PHYSICAL TRAINING FOR ARMOR CREWMEN

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

PHYSICAL TRAINING FOR ARMOR CREWMEN, by MAJ Shane A. Baker, 83 pages.

This thesis examines the physical requirements of armor crewmen and provides a method for training them to meet those requirements based on current Army doctrine and emerging fitness doctrine using the components of fitness listed in FM21-20. It compares the methodology with current training methods used by the armor force as derived from a pilot survey. The author found that muscular strength was the most important component of physical fitness followed by muscular endurance, flexibility and cardiorespiratory endurance. The author concluded that if his sample population represented the entire population then armor leaders were neglecting muscular strength, muscular endurance and flexibility in their physical readiness programs. He also concluded that units are training for the Army Physical Fitness Test instead of to mission-essential physical tasks.

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Finally, I dedicate this work to my mother who has always stressed the importance of education and has seen to her sons' education at the expense of her own. Congratulations to her for finishing her Bachelor's Degree this year.

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ACRONYMS

APFT	Army Physical Fitness Test--test that measures soldiers' fitness through three events: Two minutes of pushups, two minutes of sit-ups and a timed two-mile run.
ARI	Army Research Institute
CAS3	Combined Arms Service Staff School
CGSOC	Command and General Staff Officers Course
CR	Cardiorespiratory
HMMWV	High Mobility Multipurpose Wheeled Vehicle
METL	Mission Essential Task List--"a compilation of collective mission essential tasks which must be successfully performed if an organization is to accomplish its wartime mission(s)" (Department of the Army 1997, 1-102).
MFT	Master Fitness Trainer
MMAS	Master of Military Art and Science
MOS	Military Occupational Specialty--Soldiers' job descriptions
NCOES	Noncommissioned Officer Education System
OES	Officer Education System
PNF	Proprioceptive Neuromuscular Facilitation Exercise
PRE	Partner Resisted Exercise
PT	Physical Training
SAMS	School for Advanced Military Studies
TC	Tank Commander
TM	Technical Manual
TTP	Tactics, Techniques and Procedures
USAPFS	U.S. Army Physical Fitness School

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CHAPTER 1

INTRODUCTION

In recent military history, armored forces have been decisive in combat. The success of armored forces is contingent on the training of their soldiers in preparation for war. While armor leaders readily apply battle focus to other aspects of training, they may not apply the same focus to physical training. Commanders use mission essential task lists (METLs) to focus their training on a few critical tasks, so that they are able to expertly execute them in combat. Although most commanders apply battle focus to most training, physical training is easily overlooked. Many commanders do not scrutinize their physical training programs in order to ensure they are training their soldiers to endure the physical hardships of combat. Instead, they focus on preparing their soldiers to pass the Army Physical Fitness Test (APFT).

Armor forces bring mobility, lethality, and shock effect to the battlefield. As the Army transforms, it is rewriting its doctrine and scrutinizing its training methods. Armor crewmen have a unique mission and unique physical demands. Yet, in many instances, their physical training is no different from any other military occupational specialty (MOS). Although recent advances in technology are revolutionizing the way the Army fights, the Army may not be optimizing the physical readiness of armor crewmen. This paper examines the methods used to prepare armor crewmen for the physical rigors of combat. Its intended audience is armor leaders at the company level. This thesis answers the question, “Is there is a difference between how armor leaders train armor crewmen physically and how they should train them in light of Army doctrine and emerging fitness doctrine?" This paper examines the armor crewman's physical requirements and the training that will prepare him for the physical rigors of combat, and compare that to his current training.

In order to understand the physical requirements, the author will use the published standards found in Army Regulation 611-201, *Enlisted Career Management Fields and Military Occupational Specialties*. This regulation outlines the physical requirements for soldiers of every MOS in the Army. Many of the physical tasks associated with armor forces are maintenance related. Because of this, the author will use the maintenance technical manual, TM 9-2350-264-10-2, *Operator's Manual (M1A1)* (1990), to establish the frequency of some of the more demanding maintenance procedures. The author will also explore the physiology of fear and fatigue to discover what happens to soldiers placed under stress and if and how soldiers can prepare for or overcome those symptoms through physical training. It is important for armor leaders to have an understanding of how fear and fatigue affect soldiers in combat and to arm them with a strategy to mitigate their impact on the unit's performance in combat.

Once the author has distilled the physical requirements for armor crewmen, he will determine how to prepare them physically for combat. The author will use past and current research from various military and nonmilitary sources to formulate a training strategy. The author will break the research into the four components of physical fitness (body composition will not be considered as it is beyond the scope of this paper): Cardiorespiratory (CR) endurance, muscular endurance, muscular strength, and flexibility.

The author will find out how today's armor leaders are currently training their subordinates through the use of a survey that will be sent to active duty armor battalions and squadrons and students at the Command and General Staff Officers Course and Combined Arms Services Staff School. The author will then compare these to determine if the current training lines up with the Army doctrine and emerging fitness doctrine. If it is not, the author will recommend changes to enhance the training of armor crewmen.

This research is significant because the US will probably deploy armor crewmen in the near future and because it is incumbent upon armor leaders to prepare crewmen to meet the physical challenges they will face in the most efficient manner. The contributions of US armor forces in the recent past indicate that the Army prepares its armor crewmen well for combat. This thesis seeks to identify a gap between the method that should be used to train armor crewmen physically and the method currently employed. It is significant to armor leaders particularly at company level and below, because it provides a framework for developing a combat-oriented physical training program. Soldiers who are better prepared physically for combat will be able to better adapt to and overcome its stresses and physical demands. Additionally, soldiers who understand the purpose of their physical regimen will be more confident in their skills and abilities on the day of combat. Although the focus of this study is very narrow, it may be applicable as a model for creating physical training programs in future mounted units in general. A cursory look at the evolution of armored units and the fear and fatigue associated with combat provides insight into the current training requirements for armor crewmen.

