

**The Impact of Individual-, Unit-, and Enterprise-Level Factors on  
Psychological Health Outcomes: A System Dynamics Study of the  
U.S. Military**

by

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Bachelor of Arts, Molecular & Cell Biology and Psychology  
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Submitted to the Engineering Systems Division  
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Master of Science in Technology and Policy

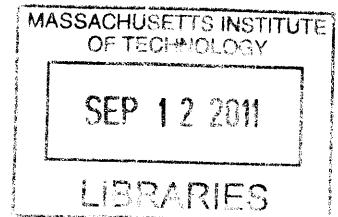
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**Abstract**

Post-traumatic stress disorder (PTSD) and other psychological health issues have emerged as a signature pathology of combat operations in Iraq and Afghanistan. However, the full continuum of care in the U.S. military for PTSD and related disorders is reported to be insufficient to meet the current and future needs of service members and their beneficiaries. The influence of external factors such as pre-traumatic risk factors and the availability of unit-level and enterprise-level resilience resources on eventual mental health outcomes have been previously considered individually, but not together in an enterprise-wide context. Although systems thinking has been applied to transform general health care systems in the United States and recommended for the military health system, there has been limited application of such ideas to the military health care system at large.

This thesis expands on previous systems thinking work to transform health care systems in the United States by building a multi-level, dynamic model of the military psychological health enterprise from accession and deployment to future psychological health screening and treatment. The model demonstrates the relationships between stress, resilience and external unit-level and enterprise-level resources, and the influence of pre-traumatic risk factors, effectiveness of pre-deployment resilience resources and the availability of psychological health treatment in theater are evaluated using sensitivity analyses in order to formulate recommendations for upstream initiatives to improve downstream health outcomes.

Increasing participation in pre-deployment resilience training and increasing unit support would have the largest effect on decreasing the number of service members predicted to develop symptoms of PTSD. Thus, it is recommended that the military consider fitting potential at-risk service members to resilience training, developing concurrent strategic short-term and long-term operational policy-making processes, and linking accession data to health outcomes to inform future psychological health policy creation.

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# **Chapter 1**

## **Introduction**

Chapter 1 presents the motivation for this research and also discusses the purpose and objectives that this thesis aims to achieve. The theoretical research model that this research is based upon and expands on is discussed in Section 1.3, and its limitations are explained in Section 1.4. Finally, the contributions and overview of this research work are presented in Sections 1.5 and 1.6.

### **1.1 Research Motivation**

Military service members face stressful situations during deployment. The academic literature and media attention increasingly focuses on those service members returning from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) in Afghanistan displaying symptoms of post-traumatic stress disorder (PTSD) and other psychological health illnesses. Twenty-six percent or more of returning troops are likely to display symptoms of PTSD and the number of diagnoses has increased in recent years [44]. As a result, efforts have been made to develop health care systems for delivering quality care to the military community, with an emphasis on coordination across the entire continuum of care (i.e. [51, 103]). It is only recently that these efforts have been expanded to examine the system of care for psychological health care delivery in the military due to the large number of service members returning from the conflicts in Iraq and Afghanistan displaying symptoms for psychological health disorders such as PTSD and major depression [49, 33].

Compounding this complexity is the growing literature documenting the emergence of risk factors for PTSD, including prior experience to traumatic events and a history of mental illness [18]. Pre-traumatic risk factors have been found to increase the likelihood of developing PTSD symptoms [54, 80]. The added uncertainty regarding how prior stressful experiences and other risk

factors affect eventual health outcomes in the service member population requires the usage of a systems approach in examining how these resources might be best leveraged for stress mitigation among service members.

Because ensuring the mental health of the military service member population is important to national security [51], military leadership currently allocates financial and human resources intended for creating resilience programs and resources to build force readiness to withstand stress experienced during service. These funds are allocated by the Military Health System (MHS)'s Defense Health Program (DHP) to create resilience programs such as Military OneSource and the Real Warriors Campaign sponsored by the Defense Centers of Excellence (DCoE). Line-item discretionary funds assigned to the services are additionally utilized for service-specific resilience programs, examples being the Army's Comprehensive Soldier Fitness (CSF) program and the Air Force's Airman Resiliency Training (ART). However, the mechanism by which service-specific resilience programs and other unit-level resources such as unit support mitigates individual-level risk factors and stress across the system remains unclear. Furthermore, the impact of enterprise-level decisions made regarding combat operations in Iraq and Afghanistan have been largely seen at the individual-level (i.e. the number of overall service member PTSD diagnoses), but the effect at the unit-level has yet to be determined.

## 1.2 Research Purpose, Key Questions and Objectives

The purpose of this thesis is three-fold:

1. **Build a dynamic model of stress emergence.** A system dynamics model of stress emergence in the enterprise was created to understand the various decisions, interactions and policies that resulted in the rise of PTSD as an enduring pathology of OIF/OEF. The model additionally provides a high-level view on how individual and organizational decisions made at all system levels to meet strategic operational goals persisted throughout the system, resulting in the unanticipated emergence of military psychological health issues.
2. **Investigate how unit-level resilience resources might impact the individual service member from accession to treatment.** Leadership has been shown to be the most influential resource impacting an individual's resilience because it affects multiple areas of a service member's life from education to training [13]. Furthermore, the unit provides additional support that may otherwise be absent from a service member's life. However, little is known

about the mechanisms by which these resources eventually affect individual-level dynamics; for example, how risk factors for PTSD influence the overall number of service member PTSD diagnoses over time.

3. **Demonstrate how enterprise-level decision making impacts unit-level dynamics.** A unique aspect of the combat operations in Iraq and Afghanistan was the exponential growth of military deployments since their inception [94]. The increased number of deployments are thought to increase the stress experienced by service members [94], but how they affect the entire military health system and unit-level resources in particular, remains unclear.

### 1.2.1 Key Questions

Four key questions were posed to frame how this thesis investigates these strategic decision-making dynamics in the military mental health care enterprise:

- What are the key individual-, unit-, and enterprise-level dynamics that influenced the emergence of PTSD as a signature pathology of Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF)?
- Which enterprise-level interactions and relationships directly influence policymaking in the military, and how do these relationships influence unit-level resources and service member health outcomes?
- Which policy options are available to military leadership to affect service member health outcomes while meeting strategic objectives are most salient in the enterprise?
- How large is the influence of unit-level resilience resources on individual-level dynamics, and how does this effect compare to other policy options available to military leadership to affect overall service member population health outcomes?

### 1.2.2 Objectives

The following research objectives were identified in order to answer these key questions:

- **Model the flow of service members from accession to treatment.** A stock and flow diagram depicting how service members move from one phase of the military service lifecycle to

another provides the baseline case for analysis, and provides the foundation for assessing how external factors would affect the service member population at large.

- **Model the causal relationships between stress, resilience and external unit-level and enterprise-level resources, and link them to the flow of service members.** Although literature has identified causal relationships between stress and resilience, and external resources and resilience [13], the dynamic mechanisms linking these causal relationships has not been modeled. Furthermore, the effects of these causal relationships are manifested in the service member flow from accession to treatment. Linking these causal relationships to the service member flow provides a foundation for a holistic examination of the organizations, processes, stakeholders and resources involved in all phases of the military service member lifecycle. This ensures that any policy recommendations and their implications were considered across the entire enterprise and not just from a particular stakeholder's point of view.
- **Using sensitivity analyses, identify the key drivers of the military psychological health enterprise that led to the rise of PTSD as a signature pathology of OIF/OEF.** Key decisions and policies influencing the emergence of PTSD as a signature wound of the wars in Iraq and Afghanistan were identified in model sensitivity analyses to determine which policies were the most and the least effective in driving expected outcomes.
- **Determine potential policy implications for the strategic decision-making regarding mental health care delivery for the individual service member.** Potential policy implications for strategic enterprise decision-making were examined and discussed to inform future work in this area.

### **1.3 Theoretical Research Model: A Multi-Level Approach**

The model expands on previous systems models created to model stress reactions by considering individual-level risk factors for PTSD and how internal and external resources might additionally predict performance outcomes. A previous system dynamics model of stress was created by Morris (2010) as a method to quantitatively assess human factors and behaviors [64]. However, this model defined resources as entities required to elicit a response action, differing from the definition of external resources utilized for this thesis. Furthermore, the Morris (2010) model does not distinguish between individual-level, unit-level and enterprise-level resources for stress.

The military has proposed a military demand-resource (MDR) model which accounts for key interactions across demands and resources to predict service member resilience and performance outcomes [13]. Although this model specifically defines external resources as military resilience resources, both this model and the Morris (2010) model do not account for individual-level risk factors that may predispose a service member to experiencing stress reactions.

A multi-level analysis of unit cohesion's relationship to stress and perceived combat readiness was conducted across the individual-level and unit-level to elucidate the association between aggregate unit stress and unit cohesion while accounting for individual-level differences [38]. While this model did incorporate multiple dimensions and considered individual service member differences, the model only accounted for unit cohesion and did not consider other unit resources. The Griffith (2002) model also did not discuss causal relationships through which unit cohesion would influence perception of combat readiness, or how unit dynamics would influence the individual service member and vice versa. This analysis of unit cohesion to stress and combat readiness is one example of a multi-level approach which examined the effect and relationship of unit cohesion while considering individual-level differences.

The examination of complex organizations and systems using a multi-level approach is a relatively recent evolution of organizational and management research, although the components of a multi-level approach have been present throughout the literature [61, 63]. A literature review conducted by Mathieu and Chen (2011) found that management research has evolved to consider a multi-level approach combining three dimensions—theory, measurement and analysis, and that the multi-level paradigm requires examination of driving variables not only from a focal unit of analysis from also from levels above and below [61]. Further support for the multi-level approach was found in Moliterno and Mahony (2011)'s work that expanded social network theory to include canonical multi-level theory. Moliterno and Mahony (2011) showed that organizations should be studied as nested networks, because they are multi-level systems which are made up of networks which exert influence across organizational levels [63].

Figure 1-1 illustrates the preliminary model describing the proposed relationships between pre-traumatic risk factors, individual-level dynamics, external unit-level resources and enterprise-wide decision-making. This preliminary model is based on the work of Bacharach, et al. (2008), which examined the relationship between the intensity of critical work place incidents experienced by firefighters, resulting stress experienced and drinking to cope. It was found that there is a significant association between the intensity of involvement in these critical incidents and drinking to cope, and

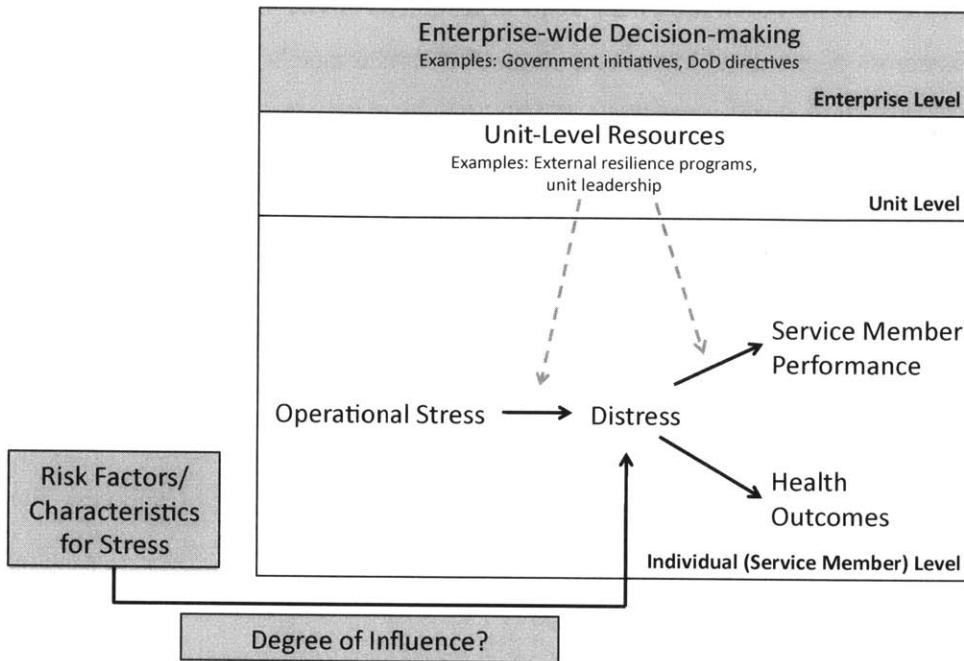


Figure 1-1: Preliminary Operational Research Model – Adapted from [12]

that the adequacy of unit-level performance resources such as training and preparedness resources attenuates the relationships between critical incidents and resulting stress, and stress and drinking to cope [12].

Military service members experience incidents in combat operations which increase the likelihood that a service member would experience the onset of PTSD symptoms as discussed previously in this chapter [94]. Additionally discussed were the external resilience resources available for the mitigation of these stress symptoms [13], intended to help ensure optimal service member performance and health outcomes. However, the availability of these unit-level resources are governed by both the service lines and enterprise-level leadership in the forms of government initiatives and Department of Defense (DoD) directives, adding an additional level of complexity than that of the Bacharach, et al. (2008) model. This work additionally builds upon the Bacharach, et al. (2008) model in considering external individual risk factors and characteristics for stress and how they influence the level of stress experienced by an individual service member. This model also focuses primarily on psychological health outcomes and job performance as opposed to coping mechanisms. Finally, the Bacharach, et al. (2008) model only considers critical incidents in the workplace, as opposed to the cumulative effect of continuous stressors in the workplace environment. An example

of this would be the cumulative effect of deployments experienced by service members, which was seen during OIF/OEF and considered to be a key factor in accelerating the onset of PTSD symptoms experienced by returning service members [94].

## 1.4 Research Design and Limitations

This thesis employs a concurrent triangulation approach as described by Creswell in utilizing both qualitative and quantitative data to determine if there is convergence, divergence, or some combination of the two [26]. It also uses the method of System Dynamics to effectively design and model the military mental health enterprise in determining potential areas for improvement to inform future work in the area. Further discussion of system dynamics as a research method can be found in Section 3.2. A literature review and available quantitative data were used to populate and validate some portions of the model, and the model was additionally validated with qualitative interview data.

Limitations of this research include:

- This thesis research did not attempt to study all types of service members; rather, it focuses on the experiences of active duty service members who fulfill all phases of the military service lifecycle from accession to deployment to treatment. Other notable populations that could be considered in future work might be National Guard and Reserve service members who may not have engaged in typical basic training and resilience training.
- This thesis research did not attempt to study all psychological health processes throughout the military service lifecycle. A focus was placed on accession and training processes as this research was primarily concerned with the potential effect of pre-existing risk factors for PTSD on a service member's behavior and experience throughout the service lifecycle.
- This thesis research was limited in terms of the number of interviews conducted, as well as the types of organizations and services represented. Each military service and its relevant medical institutions, as well as unit leaders have different requirements and methods for conducting accession processes and resilience training. Furthermore, unit leaders may have unofficial and undocumented methods for conducting resilience training and ensuring social support throughout the military service lifecycle, which were not considered throughout this research. Further research could consider these additional factors.

- This thesis research did not account for all possible scenarios that a service member might encounter through the military service lifecycle. For example, the model currently indicates that when a service member returns from deployment, he or she will either leave the service, experience the onset of PTSD symptoms, or be deployed again. In reality, a service member might remain in garrison indefinitely and not experience an onset of PTSD symptoms. Furthermore, the model assumes that all service members experiencing PTSD symptoms will be diagnosed and seek treatment, which does not occur in reality.
- This thesis research focused its quantitative analysis on service member populations in the military service lifecycle, and did not quantify the unit-level and enterprise-level dynamics explained in the model due to a lack of knowledge and data regarding those causal relationships. For example, previous studies suggest that service member resilience is key to force protection (i.e. [13]); however, there is little knowledge to date that indicates how current resilience programs are performing with regards to increasing service member resilience and decreasing service member stress. Furthermore, this thesis research was also limited with regards to the quantification of more qualitatively defined variables such as *Media Coverage* and *Government Pressure*.

## 1.5 Contributions of this Research

This thesis is part of a larger initiative by the Lean Advancement Initiative (LAI) at the Massachusetts Institute of Technology (MIT) in partnership with the MIT Collaborative Initiatives and the Military Health System (MHS) to examine the full continuum of care for psychological and mental health care, and presents areas for future research. More specifically, this thesis contributes to the field of industrial engineering and management in building upon the model presented in [12] by adding a third level of complexity, considering enterprise-level resources and applying the model to the military psychological health sphere, and by including risk factors. Additionally, this thesis research examines the effect of prolonged stress in the highly stressful work environment of military service in contrast to Bacharach, et al. (2008)'s previous work on workplace critical incidents.

Next, this thesis contributes to the field of system dynamics by applying system dynamics to model the military mental health care enterprise, providing military leadership with a comprehensive view of interactions between individual, unit and enterprise-level behaviors and actions. Most importantly, the system dynamics model provides a view as to how these actions may influence and

have negative side effects that may not otherwise have been seen and considered in policymaking context.

Finally, this thesis provides potential policy recommendations that military leadership can consider as they move forward in continuing initiatives to provide quality mental health care services for its service members. This thesis additionally discusses implications of these policies that leadership may consider in light of this work's limitations and the political and operational arenas in which military leadership operates today.

## 1.6 Thesis Overview

This thesis continues with a discussion of the significance of PTSD as a significant pathology of war, diagnostic criteria and documented risk factors for PTSD, and how these factors play into the challenges the U.S. military health care system faces in delivering quality mental health care services. An examination of previous work done in using a systems engineering approach to challenges in U.S. health care delivery will be also be discussed to illustrate the motivation for applying enterprise systems thinking to the military mental health enterprise. Next, using the knowledge gleaned from a system dynamics modeling of the military mental health enterprise, this thesis will investigate how the enterprise could be architected in the future to enhance prevention and resilience in the military mental health enterprise. Using an enterprise architecture framework developed at LAI, potential policy implications and recommendations will be discussed, as well as how this work can contribute to future research opportunities.



## **Chapter 2**

# **Using Systems Thinking to Improve Military Psychological Health Care Delivery**

Because previous research has called for a systems approach for meaningful advancements in PTSD (e.g., [19]), this thesis takes an enterprise systems approach to examine the full continuum of care in response to post-traumatic stress and related conditions as provided by the targeted enterprise. This chapter provides a backdrop for enterprise and systems engineering in health care delivery in the United States, introduces an overview of the military mental health enterprise and discusses why mental health care delivery in the military should be examined using an enterprise systems approach.

### **2.1 Individual-Level Dynamics: Post-Traumatic Stress Disorder (PTSD)**

PTSD is considered a significant pathology of OIF/OEF [94]. There is a five to 20 percent prevalence of PTSD among returning service members; over \$2 billion has been invested across the continuum of care for PTSD, with \$650 million designated for over 125 new psychological health programs [94]. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM), published by the American Psychiatric Association and widely considered to be the standard criteria for diagnosing mental disorders, PTSD is described by the following six diagnostic criteria:

- Stressor: exposure to a traumatic event, such as child or sexual abuse; terrorist attacks; combat

and military exposure

- Intrusive recollection: Persistent recollection of the traumatic event
- Avoidance/numbing: Persistent avoidance of the stimuli that triggered the traumatic event
- Hyper-arousal: Persistent arousal symptoms, not seen before the trauma, such as hyper-vigilance, difficulty sleeping and outbursts of anger
- Duration: Symptoms last for at least one month
- Functional Significance: These symptoms cause disturbance in social, occupational or other areas of normal life function [66]

### 2.1.1 Stress and Anxiety Disorders

Service members may also experience other transient conditions, including Acute Stress Reaction (ASR) and Combat (or Ongoing Military) Operational Stress Reaction (COSR) that also relate to physical or mental stress, but are typically transient in nature and thus are ideally managed differently than a more persistent condition [94]. This is important because the literature indicates that acute and chronic PTSD takes approximately three months post-trauma to develop, but that signs of ASR and COSR typically occur between two days to one month post-trauma, supporting the case for early detection and treatment of symptoms [40]. Furthermore, the literature indicates that the severity of traumatic events that can lead to the development of ASR are similar to those involved in PTSD, suggesting that if ASR is left untreated, it can lead to acute and chronic PTSD (Figure 2-1).

In taking a systems view of the care for psychological health, services that could be provided by the enterprise prior to or absent of a formal diagnosis are included. Therefore, this research takes the broader stance of including programmatic and care services for post-traumatic stress reactions, not only formally diagnosed and treated PTSD and related conditions.

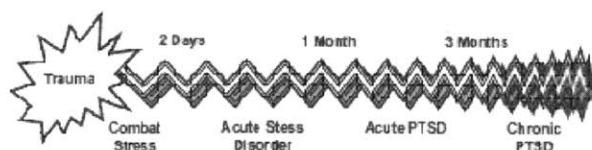


Figure 2-1: Timeline of PTSD development [40]

Table 2.1: Documented Risk Factors for PTSD [54, 67, 80]

<b>General</b>	<b>Military-Specific</b>
Previous exposure to trauma	Combat exposures
Prior and/or family history of mental health issues	Perceived threat
Poorly educated	Post-trauma recovery variables
Little family or social support	(internal resilience, unit/social support)

### 2.1.2 Influence of Documented Risk Factors for PTSD

Recent literature takes the approach of describing stress as a health-illness continuum to encourage the early recognition of stress behaviors and early access to preclinical and clinical services when needed [52, 106, 13]. The early recognition of stress behaviors introduces the question of the presence of factors that may signal an individual's predisposition to developing stress and other anxiety disorders.

Various studies have demonstrated that there are pre-traumatic risk factors for PTSD, ranging in salience and importance (Table 2.1). Literature indicates that the most generally salient pre-traumatic risk factors include prior history or family history of mental health disease; poor educational achievement; a previous exposure to life-threatening events or trauma; and little family or social support [67]. Additional risk factors experienced by military service members include war-zone stressors such as combat exposure and perceived threat of harm, especially the threat of death, serious injury and witnessing injury or death [54, 80].

In general, anyone who has experienced a life-threatening event, including combat or military exposure, sexual assault, natural disasters or a terrorist attack is at risk for developing PTSD. Most people who experience a traumatic event may never develop PTSD; the development of PTSD depends on a number of factors, most important of which is the intensity and duration of exposure to trauma [67].

The gradual development of PTSD from ASR and COSR demonstrates the need for considering upstream initiatives in determining what factors to consider when formulating policy for PTSD prevention and treatment; early detection and treatment of PTSD symptoms, whether they manifest as ASR, could lead to an overall decrease in the number of service members who would otherwise require PTSD treatment. However, the potential influence of documented pre-traumatic risk factors for PTSD and other factors known at military accession has not yet been considered in this enterprise systems approach, and may provide some insight as to how the military might use this information

to better serve their policymaking on an enterprise-wide level.

## **2.2 Unit-Level Dynamics: Resilience**

The unit has been emphasized as a key external resource for building individual service member resilience, as it provides external support via friendships and group identity for the individual service member as the unit performs its mission [13]. Also considered a key resource is unit leadership, pervasive throughout the unit and affecting all aspects of a unit's operational routine [13]. Because a lack of social support has been discussed as a risk factor for PTSD, the presence of good unit leadership and unit support might substitute for an individual's own lack of family or social support.

Although unit support is considered a key resource, negative attitudes and unit dynamics regarding mental health care in the military have been recognized as factors dissuading service members from seeking treatment [94]. The DoD has recognized that pervasive stigma within the service has a substantial impact on the system of mental health care in the military, and as a result has initiated efforts such as public service campaigns and enlisting providers to combat internal stigma in the hopes that more service members requiring treatment will seek treatment [94].

## **2.3 Enterprise Level Dynamics: The Military Health System (MHS)**

The Military Health System (MHS) is the entity within the DoD which is responsible for providing health care to U.S. military service members, service retirees and their dependents [92]. This section will discuss the current challenges facing MHS and its obligations to service members. In addition, this section will define and describe the boundaries of the MHS enterprise and the organizations and processes under consideration for this thesis research.

### **2.3.1 Challenges for Psychological Health Care Delivery in the Military**

Some of the challenges that affect the overall U.S. health care system influence certain health care systems more intensely. Psychiatric disorders are a leading cause of Existing Prior To Service (EPS) military discharges, most of which were concealed at accession, and expenses associated with these losses cost the military approximately \$27.3 million in 1998 alone, excluding the costs of medical care, subsequent disability discharges and associated attrition [69]. Because these documented

risk factors for PTSD may present themselves at accession, it may be important for the military to consider the salience of these risk factors in order to decrease the likelihood that service members displaying risk factors for PTSD result in early discharges, leading to additional EPS expenses incurred by the military. Furthermore, mental illness in military service members is a leading cause of healthcare utilization, and as military health care costs escalate and budgets remain constrained, the current system may be rendered unsustainable [103].

As the entity in the DoD that is responsible for delivering health care services to military service members and their families, perhaps one of the most important missions of MHS is to ensure a medically ready force. MHS “identifies, develops and sustains critical military capability and readiness in support of resource management and the operational planning process” [93]. Most applicable to this thesis is MHS’s responsibility to examine psychological stressors on the deployed force and determine how best to prepare the service members for deployment into battle and between deployment cycles.

MHS defines Medical Readiness goals as the following:

- Managing warfighter fatigue: the ability to evaluate fatigue and monitor its effects on performance;
- Enhancing warfighter sensory cognitive and motor capabilities: the ability to enhance and sustain human performance within the sensory, cognitive and physical domains;
- Enhancing physiological capability: the ability to improve success within the physiological domain, which includes neuroprotection, examining metabolic processes, enhancing the ability to withstand trauma, and the ability to maintain performance despite operational stressors;
- Providing/maintaining ability to operate across the full range of environments;
- Providing a healthy and fit force: the ability to provide and enhance a healthy and fit force throughout the military service member’s military career, from accession to veteran [93].

Although the focus of MHS regarding medical readiness falls largely on ensuring that service members are medically ready to serve, another aspect of medical readiness also falls upon the readiness of the medical professionals and medical operational units to perform medical duties during military operations [48]. Military medical professionals and operational units tasked by MHS to ensure that these medical readiness goals are achieved are expected to maintain a different kind of

medical readiness, which combines the attributes of medical training, clinical experience, military training and military experience in order to ensure as much as possible that the medical readiness goals of MHS can be met.

### **2.3.2 Overview of Enterprise Organization**

An enterprise can be defined as a complex, integrated, and interdependent system of people, processes, and technology that creates value as determined by its key stakeholders [72]. The targeted enterprise (Figure 2-2) is comprised of several organizations that provide care and programmatic services to all Active Duty and Reserve/Guard personnel and military retirees as well as their dependents [102]. A listing of all relevant abbreviations and acronyms for organizations, titles and terms used in this thesis can be found in Appendix A.

The Office of the Under Secretary of Defense for Personnel and Readiness (USD P&R) is a policy-establishing entity that includes several other major policy-making organizations, including Military Personnel Policy that advises Accession Policy, Military Entrance Processing Command, and the Armed Forces Chaplain Board, Readiness that oversees military readiness and training issues; and Military Community & Family Practice that oversees programs and policies that support military families. The Office of the USD P&R also includes Health Affairs, which establishes the Military Health System policies, procedures, and resources for deployment and garrison programs; is informed by Force, Health Protection & Readiness (FHP&R) which informs policy decisions as well as research and development; and oversees TRICARE—the health plan of the Military Health System (MHS) that provides purchased care through contracted private providers [91].

Stakeholders in both the military and civilian sectors are working and adopting recommendations to improve psychological health care delivery. The military's efforts are supported by Congress, which has directed a task force within the DoD to examine all matters related to mental health in the military and to provide Congress with recommendations to improve mental health care delivery in the military [103]. While some psychological health care programs implemented within the military have been found to be successful [30], the full continuum of psychological and mental health care is also reported to be insufficient for meeting the current and future needs of service members and their families [103]. This is, in part, due to disjointed efforts across the DoD, MHS, and the U.S. Armed Forces to systematically identify issues and respond accordingly. For example, experts have identified the need for the development and integrated use of a comprehensive set of measures [88] and the evaluation of program effectiveness to drive process improvements [13, 105].

