

ABSTRACT

MCGRAW, ALEX PATRICK. "Train Like you Fight": A Literature Review of Best Practices for Training Marines to Perform in Stressful Combat Situations. (Under the direction of Dr. Susan Barcinas).

United States Marines are charged with defending national security by operating in extremely stressful, life-threatening situations. The stress and stakes of combat create a moral obligation to train Marines as best as possible to face these challenges. The danger of combat, however, makes effective, realistic training difficult to execute and study. Effective training is further constrained by limited resources, organizational culture, and continuously advancing training science and technology. This literature review addresses these challenges by asking the following research question: How does the empirical and best practice literature contribute to our understanding of the most effective ways to train Marines for combat? The paper draws on research from stress science, high-reliability occupations (HRO), and simulation training. It introduces the impacts of stress, stress coping mechanisms, and the interaction of stress, training, and performance. The review presents simulation training as a common instructional method for realistic training in HROs. It proposes several principles for simulation training: types, fidelity, phases, challenge, support, repetition, progression, tailoring, inducing stress, instructor role, and evaluation. The paper concludes with ideas for Marine trainers that wish to use simulation to train their Marines for stressful situations and suggests further research on this important topic.

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“Train Like You Fight”: A Literature Review of Best Practices for Training Marines to Perform
in Stressful Combat Situations

by
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DEDICATION

This work is dedicated to the 13 U.S. servicemembers who were killed on August 26, 2021, while supporting the evacuation at Hamid Karzai International Airport in Kabul, Afghanistan. They ran to the sound of gunfire.

Marine Corps Staff Sergeant Darin T. Hoover

Marine Corps Sergeant Johanny Rosario Pichardo

Marine Corps Sergeant Nicole L. Gee

Marine Corps Corporal Hunter Lopez

Marine Corps Corporal Daegan W. Page

Marine Corps Corporal Humberto A. Sanchez

Marine Corps Lance Corporal David L. Espinoza

Marine Corps Lance Corporal Jared M. Schmitz

Marine Corps Lance Corporal Rylee J. McCollum

Marine Corps Lance Corporal Dylan R. Merola

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BIOGRAPHY

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Alex is married to the former Alison Katherine Thomson. They are the proud parents of three girls and three boys.

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TABLE OF CONTENTS

LIST OF TABLES	vii
LIST OF FIGURES	viii
CHAPTER 1: INTRODUCTION	1
Problem Statement	1
Purpose Statement.....	2
Research Question	2
Definitions.....	2
Effective	3
Train	4
Combat.....	6
High-Reliability Occupations	7
Marines	9
Detailed Problem Discussion.....	11
Organizational Culture and Change Attitudes	12
Limited Resources	13
Personnel Turnover.....	14
Lack of Institutional Knowledge	15
Efforts to Solve the Problem.....	17
Conceptual Framework.....	18
Study Significance	18
Limitations	19
Delimitations.....	19
CHAPTER 2: LITERATURE REVIEW	21
Stress	21
Stress Defined	21
Stress Effects.....	21
Stress Coping	26
Training and Stress	30
Training for Stress.....	31
Simulation Training	36
Simulation Defined	36
Simulation Design.....	43
Simulation Types	43
Fidelity	48
Simulation Phases	56
Challenge, Support, Repetition, Progression, and Tailoring	57
Inducing Stress.....	70
Instructor Role	73
Evaluation	81
CHAPTER 3: DISCUSSION AND IMPLICATIONS FOR PRACTICE	86
Challenges of Training for War	86
Stress, Performance, and Training	87
Coping with Stress	88
Increasing Realism and Stress	89

Increasing Complexity	90
Cultural Considerations	91
Simulation Training	92
Simulation as an Approach	92
Training Quality and Quantity	93
Cultural Considerations	95
Instructor Importance	96
Instructor Development	96
Dangers of Negative Training Transfer	97
Cultural Considerations	100
Suggestions for Future Research	101
REFERENCES	104

LIST OF TABLES

Table 2.1	Approaches to Training for Stress.....	35
Table 2.2	Simulation Definitions.	37
Table 2.3	Simulation Advantages and Disadvantages.	42
Table 2.4	Simulation Fidelity Definitions.	51

LIST OF FIGURES

Figure 2.1	Simulation Principles.	43
Figure 2.2	Challenge, Support, Repetition, Progression, Tailoring.....	58
Figure 3.1	Stress, Performance, and Training Interaction.	88
Figure 3.2	Training for Stress: Implementation Ideas.	92
Figure 3.3	Simulation Training: Implementation Ideas.....	96
Figure 3.4	Instructor Importance: Implementation Ideas.	101

CHAPTER 1: INTRODUCTION

Problem Statement

War is complex and dangerous, but it is an essential element of national power (United States Marine Corps, 2018, ch. 2, p. 5). The nature of war includes friction, uncertainty, fluidity, disorder, complexity, the human dimension, violence, danger, and physical, moral, and mental forces (United States Marine Corps, 2018, ch. 1). To prepare for these factors, **“training must be focused on winning in combat in the most challenging conditions and operating environments”** (Berger, 2019, p. 17, emphasis in original). Leaders have a moral imperative to prepare Marines for combat in the most effective ways possible so that the nation can accomplish its national security objectives and so that Marines have the best chance of surviving and succeeding.

This is difficult, however, because realistic combat training, like many high-reliability occupations, is both dangerous and resource intensive (Baumann et al., 2011). To best train Marines to perform under the stress of combat, Marine leaders should leverage all available research on this type of training. This paper will examine the literature to address the following question: How does the empirical and best practice literature contribute to our understanding of the most effective ways to train Marines for combat?

This literature review will take a pragmatic approach—if a study has relevance to the problem, then it will be considered. This method leads to a multidisciplinary and somewhat eclectic review. For example, theories of behaviorism, neuroscience, and learning support each have a place. Similarly, data from military research and other high-reliability occupations like police, first responders, emergency medicine, and aviation are useful. Following the literature review, the thesis will conclude with a discussion of implications for Marine training.

Purpose Statement

The purpose of this literature review is to coalesce research on training and to inform instructional strategies relevant to performance in high-stress, high-danger, and high-reliability situations. Marine Corps training and education doctrine consistently urges Marines to train in realistic, stressful situations that mimic combat (United States Marine Corps, 2016, ch. 3, p. 7, 2018, ch. 3, p. 10, 2020b, ch. 1, p. 7, 2022, ch. 3, p. 66). This guidance notes the need to stress trainees so that they are challenged to grow but are not overwhelmed (United States Marine Corps, 2016, app. C, p. 17). Despite a wide-ranging discussion of adult learning theories (United States Marine Corps, 2016, app. C), Marine training publications do little to suggest what works—and what does not—when training for high-stress situations like combat.

Policymakers may have left decision space in these publications to decentralize decisions, provide maximum flexibility to leaders, and account for evolving research (United States Marine Corps, 2018, ch. 3, p. 9). While this flexibility is understandable, many leaders charged with training Marines have minimal knowledge of training science. Additional empirically driven guidance would help these leaders develop and implement more effective and efficient training.

Research Question

The research question that directs this review is:

RQ 1: How does the empirical and best practice literature contribute to our understanding of the most effective ways to train Marines for combat?

Definitions

Several terms must be defined to support the literature review: *effective*, *train*, *combat*, *high-reliability occupations*, and *Marines*.

Effective

Effective training is training that positively effects performance. This implies that training effects can be measured consistently. While this suggests quantitative measurement, it does not limit the review to quantitative, experimental designs. It acknowledges that there are many ways of knowing, and that qualitative results can be just as applicable.

Effectiveness can be both absolute and relative. Training is effective in the absolute sense if it improves performance compared to no training. If an untrained person runs a 12:00 minute mile, completes a training intervention, then runs a 10:00 mile, then the training had an absolute effect. Closely related to absolute effectiveness is training standards. If the trainee runs a 10:00 mile but the standard is a 7:00 mile, then the training was effective in some sense but not effective *enough*. Because training consumes resources, it is important to understand performance standards—when is training *good enough*?

This leads to the concept of relative effectiveness. If one training intervention leads our untrained 12:00 runner to a 7:00 pace and another intervention results in a 6:00 pace, then both options are absolutely effective, but the second intervention is more effective compared to the first. Again, there is more nuance here. Take two training interventions with all factors equal, but one intervention takes 8 weeks and the other 12. The 8-week program leads to a 7:00 mile, and the 12-week program leads to a 6:00 mile. While the longer program produces greater performance, it also costs more resources. Effectiveness, then, is moderated by the concept of efficiency, or training that delivers the best “bang for the buck” while meeting the standard. If the standard is a 7:00 mile, then the trainer would likely choose the more efficient 8-week program to conserve limited training resources.

Train

According to Somasundaram and Egan (2004), there are at least 35 definitions of “training,” and some scholars even reject the notion of defining training as too constrictive. Among these definitions four themes arise: “develop or gain knowledge, develop or gain skills, improve performance, (and) improve organizational efficiency” (Somasundaram & Egan, 2004, p. 855). The Wiley Blackwell Handbook of the Psychology of Training, Development, and Performance Improvement describes training as “events facilitating the acquisition of knowledge, skills, and attitudes (KSAs) relevant to an immediate or forthcoming role” (Kraiger et al., 2014, p. 4). The Association for Talent Development defines training as “a formal process by which talent development professionals help individuals improve performance at work” through “activity that helps employees acquire new, or improve existing, knowledge or skills” (n.d.-b). Each of these definitions has both an internal, individual-level element and an external, performance-based, organizational-level element. To call an activity “training,” it is not enough to acquire knowledge, skills, and attitudes (KSAs)—these must be applied to improve individual and group performance.

The Marine Corps defines training as the “the process by which skills are developed through progressive repetition of tasks commensurate with required capabilities” (United States Marine Corps, 2016, app. M, p. 10). It nests this definition within the broader goal of “learning,” which is aimed at “changing behaviors to reach intended goals driven by strategic, operational, and tactical demands” (United States Marine Corps, 2016, ch. 1., p. 2). The Marine Corps, then, follows the literature in defining training as a combination of the individual acquisition of KSAs and the application of these behaviors to improve collective performance.

In U.S. military doctrine and culture, training is also distinguished from education. Training “prepares Marines to deal with the known factors of war” while education “prepares Marines to deal with the unknown factors” (United States Marine Corps, 2020b, ch. 1, p. 4). The distinction between training and education is well ingrained in U.S. military culture (Gleiman & Zacharakis, 2016). Many professionals view training as focused on specific skills that are easily practiced and quantified and education as centered on critical thinking and decision-making (Gleiman & Zacharakis, 2016, p. 87). This dichotomy is reinforced by organizational structures that break training and education enterprises into distinct commands within the larger institution (Training and Education Command, n.d.).

However, both training and education are important. They exist on a mutually dependent spectrum. In some scenarios, like developing an operations plan, critical thinking and decision-making informed by education will carry greater weight, but these plans will be useless without the trained skills to communicate, execute, and supervise these decisions. Conversely, a situation might rely heavily on trained behaviors like shooting, moving, and communicating to attack an enemy position, but these skills will be misapplied without adequate education to enable Marines to think about and judge the most appropriate actions for the problem at hand. It is impossible to completely separate training from education.

To manage scope and address the primary audience—Marine training professionals—this paper will focus on those situations and techniques that align with the Marine Corps definition of training: “the process by which skills are developed through progressive repetition of tasks” (United States Marine Corps, 2016, app. M, p. 10). However, this literature review cannot neglect the need for critical thinking training that enables successful real-life skill application.

Therefore, it will also recognize that training must target “goals driven by strategic, operational, and tactical demands” (United States Marine Corps, 2016, ch. 1., p. 2).

Combat

If war is the “violent clash of interests between or among organized groups characterized by the use of military force” (United States Marine Corps, 2018, ch. 1, p. 3), then combat is the actual violent application of that force. War is marked by friction, uncertainty, fluidity, disorder, complexity, the human dimension, violence, danger, and physical, moral, and mental forces (United States Marine Corps, 2018, ch. 1). The nature of war is important for the research question because acute stress impacts performance (Nieuwenhuys & Oudejans, 2017; Ohlson & Hammermeister, 2011).

It is important to remember that training for combat cannot fully replicate war’s intense violence. A running coach can implement a training plan that closely simulates race conditions with minimal adverse effects or ethical concerns, then test the results on race day. A military trainer can increase realism through simulation or proxy stressors, but could never test learning with live-fire, force-on-force training. Further, a Marine may train for an entire career but never employ that training in combat. While this could be a welcome indicator of effective deterrence, it makes empirical study of training effectiveness grounded in real-life results nearly impossible.

Combat stressors are further stratified by duration. In the short-term—minutes to hours—the chaos and confusion of a dangerous scenario induces a physiological fight-or-flight response, often paired with physical exhaustion because of the demanding environment (Jensen & Wrisberg, 2014; Shia et al., 2015). In the mid-term—days to weeks of sustained combat—Marines experience the cumulative effects of hunger, dehydration, fatigue, and hypervigilance (W. C. Harris et al., 2005; Lieberman et al., 2005; Tait et al., 2022). In the long-term—weeks to

months and years—repeated exposure to combat stress adds up, sometimes resulting in combat fatigue or post-traumatic stress (Britt et al., 2017; Riolli & Savicki, 2010). These stressors compound to affect performance and decision-making along all three horizons. Each timeframe reveals important implications for Marine development. However, when this paper addresses stress, it will focus on the effects of acute stress in the immediate situation. The emphasis will be on how to best train Marines to observe, orient, decide, and act (complete the “OODA loop”) (United States Marine Corps, 2020b, ch. 1, p. 6) in these acutely stressful scenarios.

High-Reliability Occupations

Many related occupations share attributes with stressful military operations including emergency medicine (DeMaria Jr. et al., 2010; Facho et al., 2021), disaster response (Rafferty-Semon et al., 2017; Wiese et al., 2021), firefighting (Baumann et al., 2011; Clifford et al., 2021) and aviation (Kinney & O’Hare, 2020; Landman et al., 2017; Martin et al., 2015). The literature terms this broad category of jobs that require high functioning to meet strict demands “high-reliability occupations” (HRO) (Flin, 2001, p. 253).

Warfighting, however, features greater stress and danger than most of these professions. Policing is the closest analog in that it frequently includes a potentially deadly clash of human wills (Baldwin et al., 2022; Li et al., 2021; Verhage et al., 2018). But even in policework, officers in lethal conflict typically act in self-defense—they do not enter a scenario with the intent to kill another human being, bad actors notwithstanding. Only in war do the professionals train for the explicit purpose of killing humans and destroying things. This leads to stress that is unique among occupations (Dixon, 2014; Jensen & Wrisberg, 2014).

Recognizing this difference, some scholars have proposed a more distinct stratification for HROs. Hannah et al. (2009, pp. 900–901) split these organizations into three categories.

Trauma organizations are those like emergency medicine and first responders who respond to life threatening situations on a regular, even hourly, basis. While the stakes are ever-present, there is usually little risk to the professional's life, and situations—while life-threatening—are rarely truly “extreme.” By comparison, HROs are those whose operations are fairly routine but require high performance standards because poor performance could quickly lead to disastrous consequences. These include aviation, nuclear power plants, and many functions of police and firefighters. HROs often involve equal danger for the professional and citizens should events go awry. Finally, critical action organizations (CAO) are those whose dangerous situations are less frequent but the most extreme. These contexts can include very high stakes for both the professional and those served. CAOs include the military, police special tactics teams, and specialized rescue teams. Even within these CAOs, the military is unique for the magnitude in which it experiences casualties and the expectation of taking other human lives.

The CAO categorization is the most accurate for describing the military, so this review could be limited only to those occupations. However, HROs in general feature enough in common with the military that research on these professions is useful. In fact, some military support jobs are more closely aligned with Hannah et al.'s HRO definition than CAO because they do not normally participate in direct combat (2009, p. 901). Therefore, this paper will draw from several HROs, although CAOs are weighted more heavily. This definition also excludes other high-performance professions like elite athletes or musicians. While these fields are highly studied for examining elite performance, the stakes are too dissimilar to rely upon for detailed recommendations. Even so, this literature is consulted briefly for its foundational work in exploring intentional practice and progression.

Marines

The term Marines refers to all those serving in the active or reserve United States Marine Corps. Although the Marine Corps is oriented to an amphibious, infantry-centric mission, Marines serve in dozens of military occupational specialties (MOS), each with its unique demands. Many of these jobs and their stresses are paralleled in the other military services or civilian professions. The findings will undoubtedly apply in some ways to other warfighting organizations and high-reliability civilian occupations.

So why limit the paper to the U.S. Marine Corps instead of the military in general or all high-reliability occupations? Since the audience for this best practices review is Marine leaders, it was necessary to focus research to this group. Further, the U.S. Marine Corps has a distinct organizational culture. The Marine Corps defines its culture in official doctrine as one that “includes the maneuver warfare philosophy, an expeditionary mindset, and the pursuit of mastery in the profession of arms, as well as Marine Corps customs, traditions, and legacy” (United States Marine Corps, 2020b, ch. 2, p. 3). It is a “culture of learning that encourages Marines’ adaptability, problem solving, initiative, reasoning, and innovation, while maintaining structure, discipline, and readiness” (United States Marine Corps, 2020b, ch. 2, p. 4).

The Marine ethos is summarized by the official motto: “Semper Fidelis – Always Faithful” (United States Marine Corps, n.d.), and the paper’s title: “Marines run to the sound of gunfire” (Dao, 2012). Semper Fidelis means that Marines are unfailingly loyal to each other, their allies, and their mission, no matter the odds or the personal cost. Marines will not leave another Marine behind. Running to the sound of gunfire conveys the notion that Marines address challenging, dangerous problems head-on rather than avoiding them. In some ways, this ethos self-selects those who aspire to live it. It becomes fully ingrained during entry level training,

which serves as a rite of passage that awards the title “Marine.” Marines further strengthen this ethos every time it is tested in the fire of real-life, stressful situations. This ethos is so central to the Marine that it is simply assumed to exist in all who have earned the title.

Organizational culture can be further defined via the Competing Values Framework (CVF) (Cameron & Quinn, 2011, p. 39). The CVF splits organizational culture into four quadrants based on the organization’s tendency towards flexibility versus stability and internal versus external focus. These quadrants are defined as clan (collaborate—flexible/internal focus), adhocracy (create—flexible/external focus), hierarchy (control—stable/internal focus), and market (compete—stable/external focus). The Marine Corps is dominated by the competitive market culture, followed by hierarchy, clan, and adhocracy. This assessment is supported by the author’s personal observations and informal peer surveys as well as by formal studies of Marine culture (Pollman, 2015). A later study focused on Reserve Marines found the same dominance of market culture within the active forces, although it noted that reservists tended to see their subculture as more clan-oriented (Borrego, 2019). The CVF does depict Marine culture as similar to U.S. Army culture (Pollman, 2018), but this is likely the result of common aspects in all U.S. military culture. The CVF’s four-quadrant framework simplifies organizational culture to help observers compare organizations across broad categories, but it can miss the nuances that separate adjacent organizations with comparable quadrant scores.

Several books have been written about the importance of organizational culture for Marine Corps success compared to the other services (Krulak, 1999). Some have argued that this culture is so strong that it can overcome severe training deficiencies to succeed in combat, such as during the chaotic opening weeks of the Korean War (Hammes, 2010, ch. 12, “Culture”). Organizational culture is offered as a common explanation for why the U.S. Marine Corps has

continued to thrive despite repeated threats to its existence and limited resources compared to other U.S. military services. Terriff (2006) suggests that the institutional paranoia resulting from these challenges has become a dominant feature of Marine Corps culture.

Understanding the unique Marine culture is important for this review of training literature because it identifies what research should be reviewed and informs how it should be presented to the audience to maximize impact. The organization's market culture is primed to continuously learn to improve readiness and honor the legacy of fighting and winning. But this same cultural emphasis on tradition, underscored by the hierarchy culture elements of structure and discipline, make the Corps resistant to change. Any proposed implications for changing training methodologies must therefore be grounded in tried-and-true training science. Recommendations should emphasize the need to increase readiness against the Marine Corps' competitive adversaries. They should demonstrate that any changes to existing training paradigms are the continuation of Marine Corps tendency to continuously innovate to ensure institutional survival. Finally, suggestions can be tied to the Marine ethos. Effective training is important to give Marines the best chance that they will succeed not if, but when they run to the sound of gunfire. It helps them honor their solemn commitment to remain "Semper Fidelis."

Detailed Problem Discussion

Marines do recognize the importance of training—no Marine argues that the Corps should train less or less effectively. Yet several factors erode leaders' ability to train their Marines as effectively as possible, including organizational culture, limited resources, personnel turnover, and lack of institutional knowledge.

Organizational Culture and Change Attitudes

Marine culture and attitudes to change impact training in two ways. First is the organization's cultural quadrant profile according to Cameron and Quinn's (2011) competing values framework. Second, Marine culture includes training-specific idiosyncrasies.

Although the Marine Corps is first a market culture, its status as a government entity with rigid disciplinary standards and highly regulated processes mean that hierarchy culture strongly influences the organization. Resistance to change is inherent in strong hierarchies. Recent criticism of the Marine Corps' Force Design (FD) 2030 modernization initiative shows this resistance is alive and well (Center for Strategic & International Studies, 2022). This manifests as both resistance to change in general and as resistance to specific techniques like student-centered learning or teaching critical thinking to junior Marines who traditionally were expected to simply follow orders. Fortunately, the Marine Corps is first and foremost a competitive culture that seeks to win no matter the odds. If the threat is strong enough, it has consistently overcome bureaucratic inertia to innovate and improve performance. As long as Marines understand the importance of more effective training for maximizing success, this competitive mindset can overcome hierarchical resistance to change.