History

Since the appearance of armored forces at the Battle of The Somme on 15 September 1916, armored forces have had a significant impact on the ways wars are fought. The crews of those early tanks faced numerous physical challenges. In addition to the fatigue and fear associated with combat, armor crewmen were constantly repairing their temperamental steeds. At the Battle of The Somme, forty-nine tanks were dedicated to the fight (Leadership Branch 1986, 1-2). Of those, only thirty-two made it to the line of departure and nine actually fulfilled their missions (Leadership Branch 1986, 1-2).

Although the British introduced the tank, it was the Germans who exploited its capabilities and made it the mainstay of combined arms warfare. German leaders utilized the tank's superior firepower and mobility as the decisive arm of their Blitzkrieg tactics. By this time tanks were more reliable, but they still required a tremendous amount of maintenance in order to keep them running. As armies developed more lethal projectiles, tanks developed heavier armor. Heavier repair parts and continuous maintenance translated to heavier lifts for armor crewmen; strength requirements increased.

Perhaps the most awesome demonstration of armor mobility and firepower is Desert Storm. During the brief conflict, armor forces again demonstrated their lethality and relevance. Armor crewmen fought on the new M1A1 main battle tank, a heavier and more lethal version of the M1. Even with brand new tanks, maintenance was still continuous and physically demanding.

Tanks have evolved steadily throughout the years. As they have become heavier and sported larger guns, armor crewmen have had to adapt to heavier ordinance and heavier repair parts. The tank skirts on the M1A1 vary in weight from 600 to 900 pounds, road wheels weigh 60 pounds each, the breech block weighs 200 pounds, and main gun rounds weigh between 41 and 53 pounds depending on the type (May 1992, 7). In order to work on the tank's track and suspension system, tank crewmen must swing the skirts open. To unlatch the number one skirt (which weighs 900 pounds), tank crewmen must actually raise it slightly on its hinges. Road wheels and track shoes wear out frequently and need to be replaced. Each track is composed of seventy-eight track shoes and each shoe weighs approximately fifty-seven pounds (New Equipment Training Team, 3-30). The breach block on the main gun requires periodic maintenance. Finally, the loader (the member of the tank crew who transfers main gun rounds from the ammunition storage rack to the breech of the main gun) must be able to load tank rounds in seven seconds or less for sustained periods. To summarize, the evolution in tank design has meant an increase in muscular strength requirements for armor crewmen.

Recent History

Although the Army is transforming, armor units are still equipped with Abrams tanks. The Abrams, while arguably the best tank in the world, has been in the Army's inventory longer than any other tank. The M1A1s are particularly maintenance intensive. Due to the age of the fleet, the author contends that the physical requirements for armor crewmen are even more strenuous than at the time of Desert Storm. Not only that, but tank crewmen are called upon to conduct a wider variety of missions, ranging from peacekeeping to combat, than during the Desert Storm era. Tankers may not necessarily fight from their tanks in the next conflict if it erupts while they are conducting a peacekeeping mission. If the current model holds true, tankers in such a situation may be fighting from High Mobility Multipurpose Wheeled Vehicles (HMMWVs) or dismounted.

Fear and Fatigue

The modern battlefield is extremely stressful. The lethality of modern weapons, the proliferation of weapons of mass destruction, and information overload have made it so. But combat has always been stressful. Consider the words of a soldier in WWI enduring the terror of indirect fire:

> At first I thought of what was happening to others near me, but soon I did not even think of what might happen to myself, My mind became a complete blank. I had feelings as if I had suffered physical hurt though I was not touched, the will to do the right thing was for the moment stunned. I could not think at all . . . and at the end there was a peace again and a strange quietness and the old queer feeling of satisfaction after a bad time as if something had been achieved, then utter weariness, a desire to sleep, a numb feeling. (Moran 1987, 62)

This passage demonstrates the pressures induced by fear--the lack of coherent thought and inability to perform. It also illustrates how extremely fatiguing surviving a fearful situation can be. Another soldier, finding himself in the sights of a sniper recounted:

> Once again the crack, crack, a blow on my haversack, and then the safety of another rock. . . . Breathless, in tears and humbled to find that fear had caused my bowels to move, I lay as dead until a glance at my watch spurred me on. (Holmes 1985, 205)

Stress and fatigue are variables in the physical requirements equation. Simple tasks, easily executed during peacetime, become much more difficult in the context of battle. In his work *The Soldier's Load and the Mobility of a Nation* S. L. A. Marshall concluded that the physiological effects of fear were the same as those of fatigue (1980, 45). He noted that soldiers could march much more rapidly away from battle than toward a battle. His research showed that soldiers' physical abilities were greatly reduced in combat due to fear. A soldier at Omaha Beach carrying part of a machine gun noted:

> Normally I could run with it. I wanted to do so now but I found I could not even walk with it. I could barely lift it. So I crawled across the sand dragging it with me. I felt ashamed of my own weakness. But on looking around, I saw the others crawling and dragging the weights which they normally carried. (Marshall 1980, 43-44)

Marshall concluded that the glycogen stored in soldiers' muscles was consumed by fear in the same manner as digging entrenchments--soldiers in combat were fatigued (1980, 46).

Historians and scientists have studied the effects of fear and fatigue on human performance for years. Their work may reveal methods for addressing fear and fatigue.

Assumptions

There are several assumptions associated with this work. The first is that specific exercises directly relate to combat skills. For example, armor crewmen are required to open and close heavy hatches when operating a tank. An exercise that corresponds with this movement is the overhead press, which primarily involves the trapezius, triceps, and deltoid musculature. Second, in conducting the research, one must assume that the Army Physical Fitness School's research is factual. Since it is the Army's repository of fitness related information and has conducted numerous studies on physical fitness, this is probably a safe assumption. The author also assumes that college and university athletic studies are similarly factual and contends that their research can be applied to armor crewmen.

Limitations and Delimitations

Because of the time available, this thesis will rely heavily on past studies and research. While the thesis may have broader applicability, it will focus on active component, armor crewmen only. Although armor units traditionally operate closely with mechanized infantry units, the tasks are not the same, particularly at the individual level.

