organizations choose their approach because they *want* to, not because they *must*.

Constrained, decontextualized approaches generally come from an authority group and limit one's perspective. When they become the dominant approach, they limit meaning and interpretation. Once a dominant account develops, voices become hidden, and knowledge is lost. With the dominant account, we lose the effect of the liminal experience (29) and the liminal space (30). The dominant account reduces problems within the liminal space to science versus practice, which creates inaccurate models – models that can kill (31).

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Deduction and classical logic quickly become dominant when those in authority repeatedly discuss failures of individual judgment or threats such as liability. Described out of context and in the abstract, they become real and conform to behavior without the authority group. Individuals become hesitant, if not afraid, to decide and act.

In using classical logic and deductive reasoning, the dominant account becomes a mistranslation of the environment. Not recognizing the salience or meaning of signals, with the distance converting crisp details into ambiguous signals and the loss of contextualization, the disengaged observer readily simplifies the situation. Ambiguity is shed, evidence becomes fact, facts fit into the spectator's understanding, and knowledge becomes certitude. This emerging certitude, developed from mistranslated signals, supports the incorporation of mistranslations into the continuing use of classical logic and deductive reasoning. This creates demand for discrete data and the information necessary for the facts that will guarantee the hypothesis.

The clean separation of objects supports the laws of classical logic, a two-value logic: Truth and falsity are incompatible. Every proposition is true or false (*law of the excluded middle*); there is no gradation. The same proposition cannot be true and false simultaneously (*law of noncontradiction*). We can produce a truth table

with a two-value logic, but the proposition cannot have a value between truth and falsity, nor can it have both simultaneously. The patient *has* or *does* not have hypoxemia or fever, which will be determined by the number recorded from the measuring instrument. We have fallen into a cycle of forcing ambiguity into facts that will guarantee our hypotheses.

The mistranslation of the environment reduces complexity, which allows further use of classical logic and deductive reasoning. The drive for facts to support classical logic and deductive reasoning creates more mistranslations. This simplifying process supports the further use of classical logic and deductive reasoning. We have collected data, filed out forms, and classified the disease into the ICD-10 – we have reached our endpoint. The spectator can move on.

Framed from the fixed point of a non-engaged spectator, we can more easily explain our actions using nonoverlapping objects, classical logic, and deductive reasoning. We reduce and simplify our reasoning to fit the normative view of an unconnected spectator. However, context and meaning, critical for engagement, are lost. The dominant group sets the discourse, defines categories and classifications, limits what can be spoken about and what cannot, and who can speak with legitimacy. The dominant account is the privilege of being listened to (32). Lost are the hidden voices in the moving, turbulent, small-field view.

This is the context where reasoning impairs engagement.

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Engagement:

Engagement happens because an individual acts locally to reduce negative consequences (12). The organization and leaders can support the individual in public safety and military operations. In civilian organizations, for various reasons, such support is less reliable. Nevertheless, the individual will engage in a way that makes sense to that individual at that place at that time.

The individual can use the situation to extend understanding through engagement, like a Los Angeles Fire Department firefighter approaching an emergency told one of the authors (DvS), "I don't know what is happening, but I know what to do." Engagement bridges gaps between objective knowledge and subjective experience as the situation moves toward disorder. Engagement creates structure as it generates information. But this is information in flux, meaning that engagement constantly updates our information as we continually revise our understanding.

Operators in the field will develop their logic of practice built upon contextual relations entwined with people and work (16). The engagement of practice moves theory into the practical world, closing the gap between theory and practice and creating *the practical domain of engagement* (33).

Or the individual can fit the situation into their understanding – through deductive reasoning and classical logic. Though neither *create* information nor knowledge, they can be used to *apply* information and knowledge. However, a situation of changing information and emerging properties cannot fit into the certitude of deductive reasoning and classical logic. Reliability is more assured when practical engagement dominates, allowing the practice to adjust to the flux of circumstances.

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Functional Descriptions

An event has flux within the environment. How the observer or participant experiences that flux influences information and communication. A functional description of a forcing function focuses on the disruption produced rather than *how* the event was caused. An event flows through time as energy dissipates and transforms into other types of energy.

The Eulerian specification is decontextualized, using a fixed point of reference *outside* the flow of events (34). The Eulerian specification describes the organization's motion without reference to the forces which cause the motion. This 'top-down' perspective lies at a fixed point outside the flux of events. The benefit is qualitative and more precise information to generate state variables and demands independent of causation. Leaders and authorities use this external reference frame to create models for the reddened environment. However, the reddening of the environment increases variance, dissolving Gaussian distributions used for these models (35).