The Corps' competitive culture naturally leads to a strong training culture. Marine doctrine establishes training as a foundational element of preparing for war (United States Marine Corps, 2018, ch. 3, p. 8). This ethos begins with rigorous training in boot camp and officer candidates school, where training takes on a mythical status and successful completion results in trainees being awarded the title "Marine." Non-deployed Fleet Marine Force (FMF or simply "fleet") units consider training their primary job, and much of the supporting establishment is devoted to training—over 7,000 servicemembers are assigned to Training and

Education Command, which trains over 140,000 students annually (Training and Education Command, 2021, slide 7). The recognition of training importance does not, however, guarantee that leaders conduct training effectively or efficiently.

Limited Resources

Like any organization, the Marine Corps does not possess unlimited training resources. It must choose wisely how to spend on training expenses including equipment, supplies, technology, facilities, and travel. Government fiscal policies add another layer of complexity, making it difficult to remain agile in addressing training needs. Time is also limited. There are only 24 hours in a day, and use must be balanced to achieve organizational goals. This means that training must be prioritized by type—for example, MOS versus basic combat skills versus compliance training—and training also competes against maintenance, administration, and Marine rest and recovery to foster growth and prevent burnout.

This balancing act is known in project management as the “big three” of time, resources/cost, and scope/quality (Horine, 2017, p. 16). Practitioners generally accept that projects must sacrifice one of these elements to emphasize the other two. For example, if a project needs to be completed fast and be high quality or large scope, it will consume significant resources. Instructional design experts have proposed a similar triangle, balancing instructional effectiveness, efficiency, and appeal (Honebein & Honebein, 2015, p. 939). If the instructional designer desires training that is effective and appealing to the learner, it will not be efficient—it will cost considerable time and resources to plan and implement. Limited Marine Corps resources means that leaders must operate within the constraints of these parallel triangles.

Resource limitations are particularly acute in the Marine Corps, which is disproportionately under-resourced compared to the other services. In the fiscal year 2023

Department of Defense (DoD) budget request, the Marine Corps comprises over 13% of the active duty force but is assigned only 6.5% of the budget (Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, 2022). Culturally, the Marine Corps has developed a reputation as “penny pinchers” (Krulak, 1999, p. 141) that can do more with less. Most recently, Commandant General David H. Berger’s aggressive “divest-to-modernize” strategy within FD 2030 has cut older weapon systems to release funding for higher priority investments, including training improvements (Berger, 2022, pp. 12–13, 15). These efforts demonstrate the Corps’ ability to “do more with less” but underscore the challenging resource constraints it faces.

Personnel Turnover

The Marine Corps is also limited by personnel turnover. At the service level, the Corps turns over 75% of first term enlistees every year, representing 20% of the total active duty force (Berger, 2021, p. 6). This translates to millions of dollars and hours of training investment leaving active duty. Those who do serve past their first tour are subject to permanent change of station orders. In some cases, they transfer to another fleet unit. There, the training they completed during their first tour becomes an immediate asset which they can build upon with more advanced training. By the end of their second tour, however, nearly all Marines have been assigned to a supporting establishment tour outside the fleet. These tours are important to broaden individual experience and support Marine Corps functioning; indeed, many of these tours see Marines apply their training and experience as instructors. Unfortunately, almost all these assignments—even many of the instructor positions—result in skill decay, requiring the Marine to retrain when he returns to the fleet. This turnover also affects instructor development.

An instructor might master her craft during a schoolhouse tour but then serve multiple assignments elsewhere before returning to a training billet, if ever.

Turnover related cultural impacts fall along two lines: retention and attitudes towards training. The Corps prides itself on being “the best of the best” so it has typically focused more on intrinsic motivators and has used tangible retention incentives less often than other services. Even with recent recruiting challenges and talent management reforms, senior Marine leaders emphasize that “your bonus is that you get to call yourself a Marine” (Smith in Ziezulewicz, 2023). While this may seem trite or tone deaf, nearly any Marine would confirm that earning the title “Marine” is a substantial motivator and a core part of their identity. Nevertheless, any failure to retain the best trained Marines and instructors is a wasted investment.

Historically, training has been an important part of the culture. However, spending significant time away at training and education courses—especially lengthy professional military education degree courses lasting 2 years—has been seen as less prestigious as competing challenging billets within a Marine’s primary MOS. Likewise, instructor duty has been seen as a benefit if selected to instruct at a prominent school. In some communities, however, assignment as an instructor for less demanding courses—like entry-level MOS schools—is perceived as being for middling leaders who are not high-performing enough to compete for elite-level billets. In sum, the culture values training and education as both a student and instructor, but it is wary of those that deviate from preferred career paths.

Lack of Institutional Knowledge

The Marine Corps collectively lacks the institutional knowledge of the most effective and efficient training practices. This is not for lack of specific training knowledge. The Marine Corps Instructional Systems Design/Systems Approach to Training and Education (ISD/SATE)

Handbook (United States Marine Corps, 2016) is both practical and forward-thinking. Instructor development has improved through multiple changes over the past decade. The latest FD 2030 guidance emphasizes the need to continually improve training (Berger, 2023). Training technology and science is advancing so quickly, however, that the organization struggles to keep pace. Personnel turnover exacerbates this problem, making it difficult to build and sustain collective knowledge on the most effective training techniques.

The problem, then, is not a general lack of knowledge about training, but knowledge about specific techniques and spreading this knowledge beyond a small cadre of training experts. First, there is often a lack of focus on the importance of training Marines to perform in high risk situations, amplified by the distraction of competing priorities. Second, there is a misunderstanding of training techniques like simulation. Many Marines do not recognize that simulation types exist on a spectrum—there are many options for training a range of attitudes, behaviors, and cognitive abilities in stressful situations. Third, many Marines are uncertain how to use new technology. The organization must balance two extreme attitudes: one that believes future technology is a panacea that will solve every training problem and should be wholly adopted without critical thought, versus one that believes the old ways work best and technology can never replicate realistic live training. The reality is more nuanced and requires a balanced approach, particularly as advanced simulation technologies become mature enough to replace legacy training methods. Finally, while there are highly talented Marines who understand the complexities of realistic training and instruction, this expertise is limited compared to the need to train Marines in every rank and MOS.

Efforts to Solve the Problem

Acknowledging these issues, the Marine Corps has already taken some steps in the right direction. According to the Burke-Litwin model, the environment is the primary driver of organizational change (Burke & Litwin, 1992, p. 528). This is clearly the case for FD 2030, as organizational messaging repeatedly references the need to keep pace with threats as the DoD changes focus from the global war on terror to great power competition (Berger, 2021, 2022, 2023). To meet this challenge, the Marine Corps has implemented more competitive force-on-force exercises like the Marine Air-Ground Task Force Warfighting Exercise; more realistic small arms training; basic infantry courses that stress more critical thinking and decentralize decision-making; and more educational wargaming within professional military education. The latest FD 2030 guidance, Training and Education 2030 (Berger, 2023), highlights these improvements and seeks to modernize training and education across the force.

FD 2030 also includes efforts to improve the retention and training culture. Talent management guidance directs the Corps to increase retention to reduce annual turnover and to increase tour lengths to lessen PCS turnover (Berger, 2021, pp. 6, 11). Likewise, training and education guidance seeks to incentivize continued training and education for all Marines and to improve instructor development and assignment (Berger, 2023, pp. 7, 13–14, 16–17). Yet even if these reforms are successful, the combination of resource and personnel limitations means that maintaining training readiness will remain a constant balancing act. To address these challenges, the Marine Corps should return to the research question: how can the empirical and best practice literature contribute to its understanding of the most effective ways to train Marines for combat?

Conceptual Framework

This paper examines several concepts to answer the research question. Because of the Marine Corps' unique status among HROs, the reader must first understand stress, its impacts, how people cope with it, and how stress and training interact. The paper then reviews one training method that is particularly useful for stressful HROs—simulation. It highlights several simulation design principles including types, fidelity, phases, challenge, support, repetition, progression, tailoring, inducing stress, instructor role, and evaluation. Finally, it concludes with ideas for how to better incorporate these principles into simulation training to better prepare Marines for combat within the unique Marine Corps organizational culture.

Study Significance

This review contributes to the literature for Marines and other military professionals by synthesizing the empirical evidence surrounding training in stressful situations. It draws from a range of occupations, concepts, and theories to present implications for combat training. This paper will address this situation for several reasons. First, Marines must efficiently use limited resources (United States Marine Corps, 2016, ch. 1, p. 1). Time, money, and effort spent on training that is not helpful—or worse, counterproductive or dangerous—is a missed opportunity. Additionally, ineffective or inefficient training can impose indirect costs, like decreases in morale that effect recruiting and retention. Second, training technology and science is evolving rapidly. While some of these innovations represent true progress, other developments will prove ineffective or inappropriate for combat training. Empirical research can separate valuable advancements from fads. This is particularly important in an organization with a strong organizational culture that is inherently resistant to change—only those advancements supported by robust evidence will gain the momentum to succeed. Finally, effective training deters our

nation's adversaries (United States Marine Corps, 2020a, ch. 2, p. 15). By using the most effective combat training techniques, we can maintain our "intellectual overmatch" (The Joint Chiefs of Staff, 2020, p. 4) and compel our competitors to think twice about engaging in conflict. This relative advantage can only be sustained if Marine Corps training outpaces adversary training by flexibly implementing evolving training methods.

This multidisciplinary study also has relevance for other HROs. While some recommendations may be specific to Marine training, many of the findings will be useful to trainers in other high-stress occupations. While these occupations adopt different approaches to risk in training that affect how they use simulations, the simulation design principles are just that—principles that can be applied to many different contexts.

Limitations

By adopting a literature review methodology, this paper examines a wide body of existing research but does not directly add new empirical data to the field. While this review is thorough, it is not a systematic meta-analysis, and it is limited to primarily drawing upon literature from the past 15 years. This strategy assumes that recent studies build on previous research and enables closer review of emerging trends and technologies. Some older material, however, was included to demonstrate the lasting effectiveness of concepts like fidelity and repetition. Finally, the review was limited to English language studies in traditional high stress fields. It is possible that non-Western studies or non-traditional high-stress occupations could generate contradictory or novel findings.

Delimitations

For the sake of scope, this review largely ignores the long-term effects of combat stress and its training implications, an important topic for military professionals. It only minimally

accounts for medium-term effects like sleep loss and hunger that compound stress over several days. Likewise, this paper generally avoids stress and training effects on team performance to focus on how stress and training impact individuals. Finally, by concentrating on training rather than education, this review may overemphasize methods for training discrete or instrumental skills while neglecting the education required to develop the judgment necessary to combine and apply these skills in combat situations.

CHAPTER 2: LITERATURE REVIEW

Stress

Stress Defined

The American Psychological Association defines stress as “the physiological or psychological response to internal or external stressors” (n.d.-e). Stressors may include challenging tasks, the prospect of evaluation, a harsh environment, and fatigue (Matthews, 2016, p. 804). Stress affects people physically and psychologically, in both the short- and long-term. Stress responses vary widely based on individual differences. These responses in turn affect performance and learning. Although the term stress is often associated with the negative effects of “distress” (American Psychological Association, n.d.-a), it can also result in “eustress” (American Psychological Association, n.d.-b) which leads to positive effects through challenge and growth. This distinction is important when considering the causes and effects of stress on performance and training.

Stress Effects

Physiological and Psychological Effects. When exposed to an unexpected, stressful event, the body responds in several ways. First there is an immediate “physical reflex” towards the threat and the “fight or flight...hormonal reaction” kicks in, followed by the activation of the sympathetic nervous system—what the aviation literature calls “startle.” This fight or flight reaction floods “the body with the energy and resources to deal with life threatening situations” (Martin et al., 2015, p. 98). Physiologically, heart rate, blood pressure, and cortisol levels rise; the senses are impacted by hearing loss and tunnel vision; and brain functioning is impaired by memory loss and inaccuracy (Verhage et al., 2018, p. 347). Psychologically, stress creates fear. Acute and chronic stress can cause trauma, leading to “flashback(s)... irritability, avoidance, and

negative thoughts or feelings” (Verhage et al., 2018, p. 348). In extreme cases, the physical and psychological response escalates from fight or flight to “freeze,” in which the person becomes so overwhelmed they cease to function effectively (Leach, 2004; Schmidt et al., 2008).

Effects on Performance – Positive. The fight or flight (or freeze) response is an adaptation designed to maximize survival in threatening situations. It prioritizes physiological and psychological functions that boost short term performance. In stressful situations, elevated cortisol can cause the brain’s prefrontal cortex to take greater control and increase working memory (Vartanian et al., 2017, p. 352). This leads to a feeling of being “in the zone” or a “flow state” (Csikszentmihalyi, 1990) and increased performance. There is an “inverted u-relationship,” where performance is highest when stress is elevated above baseline but not so high as to overwhelm the person (Balters et al., 2020, p. 1). Military theorists have intuited this, proposing that brief periods of elevated stress—such as when leaders exhort their charges to higher performance during a critical point in a battle—can increase performance, as long as these periods are not prolonged, leading to chronic, detrimental stress (Cheatham, 2018, p. 26).

Additionally, stress can positively affect performance when it is experienced as eustress rather than distress. Both sports and military psychology emphasize seeing stress as a positive challenge that can stimulate growth rather than as a negative that inhibits performance (Arnold & Fletcher, 2021, p. 264; Wagstaff & Leach, 2015).

Effects on Performance – Negative. Although the stress response can elevate performance, it often impairs it. Stress degrades performance through decreased cognitive processing and reduced physical skills (Verhage et al., 2018, p. 348). Researchers have studied shooting performance extensively to measure stress effects on physical abilities. A recent meta-study showed that pressure consistently decreases marksmanship (D. Cooper et al., 2022). In

particular, the fear of being shot at increases physiological and psychological stress markers and leads to decreased working memory, cognitive performance, and shooting accuracy (Landman et al., 2016b; Taverniers et al., 2011, p. 113; Taverniers & De Boeck, 2014). Similarly, in highly realistic, life-or-death combat medicine simulations, higher stress reactivity leads to decreased performance in treatment and triage (McGraw et al., 2013, p. 142).

Stress also diminishes performance in higher order functions like communication and decision making (Renden et al., 2017, p. 116). In police work, for example, this results in not only lower performance but also more use of force errors (Baldwin et al., 2022, p. 1). The decreased cognitive and physical functioning that results from stress is more likely to have an impact as scenarios complexity increases (Zach et al., 2007). Higher anxiety negatively affects performance even for those with more training and experience. In a study of police performance in arrest and self-defense tasks, all participants performed worse in the high anxiety than low anxiety condition, even those with extensive martial arts practice (Renden et al., 2015, p. 1496).

Why does stress have such a strong impact on performance? Stress impairs situational awareness and decision-making by decreasing attentional control (Eysenck et al., 2007). This makes the person more likely to interpret information as a threat and primes the body to react against a stressor (Nieuwenhuys & Oudejans, 2017, p. 30). This priming is known as “hypervigilance.” In combat, the likelihood that boredom will instantly escalate to a life-threatening challenge increases the tendency towards hypervigilance (Jensen & Wrisberg, 2014, p. 419). Military research has shown the “overwhelmingly adverse impact of multiple stressors on cognitive performance, mood, and physiologic parameters” (Lieberman et al., 2005, p. 422). Compounded over time, fatigue caused by hypervigilance leads to “a large-magnitude loss of task engagement, representing the fatigue characteristic of operational environments” (Matthews

et al., 2014, p. 868). In high stress, dangerous situations like policing, hypervigilance can negatively impact decision-making in critical areas like use of force (Junger, 2018). Even in more monotonous military contexts where direct combat is unlikely, like unmanned aerial vehicle operations, the combination of multitasking and vigilance for hours without relief can impose stress and reduce performance (Guznov et al., 2017). Considering the need for Marines to operate effectively and ethically in highly complex, life-threatening scenarios, the strong evidence for stress-induced hypervigilance and poor decision making is concerning.

Interestingly, not all research agrees on this effect. One police study showed that while pressure increased stress and decreased accuracy, it did not significantly affect decisions to shoot or not shoot (Landman et al., 2016a, pp. 958–959). This might be because the mere presence of anxiety does not affect performance; it is whether the person allows anxiety to unsettle them. A study of U.S. Army shooting accuracy found anxiety did not correlate with poor performance unless it led to “cognitive disruption” (Ohlson & Hammermeister, 2011, p. 107). Likewise, a study of students with no flight experience found that even though all students displayed the same levels of increased anxiety during the live-flight test, those who trained in a simulator while subject to a stressor performed better than those who completed the simulator without a stressor, (McClermon et al., 2011). Finally, in a study of police recruits, Giessing et al. (2019, p. 11) found that increased self-control actually decreased shooting performance in a high stress force-on-force scenario, perhaps because the focus on emotional regulation diverted these novices’ attention from shooting accurately.

Long-Term Effects. The fight or flight response maximizes reactions to short term threats to increase survival chances. When stress persists, the psychological and physiological responses compound, usually to the detriment of the person. In military operations, the

continuous stress of challenging tasks and pressure to perform, amplified by environmental and individual factors like weather, sleep deprivation, dehydration, malnutrition, and physical exhaustion, lead to decreased performance (Tait et al., 2022). These impacts manifest in as little as 2–3 days and even with the most experienced, well-trained military professionals (Lieberman et al., 2005). While stressed individuals may initially be able to push through these cumulative effects, their performance quickly deteriorates, especially in complex thought processes like logical reasoning (W. C. Harris et al., 2005). Fortunately, there is evidence that the human body is resilient and can rebound from these effects within days. The body can recover even with only a moderate amount of rest and some of the stressors still in place. For example, simply transitioning from an extremely austere field environment with minimal sleep to a less stressful expeditionary base environment that was still far more demanding than living in garrison led to significant performance improvements in entry-level Australian soldiers (Tait et al., 2022).

If, however, the stress is not relieved, it can become chronic and lead to persistent physical and psychological problems (Stephenson et al., 2022, pp. 3–4). One of the most common long-term results of combat stress is posttraumatic stress disorder (PTSD). Following a traumatic event, a person may experience recurring flashbacks or nightmares, avoidance of or numbness to situations that remind them of the trauma, excess arousal in response to perceived threats, and survivor's guilt (American Psychological Association, n.d.-c). Although the focus of this paper is not on training Marines to handle posttraumatic stress, it is important to recognize stress' complex and enduring impacts. By better training Marines to perform in acute stressful scenarios, they will likely experience less stress both in the moment and immediately after the fact, because their success will reduce pressure. In turn, this will lead to less stress compounding over time and less incidence of PTSD.

Recognizing the potential impacts of stress, Marine Corps doctrine states that “Marines of all ranks must understand how the body and mind respond to fear and stress so that they better control their responses in any situation, including combat” (United States Marine Corps, 2020b, ch. 1, p. 14). Given the complex effects of stress, perhaps Marine Corps doctrine should not focus on *controlling* stress response but on how to *develop skills to think, decide, and act* in stressful situations.

Stress Coping

Stress response varies widely between persons (Matthews, 2021). Individual differences arise from distinct coping styles, emotional regulation skills, personal resiliency, personality traits, and experience levels. It is important to understand these differences to tailor training based on individual needs.

Coping Styles. Many attribute stress response variations to an individual’s “action orientation” (Kuhl, 1994, in Landman et al., 2016b, p. 571). Kuhl theorized that, in stressful situations, people adopt either a decision or threat orientation. Those with a decision orientation maintain a task focus. In doing so, they control their emotions, recognize long-term impacts, and manage their behavior, leading to better performance under stress. By comparison, those with a threat orientation tend to become overwhelmed by their emotions and adopt an avoidance focus as a defense mechanism, usually leading to poorer decision-making and comparatively reduced performance (Renden et al., 2014, p. 100).

Several researchers have examined the difference between these strategies. A qualitative study of real-life hand-to-hand fighting found that combatants adopted a behavioral task focus by allowing their training to take over to address the immediate threat (Jensen & Wrisberg, 2014, pp. 419–420). Although these situations were emotionally charged, participants channeled their

emotions to motivate a “problem-focused” approach and generate appropriate force to resolve the threat rather than the alternative where their emotions take over and lead to a threat avoidance approach. Likewise, K.R. Harris et al. (2017, p. 1117) found that elite police officers channel their training and stress response to adapt a challenge rather than threat focus when handling life-threatening situations. In aviation, whether a pilot successfully manages an in-flight emergency frequently depends on whether she views the situation as “hopeless” versus “challenging” (Martin et al., 2015, p. 102). Additionally, research on the similarities between military professionals and elite athletes and their high performance under stress shows that performance improves with positive attitude, resilience, emotional regulation, and a growth mindset (Wagstaff & Leach, 2015, p. 65).

Emotional Regulation. Emotions are a significant part of the stress response and have a complex impact on performance. On the one hand, emotions—whether negative or positive—can have a positive effect as they speed cognitive processing (Pegwal et al., 2019). On the other hand, emotions can have a negative effect if they are not properly regulated, influencing both the person and their teammates in a downward spiral (Chrouser et al., 2018). Marines might immediately think of controlling their emotions by suppressing and compartmentalizing them, and some of the literature agrees (Peña & Brody, 2016, pp. 572–573). For example, while experienced police officers believe emotional regulation is part of successful job performance, they rate emotion low compared to attitudes like confidence, desire, and motivation (Preddy et al., 2020, p. 386). Simple training to improve emotional regulation might employ controlled breathing (K. R. Harris et al., 2017, p. 1118; Hourani et al., 2018) or attempt to increase attentional control to complete tasks while distracted (Ben-Avraham et al., 2022).