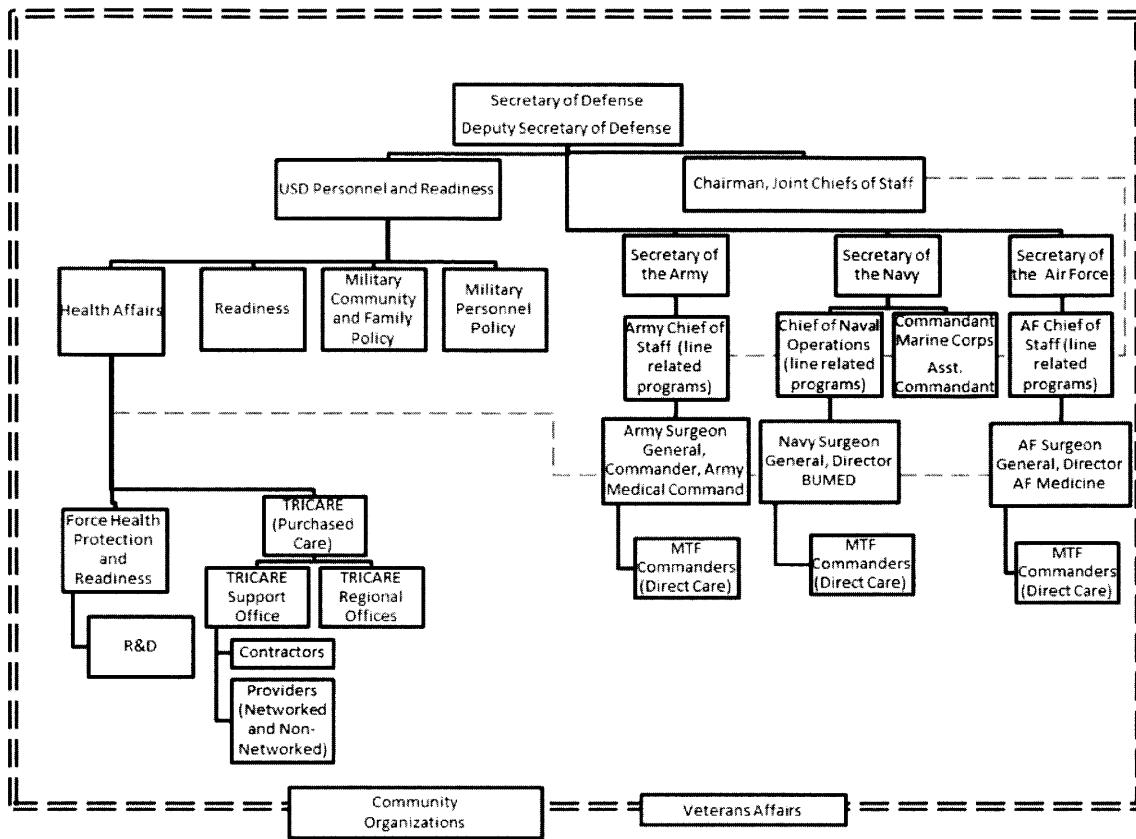


Figure 2-2: Defined Boundaries of the Military Mental Health Enterprise

Also, recommendations for improved integration across MHS care systems in order to strengthen accountability for fiscal management, align incentives, and strengthen the potential for continuous improvement in the quality of care delivered to beneficiaries have been made [103]. A systems perspective is advised for the realization of these types of improvements [19], but limited research has considered such an approach. To date, there has been little research to identify areas in which the military may leverage knowledge gained by the civilian health care system to implement further recommendations for its own system-wide improvements efforts.

The U.S. Armed Services, i.e., the Army, Navy, Air Force and Marines manage and deliver both line related and medically related health care services in garrison and in theater. The enterprise structure is such that the U.S. Armed Services Surgeons General are aligned through Health Affairs and the medical commands of the Services provide direct care through the Military Treatment Facilities (MTFs) and clinics by military personnel. The initial intent was for purchased care to be a gap

filler when direct care was unavailable or scarce due to location; however, purchased care currently accounts for approximately 65 percent of the care that is provided and has approximately twice the budget of direct care [103].

The Chiefs of Staff for the U.S. Armed Services are aligned through the Office of the Joint Chiefs of Staff and provide line-related programs and services that support the psychological health of service members. The dashed line connects and refers to the functional units of service members; activities provided by military leadership that is occupational in nature are referred to as line-related programs and services. While these functions do not directly relate to medical care, the role of line leadership through formal mechanisms such as line-led operational stress training and resilience training programs or through informal mechanisms such as leadership support is regarded as important to the overall care of service members.

Community organizations offering PTSD and mental health services as well as organizations and processes related to the VA lie on the enterprise boundary (the double-dashed line) as they do not have formal connections with other organizations within the enterprise but should be considered in order to get a holistic view of the entities that impact the system of care for post-traumatic stress and related conditions.

### **2.3.3 Coordination of Enterprise Organizations, Processes and Programs**

Figure 2-3 is a “waterdrop model” which shows the relationships between the key organizations in the military mental health enterprise as defined in Section 2.3.2.

Ippolito and Srinivasan (2011) observed that there are two large clusters in which the current state of the continuum of care for psychological health services operates; one revolves around the MHS leadership/organization, and the second revolves around the execution of care surrounding the service member [50]. Most importantly, although the execution of care delivery occurs on the individual service member level, the decision-making regarding policy implementation and resource allocation occurs at the enterprise-level. This observation supports the extension of the Bacharach, et al. (2008) model that this thesis proposes, as the theoretical research model discussed in Section 1.3 extended the Bacharach, et al. (2008) model to include enterprise-level decision-making through government initiatives and DoD directives. Ippolito and Srinivasan (2011)’s observations additionally support the initial research motivation for utilizing a systems approach to reveal potential sources of inefficiencies, as the waterdrop model indicates differing degrees of interaction between stakeholders in executing the delivery of care in the enterprise. However, the processes by

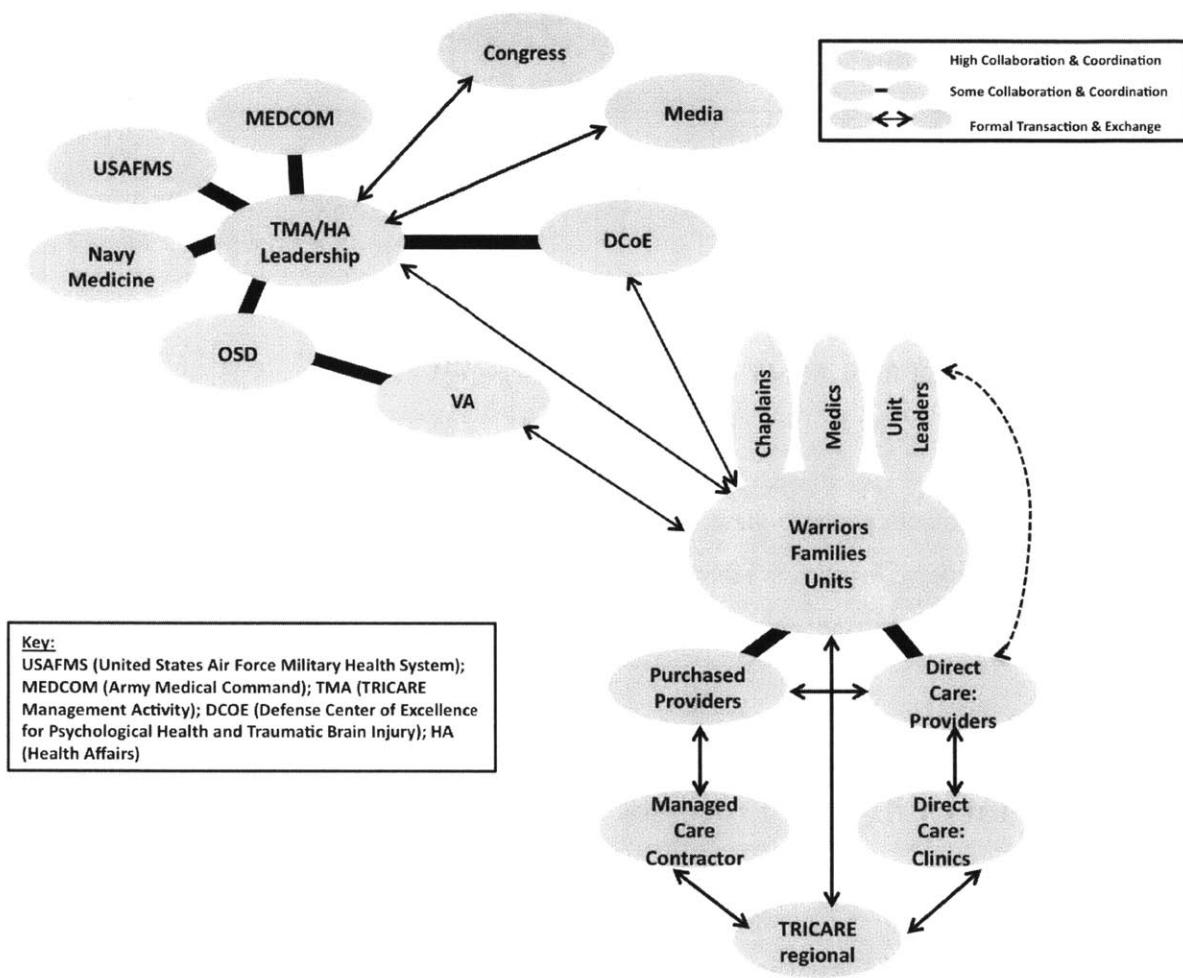


Figure 2-3: Relationships Between Military Mental Health Enterprise Stakeholders [50].

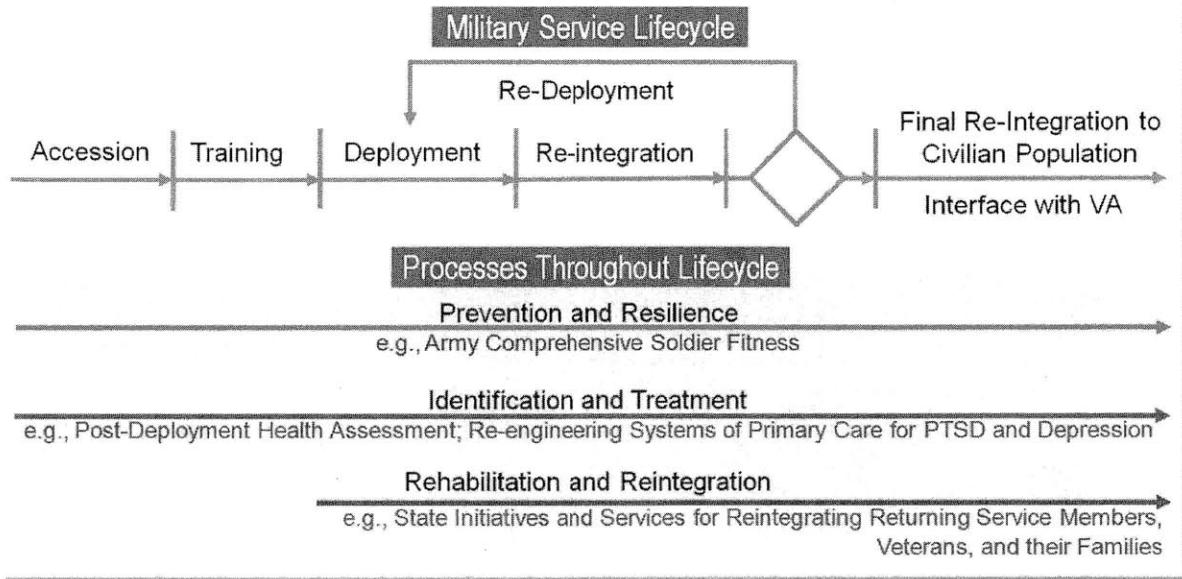


Figure 2-4: Adapted from ARMY Comprehensive Service Member Fitness Resilience Training Overview [31]

which the execution of care occur have yet to be considered in this research work. The next section will describe the lifecycle processes that are considered integral to the delivery of mental health care services in the enterprise, and which are therefore most relevant to this thesis work.

## 2.4 Military Lifecycle Processes

Additional motivation to use a systems approach in examining military mental health care delivery can be seen in the service member-centric view of the military deployment cycle (Figure 2-4). Although each lifecycle process from Accession to Treatment may have its own separate organizations and processes that are integral to each phase, there are high-level processes occurring throughout the lifecycle which require the coordination and alignment of organizations and processes across the military service lifecycle in order to operate at an optimal level. These processes include prevention and resilience processes such as the Army's Comprehensive Soldier Fitness (CSF) program; identification and treatment processes like the Post-Deployment Health Assessment (PDHA) which occurs when a service member returns from in-theatre combat; and rehabilitation and reintegration processes for integrating service members back into civilian life.

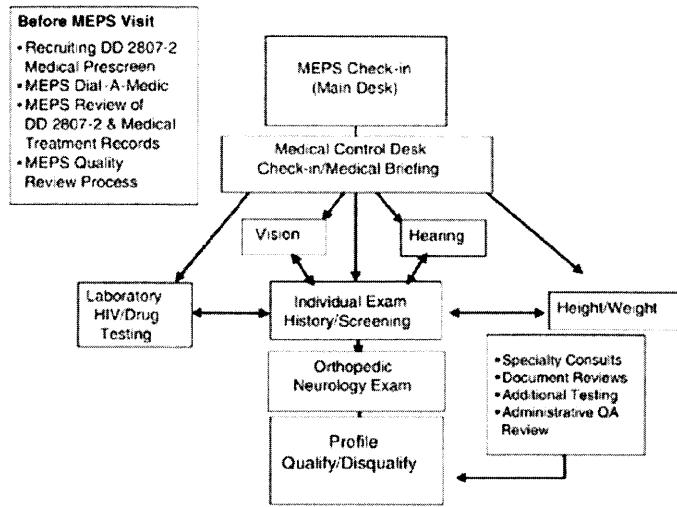


Figure 2-5: Health Assessment at the MEPS [79]

#### 2.4.1 Accession

The military accession process typically begins after the service member decides to apply to the military service. After submitting his or her application, the applicant travels to a Military Entrance Processing Station (MEPS) for processing. The MEPS process all applicants to the U.S. Armed Forces regardless of the service the applicant applied for, and their primary role in the military lifecycle process, as specified by military regulations, is to determine whether the applicant is fit to serve in the U.S. Armed Forces and which military jobs the applicant qualifies for [9]. An explanation of each of the assessments performed at the MEPS follow below.

#### Health Assessment

Because military work often involves challenging physical tasks, a comprehensive health examination is done at the MEPS as part of the accession process (Figure 2-5). Prior to the physical assessment at the MEPS, the applicant completes a medical prescreen with a recruiter, Form 2807-2 [100]. Based on Form 2807-2, a recruiter can call a MEPS medical technician through the Dial-A-Medic Program to ask questions about an applicant's medical eligibility if any concerns are apparent. Medical prescreening forms and associated documentation are then forwarded to the local MEPS for further processing.

The physical examination consists of the typical physical examination, an interview, and additional tests (urine, blood, drug and alcohol). The interview consists of questions regarding patient

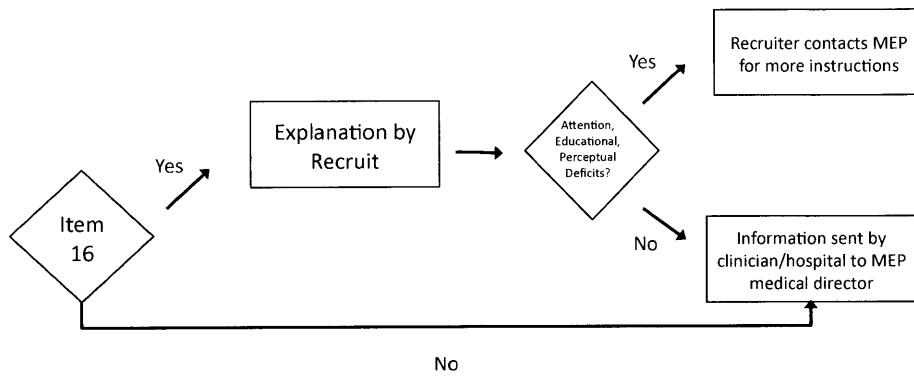


Figure 2-6: Health Assessment and Decision Making Regarding DoD Form 2807-2 Item 16

history, but most applicable to this thesis is Item 16 on Form 2807-2, related to psychiatric disorders. The item is worded as follows: “seen a psychiatrist, psychologist, counselor or other professional for any reason (inpatient or outpatient) including counseling or treatment for school, adjustment, family, marriage or any other problem to include depression, or treatment for alcohol, drug or substance abuse [100]. Item 16 is intended to be a prescreen for identifying an applicant’s history with mental health, and asks the applicant if he or she has ever been treated for or diagnosed with a mental health disorder, requiring a “Yes/No” response. If the applicant answers “yes” to Item 16, there is follow-up interview done to investigate the reasons for why the applicant has been treated for or diagnosed with a mental health disorder (Figure 2-6).

However, a full mental health assessment is not done during the accession process, although there are questions asked during the health assessment that may signal to the physician conducting the assessment that follow-up questions regarding mental health issues may need to be asked. For example, Form 2807-1, Report of Medical History, Item 17 asks the attending physician to ask the applicant if he or she has had a history of “nervous trouble of any sort (anxiety or panic attacks)”, “frequent trouble sleeping”, “depression or excessive worry”, or has “been evaluated or treated for a mental condition”, to name a few symptoms [99].

### **Medical Screening and the Granting of Health Waivers**

Throughout the application and accession process, there are decision points in the system where applicants are either disqualified or eligible for health waivers based on the information contained in the medical prescreen (Figure 2-7). Each service has its own policies by which health waivers are granted, and these waivers are granted by specific bodies in each service (Table 2.2)

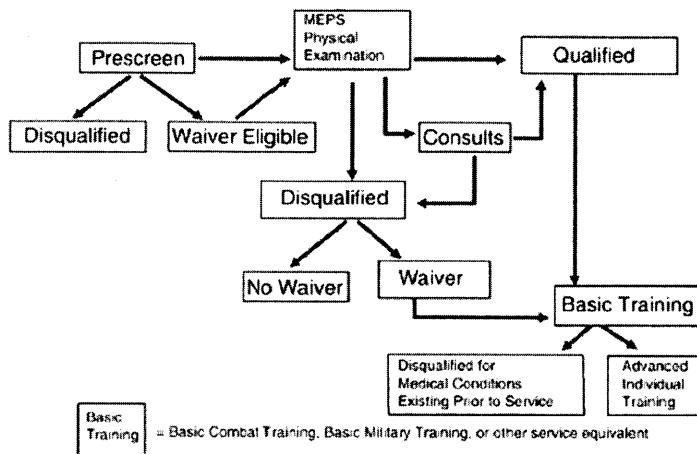


Figure 2-7: Health Waivers during Accession [79]

Table 2.2: Waiver-Granting Bodies in the Armed Forces

Service	Who Grants Health Waivers	Recommendations Forwarded to
Army	US Army Recruiting Command	
Navy	Bureau of Medicine and Surgery	Naval Recruiting Command Chief
Air Force	Air Education and Training Command Surgeon General	
Marine Corps	Reviewed by Bureau of Medicine and Surgery	US Marine Corps Commandant

Data on each applicant are entered into the MEPCOM Integrated Resource System (MIRS), which includes biographical information, medical profile, disqualification coding by parts of the body, and waiver approvals.

### **Information Captured at Accession**

General qualifications for serving in the Armed Forces are summarized as follows [7]:

- U.S. citizen or permanent resident alien
- 17-35 years old
- Healthy and in good physical condition
- In good moral standing
- High school or equivalent education

Figure 2-8 summarizes the number of applicants and accession rates for each service branch for fiscal years 2004-2008 in comparison to 2009.

Service	2004 – 2008			2009	
	Applicants	Accession rate within fiscal year	Accession rate overall	Applicants	Accession rate within fiscal year
Army	409,783	48.3	62.2	104,406	44.8
Navy	242,412	34.9	69.8	57,785	26.3
Marines	215,058	44.2	73.7	47,597	33.6
Air Force	164,675	42.4	80.9	41,582	40.3
Total	1,031,928	-	-	251,370	-

Figure 2-8: Accessions for Enlisted Applicants at MEPS Who Received a Medical Examination by Service: 2004-2008 vs. 2009 [2]

### **Education Credentials and Qualification Testing**

Applicants are all required to take the Armed Services Vocational Aptitude Battery (ASVAB), a multiple-choice test that measures aptitude in ten different areas applicable to military work, such as abilities in math and electronics [8]. Also called the Armed Forces Qualification Test (AFQT), to be considered for enlistment, each service has a baseline score which can be an indicator for acceptance into the service; for example, to enlist in the Army, an applicant should score at least a

31 on the ASVAB [8]. Figures 2-9 and 2-10 summarize the educational and AFQT score levels of all applicants to each service branch in aggregate for fiscal years 2004-2008 in comparison to 2009.

Education	2004 – 2008				2009			
	Applicants		Accessions		Applicants		Accessions	
	Count	%	Count	%	Count	%	Count	%
Below HS Senior <sup>†</sup>	20,559	2.0	11,336	1.6	5,124	2.0	2,018	2.1
HS Senior	289,302	28.0	201,334	28.2	55,522	22.1	17,489	18.5
HS Diploma	651,650	63.1	457,129	64.0	169,106	67.3	67,005	70.8
Some College	42,174	4.1	28,169	3.9	10,899	4.3	4,400	4.6
Bachelor's and above	28,243	2.7	16,712	2.3	10,719	4.3	3,791	4.0
Total	1,031,928	-	714,680	-	251,370	-	94,703	-

<sup>†</sup> Encompasses the following: 1) those pursuing completion of the GED or other test-based high school equivalency diploma, vocational school, or secondary school, etc; 2) those not attending high school and who are neither a high school graduate nor an alternative high school credential holder; 3) one who is attending high school and is not yet a senior.

Figure 2-9: Education Level of Enlisted Applicants Who Received a Medical Examination in 2004-2008 vs. 2009 [2]

AFQT score	2004 – 2008				2009			
	Applicants		Accessions		Applicants		Accessions	
	Count	%	Count	%	Count	%	Count	%
93 – 99	58,351	5.7	42,241	5.9	17,256	6.9	6,592	7.0
65 – 92	362,850	35.4	261,860	36.7	95,699	38.2	37,369	39.5
50 – 64	266,876	26.0	186,863	26.2	66,134	26.4	25,220	26.7
30 – 49	308,309	30.0	210,829	29.5	67,801	27.1	24,938	26.4
11 – 29 <sup>†</sup>	29,991	2.9	11,713	1.6	3,556	1.4	422	0.4
< 11	637	-	21	-	82	-	7	-
Missing	4,914	-	1,153	-	842	-	155	-
Total	1,031,928	-	714,680	-	251,370	-	94,703	-

<sup>†</sup> Individuals scoring in the 10 percentile or lower are prohibited from applying. However, some exceptions are apparent.

Figure 2-10: AFQT Score Categories of Enlisted Applicants Who Received a Medical Examination in 2004-2008 vs. 2009 [2]

Table 2.3 summarizes and compares the information captured at accession against the known documented risk factors for PTSD.

Table 2.3: Comparison of Factors Recorded at Accession and Pre-Traumatic Risk Factors

Accession	Pre-Traumatic Risk
Education credentials	Poorly educated
ASVAB scores	
Item 16 and follow-up explanations	Family instability/Childhood antisocial behavior
Physical health	War-zone stressors

#### 2.4.2 Training: Resilience Programs and Resources

The training phase of the lifecycle typically consists of basic combat training and other trainings specific to the service member's desired career path (i.e. leadership training and other skills training for specific military jobs) [10]. It is during this stage that all training, counseling and medical evaluations are completed to ensure all service members and their families are ready for deployment. In addition to basic combat and advanced individual trainings, readiness and resilience activities are also performed during the training stage.

The Bacharach, et al. (2008) model indicates that the quality and availability of performance-level resources attenuates distress level experienced resulting from work place critical incidents [12]. Although the resources discussed in Bacharach, et al. (2008)'s model focused primarily on material resources like equipment to ensure firefighter readiness, this thesis will define unit-level performance resources as resources to build internal resilience within the service member population in an effort to ensure optimal service member performance, as described in Chapter 1.

An example of a unit-level resilience resource is the Army resilience program previously known as Battlemind. Mandated in 2007, Battlemind Training was the Army's original resilience training developed by the Walter Reed Institute of Research. Battlemind was incorporated into the Army's Comprehensive Soldier Fitness resilience training program in 2009 and included deployment cycle modules, lifecycle modules, and modules for medical personnel [16]. Army service members who had attended pre-deployment Battlemind training (consisting of resiliency-building modules both pre- and post-deployment) were significantly less likely to screen positive for a mental health problem than those who had not attended (12 percent vs. 20.5 percent) [76].

In addition to discretionary funding designated to be spent by the services, the government directs funding through DHP for creating external resilience resources to prevent and mitigate service member stress resulting from combat exposure and other critical incidents. Each service receives discretionary funding from the federal government, and service-specific resilience programs can

be a byproduct of this discretionary spending. A partial list of service-specific and service-wide resilience resources can be found in Tables 2.4 and 2.5.

Table 2.4: Examples of Service-Specific Organizations and Programs Contributing to Resilience Building (Adapted from [16])

Organizations & Programs	Descriptions
<b>Army Comprehensive Soldier Fitness</b>	Uses a balanced, multifaceted approach combining individual assessment, tailored virtual training, classroom training and embedded resilience experts.
<b>Navy Operational Stress Control (OSC)</b>	Led by Navy Medicine, goals are to build resilience in Navy sailors, units and families and decrease stigma associated with psychological health issues.
<b>Marine Corps Combat Operational Stress Control (COSC)</b>	Focuses on force preservation, mission readiness, and long-term health. Fully integrated into unit and formal education and active duty and Reserve training.
<b>Airman Resilience Training (ART)</b>	Pre-exposure preparation and reintegration education for deploying Air Force service members. Structured into classes focusing on deployment stress, environments, reactions, prevention and seeking help.

Table 2.5: Examples of Service-Wide Organizations and Programs Contributing to Resilience Building (Adapted from [16])

Organizations & Programs	Descriptions
<b>Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCoE)</b>	DCoE's Resilience and Prevention (R&P) unit leads DCoE's resilience efforts, including hosting an annual warrior resilience conference.
<b>Military OneSource</b>	A resilience-supporting program designed by Military Community and Family Policy (MC&FP) to be a "one-stop" resource for service member and family assistance.
<b>Yellow Ribbon Program</b>	Provides a range of resilience and prevention education for National Guard and Reserve service members and families.

### **2.4.3 Training: Pre-Deployment Health Assessment (PHA)**

As mentioned, medical evaluations are completed during training to ensure that a service member is fit to be deployed into combat. To fulfill this obligation, every service member is required to complete the Pre-Deployment Health Assessment (PHA) within 60 days of expected deployment date [98]. The PHA's purpose is to assess a service member's health prior to deployment, and asks the service member to self-evaluate his or her physical and mental health; the complete form is then evaluated by a health provider to ensure the service member can be properly diagnosed and receive adequate care [97]. Examples of questions asked on the PHA that could be used to help evaluate a service member's mental health include the following: "During the past year, have you sought counseling or care for your mental health?" and "Do you currently have any questions or concerns about your health?"

### **2.4.4 Deployment: In-Theater Diagnosis and Care**

During deployment, if a service member feels as though he or she requires mental health care, there are various resources in theater available for service members to be diagnosed and get support for mental health problems, although a formal mental health assessment is not performed in theater unless a service member seeks treatment [94]. Each military unit has access to multifaith chaplains who offer nonclinical counseling, as well as access to treatment facilities in theater [94]. There are also mental health practitioners embedded in operational units in theater; for example, the Marine Corps utilize a program called the Operational Stress Control and Readiness Program (OSCAR) to integrate mental health professionals at the regiment level to teach and guide Marines through deployment [65, 94].

### **2.4.5 Post-Deployment: Health Assessments and Treatment**

When a service member is scheduled to return from deployment, a Post-Deployment Health Assessment (PDHA) is conducted. The PDHA is a face-to-face health screening with a trained health care practitioner which occurs in-theater during medical out-processing or within 30 days upon returning to base [73]. The purpose of the PDHA is for a provider to review with a service member any current health concerns, especially with regards to mental health or psychosocial issues associated with deployment activities or any exposures to toxic materials during deployment [73]. Upon returning from deployment, a service member is required to complete the Post-Deployment

Condition(s)	DoD	Civilian, Baseline	Civilian, Lower-Bound	Civilian, Upper-Bound
<b>Evidence-Based Treatment</b>				
PTSD	\$1,374.48	\$1,658.34	\$1,334.70	\$1,810.80
Major depression	\$585.56	\$1,099.16	\$568.75	\$1,349.03
Co-morbid PTSD/ major depression	\$1,392.73	\$2,989.13	\$1,352.95	\$3,759.90
<b>Usual Care</b>				
PTSD	\$298.19	\$444.93	\$289.58	\$518.11
Major depression	\$239.57	\$294.09	\$232.38	\$323.16
Co-morbid PTSD/ major depression	\$298.19	\$444.93	\$289.58	\$518.11

NOTE: The civilian baseline estimate assumes that 35 percent of discharged personnel get care through the VA; the lower-bound estimate assumes that all discharged personnel get care through the VA; and the upper-bound assumes that no discharged personnel get care through the VA.

Figure 2-11: Estimated Treatment Costs for a Three-Month Course of Psychological Health Treatment [94]

Health Reassessment (PDHRA) 90-180 days after deployment if he or she was deployed outside the continental United States for 30 days or more [41].

Treatment options for service members in garrison are similar to those in theater. Service members requiring treatment either because they have screened positively for a mental health disorder or feel as though they need treatment for mental health issues can seek help from or be referred to mental health care providers in garrison, at MTFs, or from providers outside of the TRICARE network [94]. Alternatively, they can also seek services from post-deployment programs that may or may not be sponsored by the DoD—an example is Military OneSource, described in Table 2.5. Treatment costs vary depending on the services rendered and the network or organizations where treatment was pursued. A study done by RAND (2008) to estimate and model the costs of treatment for psychological health issues for military service members found that the cost of psychotherapy and visits to primary care or psychological health providers were primarily reimbursed by TRICARE (for active duty service members) and Medicare (for service members who have left the DoD) [94]. Figure 2-11 summarizes the estimated treatment costs for a typical three-month course of treatment as modeled by RAND (2008).

In early analysis of these lifecycle processes, it was noted that there was useful information at each phase of the lifecycle that is not leveraged; for example, the dynamics of each enterprise stakeholder (i.e. government, mental health care practitioners, service members) and their deci-

sion making processes are examined separately with little consideration to how they affect each other [34]. These observations, in addition to what is known about the execution and focus of stakeholders with regards to service member health care delivery, indicate that a systems view is critical in revealing the underlying cause-effect relationships that can be leveraged to improve mental health care delivery services in the enterprise. Further understanding of how a systems approach might be used in solving the challenges of the military mental health care enterprise may be found in previous applications of systems thinking to the challenges faced by the U.S. health care system at large.

This chapter has previously described the boundaries of the complex enterprise that this thesis is concerned with, and has now discussed the relevant stakeholders, processes and interactions of this research work. In addition, motivation for utilizing systems thinking to examine this enterprise has been introduced. Now that we understand the enterprise of interest, the next section will provide further insight as to why this thesis will be utilizing an enterprise systems approach to understand the dynamics surrounding decision-making for mental health care delivery in the military.

