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# Designing for the Operational Middle: A Sociotechnical Framework for Integrating Psychosocial Risk Into Aviation Human Factors and Safety Management

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## ABSTRACT

The discipline of aviation human factors has historically organized itself around two design problems: the prevention of acute failure and the optimization of crew coordination. Both have produced substantial gains in system reliability, but neither fully addresses the psychosocial layer beneath them: the everyday cognitive, affective, and interpersonal conditions under which the workforce continuously produces safe performance. This paper develops a sociotechnical framework for addressing that gap. It introduces and formalizes the operational middle as a design construct: the population of aviation professionals who are certified, operationally performing, and not in crisis, but who are managing chronic psychosocial load that remains largely invisible to current monitoring, certification, and support-utilization systems. A Five-Layer Sociotechnical Model of Aviation Mental Health is proposed, distinguishing the technical, procedural, team-coordination, psychosocial, and stakeholder-environment layers of the aviation system, and locating the operational middle within the under-designed psychosocial layer. Drawing on convergent empirical signals - including cross-national workforce help-avoidance patterns and large-scale passenger perception data (N = 2,772) - the paper argues that the case for psychosocial redesign is now both internally and externally validated. Training implications are discussed through the lens of adaptive operational competencies, demonstrating how psychosocial resilience capabilities may be integrated into existing Crew Resource Management (CRM) and Evidence-Based Training (EBT) architectures rather than through parallel systems. The paper contributes a theoretical and design-oriented framework that reframes psychosocial conditions not as workforce wellbeing concerns running adjacent to safety, but as operational variables within sociotechnical systems that influence whether trained safety behaviors emerge under stress.

**Keywords:** Sociotechnical systems, Aviation human factors, Psychosocial risk, Operational middle, Crew resource management, Safety management systems, Workforce resilience, Mental health

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## INTRODUCTION

Commercial aviation has produced one of the most reliable safety records of any high-consequence industry. The disciplinary apparatus that produced it (i.e. engineering reliability, procedural standardization, redundancy, Crew Resource Management (CRM), Threat and Error Management, and data-driven Safety Management Systems (SMS)) represents a mature and integrated body of practice (International Civil Aviation Organization, 2018; Stolzer et al., 2023). Within this apparatus, the discipline of aviation human factors has occupied two principal design positions: the prevention of acute human error and the optimization of crew coordination. Both have been enormously productive. Neither, however, addresses the design problem that this paper takes as its subject.

That problem is the psychosocial layer of aviation work. That is to say, the everyday cognitive, affective, and interpersonal conditions under which the workforce continuously produces safe performance. This layer is implicit in much of human factors thinking, but it is rarely treated as a formal design surface. When mental health enters aviation safety discourse, it tends to enter through the lens of catastrophic outlier events, with the regulatory response oriented toward detecting and excluding acute psychological impairment (Pasha and Stokes, 2018). The result is a system whose mental health logic is built around the extremes of the distribution, leaving the center (the large population of professionals who are certified, performing, and managing the chronic stressors of the work) under-designed and under-resourced.

Aviation is uniquely positioned for compounded psychosocial load because many of its stressors are not isolated but cumulative, interacting across operational, physiological, cognitive, and social domains simultaneously. Pilots and other aviation professionals routinely operate under chronic fatigue exposure associated with circadian disruption and irregular schedules (Cahill et al., 2021; Wu et al., 2016), prolonged social isolation during multi-day and long-haul operations, sustained high cognitive workload, elevated responsibility for consequence-sensitive decision-making, and organizational cultures that implicitly reward emotional compartmentalization and uninterrupted performance reliability. Unlike many occupations, aviation frequently operates under a "no bad days" expectation in which personal strain is expected to remain operationally invisible regardless of cumulative load. The challenge, therefore, is not any single stressor in isolation, but the interaction and accumulation of these conditions over time.

