High-Reliability Organizing Fundamentals: Time and Acceleration

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How odd that we engage dynamic, accelerating situations with static, well-defined, and discrete concepts as our frames of reference. It does seem prudent to use well-accepted frames of reference for risky operations. For example, we commonly rely on standards of care and evidence-based medicine for routine and emergency care. Standardized frames of reference, such as the International Classification of Disease and Diagnostic and Statistical Manual, support the collection of information, documentation, and clarity during communication. These frames of reference enable us to understand events and support our predictions about the effectiveness of interventions.

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Yet, we live in a fluctuating environment. Feedback loops amplify or dampen processes that redden environmental noise. Red noise brings long-period forcing energy to the environment, to which elements and systems must respond. When feedback occurs within a single variable, it is autocorrelation—red noise. Feedback occurring between multiple variables is cross-correlation and can cross scales of space and time (1, 2). Feedback creates stochastic variability within the environment, which gives rise to stability and homeostasis (3).

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Information is contextual, if not transient. In the dynamics of engagement, what hurts you now will help you later, just as what helps you now will hurt you later. One of the authors (DvS) served on a fire rescue ambulance where teams of two responded to medical emergencies without on-scene support from fire companies and police units or portable radios. They were trained to respond unassisted for calls with "assailant on scene." In this environment, they quickly learned that any stance, countenance, or word was situational. They would learn if their efforts helped or hurt only by scrutinizing faces. Listening to these experiences, people quickly classified what they heard to fit into some familiar standard—a standard used in stable situations without immediate threat. Such stories remain unshared.

"Unfortunately, information then becomes lost. Those present at the operational beginning of a field of study have witnessed how the painful lessons learned become converted to safe and reliable standards. Most commonly, what is lost is the practice of engaging uncertainty and ambiguity. New "arrivals" also have a new baseline; they view the domain at their entry as the standard from which they improve the science..."

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Individuals and designed systems experience these environments locally. The view of the "spectator," far removed in time and space, is one of a technological system with greater emphasis on prediction, design, and commands from the outside. Moving closer, in an environment influenced by events, the "observer participant" has the Whole Field View Specification and contributes to the self-organizing response. The "operator" has the Local Grouping Specification, with an immediate local, nonlinear response to the situation. Nonlinearity now confounds linear time.

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> "Technological systems become organized by commands from the outside, as when human intentions lead to the building of structures or machines. But many natural systems become structured by their own internal processes: these are self-organizing systems, and the emergence of order within them is a complex phenomenon that intrigues scientists from all disciplines."
>
> *Eugene F. Yates* (7)

Information carries different salience, relevance, and meaning, depending on context, even when individuals are standing adjacent, see Table 1 (8). Our explanations and theories should predict the same phenomena in any of these specifications or reference frames.

The problem, however, is that for conceptual tractability and theory development, we have separated the individual and organization from the environment. By isolating the study population or sample from the environment, we eliminate variability in the environmental noise. "White noise" is environmental noise that has constant variance per unit frequency. That is, there is an equal and independent representation of energy over all frequencies and *without* autocorrelation (feedback). Much research occurs in controlled and protected white noise environments.

"Elements and events in white noise environments are fully independent, purely random, and without temporal correlation because there is no predominant energy frequency. They form a Gaussian distribution amenable to statistical analysis and calculated probabilities. Variance decreases over time or with increasing data. For these reasons, researchers prefer white noise environments."

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Table 1: Specifications of the Whole Field View and Local Groupings (9)

Whole field view	**Local groupings**
Eulerian, quantitative	Lagrangian, qualitative
Decontextualized	Contextual
External, fixed point Select a viewing point Focus on specific location	Within flow Select a starting point Focus on individual moving parcel
Flow	Trajectory
Multiple fixed positions	Continuous measure with position and pressure
Rate of change of system	Individual parcels

because there is no predominant energy frequency (10, 11). They form a Gaussian distribution amenable to statistical analysis and calculated probabilities. Variance decreases over time or with increasing data. For these reasons, researchers prefer white noise environments.