## **2.5 Enterprise Systems Engineering and System Dynamics in Health Care Delivery**

An enterprise systems approach aims to identify key stakeholders, observe the interdependencies among enterprise entities, including its organizations and processes, and understand the stability and flow of enterprise entities [70]. This approach has been applied to the health care domain in recent literature. Oliveira et al. (2010) utilized an enterprise systems approach to identify similarities in processes like patient flow, hospital organization and strategy between leading hospitals in the United States and the United Kingdom [78]. An extension of the enterprise systems approach was seen in an adaptation of the Lean Enterprise Self Assessment Tool (LESAT) for health care organizations; LESAT is a tool originally created based on lean enterprise principles to gauge how “lean” an organization is and its readiness to change [42]. Further support for using a systems approach to analyze health care systems is found in Rouse (2008). Rouse (2008) provides a foundation for utilizing systems thinking in studying health care systems, as health care systems are complex adaptive systems that require the incentivizing of outcomes and wellness for optimal performance [87]. Thus, Section 2.5.1 will describe recent work and further motivation for utilizing systems thinking in health care delivery as a foundation for this thesis research.

### **2.5.1 Systems Thinking in Health Care Delivery**

In recent years, the U.S. health care system has seen escalating costs in delivering patient care that has been attributed to the relative fragmentation of the system; unfortunately, limited technical and intellectual capital has been employed to improve or optimize the operations of the U.S. health care systems or in assessing its performance to date [74]. The National Academy of Engineering and Institute of Medicine also found that further complicating efforts to improve the delivery of health care in the United States has been the complexity of the issues surrounding the health care system, such as the effects of rapid advances in medical technology; the incentive structure of the U.S. health care and insurance markets; and the underinvestment in information technologies [74]. An approach that considers the health care system holistically and analyzes all system entities and their effects may aid in the examination of complex issues surrounding health care delivery in order to develop robust recommendations for optimal system quality and performance.

The shift towards using systems thinking to improve the U.S. health care system occurred in 2001, when the Institute of Medicine put forth the following quality characteristics that would describe a high performing, transformed, patient-centered health care system (Figure 2-12):

- “Safe—avoiding injuries to patients from the care that is intended to help them
- Effective—providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively)
- Patient-centered—providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions
- Timely—reducing waiting times and sometimes harmful delays for those who receive and those who give care
- Efficient—avoiding waste, including waste of equipment, supplies, ideas and energy
- Equitable—providing care that does not vary in quality because of personal characteristics, such as gender, ethnicity, geographic location, and socioeconomic status” [74, p. 14-15]

Based on these quality characteristics, a partnership between the National Academy of Engineering and the Institute of Medicine was established to use systems thinking and systems engineering tools to tackle the systemic problems in health care delivery. This partnership identified

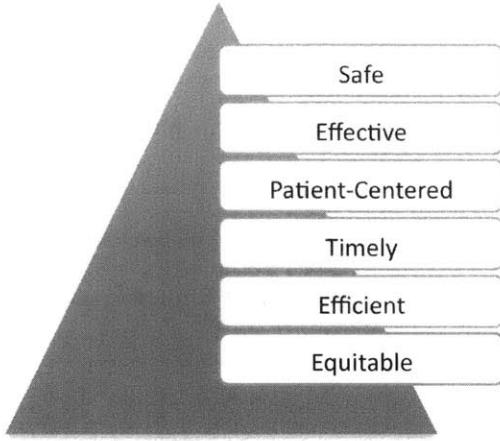


Figure 2-12: Six Interrelated Dimensions of Quality for a Transformed Health Care System [74].

modeling and simulation as a promising area that would benefit from using these tools to transform health care delivery, and recommended that research on the organizational, economic and policy-related barriers to utilizing systems engineering tools in health care be an integral part of the future research agenda at large [74]. The National Academy of Engineering and the DoD also concurrently identified the system of care for psychological health in the military and in particular, for traumatic brain injury (TBI) as an area in MHS which could benefit from the use of systems engineering tools for transformation [75]. Accordingly, this thesis will utilize a systems thinking tool to identify areas in military psychological health care delivery that could be considered for transformation.

### **2.5.2 Applications of System Dynamics in Health Care: A Preliminary Systematic Literature Review**

System dynamics is a method to enhance learning in complex systems which deals with the system's dynamic complexity and used to inform potential policy resistance [90]. For example, it has been used to model topics such as political instability, building material resource availability, land reclamation in the mining industry, energy and power systems, coastal ecosystem dynamics, aviation systems, and agenda setting and public policy making [95]. An area in which system dynamics has emerged as a widely accepted research method is health care systems. In order to understand and summarize the existing literature, a preliminary systematic literature review was performed (see Table 2.6). The total number of publications that use system dynamics to study health care systems questions remains relatively little. A literature search in Google Scholar with the keywords “system

Table 2.6: Preliminary Systematic Literature Review Protocol

<b>Purposes of this Systematic Literature Review</b>	To identify and review prior work performed using system dynamics to illustrate potential policy effects in health care and public health.
<b>Search Strategy</b>	Search selected databases with specific keywords. Remove duplicates.
<b>Exclusion Criteria</b>	Studies were excluded if the majority of the study did not address the application of system dynamics to health care processes or public health outcomes.
<b>Keywords</b>	“system dynamics” AND “health” “system dynamics” AND “healthcare”
<b>Databases/Journals</b>	Google Scholar (injournal: System Dynamics Review; anywhere in text) MIT DSpace (Master’s-level theses; in abstract)

dynamics” and “health” and “system dynamics” and “healthcare” within the journal *System Dynamics Review* generated 123 titles. After utilizing the exclusion criteria, 14 search results remained for review. The same search within the MIT DSpace database for Master’s-level theses showed only six theses and utilizing the exclusion criteria then produced a final list of three MIT theses. Therefore, the total number of titles reviewed was 17.

Koelling and Schwandt (2005) reviewed and summarized literature which utilized system dynamics in health systems, including applications to the organization of health systems, clinical research, delivery, disease prevention, epidemiology and dentistry. They found that research interest in health systems was increasing, especially with regards to health care systems, demonstrating a focus on individual or population health issues [56]. Koelling and Schwandt (2005) also emphasized the use of system dynamics as a modeling tool for health care systems as integrated policies affecting multiple stakeholders can be effectively modeled, resulting in broad improvements at the system level [56]. The preliminary literature review done for this thesis additionally found that much of the prior work done with system dynamics in health care outside of the MIT thesis domain primarily illustrated health care issues at the national level, and focused on modeling national level systems for scenario planning in various contexts. A summary of relevant studies and their categories can be found in Table 2.7.

Table 2.7: Summary of Literature Review

Category	References
Scenario Planning at the National Level	Homer (2006); Royston (1999); Wolstenholme (1999); van Ackere (1999); González-Busto (1999); Homer (2004); Dangerfield (2001); Hirsch (1999); Lane (2000)
Policy Creation to Drive Health Outcomes	Cavana (1999); Wolstenholme (2007); Homer (2007); Ritchie-Dunham (1999)
Consequences of Technology and Innovation Implementation in Health Care	Bayer (2007); Lin (2007); Newkirk (2009); Couturier (2010)

### Scenario Planning at the National Level

System dynamics has been used to model multiple interacting diseases and risks, demonstrate the interaction of delivery systems and diseased populations, and illustrate potential matters of national and state policy [47, 27]. For example, Homer, et al. (2004) utilized system dynamics to project the costs and benefits of a program designed to improve chronic care in a county of Washington state, as chronic care was widely considered to be wasteful and unresponsive to patient needs [46]. Most importantly, this system dynamics model demonstrated the value of system dynamics modeling to enable leadership to better design policies based on projected critical success factors, system limitations and predicted outcomes. Hirsch and Immediato (1999) also utilized system dynamics models to help decision-makers think about how to implement new initiatives and changes based on large-scale policy changes affecting a health care system at large [43]. This study demonstrated that the value in building a system dynamics model lay in the model's ability to support sensitivity analyses for scenario planning, reveal potential time delays, and test scenarios that would not otherwise be pursued in the real world [43]. This directly supported Koelling and Schwandt (2005)'s work which additionally showed these strengths of system dynamics versus other methods like discrete event simulation [56]. Other studies have also explored potential scenario outcomes by using system dynamics to illustrate the effects that waiting lists have on health care delivery in two different national health care systems, the UK National Health Service (NHS) and Spain's National Health Service, eventually enabling robust data-driven recommendations to counter predicted long-term policy impacts [104, 35].

Further motivation for using system dynamics as a method for modeling stress reactions and their effects on mental health care in the military can be found in Royston, et al. (1999) and Wol-

stenholme (1999). It was found that system dynamics modeling proved useful in several areas of health care policy and program development and implementation in England, especially in the areas of assessing public health risks; screening for disease, managing waits for hospital treatment, planning the health care workforce, and developing emergency health and social care [89]. There was an emphasis placed on the future potential of system dynamics for exploiting the potential synergy between systems thinking and scenario planning [89], both of which provide motivation for this thesis work. A stock and flow model of total patient flow was used to test alternative initiatives for improving the United Kingdom health system and showed that system dynamics could be used to create a national-level, quantitative analysis of health care systems [107]. Because the military health system is also a national-level health care system, a stock and flow model can also be applied to the service member lifecycle flow, enabling a potential quantitative analysis of the system to inform policy planning in the military health system as well.

### **Factors in Policy Creation to Drive Health Outcomes**

Lane, et al. (2000) utilized system dynamics to model the interactions between hospital demand, accident & emergency (A&E) resource allocation, other processes, and bed numbers, and the findings carried a significant policy implication that could be applied to this thesis research. While some delays were unavoidable in A&E units, waiting time reductions could be achieved by selective augmentation of resources within and related to the A&E units [58]. Similarly, this thesis explores whether or not selective allocation of resources related to psychological health in the military may have a beneficial impact on the delivery of mental health care in the military. The influence of delays in military mental health care delivery will also be explored.

System dynamics modeling exercises were used to illustrate the different priorities and perspectives of different health care stakeholder groups, which showed that these different stakeholder priorities and perspectives inadvertently influence policy creation and the eventual quality of health care services, leading to suboptimal health outcomes [23, 108]. Cavana, et al. (1999) led a system dynamics exercise among groups that combined clinicians, policy drafters, managers, scientists and economists and found that each stakeholder group held different views regarding the inefficiencies and causes of health inequalities in the New Zealand Ministry of Health, showing the importance of a holistic systems thinking approach to policy creation for driving health outcomes [23]. Similarly, Wolstenholme, et al. (2007) demonstrated how mismatches between how management views organizational performance and actual behavior leads to unintended negative consequences for pa-

tient care via informal coping policies, and additionally argues for the investigation of sustainable policies downstream to alleviate the upstream problems perpetuating these informal coping policies [108]. In contrast, other system dynamics models illustrated how upstream initiatives had a large impact on chronic illness prevalence with regards to risk factor mitigation, patient behaviors and living conditions, as well as on preventing public health crises and epidemics [45, 85]. Similarly, this thesis will follow these works by considering upstream initiatives based on the health information assessed at military accession, and how this knowledge might be utilized in upstream initiatives to ensure optimal mental health outcomes in the military population downstream. As the literature has also shown the value in considering all stakeholder perspectives in creating a system dynamics model of the enterprise of interest, this work also will be taking a holistic perspective in its qualitative assessment of stakeholder interactions in military mental health care delivery.

### **Consequences of Technology and Innovation Implementation in Health Care**

Recent literature has begun to focus on the consequences of implementing new technologies and innovations in health care, from screening practices to advances in health information technologies [59, 14]. Other work has also focused on how the U.S. health care landscape may have influenced and perpetuated breakdowns in drug safety [25] and examined innovations in health programs on a global scale in the developing world [68]. All of these works demonstrated the value of system dynamics in revealing unanticipated negative side effects from these technologies and innovations, and especially from the policies which emerged to regulate them. Lin (2007) used system dynamics to illustrate how increased and improved screening practices from revised diabetes guidelines perpetuated the increase of diabetes prevalence in the United States, because these practices were better able to diagnose cases which otherwise would have gone untreated [59]. The system dynamics model in Couturier (2010) showed how the behaviors of inherent stakeholders like clinicians and pharmaceutical salespeople assisted in the approval of the drug Vioxx without adequate oversight over its safety [25]. Finally, both Newkirk (2009) and Bayer (2007) investigated the impacts of separate innovations in the health care sphere (disease-focused global health aid programs vs. telecare). Using system dynamics models, both of these studies revealed that the impact of these innovations must be carefully assessed over time, and indicated levers that could be adjusted to ensure optimal performance in their respective contexts. In the context of military mental health care delivery, resilience programs and resources can also be considered an implementation of innovation, and their impact on overall health outcomes will also be investigated using system dynamics.

## **Summary of Literature Review**

This preliminary literature review has illustrated that system dynamics is emerging as a method to study complex systems in health care, ranging from delivery systems to the regulatory system surrounding drug approval in the United States. More specifically, system dynamics has been utilized to aid scenario planning for national health care systems, to identify the drivers behind population health outcomes and the performance of health care services, and to demonstrate potential positive and negative consequences of implementing new technologies and innovations to improve health care systems at large. As a complex national health care system that is concerned with the health outcomes of a large population (military service members) and is currently investigating the use of new technology like telemental health care for implementation, this preliminary literature review provides support for the application of system dynamics to study the military mental health care enterprise.



# **Chapter 3**

## **Methods**

Now that the enterprise has been defined and the problem statement has been described in its relevant context, this chapter will outline the research methods used to achieve the research objectives described in Section 1.2. Section 3.1 will again emphasize the systems thinking approach, leading into a discussion of system dynamics as a tool for guiding systems thinking in Section 3.2. The system dynamics model of the military mental health enterprise is introduced in Section 3.3, followed by its assumptions in Section 3.4. Finally, this chapter concludes with a discussion of the qualitative and quantitative methods utilized for data collection and analysis.

### **3.1 Value of Systems Thinking**

In taking a systems approach to these challenges in military mental health care delivery, it is important not only to consider factors at accession that may influence subsequent decision-making throughout the military service lifecycle, but also the overall dynamics of policy implementation and how policy effects may cascade throughout the system. As referenced in Chapter 2, the focus of enterprise-level organizations, leadership, and decisions have a profound influence on the individual service member. Processes across the lifecycle require examination across the entire lifecycle. Similarly, decision-making and their resulting dynamics across the enterprise exert influence over the entire lifecycle as well (Figure 3-1). Adding complexity to the decision-making process is that cause-effect relationships across lifecycle phases may not be inherently obvious to key stakeholders; in a time of crisis and war when decisions and policies need to be formulated and implemented quickly, it may be difficult to see how effects from decisions may affect the entire enterprise as a whole.

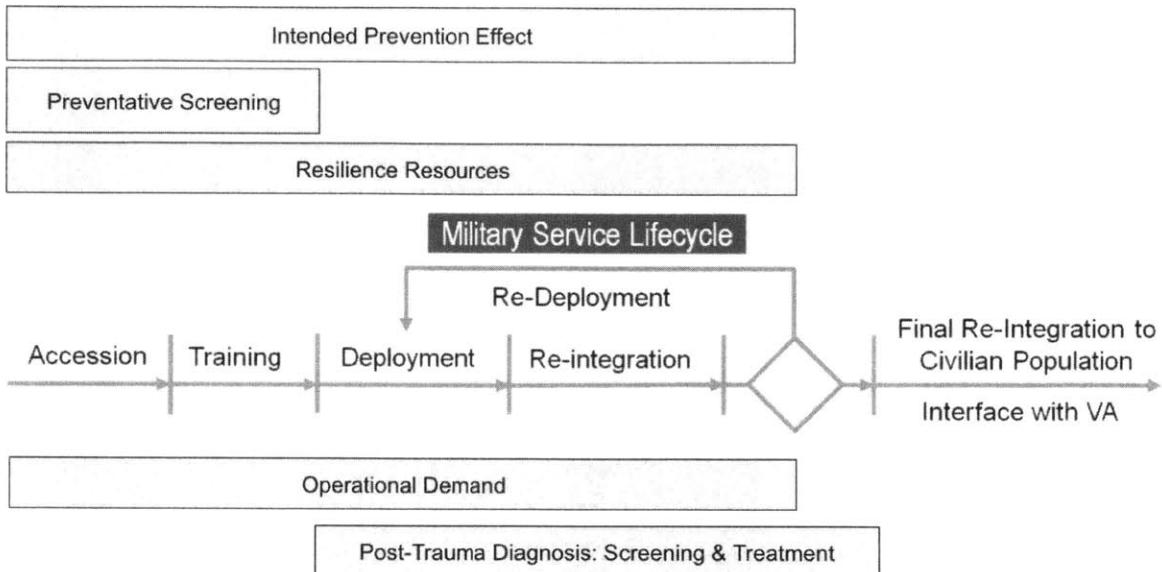
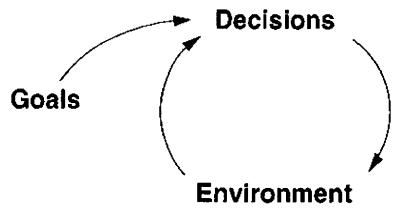


Figure 3-1: Influence of Decision-Making Dynamics across the Lifecycle

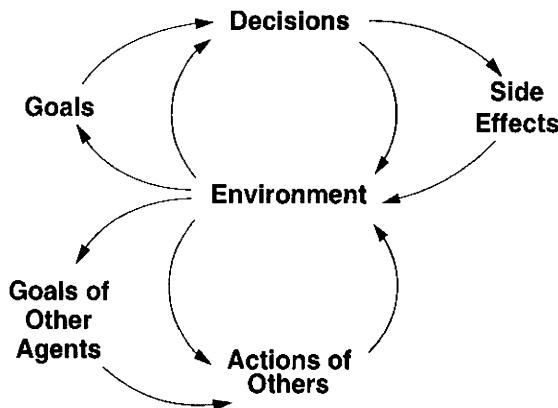
### 3.2 System Dynamics: Tools for Systems Thinking

As illustrated in Section 2.5.2, the usefulness of system dynamics as a framework for operations management and management science has been demonstrated in recent literature. Größler et al. (2008) found that although feedback loops, accumulation processes and delays exist and are widespread in operations management, these phenomena are often overlooked or not considered, rendering system dynamics extremely powerful in examining the structural aspects of operations management such as supply chains and improvement programs in operations [39]. Furthermore, system dynamics model simulations allow the social scientist to experiment with the model, enabling real-world applicability and the demonstration of policy implications when real-world testing is not feasible or appropriate. Perhaps most importantly, system dynamics can be used to examine unanticipated side effects and feedbacks that may occur as a result of policy implementation, rendering it a valuable tool for this thesis and its policy implications and recommendations (Figure 3-2).

System dynamics uses two different tools for modeling a complex system: causal loop diagrams and stock and flow diagrams.



Our decisions alter our environment, leading to new decisions,



but also triggering side effects, delayed reactions, changes in goals and interventions by others. These feedbacks may lead to unanticipated results and ineffective policies.

Figure 3-2: System Dynamics: the feedback view [90]

### 3.2.1 Causal Loop Diagrams

Causal loop diagrams illustrate a causal relationship between two variables [90]. For example, Figure 3-3 illustrates a positive causal relationship between birth rate and population—as the birth rate increases, population increases; as the birth rate decreases, population always decreases. A positive causal relationship, therefore, is one that illustrates two variables changing in the same direction. A negative causal relationship, in which two variables are moving in opposite directions, is also illustrated in Figure 3-3. As the death rate increases, the population decreases. Note that in this example, birth and death rates refer to the number of people born or that die per time period, whereas the fractional birth or death rate is the actual birth or death rate of any given year. To illustrate, an unemployment rate is the ratio of the number of unemployed people to the labor force (i.e. 9 percent). A fractional unemployment rate would be 9 percent *per year*.

Feedback loops illustrated in Figure 3-3 show a reinforcing feedback loop between variables

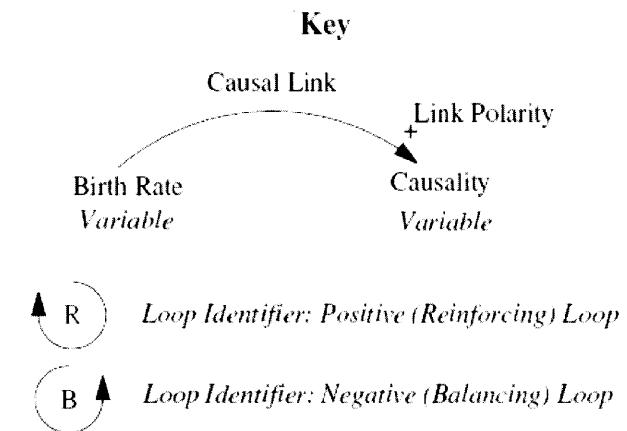
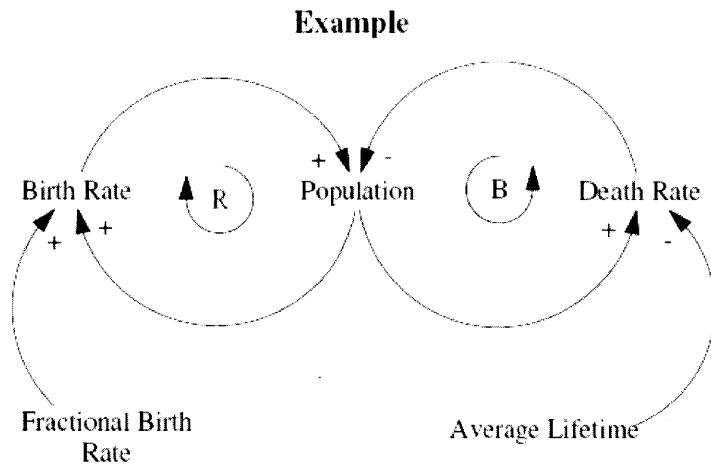


Figure 3-3: Causal loop diagram notation [90]

Birth Rate and Population, whereas variables Death Rate and Population Rate form a balancing feedback loop. A reinforcing feedback loop like the one shown between Birth Rate and Population indicates that as the birth rate increases, population also increases. As population increases, birth rate increases, reinforcing the behavior and thus the loop is a reinforcing loop. In contrast, as the death rate increases, the population decreases, and because variables Population and Death have a positive causal relationship, as the population decreases, the death rate also decreases. The feedback effect opposes the initial change so the loop is balancing.

The value of causal loop diagrams is in their ability to demonstrate important feedback mechanisms throughout the system. However, a major limitation of causal loop diagrams is their inability to illustrate the accumulation and depletion of various system variables and how these variables

might change over time.

### 3.2.2 Stock and Flow Diagrams

Stock and flow diagrams illustrate how accumulations of a variable move through a complex system [90]. They depict the state of the system and provide information for the basis of decision-making, making them a powerful tool for analysis and for determining potential policy implications. Furthermore, stock and flow diagrams leverage time by providing insight into how the passage of time affects the overall system—since stocks cannot accumulate or deplete without associated flows, over time a stock will continue to accumulate unless an action is taken on its inflow and outflow.

System dynamics depicts stocks as rectangles, inflows are represented with pipes pointing into the stock and outflows with pipes pointing out of the stock. Flows are controlled by valves and clouds represent the sources and sinks of flows which lie outside of the complex system of interest. Figure 3-4 illustrates this concept—as flow Birth Rate increases, the stock Population accumulates; as flow Death Rate increases, stock Population decreases.

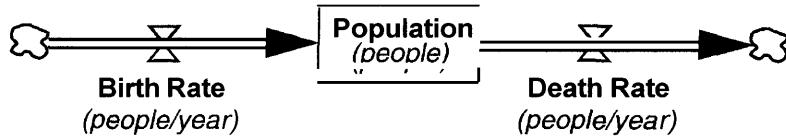


Figure 3-4: Stock and flow diagramming notation [90]

## 3.3 System Dynamics Model of the Military Mental Health Enterprise

A system dynamics model (Appendix B) of the military mental health enterprise was created, with causal loop and stock and flow diagrams, to understand the various decisions, interactions and policies that resulted in the rise of PTSD as an enduring pathology of OIF/OEF as discussed in Section 1.2. The stock and flow diagrams modeling the military service member lifecycle illustrates the effect that the waiver process and deployment rates have on the overall lifecycle, and validates external observations seen by other studies (i.e. [94]). As leadership and policymakers work to alleviate imminent concerns like operational demand, the model additionally demonstrates how feedback effects from these policies may linger for years to come as the feedbacks are perpetuated through the multiple levels of the enterprise. The waiver process and deployment rates are examples

of enterprise-level policies that affect the unit and eventual health outcomes on the individual level, showing how the model illustrates the importance of a multi-level approach in outlining a long-term psychological health care strategy for the enterprise.

### **3.4 Model Assumptions**

Limitations of this research have been previously discussed in Section 1.4. To reiterate, this research did not attempt to study all types of service members and all psychological health processes throughout the military service lifecycle; nor did it attempt to study all possible scenarios potentially experienced by a service member. Furthermore, most unit-level and enterprise-level dynamics were not quantified due to limitations with data collection and retrieval.

Additional model assumptions include:

1. The system dynamics model assumes that all rates are constant throughout the year because the model's defined time step is one year. For example, the model assumes a constant base fractional deployment rate at 12 percent per fiscal year. Assuming that rates remain constant allows the model's sensitivity analyses to project a general picture of future health outcomes for informing future policy recommendations. However, the downside of assuming constant rates in this model is that this is likely not the case in reality. It would be more practical to define the model's time step by month to better capture the deployment data which tracks changes in troop numbers per month (i.e., in [15]) and gain higher resolution of the dynamics, but data provided by AMSARA is defined and tracked by fiscal year. With the fractional deployment rate example, deployment rate will likely vary throughout the year based on the demands of the operation (i.e. lengthening of deployment cycles, as was seen in OIF/OEF), or could change based on staffing needs. The model does account for operational demand and its effect on the fractional deployment rate, but this causal relationship has not been quantified to the extent that exact deployment rates can be predicted based on incremental changes in operational demand.
2. Although the model accounts for operational demand and changes in deployment rate by testing the salience of deployment rates on future health outcomes over time, the model does not account for individual differences in deployment assignments due to the limitations of system dynamics as a method. For example, the literature indicates that the cumulative effect of multiple deployments and lengthened deployment cycles is manifested in the increased

onset of PTSD symptoms over time (i.e. [94, 15]). However, the model is unable to track individual differences in the number of deployment cycles served, or track which individual service members have had lengthened deployment cycles. This is because system dynamics aggregates service members in stocks to produce a continuous function by which conclusions can be drawn regarding the population at large. Therefore, although the model does illustrate that a service member can deploy into theater, return, and be deployed again, it does not distinguish between service members who are on their first deployment in theater and service members who may have served multiple deployments and are being deployed again.

3. The model assumes rates are constant across the entire lifecycle for all service members, mostly due to the general lack of available data for some rates (i.e. deployment and accession rates for the National Guard service members). For example, the model assumes that the rate at which National Guard and Reserve service members are deployed would be the same as the rate at which active duty service members are deployed. Similarly, the model assumes that the rate at which service members experience an onset of PTSD symptoms in theater is the same as the rate in which service members experience an onset of PTSD symptoms in garrison. Assuming constant rates across the entire lifecycle for all service members again enables the generalization of the model findings across the entire service member population. In reality, initial deployment rates for active duty and National Guard and Reserve Corps service members are likely not the same because National Guard and Reserve service members would be deployed in the event that service members additional to the active duty force are required to support forces in theater. Deploy again rates, where service members are assigned back into theater, may not be the same as initial deployment rates. This might be due to scenarios such as service members not having yet been cleared for deployment, service members being medically discharged, or even service members dropping out of the service. Similarly, rates for the onset, diagnosis and treatment of PTSD were assumed to be constant in theater and in garrison. Previously discussed in Section 2.1.2 were the military-specific risk factors found by Phillips, et al. (2010) and King, et al. (1999). Because of the extreme stressors service members might experience in theater, it could be posited that onset, diagnosis and treatment rates might be different in theater than in garrison. Resources for psychological health in theater might also be allocated differently, affecting these rates as well. Furthermore, it could be argued that assuming constant rates across the entire lifecycle would lead to overgeneralization of the model findings. It may be beneficial to consider outliers and other

unique individual service member characteristics, as they could inform policy for specific populations within the overall service member population.

4. There is a distinction made between service members who are diagnosed in garrison and service members who are diagnosed in theater. However, when service members diagnosed in garrison are deployed again into theater, they re-enter the stock of deployed service members and do not enter the stock of deployed diagnosed service members because they were not previously diagnosed in theater.
5. The model assumes that as a service member deploys, another service member returns because every service member is given a set of deployment dates that correspond to a deployment cycle typically lasting 12 months for every two years outside of combat [94]. The effect this assumption has on the model simulations is exemplified by equaling fractional deployment rates and fractional return rates. As with deployment rates, return rates are likely to vary over time and are likely to be dependent on the demands of the combat operation. System dynamics also does not allow the model to consider discrete deployment events. This model's defined time step is one year; regardless of the deployment events that occur during this year, it will always implement the defined number of service members into the system at a constant flow per year. For example, if the model were to specify that 100,000 service members enter the system per year, a total of 100,000 service members will enter the system each year regardless of how they are distributed over that year. Furthermore, other work has also indicated that the rate of deployment per unit is only one way to examine the burden of deployment because the make-up of a unit changes as individuals are reassigned or replaced [15].
6. Qualitative interview data, described in Section 3.5, indicates that the definition of resilience is not mutually agreed upon among enterprise stakeholders as the relationship between stress and resilience may vary on an individual basis. The model therefore assumes that individual-level factors refer to factors affecting the entire service member population at large to again provide for generalization of the model findings.
7. The model starts at year zero with initial stock values as assigned from the literature (if applicable). As a result, all service members after year zero must then enter the system through application and accession, providing a realistic depiction of the military service member life-

cycle at large. As discussed in Section 2.4, all service members must apply and be accepted into the military. The model additionally assumes that all applicants enter the system without already having been diagnosed with PTSD and without having received prior treatment for PTSD. In other words, service members only receive a diagnosis of and treatment for PTSD as they progress through the stock and flow diagram. Although it is unlikely that all applicants would enter the system without already having been diagnosed with PTSD, the likelihood that this would be the case would be extremely small, as the accession processes described in Section 2.4 are designed to screen applicants who previously suffered from psychological health issues. Even though these applicants may appear in the system as a successful applicant (a Type II error) or a waiver acceptance, the effect that these members would have on the overall dynamics is likely very small.