From a sociotechnical perspective, this accumulation matters because it produces system-level effects rather than merely individual experiences. Fatigue influences communication quality and operational performance (Cahill et al., 2021; Alaminos-Torres et al., 2023); chronic stress alters attentional control, cognitive flexibility, and decision-making under pressure (Venus et al., 2022); psychological insecurity suppresses safety voice and challenge behavior within teams (Edmondson, 1999; Perkins et al., 2022); and emotional exhaustion degrades interpersonal coordination and adaptive crew functioning (Gemmano et al., 2024; Salas et al., 2006). These are not separate wellbeing concerns running parallel to operational safety; they are mechanisms through which operational safety itself is continuously produced or degraded. The persistence of these patterns across operators, regulatory environments, and national contexts suggests that the issue is not reducible to individual coping deficits, but reflects a broader systems-design problem. In this sense, psychosocial strain should be understood not merely as a workforce condition, but as a systems symptom emerging from the interaction between operational demands, organizational structures, and the conditions under which aviation work is performed.

This paper has three aims. First, it names and formalizes a design construct - the operational middle - to make visible the population currently absent from aviation mental health frameworks and to specify its properties so it can be designed for. Second, it introduces a Five-Layer Sociotechnical Model of Aviation Mental Health that locates the operational middle within the broader system architecture and clarifies why current frameworks miss it. Third, it identifies training implications for integrating psychosocial resilience into existing CRM and Evidence-Based Training (EBT) structures, drawing on a developing literature on adaptive operational competencies.

The argument draws on prior empirical work, including a large-scale passenger perception study (N = 2,772) (Perkins et al., n.d.) that documented an external stakeholder signal aligned with the internal workforce signal of help-avoidance. That prior work is summarized briefly here as evidence for the claim that the design case is now externally as well as internally validated; the present paper's contribution is theoretical and design-oriented rather than empirical.

Several developments make the present moment uniquely consequential for this redesign problem. Commercial aviation is operating under conditions of sustained workforce strain characterized by staffing shortages, elevated fatigue exposure, operational volatility, and increasing scrutiny regarding employee wellbeing in the aftermath of the COVID-19 pandemic (Cahill et al., 2021; Folke and Melin, 2024; Wandelt and Wang, 2024). Simultaneously, digital intervention technologies capable of delivering scalable, low-friction resilience and mental health support have advanced substantially, including AI-enabled monitoring systems, conversational support platforms, adaptive behavioral interventions, and operationally embedded "digital copilot" architectures designed to support continuous performance and wellbeing in safety-critical environments (Cahill et al., 2020; Rathnayaka et al., 2022; Ćosić et al., 2024; Zheng et al., 2025). Emerging sociotechnical research further suggests that the effectiveness of AI-mediated support systems depends not only on technological capability, but on workforce perceptions of confidentiality, institutional trust, transparency, and structural separation from evaluative or certification functions (Chawla et al., 2026). The result is a convergence of operational strain, stakeholder attention, and technological capability that did not previously exist at this scale.

## SOCIOTECHNICAL SYSTEMS THEORY AND THE AVIATION APPLICATION

Sociotechnical systems (STS) theory, originating in the work of Trist and Bamforth on British coal mining (Trist and Bamforth, 1951) and elaborated across high-consequence industries (Cherns, 1976; Clegg, 2000), holds that effective performance in complex work emerges from the joint optimization of technical and social subsystems and that these subsystems are interdependent. Cherns' design principles (Cherns, 1976) and Clegg's later synthesis (Clegg, 2000) established that sociotechnical design is not a phase of system development but a continuous condition of system function: any redesign of one subsystem propagates into the other, whether designers attend to that propagation or not.

Aviation has applied STS thinking productively at the level of crew-automation interaction, error management, and procedural design (Harris and Stanton, 2010; Walker et al., 2023). The application has been less complete at the level of the psychosocial conditions that shape whether trained behaviors actually emerge under stress. The paper's claim is that this is a design omission rather than an inherent limit of the framework: the same theoretical apparatus that produced CRM can, if extended, produce a design treatment of the psychosocial layer.

The framework proposed here departs from conventional occupational wellbeing models in a critical way: rather than treating wellbeing as an individual endpoint, it treats psychosocial conditions as operational determinants of system performance. The paper does not argue that aviation organizations should address mental health solely because worker wellbeing is ethically desirable, although it is. It argues that psychosocial conditions are operational variables within a sociotechnical system; and, therefore, belong inside safety architecture itself. The distinction is consequential because it shifts psychosocial resilience from an adjacent Human Resource concern to a core systems-design concern.