Recent research, however, has found multiple effective emotional regulation strategies, including “situation selection” (removing oneself from or avoiding the situation), “situation modification” (changing the situation while one is in it), “attentional deployment” (distracting oneself or focusing on the task rather than the emotion), “cognitive change” (changing the way one thinks about the situation, which then changes emotions), “response modulation” (directly altering one’s emotional response) and “authentic expression of emotion without modification” (Gagnon & Monties, 2023, p. 85). This last category is noteworthy because it allows for emotional expression rather than merely suppressing or compartmentalizing it. It echoes previously discussed research showing that emotions can be channeled to improve performance in deadly situations (K. R. Harris et al., 2017; Jensen & Wrisberg, 2014). Under this model, training for emotional regulation should teach strategies that encourage the person to acknowledge their emotions, process them, and use them for positive ends rather than compartmentalize or ignore them (Crane, Rapport, et al., 2019).

Long-Term Resilience. Psychologists have also studied the impact of coping strategies and behavior on stress’ long-term effects. Riolli & Savicki found in a study of 638 Iraq War veterans that positive coping strategies including “positive reinterpretation, emotional social support, and humor” improved outcomes, while negative coping behaviors such as “venting emotions, denial, mental disengagement, behavioral disengagement, and alcohol and drug use” were harmful (2010, p. 97). Further, research on combat PTSD indicates there is a difference between active and passive participation in stressful combat events (Britt et al., 2017). When combatants have the chance to actively impact the outcome of a stressful scenario—to “fight back”—they are more likely to experience posttraumatic stress but are also more likely to derive posttraumatic growth from these experiences and view them as positive. Conversely, those who

merely see or are subject to violent combat with no ability to respond are less likely to grow and heal from this trauma.

However, the research on PTSD and coping varies. A study of Canadian police trainees (LeBlanc et al., 2008, p. 89) found that coping style has no effect on performance, perhaps indicating that in the moment, training takes over, regardless of personality. The authors did find, however, that a task-oriented style is more effective than emotional or avoidance styles at both lowering immediate physiological stress responses and preventing long-term trauma.

Personality and Coping. According to Matthews et al., whether a person takes a decision/task-oriented approach or a threat/emotion-oriented approach is influenced by individual traits “including broad superfactors (e.g., neuroticism), specialized general resilience traits (e.g., hardiness), emotion-regulation traits (e.g., emotional intelligence), and contextualized traits (e.g., test anxiety)” (2017, p. 144). Delahajj et al. found that those whose personality defaults to a task-focused coping style tend to adopt task-focused coping behavior and perform better than those with an emotionally-focused style and behavior (2011, pp. 61–62). Similarly, the personality traits of “low sensitivity to threat (BIS), high self-control strength (AOT) and affinity for thrill and adventure (TAS)” are linked to higher police shooting performance (Landman et al., 2016a, p. 959). Finally, research on complex arrest scenarios found that higher trait anxiety—or default personality tendencies towards anxiety—led to higher state anxiety in both low and high stress situations, although trait anxiety did not directly correlate with performance (Renden et al., 2017, p. 122).

Stress and Experience. Greater experience is widely acknowledged to reduce anxiety and improve performance in high-stress scenarios. Studies have shown that experienced soldiers, police officers, and first responders display less physiological reactivity to stress and greater task

engagement than untrained people or minimally trained novices (Friberg et al., 2021; LeBlanc et al., 2008; Lieberman et al., 2005, p. 427). Experience improves shooting performance in threatening force-on-force scenarios (D. Cooper et al., 2022; Landman et al., 2016a, 2016b, p. 576; Vickers & Lewinski, 2012). Experienced high-reliability professionals perform better because their greater depth and breadth of knowledge and skills not only directly increase task proficiency, but also improve problem framing and solving (Clifford et al., 2021; Landman et al., 2017; Mohrmann et al., 2015) and generate confidence that leads to a challenge rather than threat avoidance attitude (Martin et al., 2015, p. 102). Therefore, while coping traits and style may affect behavioral orientation to stressors, it is possible to shape these characteristics through training and experience.

Training and Stress

While experience improves performance under stress, developing experience takes time. Recognizing the potentially harmful impact of stress, HROs have developed myriad training interventions as a proxy for experience to mitigate these effects and improve performance in life-or-death situations. Since training while under stress is a common strategy for improving performance in intense environments, it is important to understand how stress affects training—both positively and negatively.

Stress Effects on Training – Positive. Training while exposed to stressors is often called stress exposure or inoculation training (SET/SIT). Repeated exposure to stress in training has consistently been shown to improve performance in stressful real-life settings (DeMaria Jr. et al., 2010; Heusler & Sutter, 2022; Landman et al., 2018; McClernon et al., 2011; Zach et al., 2007). Stress also stimulates growth through challenge (Taverniers & De Boeck, 2014). Finally, training

that is stressful because it is realistic (Taverniers et al., 2011; Taverniers & De Boeck, 2014) and emotionally charged (DeMaria Jr. et al., 2010) leads to greater learner engagement and learning.

Stress Effects on Training – Negative. Conversely, there are important negative aspects to including stress in training. When trainees experience excessive or poorly timed stress, they cannot learn because they are too focused on the threat (Taverniers et al., 2011). The Marine Corps acknowledges this by noting that trainers must balance the desire to train in realistic, stressful conditions with the need to ensure stress does not harm learning (United States Marine Corps, 2016, ch. 3, p. 7). Just as importantly, overstressed instructors also limit training effectiveness (Thompson, 1989). As military instructors are often subject to high workloads and supervise dangerous training events, managing their stress levels is key for training effectiveness.

Training for Stress

Recognizing the complex impact of stress on performance, HROs have implemented several strategies to train for stress. These methods can be grouped into four broad categories: attitudes towards stress, behavioral conditioning, cognitive processes, and exposure training.

Training Attitudes Towards Stress. Trainees should understand that high-reliability occupations involve life-or-death circumstances which generate extreme stress and impair performance. However, a proactive mentality that acknowledges these often traumatic stresses can greatly improve outcomes. Training to adopt a challenge rather than threat mindset improves performance in stressful scenarios where attention is distracted (Gildea et al., 2007, p. 756). Likewise, a task-oriented focus improves performance in dangerous, high-pressure military situations (Jensen & Wrisberg, 2014; Ohlson & Hammermeister, 2011). This task-oriented stress exposure training can even transfer to unfamiliar stressors and scenarios (Driskell et al., 2001). Long-term, by adopting a growth mindset, trainees are more likely to realize positive benefits

from stress (Crane, Rapport, et al., 2019; Crane, Searle, et al., 2019; Wagstaff & Leach, 2015). Task orientation is also better than emotional, threat avoidance attitudes for preventing long-term trauma (LeBlanc et al., 2008, p. 89). Taking a task-oriented approach to stress which sees pressure as a chance for growth provides the foundational attitude necessary to succeed in high-reliability occupations. Likewise, developing emotional regulation techniques can improve professionals' ability to navigate emotionally complex stressful situations (Crane, Searle, et al., 2019; Fitzwater et al., 2018).

Training Behaviors for Stress. Another strategy is to train discrete behaviors repetitively until they become automatic processes, often called “muscle memory” (United States Marine Corps, 2016, ch. 3, p. 12). This behaviorist training improves reaction times and accuracy (Heusler & Sutter, 2022). It frees up cognitive processing—which is already reduced by stress—for more complex processes like developing situational awareness and making decisions. Automatic response is developed by extensive training (Gamble et al., 2018) and is frequently reported as being relied upon in combat (Jensen & Wrisberg, 2014).

However, the literature cautions that overemphasis on training for automatic behavior can actually be harmful in high risk scenarios. Repetitive training can create “false expertise by automating responses without applying rational thought” in police use of force (Junger, 2018, p. v). HRO training often focuses on preparing trainees for the worst case scenario, which can condition them to overperceive threats, leading to excessively aggressive behavior (Staller et al., 2022, p. 124). Behaviorally centric training turns recruits into great hammers, but it also encourages them to see many nails.

Behavioral training alone does not work when lives are on the line because these scenarios are especially complex. Training must move beyond the foundations of automatic

behaviors to integrate these skills into decision-making during stressful training situations (Renden et al., 2017, p. 126). Experienced Australian police officers identified that behavioral responses should be automatic in deadly force scenarios but must be informed by appropriate assessment and appraisal of the situation (Rajakaruna et al., 2017). Likewise, expert American use of force instructors identified automaticity of behavior as important in deadly force scenarios but only 17th among 23 necessary skills—far less essential than situational awareness, decision-making, critical thinking, and problem solving, which all ranked in the top 5 (Preddy et al., 2020, p. 386). In aviation, high-stress situations can lead to misapplied automatic behaviors unless pilots develop the appropriate metacognitive skills to adapt their mental frames to unexpected scenarios (Landman et al., 2017, p. 1161; Myers et al., 2018).

Thus, at best, training to ingrain automatic behavior is necessary for successful performance but not sufficient. While the behaviorist approach to training develops muscle memory and a strong foundation of combat skills, Marines must progress to more complex training that emphasizes situational awareness, critical thinking, and decision-making abilities that allow the Marine to apply these skills in an integrated fashion.

Cognitive Process Training. As Marines develop the attitudes and behaviors to perform under stress, cognitive process training helps to tie these skills together in application. This training can be as simple as basic drills to build working memory capacity (Blacker et al., 2019). Situational awareness (SA) training teaches the trainee how to efficiently and accurately sense and process information. It reduces mental workload and improves decision-making (Heusler & Sutter, 2022; Papanikou et al., 2021; Saus et al., 2006, p. S4). Other cognitive training focuses on improving critical thinking and decision making (Engel et al., 2022, p. 207; Helsdingen et al., 2010). While trainees who undergo behaviorally focused, procedure-based training perform

better on routine tasks under stressful conditions, trainees who learn systems-based problem solving are more effective at solving complex, novel problems under these same conditions (Hockey et al., 2007). Similarly, the aviation literature discusses the metacognitive benefit of improving and expanding mental frames to better confront startling events (Landman et al., 2017; Mohrmann et al., 2015).

Stress Exposure Training. Once a trainee achieves the baseline attitudes, behaviors, and cognitive processes for stressful situations, she must test these under actual stress. Thus, the final category of training strategies for stressful situations is perhaps the most intuitive: training while under stress, also known as stress exposure or inoculation training (SET/SIT). In the Marine Corps, this is captured in the axiom: “Train like you fight” (see Berger, 2019, p. 17). Using realistic simulations to approximate real-life conditions and stressors improves performance in military (Zach et al., 2007), police (Heusler & Sutter, 2022; Oudejans, 2008), emergency medicine (DeMaria Jr. et al., 2010; Vartanian et al., 2017), and aviation professionals (Landman et al., 2018; Miller et al., 2020). The contextual cues and stressors do not have to be high fidelity simulations to induce a stress response and to improve performance. For example, stressors can be as simple as a body part exposed to ice (Clements, 2020; McClernon et al., 2011; Neill, 2020), irritating noise (Driskell et al., 2001; Hockey et al., 2007), or an electric shock (Friedland & Keinan, 1986; Gamble et al., 2018).

Table 2.1. Approaches to Training for Stress.

Attitudes	Behavior	Cognition
Decision vs. threat focus (Landman et al., 2016a)	Muscle memory and automatic response (Gamble et al., 2018; Jensen & Wrisberg, 2014; United States Marine Corps, 2016)	Situational awareness (Heusler & Sutter, 2022; Papanikou et al., 2021; Saus et al., 2006)
Task focus (Driskell et al., 2001; LeBlanc et al., 2008; Ohlson & Hammermeister, 2011)	Problem of overconfidence (Junger, 2018; Staller et al., 2022)	Critical thinking (Engel et al., 2022, p. 207; Helsdingen et al., 2010)
Challenge vs. threat mentality (Gildea et al., 2007)	Integrating skills (Preddy et al., 2020; Rajakaruna et al., 2017; Renden et al., 2017)	Systems-based problem solving (Hockey et al., 2007)
Growth mindset (Crane, Searle, et al., 2019; Wagstaff & Leach, 2015)		Mental frames (Landman et al., 2017; Mohrmann et al., 2015; Myers et al., 2018)
Exposure		
Stress-test attitudes, behavior, and cognition (Berger, 2019, p. 17; DeMaria Jr. et al., 2010; Heusler & Sutter, 2022; Landman et al., 2018; Miller et al., 2020; Oudejans, 2008; Vartanian et al., 2017; Zach et al., 2007)		
Using a variety of stressors (Clements, 2020; Driskell et al., 2001; Friedland & Keinan, 1986; Gamble et al., 2018; Hockey et al., 2007; McClernon et al., 2011; Neill, 2020)		

Limitations of Training. Despite its benefits, training can only improve performance so much. No matter how realistic, real life is always more nuanced, complex, and intense than training (Staller et al., 2022, pp. 128–129). Acutely stressful situations impair the person and lead to reduced performance, no matter how experienced or well-trained (Baldwin et al., 2022; Kinney & O’Hare, 2020; Lieberman et al., 2005; Renden et al., 2015). This same effect occurs with moderate stressors over time—training cannot fully overcome the combined effects of multiple stressors compounded over several days (W. C. Harris et al., 2005; Lieberman et al., 2005; Tait et al., 2022). Some of these limitations are absolute—like the minimum performance needed to employ weapons or operate dangerous equipment. For the Marine in combat, these

limitations are also relative. The enemy will likely face similar acute and compounded stress. Training does not need to eliminate the effects of stress; it must merely mitigate them enough so that Marines can out-cycle their adversaries in the OODA loop. The Marine leader must recognize, then, that training Marines' attitude, behavior, and cognitive processes and exposing them to stressful situations is not a panacea but is nonetheless an important tool for maximizing operational performance.

Simulation Training

A traditional image of simulation could be a pilot "flying" a full motion, software driven cockpit replica or a medical student "operating" on a fully responsive manikin. In 2023, one might conjure images of a fully immersive virtual reality (VR) headset with life-like sights, sounds, haptic (touch) feedback, and one day even smells (Niedenthal et al., 2023). Two other extremes, however, illustrate simulation's full possibilities. A military live-fire exercise could be considered a simulation in that it uses a pre-determined scenario and certain limitations that make it an approximation of real-life combat, albeit a very realistic one. On the opposite end, immersive case studies and role plays can be a form of simulation. If a military professional reads a rich account of a combat situation, uses mental imagery and acting to place himself in the character's shoes, then makes a decision while considering the stresses conveyed by the scenario description, then this also constitutes simulation training.

Simulation Defined

The literature presents several simulation definitions. The Association for Talent Development defines simulation as "a broad genre of experiences...games...and immersive learning simulations... (that) model and present situations; portraying actions and demonstrating how the actions affect relevant systems, and how those systems produce feedback and results"

(n.d.-a, “Simulation”). The APA defines simulation as “a technique in which trainees learn a complex or hazardous task by practicing with a replica of the task...(including) computer simulations, mechanical training aids, or plausible but fictitious scenarios” (American Psychological Association, n.d.-d). A health professions review adopts a broad definition of simulation to include any training activity that is designed to “evoke or replicate substantial aspects of the real world” (Lateef, 2010, p. 348). Meanwhile, one military perspective does not use the term “simulation” at all, but rather “experiential instruction,” with simulated aspects available in “live or real-world, digital and blended” training methods (Newsome & Lewis, 2011, pp. 122–125). Finally, the U.S. Marine Corps defines simulation as “low risk, educational experiences, which substitute for some real life situation” (United States Marine Corps, 2016, app. F, p. 4). Common themes in these definitions include experiential learning, replication of real world tasks and contexts, and risk reduction.

Table 2.2. Simulation Definitions.

Source	Definition
Association for Talent Development	"A broad genre of experiences, including games for entertainment and immersive learning simulations for formal learning programs. Simulations use simulation elements to model and present situations; portraying actions and demonstrating how the actions affect relevant systems, and how those systems produce feedback and results." (n.d.-a, “Simulation”)
American Psychological Association	“A technique in which trainees learn a complex or hazardous task by practicing with a replica of the task. This may involve the use of computer simulations, mechanical training aids, or plausible but fictitious scenarios (e.g., business games or case methods). For example, a medical student may practice inserting an intravenous line on a mannequin before doing so on a live patient, and factory workers may use virtual reality to practice operating a new piece of heavy machinery prior to using the actual equipment.” (n.d.-d)

Table 2.2 (continued).

Source	Definition
Lateef – Health professions education	"A technique for practice and learning that can be applied to many different disciplines and types of trainees. It is a technique (not a technology) to replace and amplify real experiences with guided ones, often ‘immersive’ in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion.” (2010, p. 348)
Newsome & Lewis – Military training context	“ <i>Experiential instruction</i> ” [emphasis added]: “Trainees practise the behaviours desired...training methods can be categorized into three main categories: live or real-world, digital and blended.” (2011, pp. 122–125)
U.S. Marine Corps	“Low risk, educational experiences, which substitute for some real life situation. It may involve groups or whole units. Some kinds of simulations are role playing, inbasket exercises (used in random order to simulate a series of matters or decisions which a leader might actually encounter), organizational or management games- students manipulate an organization or some component part to produce certain outcomes, hardware simulations (students use trainers that resemble, to some degree, the equipment that is to be used on the job; e.g. flight simulator and virtual reality).” (2016, app. F, p. 4)

This paper will use the Marine Corps simulation definition as it echoes the literature and aligns with the review’s purpose. It is sufficiently broad to allow the inclusion of any purposefully designed experiential learning technique that incorporates some element of realism—especially those that induce realistic stress—while acknowledging that even the most realistic training cannot match the stress and stakes of actual combat or other HROs.

It is important to identify what this definition of simulation excludes. It does not include many traditional classroom pedagogies like lecture, discussion, or general reading. While these methods may discuss stress and its effects and indeed can be important for building foundations of how students should train for stressful situations, they do not intentionally expose students to realistic stressors to elicit performance improvement. These traditional techniques may also be

present in simulation phases like briefing and debriefing, but they are not what make simulation unique. This definition also excludes on the job learning—whether formal or informal—because that learning comes directly from real-life experiences, not an approximation of real-life.

Simulation Advantages. Simulation provides several advantages compared to other training methods. These include “reduced cost, greater access, wider distribution, more frequent use, and ‘just-in-time’ training” (Proctor & Woodman, 2007, p. 55), along with lower risks and the ability to practice student-specific weaknesses and readily evaluate performance (United States Marine Corps, 2016, app. F, p. 4). In some occupations, like the military, real-life practice on the job might be unavailable for an extended period. This makes simulation the next best option for consistent practice.

The literature abounds with examples of these benefits. For high-reliability occupations, the chief benefit of simulation is that it lowers risks—to trainees (Garcia et al., 2019, p. 276; Taylor & Barnett, 2013), instructors (Alison et al., 2013), and the people they serve, including patients (Lateef, 2010, p. 348), passengers (Myers et al., 2018, p. 3), and citizens (Jenkins et al., 2020). Simulation allows repeated practice of skills until mastered (Issenberg et al., 2005, p. 23), particularly for low occurrence, high stakes events like combat (Jensen & Young, 2016), police use of force (Rajakaruna et al., 2017, p. 518), in-flight emergencies (Myers et al., 2018, p. 3), life-threatening medical events (Ricketts, 2011, p. 652), or major fires (Pedram et al., 2021, p. 1073). This repeated practice made possible by simulation training increases confidence in performing combat tasks (Fatkin & Hudgens, 1994; Jensen & Young, 2016) and handling stress (Crane, Rapport, et al., 2019). Simulation reduces training costs (Doozandeh & Hedayati, 2022, p. 117), particularly when considering the impact on professional performance (Lateef, 2010, p. 352; Myers et al., 2018, p. 3) and when using low-fidelity simulations or increasingly capable

and inexpensive higher fidelity digital simulations (Newsome & Lewis, 2011). Simulation allows for immediate coaching (Schwägele et al., 2021) and the integration of trained attitudes, behaviors, and cognitive processes to address complex problems (Jenkins et al., 2020; Renden et al., 2017). Finally, it exposes trainees to the stressful and even traumatic sights, sounds, and emotions involved in high-risk professions (Bukoski et al., 2018, p. 82; DeMaria Jr. et al., 2010; Di Stasi et al., 2022; Taverniers & De Boeck, 2014). This exposure allows the trainee to process and adjust to these chaotic stimuli in training so they are not seeing them for the first time in combat, where a poor reaction could prove fatal. Stress exposure is more helpful when it can be repeated regularly; this repetition afforded by simulation can decrease stress reaction intensity without adverse, traumatic side effects (Ghazali et al., 2019). Clearly, simulation is a valuable and versatile tool for realistic training in HROs.

Simulation Disadvantages. There are, however, limitations to simulation. The Marine Corps cautions that simulation requires an existing knowledge foundation and instructors trained on the simulation method and equipment (United States Marine Corps, 2016, app. F, p. 4). Depending on the type of simulation, it might still be very costly and allow only a single trainee or a small group of trainees to participate at one time. Developing complex and realistic scenarios can be extremely time and resource consuming (Abdelgawad, 2018, p. 23.1). Although many types of simulation are usually cheaper than live-fire, they can still be very costly and challenging to establish and maintain (Jarmasz & Martin, 2018). This leads to repeating a limited number of scenarios multiple times (Baumann et al., 2011) and results in the trainee not taking the scenario as seriously, especially if the simulation is not highly realistic and immersive (Bukoski et al., 2018, p. 82; Couperus et al., 2020).

The disadvantages listed above discuss limitations based on learner suitability and logistics, but more concerning considerations arise when simulation trains behaviors that are harmful in real life. This is known as negative training transfer (Blaiwes, et al., 2001, in Myers et al., 2018, p. 1). In aviation, several instances of simulations that failed to properly model aircraft performance or environmental conditions have contributed to fatal crashes (Myers et al., 2018, pp. 1, 13–15). Likewise, using simplistic PC joystick controls (Neubauer et al., 2018, p. 226) or game physics (Newsome & Lewis, 2011, p. 134) can build bad habits for real-life combat.