8. The model assumes that combat operations are ongoing throughout the duration of sensitivity analyses, without interruption. This is due to the utilization of system dynamics as a method, as it aggregates population data and utilizes a continuous function to generate reasonable conclusions. The incorporation of delay levers, as well as table functions, allows system dynamics to consider discontinuous functions and would strengthen the model overall. The addition of table functions and delay levers were considered but were eventually not used due to the lack of quantitative data for the variables of interest.

### **3.5 Data Sources and Model Validation: Qualitative Methods**

The model was created based on the literature review described earlier in Chapter 2 and validated with qualitative interview data from interviews conducted with six individuals involved with military service lines, service medical commands and military accession policy, as well as individuals at the Defense Centers of Excellence (DCoE), the Joint Chiefs of Staff and the Office of the Assistant Secretary of Defense for Health Affairs (OASD-HA). Interviews conducted with individuals outside of the services implies that the group the participant represented offered its services across the military service lines and commands, and are not specific to any given military service line. Collecting qualitative data in conjunction with quantitative data analysis to triangulate research findings is advantageous because it can result in well validated and substantiated findings [26].

Interviews were designed to last for approximately 30 minutes to one hour and required no previous preparation on the part of the participant. However, preliminary material such as an outline of

the literature review and research purpose and the preliminary model discussed in Chapter 1 were provided to the participant prior to the interview if the participant wished to gain some preliminary background insight as to the research being conducted and the research questions posed. The interview format was unstructured and followed an open-ended approach in which the participant could provide anecdotes and examples from his or her own personal experiences. There was no standard interview guide due to the varying roles that all participants played in the enterprise; however, questions typically followed a variation of the format below:

1. Basic Information about Author and Research Supervisor
2. Introduction and Discussion of Preliminary Research Model
3. Participant's Insights on the Processes or Key Individual-, Unit-, and Enterprise-Level Dynamics in the Research Model

Depending on the role that the participant played in the enterprise, additional information was garnered. For example, if a participant played a large role in the development of a resilience program or had expertise regarding a specific program or process, the interview questions were primarily structured to allow the participant to describe his or her role in the context of that specific program or process. If necessary, interviews typically ended with a request for supplementary documentation for the program or process that the participant represented. Qualitative data from these interviews were used and summarized to support key findings of this research in the form of quotations and interspersed throughout as illustrations of key insights. These insights will be discussed in Chapter 4.

### **3.6 Data Sources and Model Validation: Quantitative Analysis**

VensimPLE, a system dynamics software capable of developing and analyzing high level feedback models, was used to build and design the system dynamics model and perform sensitivity analyses. Available published data regarding service member deployment and PTSD symptoms reported from Belasco (2009) and RAND (2008), as well as service member accession data from the Accession Medical Standards Analysis & Research Activity (AMSARA) 2010 Annual Report was used to populate and quantitatively validate the stock and flow lifecycle diagram (Appendix C) before proceeding to hypothesis testing. A summary of values is provided in Table 3.1, and these values

were defined as the “Current” condition in all sensitivity analyses unless otherwise stated. As stated previously in Section 3.4, unless otherwise specified all fractional process rates (i.e. Fractional Accession Rate) were held constant across the entire military lifecycle regardless of service affiliation or deployment status.

Table 3.1: Summary of Model Values

Source	Variables	Values	Units
<b>AMSARA 2010 Annual Report</b>	Military Service Applicants	251,370	Service Members
	Accepted Military Service Members	234,547	
	Applicants Granted Health Waivers <sup>1</sup>	16,823	
	Applicants Eligible for Health Waivers	27,421	
	Accepted Reserve Service Members	45,683	
	Accepted Guard Service Members	56,866	
<b>AMSARA 2010 Annual Report</b>	Fractional Accession Rate <sup>2</sup>	0.593	Unitless
	Fractional Waiver Approval Rate	0.614	
	Fractional Health Waiver Rejection Rate	0.386	
	Fractional Health Related Rejection Rate	0.109	
	Fractional Waiver Acceptance Rate <sup>3</sup>	0.394	
<b>Belasco (2009)</b>	Service Members Deployed	186,300	Service Members
	Fractional Deployment Rate	0.12	
<b>RAND (2008)</b>	Fractional Diagnosis Rate <sup>4</sup>	0.25	Unitless
	Fractional Onset Rate <sup>5</sup>	0.26	
	Fractional Treatment Rate	0.30	

<sup>1</sup> Applicants who receive a permanent medical disqualification are eligible for waivers, in contrast to temporary disqualifications which cover medical conditions such as being overweight [2].

<sup>2</sup>No accession rate was given for Guard or Reserves.

<sup>3</sup> Applicants who received waivers and accessed within one year of application. Regulations state that accessions must occur within one year of application, although it is fairly common for applicants to request and be granted a one-year extension [2]. For simplification purposes, this model considered all accessions to occur within one year as per the regulations.

<sup>4</sup>RAND (2008) found that the diagnosis rate for any given fiscal year ranges from 10-31 percent depending on the study and methods used. 25 percent was chosen as the value used for this model based on a model sensitivity analysis performed predicting an incidental percent change in diagnosed service members between 25-31 percent compared to the range of 10-25 percent (5 percent vs. 51 percent). A diagnosis rate of 25 percent was therefore considered a good estimate of the upper bound of predicted diagnosed service members.

<sup>5</sup>This fractional onset rate is considered to be underreported, as it only reports the percentage of service members who seek psychological health treatment without being formally diagnosed [94].



# **Chapter 4**

## **Findings and Discussion**

### **4.1 Overview of Findings**

This section discusses the findings produced from the sensitivity analyses conducted using the system dynamics model created as described in Section 3.3. Section 4.2 discusses the individual-level dynamics of a typical service member progressing through the military service lifecycle from accession to treatment. Next, Section 4.3 describes the unit-level dynamics and specifically discusses how unit-level resources like service-specific resilience training changes overall service member dynamics, especially the predicted number of service members reporting PTSD symptoms. Section 4.4 explains how policymaking at an enterprise-level regarding screening and treatment processes and providing funding for resilience resources in the context of increasing operational demand affects all levels of dynamics in the enterprise. These sections provide the context for potential policy implementation and set the foundation for a discussion of policy implications to be considered by military leadership. Figure 4-1 summarizes the enterprise-level, unit-level and individual-level dynamics that will be explained in this chapter.

### **4.2 Individual-level Dynamics**

#### **4.2.1 Military Service Member Flow from Accession to Treatment**

Appendix C shows the stock and flow diagram for service member movement from accession to treatment. It shows the major routes by which service members flow through the military life cycle. As discussed in Section 2.3.2, this thesis defines the enterprise as containing all organizations

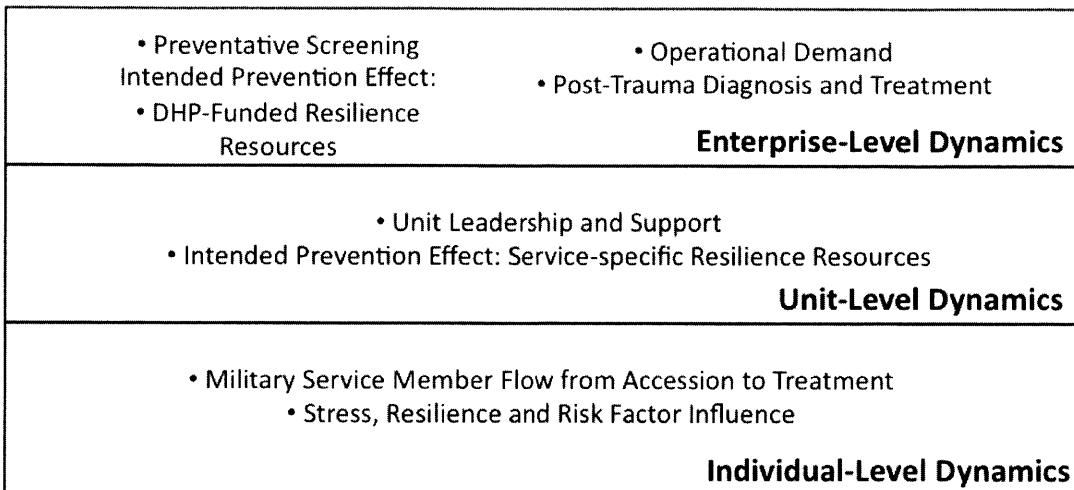


Figure 4-1: Summary of dynamics discussed in this chapter.

related to mental health care from accession to treatment. Although community organizations and organizations related to the VA do offer PTSD and mental health services for military service members beyond deployment and treatment (i.e. reintegration into civilian society), they do not have formal connections with other organizations within the enterprise and as a result this thesis is not considering lifecycle processes beyond treatment. Typically, active duty service members enter military service by applying and going through the accession processes at the MEPS (described in Section 2.4). However, there are other routes by which service members may access into military service. For example, the waiver-granting process described in Section 2.4 provides another route for active duty service members to access into the service. Additionally, National Guard and Reserve Corps members have separate application processes, although they also go through the same MEPS processes as active duty members.

The processes that architect this stock and flow diagram were previously described in Section 2.4. Military service members who access into military service are eventually deployed in theater and return to their home base assignments after a period of deployment. Service members are either deployed again or stay at their home base. Service members who begin to experience symptoms of stress reactions and PTSD are eventually diagnosed and treated. It should be noted that although service members may not have been formally diagnosed with a stress disorder, they may still seek treatment or counseling. In addition, service members who experience an onset of symptoms may not be diagnosed and may be deployed again without diagnosis or treatment.

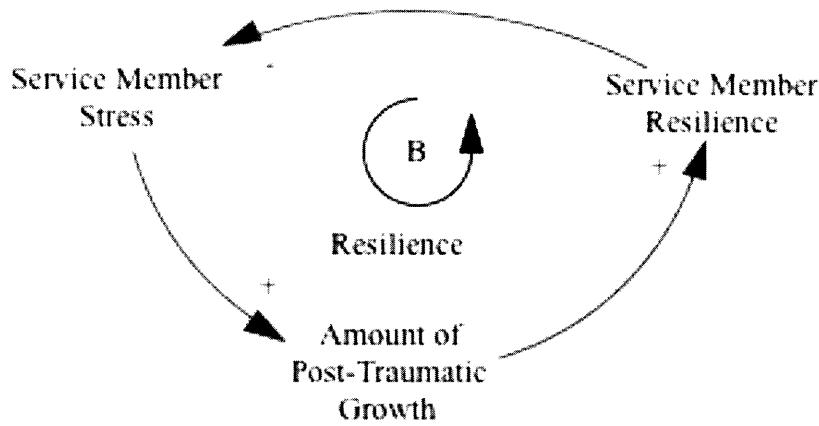


Figure 4-2: Balancing loop relationship between service member stress, resilience and post-traumatic growth.

#### 4.2.2 Stress, Resilience and Risk Factor Influence

Service member resilience, defined as the ability to withstand, recover, grow and adapt under challenging conditions, is currently considered by the military as critical to managing service member stress; without resilience, service member performance suffers and the more stress a service member experiences, the more his or her ability to withstand that stress decreases, even with prior resilience training [13]. Additionally, the literature suggests that the experience of distress can lead to an overall positive experience, allowing the affected persons to become more self-sufficient and increasing coping mechanisms that lead to overall post traumatic growth [20, 60]. A study of 1,287 American war veterans found that the higher the amount of combat exposure, the more likely the veterans were to perceive their military experience as positive [4]. The relationship between service member stress, resilience and the amount of post traumatic growth can be therefore modeled as a balancing loop, with post traumatic growth serving as a vehicle for increasing service member resilience to combat stress (Figure 4-2).

Adding complexity to the stress-resilience relationship is the influence pre-traumatic risk factors have in affecting the likelihood of an individual experiencing post-traumatic stress, previously discussed in Section 2.1.2. In applying the stress-resilience individual-level dynamics, service member resilience should mitigate the influence of an individual's risk factors and an individual's predisposition to development of post-traumatic stress from factors such as a history of prior mental illness or a lack of family and social support [54]. Factors building resilience such as a strong social support network and education would also serve to mitigate service member stress by supporting a service

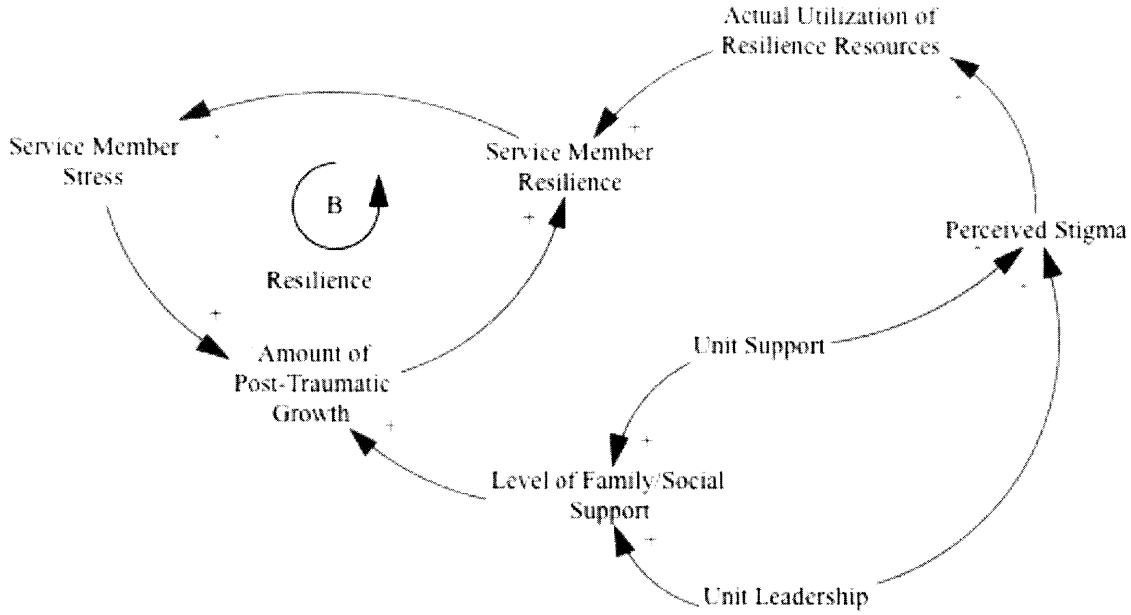


Figure 4-3: Effect of unit support and leadership on the resilience balancing loop.

member's resilience building efforts. Now we will discuss the unit and enterprise-level dynamics that influence these individual-level dynamics.

## 4.3 Unit-level Dynamics

### 4.3.1 Unit Leadership and Support

Section 2.2 previously described the importance of the military culture in providing an internal social support to service members during their time in service. Additionally discussed were the effect that good unit leadership and support might have in helping service members cope with stress resulting from their time and experiences in the military service, and how leadership and support would serve to mitigate the stigma previously associated with seeking mental health care in the military. Thus, unit leadership and support should serve to mitigate any risk factor influence that would predispose an individual to developing psychological health issues downstream during their time in service, and further contribute to the balancing loop dynamics of the stress-post traumatic growth-resilience relationship (Figure 4-3).

A study done among Air Force medical personnel to examine the relationship between unit cohesion, stress exposure and PTSD indicated a significant linear correlation between unit cohesion

and the severity of PTSD symptoms ( $r = -0.30, p < 0.01$ ) [29]. In this study, unit cohesion was measured using a 5-item, rationally derived measure similar to a study done by Brailey, et al. (2007) with internal reliability of  $\alpha = 0.82$  [17]. The Brailey, et al. (2007) study measured unit cohesion using items from the Deployment Social Support Scale of the Deployment Risk and Resilience Inventory, a set of scales developed and validated to assess 14 key deployment-related risk and resilience factors with significant implications for long-term health outcomes [55]. Sample items included: “To what extent is your unit like a family to you”, and “How good are the available role models and leaders in your unit?” Participants were asked to respond to items using a 5-point scale ranging from “not at all” to “extremely.”

Based on these findings, causal relationships between variables *Unit Support* and *Fractional Onset Rate* and Unit Support and *Fractional Deployed Onset Rate* were added to the stock and flow diagram (see Appendix D). The baseline onset rate as defined by RAND (2008) was 26 percent. Averaging the mean unit cohesion score between male and female groups in the Dickstein, et al. (2010) study (12.60 and 11.67, respectively) and accounting for the five-item survey by dividing by 5 generated a mean unit cohesion score of 2.427 for a service member population for the baseline “Current” condition. Because the Dickstein, et al. (2010) study found that the interaction between unit cohesion and PTSD symptoms was a significant inverse linear relationship, a meta-analysis was performed to determine the predicted mean unit cohesion score for the Brailey, et al. (2007) study as shown below:

<b><i>r</i></b>	<b>Unit Cohesion Score</b>
-0.30 [29]	2.427
-0.32 [17]	x

$$-0.30x = -0.32 * 2.427$$

$$x = 2.59$$

The percent change in mean unit cohesion scores was calculated to determine the predicted onset rate for the mean unit cohesion score of 2.59:

$$2.59 - 2.427 = 0.163, \% \text{ change} = 6\%$$

$$0.06 * 0.26 = 0.0156$$

$$0.26 - 0.0156 = 0.24$$

$$\text{Predicted onset rate} = 0.24$$

An equation for variables Fractional Onset Rate and Fractional Deployed Onset Rate was then defined using Microsoft Excel:

$$\text{Fractional Onset Rate} = -0.122 \times \text{Unit Support} + 0.56$$

$$\text{Fractional Deployed Onset Rate} = -0.122 \times \text{Unit Support} + 0.56$$

Following both the Dickstein, et al. (2010) and Brailey, et al. (2007) studies, Unit Support was also defined on a range of 1-5 and a sensitivity analysis was performed accordingly. Sensitivity analysis results both validated and predicted the number of service members expected to report PTSD symptoms, based on the parameters of the stock and flow diagram and the definition of fractional onset rate (Figure 4-4). Unit support has a substantial effect on the predicted number of service members expected to experience PTSD symptoms but would hit a maximum effect at a unit support of 4.6, when Fractional Onset Rate would be equal to zero. However, because this relationship was defined linearly based on the literature, it would be possible for the calculated fractional onset rate to have a negative value past a unit support score of 4.6. For this model's purpose and analysis, the desired Fractional Onset Rate is zero to illustrate the ideal, desired state for the enterprise.

However, the presence and effects of unit leadership and support would be most effective in-theater, as unit leadership and support levels are initially high during deployment and later fall [76]. Previously deployed National Guard and Reserve Corps service members also reported feeling that unit support was highest during their first deployment cycle [81]. Interestingly, as perception of unit leadership and morale begin to fall around months 8-10 of a typical deployment cycle, the percent of service members reporting feeling they “would be better off dead” or feeling that they might hurt themselves in some way begins to increase [76]. Although the relationship between these two observations may not be directly causal, it suggests that unit leadership and support for building service member resilience in mitigating service member stress to affect downstream health outcomes is likely critical mid- to late-deployment cycle, providing motivation for providing additional unit resources for resilience building in-theater.

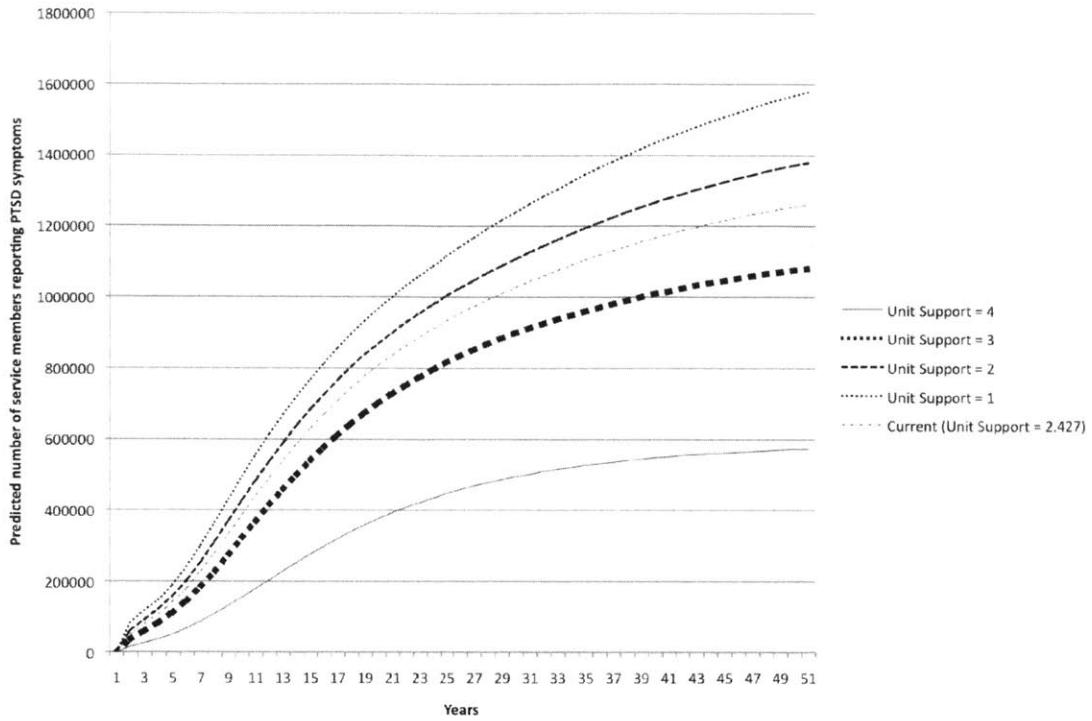


Figure 4-4: Predicted effect of enhanced unit support.

#### 4.3.2 Intended Prevention Effect: Service-specific Resilience Resources

As discussed in Section 2.2, service-specific resilience resources act in an analogous fashion to the unit-level resources for training and preparedness in the Bacharach, et al. (2008) model, serving to attenuate stress experienced and further balancing the individual-level dynamics discussed in Section 4.2. Individual-level dynamics also serve to inform the availability of unit-level resources in the model. The stock of *Diagnosed Service Members* informs the efficacy and future availability of these service-specific resources because recommendations for resilience resource allocation is made largely on this measure and how it changes yearly. For example, the effect of the pre-deployment Battlemind training was measured by the number of service members who screened positive for mental health problems—as discussed in Section 2.4.2, attendance at pre-deployment Battlemind training decreased the number of service members eventually screening positive for mental health problems by almost 8 percent (12 percent vs. the 20.5 percent who screened positive not having attended pre-deployment Battlemind training). This result provided inertia for a recommendation to emphasize Battlemind training for all service members throughout the deployment cycle. However, it was noted that some units implemented pre-deployment Battlemind training in combination with

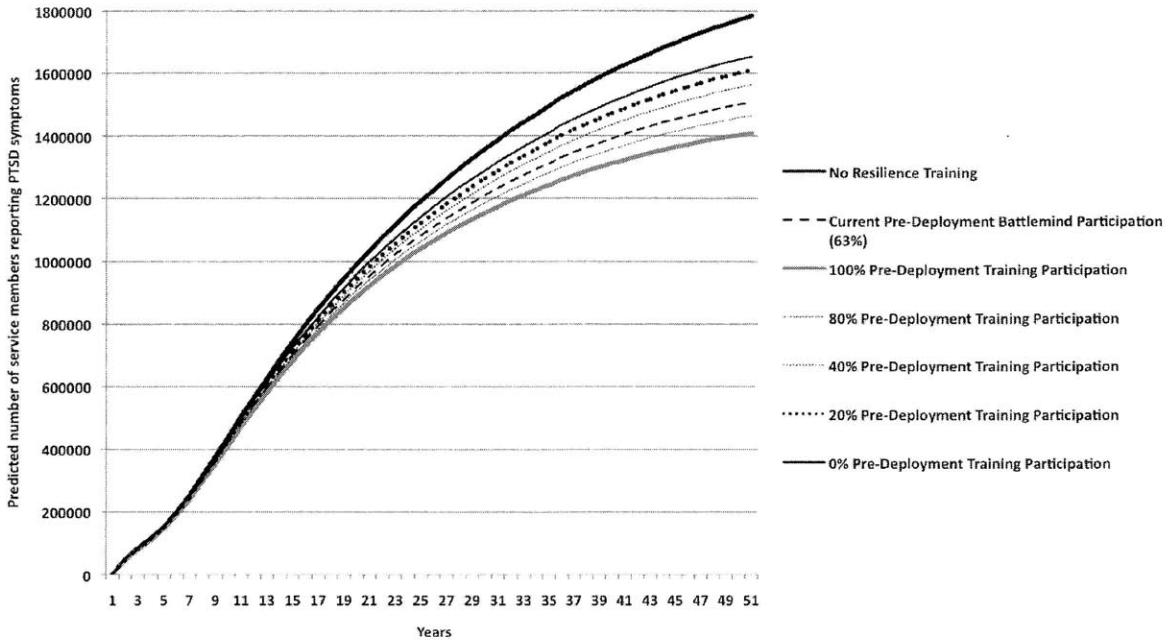


Figure 4-5: Predicted effect of pre-deployment Battlemind resilience training.

other psychological health interventions, confounding the effect that pre-deployment Battlemind training alone has on overall psychological health outcomes [76].

Based on the MHAT V (2008) findings and recommendation, a causal relationship between variables *Actual Utilization of Resilience Resources* and Fractional Onset Rate was added to the overall stock and flow diagram (see Appendix E). Actual Utilization of Resilience Resources was defined to be the percentage of service members who reported attending pre-deployment Battlemind training as was defined by the MHAT V (2008) study. Taken into account was the effect size seen in the MHAT V (2008) study resulting from the potential combination of different types of pre-deployment trainings as noted. Fractional Onset Rate was subsequently defined as:

$$\begin{aligned} & \text{Actual Utilization of Resilience Resources} \times 0.12 \\ & + (1 - \text{Actual Utilization of Resilience Resources}) \times 0.205 \end{aligned}$$

Figure 4-5 illustrates the predicted effect of implementing required pre-deployment resilience training. Based on the architecture of the stock and flow diagram, increasing the participation rate of service members in pre-deployment resilience training would decrease the overall number of predicted service members who would otherwise report PTSD symptoms. Because the participation

rates varied linearly and the causal relationship between Actual Utilization of Resilience Resources and Fractional Onset Rate was also defined linearly, the overall effect of increasing the participation rate was a linear incremental shift downwards along the y-axis.

The condition “No Resilience Training” illustrates the simulation run with a constant onset rate of 26 percent, the lower bound of the range of onset rates (26-30 percent) as specified by RAND (2008). Condition “0% Pre-Deployment Training Participation” is based on the definition of “Fractional Onset Rate” with the presence of pre-deployment resilience resources. Theoretically, these two conditions should be similar because the initial model assumed that resilience programs had no effect on the fractional onset rate. The separation of the two conditions over time indicates a potential inherent bias in the model introduced by the presence of the variable representing participation in pre-deployment resilience resources or other dynamics that have not yet been identified. Additionally, it may represent potential differences between the RAND (2008) report and the MHAT V (2008) report in defining onset rates of PTSD among the service member population, and these differences should be explored in future work.

This sensitivity analysis illustrates the potential danger of policymaking based on short-term measures like the yearly number of service members reporting PTSD symptoms. While these short-term, yearly measures are useful for guiding funding policies and decisions, they do not account for long-term negative effects, combined resilience trainings, or the compounding effects of multiple deployments and combat exposures. As illustrated in Figure 4-5, the overall effect of implementing pre-deployment resilience training does not occur until approximately 10 years after implementation. Combat operations in Iraq and Afghanistan began in 2001 and the pathology of PTSD as a signature wound of these wars is beginning to become salient approximately ten years later, demonstrating the applicability of this model to future policymaking.