This framing is also consistent with the World Health Organization's definition of mental health as "a state of mental well-being that enables people to cope with the stresses of life, to realize their abilities, to learn well and work well, and to contribute to their communities" (World Health Organization, 2022). Within aviation, this definition is particularly consequential because safe performance depends precisely on these capabilities: adaptive coping under stress, sustained cognitive functioning, interpersonal coordination, learning, and effective operational performance under variable conditions. Mental health, from this perspective, is not external to aviation safety performance; it is one of its enabling conditions.

## THE FIVE-LAYER SOCIOTECHNICAL MODEL OF AVIATION MENTAL HEALTH

The paper proposes a five-layer model of the aviation sociotechnical system, organized to clarify where current frameworks operate and where the operational middle sits. Before presenting the layers, two structural clarifications are necessary to prevent misreading.

First, the model is not a hierarchy of importance (all layers are required for safe performance) but a stratification of design surfaces, defined here as domains for which formal competency frameworks, assessment instruments, training curricula, and regulatory oversight have been systematically developed. By this definition, a mature design surface is one for which the field has established observable behavioral markers, recurrent training structures, and formal assessment mechanisms capable of evaluating performance under operational conditions (Salas et al., 2006; Helmreich et al., 1999). An under-designed surface is one where the relevant conditions are acknowledged but not yet formally instrumented. This distinction is the model's primary analytic contribution.

Second, Layer 5 is categorically different from Layers 1–4. Layers 1–4 describe components internal to the operational system; Layer 5 describes the environment in which that system is embedded. Classical STS theory treats the system–environment boundary as analytically significant (Trist and Bamforth, 1951; Clegg, 2000), and this model preserves that distinction. Layer 5 is included because the argument of this paper turns on the pressure that environment is now exerting on Layer 4; collapsing it into the system would obscure that dynamic rather than illuminate it.

**Layer 1: Technical.** Aircraft, automation, instrumentation, sensors, and the engineered tools of flight. Aviation human factors has shaped this layer through decades of work on display design, automation philosophy, and human–system integration (Wickens et al., 2015). It is the most mature design surface in the model.

**Layer 2: Procedural.** Standard Operating Procedures, checklists, callouts, briefings, and the codified behaviors that translate technical capability into reliable performance. Procedural design is the layer at which most regulatory action operates, and the one most amenable to compliance verification.

**Layer 3: Team Coordination.** The observable interpersonal behaviors of crew performance: communication structure, leadership enactment, workload distribution, and decision-making under stress. CRM, Line-Oriented Flight Training, and EBT have made this a mature design surface with defined competencies, observable behavioral markers, and recurrent assessment mechanisms (Salas et al., 2006; Helmreich et al., 1999). Importantly, Layer 3 is defined here as the behavioral expression of coordination (i.e., what crews demonstrably do together under operational conditions).

**Layer 4: Psychosocial.** The internal and structural conditions that determine whether Layer 3 behaviors actually emerge under stress: emotional regulation under cumulative load, fatigue and recovery, psychological safety as a team-level property, help-seeking behavior, and the management of chronic strain. The distinction between Layers 3 and 4 is deliberate and consequential: Layer 3 describes observable crew behaviors; Layer 4 describes the enabling conditions (cognitive, affective, and organizational) that make those behaviors possible or suppress them. Emotional intelligence, for example, appears in both layers by design: as an observable behavioral competency at Layer 3, and as an internal regulatory capacity at Layer 4. The boundary is not between different constructs but between their observable expression and their enabling substrate. Layer 4 is implicit in CRM training but has not been formalized as a competency surface with its own assessment instruments, behavioral indicators, or training curricula, which is precisely the design gap this paper identifies as the next priority for the discipline.

**Layer 5: Stakeholder Environment.** The regulatory, commercial, public, and labor-relations conditions in which the system is embedded. As noted above, this layer is analytically external to the operational system rather than a component of it. Sociotechnical theory has long recognized that systems are shaped by their environments (Clegg, 2000), and in aviation, passenger trust, regulatory expectation, and union–management dynamics all constitute environmental pressures that influence internal system design. Operational pressure represents one mechanism through which external stakeholder demands are translated into work-related stress (WRS), particularly when productivity, efficiency, or compliance pressures interact with limited operational resources and organizational constraints (Marsman et al., 2024). Layer 5 is included here not to collapse the system–environment boundary but to make the boundary's permeability visible - specifically, the mechanism by which external stakeholder expectations are currently transmitting pressure onto the under-designed Layer 4.