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The Lagrangian flow specification describes the velocity and gradients of events *within* the flow of events. This produces descriptions of demands on individual elements at specific points.

Within the flux of events, a 'bottom-up' perspective with the Lagrangian view, the operator is personally at risk, and changing contexts necessitates updating less reliable information. Rather than algorithms that fit a specific situation, accuracy becomes the platform for decision-making.

We sacrifice accuracy for conceptual tractability when we separate the organization from the environment.

The Local Field View – Experiencing Movement

The Lagrangian flow specification generates qualitative measures from the view *within* the flow of events. This is not only contextual at the moment but also measures the changing context in

real-time, more closely revealing the operator's experience. It is a continuous measure of the changing position and the pressure experienced by the individual, small groupings, or teams.

The Whole Field View – Observing the Action

The Eulerian flow specification provides quantitative measures from a fixed point of reference *outside* the flow of events. The decontextualized focus is on a specific location, though multiple, fixed positions can provide these measurements. The benefit is producing an objective measure of the rate of change in the system. Because of the de-contextual characteristic of the whole field view, the most productive use is when the observation points are operationally relevant. Staffing these points with observers having intimate knowledge, that is, knowledge by acquaintance, of the particular operations, is vital for the meaning and interpretation of information.

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The *engaged* observer in the whole field view is indispensable during the engagement. The whole field view reveals distant or approaching threats, identifies useful resources, and contributes thought processes uncontaminated by stress or fear. The engaged whole field observer seeks out hidden voices for the local specific information they can access. The experienced engaged observer can calibrate information for accuracy and support the free flow of information in a generative organization (13, 36). Mistranslation remains possible, but connected involvement can calibrate information in real time.

The farther from the situation the observer is, whether by experience, physical distance, or distance in the hierarchy, the less effective or reliable the judgment will be necessary for these operations. At the worst, the observer becomes a spectator.

"The objective, dispassionate, decontextualized frame becomes privileged because objective knowledge can readily be inserted. The danger is the 'logical' acceptance of these insertions."

The objective, dispassionate, decontextualized frame becomes privileged because objective knowledge can readily be inserted. The danger is the 'logical' acceptance of these insertions. For example, one of the authors (DvS) has had multiple discussions with intensivists, emergency physicians, respiratory care practitioners (RCPs), and paramedics about the cause of the sense of suffocation in patients. Generally, the belief that low oxygen saturation or high carbon dioxide levels cause the sensation of suffocation is inserted as objective science. Special Operations Force (SOF) operators experienced in HALO (High-Altitude Low-Opening) parachute jumps and military aviators trained in high-altitude pressure chambers have found this belief hard to understand. A rudimentary internet search will produce US Air Force training videos that demonstrate the giddiness or euphoria caused by hypoxemia.

One of the authors (DvS) had personal experience with hypoxemia during an episode of high-altitude pulmonary edema at 20,000 feet in the Himalayas. During the solo descent to high camp, the author observed a glacier covered with what appeared to be fresh snow or, in his confusion from hypoxemia, white vegetable shortening. Discerning the difference between snow and shortening was even more challenging when his vision went from tunnel to binocular vision with the loss of depth perception. The author considered a side trip to examine the glacier's covering, especially since it appeared to be a few steps away. Though breathing rapidly, the author never experienced suffocation. The experts continue to insist otherwise. (The elevation of the glacier was 13,000 feet. The author did not step over to the glacier.)

The farther one is from the engagement experience, the easier these insertions are.

"The privilege of the whole field view comes from the distance central authority has from evolving events. Viewing from a distance reduces the details while decontextualizing the view. "

The privilege of the whole field view comes from the distance central authority has from evolving events. Viewing from a distance reduces the details while decontextualizing the view. With muddled details and lessened environmental interference, "it's not complicated." From a fixed position outside the event, elements of the problem appear discrete, and solutions flow in a linear, "dose-dependent" manner. The rate of change and flow of events are *quantitative* measures preferred by spectators for their discrete character and tractability. On the other hand, *qualitative* descriptions tell you about the thing, such as traits and texture, allowing overlapping characteristics and contributing to ambiguity (37). It is in ambiguity and complexity that we identify effective interactions.