The model itself also illustrates observations made during qualitative interviews on the absence of adequate utilization measures for resilience resources in determining resilience resource efficacy. Figure 4-6 shows a portion of the dynamics which illustrates that there is no direct feedback to the government as to the effectiveness of these resilience resources. This can be thought of as the government’s return on investment (ROI) for resilience resources, which is currently nonexistent. Furthermore, according to interviews conducted, there are no clear measures of resilience resource utilization or usefulness, leading to a plethora of resilience programs currently in place: “...instead of figuring out which programs work and which don’t, new programs are created.” Insights provided by interviewers indicated a level of frustration with resource allocation within the military in deploying

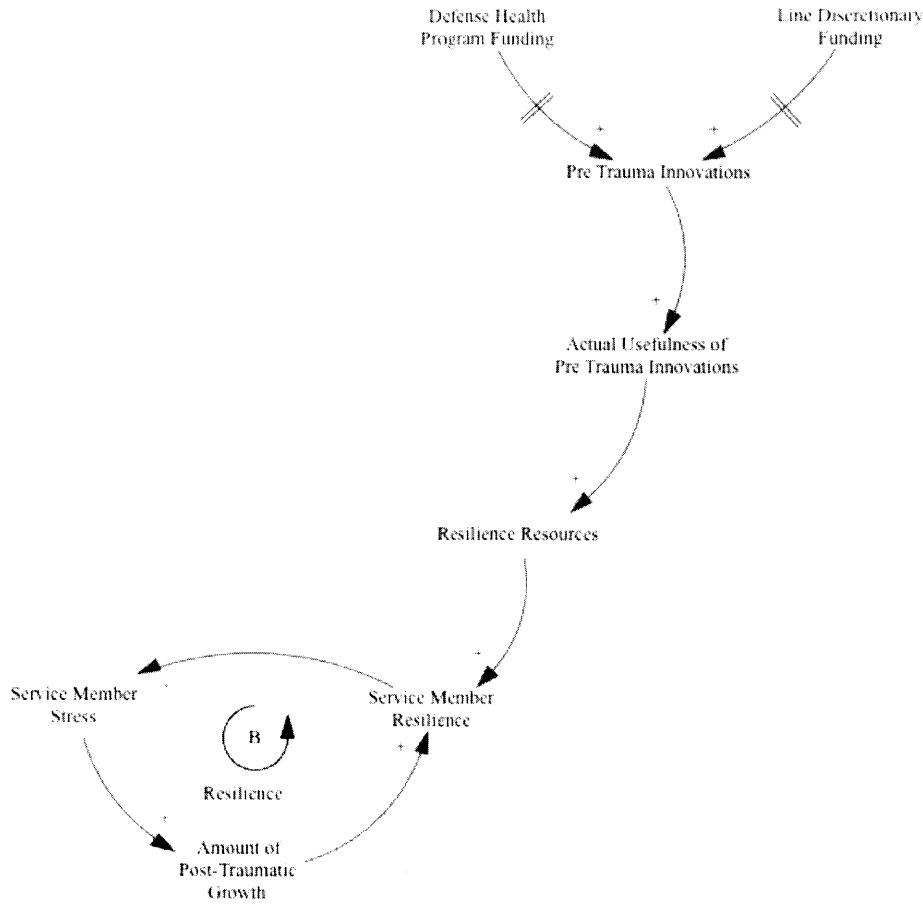


Figure 4-6: Intended effect of resilience programs on individual-level dynamics.

external resilience resources. These dynamics are not unique to service-specific resources, and are also affected by factors which affect the enterprise at large. The next section will now discuss the dynamics that operate at an enterprise-level to affect the unit and the individual, and will also examine how unit-level and individual-level dynamics also effect changes at the enterprise-level.

## 4.4 Enterprise-level Dynamics

### 4.4.1 Preventative Screening

In assessing the military's approach to mitigating the cumulative effects of operational demand dictated by OIF/OEF resulting in returning service members displaying symptoms of PTSD, a logical process to analyze is the military's assessment of potential candidates for military service. With the knowledge available regarding pre-traumatic risk factors for PTSD, an understanding of how the

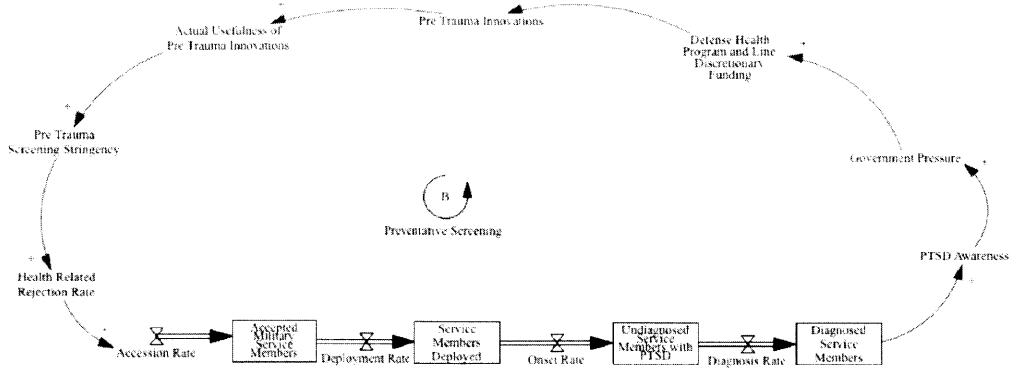


Figure 4-7: Preventative screening dynamics.

military currently assesses potential candidates for these risk factors provides insight on determining whether the military could have anticipated these outcomes and how decision-making would have been affected in this context.

Figure 4-7 shows the current state dynamics of military preventative screening. An increase in PTSD awareness should result in an increase of government pressure and action through policy instructions, memos and directives. This increase in government funding can be funneled towards research and innovations in screening mechanisms; the more useful these innovations, the more likely they will be used, and screening stringency should increase as a result. However, this should increase the number of service members rejected due to health reasons, decreasing the number of applicants that eventually enter the service and eventually decreasing the number of service members that require treatment for PTSD. This represents an inherent trade-off between the number of diagnosed service members and the number of accepted service members—the higher the number of diagnosed service members, the lower number of applicants will be accepted into the service based on increased screening stringency.

The costs of an all-volunteer force, the economic consequences of failing to meet recruiting targets and the estimates of economic loss that psychological health has had on the military have been discussed at length in prior literature (i.e. [94, 96]). It might therefore be expected that increasing screening stringency for preventative purposes might have a larger effect on reducing the onset rate versus increasing participation in pre-deployment resilience training. Intuitively, increasing preventative screening would minimize the likelihood that an at-risk service member would require psychological health services downstream. Interestingly, adjusting the percentage of service members rejected due to health related reasons would not have a large effect on the number of service

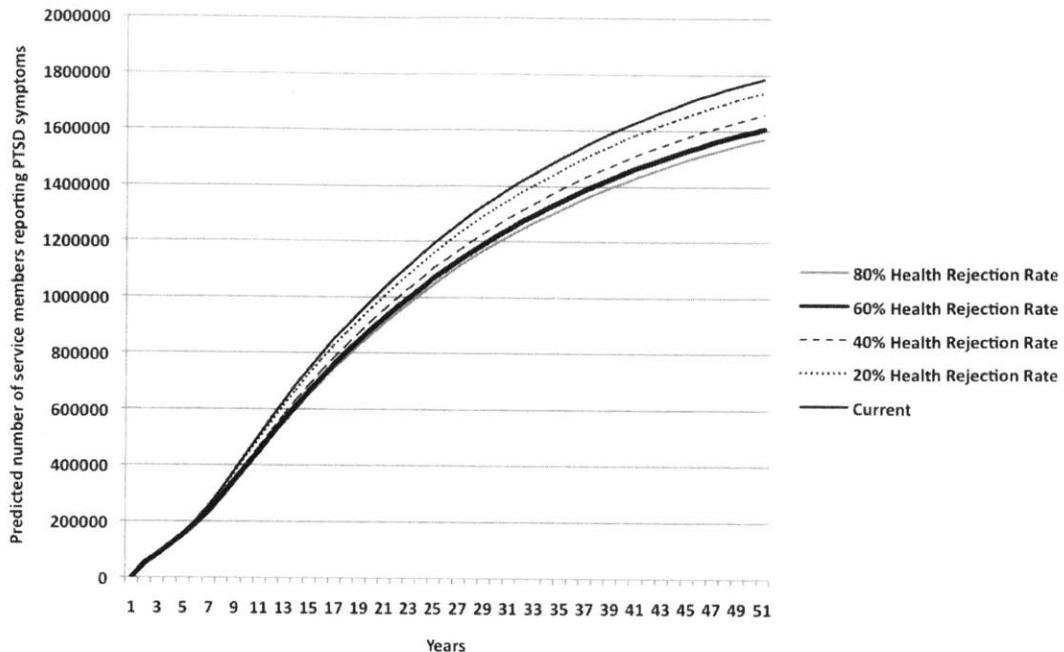


Figure 4-8: Predicted health screening dynamics.

members predicted to experience PTSD symptoms; after 10 years, raising the health related rejection rate from the current 10.8 percent to 80 percent would result in a decrease of about 100,000 additionally rejected service members (Figure 4-8).

This finding implies that a policy to increase screening standards as a method to decrease the number of service members eventually experiencing mental health problems over would not be as effective as other strategies, such as mandating pre-deployment resilience training as was explored in Section 4.3.2. However, one possible caveat has been discussed earlier in this section—increasing screening stringency implicitly leads to a decrease in the stock of available service members that may experience symptoms of PTSD in the future, which may explain the slight decrease in PTSD occurrence. The extent to which screening stringency might otherwise lead to increased service member performance and decreased future onset rates has not been previously explored and would provide more guidance for future policymaking in this area.

#### 4.4.2 Intended Prevention Effect: DHP-Funded Resilience Resources

As with unit-level resilience resources, the effectiveness of DoD-wide resilience resources is not seen or measured until the stock of service members diagnosed decreases or becomes zero. This is

because resilience resources serve to attenuate the stress experienced by boosting service member resilience, resulting in a downstream decrease of symptom onset rate and decreased diagnoses. Additionally, there are more system delays seen as it takes time for awareness of these resilience resources to develop to provide the impetus for utilization of these resources. Because of these delays, it becomes difficult for the government to determine how effective these resilience resources are.

The first example of a time delay in this balancing loop is the effect that the onset and diagnosis of symptoms among the service member population (*Onset and Diagnosis*) has on building awareness of PTSD (*PTSD Awareness*) as a significant pathology of OIF/OEF. The number of diagnosed service members follows S-shaped growth over time (Figure 4-9). S-shaped growth is a commonly observed mode of behavior that results from initial exponential growth that gradually slows until the state of the system reaches an equilibrium level. The dynamics that result in S-shaped growth are illustrated in Figure 4-10. In this model, the S-shaped behavior of the number of diagnoses results from the reinforcing loop structure of diagnosed service members re-entering the system due to deploying again with or without treatment, eventually balanced by the carrying capacity of the stock of service members awaiting diagnosis. As a result, awareness of PTSD as a pathology of OIF/OEF will build over time as the number of diagnoses increases, but the effect will be muted until the number of diagnoses enters the accelerated growth phase. The number of diagnoses follows S-shaped growth because of how system dynamics operates with stocks and flows. As described in Section 3.2.2, stock and flow diagrams illustrate accumulations of a variable. Because the number of diagnosed service members is defined as a stock variable in the model, eventually the stock will reach its maximum capacity. Because the flow *Treatment Rate* is constant, once the stock *Diagnosed Service Members* reaches capacity, it will increase at a constant rate and decrease at a constant rate from that point forward. Awareness of resilience resources must build for resource utilization to occur. Once resource utilization occurs, the effectiveness of these resources in building service member resilience would not be seen unless there is a subsequent decrease in symptom onset rate and diagnoses (i.e. Section 4.3.2).

The second example of time delays in this balancing loop is the relationship between the pressure put on the government by the public to enact action for providing quality services for returning service members (*Government Pressure*) and the subsequent legislation enacted to provide funding for these external resources (*DHP Funding and Resilience Resources Awareness*). A portion of these delays results indirectly from the first time delay between Onset and Diagnosis and PTSD

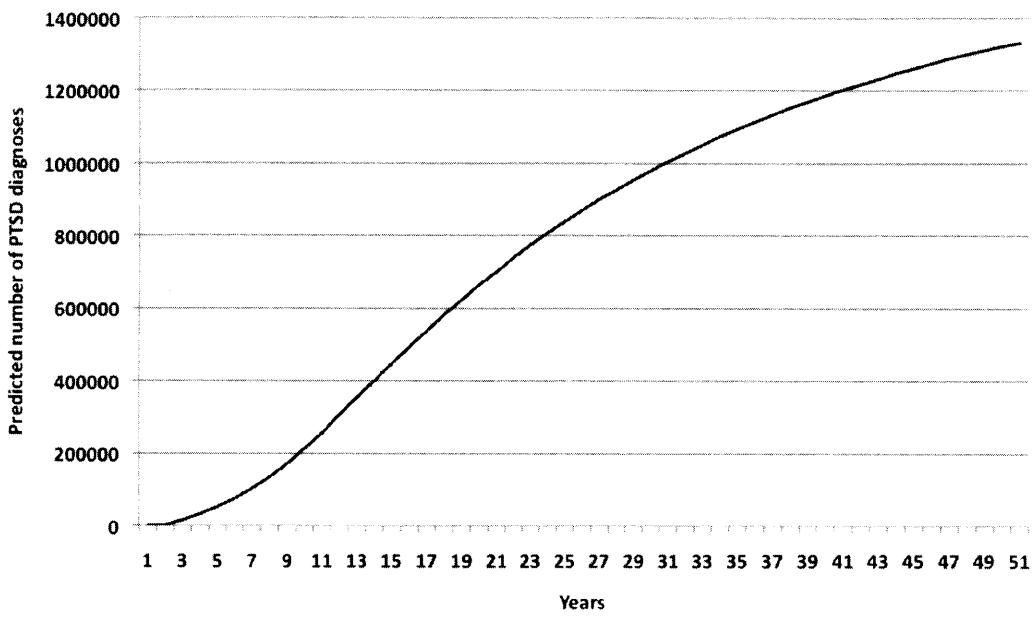


Figure 4-9: S-shaped growth of diagnoses.

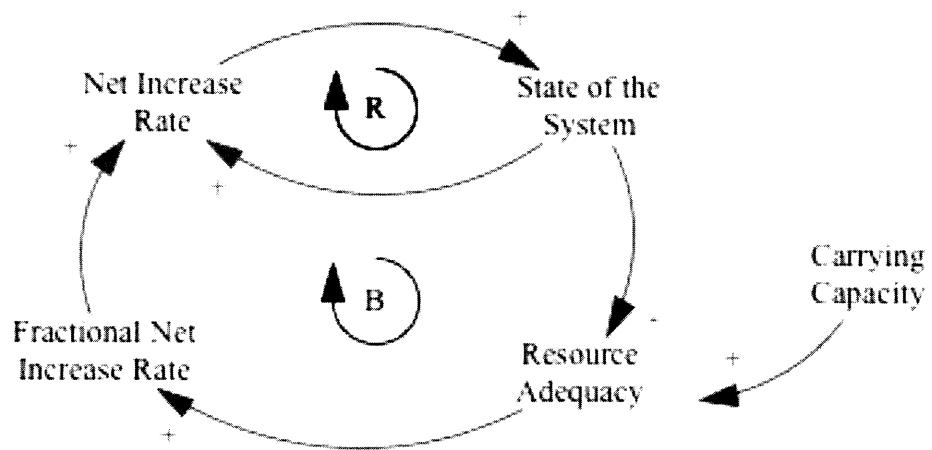


Figure 4-10: S-shaped growth behavior - adapted from [90]

Awareness. As has already been shown, it takes time for the population of diagnosed service members to grow to the extent that awareness of PTSD enters the public agenda and builds pressure for government leaders to enact legislation that provides the funds to support resilience resources. An example of this time delay is the publication of the 2007 *Washington Post* report regarding cases of neglect at Walter Reed Army Medical Center [83], which will be discussed in greater depth in Section 4.4.4. Furthermore, combat operations in Iraq began in 2001 and this report was published in 2007; this six year difference could be considered a six year time delay for PTSD awareness to reach a threshold level to warrant action for changing behavior in the system.

Additional time delays between these variables occurs as a result of the political process. An overview of DoD issuances, policies put forth by DoD leadership, can be found in Appendix F and are listed by need and time sensitivity from the least time sensitive (Directive) to the most time sensitive (Directive-Type Memo). Directive-type memos are used to address the most time sensitive actions and are valid for no more than 180 days, after which it must be incorporated into an existing issuance, converted into a new issuance, renewed or canceled [28]. Instructions are revised every five years, and directives are revised two to three years after their issuance.

It is clear that the length of time the political process requires, as well as the length of time required for PTSD awareness to reach a threshold for political action plays a role in perpetuating the behavior that govern these enterprise-wide dynamics. However, it is difficult to discern to what extent the system delays are affecting the system dynamics due to the general lack of data available to quantify relationships between verified qualitative variables like PTSD Awareness and *Perceived Stigma*.

#### **4.4.3 Operational Demand**

As discussed previously in Section 2.3.1, the combat operations in Iraq and Afghanistan are unlike any conflict the United States has previously fought; the cumulative effect of deployments, increased frequency of deployment cycles and conflict length have all contributed to the increased prevalence of PTSD seen by the military in recent years [94]. Figure 4-11 shows that an increase in operational demand would lead to an increase in the number of service members required to meet that demand. Coupled with the fact that all three components of the Army have had to meet operational demand amidst being unable to meet recruiting targets, observers noted that the armed forces would not have had enough troops available to accomplish their missions [96], demonstrated by the variable *Service Member Shortfall*.

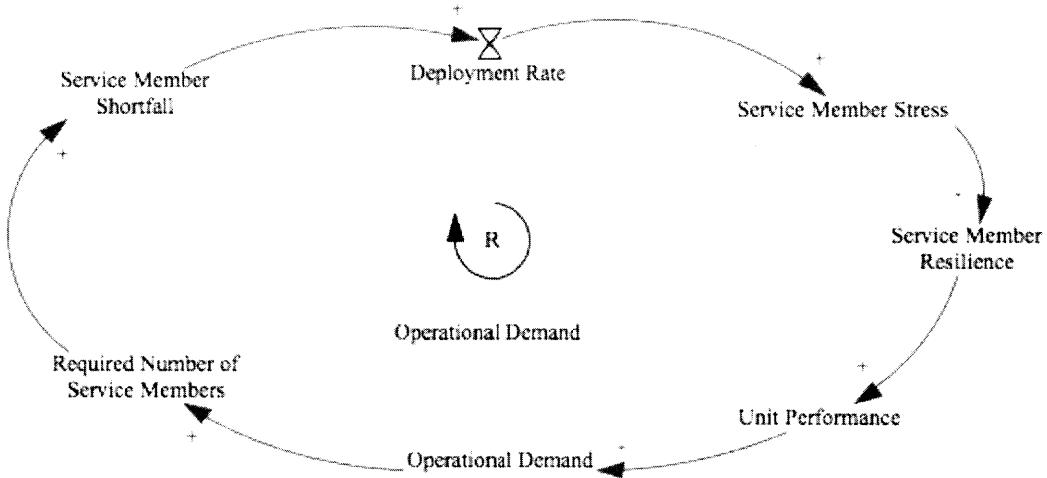


Figure 4-11: Operational demand dynamics.

A sensitivity analysis to determine the salience of deployment rates on the system over time indicates that over time, a higher deployment rate leads to a higher number of deployed service members in the short-term, but that a lower deployment rate over time would lead to a higher cumulative number of service members over time (Figure 4-12). With a lower deployment rate, over time the stock of *Service Members Deployed* would take more time to reach its carrying capacity as a stock. Outflows remain constant, so a higher fraction of those service members flowing through the lifecycle would return to deployment, increasing the likelihood that they would experience an onset of PTSD symptoms. In the short-term, with higher deployment rates the enterprise would see an increased number of service members reporting PTSD symptoms because a larger number of service members flow through the lifecycle earlier (Figure 4-13). However, a higher deployment rate enables the lifecycle to be saturated faster as a higher number of service members are pushed through the system, ensuring resources are utilized faster over time. As a result, a higher deployment rate over time would lead to an overall decrease in the predicted number of service members expected to experience an onset of PTSD symptoms in the long-term.

These enterprise-level dynamics are influenced by individual-level dynamics. For example, higher deployment rates at the onset would increase overall the number of service members reporting an onset of PTSD symptoms in the short-term. Because leadership uses the number of service members reporting PTSD symptoms as a metric for policy and decision-making, an increase in

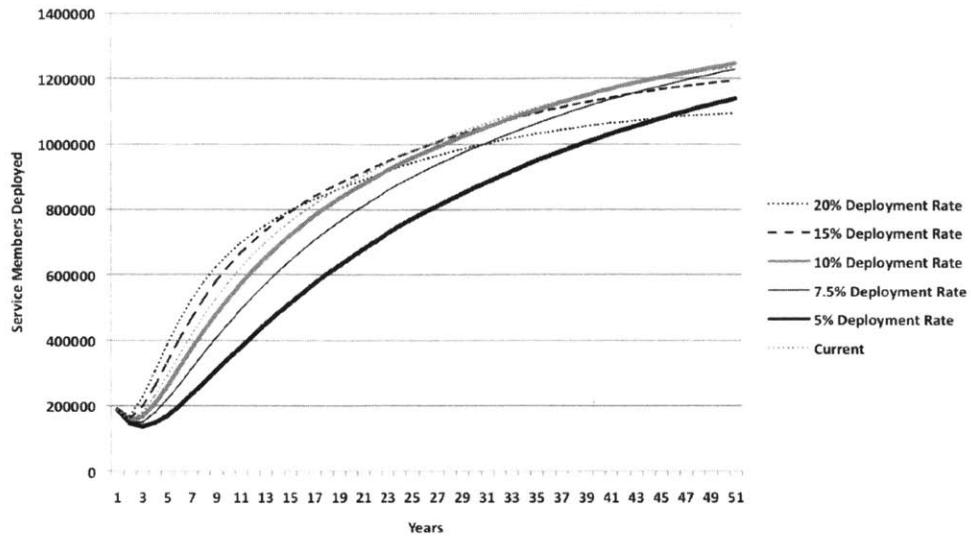


Figure 4-12: Predicted number of deployed service members over time.

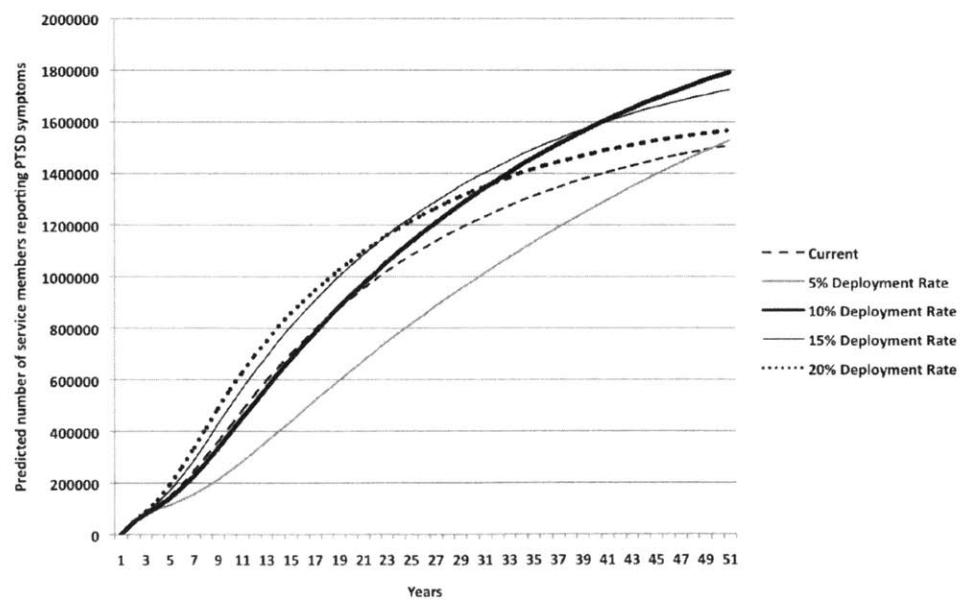


Figure 4-13: Predicted deployment rate dynamics.

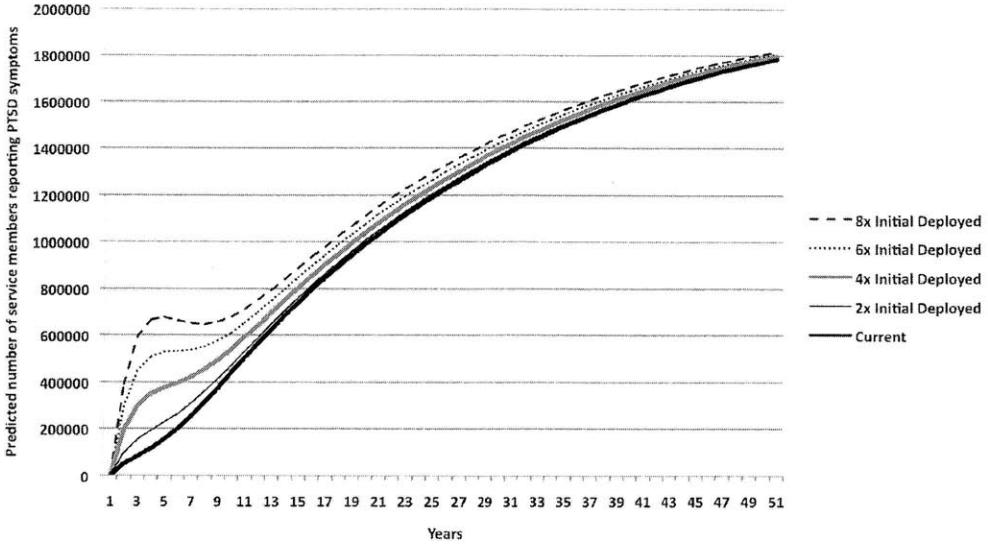


Figure 4-14: Predicted initial deployment number dynamics.

the number of service members experiencing PTSD symptoms would influence policymakers to increase the deployment rate in order to meet operational demand due to the decrease of available healthy service members. These dynamics are also reflected if the initial number of service members deployed were increased. In 2009, the number of service members deployed totaled 186,300 [15]. Figure 4-14 illustrates how increases in the initial number of deployed service members might initially yield a higher number of service members reporting PTSD symptoms. However, over time the numbers of service members experiencing PTSD symptoms eventually hit a threshold of about 1.8 million over a range of 50 years. Figure 4-14 also shows how every two-fold increase in initial service members deployed predicts an additional increase of approximately 100,000 service members expected to experience PTSD symptoms during the first five years of combat operations. However, after 10 years the predicted differences in the number of service members expected to develop PTSD symptoms would become negligible. This suggests that a different strategy is required to address the short-term increase in the number of service members who would require mental health services, while long-term planning might rely on a different strategy based on the threshold predicted by the model. Furthermore, this illustrates the importance of utilizing a different performance metric for long-term mental health care delivery planning. The usage of the number of service members reporting PTSD symptoms as a basis for strategic decision-making and resource allocation would be useful in the short-term, but a separate performance metric to inform long-term resource allocation should be flexible enough to accommodate deviations from the predicted scenarios.

Further support for long-term resource allocation planning can be found in prior literature which indicates that the consequences of undiagnosed psychological health issues such as PTSD range from marital issues and domestic violence, increased vulnerability to homelessness and substance abuse (i.e. [94, 86, 53]). Although combat operations are unlikely to be prolonged continuously for 50 years, the rate of diagnoses could still occur after combat operations in Iraq and Afghanistan conclude. Combat operations have been extended for upwards of 10 years since 2001, and general public awareness was raised with the Washington Post report in 2007 six years later. With the knowledge that undiagnosed psychological health issues might result in suicides, domestic violence and other societal issues, it is reasonable to expect that psychological health diagnoses and their societal consequences resulting from combat operations in Iraq and Afghanistan may continue for a prolonged period of time.

The influence of a prior history of mental health issues would additionally perpetuate itself by indirectly increasing operational demand via an overall increase in service member stress experienced and a decrease in overall service member resilience. Unit-level resilience programs have been shown in Section 4.3.2 to have an overall decrease in the overall number of service members predicted to report an onset of PTSD symptoms over time. As a result, these dynamics comprise a reinforcing loop demonstrating the potential effect of individual-level factors perpetuating themselves in enterprise-wide dynamics.

These results may seem counterintuitive as prior literature has indicated the salience of the cumulative effect of deployments and increased frequency of deployment cycles on future health outcomes (i.e. [94, 15]). However, although the model does mimic the deployment cycle by returning flows of service members into theater (i.e. *Returned Service Members* become *Deployed Service Members*, etc.), it does not track individual service members and the number of deployments each service member may have had, nor does it track the length of time an individual service member might spend in theater. The model's parameters are such that the individual-level dynamics are considered at a population level and also thereby considering all service members and their characteristics in aggregate, resulting in that resolution loss. As a result, the model does not yet have the capability to determine how multiple deployments may affect future health outcomes at the individual-level. However, the model does have the capability to determine how a constant deployment rate of service members and changes in initial service member deployment over time would affect future health outcomes overall.

#### **4.4.4 Post-Trauma Diagnosis and Treatment**

The routes of diagnosis and treatment were previously discussed in Chapter 2. Agenda-setting theory stipulates that the news media has a large influence on audiences by their choice of what stories to consider newsworthy and how much prominence and space to give them [62]. McCombs and Shaw saw nearly perfect correspondence between ranking of major issues on the press and public agendas; the public learns about the issues of the press agenda with relatively little effort and movement of issues from press to public agenda is relatively salient [62].

The media coverage of the nation's response to its obligation to furnish health care for OIF/OEF service members further exemplifies McCombs and Shaw's observations regarding the movement of issues from the press to the public agenda. The public consciousness of the importance of the U.S. military and veterans health care systems in providing care to its veterans was heightened to a level not seen since the end of the Vietnam War [51]. For example, in 2007, the Washington Post published a series of articles outlining cases of neglect at Walter Reed Army Medical Center, resulting in an extensive analysis of the Veterans Affairs health care system, as well as the resignation and termination of multiple military leaders associated with Walter Reed [83]. Similarly, we can expect that increased media coverage of PTSD builds public awareness, propelling the government to invest funding in proper screening and treatment resources for returning service members, increasing the number of diagnosed service members and resulting in reinforcing behavior loops (Figure 4-15).

Increased funding to determine the efficacy of current screening and treatment resources and to improve technologies that would improve psychological health treatment would also decrease the associated costs with screening and treatment. For example, telemental health care is currently being investigated as an alternate treatment method for service members requiring treatment. A comparative cost-analysis study by Grady (2002) found that telemental health care was the least expensive form of psychological health treatment when compared to in-person treatment options among Navy service members [37]. Integrating technologies such as telemental health care to decrease treatment costs would help to increase the treatment rate, as less service members would require in-person treatment resources, which can then be diverted to areas of need (i.e. in theater) and also increase the number of service members seeking treatment who would have otherwise gone untreated.