Although the previous examples highlight negatively transferred behaviors, negative transfer can also affect attitudes and cognition. Simulation training plans that disproportionately focus on high-risk scenarios may effectively teach trainees to handle these problems but may also condition them to over expect these problems in real-life if not tempered by situational awareness, critical thinking, and decision-making training. Police trainees have observed that while simulated training scenarios cannot match the intensity of real-life use of force situations, the prevalence of high-risk scenarios in training led them to expect these situations in real-life much more than they actually occurs (Staller et al., 2022, p. 128). Other researchers have put forward evidence that this negatively conditions officers to interpret encounters in the most threatening way possible (Junger, 2018), which leads to a warrior mindset when a guardian mentality is more appropriate (McLean et al., 2020; Rahr & Rice, 2015).

A similar type of negative transfer can result from efforts to “game the game,” (Frank, 2012) which is more likely in lower-fidelity simulations like computer or board games (Newsome & Lewis, 2011, p. 140). A player who is focused primarily on winning—consciously or subconsciously—may exploit flaws or limitations in game design, leading to decisions that are unrealistic or even unethical. For example, a study of a computer first person shooter for military

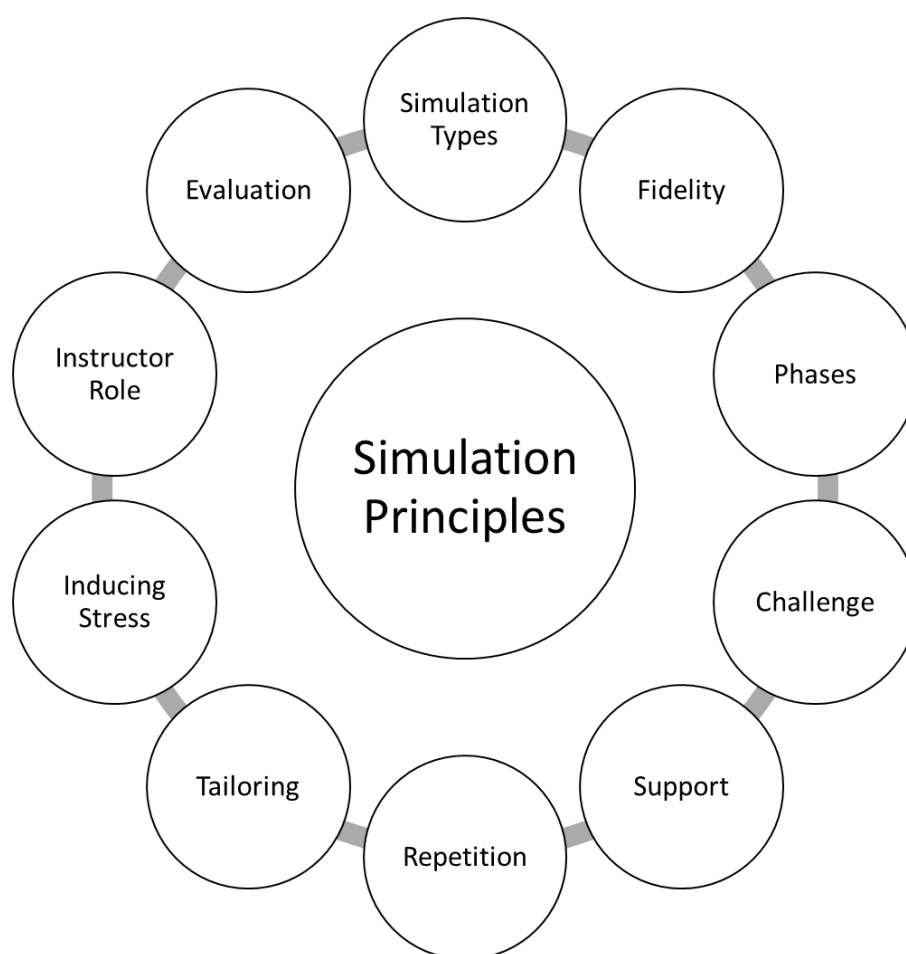
operations in urban terrain (MOUT) found that the software oversimplified human behavior, communication, and decision-making; used unrealistic depictions of physical effects; and encouraged “risky and aggressive behaviour” (Newsome & Lewis, 2011, p. 134). Sound design can mitigate major problems but, taken to the extreme, might eliminate the benefits of these simulation types like lower cost and being easier to learn and play. An effective instructor can manage game flow and adjudicate rules to keep trainees on-track and focused on learning objectives, but this does require a well-trained, experienced facilitator (Alklind Taylor, 2015, p. 3; Jansen & van Zelst, 2021, p. 284).

Table 2.3. Simulation Advantages and Disadvantages.

Advantages	Disadvantages
Lower physical and psychological risk to the learner	Must have foundation of knowledge and skills
Cost savings	Higher fidelity is costly
Increased access to training	Some systems limit number of trainees
Highly repeatable, allowing immediate feedback and self-correction	Scenario development time consuming
Easily tailorable to trainee	Trainees do not take it seriously because it is not real or has no stakes
Built in formative and summative evaluation	Negative training transfer
Only option for some dangerous tasks	Conditions to worst case scenario
Builds confidence	“Gaming the game” can condition risky, unethical, or unrealistic behavior
Exposure to trauma and danger fosters inoculation	
Enables group practice of teamwork and communication in stressful situations	

While simulation's potential disadvantages and pitfalls are significant, they can be mitigated with proper design and employment. Trainers must understand these limitations to minimize their impact while maximizing the advantages of simulation for training to stressful situations. The remainder of Chapter 2 will discuss the common principles of simulation design—simulation types, fidelity, phases, challenge, support, repetition, tailoring, inducing stress, instructor role, and evaluation (see Figure 2.1).

Figure 2.1. Simulation Principles.



Simulation Design

Simulation Types. There are many simulation types under the broad definition of simulation that includes any purposeful experiential learning activity that mimics some aspect of

real life. *Simulation & Gaming* lists “computer- and internet-mediated simulation, virtual reality, educational games, video games, industrial simulators, active and experiential learning, (and) case studies” as the simulation types studied in its issues (SAGE Journals, n.d.).

Importantly, different fields have different connotations of what constitutes a “simulation,” often associated with technology. For example, in medicine, the use of role playing, manikins, and VR are considered simulations (Kirkham, 2018, p. 44; Shin et al., 2015). Live-tissue training on animals is not, although it was the primary source of realistic training before simulator technology (Bukoski et al., 2018; Vartanian et al., 2017). In aviation, “simulators” is used for those devices with a realistic cockpit and wrap-around visuals; they may or may not include motion (Marsh, 2011). These are distinguished from less realistic computer-based training systems which are known as PC-Based Aviation Training Devices (PCATD) (Reweti et al., 2017, p. 127) or part task-trainers (Myers et al., 2018, p. 4). Although these methods may provide valuable training transfer (Korteling et al., 2017; Reweti et al., 2017), they are not considered “official” simulations for certifying aircrew proficiency (Marsh, 2011).

Military literature casts a wider net for simulation types. The Marine Corps definition includes “role playing...organizational or management games...(and) hardware simulations (like)...flight simulator(s) and virtual reality” (United States Marine Corps, 2016, app. F, p. 4). Newsome and Lewis (2011, pp. 122–125) divided realistic, experiential military training into three categories. Live training includes battle drills, blank rounds, laser tag, paint simunitions, and live projectiles. Digital training consists of constructive, computer based command and control scenarios, virtual training—like the interior of a vehicle simulated on computer screen—and first-person shooter games. Blended training combines live and digital simulations. Finally, a RAND study of Army simulations distinguished physically simulated military equipment—such

as a tank simulator that replicates the actual tank—from virtual military equipment—the representation of a tank in a virtual environment like a PC game (Straus et al., 2019, p. 12).

This paper uses the broader Marine Corps definition of simulation types because it encompasses more of the training methodologies useful for training to perform under stress. It is nonetheless important to understand that other fields—and even Marines themselves—may use narrower categorizations of simulation types. This understanding will help prevent miscommunication when discussing simulation concepts. What follows is a brief description of simulation types. This list is not exhaustive but seeks to illuminate and define several options.

Live Training. Live training involves real people using real equipment in real locations to complete actual job tasks. Yet, some aspect of live training is simulated, distinguishing it from on-the-job training. The simulated portions could include a combination of a scenario developed by the trainers, dedicated training space, and training-specific equipment. Live training provides the most realistic job conditions. It allows experienced trainees to integrate multiple competencies in complex scenarios, often in teams. Examples include conducting battle drills or using live ammunition on a training range in the military (Newsome & Lewis, 2011, pp. 122–124), perhaps with robotic targets (Berger, 2023, p. 10); using soap cartridges in police use of force scenarios (Landman et al., 2016b, p. 573); live tissue training in medicine (Bukoski et al., 2018); training flights in a training aircraft and airspace in aviation (McClernon et al., 2011); and firefighters fighting live fires in a fire training building (Baumann et al., 2011).

Immersive Simulators. Immersive simulators are a replica of a mechanical structure or physical environment. The external environment is typically represented virtually by digital displays. These simulators are highly realistic. Their complex nature makes them better suited to more experienced trainees. Virtual rendering allows the instructor to generate a variety of

scenarios and environments which can be repeated for practice and randomized to broaden exposure. In some simulators, the trainee can practice on his own to build mastery. Many of these simulators can also be used to present complex scenarios requiring the trainee to integrate skills, decision-making, and teamwork (Hontvedt & Øvergård, 2020, p. 105). Immersive simulator examples include aircraft (Myers et al., 2018), tanks (Straus et al., 2019, p. 14), medical facilities (Lateef, 2010, p. 351), air traffic control towers (Miller et al., 2020, p. 293), and the inside of a medical helicopter (DeForest et al., 2018, p. e384).

Virtual, Augmented, and Mixed Reality. This simulation type uses a headset or glasses to provide a virtual display (virtual reality—VR), augment what the user sees in real life with graphic overlays (augmented reality—AR), or a combination of these two technologies (mixed reality—MR). Altogether these technologies are sometimes called “extended reality (XR)” (Kaplan et al., 2021, p. 706). XR may include peripheral devices like haptic hand controls or motion capture suites which enhance the simulation (Duggan et al., 2019, p. 272). XR can be very realistic like immersive simulators but is more portable and affordable. This makes it useful for scenarios requiring an immersive experience but with simple physical interaction, such as firing a personal weapon. It is not as well suited for complex physical interaction like flying an aircraft with all its controls. XR may be integrated with other technologies such as immersive simulators or manikins to provide a more realistic experience (Kirkham, 2018, p. 44). XR applications include active shooter (McAllister et al., 2022), vehicle maintenance (N. Cooper et al., 2021), firefighting emergency shutdown procedures (Tyagi et al., 2021), firefighting in space (Finseth et al., 2018), military (Rao et al., 2020) and police (Garcia et al., 2019) use of force, combat medicine (Couperus et al., 2020), and complex surgery (Frederiksen et al., 2020).

Partial Task-Trainers. Partial task-trainers (PTT) replicate some part of a task; they are not meant to recreate a fully integrated real-life scenario as would be encountered on the job. This technology allows repeated practice of a specific skill as the trainee builds expertise, particularly for novices who are not ready for a fully immersive simulation. Although not fully immersive, the portion of the job that the PTT simulates can still be highly realistic. Examples include partial manikins (Kirkham, 2018, p. 44; Shin et al., 2015, p. 177), low-end PCATDs (Myers et al., 2018, p. 4), vehicle repair (Ganier et al., 2014, p. 835), electronic and mechanical systems troubleshooting (Doozandeh & Hedayati, 2022), fire hose operation (Wijkmark et al., 2022, p. 12), command and control desktop simulators that incorporate AI (Pimental, 2022), vehicle weapon stations (Straus et al., 2019, pp. 18–19), and ship controls (Neill, 2020, p. 19).

Computer Simulations and Games. This category describes using a PC and software to virtually represent the work environment. Trainees act in the scenario as they would in real-life. Computer games are an inexpensive way to generate complex, realistic, and variable scenarios to practice repeatedly, although it can be difficult to achieve true realism. Controls are typically mouse and keyboard. This means that unlike higher fidelity immersive VR, computer simulations usually do not intend to generate physical skills for real-world use. Some flight programs might use a joystick which leads to limited physical skills transfer (Çetin et al., 2012; Korteling et al., 2017), but as these controls become more complex, they slide into the range of PTTs or full simulators. Computer games have been used to teach military tactics (Proctor & Woodman, 2007) and command and control (Villado et al., 2013), vigilance (Szalma et al., 2018), basic flight skills (Donderi et al., 2012), spacecraft life support systems troubleshooting (Hockey et al., 2007), medical diagnosis (Kanthan & Senger, 2011), and firefighting problem assessment (Wijkmark et al., 2022, p. 8).

Role Playing. In this method, the trainee plays a realistic role to simulate some or all aspects of the job. The trainee can interact with other trainees, instructors, or virtual characters. This could be as simple as talking out a situation face-to-face but is often combined with other simulation types. Role playing is helpful for focusing on the communication and soft skills required for a job. Examples include military command and control simulations (Alklind Taylor & Backlund, 2012; Kylesten & Nählinder, 2011), firefighting decision-making (Clifford et al., 2021; Gnam et al., 2019), medical simulations (DeMaria Jr. et al., 2010; Kirkham, 2018; Shin et al., 2015, p. 177), complex police scenarios (Y. Liu et al., 2018; Rajakaruna et al., 2017; Vickers & Lewinski, 2012), and aviation crew resource management (Mohrmann et al., 2015).

Tabletop Exercises and Games. In this simulation type, the trainee works through a scenario on a board, model, or computer. This method is often combined with role playing as the trainee assumes the role of a leader in the scenario and may work alongside or compete against other players who are fellow trainees or instructors. This method focuses on thought processes, situational awareness, and decision-making; it does not typically train physical skills that transfer to the job. It allows training on large and complex scenarios at very low cost, though these take considerable time and expertise to develop. These exercises have been used in military wargames (Frank, 2014), emergency medicine (Facho et al., 2021), disaster relief (M. L. Anderson, 2014; Wiese et al., 2021), policing scenarios (Jenkins et al., 2020, p. 449), and aviation management decision-making (Corrigan et al., 2015).

Fidelity. The next simulation principle and the most important concept for understanding these simulation types is their realism or fidelity (Griffith et al., 2016, p. 387). Scholars classify fidelity in two ways: level and type (Ganier et al., 2014, pp. 829–830). Fidelity level is often categorized as high, medium, or low, although how these levels are defined varies widely by

context. Health professions training research gives the following examples: instructor role playing or PTTs are low fidelity. Manikins with built in vital signs and software that allow instructor input are medium fidelity. Advanced manikins with highly realistic responses or that are augmented by virtual reality that enables student-to-patient communication are high fidelity (Kirkham, 2018, p. 44; Shin et al., 2015, p. 177). By comparison, the equipment troubleshooting field classifies low fidelity as simple drawings of a system; medium fidelity as two-dimensional simulations and diagrams; and high fidelity as three-dimensional representations, video, and virtual or augmented reality (Doozandeh & Hedayati, 2022, p. 122). In aviation, where simulation first began as a widespread training tool, the U.S. Federal Aviation Administration (FAA) has seven classes of non-motion and four classes of motion simulators, each with exacting certification standards. These range from basic PCATDs to full motion simulators meant to mimic real flight as closely as possible. As the level of fidelity increases, FAA regulations allow pilots to complete increasingly complex flight events, including full instrument proficiency checks in the most advanced full motion simulators (Marsh, 2011).

Overarching U.S. military training doctrine does not define fidelity but simply reminds trainers that they should consider the appropriate fidelity level when designing training (Chairman of the Joint Chiefs of Staff, 2015). Within the DOD's modeling and simulation engineering community, fidelity is "the degree to which a model or simulation reproduces the state and behavior of a real world object" and is broken down into six measures including "accuracy; precision; repeatability; resolution; scope; (and) sensitivity" (Department of Defense Under Secretary of Defense for Research and Engineering, n.d.). For this paper, considering these varying definitions, it is more useful to conceptualize fidelity level as a spectrum and as relative—this method is higher fidelity than that one, or this method is closer to reality. Using the

broad definition of simulation put forward in this paper, this means that fidelity could range from very low, such as immersive storytelling (Andrews et al., 2009), to very high, like live-fire training using simunitions (Newsome & Lewis, 2011, pp. 123–124).

Fidelity Type. Fidelity type refers to the ways researchers classify realism among a simulation's elements. Hays & Singer's 1989 (in Taylor & Barnett, 2013, p. 673) definition splits fidelity into three types. Physical fidelity is the way the simulation matches reality as perceived by the senses. Functional fidelity is the way the simulation responds compared to its real-life counterpart. Psychological fidelity is the way the simulation evokes realistic thoughts and feelings. Myers et al. (2018, p. 5) took a similar approach in categorizing fidelity within aviation simulators as physical, functional, and cognitive (instead of psychological). Conversely, Hontvedt and Øvergård (2020, p. 86) delineate technical, psychological, and interactional fidelity, with the latter concept used to describe how well the simulation replicates team interaction requirements. Naismith et al. (2020, pp. 141–142) take a similar approach by categorizing fidelity as physical, psychological, or "sociological" to describe interpersonal relationships. Macchiarella and Mirot (2018, p. 66) add mathematical fidelity to physical, functional, and psychological-cognitive fidelity when discussing unmanned aircraft simulators. Other, more detailed reviews of fidelity separate the types into physical, visual-audio, equipment, motion, psychological-cognitive, and other (D. Liu et al., 2008, p. 61). Finally, the most simplified separation splits fidelity into two basic categories, normally called physical and psychological (Alison et al., 2013, p. 257; Ganier et al., 2014, pp. 829–830; Lucas et al., 2023, p. 3), although N. Cooper et al. label them surface and cognitive fidelity (2021, p. 3). These definitions place everything involving the external physical and functional aspects of the simulation in physical fidelity, and everything involving how well the simulation stimulates

realistic internal thought processes in psychological fidelity. This distinction is important because evidence shows that physical fidelity, while critical in some contexts, is not as important as ensuring the simulation matches psychological job demands (Salas et al., 2012, pp. 88–89).

This paper will use the physical and psychological fidelity type distinction. First, this is the simplest categorization. Second, while the U.S. military has not defined fidelity types within its own doctrine, a 2019 RAND study of U.S. Army simulation fidelity used these two types, with functional fidelity incorporated within physical fidelity (Straus et al., 2019, pp. xii–xiii). Importantly, under this split, psychological fidelity includes the effects of interactional and sociological fidelity on personal thought processes and emotions. Considering that research often shows that physical and psychological fidelity have differing levels of importance for training effectiveness, this is an appropriate approach to discussing simulation types within this paper.

Table 2.4. Simulation Fidelity Definitions.

Fidelity Levels	
Terms	Source
Low, medium, high	Doozandeh & Hedayati (2022, p. 122) (troubleshooting); Ganier et al. (2014, p. 829) (tank maintenance); Kirkham (2018, p. 44) (medical); Shin et al. (2015, p. 177) (medical)
Fidelity Types	
Terms	Source
Physical, psychological	Alison et al. (2013, p. 257); Ganier et al. (2014, p. 830); Lucas et al. (2023, p. 3); Salas et al. (2012, p. 88); Straus et al. (2019, pp. xii–xiii)
Surface, cognitive	N. Cooper et al. (2021, p. 3)
Physical, functional, psychological	Hays & Singer (in Taylor & Barnett, 2013, p. 673)
Physical, cognitive, functional	Myers et al. (2018, p. 5)

Table 2.4 (continued).

Fidelity Types	
Terms	Source
Technical, psychological, interactional	Hontvedt & Øvergård (2020, p. 86)
Physical, psychological, sociological	Naismith et al. (2020, pp. 141–142)
Mathematical, physical, functional, psychological-cognitive	Macchiarella & Mirot (2018, p. 66)
Physical, visual-audio, equipment, motion, psychological-cognitive, other	Liu et al. (2008, pp. 64–67)

Physical Fidelity and Training Effectiveness. Understanding fidelity is important because for both research and practical, applied purposes. Researchers frequently study the training effectiveness of fidelity levels and types across various contexts. Instructors need information about fidelity to make decisions about simulation training design and implementation. Fidelity is hard to quantify, however, so the impact of fidelity on training effectiveness is difficult to assess (Doozandeh & Hedayati, 2022, p. 119).

Higher physical fidelity is often better for developing physical skills (Hontvedt & Øvergård, 2020, p. 92), especially tasks requiring fine motor skills like surgery (N. Cooper et al., 2021, p. 2). High physical fidelity simulations are generally regarded as necessary and effective in medical education (Issenberg et al., 2005).

High physical fidelity is also valued in aviation training, but the term “high fidelity” carries significant nuance, even within simulation types. For example, a computer flight simulator could be a generic program that uses simple joystick and throttle controls like Microsoft Flight Simulator or an aircraft-specific software such as Falcon 4.0 for the F-16 (Korteling et al., 2017). In this case, the closer approximation—Falcon 4.0—led to greater

training transfer as tested in a high fidelity military F-16 simulator. Conversely, a PCATD Piper simulator with multiple displays, realistic controls, and instrument panels performed just as well as a higher physical fidelity immersive Piper simulator (Reweti et al., 2017). This seeming contradiction is likely because in the Reweti et al. (2017) study, both groups trained to the Piper aircraft with relatively realistic—even if different—controls and instruments, while in the Korteling et al. (2017) study the experiment compared a group who trained on an F-16 PC program to those who trained on the generic Microsoft Flight Simulator PC program.