The operational middle is the population whose performance depends most heavily on Layer 4 and who are least visible to the design instruments targeting Layers 2 and 3. The invisibility is not incidental: it is a direct consequence of the absence of formal instrumentation at Layer 4. You cannot monitor what you have not defined, and you cannot intervene on what you cannot measure. Layer 5 (specifically the convergence of passenger expectation and workforce behavioral signals) has begun to exert pressure on Layer 4 from both outside and inside the system simultaneously, a point developed in Section 5.

## FORMALIZING THE OPERATIONAL MIDDLE AS A DESIGN CONSTRUCT

The term "operational middle" has appeared in adjacent literatures as a descriptive shorthand. The contribution of this paper is to formalize it as a sociotechnical design construct with specific and definable properties. Aviation mental-health frameworks have historically been shaped by catastrophic outlier logic, despite broader epidemiological evidence demonstrating that the majority of mental-health burden exists within mild-to-moderate rather than severe ranges for the general population. Kessler et al. (2005) reported that approximately 77.7% of 12-month DSM-IV disorders in the general population fell within mild or moderate categories. While these findings are not aviation-specific and should not be assumed to map directly onto pilot populations, they nevertheless provide broader epidemiological context suggesting that mental-health burden is often concentrated within non-acute ranges rather than exclusively within severe psychiatric presentations. This distinction is central to the operational middle construct advanced here: the population most consequential to everyday aviation safety is unlikely to consist primarily of individuals in acute psychiatric crisis, but rather operational professionals managing cumulative psychosocial strain while continuing to function within certification and performance boundaries.

**Definition.** The operational middle is the population of aviation professionals who simultaneously meet four conditions: (i) currently hold valid medical and operational certification; (ii) are actively performing in safety-critical roles; (iii) are managing chronic psychosocial load (i.e., fatigue, schedule disruption, social isolation, workload pressure, and mild-to-moderate distress) that is non-trivial in its cumulative effect on performance; and (iv) are not visible to existing surveillance, certification, or support utilization data because they have not crossed thresholds that would trigger intervention. The fourth condition is not a peripheral feature of the construct; it is its defining design problem. Invisibility is not incidental; it is a structural consequence of deploying monitoring instruments calibrated to detect acute impairment in a population whose primary characteristic is the absence of acute impairment. The operational middle cannot be seen by tools that were not built to see it.

**Diagnostic properties.** Because the operational middle is defined in part by its absence from formal data systems, it cannot be identified at the individual level through standard surveillance. It is identifiable at the population level, however, through three indirect indicators that are well documented and cross-nationally consistent in the workforce literature. First, systematic underutilization of formal support resources despite their structural availability - a pattern sufficiently robust that review evidence suggests formal utilization records may substantially underestimate the actual mental-health burden carried by the pilot workforce (Wu et al., 2016; Bor et al., 2016; Ackland et al., 2022). Previous work has demonstrated high rates of healthcare avoidance behavior due to fear of certificate loss, suggesting a system-level barrier as opposed to individual misaction (Hoffman et al., 2022a; 2022b; 2023). Some have argued this has resulted in a healthcare barrier for personnel due to these system-level factors (Hoffman, 2022a). Second, widespread reliance on informal coping channels (including peer networks, anonymous online resources, and individual self-management strategies) as substitutes for, rather than complements to, formal support (Cahill et al., 2021; Cross et al., 2024; Walden and Thomas, 2025). Third, consistent attribution of help-avoidance to certification fears, confidentiality concerns, stigma, and institutional distrust; a pattern that extends beyond aviation to safety-critical industries broadly, where research on voluntary reporting systems demonstrates that fear of reprisal can suppress disclosure even where formal protection mechanisms nominally exist (Perkins et al., 2022; Chawla et al., 2026; Chien et al., 2022; Minoretti, 2025). The cross-national and cross-organizational consistency of all three indicators is itself analytically significant: when the same behavioral pattern appears across different regulatory environments, organizational cultures, and national contexts, the system (rather than the individual) is the appropriate unit of analysis. The operational middle is not a collection of individuals who have failed to seek help; it is a population whose rational adaptation to system design has made help-avoidance the path of least personal risk (Hoffman et al., 2022a).