Sensitivity analyses performed demonstrate the salience of providing available psychological health care in theater. Figures 4-16 and 4-17 contrast the effect of providing psychological health care to service members in theater. Without in theater care, the likelihood of PTSD and other

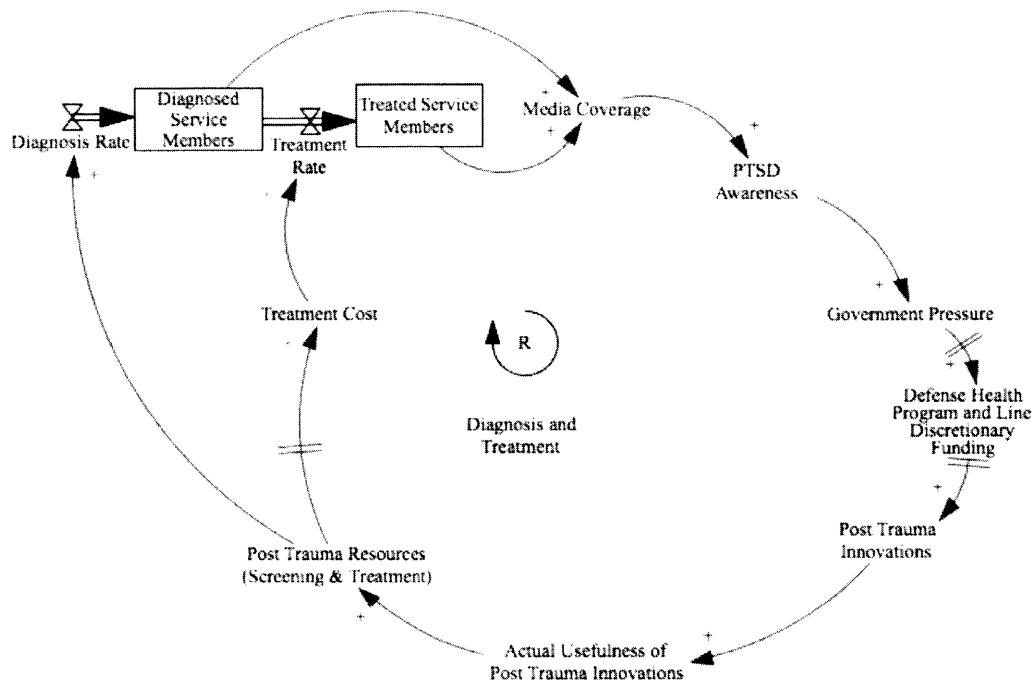


Figure 4-15: Post-trauma diagnosis and treatment dynamics in garrison.

psychological health issues remaining a significant pathology of OEF/OIF is clear—the higher the sustained deployments, the more likely it is that the gap between diagnosed and treated service members will persist (Figure 4-16). However, as seen in Figure 4-17, the treatment gap eventually closes, even at a deployment rate of 20 percent.

Finally, the relationship between individual-level, unit-level and enterprise-level dynamics can be seen in the sensitivity analysis performed to examine the influence resilience resources could have on the population of service members requiring treatment. Figure 4-18 shows that requiring service members to participate in pre-deployment resilience training could have a small impact on closing the predicted treatment gap and support in theater care. In theater care still appears to have the most impact on closing the predicted treatment gap in the face of increasing deployment rates, but the sensitivity analysis performed to illustrate how resilience resources would support in theater care shows that pre-deployment resilience participation also decreases the treatment gap. This is because pre-deployment resilience resources decreases the onset rate, versus the impact that in theater care has on decreasing the overall stock of service members who are eventually diagnosed and treated in garrison.

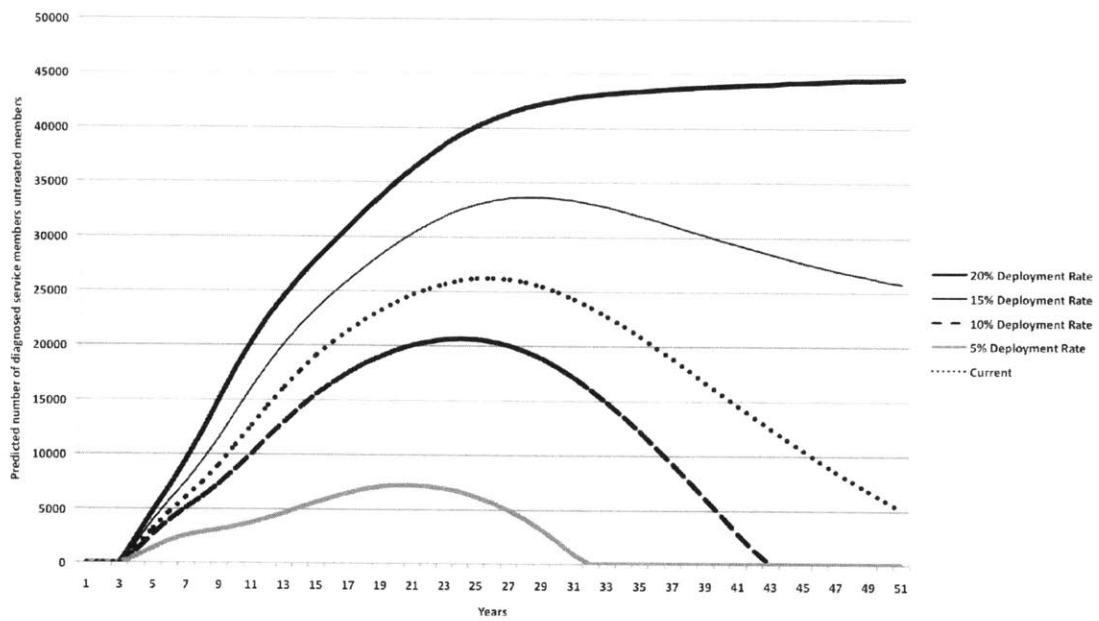


Figure 4-16: Predicted treatment gap without in theater care.

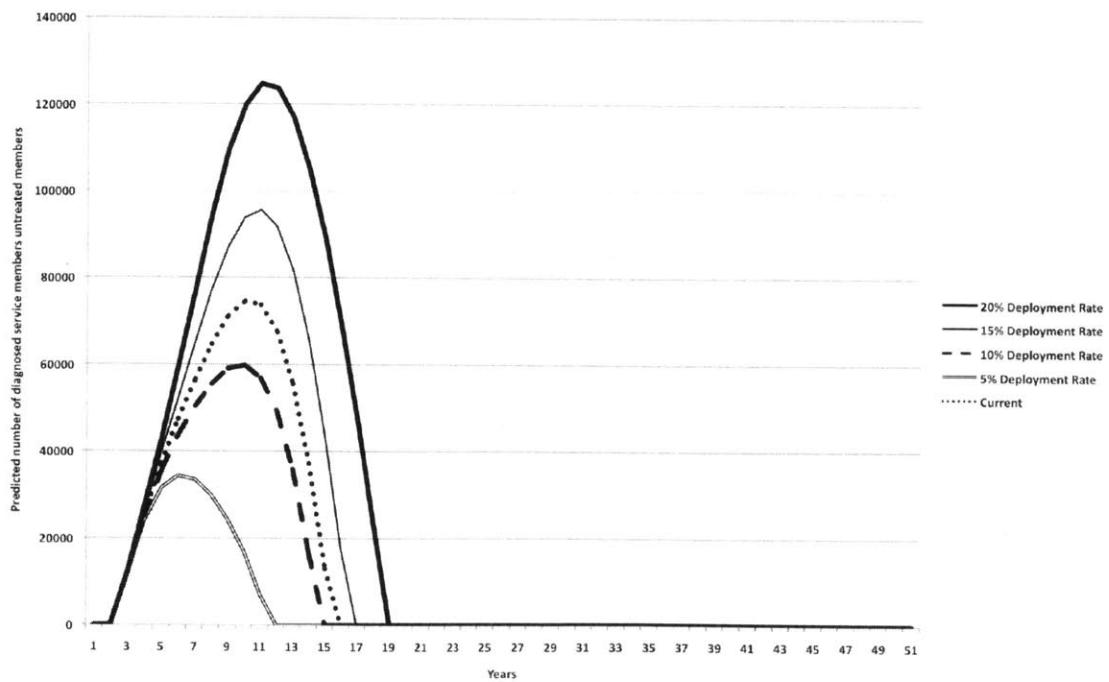


Figure 4-17: Predicted treatment gap with in theater care.

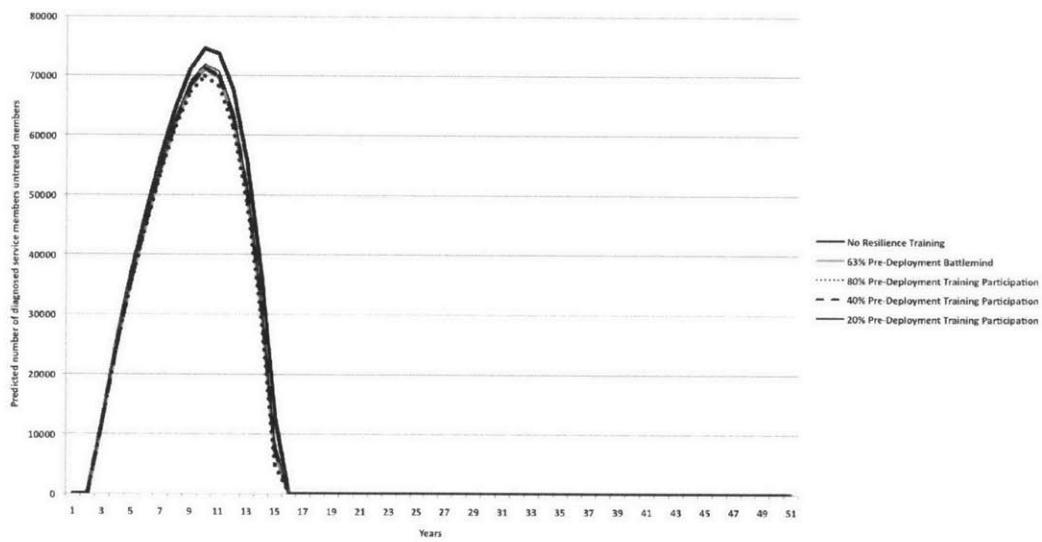


Figure 4-18: Predicted effect of required pre-deployment resilience training on treatment gap.



# Chapter 5

## Conclusions and Future Work

This chapter concludes this thesis by introducing potential policy recommendations for consideration and their implications, and presents ideas for future research work. Section 5.1 summarizes the insights gained from the model and sensitivity analyses performed, providing support for the policy recommendations proposed and discussed in Section 5.2. Finally, Section 5.3 proposes areas for future work to improve on this work at large and supports the architecting of a future state for the defined enterprise.

### 5.1 Model Insights

Six main insights emerged from the system dynamics model:

1. **Unit support had a substantial effect on the predicted number of service members expected to screen positive for PTSD symptoms over time; additionally, unit leadership and support may have the most effect in theater during a deployment cycle.** As seen in Figure 4-3, a unit cohesion score of 4 would decrease the predicted number of service members expected to experience an onset of PTSD symptoms by more than two-fold in 25 years from approximately 1 million with the current cohesion score of 2.427 to less than 500,000. Each increase of 1 in the unit cohesion score led to a decrease in the population of service members expected to screen positive for PTSD symptoms over time, with the largest increase seen between scores 3 and 4. Further work could also investigate the potential connection between the observed drop in service member perception of unit cohesion mid- to

late-deployment cycle and the influence of increasing unit cohesion and leadership in theater.

2. **Pre-deployment resilience programs decrease the number of service members predicted to experience PTSD symptoms, although significant differences are only seen after a long period of time.** The policy options military leadership has to decrease the number of service members predicted to experience PTSD while maintaining a force large enough to meet operational demand include increasing the deployment rate and increasing the number of health waivers granted as strategies to increase the overall number of service members. Other options include mandating pre-deployment resilience training to improve the likelihood that a service member would be able to cope with stress experienced. Based on sensitivity analyses, the policy most likely to have the most impact on decreasing the overall number of service members that would experience an onset of PTSD symptoms would be to increase service member participation in pre-deployment resilience training as per the MHAT V (2008) study.
3. **Increasing screening stringency and the percentage of service members rejected at accession due to health reasons alone would not have as large of an effect on the predicted number of service members expected to screen positive for PTSD symptoms over time as pre-deployment resilience training or increased unit support.** Figure 4-8 showed the results of the sensitivity analysis performed to test the potential implementation of increased stringency in health screenings during accession. The sensitivity analysis indicated that increasing screening stringency would likely not have as large of an effect as pre-deployment resilience training or unit cohesion on future psychological health outcomes—the slight differences in health outcomes would only be seen almost 50 years later. This is partially due to the overall decreased initial service member population from increased screening standards available to flow through the system. Other mechanisms by which increased screening might result in improved future psychological health outcomes is otherwise unclear due to a general lack of data regarding information known at accession and subsequent health outcomes.
4. **Increasing the deployment rate results in an overall decrease in the carrying capacity of service members expected to screen positive for PTSD over time, whereas increasing the initial number of service members deployed does not have a large effect on future aggregate health outcomes.** Initially increasing the number of service members deployed would have an effect much earlier in the system by pushing through a higher number of service members in the first few years of the sensitivity analysis, as illustrated in Figure 4-

14. However, this initial spike in service members would be mitigated downstream as service member stocks accumulate more slowly over time. Increasing the deployment rate results in an overall decrease in the carrying capacity of service members expected to experience an onset of symptoms over time because stocks would accumulate faster, ensuring that the system reaches its carrying capacity sooner. Once the stock of Diagnosed Service Members reaches its carrying capacity, no more service members can flow into that stock, so they are pushed into the other outflow (i.e. treatment in theater), and the system continues to use the “Diagnosis Rate” flow to deplete the “Undiagnosed Service Members with PTSD” stock at a constant rate. A higher deployment rate increases the likelihood that service members will be forced to seek treatment in theater during deployment as the system’s carrying capacity is filled at an earlier point in time, ultimately decreasing the overall number of service members who would otherwise need treatment in garrison.

5. **The effect of the general lack of performance and utilization measurements for external resilience resources, when combined with systemic time delays, is manifested in individual-level dynamics.** In general, there is a lack of knowledge regarding the efficacy of external resilience resources, and resources instead are diverted into creating new programs. A lack of utilization data increases the difficulty to which resilience resources may be leveraged for training service members, as it leads to the assumption that these resilience resources either do not exist or do not work, and further results in extraneous programs, a source of enterprise waste.

Although the MHAT V (2008) study did provide one example of utilization and performance measurements for the Army’s pre-deployment Battlemind training, the mechanisms by which the pre-deployment training serve to improve eventual mental health outcomes in the service member population remains unclear. Furthermore, there has been little follow-up to determine the long-term outcomes and efficacy of the MHAT V (2008) study on pre-deployment Battlemind training. The model utilizes current literature to indicate relationships between service member stress experienced, service member resilience and post traumatic growth to mitigate PTSD onset rate. However, there is no literature to date that has mathematically modeled these relationships because there is little empirical data to suggest how these variables are related beyond an assumed linear relationship. These mathematical equations based in empirical data will be critical for expanding this system dynamic model’s capability to

predict this system's outcomes.

As seen throughout the model, time delays in building awareness of PTSD, providing government funding and building usable and reliable pre-traumatic and post-traumatic innovations introduces complexity in decision-making throughout the enterprise. For example, it takes time for awareness of PTSD within a group of service members to emerge in order to propel the government to initiate legislation to allow for funding for resilience resources. Secondly, as mentioned, the actual utilization of resilience programs is unknown, adding another dimension of complexity for decision-making in the enterprise regarding resilience resources. In the mean time, the reinforcing loop of risk factor influence masks any immediate balancing effects from resilience resources, rendering it difficult to determine how best to allocate resources by key decision-makers ingrained in the system. Because of the operational demand dictated by OIF/OEF, decision-making needed to occur in the face of these time delays, which are less than ideal circumstances in which to be making large-scale organizational and strategic decisions.

6. **Enterprise-level decision-making based on a lack of outcomes data leads to a gap in fulfilling individual-level needs.** Qualitative data from interviews conducted with members of the Military Health System indicate that this stress-resilience relationship may not be as simple as a negatively correlated relationship between stress and resilience. The military's current view of resilience is that the more service member stress experienced, the more a service member's resilience decreases without prior resilience training [13]. In reality, this resilience ability decreases initially but builds over time with post traumatic growth as the service member learns to cope and deal with his or her stress [20, 60, 4]. The relationship between stress and resilience additionally varies on an individual basis, adding system complexity in assessing potential cause-effect relationships in the enterprise.

## 5.2 Potential Policy Recommendations and Their Implications

Combat operations in Iraq and Afghanistan are now in their tenth year, which had not been predicted. The military was also facing potential shortfalls in meeting recruitment targets while relying on an all-volunteer force [96]. This section discusses the potential policies the military could implement in order to prepare a medically ready force and the underlying issues and implications that should be considered in this policy discussion.

### **5.2.1 Increased Screening Stringency Implications and the Fitting of Potential At-Risk Service Members to Resilience Training**

Literature indicates that there is a documented history of military screening policies [24, 84, 21]. During World War II, psychiatric screening was considered essential to the military effort with the goal of rejecting all service members with a greater than average likelihood of having difficulty adjusting to military service life [21]. After World War II, psychiatric screenings were integrated into the general medical examination at accession, as the accession standards had been considered excessive and thought to result in an unnecessary loss of potential service members [84]. Screening processes were unable to evaluate the most important factors influencing the adjustment of a soldier, including the leadership he would receive, his degree of motivation, the type of position and unit assigned, and the degree of external stress to which he would be exposed, and it was advocated that greater proficiency of evaluating service suitability would be better accomplished by evaluating recruits under military conditions, rather than by using extensive induction screening procedures [21]. However, others have urged a review of current screening effectiveness, as a significant number of recruits are discharged in their first 6 months because they fail to meet minimum performance criteria or because of disqualifying medical criteria [24]. In the context of budget restraints and the continuation of military operations in Iraq and Afghanistan, the recruitment and retention of high-quality enlistees is extremely important for the U.S. military; the General Accounting Office concluded that an improvement in screening mechanisms could result in substantial financial savings to the Department of Defense [24]. However, based on our current findings, we recommend that military leadership additionally explore the potential fitting of at-risk service members to resilience resources and training.

The military should also consider policy options in light of service member shortfalls due to the extension of combat operations in theater. As discussed, the military has a few options to ensure a substantially numbered force. First, it can accept more overall service members by increasing recruitment and lowering standards. This sensitivity analysis was performed and discussed in Section 4.4.1. However, lowering standards implied a higher rate of service members who could present with PTSD symptoms over time, especially if they displayed risk factors that were highly correlated with the onset of PTSD symptoms. In contrast, by raising screening standards, the military risks not having enough manpower to meet operational demands in theater. The possibility of being too conservative with screening based on the potential that service members will develop PTSD resulting

from combat exposure could lead to a depletion of the all-volunteer force, especially considering that the services ability to maintain their force levels in combat operations depends partly on their success in attracting volunteers.

A policy barring those recruits determined most at-risk for developing PTSD could theoretically be applied with the justification being that they would not be medically ready to serve. However, a ban on service members displaying risk factors for PTSD calls to mind a similar issue which the military is currently facing—the ban on homosexuals serving in the military and the “Don’t Ask, Don’t Tell” policy<sup>6</sup>, currently under repeal. Pending certification of the policy’s repeal, military discharges were still occurring under “Don’t Ask, Don’t Tell” until July 6, 2011, when the 9th U.S. Circuit Court of Appeals ruled that the federal government must cease enforcement of “Don’t Ask, Don’t Tell” [82].

There are established medical thresholds that potential service members must clear in order to enlist and begin basic military training. The difference with these medical enlistment requirements and “Don’t Ask, Don’t Tell” is that the medical enlistment requirements as set by the Department of Defense are in place to ensure that service members are physically fit to perform their military duties as opposed to ensuring a cohesive unit and maintaining military culture: “The prohibition against homosexual conduct is a longstanding element of military law that continues to be necessary in the unique circumstances of military service” [1]. Homosexuality or exposure to a past traumatic event in the past is something that is extremely difficult, if not impossible to change and may not always lead to a service member’s inability to fulfill his or her military duties. Banning citizens from military service because of something they cannot change (in this case, their predisposition to PTSD based on previous exposure and risk factors) may prove extremely controversial, as is seen with “Don’t Ask, Don’t Tell.” It could be possible grounds for discrimination suits and potentially costly to the military, which is facing an already strained all-volunteer force. The Government Accountability Office (GAO) estimated that the costs to the military resulting from enforcement of “Don’t Ask, Don’t Tell” totaled approximately \$95 million over 10 years to cover the recruitment and replacement of service members dismissed [77].

Enforcing a ban on service members displaying risk factors for PTSD would also likely increase the stigma associated with PTSD and other psychological health disorders and likely increase the number of Type II (false negative) errors occurring during the health assessment process at accession. Increasing the stigma associated with PTSD and other psychological health disorders would likely cause potential applicants to the service to lie about previous history with psychological health

disorders, as well as lying about any issues at home or other social settings, because of an increased fear that applicants will automatically be disqualified and negatively viewed. An example from the “Don’t Ask, Don’t Tell” history indicates that encouraging these recruits to apply and to not be ashamed of their prior medical history would likely help to eliminate any potential stigma resulting from negative views of psychological health issues. The DoD published a comprehensive report on the potential effects of repealing “Don’t Ask, Don’t Tell”, and the results indicated a positive response—approximately 70 percent of military personnel thought that integrating gays into the military would be positive, mixed or of no consequence [101]. Qualitative interview data also suggests that a similar policy for PTSD risk factors and prior history of psychological health issues would have negative consequences on the military force: “You want balance and diversity in the force.”

The military can also increase deployment rates to ensure it has enough service members in theater to meet operational demands. This sensitivity analysis was performed in Section 4.4.3 and illustrated that although deployment rates do play a substantial role in contributing to the number of service members predicted to experience PTSD symptoms in the short-term, in the long-term high deployment rates lead to an overall lowered number of predicted service members experiencing PTSD symptoms. Most importantly, the overall effect of deployment rates in lowering the number of service members predicted to experience PTSD symptoms was not as salient as the effect of implementing pre-deployment resilience training. However, this model did not account for the effect of repeated deployments on external stakeholders such as families.

Since the military relies on an all-volunteer force, it must depend on the number of accepted applicants who eventually access into the service. With this knowledge of potential risk factors for PTSD and other psychological health issues, further consideration should be taken to ensure that the maximum number of applicants are able to contribute to the force, even if it may not be in combat operations. Military Occupational Specialties (MOS) could be revisited and redefined to ensure that applicants predisposed to developing psychological issues resulting from traumatic experiences can contribute in other ways.

A policy option that has not been explored in-depth is fitting service members who display risk factors for PTSD to resilience training, and a possible mandate that these service members undergo additional resilience training. Existing barriers to mental health care within the military health system make it extremely difficult for service members to receive care for their symptoms, in addition

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<sup>6</sup>“Don’t Ask, Don’t Tell” is the common term for the policy enacted by the federal government to prohibit openly gay and lesbian citizens from serving in the armed forces, while preventing the military from attempting to reveal or discover any active service members who might be gay or lesbian (10 U.S.C. § 654).

to the negative stigma faced by the service members while serving. Additionally, the availability of mental health services is variable; some programs or MTFs may not have enough resources to treat all who wish to be treated, or psychologists embedded in-theatre are not trained enough to treat all in-theatre service members, even if there are enough psychologists available [94]. Commanders are likely to be uncomfortable with allowing service members to leave their posts for mental health treatment, as their manpower decreases with every soldier who asks for mental health treatment. Finally, the consequence of requiring mandatory mental health treatment for those displaying a predisposition to developing PTSD may manifest itself later, after the soldier has completed the treatment and is cleared for deployment. As mentioned previously, military screening for risk factors predisposing someone to PTSD could lead to a negative flag on a recruits record, subsequently resulting in consequences such as adverse effects on self-esteem and a negative psychiatric label. These consequences could result in further unintended alterations of behavior within the unit, as unit members may be likely to further protect their labeled comrade from more extreme combat situations. The unit also risks alienating the service member in question if the service member never develops PTSD and feels as though his unit is overprotecting him or her, creating a destructive cycle of negative self-esteem by the individual in question.

However, additional training for at-risk service members could targeted by unit and not to an individual. For example, at-risk service members could be grouped together into a unit for additional resilience training, in addition to the basic and advanced training they would have received with their cohort for their assigned posts. Alternatively, at-risk service members could be pulled from different units and grouped together for resilience training, ensuring a different type of unit support—the support at-risk service members would have with each other, regardless of affiliated service. Fitting additional resilience training to specific units or by grouping at-risk service members together to receive training together would help to reduce any potential stigma an individual service member would face from his or her unit should he or she be flagged at-risk, ensuring the entire unit and possibly the entire military force becomes more resilient together.

Furthermore, resilience training as an upstream, preventative measure would assist in alleviating some of the resource allocation issues faced by the enterprise. Previously mentioned were the variable availability of mental health services, in addition to the occasional lack of services altogether in some MTFs or in theater. Resilience training would reduce the strain placed on psychological health and medical personnel as it would decrease the number of service members predicted to require treatment as a direct result of the decrease in the number of service members experiencing an

onset of PTSD symptoms.

### **5.2.2 Strategic Short-term Operational Decision-making and Concurrent Long-Term Operational Policymaking**

Research has largely been devoted to investigating the relationships between one or two of these levels and their respective factors influencing both the organization and the individual (i.e. [12, 22]). While this research expands this to include a tertiary level of enterprise dynamics, the military must deal with a fairly unique external environment when considering policy implementation for service member health care delivery. Health care policy implementation must consider external enterprise-wide factors such as military operational strategy, media attention, political climate and war hazards; unit-level factors like resilience resources and job performance; and individual-level factors such as individual risk factors when deciding which policies to change or enact to ensure high enterprise performance.

Based on qualitative interview data and additionally validated by the system dynamics model of the enterprise, we have seen that the primary mode of decision-making in the military mental health care enterprise is reactive decision-making. An example of reactive decision-making occurred in the enterprise-level dynamics of operational demand discussed in Section 4.4.3. Leadership uses the number of service members reporting an onset of PTSD symptoms as a performance metric for mental health care delivery and would likely enact a policy to reduce the number of service members presenting with PTSD symptoms via methods like accession screening, increasing the number of mental health care providers, or increasing the number of resilience resources available to service members. However, as described in Section 4.4.4, past literature suggests that when media coverage and public awareness focus on post-deployment dynamics, attention is diverted away from developing prevention and resilience efforts that may have a larger impact [62]. By focusing on post-deployment dynamics, decision-making tends to focus on what the military can do “right now” to assist service members as dictated by service member needs and desires for proper diagnosis and treatment. There is an inherent trade-off in increasing the number of diagnosed service members, as an increase in diagnosed service members ultimately results in an increase in service member short-fall as these diagnosed service members are thereby unable to serve in combat temporarily. This then perpetuates the operational demand dynamics previously discussed, contributing to the personnel issues seen by the military during OEF/OIF. This focus on post-deployment dynamics may prove detrimental in the long-term as the military considers how best to learn from these operational

inefficiencies to strategize a long-term solution for prevention and resilience.

Additional complexity results from inherent system delays, such as the required time for the number of diagnoses to reach the exponential growth phase and arises from decision-making without the use of adequate performance and utilization metrics to accurately divert funding through DHP or through discretionary funding to increase the number of high-performing resilience programs. Qualitative interview data also indicates that part of this complexity results from the use of discretionary funding to create and fund resilience programs. Since this funding is dispersed at the line's discretion, it is not specifically earmarked for resilience. As a result, it is difficult to track line resilience resources as they are created, merged with other resources, or ended. Additionally, this leads to a breakdown in communication and information flow regarding the performance and utilization of these programs.

The policymaking process also partially contributes to reactive decision-making. For example, directive-type memos are valid for 180 days and issued for time-sensitive actions with the likelihood that they will become permanent DoD issuances, instructions or directives (see Appendix F). It could be argued that the need for directive-type memos directly supports unforeseen circumstances involving the DoD and that there is a concurrent effort via DoD instructions and directives to establish more long-term policymaking. However, the sensitivity analyses done in this thesis work illustrate the danger of issuing reactive policies based on early data retrieval. For example, it may appear early on that high deployment rates contribute to a higher onset rate, but the long-term outlook indicates that the number of service members experiencing an onset of symptoms will be lower in the long-term. Directive-type memos provide policymaking with some flexibility as they are only effective for 180 days, enabling organizations to further review the effectiveness of the policy, but relying on directive-type memos to change or implement policy as needed can lead to an overwhelming number of memos. This increases complexity and also increases the likelihood of increasing enterprise waste.

When considering these decision-making complexities in conjunction with the need for high service member performance to meet operational demand, the difficulty of decision-making in the military to adequately propose policies that can adequately adapt to fit individual-level needs as well as enterprise-level demands becomes clear. Adequate resource performance and utilization metrics should be crafted to track and measure the creation and termination of resilience resources over time, as well as resource efficacy. Recommendations for resilience resources should then be data-driven, using the data generated from these performance metrics. In addition, although operational

demand will call for short-term, strategic decision-making, these policies should be concurrently crafted with a long-term strategy focusing on health outcomes predictions based on the short-term policies implemented.