Even in studies of motion simulators—which as a category are higher physical fidelity than non-motion simulators—there are varying degrees of motion fidelity available, with higher fidelity generally leading to better performance (Zaal et al., 2015). In any case, learning is most effective when the level of physical fidelity is matched to the learning objective (Hontvedt & Øvergård, 2020, p. 96); tasks requiring detailed information like piloting a ship through a narrow harbor require higher fidelity than piloting the same ship through open water.

High Physical Fidelity Limitations. Despite providing more realistic training, there are noted drawbacks and challenges to high physical fidelity simulations. First is the uncanny valley effect, in which sometimes both low and high fidelity are more effective than medium fidelity, especially when comparing computer virtual environments, partially immersive VR, and fully immersive VR (Pollard et al., 2020, p. 792). In these instances, the mind is willing to except a level of simulation artificiality and focus on key learning objectives with the computer-based simulation because it knows the PC is not designed to seamlessly replicate reality. Likewise, fully immersive VR is so realistic that it tricks the mind into ignoring any inaccuracies, allowing the trainee to concentrate on learning and performance. Partially immersive VR, however, is

realistic enough that the user subconsciously thinks it should be exactly like real-life. Because it cannot meet this demanding requirement, any flaws in presentation distract the brain.

Related to the uncanny valley is the problem of motion sickness. In a flight simulator, this may seem like an effect of realistic training—motion sickness can also happen in a real plane. Unfortunately, the effect can be worse in a simulator as the brain cannot reconcile slight differences in physical/spatial and visual perception (Geyer & Biggs, 2018). This means that a pilot who can handle the motion in real flight may still struggle in a simulator. More importantly, motion sickness is also a common concern with VR (Binsch et al., 2021, p. 189; Pedram et al., 2021, p. 1077; Taylor & Barnett, 2013, p. 672; Tyagi et al., 2021, p. 4), where the simulations typically replicate environments where motion sickness is not expected, such as walking through a room or completing a mechanical task. In some cases, a lower fidelity, conventional VR system is better for preventing motion sickness than a more advanced, 360 degree immersive VR system because there is less head movement (Frederiksen et al., 2020, p. 1250). There is potential that technological advancements will lead to very high fidelity VR systems that do not lead to motion sickness such as those complete with glasses, haptic gloves, and mock tools (N. Cooper et al., 2021, p. 17). Until these technologies are widely available and proven to not induce sickness across large populations, simulation designers should consider the potential effects of motion sickness when choosing VR simulation types.

Even when physical fidelity is high enough to seamlessly present realism, it can have detrimental side effects. It can increase the risk of negative training transfer compared to lower fidelity simulations because the trainee expects the real-life equivalent will behave exactly like the simulator, but it does not (Myers et al., 2018, p. 6). High fidelity simulations are also less than ideal for novices compared to experts. For example, medical trainees tend to learn best by

starting with lower fidelity tabletop exercises before moving to higher fidelity manikins (Facho et al., 2021, p. 4). This is because novice trainees can only process so much new information, so simpler simulations are easy to grasp (Doozandeh & Hedayati, 2022, p. 129). Conversely, as trainees progress, they tend to show more training transfer with high fidelity rather than low fidelity simulations because they need more challenging stimuli.

Psychological Fidelity and Training Effectiveness. While the literature examining physical fidelity and its importance is mixed, the case for high psychological fidelity is clearer. High psychological fidelity is particularly suited for “developing mental models and problem-solving strategies” (Hontvedt & Øvergård, 2020, p. 92). Simulations that realistically portray the mental challenges of the situations they train towards are generally more effective, whether the physical fidelity is high or low. A RAND research review of simulation showed that high psychological fidelity is effective for training with any level of physical fidelity, but high physical fidelity is only effective when paired with high psychological fidelity (Straus et al., 2019, p. xiv). For example, a study of Dutch airmen and sailors found that critical thinking training improved thinking processes and decision making in a low fidelity scenario discussion and a high fidelity simulator alike (Helsdingen et al., 2010). In health professions, a low fidelity, email-based game was perceived highly engaging despite the simple interface because it effectively simulated the psychological complexity of interpersonal problem-solving (Kuipers et al., 2019). Similarly, trainees in a simulation for mental health providers found that psychological and sociological fidelity were more important than physical fidelity (Naismith et al., 2020). This finding aligns with the fact that mental healthcare relies far more on cognitive and social competency than discrete physical skills. Finally, a study of PC-based virtual soft

skills training showed that it did not need to have high physical fidelity or be matched to the specific context to train better performance (Lucas et al., 2023).

The bottom line is that fidelity is essential to simulation but is a complex subject, requiring judgment in application. There are advantages and disadvantages of training methods across the fidelity spectrum, so trainers must be familiar with these aspects to apply simulation types in the most appropriate situations, maximize benefits, and minimize risks.

Simulation Phases. According to Kortmann & Peters (2021, p. 257), simulation training occurs across four phases: preparation, briefing, game execution, and debriefing; see also Alklind Taylor and Backlund (2012, p. 4), who label the implementation phase “gameplay/training.” It is of note that many scholars combine briefing and preparation into a single preparation phase prior to simulation execution (Alklind Taylor et al., 2012, p. 659; Frank, 2014, p. 155; Jansen & van Zelst, 2021, p. 274). This research paper utilizes the four phase approach as it distinguishes between pre-simulation actions that directly involve the trainee (briefing) and those that do not (preparation). Preparation involves the actual creation of simulation training. The instructor should understand both the learning objectives and the capabilities and limitations of available simulation methods to design a simulation that meets learning needs. The instructor might provide learning objectives to a simulation technical expert to create an appropriate scenario or design and develop the scenario himself. In the briefing phase, the instructor informs the students how the simulation will work, including educational objectives, gameplay, technical details, and scenario background. This briefing should build on trainees’ earlier learning from non-simulation means like lecture and discussion. The simulation execution phase includes the entirety of trainees’ direct interaction with the simulation. It could start with trainee briefings that mimic real-life preparation, move into execution, and conclude

when the instructor ends the exercise. During execution, the instructor may assess trainee performance, give feedback, steer the game, or even participate as a player herself. Once the simulation is complete, the instructor prepares and leads the debrief phase. This phase includes instructor-trainee discussion that enables reflection on performance during the simulation. It often uses recording tools embedded within simulation technologies that allow the instructor to replay critical simulation events (Straus et al., 2019, pp. 89–90).

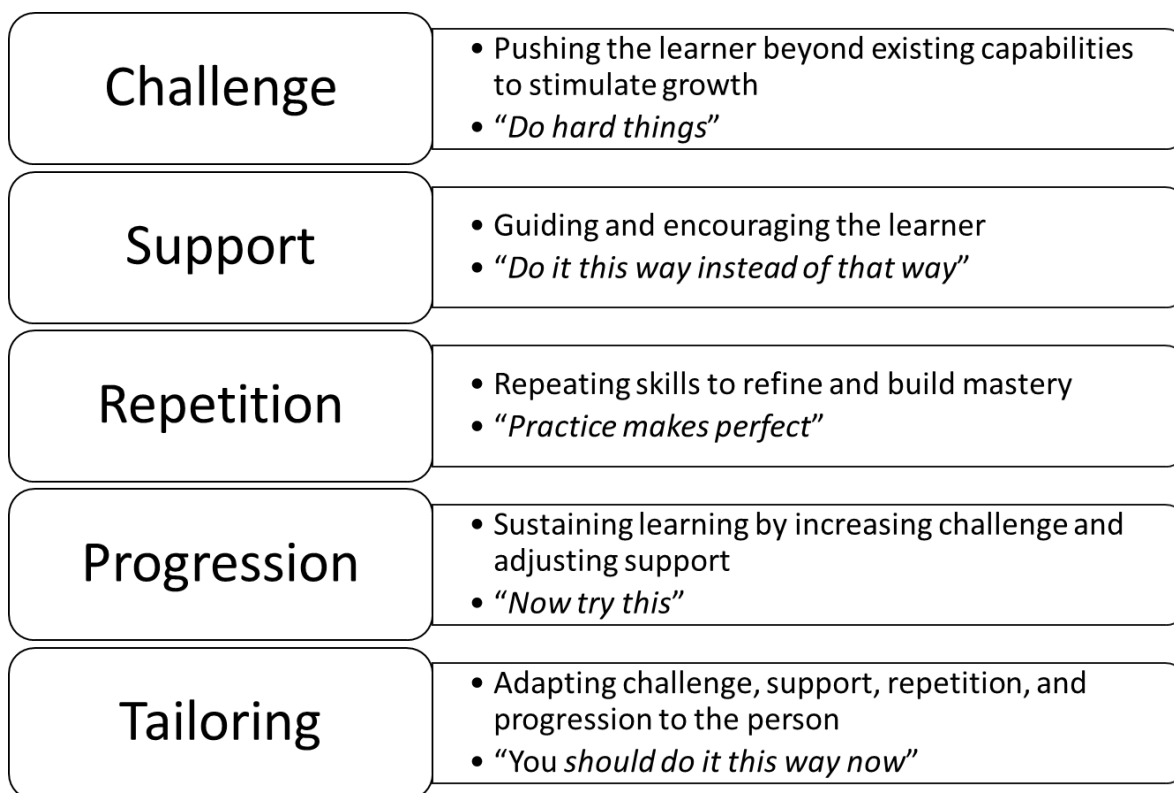
Note that these phases, particularly briefing, execution, and debriefing, often occur as a cycle. These cycles can be long or short. For example, a 20-minute simulation book-ended by 10-minute briefs and debriefs could be repeated several times a day. A multi-day exercise might use a 1-hour brief, 8 hours of simulation, then a 1-hour debrief before pausing for the night and repeating the cycle the next day. Finally, a large, force-on-force, live exercise might see a multi-day briefing period, 2 weeks of 24/7 operations allowed to play out, then a multi-day debrief.

Within each period of simulation execution, there is also a coaching cycle resulting from trainee interaction with the simulation and any feedback the instructor chooses to give (Alklind Taylor et al., 2012, p. 660). Depending on the instructional goals and simulation type, the instructor can choose to pause or break-in to the simulation to ask questions or give direction; or let the simulation play out, whether it is a 20 minute, full-day, or weeks-long simulation. While this is distinct from the more formal briefing-training-debriefing phase cycle, it is equally important and is addressed in more detail in the section on instructor role.

Challenge, Support, Repetition, Progression, and Tailoring. The next key elements of simulation training are the interrelated concepts of challenge, support, repetition, progression, and tailoring. Challenge stimulates learner growth. Support ensures the learner does not become overwhelmed or learn flawed techniques. Repetition is the repeated practice of skills to build

proficiency. Progression encourages sustained learning as repetition becomes easier. Tailoring adapts challenge, support, repetition, and progression to the individual learner. These mechanisms are needed to ensure that training results in growth rather than harm.

Figure 2.2. Challenge, Support, Repetition, Progression, Tailoring.



These concepts are familiar to anyone who has exercised regularly—the body needs challenge, support, repetition, progression, and tailoring to stimulate growth and performance improvement. Training for stressful scenarios is no different.

Continuing the fitness analogy, suppose that a trainee can squat 3 sets of 12 repetitions for a maximum weight of 225 pounds. To improve performance at a noticeable rate, the trainee must exercise at or near this challenging intensity. Attempting 3 x 12 with under 100 pounds might work well for the occasional recovery day, but it will not lead to strength gains and will result in detraining if used consistently. To progress, the trainee needs to increase intensity by

adjusting the sets, repetitions, or load. The challenge must also be reasonable. The trainee cannot expect to increase the load to 400 pounds and complete 3 x 12, and probably not even 1 x 1.

This training must be supported. As a lifter develops technique, strength, power, and endurance, she could support herself by reading and watching videos about lifting or analyzing her technique in a mirror or video recording. A coach could further support development by teaching skills and analyzing her performance to correct deficiencies. Support could also be quite literal in the physical sense, like the use of a spotter or weightlifting rack with safety bars when lifting near-maximum loads.

Proficiency in a lift is not developed through a single attempt but through repetition. A trainee can practice the movement multiple times in a set, for multiple sets in a workout, and for multiple workouts across a training program. The higher quality these repetitions—the closer they match the desired standard—the better they will ingrain the skills. These repetitions must be intentional—aimed at improving technique and performance. Spacing repetitions over time allows the body to adapt and ensures that the skills developed do not decay for lack of practice.

As repetitions accumulate and the body adapts to new intensities and movement patterns, the trainee will need to continually increase intensity to stimulate progression, known as “progressive overload.” This concept of gradual, manageable challenge applies across ability levels; once someone can lift 3 x 10 consistently, they are probably ready to increase to 3 x 12, whether the load is 135 pounds or 405 pounds. It also applies to complexity. A beginning lifter might focus on general, simple movement patterns at lower loads until she ingrains the correct technique. As she progresses, she can integrate these into more complex exercises. For example, she might learn the front squat, hang clean, and overhead press independently before combining these movements into a clean and press.

Finally, this challenge, support, repetition, and progression must be tailored to the individual. This seems obvious at first, but the need for deliberate tailoring becomes clear when considering how training plans are typically developed. An athlete training on his own might use a training plan from a book or website. Likewise, a coach typically trains several athletes and may use a base program for trainees with similar goals. While there are many training plans available, it is unlikely that a chosen plan will meet a trainee's exact needs. There are two ways to approach this problem. First is to build auto-regulation into the program. A plan might require an initial strength test then calculate training loads based on a percentage of maximums, with the trainee instructed to progress to the next level once they reach a certain standard. The alternative is to use expert judgment to tailor the program. An experienced lifter can modify an existing plan or create their own; a trained coach could do the same for her trainees.

This lengthy analogy can be helpful for understanding challenge, support, repetition, progression, and tailoring in simulation training for high-reliability professions. A Marine learning his job through simulation training must undergo a series of training events that challenge his current abilities; are appropriately supported to encourage learning; provide repeated practice; progress from easy to difficult, simple to complex, and isolated to integrated skills; and are tailored to his developing abilities. The following sections will discuss literature surrounding challenge, support, repetition, progression, and tailoring for training HROs.

Challenge. Research shows that for adults to improve their performance, they must be pushed outside their comfort zone (Ericsson, 2018, p. 754). Marine Corps training philosophy concurs that adults learn best when challenged (United States Marine Corps, 2016, ch. 5, p. 20). Trainees should set performance goals that motivate them to train in challenging ways (Meyer, 2018, p. e271). Instructors must foster a supportive but challenging environment (United States

Marine Corps, 2016, ch. 3, p. 18), and they can design scenarios that place trainees outside their comfort zone (Stefaniak, 2017, p. 29). Pushing trainees outside their comfort zone is especially important for training to stressful situations (Arnold & Fletcher, 2021, p. 278). Trainees can be challenged not only by introducing new or more complex skills or combining skills, but most importantly by adding stress to previously mastered skills. Finally, adding challenge to training is most effective when the challenge is not random but is directly linked to the training task—that is, it is realistic to the context (Healy & Bourne, 2013, pp. 392–393).

Challenge is applied to simulation training anytime the simulation pushes the trainee outside her comfort zone. This could mean training novices on a completely new and unfamiliar task like flying an airplane (McClernon et al., 2011), searching for targets using an unmanned aerial vehicle feed (Guznov et al., 2017), or applying a tourniquet (Friberg et al., 2021). Once trainees develop fundamental skills, simulations can challenge them by requiring them to integrate these skills into complex situations like arresting a suspect (Renden et al., 2017), deciding to use lethal force (Baldwin et al., 2022), performing a challenging surgery (Frederiksen et al., 2020), managing disaster response (Rafferty-Semon et al., 2017), or commanding and controlling an air defense system (Helsdingen et al., 2010). As trainees gain proficiency, instructors can add stressors to increase the challenge. One example is having trainees perform a task faster or at a greater difficulty level than required in real-life so that the real-life task seems slower and easier by comparison (Donderi et al., 2012; Rao et al., 2020). Another possibility is introducing unexpected events to experienced trainees to force them to expand their mental frames (Landman et al., 2018). Several specific ways to add challenging stress to training are discussed further in the section on inducing stress.

Support. Scholars generally agree that trainees learn best with support, usually in the form of feedback (Merrill, 2002, pp. 49–50). This is backed by cognitive load theory, which focuses on reducing cognitive load so that students can focus on learning the material. Instructors reduce cognitive load by providing support that prevents learner errors either through “training wheels” or “scaffolding” (Hutchins et al., 2013, pp. 854–855). The training wheels strategy involves preventing students from completing more complex parts of a task before mastering simpler skills or providing students partially or fully worked examples to demonstrate the correct solution. Scaffolding, while similar to training wheels, focuses on the gradual removal of support mechanisms as trainees gain proficiency. Gradually removing support as the learner gains proficiency is also called “diminishing coaching” (Merrill, 2002, pp. 49–50). In this approach, feedback should be slowly reduced and transferred from instructor-led to trainee-led as trainee proficiency increases (Jenkins et al., 2020, pp. 445–446).

The primary debate on learner support is how much support should be provided and when. Keith describes these philosophies as theories of error in learning (2011). Some trainers correct errors only when absolutely necessary to allow students to make mistakes and learn from experience. Students might even be encouraged to make mistakes as a positive part of learning. This philosophy prefers allowing the scenario to continue unless there is a safety or technical issue, or the trainee is clearly no longer learning due to a meltdown or because they are trying the same wrong solution over and over again (Jenkins et al., 2020, p. 446).

Conversely, some instructors may choose to quickly correct student errors to prevent them from developing inaccurate mental models or bad habits—negative training transfer (Alklind Taylor et al., 2012, pp. 661–662). Adherents to this immediate intervention philosophy

contend that it reinforces correct behavior and weakens incorrect behavior (Wouters & van Oostendorp, 2017, pp. 131–132).

It is important to remember that both philosophies of error management do result in the instructor correcting the error; the distinction is whether this correction occurs immediately following the error or later in a debrief once the simulation is complete. Which approach the instructor takes is dictated by the context and by learner needs for support and progression. Error management exists on a spectrum, with more or less mistakes allowed depending on the context. Novices typically need more support and faster error correction as they learn fundamentals, while experienced trainees can be given more freedom to challenge themselves and learn through realistic consequences. Additionally, in some situations, like testing, the instructor will not provide feedback except realistic responses within the simulation because they want to assess how well the trainee performs without coaching.

Once the instructor decides how much support to provide based on learning objectives and trainee expertise level, he can choose which simulation option fits best based on the desired level of support. Some technology is not conducive to immediate feedback, either because the instructor cannot see what the trainee sees, as in some forms of VR (Duggan et al., 2019, p. 273), or because the training is too chaotic to pause, like a live exercise. A repeatable, reviewable technology like an immersive simulator or partial task-trainer would be appropriate for repetitive practice. If, however, the trainee would benefit from more complex interaction that is allowed to “play through,” then a live exercise would be a better fit. An effective instructor will use a combination of simulation types to provide the appropriate support based on learner needs.

Repetition. “Practice makes perfect,” or so the saying goes. Others prefer the qualified axiom: “*Perfect* practice makes perfect.” Some have argued that the difference between

practicing and not practicing is much greater than the difference between unguided and deliberate practice (Macnamara & Maitra, 2019). Conversely, Ericsson (2018) and others (Coughlan et al., 2014) assert that deliberate practice makes a significant difference, particularly when practice is aimed at advancing someone's skills from competent to elite. The benefit of practice is likely a both/and proposition; any practice will help a novice develop skill, but some form of intentionality and refinement is needed to progress to higher levels. Additionally, the inherent benefit of deliberate practice is that it safeguards against negative training transfer.

Given the need for Marines and other high-reliability professionals to operate at high levels and avoid negative training transfer, this paper recognizes that high stress practice must be designed with expertise development in mind. The literature defining this type of repetition is nuanced. Ericsson originally defined "deliberate practice" as "activities that focused on explicit goals of improving aspects of individual performance with established practice activities that offered immediate feedback and opportunities for repetition after reflection" (Ericsson & Harwell, 2019, p. 3). He created this definition in the context of music lessons, where a teacher coaches a student weekly then gives the student tasks to practice during the week that will allow skill development and correction without the teacher's immediate feedback. In defending this definition decades later, he distinguished it from other practice types including purposeful (student-guided with minimal coach support), structured (coach-guided but without individual tailoring), and naïve (unguided) (Ericsson & Harwell, 2019, p. 6).

For simplicity, this paper uses the term "intentional practice" to describe any practice activity with a mechanism designed to guide practice to improve performance. It includes Ericsson's deliberate, purposeful, and structured practice types. It also recognizes that training Marines via deliberate practice may not always be practical due to resource limitations.

Concurrently, it acknowledges that any form of intentional practice is better than unguided practice for both expertise development and decreasing the risk of negative training transfer.

This intentional practice must be sustained over time to ingrain skills and improve performance. This concept is known as “spacing” (McDaniel, 2012). Spacing provides chances for trainees to practice their skills in the real-world in between training sessions. This has been shown to improve transfer, especially in soft skills training (Ibrahim et al., 2017).

Spacing is also important to prevent skill decay. Decay of even the most important skills can occur in as little as 6 months (Landman et al., 2022). Skill decay is particularly concerning in the military, where real-world missions may be years apart (Villado et al., 2013, p. 53) and training is limited by resources. This decay can even occur among highly experienced professionals, who may perform worse than novices on highly specific skills because they are further removed from repetitive training (Baldwin et al., 2022, p. 16). Fortunately, spacing has been shown to prevent skill decay in both medical training (Bluestone et al., 2013, pp. 11–12) and the military (Jastrzembski et al., 2013, p. 169).