**Design implication.** The operational middle is not addressable through interventions designed for the tails of the distribution. Tools designed for crisis response do not engage it; tools designed for high-acuity clinical presentation do not match its profile. It requires design instruments calibrated to ordinary professional life: routine, low-friction, embedded in normal training and operational rhythm, and structurally decoupled from certification consequence. Critically, the measurement problem is itself a design instruction: the fact that this population does not appear in utilization data is not a reason to doubt its existence. It is evidence that the instruments are wrong, not that the population is absent.

The framework does not pathologize ordinary occupational stress, nor does it suggest that all psychosocial strain constitutes impairment. Its premise is that chronic psychosocial load is an ordinary operational condition that influences human performance variability and therefore warrants systematic design consideration; the same logic that brought fatigue risk management inside the SMS rather than leaving it to individual pilots to manage privately.

## THE CASE FOR REDESIGN: CONVERGENT EVIDENCE FROM WORKFORCE BEHAVIOR AND PUBLIC EXPECTATION

A theoretical case for redesign is not, by itself, sufficient to mobilize change in a conservative regulatory environment. What makes the present moment different is the convergence of two independent signals, one from inside the workforce and one from outside the system.

**Internal signal: workforce help-avoidance as design feedback.** As established in Section 4, the cross-national stability of help-avoidance behavior across different regulatory environments and organizational cultures is itself diagnostic: it identifies the system as the source of the pattern rather than the individuals within it. For the purposes of the convergence argument, the critical point is not the existence of the pattern (that has been documented) but what it communicates: the workforce is providing continuous behavioral feedback that the architecture of support is misaligned with the conditions under which it is expected to be used. That feedback has not yet produced a design response.

**External signal: passenger perception as stakeholder input.** Recent large-scale survey work (N = 2,772) has documented that the traveling public has independently expanded its working definition of aviation safety to include crew psychosocial wellbeing and has attached measurable economic value to that expansion (Perkins et al., n.d.). The published findings include near-universal agreement (93.2%) that pilot mental health is linked to flight safety, majority willingness to pay a premium for airlines demonstrably committed to crew wellbeing (59.3%), and majority preference for higher-priced mental-health-supportive carriers under direct cost trade-off (63.9%). For the present paper, the analytic point is not the magnitude of the willingness-to-pay finding; it is that an external stakeholder population has independently arrived at a definition of safety that maps onto Layer 4 of the proposed model. The system's environment is already pricing the design problem the system has not yet formally addressed.

**Convergence.** The internal signal indicates that the design is misaligned with the workforce; the external signal indicates that the design is now also misaligned with stakeholder expectation. These signals point in the same direction. From a sociotechnical standpoint, two independent feedback channels reporting the same misalignment is a design instruction, not a coincidence.

In sociotechnical terms, the passenger perception findings are significant not because passengers possess operational expertise, but because stakeholder environments influence system legitimacy, commercial pressure, and institutional adaptation. A proportion of the traveling public may be signaling that psychosocial resilience has become part of the social contract of aviation safety, regardless of whether formal safety architecture has adapted to reflect it.

## TRAINING IMPLICATIONS

Training implications follow directly from the operational middle's defining property: instruments must be embedded in the routine training and operational rhythm of certified, performing professionals rather than oriented to crisis response. Existing CRM and EBT frameworks already contain many of the interpersonal and adaptive competencies relevant to psychosocial resilience, including communication, workload management, leadership, and teamwork; the present gap is less one of conceptual absence than of explicit integration and operational framing. Integration is feasible because the relevant competencies admit of behavioral definition and observable assessment, consistent with existing EBT observable-behavior taxonomies, rather than requiring evaluation of attitudes or self-reported internal states.