Although it is a component of physical fitness according to FM 21-20, this work does not address body composition. While the author concedes that body composition is an important factor in physical fitness, this thesis is dedicated to physical training. Although physical training affects body composition, nutrition affects it even more significantly and will not be addressed in this paper.

Conclusion

The following chapters will answer the question of whether there is a difference between how armor leaders train armor crewmen physically and how they should train them in light of army doctrine and emerging fitness doctrine. In doing so, the author will determine the physical requirements for armor crewmen, find an optimal solution for preparing soldiers to meet those requirements, and compare the findings with the current training methodology.

CHAPTER 2

LITERATURE REVIEW

The purpose of this thesis is to determine if there is a difference between how armor leaders train armor crewmen physically and how they should train them in light of army doctrine and emerging fitness doctrine. The first requirement is to determine the current physical requirements for armor crewmen. In order to understand the physical requirements, the author will confer with the experts who train leaders at the Armor School. Additionally, the author will use the published standards from Army Regulation 611-201, which delineates the physical qualifications and general requirements for each military occupational specialty. The author will also use the maintenance technical manual to establish the frequency of some of the more demanding maintenance procedures. Finally, the author will explore literature on the physiology of fear and fatigue to discover what happens to soldiers placed under stress and if and how soldiers can prepare for or overcome the symptoms through physical training.

Once the author has distilled the physical requirements for armor crewmen, he will determine how to prepare them physically for combat. The author will use past and current research from various military and nonmilitary sources to formulate a training strategy. The author will find out how today's armor leaders are currently learning to train their subordinates for combat through the use of a survey. The author will then compare the two methodologies to determine if there is a gap between emerging physical training doctrine and the way armor leaders currently train their crewmen.

This research is significant because the U.S. will probably deploy armor crewmen in the near future and it is incumbent upon armor leaders to efficiently prepare them to meet the physical challenges they will face. It is important for armor leaders to have an understanding of how fear and fatigue affect soldiers in combat and to arm them with a strategy to reduce their impact on unit performance.

The references for this paper are divided into four categories. The first references will introduce readers to some of the related, unpublished works in the area of physical training. The second references will define the physical requirements for armor crewmen and related historical works and studies describing the effects of fear and fatigue on soldiers. The third category of references will introduce literature that links physical training to meeting the demands of combat. The fourth category of works will define the current physical training of armor crewmen.

Related, Unpublished Works

There are several related Master of Military Art and Science (MMAS) Theses and School for Advanced Military Studies (SAMS) Monographs related to this work. In his monograph "Physical Training for the Modern Battlefield: Are We Tough Enough?" MAJ M. Hertling concluded that soldiers were training for the next physical fitness test rather than the next war (1987, 34). He also saw that the two were not necessarily synonymous and recommended that the APFT be deemphasized in lieu of more specific training and testing based on a division's real world mission and area of operations (Hertling 1987, 39). He recommended Master Fitness Trainers (MFTs) spend an additional week at the Master Fitness Trainers Course to learn about and design physical readiness programs based on their unit's mission and area of operations. Finally, MAJ

Hertling recommended including mental relaxation and progressive imagery into the Master Fitness Trainer curriculum and into Army units in general as a means of overcoming combat stress. He felt that the physical and mental readiness of soldiers were inextricably linked and should be trained together.

MAJ Hertling's recommendations came as a result of studying the physiological effects of fear and fatigue on soldiers, success stories of units renowned for their physical accomplishments on the battlefield, Soviet physical readiness training (his paper was written at the height of the Cold War) and U.S. Army physical training and doctrine. Even though his monograph was written over a decade ago, it is important to this paper because it challenged the status quo of the time and provides a framework for evaluating physical readiness strategies today. Additionally, his paper appears to lay the groundwork for several other related papers.

Hertling's recommendation to include mental relaxation and visual imagery was a result of his study of fear. His research indicated that soldiers performed poorer in combat because of fear. He likened the reaction to "pre-competition jitters" of athletes and reasoned that the techniques used to help athletes perform under pressure could be used to mentally prepare soldiers to perform at their best as well (Hertling 1987, 41).

MAJ Hertling's study of fatigue indicated that its effects could be mitigated through specific training. He cited research that linked fatigue to failure at the neuromuscular junction, the contractile mechanism of the muscle and the central nervous system (Hertling 1987, 4-5). His research found that soldiers could be trained to perform more efficiently and that their training could stave off the negative effects of fatigue (Hertling 1987, 8).

Hertling also gave examples of great commanders who were known for training their soldiers harder than their contemporaries, which resulted in noteworthy exploits on the battlefield. He cited a study conducted at the U.S. Military Academy, which correlated successful combat leaders with a high degree of physical fitness (Hertling 1987, 9). His historical vignettes included such noted leaders as Alexander Suvorov, Stonewall Jackson, Lucian Truscott, and Terry Allen. In every case, these commanders ensured that their soldiers were physically combat ready through rigorous and realistic training.

Of great interest is Hertling's discussion of Soviet physical training. Hertling asserted that the Soviets trained more rigorously for the physical stresses of war than their U.S. counterparts. The Soviets emphasized physical training and tested their soldiers regularly in hand to hand combat, performance in a pentathlon, and a service specific biathlon and competition in five Olympic-event sports (Hertling 1987, 23). The biathlon was the most difficult and mission specific event. As an example, the paratroop biathlon consisted of throwing grenades at targets while sliding down a cable line from a ten meter tower, clearing the ground below with a submachine gun prior to executing a parachute landing fall, crawling through barbed wire, negotiating an obstacle course and climbing across a rope bridge suspended above burning oil while firing a weapon at targets on the far side--for time (Hertling 1987, 23-24).