### **5.2.3 Linking Accession Data to Health Outcomes to Inform Future Policymaking**

This thesis utilized data from AMSARA to populate the stock and flow diagram of the system dynamics model. Based on this data, simulations were run to generate long-term potential scenarios that could be used to support policy implementation as discussed in examining screening and waiver granting processes. Using this logic, policies regarding mental health screening and waiver granting should also be grounded in data that documents the eventual health outcomes of service members who had been granted waivers for previous mental health conditions. However, qualitative interviews and data from AMSARA indicate that this is currently not the case.

Table 5.1 summarizes the most frequent mental and behavioral health conditions for which health waivers were applied for in 2010 [2]. The data indicates that over 50 percent of waivers sought for these mental and behavioral health conditions were eventually granted, but that the total number of successful waiver applicants who eventually access into the service is a small fraction of the total service member population (approximately 2,000 versus the 186,300 initial service member population number used for the model). Although the magnitude of service members eventually accessing with a mental health waiver might be considered relatively low in comparison to other health disqualifications (i.e. cannabis dependence or abuse), the connection between medical conditions screened for at MEPS, eventual waiver application success and eventual health outcomes still remains relatively unknown.

To date, only one study has explored the relationship between mental health status at accession and eventual service member attrition. Research done at Lackland Air Force Base tentatively shows a strong negative correlation between a service member's performance on a questionnaire designed to describe a recruit's pre-service mental and behavioral health and attrition [32]. This study resulted from the identification of an unmet need to classify service members based on their likelihood to submit to attrition as a result of previous mental health history during the training period in the Air Force. This study also provides support for screening improvements to reduce the number of trainees with a history of behavioral problems from entering the service, as well as to better fit service members to their occupations. Although the potential implications of increased screening has already been discussed in Section 5.2.1, this study provides an example of how information at

Table 5.1: Top Most Frequent Mental and Behavior Health Conditions [2]

Mental & Behavioral System	Applied waiver	% Sought	Waived	% Waived	Accessed	% Accessed
Cannabis dependence or abuse	7,050	35.3	4,241	60.2	1,162	27.4
Cocaine dependence or abuse	988	40.7	597	60.4	75	12.6
ADD/ADHD	544	27.0	334	61.4	171	51.2
Suicidal behavior	199	22.3	122	61.3	35	28.7
Conduct/behavior disorder	187	27.1	102	54.5	32	31.4
Amphetamine dependence or abuse	178	27.6	103	57.9	10	9.7
Personality disorders	124	22.2	75	60.5	12	16.0
Alcohol dependence or abuse	119	22.4	71	59.7	22	31.0
Adjustment disorders	82	30.1	47	57.3	19	40.4
Unspecified or mixed substance dependence or abuse	79	35.7	42	53.2	7	16.7

an early stage of the military lifecycle (accession) can be used to inform policy implementation that can have widespread systemic effects that can lead to increased prevention and overall behavioral wellness among the military service member population. Most importantly, this example provides additional support for long-term operational policymaking. It illustrates how enterprise and unit-level decisions (i.e. Air Force leadership) can have substantial effects on the individual service member (i.e. increasing the stringency to which a service member might access into the service), effects that will be perpetuated into the long-term.

### 5.3 Future Work

Although the model and its results have informed potential policies military leadership should consider in its future vision of psychological health care delivery, its limitations present areas for future work that can improve and better inform decision-making in the long-term. A discussion of these ideas, based on the model assumptions and thesis limitations previously discussed in Sections 1.4 and 3.4, follow below.

### **5.3.1 Consideration of Other Populations**

The system dynamics model developed for this thesis research briefly considers the effect of National Guard and Reserve service members to the extent that they undergo the same accession processes as active duty service members but do not engage in the same basic training and resilience training as active duty service members. Future research could analyze potential differences in resilience and preparedness levels between active duty and Reserve and National Guard service members. In addition, there is a potential opportunity to leverage the Delayed Entry Program (DEP) as an area where current resilience resources available for active duty service members can be extended to Reserve and National Guard service members. The potential impact of this extension could be studied for future policy planning.

### **5.3.2 Modeling Individual Effects on Population Health Outcomes**

As a research method, system dynamics studies high-level effects and aggregates population differences into a continuous function, allowing conclusions to be made about a population at large. However, this implicitly means that any individual differences and data outliers are lost. An individual service member's experiences, such as the number of deployments served and any lengthened deployments served, are important factors when considering an individual's likelihood to develop PTSD symptoms, and this system dynamics model does not have the capability to determine how an individual may directly affect overall population health outcomes. A dynamic model developed by Atkinson, et al. (2009) modeled the relationship between deployment tempo, combat stress and PTSD prevalence [11]. The strength of the Atkinson, et al. (2009) model is its ability to account for individual variation by accounting for variation in risk across different service member populations, assigning different stress strengths to individual service members and allowing service members to accumulate stress in a stochastic process. However, the conclusions that the Atkinson, et al. (2009) model generates are still based on the aggregate service member population at large. Future work could expand on the system dynamics model in this thesis and the concepts of the Atkinson, et al. (2009) model by determining an individual service member's contribution to the dynamics in both models. The knowledge gained from this exercise would enable more robust scenario planning and inform the future fitting of service members to resilience training and health assessment policymaking.

### **5.3.3 Variance of System Delay and Combat Operation Lengths, Rates and Time Steps**

The influence of delays was discussed as instrumental to the reinforcement of behavior in this system (i.e., post-trauma screening and diagnosis dynamics). However, this work did not attempt to quantify this influence. Future work should elucidate and quantify variables such as media influence, awareness of PTSD and its effect on government funding initiatives for innovations in post-trauma screening and diagnosis. The lengths of these delays should also be varied to determine the salience of these delays on the system dynamics. Varying the lengths of combat operations and introducing pauses would better determine the long-term effects of undiagnosed psychological health issues, which can be used to better inform future resource allocation for the larger societal and public health contexts.

Section 3.4 describes the model's assumption that deployment rates are equal to return rates, based on the assumption that for every service member that deploys, a service member returns. However, this may not be realistic as the number of service members deployed are due to other factors such as the demands of operations in theater as well as the number of service members whose deployments have been lengthened due to operational demand. Varying the deployment rates and return rates based on these factors would increase the resolution of the model in evaluating the effects of multiple deployments and unexpected lengthened deployments and shortened rest periods on eventual psychological health outcomes, as these factors have been shown to increase the likelihood of the onset of PTSD symptoms [94].

Also mentioned in Section 3.4 is that the model's defined time step is one year because the data utilized in this work was collected and reported by fiscal year, although other data sources did increase the resolution of their data reported to month-long ranges (i.e., [15]). Decreasing the time step to one month would improve the resolution of the model and expand on this work if more detailed (monthly or quarterly) data sources can be identified for usage, as the model would then be able to predict service member population changes monthly, rendering it a powerful tool for deployment and resource planning.

### **5.3.4 Accounting for Post-Deployment Surges in Psychological Health Care Demand**

As discussed in Section 3.4, the model assumed that as a service member deploys, another one returns. This means that over time, the model eventually hits a threshold level of service members

as stocks accumulate in the model. However, this assumption implicitly assumes that there is no variation in the rates at which service members are deployed or return, which is likely not the case in real life. As a result, future modeling could incorporate other methods to test alternate scenarios. An example of a scenario that might be investigated in future work could be the scenario in which more units return home than normal, leading to a larger than anticipated demand for psychological health resources. This model currently informs policymaking on the assumption that these predicted service member numbers will hit a threshold level, and alternate modeling methods could better inform policymaking by incorporating dynamic changes in demand to better inform resource planning.

### **5.3.5 Further Analysis and Investigation of Unit Cohesion Effect During Deployment**

Section 4.3 discussed the effect of unit cohesion on decreasing the number of service members predicted to screen positive for PTSD symptoms. Furthermore, the MHAT V (2008) study found that service members felt that unit cohesion decreased over the early to mid-stages of the deployment cycle, with its lowest point during mid-deployment. However, there was no follow-up to these findings. Future modeling work should also consider the effect of deployment time on unit leadership and unit support. Future study could also focus on the relationship between deployment activities and unit cohesion to inform unit leadership of how they can best support their service members during mid-deployment in order to build collective unit resilience and increase the likelihood that their service members will not develop symptoms of PTSD and other psychological health issues.

This model could be further strengthened by the usage of a table function to illustrate the effect of unit cohesion on future service member health outcomes. Because many variable relationships are nonlinear, system dynamics often uses table functions to illustrate the effect of these nonlinear relationships, which are specified by a table of values for the independent and dependent variables [90]. This model utilized a linear, analytic relationship to describe the relationship between unit cohesion and health outcomes as the literature indicated a linear correlation between the two variables. However, the ability to change the shape, slope and saturation points of the function within the model's parameters was lost as a result. With additional data, the incorporation of a table function to describe the relationship between unit cohesion and future health outcomes would give the model more flexibility in performing additional, more robust sensitivity analyses, as well as testing scenarios that may be more realistic. A table function would also be able to test additional quantita-

tive data resulting from future study in this area, providing more information about the variance of the relationship between these two variables.

### **5.3.6 Further Quantitative Analysis of External Resilience Resources**

The comprehensive system dynamics model of the military mental health enterprise clearly demonstrates the existence of potential feedback mechanisms that may not have been previously considered by policymakers in a time of war. Furthermore, the model illustrated the importance of outlining a long-term strategy for the enterprise as leadership and policymakers work to alleviate imminent concerns like operational demand, as feedback effects from these policies may linger for years to come as seen in the military's work to combat PTSD and psychological health issues resulting from OIF/OEF.

The stock and flow modeling of the military service member lifecycle illustrates the effect that the waiver process and deployment rates have on the overall lifecycle and validates external observations seen by other studies (i.e. [44, 94]). Although literature has suggested that resilience programs do have a positive effect on reducing onset and diagnosis rates, the mechanism by which this occurs has not yet been quantified because of a lack of performance and utilization data. Furthermore, it is unclear as to what the optimal number of resilience programs might be, as well as the impact of potentially integrating similar programs across the services. Exploration of the extent to which external resilience programs are successful in both the long-term mitigation of service member stress and their impact on long-term service member preparedness could be considered. As with the relationship between unit cohesion and future health outcomes, a table function could be also implemented into the model to test quantitative data and its variance, as well as test additional scenarios involving the function's slope and saturation points. Furthermore, the sensitivity analysis performed to analyze the salience of pre-deployment resilience training participation on future health outcomes indicated potential differences between data sets used in the RAND (2008) and the MHAT V (2008) study, in addition to a potential inherent bias introduced by the variable added to represent pre-deployment resilience training participation or other dynamics not yet studied or represented. These dynamics and factors should also be highlighted for future study.

In addition, this research was limited in terms of the types of organizations and services represented. This thesis research primarily focused on the Army's resilience efforts as well as resilience efforts that were not specific to a service branch. While other services were briefly considered insofar as to recognize that each service has different training requirements and methods for conducting

accession processes and resilience training, there is anecdotal evidence to suggest that there may be undocumented and unofficial methods for conducting resilience training and ensuring a level of social support for service members throughout the lifecycle. Further research could consider how best to represent these external factors in the model for quantitative analysis.

### **5.3.7 Quantitative Analysis of Post-Trauma Diagnosis and Treatment Dynamics**

As discussed in Section 1.4, this thesis did not attempt to study all psychological health processes across the lifecycle and a focus was placed on accession and training processes. Sensitivity analyses discussed in this thesis were performed based on the stock and flow diagram of the military service lifecycle (Appendix C), the basis for the overall system dynamics model of the enterprise (Appendix B). Although enterprise-level dynamics were elucidated based on the qualitative and quantitative methods used, sensitivity analyses were conducted based on the stock and flow model of the military service member lifecycle due to the general lack of quantitative data available regarding post-trauma diagnosis and treatment dynamics and their causal relationships to external factors like screening stringency and usefulness of psychological health innovations. Literature that the sensitivity analyses were built on have shown that there is literature indicating correlations between various external factors and health outcomes (i.e. [76, 17, 29]). However, the exact causal mechanisms by which these correlations occur have not been quantified, and future work could identify and quantify these relationships, increasing the resolution to which these dynamics are viewed.

### **5.3.8 Investigation into the Linkage of Accession Data and Future Health Outcomes**

As discussed throughout this thesis, prior mental health history has been documented in recent literature as a pre-traumatic risk factor for PTSD, and a significant number of active duty service member suicides were found to be the result of at least one significant life stressor, including a behavioral health diagnosis [54, 6]. Although this information is publicly available, it is unclear as to how this knowledge could be leveraged or used to inform future accession policy as there is currently no linkage of accession data to future health outcomes. Future work could investigate further into the different behavioral health diagnoses that eventually led to suicides and determine whether PTSD may have been a major factor in these outcomes to inform future accession policymaking.

### **5.3.9 Consideration of Additional External Political and Social Dynamics**

Section 2.5.2 discussed previous work which applied system dynamics to health care settings to model integrated policies involving multiple stakeholders, demonstrating the value of system dynamics as a modeling method to elucidate leverage points for effecting visible change at the enterprise-level as opposed to focusing on the unit-level or individual-level. Although system dynamics has been applied in investigating complex issues in health care, the body of literature still remains relatively little; additionally, system dynamics applications to military settings have only recently emerged. A working paper by Anderson & Black used system dynamics to model insurgency and counter-insurgency dynamics that visualized the accumulations of social capital and the activities that affect the political and social context in which social capital is generated in times of warfare [5]. Combat operations in Iraq and Afghanistan were also affected by political and social dynamics such as the creation of a new democratic governments, the training of internal military forces and resistance to opposing guerrilla warfare (i.e. [36, 57, 94]). Because PTSD is considered a significant pathology of OIF/OEF, future work could investigate the connection between the political and social dynamics in the Middle East and the dynamics modeled for this thesis. In addition, the effect of PTSD on society as manifested through issues such as substance abuse, domestic violence and homelessness were briefly discussed in Section 4.4.3 as additional enterprise-level dynamics to consider that are likely connected to psychological health issues experienced by military service members and veterans. Future work could also build upon the system dynamics model in this thesis to investigate and include these societal dynamics as well.

### **5.3.10 Additional Qualitative Validation and Development of a Collaborative Model**

Section 3.5 referenced the qualitative interviews conducted as a basis for and to validate the system dynamics model presented in this thesis. However, validating the qualitative model with a limited interview set and without collaborative thinking can oftentimes be quite challenging. Adamides and Karacapilidis (2005) recognized the value of group model building, which involves stakeholders in the model building process, combining each stakeholder's perspective and ideas to build a model representing the context in which the organization operates to facilitate strategic planning [3]. Additional interviews with other service members from the line and medical settings, as well as with military psychological health providers, strategic analysts and decision makers would provide additional validation for the model. In addition, this work could drive the expansion of the system

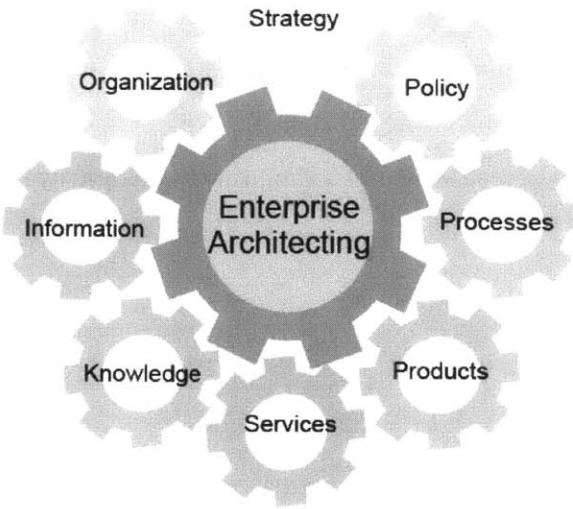


Figure 5-1: Enterprise Architecting—Eight Views [71]

dynamics model in this thesis into a collaborative model for future research in the area of military health care delivery.

### **5.3.11 Enterprise Architecting—A Framework for Complex Systems**

Nightingale and Rhodes [71] found that enterprises are often insufficiently architected from a single point of view, such as a strategy view or a process view, and posit that enterprises must be architected from all architectural views collectively (Strategy, Organization, Processes, Knowledge, Information, Policy, and Products/Services), as alignment across all views is critical to achieving performance [71] (Figure 5-1).

The military system for delivering psychological health care is also a highly complex, large enterprise that consists of multiple organizations, processes and stakeholders. This thesis work has demonstrated how a systems approach can inform policymaking in military mental health care delivery by showing how intended policies may have unintended downstream consequences. Policy recommendations and their implications were explored. In addition, this work has highlighted areas to consider in architecting a future enterprise state, such as the existence of time delays in DoD policy creation and the usage of health outcomes information to inform performance measurements and military health policies. Future work could address how to utilize the Enterprise Architecture (EA) framework for creating a future state that incorporates these policy recommendations. Other

work could analyze where these policy recommendations would have the most impact in the enterprise by mapping these areas of consideration to relevant architectural views. Finally, utilizing the EA framework to architect a future state would supplement the system dynamics work done in this thesis by demonstrating which views were not captured in the system dynamics model, and suggest how these views might be best represented as additions to the system dynamics model.

## **Appendix A**

# **List of Acronyms and Abbreviations**

**A&E** accident & emergency

**AFQT** Armed Forces Qualification Test

**AMSARA** Accession Medical Standards Analysis and Research Activity

**ART** Airman Resiliency Training (Air Force)

**ASR** Acute Stress Reaction

**ASVAB** Armed Services Vocational Aptitude Battery

**COSC** Combat Operational Stress Control

**COSR** Combat (or Ongoing Military) Operational Stress Reaction

**CSF** Comprehensive Soldier Fitness

**DCoE** Defense Centers of Excellence

**DEP** Delayed Entry Program

**DepSecDef** Deputy Secretary of Defense

**DHP** Defense Health Program

**DoD** Department of Defense

**DSM** Diagnostic and Statistical Manual of Mental Disorders

**EA** Enterprise Architecture

**EPS** Existing Prior to Service

**FHP&R** Force, Health Protection & Readiness

**GAO** Government Accountability Office

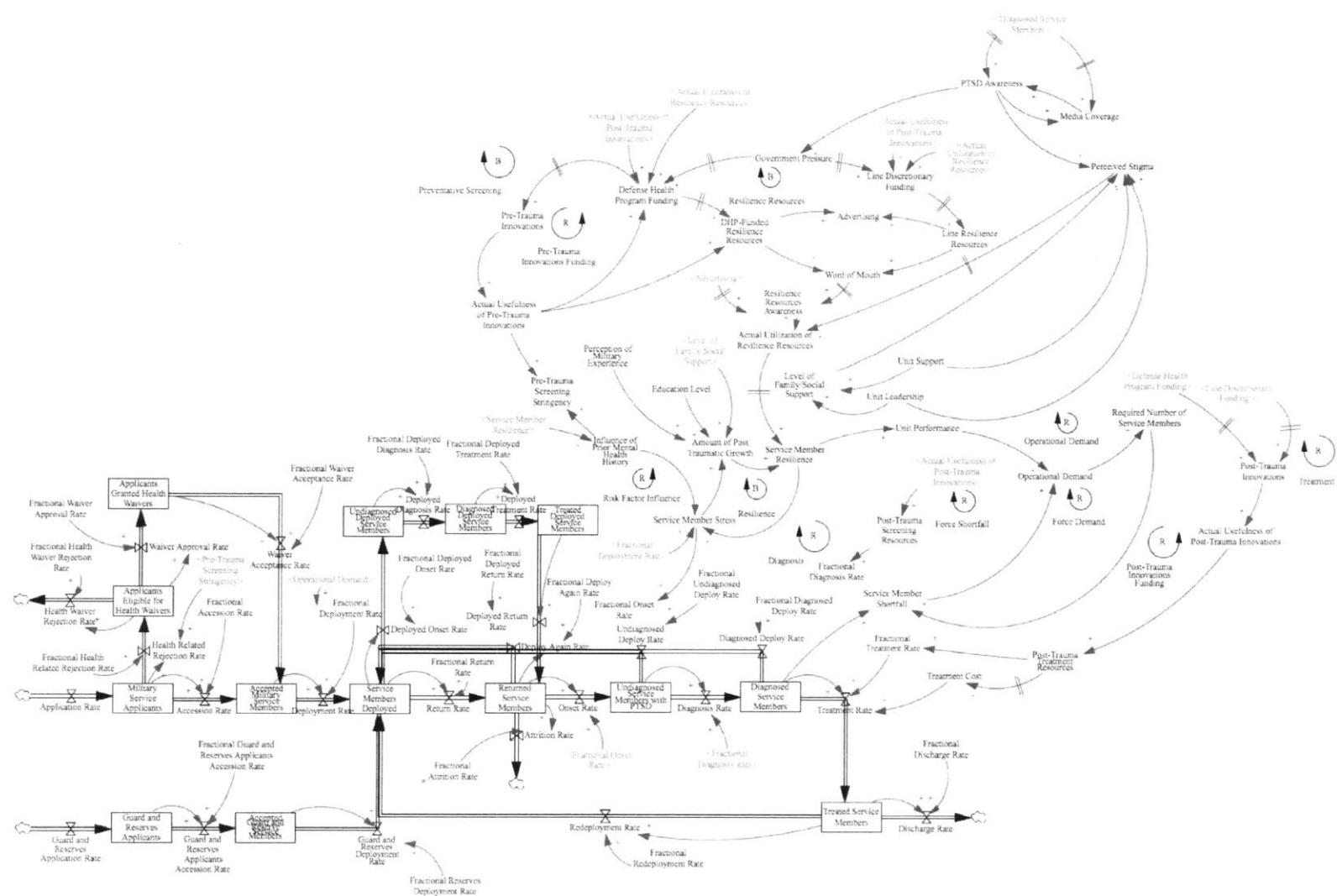
**LAI** Lean Advancement Initiative

**LESAT** Lean Enterprise Self Assessment Tool

**MDR** military demand-resource  
**MEPCOM** U.S. Military Entrance Processing Command  
**MEPS** Military Entrance Processing Station  
**MHAT** Mental Health Advisory Team  
**MHS** Military Health System  
**MIRS** MEPCOM Integrated Resource System  
**MIT** Massachusetts Institute of Technology  
**MTF** Military Treatment Facility  
**MOS** Military Occupational Specialties  
**OASD-HA** Office of the Secretary of Defense for Health Affairs  
**OEF** Operation Enduring Freedom  
**OIF** Operation Iraqi Freedom  
**OSC** Operational Stress Control (Navy)  
**OSCAR** Operational Stress Control and Readiness Program (Marine Corps)  
**OSD** Office of the Secretary of Defense  
**PAS** Presidentially-appointed, Senate-confirmed  
**PDHA** Post-Deployment Health Assessment  
**PDHRA** Post-Deployment Health Reassessment  
**PHA** Pre-Deployment Health Assessment  
**PSA** Principal Staff Assistant  
**PTSD** Post-traumatic stress disorder  
**ROI** return on investment  
**SecDef** Secretary of Defense  
**TBI** traumatic brain injury  
**USD P&R** Office of the Under Secretary of Defense for Personnel and Readiness  
**VA** Veterans Affairs

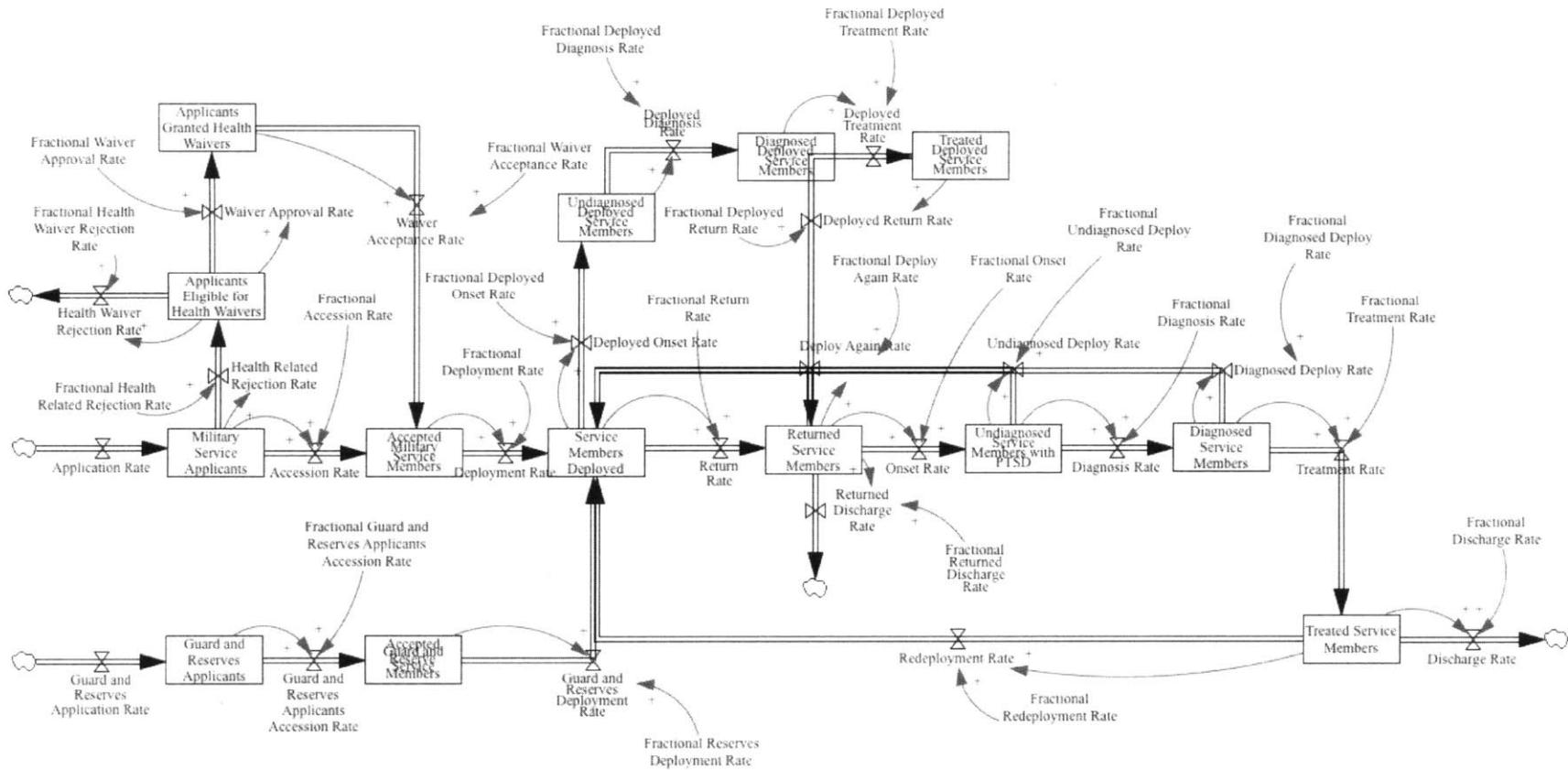
## **Appendix B**

# **System Dynamics Model of the Military Mental Health Enterprise**



## **Appendix C**

### **Stock and Flow Diagram: Military Service Lifecycle**



## C.1 Documentation

- (01) Accepted Guard and Reserve Service Members= INTEG ( -Guard and Reserves Deployment Rate+Guard and Reserves Applicants Accession Rate , 102549) Units: Service Members
- (02) Accepted Military Service Members= INTEG ( Accession Rate+Waiver Acceptance Rate-Deployment Rate, 234547) Units: Service Members
- (03) Accession Rate= Fractional Accession Rate\*Military Service Applicants Units: Service Members/Year
- (04) Applicants Eligible for Health Waivers= INTEG ( -Health Waiver Rejection Rate-Waiver Approval Rate+Health Related Rejection Rate , 27421) Units: Service Members
- (05) Applicants Granted Health Waivers= INTEG ( -Waiver Acceptance Rate+Waiver Approval Rate, 234547) Units: Service Members
- (06) Application Rate= 251370 Units: Service Members/Year
- (07) Deploy Again Rate= Fractional Deploy Again Rate\*Returned Service Members Units: Service Members
- (08) Deployed Diagnosis Rate= Fractional Deployed Diagnosis Rate\*Undiagnosed Deployed Service Members Units: Service Members/Year
- (09) Deployed Onset Rate= Service Members Deployed\*Fractional Deployed Onset Rate Units: Service Members/Year
- (10) Deployed Return Rate= Fractional Deployed Return Rate\*Treated Deployed Service Members Units: Service Members/Year
- (11) Deployed Treatment Rate= Diagnosed Deployed Service Members\*Fractional Deployed Treatment Rate Units: Service Members/Year
- (12) Deployment Rate= Fractional Deployment Rate\*Accepted Military Service Members Units: Service Members/Year
- (13) Diagnosed Deploy Rate= Diagnosed Service Members\*Fractional Diagnosed Deploy Rate Units: Service Members/Year
- (14) Diagnosed Deployed Service Members= INTEG ( Deployed Diagnosis Rate-Deployed Treatment Rate, 0) Units: Service Members
- (15) Diagnosed Service Members= INTEG ( Diagnosis Rate-Diagnosed Deploy Rate-Treatment Rate, 0) Units: Service Members
- (16) Diagnosis Rate= Fractional Diagnosis Rate\*Undiagnosed Service Members with PTSD

Units: Service Members/Year

(17) Discharge Rate= Treated Service Members\*Fractional Discharge Rate Units: Service Members/Year

(18) FINAL TIME = 100 Units: Year The final time for the simulation.