Several authors have argued that mental health literacy, help-seeking knowledge, early recognition of psychosocial distress and practical coping skills should be incorporated more directly into aviation training environments in ways that normalize support utilization while remaining separated from certification consequence (Cahill et al., 2021; Chien et al., 2022; Minoretti, 2025; Cavagnetto et al., 2025). Further empirical work is required to identify and validate practical tools that help pilots manage acute stress, cumulative psychosocial strain, and related operational challenges, some of which may be appropriate for integration into simulator and recurrent training environments, or CRM classroom training. Emerging work on startle-management interventions suggests that adaptive cognitive and behavioral responses to acute stress are trainable within operational contexts and are perceived to have positive effects (Vlaskamp et al., 2025). Related research indicates that strengthening self-efficacy may reduce stress exposure and longer-term mental-health effects, findings observed in cabin crew populations and aligned with Bandura's (1977) foundational theory of self-efficacy (Vlaskamp et al., 2026). Sports and performance psychology may offer transferable approaches to attentional control, emotional regulation, recovery, and adaptive performance under pressure (Beltrán, 2024; Caso et al., 2025). Importantly, emotional intelligence, psychological safety, and related interpersonal competencies already align closely with existing observable behavior structures within contemporary EASA competency frameworks and CRM competency models (Perkins et al., 2025; 2024), suggesting that many psychosocial competencies may be integrated through extension of existing CRM and EBT architectures rather than through creation of separate training systems. The training implications discussed here concern adaptive operational competencies, not clinical intervention; confidential clinical care and peer-support pathways remain a separate and complementary layer of the broader support architecture, and effective implementation will require instructor preparation to assess these competencies reliably without pathologizing normal stress responses.

## LIMITATIONS AND FUTURE WORK

The contributions advanced here (that is, the Five-Layer Sociotechnical Model, the operational middle construct, and the training implications discussion) constitute a design proposal rather than a validated intervention. First, the integration of psychosocial competencies into existing CRM and EBT structures requires empirical operationalization, including development of behavioral indicators and inter-rater reliability data within recurrent-training assessment contexts. Second, the structural decoupling of any psychosocial training data from certification (the principle on which workforce trust depends) requires formal regulatory engagement and data governance agreements with unions and legal counsel that this paper specifies as necessary but does not deliver. Third, the emotional intelligence construct, while empirically grounded in pilot performance research (Perkins et al., 2025), requires translation into specific observable behavioral markers before it can be reliably integrated into existing CRM/EBT assessment rubrics. Fourth, the framework's expected effects on operational outcomes - support utilization, voluntary disclosure, safety voice frequency, and reportable event quality - require longitudinal evaluation across multiple operators and regulatory environments. Fifth, the framework is developed with reference to commercial two-crew pilot operations; extension to air traffic control, cabin crew, single-pilot, and maintenance populations will require domain-specific adaptation.

Future work should pursue prototype implementation studies in partnership with operators willing to integrate psychosocial competencies into their EBT cycles, with paired SMS data collection to evaluate effects at both the individual and system levels. A parallel line of work should develop and evaluate low-barrier-to-entry support and resilience-building platforms designed specifically for aviation professionals; tools that meet operators where they already are, outside the certification-adjacent environments that typically suppress engagement. Regulatory pathway development, particularly the formal separation of any psychosocial training data from certification records, is a parallel priority without which any future implementation will be unable to secure the workforce trust on which use depends.

## CONCLUSION

The operational middle is the design problem aviation human factors has worked around rather than worked on. It is the population on which everyday safety depends and which current frameworks cannot see. This paper has argued that the discipline now possesses both the theoretical apparatus (i.e., sociotechnical systems theory) and the empirical justification (i.e., convergent internal and external signals) to address the psychosocial layer directly. The Five-Layer Sociotechnical Model locates the design problem; the operational middle construct names the population; existing CRM and EBT architectures provide the integration path through which psychosocial resilience can be operationalized as a trainable, observable, and assessable capability.

Aviation safety evolved by recognizing that technical reliability alone could not produce safe performance. CRM emerged when the industry acknowledged that interpersonal coordination was itself a design surface. The argument advanced here is that the psychosocial conditions underlying that coordination represent the next layer requiring formal integration into safety architecture. Aviation human factors is the discipline best positioned to formalize that integration before it is forced to by the consequences of leaving it undone. The operational middle is not peripheral to aviation safety. It is the human environment in which aviation safety is continuously produced.

## AI USE DISCLOSURE

The author(s) used a large language model (Anthropic Claude) as a writing aid in the preparation of this manuscript. The model was used to support structural organization, language refinement, and consistency editing of author-generated content. The theoretical framework, the Five-Layer Sociotechnical Model, the formalization of the operational middle construct, the training implications discussion, and all interpretive and design claims are the work of the human author(s). The empirical findings cited from prior published work were generated and analyzed by the author(s) in that prior research. All sources were selected and verified by the author(s), who take full responsibility for the content, accuracy, and integrity of this manuscript.

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