The tank driver test for armor crewmen was similarly specific and difficult. Tankers had to jump into a six-foot trench, hoist a forty kilogram cargo from the earthworks and carry it 200 yards and back, sprint 100 yards to a labyrinth and secure ammunition boxes and transport them over a destroyed bridge to a tank. Once at the tank, the soldiers had to fight their way past an enemy soldier using hand to hand combat. Time stopped once the soldier loaded the ammunition in the tank's machine gun and charged the weapon (Hertling 1987, 24).

Hertling compared this to the "corporate" fitness of the soldiers in the U.S., asserting that most of those soldiers were training to meet the standards of the Army Physical Fitness Test (APFT) rather than training specifically for war (Hertling 1987, 35). Hertling's experience led him to believe that most of the Army was training to achieve high marks on this standard test rather than developing specific training to meet the specific needs of its various units (Hertling 1987, 34).

In "Physical Fitness and the Seventy-Fifth Ranger Regiment: The Components of Physical Fitness and the Ranger Mission," MAJ M. Pemrick applied Hertling's recommendation to develop specific physical training regimens based on a unit's combat mission (1999). He concluded that although the Seventy-Fifth Ranger Regiment maintained a high degree of physical fitness, its training overemphasized aerobic conditioning and did not place enough emphasis on strength, flexibility, coordination, and speed training (Pemrick 1999, 72).

His thesis is important to this paper because it illustrates a method for quantifying the type and frequency of physical exertion as it relates to a unit's mission. Pemrick researched the history of the Rangers in combat with an eye toward the physical demands placed on them. He analyzed current Ranger missions to find out the types of physical exertion Rangers might expect in combat and the frequency with which they might perform them. Finally, he correlated the physical events with the components of physical fitness from FM 21-20 and compared the results with how the Seventy-Fifth Ranger Regiment was preparing for the physical challenges of combat.

MAJ Pemrick used the Seventy-Fifth Ranger's Mission Essential Task List (METL) to derive the types of physical activities soldiers would be expected to perform in combat. He identified the two tasks from a Ranger Rifle Company of the Seventy-Fifth Rangers that he thought would most likely be executed, because of historical precedent: Perform airfield seizure and Perform raid. Next, he identified the platoon level collective tasks that supported the company level tasks and distilled the physically demanding tasks by looking for those tasks which were likely to be performed and would "place significant physical demands on the individual" (Pemrick 1999, 35). He listed seven platoon level tasks that would probably be performed and would certainly be physically demanding. He then identified the physically demanding individual tasks that supported the seven platoon collective tasks. He assigned a weight to those tasks based on the frequency with which they appeared in the seven platoon tasks (Pemrick 1999, 37). MAJ Pemrick analyzed each individual task to find out which component(s) of fitness they utilized: Aerobic, anaerobic, strength, flexibility, speed, or coordination. He constructed a matrix of the weighted tasks and the degree of the fitness components utilized to determine which components deserved the most emphasis based on real world missions. In the same manner, MAJ Pemrick analyzed the physical tests conducted to assess the Rangers' fitness level: the APFT, pull-ups, timed five-mile run and timed twelve-mile road march with forty-five pound rucksack. Finally, Pemrick compared the results of the physical demands of combat missions to the tests.

Pemrick concluded that the Seventy-Fifth Rangers overemphasized the aerobic component of fitness at the expense of strength. He concluded that the emphasis on aerobic conditioning was due to the APFT and recommended a Ranger-specific test for the Seventy-Fifth Ranger Regiment. The new test would consist of a timed five-mile road march with forty-five pound rucksack, rope climb (as many trips to the top as possible in two minutes) and timed casualty carry (soldier of like weight 150 meters) (Pemrick 1999, 79). MAJ Pemrick concluded his thesis by recommending a properly balanced physical training program for the Seventy-Fifth Ranger Regiment to further enhance their combat readiness (1999, 80-81).

In a similar thesis entitled "Physical Training Programs in Light Infantry Units: Are They Preparing Soldiers for the Rigors of Combat?" MAJ F. O'Donnell concluded that light infantry units were neglecting mobility in their physical training (O'Donnell 2001, 99). His work is important to this paper because, like Pemrick's thesis, it describes a methodology for capturing wartime physical tasks and comparing them with physical training in combat units.

In determining whether light infantry units had the proper combat focus in their physical training programs, MAJ O'Donnell evaluated the light infantryman's most physically demanding tasks against the components of physical readiness: Strength, endurance and mobility. He conducted a survey to determine how light infantry units were conducting physical training and assessed that against the components of physical readiness as well. Finally, MAJ O'Donnell compared the results (O'Donnell, 2001, 92-93).

MAJ O'Donnell compared the rifle company METLs from all the light infantry units in the Army and identified the common tasks. Using a method similar to the one used by Pemrick in his thesis, O'Donnell isolated the most physically demanding and relevant light infantry tasks. With the help of a sports physiologist, O'Donnell evaluated each task in terms of an expanded list of readiness components that included: Muscular strength (strength), muscular endurance (endurance), aerobic endurance (endurance), anaerobic endurance (endurance), motor efficiency (mobility), and flexibility (mobility). He found that the combat tasks demanded high levels of motor efficiency, muscular endurance, anaerobic endurance and muscular strength, in that order (O'Donnell 2001, 93).

O'Donnell's survey revealed that units in the field emphasized muscular endurance, anaerobic endurance, muscular strength, aerobic endurance, flexibility and motor efficiency in that order (O'Donnell 2001, 93). He concluded that units were only disproportionately emphasizing two components of physical readiness – motor efficiency and muscular endurance (O'Donnell 2001, 94). While units overemphasized muscular endurance, they did not adequately emphasize motor efficiency. He also found that while aerobic endurance was being properly emphasized, running was overemphasized (O'Donnell 2001, 95). Essentially, the only forms of aerobic endurance training units performed were running or road marches (O'Donnell 2001, 94). O'Donnell recommended that light infantry units devote training time to events such as obstacle courses, guerilla drills and grass drills to develop both aerobic and motor efficiency simultaneously. His other recommendations included developing a light infantry specific assessment to assist commanders in assessing the physical readiness of their units, educating leaders on combat focus to develop proper physical training programs, increasing the amount of mobility training, sustaining weekly foot marches, and reducing running frequency and distance (O'Donnell 2001, 106).