The problem is not with our classifications, theories, logic, or reasoning. The problem lies with the removal of time in our conceptual structures and mental processes. Eliminating time as a variable allows us to use Newtonian constructs within a Euclidean space. The rules of Euclidean geometry, that any two points have a measured distance between them, permit the construction of hierarchies, whether conceptual, structural, or operational.

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Time in Newtonian physics and Euclidean space is a "prothetic" process. That is, time is a quantitative measure that we can add to. Qualitative measures are "metathetic" processes on the physiological level. We substitute additions rather than adding to existing measurements as we are changing the quality of the process. Nonlinearity confounds time when we consider time to be a linear measurement that we can only add to (12).

Another model of time is the branching tree model, where the past is fixed and linear, but the future is open. Time branches into multiple possible futures with a specific modal logic—*temporal logic* (13). Branching tree models are less useful for planning, but they do provide concepts and logic for engagement of novel or uncertain situation.

Temporal logic reasons how time qualifies statements and propositions with two basic operators—future and past. The asymmetry of time describes how the past is fixed, yet the future is branching and open to influence and change (13). This fits the effect of increasing entropy as an increase in possible futures rather than an increase in disorder.

Temporal logic can also be modified for concepts of time. For example, *X* is always true while Y is only sometimes. While the past is fixed and already determined, logical processes can account for the branching of time in the future. "Temporal logic" addresses problems of causality and mechanism, continuous change, planning actions, concurrent or discontinuous events, and the persistence of a fact rather than the truth of a fact.

Temporal logic moves us from a deterministic view of linear time that focuses on the path to the future. While there may be a feeling of security for families to know the percentage survival rate, such discussions do not reflect time experienced as a liminal state. During live-or-die experiences, there is no sense of time.

One model of time differentiates propositions that may change truth value over time from those that are always true or always false. "Tensed" propositions accurately describe the world but can change their truth value over time. "Tenseless" propositions are always true or always false. Tensed propositions permit accurate classification of events as past, present, or future. Reality (present) is complete, reality in the past was different, and reality in the future will be different. Tensed propositions explain why we give significance to the past-present-future distinction; some things in the past will always be good or bad (4).

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Amplification from positive feedback creates the appearance of acceleration. This comes from a measure of time lag in the feedback. Short, amplified feedback loops rapidly branch and change the direction and velocity of events.

Physiological and neurological limits to time limit response times and lengthen time lags. Individual and group experience, cohesiveness, and capability are unmeasured influences on time lags. We cannot go faster than that, much like the speed of light limits speed. It is common amongst the less experienced to think one must think fast and act fast. Not really, as it is not thinking fast versus thinking slow, rather, it is thinking effectively and acting smoothly.

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Education, training, and planning tend to use a non-accelerating, inertial reference frame. This is an analogous problem to one addressed by Albert Einstein (5, 14). The principle of relativity

(in the restricted sense), used by Newton, does not hold for motion. In Newtonian physics and Euclidean space, time was considered absolute, and a reference frame became the favored frame. This did not accommodate moving or accelerating frames of reference. In 1905, Einstein addressed the problem that the mutual speed of the frames is constant. This is his Special Theory of Relativity. In 1915, he addressed the problem that the mutual speed of the frames is NOT constant in his General Theory of Relativity:

The theory of relativity (in the restricted sense) appeared to be unsatisfactory only in one point of fundamental importance. It appeared to give preference to one system of coordinates of a particular state of motion (at rest relative to the ether) as against all other systems of coordinates in motion with respect to this one. In this point the theory seemed to stand in direct opposition to classical mechanics, in which all inertial systems which are in uniform motion with respect to each other are equally justifiable as systems of co-ordinates (Special Principle of Relativity). In this connection, all experience also in the realm of electro-dynamics (in particular Michelson's experiment) supported the idea of the equivalence of all inertial systems, *i.e.*, was in favor of the special principle of relativity (5).