Given limited training resources and the need to sustain countless skills, the key question is how much spacing and sustainment are needed. Landman et al. (2022, p. 9) recommended refresher training for combat lifesaving skills at 2 months. Another study of U.S. Air Force pilots recommended a formula based on the length and density of training—longer training programs with more practice per day lead to greater skill retention (Jastrzembski et al., 2013).

Instructors can incorporate repetition and spacing into simulation training to maximize training retention. Trainees can practice physical skills using low-cost options like battle drills (Newsome & Lewis, 2011, p. 122) and eventually XR. Likewise, they can practice complex decision-making on PC-based simulators and tabletop wargames that require relatively minimal

resource investment. Instructors should instill a mindset of intentional training in their students. This could be purposeful practice, like the trainee's self-directed learning in supplemental activities such as martial arts training (Renden et al., 2015) or PC flight simulators (Petty & Barbosa, 2016). The instructor could structure this practice, providing a rough training plan of which skills to practice in available simulation technology. It could also be deliberate practice, with the instructor meeting with the trainee weekly to give feedback and assign further practice. Regardless of method, simulations should be spaced over weeks, months, and years to encourage retention and allow trainees to practice their skills on the job in between training blocks. The bottom line is that Marines must practice *intentionally* to maximize training repetition value.

Progression. Before trainees can progress, they need to establish a foundation. They must be able to practice and learn a skill competently before being stressed with testing or stressors (Rajakaruna et al., 2017, p. 518). This progression is also tied to fidelity in simulation studies. For example, medical trainees performed best by starting with lower fidelity simulations like tabletop exercises before moving to higher fidelity scenarios like manikins (Facho et al., 2021, p. 4). By the same token, experienced trainees tended to show more training transfer with high fidelity simulations, likely because they needed more challenging situations brought upon by more complex simulations, while novice trainees transferred more training with low fidelity simulations because they needed to start with simpler scenarios (Doozandeh & Hedayati, 2022, p. 129). As repetitions accumulate, skills that were difficult become easy. For trainees to continue to grow, the level of challenge should increase and the amount of support decrease as students gain proficiency. Instructors can encourage continued progression by increasing challenge, complexity, and stress.

As trainee skills increase, challenge must also increase to maintain the “flow” state that balances anxiety and boredom to maximize learning (Alklind Taylor, 2014, p. 50). Literature on elite sports performance recommends “gradually increasing pressure via challenge and the manipulation of the environment” (Arnold & Fletcher, 2021, p. 273). The sports field also found that true experts tend to focus on improving those skills they find the most challenging (Coughlan et al., 2014). In military research, progression from easy to challenging scenarios in training for command and control (Villado et al., 2013, p. 59) and military pilot training (Jastrzembski et al., 2013) can help mitigate long-term skill decay. Marine Corps instructional design thus adopts a progression model, with practice advancing from guided to structured to independent (United States Marine Corps, 2016, ch. 3, p. 12).

One way to increase challenge is to increase complexity; learners should progress from simple to complex problems (Merrill, 2002, p. 46). This reflects the foundational learning theory in Bloom’s taxonomy, as students learn to remember and understand content before applying, analyzing, evaluating, and creating with their new knowledge, skills, and attitudes (L. W. Anderson & Krathwohl, 2001). To progress beyond basic competency and develop expertise, trainees must “practice with a variety of problems to enable students to experience complexity and ambiguity” (Elvira et al., 2017, p. 193). Simply advancing to a single complex, culminating exercise is not enough. Trainees can progress to training on a wide variety of complex, stressful scenarios, or they will become conditioned to only the specific scenarios they train on and will be less likely to transfer training to new situations (Baumann et al., 2011; Landman et al., 2018). Finally, the complexity of these scenarios must include the ethically challenging, chaotic, and ambiguous circumstances present in life-or-death situations (Jenkins et al., 2020, pp. 444–445).

As trainees progress in their proficiency with basic skills and begin integrating these skills within complex simulations, they can be exposed to stress to prepare them for combat. Research has found that stress is best introduced with a phased approach, where trainees initially develop skills in a low-stress, supportive environment, then stress is added in a later training phase (Friedland & Keinan, 1992). This method is more effective than introducing stress from the beginning and slowly increasing it. Numerous studies already referenced demonstrate the benefits of adding stress to increase performance in high-stress situations, but two more stand out for the specific principle of adding stress to facilitate progression. In the first, trainees in a VR International Space Station simulation who trained with a moderate stressor of simulated light smoke improved performance on a high stress test with simulated heavy smoke compared to a control group who went straight from training with no smoke to the heavy smoke test (Finseth et al., 2018). Second, a study of Israeli security officer trainees found that increasing stress throughout a 9-week course improved performance in stressful evaluations (Zach et al., 2007).

When developing a simulation training plan, the instructor should consider how she will progress the trainee by increasing challenge, complexity, and stress. She can increase challenge by progressing simulation fidelity from partial-task trainers to VR, then immersive simulators, and then finally live exercises. This progression would also likely increase complexity. Even within a simulation type, she could increase complexity by adding more variables to a VR scenario or by running widely different scenarios through an immersive simulator. Ethical complexity can be introduced first with stand-alone ethical decision games (United States Marine Corps, 2016, ch. 7, p. 14) and then by incorporating these dilemmas into higher fidelity simulations. As the trainee masters increasingly challenging and complex skill sets, progression can be maintained by adding realistic stress; several examples are provided below in the section

on inducing stress. In sum, the instructor should create a logical progression of increasing challenge and decreasing support to stimulate continued growth as the trainee gains repetition.

Tailoring. Implied in the application of challenge, support, repetition, and progression is the need to tailor these concepts based on the individual learner. The Marine Corps acknowledges that what is “effective” varies by learner and context (United States Marine Corps, 2020b, ch. 3, p. 5)—thus training should be adaptable, supported by both systems (instructional methods) and people (instructors). A meta-study of scaffolding found that the balance between support and challenge was more effective if it was tailored to the individual learner than if it progressed at fixed intervals (Hutchins et al., 2013, p. 861). Instructors must ensure that learning objectives are matched to the learner’s needs, style, and proficiency level (Kirkham, 2018, p. 46). Finally, instructors must remember that individual progression is not linear, but is likely to have “peaks and valleys” (Brou et al., 2022, p. 40). Once the instructor tailors learning for a trainee, it may require future adjustment to optimize continued learning.

One benefit of simulation is that it can be tailored to the audience, from familiarizing novices with work scenarios to enabling experience sharing between experts (Lukosch et al., 2018, p. 303). The instructor guiding the simulation can tailor the simulation to the trainee’s ability level (Alklind Taylor & Backlund, 2012, p. 6). Leveraging simulation to tailor training is particularly important when considering that instructors must often manage several trainees at different levels and preferences. Many forms of simulation can be quickly reset after each iteration, allowing the instructor to quickly change the scenario’s difficulty, complexity, and stress level based on trainee needs. As advanced technologies like AI improve automation, the simulator itself will be able to progress the trainee through a responsive program with challenge, support, and stress levels matched to the trainee’s developing proficiency. The instructor can

combine her own knowledge and experience with simulation tools to develop a training program tailored to the trainee.

Inducing Stress. To stimulate progression in certain contexts, simulation designers can eventually add stress to training. As a reminder, stress can result from danger, intensity, high stakes, pressure, evaluation, time constraints, complex tasks, emotional challenges, environmental factors, physical exertion, and fatigue. These stressors are a key aspect of fidelity (Thompson, 1989, p. 9); they are the most important aspect in light of this paper's focus.

Stress can be induced via both physical and psychological fidelity. While simulation can never fully replicate the stress of combat, some stressors are more realistic, and some are mere proxies. Physical stressors tend to be more realistic as physical fidelity increases and more proxies as it decreases, such as actual explosions during live training versus explosions played on a speaker while completing a tactical decision game. By comparison, psychological stressors tend to be more even across low to high physical fidelity, if the psychological fidelity is kept high. For example, the stress of evaluation and time compression are roughly the same in a tabletop wargame and a live-fire exercise, as long as the stressor intensity is equivalent. Instructors can use this knowledge to increase realism in simulations with otherwise low physical fidelity, allowing them to design effective training at lower costs.

Simulations with higher physical fidelity do, however, allow more compounding of realistic stressors. This generates the greater cumulative stress level necessary for closely replicating combat or encouraging progression in highly skilled trainees. Take, for example, a Marine at the end of a week-long field exercise with the associated lack of sleep, nutrition, and water and sustained battling of the elements. Even with these existing stressors the same, asking

the Marine to complete an evaluated MOUT building clearing exercise using paint simunitions will be far more stressful than asking him to complete the same test as a tabletop exercise.

Methods to Induce Stress. There are many ways to induce stress in training. Physically, this could mean fatiguing the trainee through lack of sleep, food, and water (Lieberman et al., 2005; Tait et al., 2022); making the simulation physically demanding (Shia et al., 2015); or requiring extended vigilance on a task (Guznov et al., 2017; Hockey et al., 2007; Szalma et al., 2018). Physical stress can also be simulated via sensory overload, such as loud or distracting noises that are present in the real-world task (Binsch et al., 2021; Di Stasi et al., 2022); distracting light or lack of light (Anghel et al., 2015; DeForest et al., 2018); unpleasant realistic smells (McGraw et al., 2013); or mildly painful stimuli like a cold pressor (McClernon et al., 2011; Neill, 2020) or electric shock (Gamble et al., 2018). These sensory stressors are often used in combination to create a more realistic stressful environment (Binsch et al., 2021; DeForest et al., 2018; Di Stasi et al., 2022; McGraw et al., 2013).

Environmental stressors like heat (Lieberman et al., 2005; Tait et al., 2022), cold (Lieberman et al., 2009), precipitation, and wind can be simulated indoors or added by training in a field environment with weather conditions similar to the combat operating environment (Pandolf & Burr, 2001). Likewise, contaminated environment operations can be simulated with tear gas or by requiring trainees to don cumbersome protective gear (Fatkin & Hudgens, 1994).

Important to the concept of inducing stress is that nearly all these physical stressors can be applied across virtually any simulation type. An instructor that uses artillery simulation devices and blank ammunition to add to the chaos of a life-fire attack can use the same methods to add stress to a tabletop exercise. Similarly, many simulation training activities can be conducted in harsh elements. Although high fidelity, technologically advanced simulators might

be restricted by strict environmental requirements, creative instructors can stress the trainee via discomfort such as adding a cold pressor or sensory stimulation like unpleasant smells.

Psychologically, emotional stress can be induced with actors (DeMaria Jr. et al., 2010) or graphic depictions of trauma (McAllister et al., 2022). Danger can be conveyed by shooting at trainees with paint simunition rounds, whether the trainee is a police officer that has to decide to use force and shoot accurately (Oudejans, 2008; Taverniers & De Boeck, 2014) or execute complex tactical tasks (Taverniers et al., 2011), or a first aid provider in a tourniquet application scenario (Friberg et al., 2021). The pressure to save other lives can be simulated via frantic actors (DeMaria Jr. et al., 2010) or by using live animals that bleed in training traumatic medical care (Bukoski et al., 2018). Finally, simulations can add the stress of time compression by forcing split second decisions (Vickers & Lewinski, 2012).

Like physical stress, psychological stress can be induced in ways that are both generic and specific to the training task. The pressure of performance and evaluation or operating under time constraints can be universally applied to various degrees to create stress. Likewise, complexity, chaos, and ambiguity can be introduced deliberately to increase psychological stress and require critical thinking and decision-making. Many of these stressors can be added in a generic and random sense, such as establishing an arbitrary time limit or removing random pieces of key information from a scenario. Conversely, they could be more targeted and realistic, such as requiring the trainee to assemble a weapon based on its field manual's time standard or allowing miscommunication between participants to realistically affect a command and control exercise. Similarly, the instructor could deliberately introduce equipment malfunctions at key points in the exercise to require troubleshooting and problem solving. This same effect could be achieved by allowing naturally occurring equipment problems to play out.

In short, there are numerous ways to add physical and psychological stress to simulations to encourage greater proficiency in realistic conditions. The informed and artful instructor should understand the effects, advantages, and limitations of these stressors when used across simulation types to effectively apply them to meet individual learner needs. The instructor should also consider ethical implications of stressors and their potential for physical and psychological harm. There is a moral necessity to add realistic stress in training to prepare trainees for dangerous and stressful situations, but this should be balanced with the trainee's stress handling capacity.

Instructor Role. As in any human activity, the person is more important than the technological system in which they work. An expert facilitator can facilitate learning from a poorly designed simulation, while even the most advanced simulation may be limited without an instructor to guide the learning experience. A helpful metaphor is the simulation facilitator as an “Unseen Helmsman” (Kortmann & Peters, 2021, p. 255), quietly steering the learning situation and the trainee towards learning.

Instructor Competencies. The Unseen Helmsman faces a complex challenge. Kortmann and Peters (2021, p. 261) identified 21 KSAs as facilitator competencies. Their work establishes that simulation instructors are successful when they have professional, player-oriented, and adaptive attitudes. Their knowledge should encompass both the simulation and the job it is training. They should have the skills to technically run the simulation and to facilitate individual and group learning, tailoring the training to meet learning needs. These KSAs should be balanced and emphasized at different times depending on the simulation phase and learner needs. For example, a facilitator may choose to stretch the game rules at one point to encourage learning and at another point strictly enforce the rules to allow natural consequences to serve as the teacher. Research in complex warfighting simulations supports these notions, emphasizing the

role of simulation facilitators in planning, guiding, and debriefing training. Instructors should be experts both in the content—warfighting—and the technical aspects of the simulation system itself (McIntyre et al., 2013, p. 292).

Instructors can fill several roles throughout the four simulation phases and often serve in multiple roles simultaneously. These include facilitator, debriefer, coach, player/participant, off-game facilitator, leader, subject matter expert, champion, and technical support (Alklind Taylor, 2015, p. 2). Other experts have used the simpler metaphor of the simulation instructor as scientist, rascal, and sage (Jansen & van Zelst, 2021, p. 277). The scientist develops the simulation, clarifies rules, and shares knowledge. The rascal interjects confusion, complexity, and challenge to stimulate learner growth. The sage coaches the learner and encourages her to find the lesson for herself. These frameworks bear some similarity to Kolb et al.'s roles of coach, facilitator, subject expert, and standard setter/evaluator (2014, p. 220).

Instructor Responsibilities by Phase – Preparation. Simulation training literature supplies multiple indications of how the instructor can best support learners. During preparation, the instructor can consider learning outcomes—both technical and non-technical—instructor strengths and weaknesses, student learning gaps, and individual learning styles (Kirkham, 2018, p. 46) when developing the simulation. The simulation should be designed around learning objectives robust enough to present challenging problems. The simulation fidelity level and type can be chosen to match learning objectives (Hontvedt & Øvergård, 2020, p. 107). Flexibility is essential. The scenario should be flexible enough to allow students to explore various solutions and for the facilitator to adapt the simulation to meet learner needs. To foster training transfer, instructors can explain why the simulation training is important before trainees even show up (Krauss et al., 2014, p. 185). Finally, complex situations requiring critical thinking and problem

solving benefit from a “primer pack” to brief the trainees on the scenario (Curry, 2020, pp. 48–49). This may be provided by the instructor, but it can also be created by the students from raw information during the briefing phase as part of the learning process.

Briefing. Typically, simulations include a briefing phase that prepares the learners for participation in the simulation event. Crookall (2014, p. 420) suggests that a specific, explicit learning objective and purpose is appropriate as a part of the learner briefing, although certain contexts may be intentionally designed with implicit learning objectives that unfold throughout the simulation. Participants should understand not only the exercise goals but how they tie to real-life job tasks (Stuns & Heaslip, 2019, p. 215). The briefing phase also ties the simulation to previous learning, provides instructions on the specific simulator technology and scenario, and introduces the simulation debriefing guide so the trainees understand what they will discuss after the simulation (Kirkham, 2018, pp. 47–48). The facilitator can encourage students to fully enter into the scenario’s realism (Kirkham, 2018, p. 48) while encouraging the “psychological safety” (Potter et al., 2022, p. 250) needed to maximize learning.

Execution. During simulation execution, the instructor can keep the trainee focused on learning rather than performance—winning the game or beating the sim—and assist the learner transfer his learning into meaning for real-life (Frank, 2014, p. 155). The instructor will also work to ensure the game functions smoothly—technically and administratively. The instructor’s most central role during execution is as a facilitator that coaches via performance feedback.

Coaching. Instructor feedback is focused on coaching that supports intentional practice. Instructors support intentional practice during simulations through what Alklind Taylor et al. term a coaching cycle (2012, p. 660). The cycle begins when the trainee completes actions in the simulation, resulting in simulation feedback; the instructor may also choose to give feedback.

Both feedback forms drive subsequent trainee actions. Schwägele et al. labeled this process the impulse-debriefing-spiral (2021, p. 376). They encourage instant feedback during the simulation so the trainee can immediately apply their learning to build better habits and mental frames. In this model, the instructor uses the post-simulation debriefing phase more for explaining how the training should transfer to the job than for correcting errors from the simulation.

Evidence suggests that this immediate feedback can improve learning. Providing instant feedback to adjust performance is well-established best practice in high-stress simulations like military pilot training (Svensson et al., 2013, p. 274). This instant feedback can be given relatively easily in jobs like aviation, where the instructor might serve as a co-pilot, or for short, discrete skills like shooting (Heusler & Sutter, 2022), where the trainee can practice a brief psychomotor sequence dozens of times in succession and receive coaching after each shot.

Other training situations require more creative mechanisms. In one study, student teachers appreciated real time coaching via wireless earpiece while they delivered a practice lesson, as this helped them identify small adjustments in the moment that they would have otherwise missed in post-lesson debriefs (Sharplin et al., 2016). Similarly, a study of untrained college students assessed their performance on a computer-based firefighting simulation (Scoresby & Shelton, 2014). Students were given the opportunity to practice “reflective redo” (Scoresby & Shelton, 2014, p. 668) by playing back the simulation from the point of error instead of restarting the entire scenario, using self-reflection and instructor support to identify errors and focus on improving those areas where they failed. Most students preferred this method of concentrating on “sticking points” and demonstrated improved performance on subsequent scenarios. A minority of students, however, preferred restarting the scenario from the beginning to put themselves in the correct mental frame.

If the instructor desires to provide immediate feedback in a less intrusive, more realistic way, she could also assume the role of “puckster” (Alklind Taylor et al., 2012, p. 662). In this role, the instructor can take control of characters or events normally driven by the simulation and modify them to meet a specific learning objective, such as using a realistic inject to “kill” a student who does not follow trained procedures. Likewise, the instructor can role play a key position in the simulation. In health professions, the facilitator could serve as a medical assistant that responds to trainee directions based on an assistant’s expected competency (Kirkham, 2018, p. 48). In aviation, the instructor could role play air traffic controllers, ground personnel, or the flight crew (Myers et al., 2018, p. 16). This method allows the instructor to respond realistically to student actions and permits direct observation of student performance. Ultimately, the degree to which facilitators are hands on or hands off depends on whether the learner is better served by practicing discrete skills to improve performance and muscle memory or by working on higher order skills that require critical thinking, problem solving, and the playing out of natural consequences in complex systems.

Debriefing. Debriefing is arguably the most important part of the simulation process (Issenberg et al., 2005, p. 21) and is where much of the meaning making learning occurs. It encourages learner reflection and supports “transfer from the game world to the real world” (Lukosch et al., 2018, p. 303). Often, allowing time to decompress between execution and debriefing can help students to better reflect on their experiences and internalize learning (Jenkins et al., 2020, p. 445).

Most often, the instructor supports debriefing by facilitating reflection and discussion, providing expert advice and feedback, and helping the learners process their simulation experience, including stress and emotions (Alklind Taylor, 2015, p. 2; Alklind Taylor &

Backlund, 2012, pp. 7–8; Crookall, 2014, p. 420). Thorough debriefing is especially crucial if the instructor used a hands-off approach during execution. Instructors even have an ethical obligation to debrief. If they do not, at best they waste learners' time, and at worst the trainees learn the wrong things (Crookall, 2014, p. 423). The instructor can convey to the student the simulation's limitations and differences from real-life so that the trainee does not learn incorrect behaviors, especially if those behaviors worked in the simulation (Myers et al., 2018, p. 16).

To facilitate debriefing, instructors may choose to use a post-execution break to prepare notes and review automated debriefing data generated by the simulation system (Alklind Taylor & Backlund, 2012, pp. 7–8). They might also use a debriefing guide (Kirkham, 2018, p. 48) or adopt a specific debriefing strategy appropriate for their context (Schwägele et al., 2021, p. 368). These methods standardize debriefing and maximize learning in the limited time available.

Despite the importance of debriefing and the techniques available, many instructors struggle with this part of simulation training. A qualitative study in health professions found that novice debriefers need additional formal training, mentorship, and job aids to give more effective debriefs (Ng & Lugassy, 2021). Similarly, a RAND study of U.S. Army simulations found that most instructors gain debriefing knowledge informally; as a result, the think tank recommends more formal training on debriefing (Straus et al., 2019, pp. 97–98). While many instructors conduct robust debriefs, this debriefing is not typically uniformly applied—debriefing quality is more often the result of personal experience or professional subculture.

Another challenge to debriefing is group dynamics. Interpersonal conflict and organizational culture can affect what lessons trainees take away from a simulation. Group dynamics can be highly complex and require an experienced facilitator to manage (de Wijse-van Heeswijk, 2021). Although this paper is focused on individual learning, much of Marine Corps

training occurs in a group setting. Interested readers can read Hermann (2015, pp. 216–218) for recommendations on how to facilitate learning through group dynamics during briefing, simulation, and debriefing.