Another thesis, "A Progressive Resistance Weight Training Program Designed to Improve the Armor Crewman's Strength" by CPT B. May specified a strength-training regimen for armor crewmen (1992). The thesis recognized that armor crewmen have high strength requirements and CPT May presented a detailed methodology for improving the strength of armor soldiers. May's thesis is important to this study because it analyzes the strength requirements of armor crewmen and provides a valid method for improving this important aspect of physical readiness.

CPT May set the stage for the significance of his research by describing the increases in strength requirements for tankers over the years. May pointed out that as tanks and tank munitions got heavier, strength requirements increased. As a result, armor crewmen needed to be stronger to perform their normal crew duties such as stowing ammunition and routine maintenance. May also noted that emergency tasks such as crew evacuation had not gotten any easier with time--soldiers still need to be quite strong to evacuate their wounded from a tank turret or driver's compartment (May 1992, 6-7).

May analyzed the muscles used by armor crewmen in completing routine repairs and day to day operations. He found gym exercises that closely replicated the action performed by the armor crewman. For example, May determined that overhead presses closely replicated opening turret hatches from within the tank (May 1992, 83). CPT May concluded that armor crewmen use all the major muscle groups while performing their duties (May 1992, 85).

May set out to find the most effective method of training armor crewmen. He used studies from textbooks as well as books purveyed by fitness mavens to find out which techniques worked the best. He concluded that the best way to increase strength was through a progressive resistance program using free weights (because free weights utilize stabilizing muscles, they are portable and they are cheaper than other systems) (May 1992, 74-75). He advocated training the entire body three times per week utilizing three sets of six repetitions per exercise (May 1992, 68-71). His assertion came from comparing the studies and the advice of the authors in his research. May's exercises included squats, bench press, bent-over rows, overhead press, triceps extensions, biceps curls, dead lift, toe raises, upright rows and wrist curls. May concluded his thesis by recommending that the Armor Center conduct a formal study to validate his program (May 1992, 90).

Physical Requirements and Historical Significance

Army Regulation 611-201, *Enlisted Career Management Fields and Military Occupational Specialties* lists the physical requirements for career management field (CMF) 19 soldiers, or armor crewmen (Department of the Army 1995). CMF 19 has a physical demands rating of very heavy. The regulation further states that armor crewmen frequently lift 125 pounds one foot, occasionally lift and carry 130 pounds 150 feet and frequently climb nine feet (Department of the Army 1995, 137). This information is important in establishing the physical requirements for armor crewmen.

Technical Manual 9-2350-264-10, is the crew level maintenance manual for the Abrams main battle tank. It is a very detailed manual that shows tank crewmen how to properly maintain the M1A1. It also provides a schedule for when maintenance checks and services should be performed. Since most of the physical tasks tankers perform are maintenance related, this technical manual is a valuable source of information. The manual reveals that daily and weekly maintenance checks require great physical strength and muscular endurance.

Historical vignettes demonstrating the importance of physical readiness are germane to this study. R. Holmes captured the effects of fear on soldiers in combat in *Acts of War: The Behavior of Men in Battle* (1985). His work spans from the First World War to the Falkland War and studies the impact of fear on soldiers. His research led him to some revealing statistics. During the Korean War, historians found that 69 percent of soldiers reported feeling the following responses to fear: Increased heart rate, a sinking feeling in the stomach, uncontrolled trembling, cold sweat, weakness or stiffness, and vomiting in order of frequency (Holmes 1985, 205). Six percent reported uncontrolled urination and 5 percent reported uncontrolled defecation (Holmes 1985, 205). Holmes' work is relevant to this paper because it explores how soldiers respond to fear in combat.

S. L. A. Marshall's *Soldiers Load and the Mobility of a Nation* examines soldiers' physical response to combat related fear and fatigue (Marshall 1980). Marshall's study led him to conclude that fear reduces soldiers' effectiveness. Soldiers who have no problems marching twelve miles in peacetime will have difficulty doing so in combat. The positive effects of adrenaline demonstrated by athletes in physical competitions have a negative effect on soldiers in combat (Marshall 1980, 46). Marshall found that fear sapped the strength of men in combat as if they had completely fatigued their bodies physically (Marshall 1980, 46).

Meeting the Physical Requirements

Exercise Physiology: Human Bioenergetics and Its Application by G. A. Brooks, T. D. Fahey, T. P. White and K. M. Baldwin is an in depth study of exercise physiology (2000). It covers human performance, bioenergetics, human movement, metabolism, metabolic response to exercise, the respiratory and cardiovascular systems, muscular structure and development, exercise under various conditions, diseases, nutrition and athletic performance, gender differences in growth and development, exercise and the elderly and fatigue. It is a comprehensive text and is important to this thesis because it represents the latest research in its treatment of fatigue, CR conditioning, the development of muscular strength, and the development of flexibility.

The study of fatigue is important to this study, because it may provide clues to developing physical training to mitigate its effect on soldiers. Fatigue as defined in *Exercise Physiology* is the "inability to maintain a given exercise intensity" (Baldwin et al. 2000, 801). The study of physiological fatigue is very complex and scientists find it difficult to identify the cause and site of fatigue in humans in most cases. There are an incredible number of variables that factor into the body's ability to maintain exercise intensity. Because the human body is a complex system of systems, organs, tissue and cells, it is hard to isolate the site of fatigue; there may be several, interrelated fatigue sites at one time (Baldwin et al. 2000, 817).

Fatigue may be associated with the depletion or accumulation of metabolites. Since lactic acid is present in fatigued tissue, it was long held responsible for muscle fatigue, soreness and pain. Scientists now believe this is not the case, but the accumulation of calcium ion in mitochondria and cytosol may impair muscle performance (Baldwin et al. 2000, 817-818). Conversely, the depletion of metabolites such as creatine phosphate and adenosine triphosphate, blood glucose, muscle glycogen, liver glycogen and muscle and arterial oxygen impair muscle activity (Baldwin et al. 2000, 817).