In his Special Theory of Relativity, Einstein postulates (14):

- The laws of physics are the same in all inertial frames of reference. The laws of physics have the same form in all inertial reference frames.
- The speed of light in a free space (vacuum) has the same value in all inertial frames of reference. Light propagates through empty space with speed c independent of the speed of the source or observer.
- Hence: the speed of light, which is a consequence of the laws of physics (Maxwell), is the same in all inertial reference frames.

High Reliability Organizing accommodates structural limits on response to a forcing function or abrupt change (Karl Weick, personal communication). We see this in the five characteristics of HRO (15):

- *Preoccupation with Failure* describes vigilance for disruptions, discrepancies, covert compensated failure, or other early signs of an approaching forcing function.
- *Reluctance to Simplify* and its corollary, *Efforts to Complexify*, recognizes the information that is found in noise and that noise may develop toward a crescendo—the situation doesn't stop because information was collected, and authorities notified.
- *Sensitivity to Operations* maintains all operations using authority migration, when necessary, not to become distracted by events; the organization must maintain routine operations to engage a crisis as well as continue its purpose of operations.
- *Commitment to Resilience* distributes decisions to those in the best position to act and encourages information flow toward those who can use it, a generative form of organization (16); short lag feedback loops, emerging from authority migration and distributed decision-making, keep the organization responsive to abrupt changes.
- *Deference to Expertise* accepts various frames of reference without preference and utilizes the different specifications of the flow of events (8).

For the individual and the organization, the five HRO characteristics reduce the influence of "a preference to one system of coordinates of a particular state of motion."

"High Reliability Organizing accommodates structural limits on response to a forcing function or abrupt change. We see this in the five characteristics of HRO: Preoccupation with Failure, Reluctance to Simplify and its corollary, Efforts to Complexify, Sensitivity to Operations, Commitment to Resilience, Deference to Expertise."

In Euclidean Geometry of three dimensions (14):

- Any 2 points have a measured distance between them.
- There is a coordinate system. Distance is independent of the system of coordinates chosen and can be measured with a standard measuring rod.
- With respect to these transformations, the laws of Euclidean geometry are invariant.

In the Special Theory of Relativity (14):

- Corresponding to two neighboring points in *space-time* (point events), there exists a numerical measure (distance ds) which conforms to the equation using time as a 4th dimension.
- An inertial system. It is independent of the inertial system chosen and can be measured with the unit measuring rod *and* a standard clock.
- With respect to these transformations, the laws of physics are invariant.

"Because the order of the members of some pairs of events can be reversed by changing one's reference frame, we must consider whether the events' ability to influence each other can similarly be affected by a change of reference frame."

Causality. "Because the order of the members of some pairs of events can be reversed by changing one's reference frame, we must consider whether the events' ability to influence each other can similarly be affected by a change of reference frame." Situations developing from Red Noise forcing functions or Pink Noise abrupt change have influences on causation similar to those identified by Einstein:

- Feedback can be contingent, indirect, nonlinear, or very short (acceleration).
- Respond more intensely to local influences.

- Have greater granularity.
- Operate more commonly with nonlinearity and self-organization.

Conclusion:

The inclusion of time, feedback, and causation as relativity of reference frames more closely represents the experience of those involved in a Neonatal resuscitation.

Time and its manifestation as rates of feedback within HRO have been overlooked by those with knowledge of HRO solely by description. Appreciating the significance of time and feedback brings forward movement and acceleration as considerations for High Reliability Operations. Time and feedback explain the weakness of hierarchical structures during a forcing function or abrupt change. Veteran HRO operators have long discussed that the first action upon encountering an event is "do something." Any action that breaks a series of feedback loops also decreases amplification, moving the system toward stability.

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