The clarity of distance allows the mastery of research articles, concepts, and rules (there is a singular "right way") to be masked as clinical expertise. Deductive reasoning (facts guarantee the hypothesis) gives protection by its daunting, impenetrable certitude. The finality of classical logic (logically derived hypotheses cannot be changed) stops discussion. Too quickly, this becomes a leader's identity, if not a description of the ideal leader.

Classical Logic:

The classical predicate or *first-order logic* is a formal language expressing propositions regarding predicates, variables, and quantifiers. Predicates express propositions as statements involving the arguments. The simplest predicates express properties of things. A statement makes an assertion that may be true or false contingent on the values of the variables.

Classical logic and scientific rationality are founded on deductive reasoning (facts guarantee the conclusion), statements that are either true or false (bivalence), and discrete entities having distinct properties (law of the excluded middle). Environmental stochastic noise separates the world of practice from scientific theory. It sep-

arates the formal knowledge produced by management scholars from the applied knowledge needed by practitioners.

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An agitated patient with mechanical ventilation can disconnect from the ventilator. Cardiac arrest can come quickly. Rapid administration of sedative medication brings quick resolution. Sedation is not available in the subacute nursing facility. One of the authors (DvS) taught the subacute RCPs to hand ventilate for patient calm (38). Over time, the property of mechanical ventilation shifted from *enabling life* to *enhancing life* as children began smiling, talking, and interacting with their parents.

Further extension occurred for infants with weak abdominal musculature who developed acute respiratory distress during a bowel movement. The RCPs learned mild backpressure, a PEEP of 8 cm H_2O, would prevent ventilator-related agitation. More significant was the experience of hand ventilation for agitation in children with neurological deficits. After a few breaths, they awaken, and older children may begin talking. Discussion with a neuropsychiatrist revealed that these children were likely in hypoactive delirium (an ICD-10 diagnosis) secondary to hypoventilation.

The scientific method uses classical logic closely related to the study of *correct reasoning,* making this the presumptive correct logic for science (39). However, as noted in the vignettes above, our experience belies classical logic as correct reasoning. Classical logic can impair the extension of a discipline.

> At the beginning of one of the author's (DvS) experiences with long-term ventilation, he followed the goal of weaning the child from the ventilator following blood gas evaluation for O_2 and CO_2. One day a child's grandmother beseeched an LVN to ask if the doctor could leave her grandson on the ventilator. She liked that he smiled, and he had never smiled before. The difference in ventilator management by blood gas versus smile created logical inconsistency with staff from various PICUs. The child's affective response contradicted scientific rationality and logic, along with standard respiratory care references that mechanical ventilation was difficult for a patient to tolerate. After several such experiences, the author began teaching that because we can wean the child from the ventilator, it does not mean we should. Many objective intensivists do not share this subjective view.

Other Logics:

Reddened noise environments give us partial (incomplete) and excessive (contradictory) information. "A logic is called paraconsistent if it 'tolerates contradictions' and paracomplete if it does not 'enforce completeness/exhaustiveness'" (40). Paraconsistent and paracomplete logic systems allow us to work with partial truths, meeting the needs for rapidly changing, conflicting information and adjusting solutions. This is the operator, working contextually "bottom-up" from within the trajectory, inside events, feeling the pressure of elements. Nonmonotonic logics allows us to change our solutions as events evolve.

Modal logics conform to changing events and support flexible thinking, allowing qualifications such as "necessarily" and "possibly."

Paraconsistent logics allow contradictions. Therefore, there is no "principle of explosion." In classical logic, accepting a contradiction means everything and anything can follow – the "explosion." Paraconsistent logics allow us to make logical inferences using contradictions.

Paracomplete logics do not have the "law of excluded middle" (either the proposition is true or false). This allows the use of gradations and shared qualities.

"We can use these logics to infer reliable information from imperfect information, understand our changing beliefs in a dynamic world, manipulate uncertain information, appreciate how time changes the truths and information with which we work, and comprehend how situations create different but logical duties and obligations. "

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Modal Logics

Classical logic evaluates a premise by its appearance or form. The modal logics evaluate a premise through different ways or modes that things are true. In this way, modal logics address the limits of scientific logic. This is the logic of "modalities," *modes* (means) of truth, by using a variety of operators dependent on the domain of the logic (41).

These partial operators limit the operator's action, classifying propositions as *contingently* true or false and allowing claims about what is necessary, possible, contingent, essential, and accidental. In the 20th Century, modal logics developed to work with time, knowledge, belief, belief revision, and moral obligation (42). Modal logics conform to changing events and support flexible thinking.