Environment adds another dimension of variables to the problem, which further complicates identifying the causes of fatigue. The body's endurance declines when exercising in heat. The circulatory system has to work harder to distribute blood to the active muscles and to keep the body cool. If one becomes dehydrated, the body shifts fluid and electrolytes among body compartments, which, combined with the elevated temperature irritates the central nervous system which may then alter the individual's perception of difficulty in exercising (Baldwin et al. 2000, 818).

Another factor in fatigue is the state of the individual. A well-rested individual will demonstrate greater tolerance to exercise than a similarly conditioned individual who has already exercised and has had little or no recovery time (Baldwin et al. 2000, 801).

Muscular fatigue during competition most often seems to be due to fatigue of skeletal muscle and not other systems (Baldwin et al. 2000, 818). The central nervous system, its motor neurons and neuromuscular junctions appear to be more robust and less likely to fail to maintain performance (although in some instances the CNS limits the performance of muscles) (Baldwin et al. 2000, 818).

Exercise Physiology states that aerobic exercise works best for improving the cardiovascular system's capacity (2000, 331). In order to improve cardiovascular capacity, aerobic exercise should involve 50 percent or more of the body's musculature and should last at least fifteen to twenty minutes per exercise session (Baldwin et al.

2000, 331). The body should be exercised in this manner three to five times a week at an intensity above 50 to 60 percent of maximum volume of oxygen consumed (V_{O2max}) (Baldwin et al. 2000, 331).

In order to develop strength, *Exercise Physiology* acknowledges that most studies have found that a strength training regimen of between four and eight repetitions elicit the best response (2000, 431). In untrained individuals one set of exercise was found to be as effective at building strength as three (Baldwin et al. 2000, 432). In trained individuals, studies showed that three sets were more effective at building strength than one (Baldwin et al. 2000, 432). *Exercise Physiology* notes that the most successful strength athletes generally train three or four days a week during the off-season and one to three times a week during competition. In both instances heavy, multi-joint exercises such as squats, presses and pulls are usually trained only two days per week (Baldwin et al. 2000, 446).

Exercise Physiology recommends stretching to develop flexibility and identifies three types of stretching (2000, 453). The first is static stretching, which is a gradual elongation of the muscle. Ballistic stretching is stretching the muscles quickly in a bouncing movement. This method is not recommended due to the high chance of injury associated with it. The third type of stretch is proprioceptive neuromuscular facilitation. This type of stretch is a contraction-relaxation technique. The individual contracts his muscle for several seconds prior to stretching it and the process is repeated several times.

Exercise Physiology recommends stretching the muscles after they are warm (after aerobic exercise or weight training) mildly or moderately for ten to thirty seconds (studies indicate there is no added value to stretching longer) (Baldwin et al. 2000, 453). Individuals should rest thirty to sixty seconds between stretches and repeat stretches a minimum of four times to increase flexibility (Baldwin et al. 2000, 454). Stretching exercises should be performed a minimum of two to three days per week (Baldwin et al. 2000, 454).

An article from the U.S. Army Physical Fitness School entitled "The Right Dose of Running" concludes "It is likely that distance running, the centerpiece of Army PRT (physical readiness training) culture, is providing a false sense of fitness" (U.S. Army Physical Fitness School 2002, 6). It asserts that most units will need a high level of anaerobic endurance to be able to perform their mission essential tasks (U.S. Army Physical Fitness School 2002, 3). The article adds that a physical training program built around distance running will do little to prepare most soldiers for battle (U.S. Army Physical Fitness School 2002, 3). The article also indicates the overuse injuries associated with distance running and describes a study comparing the rate of injury in two groups of runners. The first group ran for thirty minutes three times a week at a given intensity and the second ran for forty-five minutes three times a week at the same intensity. Although both groups enjoyed the same aerobic fitness improvement, the first group sustained less than half the injuries of the second (U.S. Army Physical Fitness School 2002, 2).

The article concludes that the right dose of running is enough to prepare soldiers for combat and the Army Physical Fitness Test. The article recommends devoting more time to activities that will improve soldier mobility and strength (U.S. Army Physical Fitness School 2002, 6).

Another textbook, *High-Performance Sports Conditioning: Modern Training for Ultimate Athletic Development* is a series of essays written by a panel of some of the top strength and conditioning coaches in the world (2001). The book is edited by Bill Foran, the strength and conditioning coach of the Miami Heat and includes chapters on aerobic endurance, muscular strength and endurance and flexibility.

The chapter on aerobic endurance was written by Jack Daniels, Ph.D. Named the "World's Best Coach" by *Runner's World*, Daniels is a professor and distance running coach at State University of New York at Cortland. Daniels asserts that aerobic endurance is important in both anaerobic and aerobic events. During anaerobic events, requiring short, intense bursts of physical activity, aerobic fitness helps one recover more quickly (Foran 2001,196). Since pyruvic and lactic acids are removed from the body through aerobic processes, people in good aerobic condition are able to eliminate waste from the body more rapidly and as a result will be better able to withstand repeated bouts of high intensity exercise (Foran 2001,196).

During aerobic events requiring prolonged exercise, aerobic endurance is clearly important. People in good aerobic condition are able to sustain long periods of exercise with less toll on their bodies than people who are in poor aerobic condition. Just as recovery from anaerobic activity is an aerobic process, recovery from bouts of prolonged exercise is also an aerobic process (Foran 2001, 197). Hence, one in good aerobic condition will be able to recover more rapidly than one who is not.