Cautions to Instructor Role Importance. Despite the large body of research supporting the instructor's essential role in simulation training, there are some caveats to this concept. First, there are scholars who contend that excessive feedback can actually inhibit learning. Research in both policing (Jenkins et al., 2020, p. 446) and medicine (Al-Saud et al., 2017, p. 241) cautions that feedback should not be overused or it will lead to student dependence on the feedback for fixing errors. This should make sense to anyone who has experienced a micromanaging coach or supervisor who is ready to correct the moment someone strays from perfection. To counter this, the instructor can recall the principles of challenge, support, and progression to tailor feedback amounts. A novice will benefit from more robust and immediate support as he establishes foundational skills. As he progresses toward expertise, the instructor can remove support (immediate feedback) and allow him to struggle with a problem in a safe simulation environment. The instructor can then supply feedback after the simulation, giving the trainee time to reflect and learn from mistakes, preventing him from relying on feedback in the moment, and ensuring the right lessons were learned.

Outside the potentially negative effects of instructor intervention, there is also evidence that people can learn from simulations with zero instructor support. This is intriguing because instructors are often in high demand and short supply (Alklind Taylor & Backlund, 2012, pp. 2, 9). In one example, a player flew almost 3,000 mission in an air combat simulation on a PC with joystick and keyboard and improved his performance using only his own detailed reflections (Petty & Barbosa, 2016). The caveat is that this study made no attempt at measuring training

transfer; it only showed that performance improved within the simulation. The player did, however, discover many lessons taught to actual air combat pilots, suggesting some value in this approach. This should not discredit instructor involvement, but highlight the benefit of repetition and reflection, something that students could do more now with the proliferation of inexpensive, accessible simulation technology like computers and VR.

A study of dental novices reinforces the notion that instructor-free simulations can be good, but instructor-guided simulations are better (Al-Saud et al., 2017). Trainees performed better when given instructor feedback only compared to VR feedback only, and performance was highest when instructor and VR feedback were combined. Thus, while autonomous, instructor-free simulations can provide valuable repetitions otherwise unavailable, this training is even more effective when paired with adept instructor guidance.

Another advancement in simulation technology is the development of semi or fully automated simulation generation programs. Multiple models have been proposed for generating scenarios tailored to the learner's needs (Luo et al., 2013), including for military scenarios (Zook et al., 2012). Others have shown the benefits of crowd sourcing to both generate more varied scenarios and ease the burden on instructors who spend considerable time developing each scenario (Sina et al., 2014). Recently, a team of U.S. Army medical professionals developed fully autonomous immersive virtual reality simulations that trainees can use without the aid of an instructor, although these scenarios required significant instructor development beforehand (Couperus et al., 2020). These studies on automated simulation generation shows the upside of using technology not to replace instructors, but to augment their work and free them to focus on more complex tasks requiring human judgment.

The instructor plays an essential role in simulation training as the human that interacts with and supports fellow human trainees. The simulation facilitator actively applies diverse skills across all simulation phases but especially as a coach through execution and debriefing. The ethical implications of poorly designed and executed simulation training make the instructor even more important. Even with the rapid advancement of artificial intelligence (AI) that may subsume many of the design, feedback, and tailoring functions, human instructors will be needed to connect with trainees and ensure their learning best supports future job performance in HROs.

Evaluation. Training evaluation is essential to ensure that training meets organizational needs. Evaluation comes in many forms— assessment and evaluation, trainee and program, formative and summative. Evaluation can be conducted by internal or external evaluators using various approaches based on the evaluation’s purpose. There are different evaluation levels and several evaluation instruments. These levels and instruments can be applied to simulation training to measure training effectiveness in support of organizational goals.

Evaluation and Assessment. Leaders can evaluate training at the trainee and program levels. Both are important for measuring training effectiveness. Some use the term *evaluation* for program level analysis (Fitzpatrick et al., 2011) and *assessment* for trainee level measurement (Broadbent et al., 2018). The Marine Corps adopts this distinction between evaluation as measuring “the effectiveness and efficiency within an instructional program” (United States Marine Corps, 2016, ch. 8, p. 1) and assessments as testing “a student’s knowledge and skill level” (United States Marine Corps, 2016, ch. 7, p. 18). Others, like the Kirkpatrick Model (Kirkpatrick & Kirkpatrick, 2016) use the term “training evaluation” to represent both evaluation and assessment at the program and trainee levels. Additionally, the term “feedback” is often used to signify the communication loop that occurs during evaluation and assessment and is

sometimes used interchangeably with evaluation and assessment. For simplicity, this paper will use the term evaluation to refer to any effort made to measure trainee or program performance.

Formative and Summative Evaluation. Evaluation is typically broken into two types based on its intended use: formative and summative (Fitzpatrick et al., 2011, pp. 20–25). Formative evaluation helps form that which it evaluates. It is used to improve the trainee or program. As a result, it usually occurs while training is in-progress, is conducted by internal evaluators, and tends to be less formal. By comparison, summative evaluation summarizes that which it evaluates. It helps leaders judge and decide about the future of training programs. It is typically conducted after a training program is complete, may use external evaluators, and is usually more formal.

Formative and summative evaluation can be used at both the trainee and program levels. Formative evaluation for a trainee might be an instructor providing feedback to encourage and correct trainee performance. At the program level, formative evaluation could be used to improve instructional delivery from one lesson to the next. Summative evaluation for the student usually consists of graded examinations at the end of a course or instructional block (Kirkpatrick & Kirkpatrick, 2016, p. 43). Summative program evaluation judges whether the program achieved its intended outcomes (Fitzpatrick et al., 2011, p. 175). Although formative and summative evaluation are distinct, they exist on a spectrum and often overlap or are even mutually supportive. For example, the summative results from one course iteration could be used formatively for the next iteration.

Evaluation Approaches. Evaluation is not limited to training, so an evaluator may choose from several approaches to fit the evaluation's purpose and audience. According to Fitzpatrick et al. (2011, p. 123), these approaches can be judgment focused, expertise- or consumer-oriented;

program-oriented; decision-oriented; or participant-oriented. Each approach can be tailored to evaluate training. For any approach, the evaluation can be conducted by internal or external evaluators or a combination of both (Fitzpatrick et al., 2011, pp. 27–28). Internal evaluators are often less expensive and bring more intricate knowledge of the program, while external evaluators can add outside expertise and perspective. The evaluation's purpose will dictate the choice of evaluators.

Kirkpatrick's Four Levels. One of the most widely used evaluation frameworks in training and development is Kirkpatrick's Four Levels (Fitzpatrick et al., 2011, pp. 20, 334). The Four Levels are Level 1 – Reaction, Level 2 – Learning, Level 3 – Behavior, and Level 4 – Results (Kirkpatrick & Kirkpatrick, 2016, p. 10). In theory, if the trainee reacts favorably (Level 1), demonstrates learning (Level 2), and transfers newly trained behaviors to the job (Level 3), then the training will lead to organizational results (Level 4). When designing and developing training, leaders should work backwards (Kirkpatrick & Kirkpatrick, 2016, p. 11). That is, they should consider the desired organizational results, what new behaviors would support these results, what learning is required to implement the new behaviors, and what reaction is necessary to facilitate learning. The Kirkpatrick model is typically used for program-oriented, objectives- or standards-based evaluation approaches. It can also be used to judge training program value via return on expectations (Kirkpatrick & Kirkpatrick, 2016, p. 34) or to inform decisions about a training program.

Of the four levels, the Kirkpatricks contend that Level 3 Behavior is the most important (2016, pp. 14–15). This is where training transfer occurs—where learning translates to organizational results. It is also where organizational support outside of training is necessary to reinforce learning and maximize training transfer. Level 3 is so central to training impact that if

an organization can improve on the job behavior, it will probably lead to Level 4 Results, and it also likely means that Level 1 Reaction and Level 2 Learning were sufficient.

Evaluation Tools. Training effectiveness can be difficult to measure. This is especially challenging for the military, where trainees may not practice their skills in combat for years, if ever. Because of the stakes involved, it is important for the military to evaluate training effectiveness across all four levels. While there are options available for each level, training professionals should especially consider the challenges and opportunities present when evaluating simulation training for stressful situations. In particular, the simulation assessment chosen should match the learning objectives, whether they involve physical skills, cognitive problem solving, or situational teamwork (Hontvedt & Øvergård, 2020, p. 92).

For Levels 1 and 2, simulation training moves beyond the traditional written exam by requiring students to apply their knowledge rather than simply reproduce it. Since simulations encourage realistic practice, instructors can particularly focus on assessing learner presence and engagement with the simulation (Garcia et al., 2019; Griffith et al., 2016; Wijkmark et al., 2022) along with more traditional performance indicators. Simulation technology can be used to record trainee behavior, generating comprehensive performance data that supports more tailored formative feedback and more detailed summative analysis.

Simulation is especially helpful for encouraging training transfer with Level 3 “required drivers” that reinforce, encourage, reward, and monitor trainee performance (Kirkpatrick & Kirkpatrick, 2016, p. 53). In the military, where chances to perform the job—combat—might be years apart, simulation enables the repetition of behaviors that would otherwise be too impractical or dangerous to practice. This regular practice helps trainees reinforce behaviors, especially where they experience sticking points. Simulations can encourage trainee behavior via

instructor or automated feedback. The unit can reward trainees by tying quality and quantity of simulation practice to career progression through MOS-specific training and readiness manuals (see, for example, United States Marine Corps, 2022).

Long-term, the most realistic measurements of Level 4 leading indicators (Kirkpatrick & Kirkpatrick, 2016, p. 60) come from biennial, unit-level Marine Corps Combat Readiness Evaluations (MCCRE) (United States Marine Corps, 2019). These are informed by training and readiness manuals and often include a combination of live and simulation training. Here, again, simulation proves invaluable. For many unit types, incorporating simulation is the *only* way to evaluate all mission essential tasks in a way that is both safe and logistically feasible. MCCREs are driven by subject matter expert qualitative observations which must be supported by quantitative data showing that the unit met performance standards. Simulation recording devices can track both quantitative and qualitative data, from capturing weapon accuracy in immersive simulators to logging communication timeliness and clarity in chat software.

Continuous formative and summative evaluation aids leaders to improve training and judge its merit. Using Kirkpatrick's Four Levels, trainers can maximize training effectiveness in support of organizational goals. Instructors who use simulation training should recognize the need for evaluation and how simulation technology can provide more realistic evaluation with more data than traditional training methods.

CHAPTER 3: DISCUSSION AND IMPLICATIONS FOR PRACTICE

The literature on training for stressful, high-reliability occupations is wide-ranging and multidisciplinary. The review in chapter 2 merely sampled the depth and breadth of this instructional issue. The reader should take away four key points from the literature:

1. Marines engage in an extraordinarily high stakes profession that they must be prepared to succeed in, but the danger and complexity of combat make preparation extremely difficult.
2. Stress is inherent in combat, and it directly affects performance. The way Marines cope with and train for stress can further influence performance.
3. Simulation, appropriately applied, is a useful and versatile approach for realistically practicing stressful, dangerous job situations.
4. The instructor is essential for implementing effective training, and especially for realistic simulation training.

Chapter 3 will discuss these points with suggestions for practitioners. It will conclude with suggestions for further research on this important topic.

Challenges of Training for War

This paper reviewed training literature from several HROs including firefighting, aviation, medicine, disaster response, and police. Each of these occupations include danger to the professional, the need to protect and save other human lives, and in the case of police, the potential to take a life, but none with the same intensity and magnitude as the military. The nature of war—friction, uncertainty, fluidity, disorder, complexity, the human dimension, violence, danger, and physical, moral, and mental forces—will not change, but the character of war will (United States Marine Corps, 2018, ch. 1, pp. 15-16, 18). These changes will quickly

compound with the rapid growth of technology like AI, unmanned vehicles, and networked weapon systems. Marine leaders have a moral obligation to do everything they can to prepare for the nature of war and its swiftly changing character. While training is only one part of military readiness, it is perhaps the most crucial.

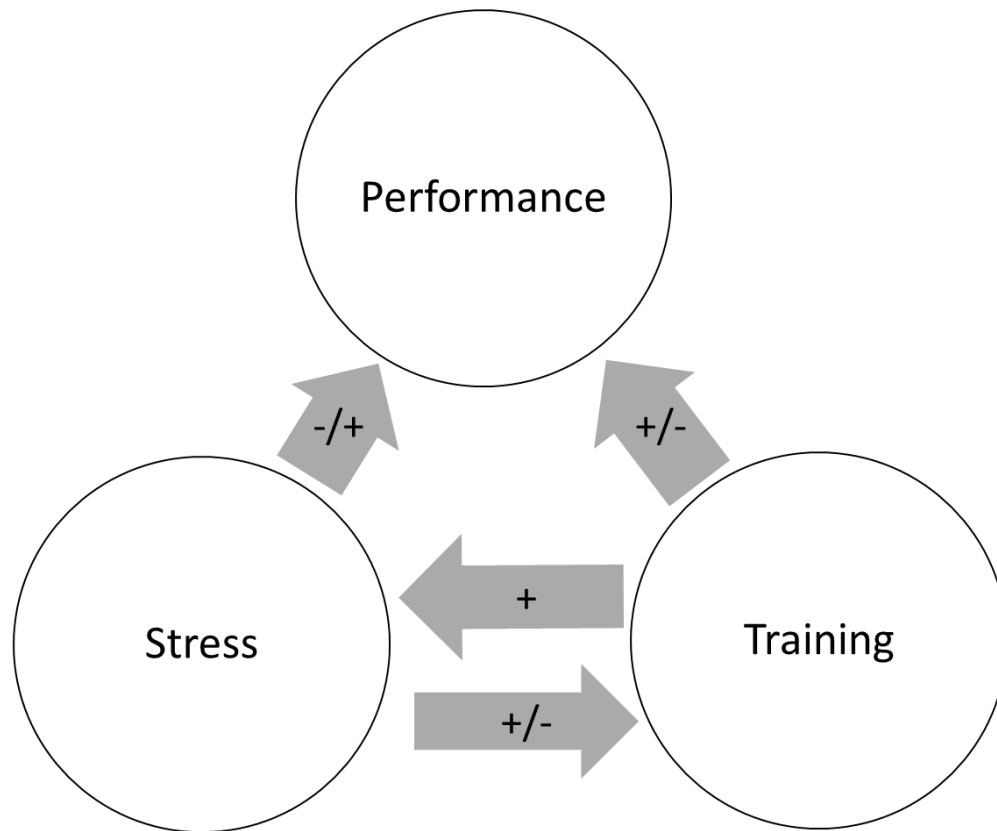
Training for war is made difficult by combat's incredible dangers and complexity. Effective training should incorporate stress without excessively endangering trainees or impeding their ability to learn. Even then, training cannot fully recreate stressful combat. Marines cannot know how well their training transfers on the job until they go to war, which happens rarely, if ever. Limited resources and personnel further constrain this training.

Additionally, the Marine Corps' very strong organizational culture directly affects training. As discussed in Chapter 1, the Marine Corps is first a competitive market culture, followed by hierarchy, clan, and adhocracy cultures. It maintains distinct attitudes toward training. Discussion throughout Chapter 3 will highlight how this culture both supports effective training and at times hinders it.

Stress, Performance, and Training

Marine leaders should recognize the complex interaction of stress, performance, and training (Figure 3.1). Stress has negative and positive effects on both performance and training. Training generally improves performance but can sometimes be detrimental, as in negative transfer. Training can also improve stress coping, which in turn may improve performance.

Figure 3.1. Stress, Performance, and Training Interaction.



Coping with Stress

Before introducing stress into training, instructors can consider teaching Marines how to handle stress. This can begin with training on the benefits of adapting a task and decision focus rather than a threat, emotional, or avoidance focus. Instructors can train Marines on how to maintain focus under different types of stress (Driskell et al., 2001). This could be as simple as a brief discussion on how to focus on the task rather than the stressful stimuli (McClernon et al., 2011, p. 210), to more advanced tactical training to focus attention on the correct indicators for the situation (Heusler & Sutter, 2022). Instructors can leverage simulation technology to support this training by pausing the simulation to discuss the scenario and review which tasks and sensory data the trainee should focus on (Saus et al., 2006).

Training to maintain task attention can be closely linked to emotional regulation training. This can move beyond training on merely controlling emotions and instead seek to integrate multiple emotional regulation strategies (Gagnon & Monties, 2023). This training could adopt a “Systematic Self-Reflection model” to build “coping resources, usage of coping and emotional regulatory repertoire, and resilient beliefs” (Crane, Searle, et al., 2019, p. 1) in Marines. This program could be as simple as a 30-minute lesson supported by 2 weeks of daily self-reflection, a plan shown to be effective in the Australian Defence Force (Crane, Rapport, et al., 2019, p. 386). For longer or more advanced courses, a 3-week, 9-session training block focusing on “goal-setting, relaxation and arousal regulation, self-talk strategies, and imagery/mental rehearsal” (Fitzwater et al., 2018, p. 100) could be similarly effective.

Given their importance and low time demands, attentional and emotional regulation training could be implemented at the entry-level, such as during phase 4 of recruit training and The Basic School for officers. Instructors could further reinforce these skills at MOS schools, where they could begin tying them to job-specific situations. In the fleet, the Marine Corps could designate task focus and emotional regulation skills as part of annual combat skill sustainment training or integrate them into MOS-specific training and readiness (T&R) manuals.

Increasing Realism and Stress

Once Marines develop basic knowledge, skills, and attitudes, training should incorporate increasing realism and stress. The Marine Corps could develop a common framework for introducing stress. Some of this already exists in MOS T&R manuals: Marines progress in tiers from entry-level to core to mission skills and follow job-specific conditions and standards for each training event. These are helpful and generally well-designed by subject matter experts, but they do not guide the leader who wishes to increase stress and realism in simple, effective ways.

The Corps could add an appendix in the ISD/SATE Handbook or T&R manuals that describes options for increasing realism and stress across training types. For low fidelity types, this could mean adding artificial sensory stimulations like loud noises or reduced visibility, increasing pressure by constraining time, or simply by adding competition to otherwise routine training events. At the high fidelity end, the Corps can continue to develop XR technologies that are more realistic and available for every MOS. It could also explore ways to provide more live-fire and force-on-force training, whether this means using traditional laser tag or paint ammunition systems or developing XR systems that include physical feedback when a Marine is hit. Finally, this appendix should also highlight the need to establish fundamental skills before adding realism and stress; how to progressively increase stress as trainees improve while avoiding burnout from too much stress; and how to design stressful, realistic training events and programs when not every Marine is at the same proficiency level.

Increasing Complexity

As realism and stress increase, so should complexity, and in turn complexity can be used to increase realism and stress. Much like realism and stress, the T&R framework is designed to progress Marines through increasingly complex skills and problems. Even so, an appendix similar to the one recommended for realism and stress could be useful for instructors to choose ways to increase complexity. At the low end, this could mean adding more variables or players to a tabletop exercise. It could also mean removing key pieces of information or adding conflicting information to a scenario, which would highlight the challenges of combat situational awareness and decision-making. The appendix could suggest techniques for incorporating ethical decision-making into simulation training. At the high end, simulation programs could be designed that allow the instructor to increase complexity in the design and execution phases, such as by

increasing the variables; using software to randomly remove information or present conflicting information; or developing scenarios that force ethical decisions that are made more visceral by immersive realism.

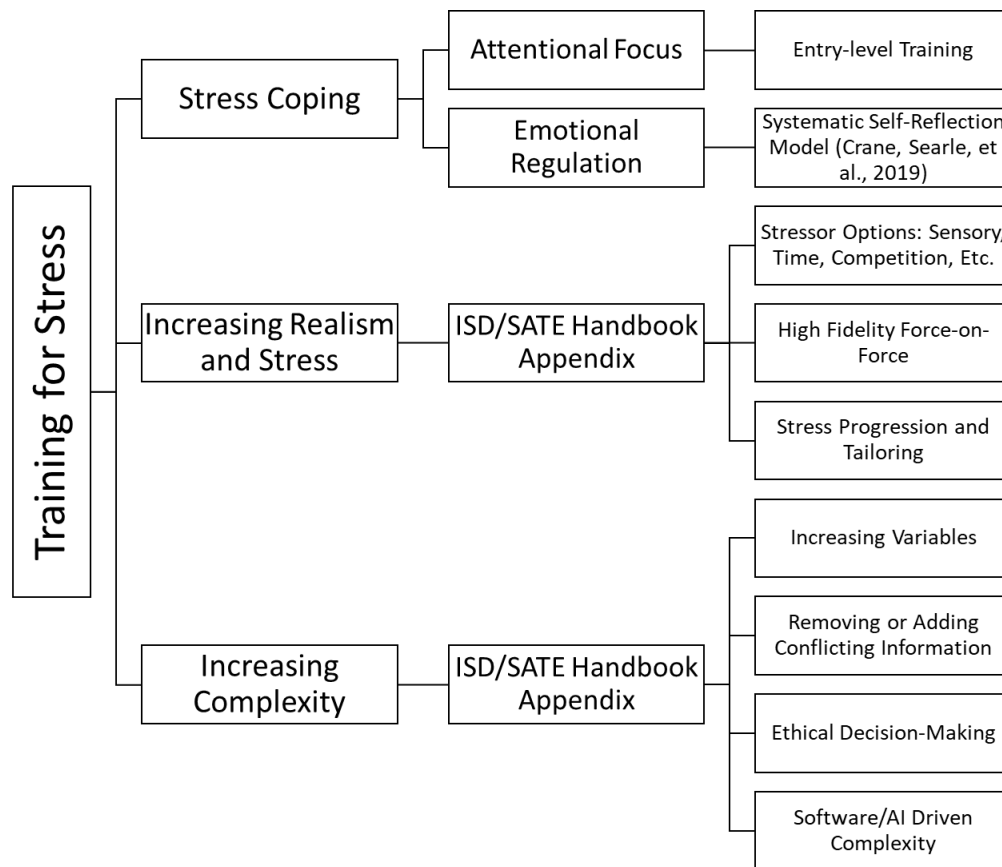
Cultural Considerations

The Marine Corps training culture has historically included stress and realism, especially in entry-level Marine training and high-end MOS training. Some aspects, however, have been lower priority, like complex decision-making for junior enlisted Marines. The recruit training model favors instant willing obedience to orders versus critical thinking and decision-making. There have been recent changes to shift this mentality sooner in a Marine's career, such as the addition of a fourth phase to recruit training (Staten, 2017) and requiring more critical thinking and decision-making during follow-on combat training (Athey, 2021). These initiatives will likely need a few more years to fully change the culture surrounding the expected capabilities and behaviors of the newest Marines.