Paraconsistent Logics

Inconsistency is the acceptance of contradictions; the rigid restraints of classical logic impair usage for uncertainty and inconsistency, particularly the law of the excluded middle. Paraconsistent logics were developed to handle conflicting information and allow contradictory yet non-trivial theories (43).

Paraconsistent logics permit inference from conflicting information in a non-trivial fashion, accommodate inconsistency in a controlled way, and treat inconsistent information as potentially

informative (44, 45). Paraconsistency is also an essential feature of common-sense reasoning which can use exceptions and counterfactuals (46-48)

"For example, using the same information and relying on the same logic system, medical specialists will develop their findings from their knowledge and experience. They may reach different, inconsistent diagnoses."

For example, using the same information and relying on the same logic system, medical specialists will develop their findings from their knowledge and experience. They may reach different, inconsistent diagnoses.

Three-valued, paraconsistent logics have an additional third value, "both true and false." This process allows reasoning with variables not embedded directly in a contradiction (48, 49).

Paracomplete Logics

Every property or statement (true or false) can be derived from within the system in complete logic systems. Systems, however, cannot be complete, the subject of Kurt Gödel's Second Incompleteness Theorem (50). Paracomplete logics allow us to work with entities undergoing continuous change. There is no need to assume "A" or "not-A." Noncontradiction, however, does apply to these logics.

Reasoning:

We strengthen our knowledge with *deduction* and the analysis of new information. We create knowledge through *induction* for synthesis when we encounter new information.

"We strengthen our knowledge with deduction and the analysis of new information. We create knowledge through induction for synthesis when we encounter new information."

Deductive Reasoning

No deduction can take the argument from true premises to a false conclusion. Thus, deductions *preserve truth*, claiming that everything derivable in the system is accurate. Deductive reasoning seems a better approach as the conclusion is guaranteed to be true. However, this is only if the premises are true. We miss the falsity as the safety margin is only putative. The premises for deductive reasoning *must* be correct. For this reason, deductive processes and classical logic do not permit changing a solution or deduction once it is reached.

Inductive Reasoning

At first contact, all we have for learning is observation. *Induction* is to learn through action. The observation begins the inductive process, how we gain knowledge, and how we extend our understanding.

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Key to this is the acceptance that knowledge is not truth in inductivism. Conclusions from inductive reasoning are plausible rather than having the certainty of the truth we see with deductive reasoning. The strength of inductive reasoning comes from the relentless pressure to confirm the plausible conclusion, described by Leonhard Euler (51) in George Pólya (52):

> "[Observations] will lead us continually to new properties which we shall endeavor to prove afterwards. The kind of knowledge which is supported only by observations and is not yet proved must be carefully distinguished from the truth; it is gained by induction, as we usually say…Indeed, we should use such a discovery as an opportunity to investigate more than exactly the properties discovered and to prove or disprove them; in both cases, we may learn something useful."

Euler believed knowledge could be inductively "assured of its truth" by the number of examples: "Anybody can satisfy himself of its truth by as many examples as he may wish to develop. And since I must admit that I am not in a position to give it a rigorous demonstration, I will justify it by a sufficiently large number of examples" (51, 52).

"When pains are taken to make each aspect of the movement as accurate as possible, the movement toward building up the idea is known as inductive discovery (induction, for short); the movement toward developing, applying, and testing, as deductive proof (deduction, for short). While induction moves from fragmentary details (or particulars) to a connected view of a situation (universal), deduction begins with the latter and works back again to particulars, connecting them and binding them together. The inductive movement is toward discovery of a binding principle; the deductive toward its testing confirming, refuting, modifying it on the basis of its capacity to interpret isolated details into a unified experience. So far as we conduct each of these processes in the light of the other, we get valid discovery or verified critical thinking," John Dewey (53).

Avoidance of the Actual World:

A Respiratory Care Practitioner (RCP) called the Pulmonologist about a newly admitted infant dependent on mechanical ventilation. The infant became agitated and struggled in the prescribed ventilator settings. She hand-ventilated the infant and found a pattern that calmed the infant. The Pulmonologist insisted on the prescribed settings. She repeatedly advised the Pulmonologist that the prescribed settings caused severe agitation, even though previous blood gas analyses in the PICU objectively supported them. She continued to describe how she could calm the child with what she learned by hand ventilation. A physician at the facility intervened in support of the RCP.