Daniels' chapter is written for distance runners but contains information that is of value to anyone wishing to increase aerobic endurance. Daniels associates aerobic conditioning with increased lactate threshold and with efficient aerobic metabolism. According to Daniels, every person has a running speed or exercise intensity (lactate threshold) where lactic acid production is equal to lactic acid elimination (Foran 2001, 229). Lactic acid production is proportional to the intensity of exercise. One can increase his lactate threshold through proper aerobic training (Foran 2001, 229). To increase lactate threshold, Daniels recommends using tempo runs and cruise intervals. Tempo runs are twenty-minute runs at lactate threshold pace. Since taking before and after blood samples is impractical in most cases, Daniels describes the intensity as 90 percent of one's maximum heart rate or "comfortably hard" (Foran 2001, 229). As an athlete's lactate threshold increases, the trainer should increase his intensity (Foran 2001, 229).

Cruise intervals are repeated runs of four to fifteen minutes in duration followed by brief (one fifth of running time) recovery periods (Foran 2001, 230). The runs are at lactate threshold pace, since the goal is increasing threshold pace.

Daniels recommends interval training to increase aerobic metabolism efficiency. Although most people are familiar with the concept, many may not understand the proper exercise intensity to elicit the designed response of taxing the ability of the runner's muscles to produce energy via aerobic metabolism. In order to have this effect, Daniels recommends running at the slowest pace that induces maximum heart rate or, in subjective terms, a pace that is "hard" (Foran 2001, 230).

The muscular strength and endurance chapter of *High Performance Sports Conditioning* was written by Steven Plisk, the director of sports conditioning at Yale University. Plisk advocates brief maximal efforts and repeated submaximal efforts to improve muscular strength (Foran 2001, 76). Brief maximal efforts translate to eight or less repetitions at 75 to 100 percent intensity of one repetition maximum for low skill movements and three or less repetitions for complex skill movements (multi-joint) (Foran 2001, 75). He defines repeated submaximal efforts as five to ten sets at 80 to 90 percent intensity to exhaustion (Foran 2001, 75).

Plisk recommends significantly greater volume work to improve muscular endurance (Foran 2001, 76). He advocates extensive intervals and intensive intervals for muscular endurance training. Extensive intervals are defined as workouts at 30 to 40 percent of one repetition maximum which consist of three to six sets of twenty to thirty repetitions per exercise with less than five minutes rest between sets (Foran 2001, 75). Intensive intervals are defined as workouts at 50 to 60 percent of one repetition maximum which consist of three to six sets lasting twenty to forty-five seconds each (regardless of number of repetitions) with one to three minutes rest between sets (Foran 2001, 75).

Nikos Apostopoulos, the director of the Serapis Stretch Therapy Clinic in Vancouver, British Columbia, wrote the chapter on flexibility (Foran 2001). Recently, controversy surrounds whether stretching does more harm than good. Tendons are incredibly strong (tensile strength of 8,600 to 18,000 per square inch compared to that of muscle which is 77 to 80 pounds per square inch) (Foran 2001, 50). As a result, injury never occurs at the middle of the tendon; they occur near the muscle-tendon junction or where the tendon connects to the bone (Foran 2001, 50). When one stretches and feels the burning sensation associated with it, this is a strain which leads to microtears in the muscle near the tendon (Foran 2001, 50). The body responds to the microinjury by releasing collagen to the area, which creates scar tissue (Foran 2001, 50). The scar tissue contracts as it ages. Such microtears take more time to heal since the blood circulation near the tendon is much poorer than at the muscle belly (Foran 2001, 50). As microtears increase, they create an acute injury which may be very debilitating (Foran 2001, 50).

Apostopolous says that stretching can be beneficial if done correctly. He recommends stretching the muscles at an intensity of 30 to 40 percent where 100 percent equals pain. One should stretch each muscle group using three sets of sixty-second stretches once or twice daily (Foran 2001, 53).

Another idea from the book that fits within the scope of this paper is the chapter about periodization by Tudor Bompa, Ph.D. Bompa is an expert in the field of physical conditioning and has written several books on the subject. Periodization is the planning of one's training so that performance peaks at the time of competition. A periodized training plan has two components, the periodization of the annual plan and the periodization of motor abilities such as speed, strength and endurance to enable the athlete to perform his best at the time of competition (Foran 2001, 267). Recently, many athletes at various levels have used periodized training plans which has helped them to perform more consistently during the competitive season (Foran 2001, 268).

Periodization of the annual plan is dependent on the number of competitive seasons in the year. Since most team sports have one season per year, they will typically use a monocycle. Sports such as swimming or track may have two seasons per year and will use a bicycle that will enable athletes to peak twice during the year. Still other athletes may compete in sports that have three seasons per year and may have a need for a tricycle. Regardless of the number of cycles in the year, each cycle consists of three training phases, the preparatory, competitive and transition phase (Foran 2001, 268). The preparatory phase lasts thirty-two or more weeks for the monocycle, thirteen or more weeks for the bicycle, and eight or more weeks for the tricycle. The goals of the preparatory phase are to gain and improve physical conditioning, improve motor skills, improve psychological outlook, improve sport technique, and to ensure understanding of the overall plan in upcoming phases (Foran 2001, 271).

The competitive phase lasts the duration of the season(s). Its goal is to improve motor skills and psychological qualities for the given sport, to perfect technique, to perfect plays and to gain experience through competition (Foran 2001, 272). The goal of periodization throughout this phase is to improve each game or competition. Once a team qualifies for the playoffs or the championship, the team should taper intensity and volume of training in order to enable the team to achieve peak performance in the championship (Foran 2001, 272).

The transition phase lasts for the duration of the off-season. Training during the off-season is informal and relaxed to allow the athlete to recover physically and psychologically from the season without detraining (Foran 2001, 273-4).

Bompa also advocates periodization of motor abilities and lists several categories: Strength periodization, endurance periodization and speed periodization. Strength and endurance periodization may have applicability to this paper. Bompa divides strength periodization into six phases: Anatomical adaptation, maximum strength, conversion, maintenance, cessation and compensation (Foran 2001, 275-276).