(19) Fractional Accession Rate= 0.593 Units: Service Members/Service Members/Year

(20) Fractional Deploy Again Rate= 0.12 Units: 1/Year

(21) Fractional Deployed Diagnosis Rate= 0.25 Units: 1/Year

(22) Fractional Deployed Onset Rate= 0.26 Units: 1/Year

(23) Fractional Deployed Return Rate= 0.12 Units: 1/Year

(24) Fractional Deployed Treatment Rate= 0.3 Units: 1/Year

(25) Fractional Deployment Rate= 0.12 Units: 1/Year

(26) Fractional Diagnosed Deploy Rate= 0.12 Units: 1/Year

(27) Fractional Diagnosis Rate= 0.25 Units: 1/Year

(28) Fractional Discharge Rate= 0.17 Units: 1/Year

(29) Fractional Guard and Reserves Applicants Accession Rate= 0.862 Units: 1/Year

(30) Fractional Health Related Rejection Rate= 0.108 Units: 1/Year

(31) Fractional Health Waiver Rejection Rate= 0.386 Units: 1/Year

(32) Fractional Onset Rate= 0.26 Units: 1/Year

(33) Fractional Redeployment Rate= 0.12 Units: 1/Year

(34) Fractional Reserves Deployment Rate= 0.12 Units: 1/Year

(35) Fractional Return Rate= 0.12 Units: 1/Year

(36) Fractional Returned Discharge Rate= 0.17 Units: 1/Year

(37) Fractional Treatment Rate= 0.3 Units: 1/Year

(38) Fractional Undiagnosed Deploy Rate= 0.12 Units: 1/Year

(39) Fractional Waiver Acceptance Rate= 0.394 Units: 1/Year

(40) Fractional Waiver Approval Rate= 0.614 Units: 1/Year

(41) Guard and Reserves Applicants= INTEG ( -Guard and Reserves Applicants Accession Rate+Guard and Reserves Application Rate , 102549) Units: Service Members

(42) Guard and Reserves Applicants Accession Rate= Fractional Guard and Reserves Applicants Accession Rate\*Guard and Reserves Applicants Units: Service Members/Year

(43) Guard and Reserves Application Rate= 102549 Units: Service Members/Year

- (44) Guard and Reserves Deployment Rate= Accepted Guard and Reserve Service Members\*Fractional Reserves Deployment Rate Units: Service Members/Year
- (45) Health Related Rejection Rate= Fractional Health Related Rejection Rate\*Military Service Applicants Units: Service Members/Year
- (46) Health Waiver Rejection Rate= Fractional Health Waiver Rejection Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year
- (47) INITIAL TIME = 0 Units: Year The initial time for the simulation.
- (48) Military Service Applicants= INTEG ( -Accession Rate-Health Related Rejection Rate+Application Rate, 353919) Units: Service Members
- (49) Onset Rate= Fractional Onset Rate\*Returned Service Members Units: Service Members/Year
- (50) Redeployment Rate= Fractional Redeployment Rate\*Treated Service Members Units: Service Members/Year
- (51) Return Rate= Fractional Return Rate\*Service Members Deployed Units: Service Members/Year
- (52) Returned Discharge Rate= Returned Service Members\*Fractional Returned Discharge Rate Units: Service Members/Year
- (53) Returned Service Members= INTEG ( Deployed Return Rate+Return Rate-Deploy Again Rate-Onset Rate-Returned Discharge Rate , 0) Units: Service Members
- (54) SAVEPER = TIME STEP Units: Year [0,?] The frequency with which output is stored.
- (55) Service Members Deployed= INTEG ( Deployment Rate+Diagnosed Deploy Rate+Guard and Reserves Deployment Rate+ Redeployment Rate+Undiagnosed Deploy Rate-Deployed Onset Rate-Return Rate, 186300) Units: Service Members
- (56) TIME STEP = 1 Units: Year [0,?] The time step for the simulation.
- (57) Treated Deployed Service Members= INTEG ( -Deployed Return Rate+Deployed Treatment Rate, 0) Units: Service Members
- (58) Treated Service Members= INTEG ( Treatment Rate-Redeployment Rate-Discharge Rate, 0) Units: Service Members
- (59) Treatment Rate= Diagnosed Service Members\*Fractional Treatment Rate Units: Service Members/Year
- (60) Undiagnosed Deploy Rate= Fractional Undiagnosed Deploy Rate\*Undiagnosed Service Members with PTSD Units: Service Members/Year

(61) Undiagnosed Deployed Service Members= INTEG ( Deployed Onset Rate-Deployed Diagnosis Rate, 0) Units: Service Members

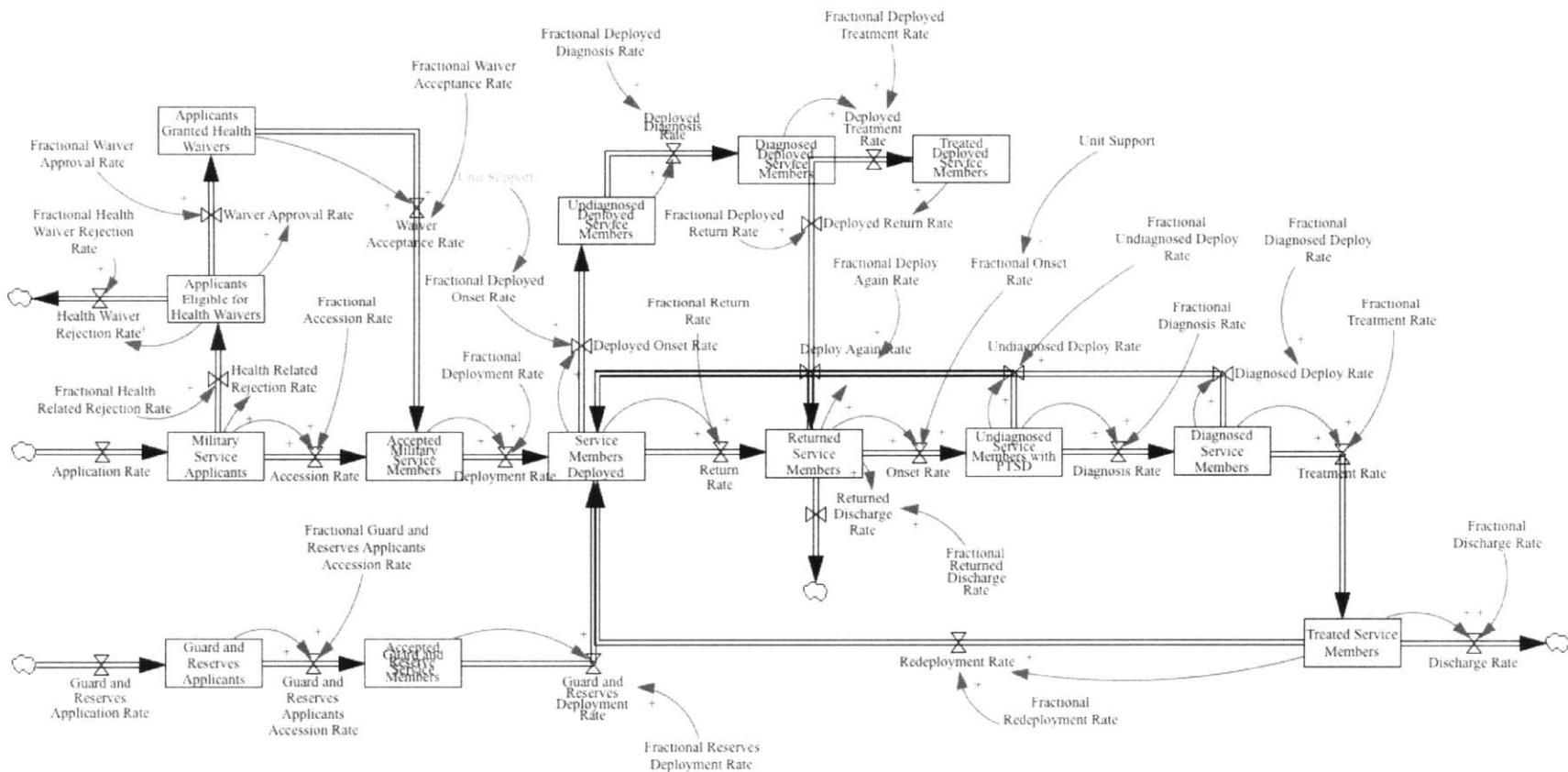
(62) Undiagnosed Service Members with PTSD= INTEG ( Onset Rate-Undiagnosed Deploy Rate-Diagnosis Rate, 0) Units: Service Members

(63) Waiver Acceptance Rate= Applicants Granted Health Waivers\*Fractional Waiver Acceptance Rate Units: Service Members/Year

(64) Waiver Approval Rate= Fractional Waiver Approval Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year

## **Appendix D**

### **Stock and Flow Diagram: Unit Support**



## D.1 Documentation

(01) Accepted Guard and Reserve Service Members= INTEG ( -Guard and Reserves Deployment Rate+Guard and Reserves Applicants Accession Rate , 102549) Units: Service Members

(02) Accepted Military Service Members= INTEG ( Accession Rate+Waiver Acceptance Rate-Deployment Rate, 234547) Units: Service Members

(03) Accession Rate= Fractional Accession Rate\*Military Service Applicants Units: Service Members/Year

(04) Applicants Eligible for Health Waivers= INTEG ( -Health Waiver Rejection Rate-Waiver Approval Rate+Health Related Rejection Rate , 27421) Units: Service Members

(05) Applicants Granted Health Waivers= INTEG ( -Waiver Acceptance Rate+Waiver Approval Rate, 234547) Units: Service Members

(06) Application Rate= 251370 Units: Service Members/Year

(07) Deploy Again Rate= Fractional Deploy Again Rate\*Returned Service Members Units: Service Members

(08) Deployed Diagnosis Rate= Fractional Deployed Diagnosis Rate\*Undiagnosed Deployed Service Members Units: Service Members/Year

(09) Deployed Onset Rate= Service Members Deployed\*Fractional Deployed Onset Rate Units: Service Members/Year

(10) Deployed Return Rate= Fractional Deployed Return Rate\*Treated Deployed Service Members Units: Service Members/Year

(11) Deployed Treatment Rate= Diagnosed Deployed Service Members\*Fractional Deployed Treatment Rate Units: Service Members/Year

(12) Deployment Rate= Fractional Deployment Rate\*Accepted Military Service Members Units: Service Members/Year

(13) Diagnosed Deploy Rate= Diagnosed Service Members\*Fractional Diagnosed Deploy Rate Units: Service Members/Year

(14) Diagnosed Deployed Service Members= INTEG ( Deployed Diagnosis Rate-Deployed Treatment Rate, 0) Units: Service Members

(15) Diagnosed Service Members= INTEG ( Diagnosis Rate-Diagnosed Deploy Rate-Treatment Rate, 0) Units: Service Members

(16) Diagnosis Rate= Fractional Diagnosis Rate\*Undiagnosed Service Members with PTSD

Units: Service Members/Year

(17) Discharge Rate= Treated Service Members\*Fractional Discharge Rate Units: Service Members/Year

(18) FINAL TIME = 100 Units: Year The final time for the simulation.

(19) Fractional Accession Rate= 0.593 Units: Service Members/Service Members/Year

(20) Fractional Deploy Again Rate= 0.12 Units: 1/Year

(21) Fractional Deployed Diagnosis Rate= 0.25 Units: 1/Year

(22) Fractional Deployed Onset Rate= -0.122\*Unit Support+0.56 Units: 1/Year

(23) Fractional Deployed Return Rate= 0.12 Units: 1/Year

(24) Fractional Deployed Treatment Rate= 0.3 Units: 1/Year

(25) Fractional Deployment Rate= 0.12 Units: 1/Year

(26) Fractional Diagnosed Deploy Rate= 0.12 Units: 1/Year

(27) Fractional Diagnosis Rate= 0.25 Units: 1/Year

(28) Fractional Discharge Rate= 0.17 Units: 1/Year

(29) Fractional Guard and Reserves Applicants Accession Rate= 0.862 Units: 1/Year

(30) Fractional Health Related Rejection Rate= 0.108 Units: 1/Year

(31) Fractional Health Waiver Rejection Rate= 0.386 Units: 1/Year

(32) Fractional Onset Rate= -0.122\*Unit Support+0.56 Units: 1/Year

(33) Fractional Redeployment Rate= 0.12 Units: 1/Year

(34) Fractional Reserves Deployment Rate= 0.12 Units: 1/Year

(35) Fractional Return Rate= 0.12 Units: 1/Year

(36) Fractional Returned Discharge Rate= 0.17 Units: 1/Year

(37) Fractional Treatment Rate= 0.3 Units: 1/Year

(38) Fractional Undiagnosed Deploy Rate= 0.12 Units: 1/Year

(39) Fractional Waiver Acceptance Rate= 0.394 Units: 1/Year

(40) Fractional Waiver Approval Rate= 0.614 Units: 1/Year

(41) Guard and Reserves Applicants= INTEG ( -Guard and Reserves Applicants Accession Rate+Guard and Reserves Application Rate , 102549) Units: Service Members

(42) Guard and Reserves Applicants Accession Rate= Fractional Guard and Reserves Applicants Accession Rate\*Guard and Reserves Applicants Units: Service Members/Year

(43) Guard and Reserves Application Rate= 102549 Units: Service Members/Year

- (44) Guard and Reserves Deployment Rate= Accepted Guard and Reserve Service Members\*Fractional Reserves Deployment Rate Units: Service Members/Year
- (45) Health Related Rejection Rate= Fractional Health Related Rejection Rate\*Military Service Applicants Units: Service Members/Year
- (46) Health Waiver Rejection Rate= Fractional Health Waiver Rejection Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year
- (47) INITIAL TIME = 0 Units: Year The initial time for the simulation.
- (48) Military Service Applicants= INTEG ( -Accession Rate-Health Related Rejection Rate+Application Rate, 353919) Units: Service Members
- (49) Onset Rate= Fractional Onset Rate\*Returned Service Members Units: Service Members/Year
- (50) Redeployment Rate= Fractional Redeployment Rate\*Treated Service Members Units: Service Members/Year
- (51) Return Rate= Fractional Return Rate\*Service Members Deployed Units: Service Members/Year
- (52) Returned Discharge Rate= Returned Service Members\*Fractional Returned Discharge Rate Units: Service Members/Year
- (53) Returned Service Members= INTEG ( Deployed Return Rate+Return Rate-Deploy Again Rate-Onset Rate-Returned Discharge Rate , 0) Units: Service Members
- (54) SAVEPER = TIME STEP Units: Year [0,?] The frequency with which output is stored.
- (55) Service Members Deployed= INTEG ( Deployment Rate+Diagnosed Deploy Rate+Guard and Reserves Deployment Rate+ Redeployment Rate+Undiagnosed Deploy Rate-Deployed Onset Rate-Return Rate, 186300) Units: Service Members
- (56) TIME STEP = 1 Units: Year [0,?] The time step for the simulation.
- (57) Treated Deployed Service Members= INTEG ( -Deployed Return Rate+Deployed Treatment Rate, 0) Units: Service Members
- (58) Treated Service Members= INTEG ( Treatment Rate-Redeployment Rate-Discharge Rate, 0) Units: Service Members
- (59) Treatment Rate= Diagnosed Service Members\*Fractional Treatment Rate Units: Service Members/Year
- (60) Undiagnosed Deploy Rate= Fractional Undiagnosed Deploy Rate\*Undiagnosed Service Members with PTSD Units: Service Members/Year

(61) Undiagnosed Deployed Service Members= INTEG ( Deployed Onset Rate-Deployed Diagnosis Rate, 0) Units: Service Members

(62) Undiagnosed Service Members with PTSD= INTEG ( Onset Rate-Undiagnosed Deploy Rate-Diagnosis Rate, 0) Units: Service Members

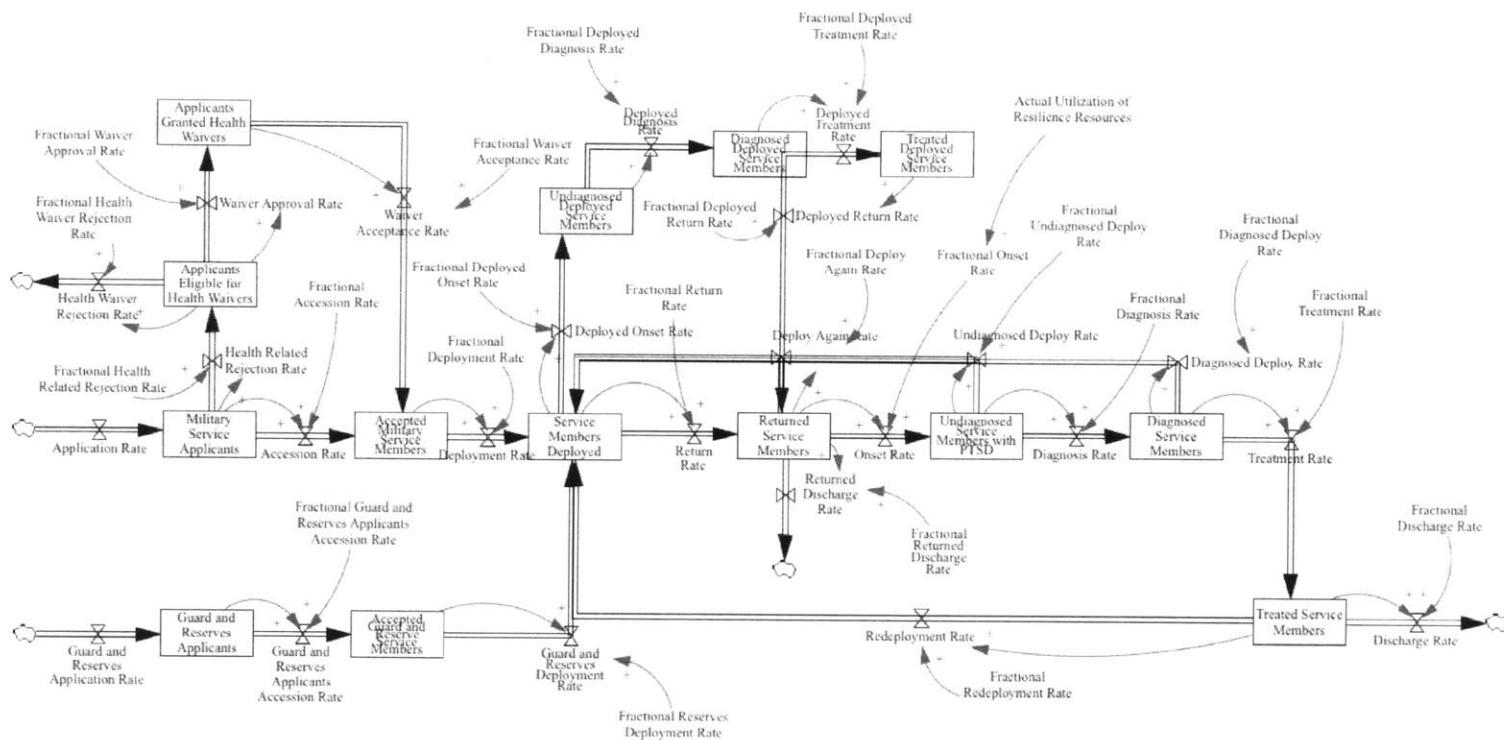
(63) Unit Support= 2.447 Units: Dmn1

(64) Waiver Acceptance Rate= Applicants Granted Health Waivers\*Fractional Waiver Acceptance Rate Units: Service Members/Year

(65) Waiver Approval Rate= Fractional Waiver Approval Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year

## **Appendix E**

# **Stock and Flow Diagram: Utilization of Resilience Resources**



## **E.1 Documentation**

(01) Accepted Guard and Reserve Service Members= INTEG ( -Guard and Reserves Deployment Rate+Guard and Reserves Applicants Accession Rate , 102549) Units: Service Members

(02) Accepted Military Service Members= INTEG ( Accession Rate+Waiver Acceptance Rate-Deployment Rate, 234547) Units: Service Members

(03) Accession Rate= Fractional Accession Rate\*Military Service Applicants Units: Service Members/Year

(04) Actual Utilization of Resilience Resources= 0.63 Units: Dmnl Pre-deployment Battlemind Training (MHAT V)

(05) Applicants Eligible for Health Waivers= INTEG ( -Health Waiver Rejection Rate-Waiver Approval Rate+Health Related Rejection Rate , 27421) Units: Service Members

(06) Applicants Granted Health Waivers= INTEG ( -Waiver Acceptance Rate+Waiver Approval Rate, 234547) Units: Service Members

(07) Application Rate= 251370 Units: Service Members/Year

(08) Deploy Again Rate= Fractional Deploy Again Rate\*Returned Service Members Units: Service Members

(09) Deployed Diagnosis Rate= Fractional Deployed Diagnosis Rate\*Undiagnosed Deployed Service Members Units: Service Members/Year

(10) Deployed Onset Rate= Service Members Deployed\*Fractional Deployed Onset Rate Units: Service Members/Year

(11) Deployed Return Rate= Fractional Deployed Return Rate\*Treated Deployed Service Members Units: Service Members/Year

(12) Deployed Treatment Rate= Diagnosed Deployed Service Members\*Fractional Deployed Treatment Rate Units: Service Members/Year

(13) Deployment Rate= Fractional Deployment Rate\*Accepted Military Service Members Units: Service Members/Year

(14) Diagnosed Deploy Rate= Diagnosed Service Members\*Fractional Diagnosed Deploy Rate Units: Service Members/Year

(15) Diagnosed Deployed Service Members= INTEG ( Deployed Diagnosis Rate-Diagnosed Treatment Rate, 0) Units: Service Members

(16) Diagnosed Service Members= INTEG ( Diagnosis Rate-Diagnosed Deploy Rate-Treatment

Rate, 0) Units: Service Members

(17) Diagnosis Rate= Fractional Diagnosis Rate\*Undiagnosed Service Members with PTSD  
Units: Service Members/Year

(18) Discharge Rate= Treated Service Members\*Fractional Discharge Rate Units: Service Members/Year

(19) FINAL TIME = 100 Units: Year The final time for the simulation.

(20) Fractional Accession Rate= 0.593 Units: Service Members/Service Members/Year

(21) Fractional Deploy Again Rate= 0.12 Units: 1/Year

(22) Fractional Deployed Diagnosis Rate= 0.25 Units: 1/Year

(23) Fractional Deployed Onset Rate= 0.26 Units: 1/Year

(24) Fractional Deployed Return Rate= 0.12 Units: 1/Year

(25) Fractional Deployed Treatment Rate= 0.3 Units: 1/Year

(26) Fractional Deployment Rate= 0.12 Units: 1/Year

(27) Fractional Diagnosed Deploy Rate= 0.12 Units: 1/Year

(28) Fractional Diagnosis Rate= 0.25 Units: 1/Year

(29) Fractional Discharge Rate= 0.17 Units: 1/Year

(30) Fractional Guard and Reserves Applicants Accession Rate= 0.862 Units: 1/Year

(31) Fractional Health Related Rejection Rate= 0.108 Units: 1/Year

(32) Fractional Health Waiver Rejection Rate= 0.386 Units: 1/Year

(33) Fractional Onset Rate= Actual Utilization of Resilience Resources\*0.12+(1-Actual Utilization of Resilience Resources )\*0.205 Units: 1/Year

(34) Fractional Redeployment Rate= 0.12 Units: 1/Year

(35) Fractional Reserves Deployment Rate= 0.12 Units: 1/Year

(36) Fractional Return Rate= 0.12 Units: 1/Year

(37) Fractional Returned Discharge Rate= 0.17 Units: 1/Year

(38) Fractional Treatment Rate= 0.3 Units: 1/Year

(39) Fractional Undiagnosed Deploy Rate= 0.12 Units: 1/Year

(40) Fractional Waiver Acceptance Rate= 0.394 Units: 1/Year

(41) Fractional Waiver Approval Rate= 0.614 Units: 1/Year

(42) Guard and Reserves Applicants= INTEG ( -Guard and Reserves Applicants Accession Rate+Guard and Reserves Application Rate , 102549) Units: Service Members

(43) Guard and Reserves Applicants Accession Rate= Fractional Guard and Reserves Applicants Accession Rate\*Guard and Reserves Applicants Units: Service Members/Year

(44) Guard and Reserves Application Rate= 102549 Units: Service Members/Year

(45) Guard and Reserves Deployment Rate= Accepted Guard and Reserve Service Members\*Fractional Reserves Deployment Rate Units: Service Members/Year

(46) Health Related Rejection Rate= Fractional Health Related Rejection Rate\*Military Service Applicants Units: Service Members/Year

(47) Health Waiver Rejection Rate= Fractional Health Waiver Rejection Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year

(48) INITIAL TIME = 0 Units: Year The initial time for the simulation.

(49) Military Service Applicants= INTEG ( -Accession Rate-Health Related Rejection Rate+Application Rate, 353919) Units: Service Members

(50) Onset Rate= Fractional Onset Rate\*Returned Service Members Units: Service Members/Year

(51) Redeployment Rate= Fractional Redeployment Rate\*Treated Service Members Units: Service Members/Year

(52) Return Rate= Fractional Return Rate\*Service Members Deployed Units: Service Members/Year

(53) Returned Discharge Rate= Returned Service Members\*Fractional Returned Discharge Rate Units: Service Members/Year

(54) Returned Service Members= INTEG ( Deployed Return Rate+Return Rate-Deploy Again Rate-Onset Rate-Returned Discharge Rate , 0) Units: Service Members

(55) SAVEPER = TIME STEP Units: Year [0,?] The frequency with which output is stored.

(56) Service Members Deployed= INTEG ( Deployment Rate+Diagnosed Deploy Rate+Guard and Reserves Deployment Rate+ Redeployment Rate+Undiagnosed Deploy Rate-Deployed Onset Rate-Return Rate, 186300) Units: Service Members

(57) TIME STEP = 1 Units: Year [0,?] The time step for the simulation.

(58) Treated Deployed Service Members= INTEG ( -Deployed Return Rate+Deployed Treatment Rate, 0) Units: Service Members

(59) Treated Service Members= INTEG ( Treatment Rate-Redeployment Rate-Discharge Rate, 0) Units: Service Members

(60) Treatment Rate= Diagnosed Service Members\*Fractional Treatment Rate Units: Service

Members/Year

(61) Undiagnosed Deploy Rate= Fractional Undiagnosed Deploy Rate\*Undiagnosed Service Members with PTSD Units: Service Members/Year

(62) Undiagnosed Deployed Service Members= INTEG ( Deployed Onset Rate-Deployed Diagnosis Rate, 0) Units: Service Members

(63) Undiagnosed Service Members with PTSD= INTEG ( Onset Rate-Undiagnosed Deploy Rate-Diagnosis Rate, 0) Units: Service Members

(64) Waiver Acceptance Rate= Applicants Granted Health Waivers\*Fractional Waiver Acceptance Rate Units: Service Members/Year

(65) Waiver Approval Rate= Fractional Waiver Approval Rate\*Applicants Eligible for Health Waivers Units: Service Members/Year

## **Appendix F**

# **Overview of Department of Defense Issuances [28]**

### **F.1 DoD Directives**

- Exclusively establish policy, assign responsibilities, and delegate authority to DoD Components
- Contain no procedures
- Two types: Direct Oversight and Chartering

#### **F.1.1 Direct Oversight**

- Require SecDef or DepSecDef direct oversight and signature; 8 pages long; contain only:
  - Non-delegable SecDef or DepSecDef responsibilities;
  - Assignment of functions and resources between/among PSAs and/or DoD Components;
  - Designation of Executive Agents and assignment of related responsibilities and authorities;  
or
  - Matters of SecDef or DepSecDef special interest

### **F.1.2 Chartering**

- Establish OSD Component Head, PAS official, Defense Agency, DoD Field Activity, or other major DoD or OSD Components official mission, responsibilities,
- functions, relationships, and delegated authorities
- Signed by the SecDef or DepSecDef
- Signed by the Under Secretaries delegated the authority in their charter for subordinate OSD PAS officials

## **F.2 DoD Instructions**

- Establish or implement policy
- May contain overarching procedures
- If exceeding 50 pages, shall be separated into volumes
- Two types: Policy and Non-Policy

### **F.2.1 Policy Instructions**

- Establish policy and assign responsibilities within a functional area assigned in an OSD Component Heads charter
- May provide GENERAL procedures for implementing the policy
- Signed only by OSD Component Heads or their Principal Deputies
- Include OSD Components charter as a reference

### **F.2.2 Non-Policy Instructions**

- Implement policy established in a Directive or policy Instruction
- Procedures are more detailed
- Provide procedures for carrying out the policy

- Signed by OSD Component Heads, Principal Deputies, or other OSD PAS officials as authorized by their charters
- Includes OSD Components charter as a reference (if the Principal Deputy or PAS official has a charter, that will be used)

### **F.3 DoD Manuals**

- Implement or supplement a Directive or policy Instruction. Shall be authorized by a Directive or policy Instruction. The authorizing issuance shall be cited in the Manual and included as a reference
- Identify uniform procedures for managing or operating systems and provide administrative information
- If exceeding 100 pages, shall be separated into volumes
- May contain a policy section; SUMMARIZING policy established elsewhere
- Signed by OSD Component Heads, Principal Deputies, or other OSD PAS officials as authorized by their charters
- All DoD publications that are not Manuals (i.e., catalogs, compendiums, directories, guides, handbooks, indexes, inventories, lists, modules, pamphlets, plans, regulations, series, standards, and supplements) shall be converted into Manuals on their next reissuance

### **F.4 Directive-Type Memos**

**Issued:**

- ONLY for a time-sensitive action that affects a current DoD issuance or that will become a DoD issuance
- ONLY when time constraints prevent publishing a new issuance or a change to an existing issuance

**May:**

- Establish policy and assign responsibilities; or

- Implement policies and responsibilities established in existing Directives or Instructions

**Signature Authority for memos:**

- Requiring SecDef or DepSecDef direct oversight - SecDef or DepSecDef
- Establishing policy–OSD Component Heads or their Principal Deputies
- Implementing policy–OSD Component Heads, Principal Deputies, or other OSD PAS officials as authorized by their charters

Effective for no more than 180 days from the date signed; after that it must be incorporated into an existing DoD issuance, converted to a new DoD issuance, reissued, or canceled

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