One of the authors (DvS) discussed the predicament with the

RCP. Early in his career, a cardiothoracic surgeon requested the author to manage a patient after extensive surgery. The surgeon advised the author on how to treat an expected problem that might arise overnight. In the morning, the surgeon was angry that the treatment was not used. The author described the incident and that the treatment did not work. The surgeon insisted the author should have tried again. The author had. The surgeon insisted there should have been a third trial. There were four trials, and the treatment never worked. The surgeon continued his anger.

When events do not follow the expected course, events move outside of one's understanding, creating fear and protective responses. Crises create abrupt gaps between what we thought we could do with what we must do. Perhaps there can be too much truth.

"When events do not follow the expected course, events move outside of one's understanding, creating fear and protective responses. Crises create abrupt gaps between what we thought we could do with what we must do. Perhaps there can be too much truth."

These are not isolated incidents. This situation is the gap and the consequences between the decontextualized dominant account and the hidden, silent voice experiencing movement and pressure in the actual world. We then disregard the silent voice of the individual at the cusp of decision, driven to indecision, then into inaction.

The laboratory, controlled studies, and the distant administrator or leader become the dominant view through decontextualization. This example is more than a physical context. Individuals carry their contexts of experience and family of origin. Styles of leadership, management, and teamwork inform context. This context also encompasses culture, experience, physiology, and the Orient function in John Boyd's OODA Loop. Boyd was a US Air Force officer and strategist who created the OODA (Observe, Orient, Decide, and Act) Loop.

For Boyd (54), Orient "Shapes the way we interact with the environment…The way we *observe*, the way we *decide*, the way we *act*." "*Seen as a result*, represents images, views, or impressions of the world shaped by *genetic heritage, cultural tradition, previous experiences*, and *unfolding circumstances*." To give up context is to lose the Orient function of the OODA Loop: how we update information, analyze and synthesize from feedback, synthesize new information, and build support for our decisions.

The dominant account fails to appreciate how actors work in their natural spaces. We lose the "heterogeneity of population and practice, diverse afterlives, how spaces of science construct individual and group expertise" (55). This excludes the silent voices of other members of the organization, which are ignored or expressed by others (56).

Faced with too much truth, the individual is at risk of decontextualizing the situation for self-protection. Knowing one thing well and keeping it out of context allows the individual to extend their theory to many domains (14) confidently. The individual can suppress voices, making them hidden, creating a subculture that may undercut the program.

The individual who decontextualizes events can entertain and obfuscate (56). How actors work in their natural spaces is disregarded (56). We can distract people from the damage of poor leadership, management, and administration and silence the voices of those lower in the hierarchy or who are considered outliers (56).

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"Any lesson in leadership, we believe, that ignores context, or that fails to pay attention to other, less powerful voices, is a hollow lesson that likely serves other purposes and interests," Michael Elmes and Bob Frame (56).

Conclusion:

Engineering models fail to account for individual preferences and variances in capabilities. Classical logic blocks the flexibility necessary to incorporate new and emerging information. Unavailable to operators are logics that allow qualifications, contradictions, and the use of gradations and shared qualities. Deductive reasoning guarantees conclusions that are, at best, transient in the flux of reddened noise-forcing functions.

HRO methods emerged from environments formed by forcing functions. The ability to work under uncertainty and extend understanding must not be sacrificed for the tractability of objectivity.

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Corresponding Author

Daved van Stralen, MD, FAAP
Associate Professor, Pediatrics
Department of Pediatrics
Loma Linda University School of Medicine
11175 Campus Street
CP-A1121
Loma Linda, CA 92350
Email: DVanStra@llu.edu

Sean McKay
Executive Partner / Director, Disruptive Rescue & Austere Medicine
Element Rescue - Response Solutions within Nonlinear Complex Environments
Greenville, South Carolina, United States

Errol van Stralen
Program Director at Ancora Corporate Training
Tuscumbia, Alabama, United States

Thomas A. Mercer
Rear Admiral
United States Navy (Retired)

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Karl Weick, Rensis Likert Distinguished University Professor of Organizational Behavior and Psychology, Emeritus, University of Michigan

William J. Corr, Captain II, Los Angeles City Fire Department (retired)

Adrian Wolfberg, National Academy of Sciences, Defense Intelligence Agency Steve

Timothy Watson, MD, FAAP, Mission Pediatrics