Marine culture has been less focused on integrated emotional regulation. Doctrine that addresses emotions typically focuses on controlling them so they do not impede performance in combat (United States Marine Corps, 2020b, ch. 1, p. 14). Although DoD professional military education guidance names emotional intelligence as a required leader competency (The Joint Chiefs of Staff, 2020, p. 4) and guidance on Marine leader development includes resources for addressing combat stress and fatigue (Marine Corps University, n.d.), there is no evidence that force modernization efforts will implement a more integrated approach to emotional regulation. Although individual leaders may choose to train their Marines on integrating emotions into warfighting, this technique is unlikely to gain widespread use without organizational support.

Lastly, the competitive Marine culture introduces the danger of “winning at all costs.” This attitude may ignore the ethical complexities of combat. Training can include these ethical complexities often to ensure that the culture prepares Marines for ethical decision-making in high stakes scenarios.

Figure 3.2. Training for Stress: Implementation Ideas.



Simulation Training

Simulation as an Approach

Many professions use specific simulation definitions that often focus on technological aspects. It is more helpful to view simulation not as a technology but as an approach for recreating real-life scenarios to practice dangerous job situations. Training for high-reliability

occupations is difficult enough, so trainers should not artificially constrain themselves to a narrow set of simulation training options.

Eclectic Approach to Simulation. A mindset that uses whatever training methods are most effective for the training needs requires instructors to adopt an eclectic approach (Honebein & Sink, 2012). Rather than adhering to a particular instructional theory or simulation type, trainers should follow the principles of simulation design and instruction set forth in this paper: fidelity, phases, challenge, support, repetition, tailoring, inducing stress, instructor role, and evaluation. Using these principles, the instructor can mix simulation types based on learner needs. For example, he could have a new logistics Marine practice rifle skills using a laser training system, complete a complex transportation-related tabletop exercise with other logistics Marines to improve problem-solving, and use an immersive vehicle simulator to train for dangerous convoy operations. The point is that instructors can be creative and broaden their horizons. They can conceive of simulation not as a narrow range of technologies, but as purposeful experiential learning activities that mimic some aspect of the real-life job, with each type having its place.

Training Quantity and Quality

Marines know that training works, but with limited resources, training literature can suggest how to maximize training quantity and quality to better develop Marines. Leaders can use simulation training to increase repetitions and make these repetitions more intentional.

Increasing Repetitions. The Marine Corps can use simulation across the fidelity spectrum to increase training repetitions for all MOSs. On the low end, tactical decision games, wargames, and tabletop exercises allow any Marine to train critical thinking and decision-making at nearly any place or time. These already exist, and online repositories could be created

that allow Marines to access them from personal devices and play on their own against AI or with other Marines from around the globe. Simple partial task-trainers can help train physical skills. For example, many companies make laser systems for practicing personal firearm skills (Hung, 2022). These systems could be purchased and fielded to units for use with issued weapon systems with minimal or no modification. They would allow every Marine increased marksmanship practice at a fraction of the cost of indoor simulated marksmanship training facilities, which only exist at major installations and are limited by how many Marines can train at one time (Marine Corps Air Ground Combat Center Twentynine Palms, n.d.).

Eventually, proliferation of higher fidelity simulations like XR technologies will allow Marines to practice more than just thinking about warfighting—they will immerse Marines in stressful environments and incorporate realistic physical skills. Initiatives like Project Tripoli (Berger, 2023, p. 9) will one day link these technologies with immersive simulators and even live training so that Marines can participate in massive, networked training evolutions from around the world using a variety of simulation types.

Increasing Intentionality. Additional repetitions will be most effective if they are completed with intentionality. Targeting performance improvement transforms simulation from play to training. Whether using a simple laser marksmanship system or an immersive VR scenario, each session should have goals. These goals could be stacked together in pre-packaged training plans that Marines can complete in a set order or in whatever sequence they prefer based on their interests and needs. Marines could move through these training programs as quickly or slowly as they need based on their learning, mission demands, and time available.

Feedback is an essential element of intentional practice. Initially, this could be basic responses programmed into the technology to react to trainee inputs. Eventually, AI can be used

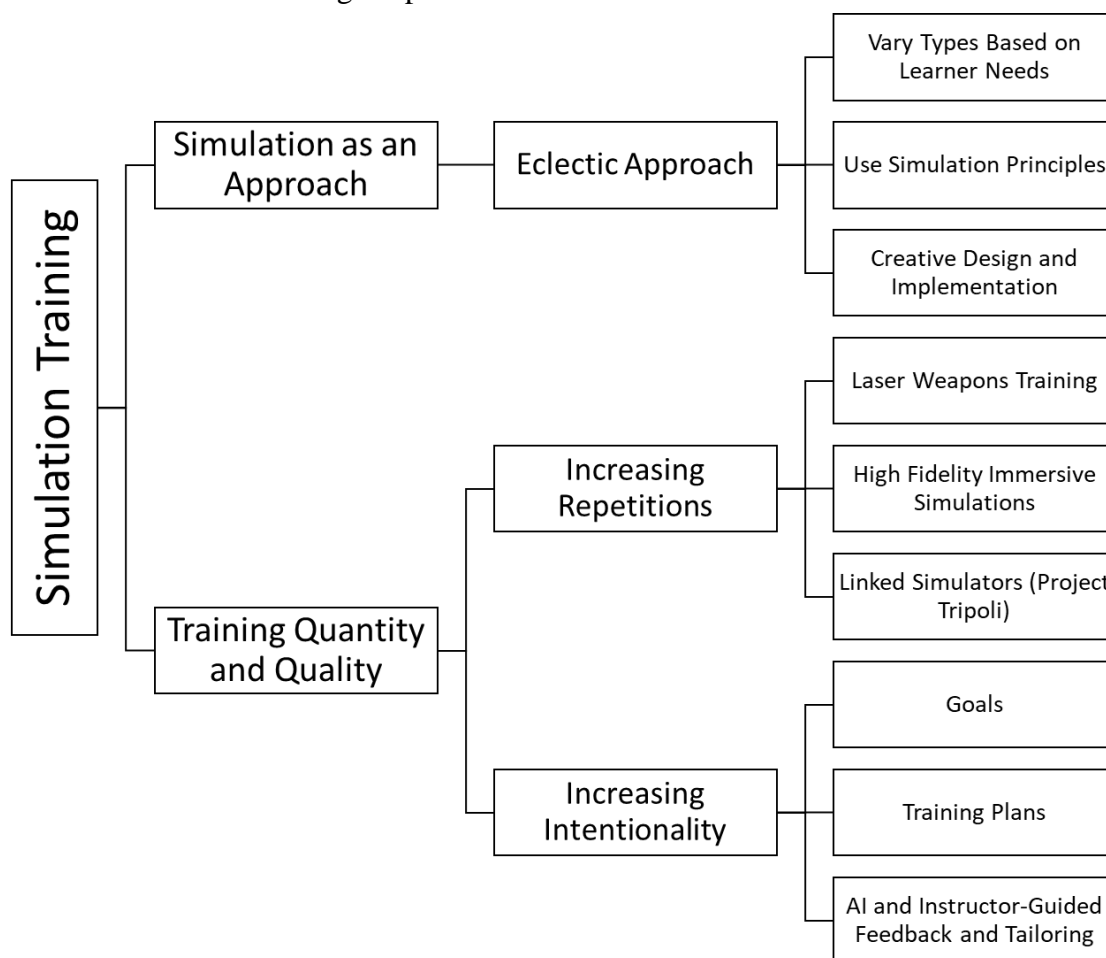
to detect patterns and fine tune feedback. As these technologies are used by more Marines, the AI can use machine learning to analyze thousands of training sessions and develop feedback based on what improves performance in other trainees using the same system. Instructors will still be used to fill the gap where AI cannot generate enough feedback, enabling expertise development as Marines become more proficient. Finally, feedback over time can drive individual training plan tailoring, whether that is by AI recommending further training or a seasoned instructor helping the Marine set new training goals.

Cultural Considerations

Narrow simulation mindsets exist in the Marine Corps largely in the same way that they do in other occupations, with Marine subcultures like aviation and infantry viewing “simulation” in different ways. While the distinctions between subcultures will never fully disappear, Marines in general can take a broader approach to simulation training and its possibilities. The Corps can leverage its competitive market culture to drive Marines to train as hard as they can for challenging missions. This desire for success can be a powerful motivator for using whatever training methods work, even if they have not traditionally been used.

Regarding simulation quantity and quality, the Marine Corps training culture has historically favored repetition, but cultural attitudes towards intentional practice are uneven. Units create training plans based on T&R manual progression models, but it can be difficult to customize these plans to individual Marines unless each Marine takes ownership of their progression. In some cases, Marines meticulously prepare and debrief every training event. In others, training is more like going through the motions. Often this is the result of individual experience—whether the instructor has been well-developed in these areas; or MOS-specific cultures—such as aviation, which has an ingrained briefing and debriefing culture.

Figure 3.3. Simulation Training: Implementation Ideas.



Instructor Importance

Instructor Development

No matter how much technology advances, war will remain a clash of human wills. It is essential, then, to prioritize the human aspect of training. This confirms the instructor as the center of gravity in stressful simulation training. While the Marine Corps has made great strides in improving formal school instructor courses and career progression, this does not help most Marine leaders who will never serve in a formal school instructor billet yet are charged with training their Marines daily in the fleet. Even for formal school instructors, their course is focused on traditional classroom-oriented instruction, not simulation or field training.

MOS training and readiness (T&R) manuals dictate training standards for every MOS and are thus wider reaching than formal school instructor courses. These manuals sometimes feature a separate syllabus for instructor development within that MOS, but many include little or no indication of how instructors should be trained. Aviation MOSs typically contain a robust instructor development syllabus. The F/A-18 Hornet T&R manual spells out dozens of training events across 26 pages, including several that require the instructor under training to observe and then instruct in a simulator (United States Marine Corps, 2020c, ch. 2, pp. 150-175). By comparison, the Direct Air Support Center T&R manual—still in the aviation field—includes only a few events focused mostly on classroom instruction and the generic requirement to instruct T&R events, although it does include the requirement to build a simulation drill (United States Marine Corps, 2022, ch. 2, pp. 7-12, ch. 3, p. 41). This is still far better than most ground MOS T&R manuals, which do not include any instructor progression requirements.

To improve instruction in all MOSs, the Marine Corps could create a baseline instructor syllabus to use in all T&R manuals. It could include basic instructor development content; lessons on the interaction of training, stress, and performance; and training on essential simulation aspects like design, preparation, facilitation, debriefing, and how to progressively add stress and realism. Aviation instructor programs are a helpful starting point, although many fields will not need the same level of detail. This baseline instructor training plan would become more important as simulation technology proliferates across all MOSs.

Dangers of Negative Training Transfer

The discussion of instructor role includes a word of caution: the best intentions can lead to disaster. Negative training transfer is a real danger. Poorly designed and implemented simulation can train behaviors that, applied in real-life, create disaster. A well-meaning instructor

could train Marines in a way that harms performance, so they must understand the dangers of negative training transfer and how to prevent it.

A Case Study: American Airline Flight 587. On November 12, 2001, American Airlines Flight 587 crashed shortly after takeoff, killing 265 people (Myers et al., 2018; National Transportation Safety Board, 2004). The aircraft encountered wake turbulence and the first officer incorrectly applied excessive rudder, shearing off the plane's vertical stabilizer and sending it into an uncontrollable descent. This error occurred despite the first officer and captain having thousands of hours flying in general and on the Airbus A300 specifically.

The mishap investigation found two critical errors in the first officer's simulation training (Myers et al., 2018, p. 1). First, the simulator's rudder pedal feel was much stiffer than the actual aircraft, which conditioned the pilot to push the pedals much harder than necessary. A danger of high-fidelity simulators is that trainee may subconsciously believe that these simulators behave *exactly* like the real-life systems they mimic, leading them to misapply behaviors on the real systems, even when feedback suggests these behaviors are not working. Second, the simulator instructors used a worst-case version of the wake turbulence emergency, suggesting to the trainees that this phenomenon would result in extreme aircraft roll of 90 degrees and require corresponding drastic rudder input. In reality, wake turbulence normally causes only 30 to 60 degrees roll, and is usually even less severe for large aircraft like the A300 (National Transportation Safety Board, 2004, p. 83). In this case, the desire to overstress trainees so they would be less stressed in real-life led to an inappropriately conditioned response. Tragically, the investigation concluded that the aircraft almost certainly would have self-corrected had the pilot applied the appropriate amount of rudder or even no rudder at all.

Implications for Simulation Training. Marines could imagine many behaviors with life-threatening implications that might be negatively conditioned by a poorly designed simulator, such as ground vehicle handling, explosive weapon effects, or combat lifesaving manikins. American Airlines changed simulation training after the crash, and these changes provide some ideas for mitigating negative transfer (National Transportation Safety Board, 2004, p. 83). The airline standardized wake turbulence scenarios so they were less extreme and matched reality. They removed the preceding heavy aircraft to prevent conditioning pilots to think this situation automatically causes heavy wake turbulence. Most importantly, they redesigned the scenario to be paused at the moment excess roll occurs so that the instructor and trainee could discuss the situation's complexity and recovery techniques. This reinforces the notion that the instructor is central to simulation training design, execution, and debrief. The instructor can ensure that the simulation matches real-life conditions and discuss with the trainee the differences between simulation and reality and how that disparity affects behavior.

While this paper has suggested several uses for AI to improve training quality, it must caution that AI is just as susceptible to imparting negative training transfer. AI is only as good as the information it receives. If this information is flawed or paints unrealistic patterns, then the machine will generate training solutions with potentially negative training transfer and deadly consequences. The instructor must be vigilant to ensure AI does not lead to negative transfer.

Finally, the instructor must remember that she cannot scientifically control behavior. Trainers train *people*, and people are not machines. Even the most rigorously designed and implemented simulation training programs do not guarantee performance improvement—they merely increase its chances. This is even more reason to ensure both trainers and trainees understand simulation limitations. Marines must spend ample time developing the critical

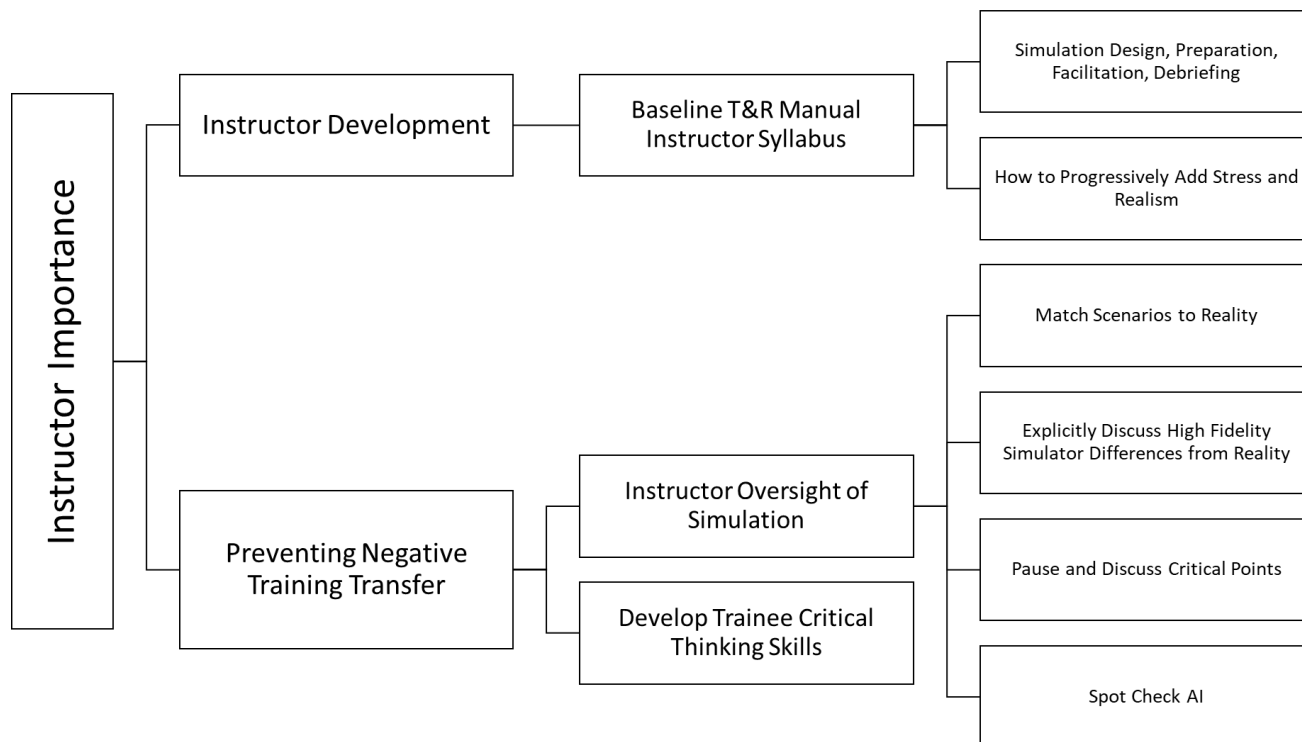
thinking and mental frames that help them see problems holistically. They must avoid viewing problem scenarios simply as inputs to which a rigidly trained process can be applied to achieve a guaranteed outcome.

Cultural Considerations

The Marine Corps' competitive market culture with a strong hierarchy may tend towards unfeeling processes and rigid solutions, but the fact that the organizational culture is founded on *becoming a Marine* means that a strong emphasis on the person has persisted (Berger, 2021, p. 5, 2023, p. 1). While technology will continue to advance and tempt leaders to turn all training over to AI, the focus on Marines as the Marine Corps' bid for success should keep instructors at the forefront of effective training. If Marines are kept at the center, then instructor development will follow as a necessity for effective Marine development.

Marine culture also favors muscle memory and ingraining behaviors. This mentality is necessary for the high stress of combat, when cognitive functioning is severely reduced, but it also primes Marines for negative transfer. How can the organization leverage culture to prevent this? It can re-emphasize that the Marine, not the simulation technology, is at the center of training. Both the instructor and trainee have a professional and moral responsibility to develop and engage critical thinking to mitigate negative training transfer from poorly designed, executed, or debriefed simulations.

Figure 3.4. Instructor Importance: Implementation Ideas.



Suggestions for Future Research

Although the military uses simulation training extensively, empirical evidence of simulation effectiveness for training transfer to military missions is lacking. This is largely due to the difficulty of evaluating Marines on the job. As a result, research from other HROs is often used to generalize findings to military contexts. Future studies could compare simulation training—in HROs in general and in CAOs specifically—to the military. They could develop a framework for which occupations and which aspects of simulation training translate well to the military and which ones do not, similar to how Hannah et al. (2010) proposed a framework for studying leadership across these fields. Similarly, researchers could try to replicate in military contexts the findings from simulation studies of HROs like police, aviation, or first responders.

Extending this research line, future reviews could investigate whether or how MOSs are represented or underrepresented in the simulation literature. For example, health professions and aviation have close military equivalents, so many of the simulation studies from these fields are useful for the military. Conversely, ground combat arms MOSs have no civilian equivalent, so there is not a large literature base to draw upon. Future research should focus on how well similar professions like policing translate. Likewise, studies of military simulation could be prioritized to those fields with no civilian counterpart.

Future research could also investigate if it is possible to empirically study Marine performance in combat and how well training transfers to real-life challenges. This is extremely difficult because operations are infrequent and when they do occur, it is hard to gather accurate, unclassified data. Researchers could use participant perceptions of training effectiveness captured in after action reports or solicited via surveys and interviews. Qualitative methods like case studies could be particularly helpful for demonstrating whether simulation training was effective. Additionally, as advancing technology enables the recording of more comprehensive human performance data, this information could be used to generate more robust empirical data on combat. While this data would be challenging to collect given security concerns, it would be worth the effort if it improves training for combat.

As simulation becomes more widely used, research can explore how training that uses solely simulation and AI compares to traditional training programs in which simulation augments live training and testing. How do these programs compare to instructor developed and led training? Are these more or less effective than traditional methods, and do they have any unintended consequences like negative training transfer or not conveying the same realism? Studies could investigate whether training based entirely on simulation and driven by AI could

save costs or add value compared to traditional methods for training stressful HROs, and if so, how and in what specific occupations or skill sets.

Finally, future research could directly address this paper's delimitations. It could study the long-term implications of stress and training, particularly the effects of high-stress training on psychological health. To this end, it could investigate the possibility of including interventions like critical incident stress management (Occupational Safety and Health Administration, n.d.) as part of instructor training. Future studies could also examine the differences in stressful team training compared to individual training, as Marines work almost exclusively in teams. Lastly, researchers could analyze the impact of and best practices for professional military education and how it intertwines with training as specifically related to preparing Marines for stressful operations.

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