The goal of the anatomical adaptation phase is to prepare the entire muscular structure of the body for the difficult training ahead (Foran 2001, 275). During this phase Bompa recommends the athlete perform two to three sets of nine to twelve exercises (Foran 2001, 275). The athlete should do eight to twelve repetitions per set at a load of 40 to 60 percent of the athlete's one repetition maximum (Foran 2001, 275). Rest between sets should be limited to one to one-and-a-half minutes (Foran 2001, 275). This phase should last four to six weeks or up to twelve weeks for those whom strength training is new (Foran 2001, 275). The anatomical adaptation phase coincides with the preparatory phase of the periodized annual training plan (Foran 2001, 275).

The goal of the maximum strength phase is, as the title to suggests, to develop maximum strength. Bompa does not give a specific repetition or number of sets, but specifies that this phase last from four to twelve weeks (Foran 2001, 275). The maximum strength phase occurs during the preparatory phase of the periodized annual training plan.

The goal of the conversion phase is to convert the muscular strength developed in the maximum strength phase into sport specific muscular endurance, power or both (Foran 2001, 276). This phase lasts four to eight weeks and spans the end of the preparatory phase and the start of the competitive or precompetition phase (Foran 2001, 276).

The goal of the maintenance phase is to maintain the power, strength and endurance levels achieved in the former phases (Foran 2001, 276). During this phase athletes should structure their training to support their individual needs. Bompa gives the example of a football lineman needing two strength and two power training sessions in a week compared to a wide receiver who needs a strength, two power and an endurance training session in a week (Foran 2001, 276). During the same period a 1,500-meter swimmer or distance runner may focus entirely on muscular endurance (Foran 2001, 276). Since this phase coincides with the competitive season, the time trainers devote to strength training will be of secondary importance to the skill specific training for competition. Trainers should therefore develop an efficient and specific program targeting the muscles used during competition (Foran 2001, 276).

The cessation phase is merely the cessation of strength training five to seven days prior to competition to conserve energy for good performance (Foran 2001, 276).

The goal of the compensation phase is to recover from the season and eliminate fatigue (Foran 2001, 276). Informal strength training during this period should focus on total body fitness instead of targeting the muscles used in competition (Foran 2001, 276). The compensation phase occurs during the transition phase of the periodized annual training plan (Foran 2001, 276).

Endurance periodization is broken into three phases: Aerobic endurance, aerobic and specific endurance and specific endurance (Foran 2001, 277). The goal of the aerobic endurance phase is to increase aerobic endurance. As the athlete’s endurance improves, the trainer must increase intensity and volume to ensure continued improvement (Foran 2001, 275). This phase lasts four to twelve months and coincides with the latter part of the transition phase and the beginning of the preparatory phase of the periodized annual training plan (Foran 2001, 277).

Trainers design the aerobic endurance and specific endurance phase to bridge the gap between general aerobic conditioning and sport-specific conditioning (Foran 2001, 277). Anaerobic conditioning that mimics competition should be introduced during this period. Trainers should use aerobic exercises of uniform and alternating intensity to develop their athlete’s endurance (Foran 2001, 277). Toward the end of this phase of training, which lasts throughout the preparatory phase of the periodized annual training plan, the trainer may employ long and medium interval training to heighten endurance (Foran 2001, 277). During both the aerobic and the aerobic and specific endurance phases, volume of training should be the greatest (Foran 2001, 277).

The objective of the specific endurance phase is to continue the development of sport specific endurance. The methods of training during this phase depend entirely on the sport for which the athlete is training. The specific endurance phase coincides with the competitive season and trainers must appropriately manipulate training intensity so that the athlete is competitive throughout the season and peaks for the championship (Foran 2001, 277).

Advanced Fitness Assessment and Exercise Prescription, written by V. H. Heyward contains information about developing CR endurance, muscular strength, muscular endurance and flexibility (1998). The following paragraphs summarize her research and findings.

Heyward recommends performing aerobic exercise for twenty to sixty minutes (continuously) three to five days a week at an intensity of 60 to 90 percent of maximum heart rate (50 to 85 percent V_{O2max}) (Heyward 1998, 84). Heyward defines three stages of CR progression: Initial conditioning, improvement and maintenance (Heyward 1998, 92). A typical aerobic exercise session should include a five to ten minute warmup, the aerobic event to be trained and ended with a five minute cool-down (Heyward 1998, 92).

The initial conditioning stage prepares the body for future aerobic exercise and typically lasts four to six weeks (Heyward 1998, 92). During this phase trainees should conduct “stretching exercises, light calisthenics and low-level aerobic activity” (Heyward 1998, 92). Initial exercise intensity should be 60 to 75 percent of maximum heart rate and should last twelve to fifteen minutes (Heyward 1998, 92). Exercise time should be increased gradually until trainees are able to exercise for twenty consecutive minutes (Heyward 1998, 92).

The improvement phase lasts sixteen to twenty weeks long and focuses on increasing intensity, frequency and duration (Heyward 1998, 92). Each of these variables should be increased independently--never at the same time (Heyward 1998, 92). Intensity should be increased gradually during this stage, frequency increased from three days per week to five days per week and duration increased every two to three weeks (Heyward 1998, 92).

The maintenance stage begins once trainees have achieved their aerobic endurance goals. During this phase, trainees can maintain their level of conditioning by exercising two to four days a week so long as the intensity and duration are the same as at the end of the improvement phase (Heyward 1998, 91).

To develop muscular strength, Heyward recommends an exercise regimen of three sets of six to eight repetitions performed at 80 to 85 percent of one repetition maximum for novices (1998, 124). She recommends five to six sets of four to eight repetitions performed at 80 to 90 percent of one repetition maximum for advanced trainees (1998, 124). To develop muscular endurance, Heyward advises a protocol consisting of three sets of fifteen to twenty repetitions at 60 percent of one repetition maximum (1998, 124).

According to Heyward, flexibility has two components: static and dynamic (1998, 203). Static flexibility is the measure of total range of motion at a given joint (Heyward 1998, 203). Dynamic flexibility is the amount of resistance to movement (Heyward 1998, 203). Flexibility can be enhanced through lengthening the muscles past their relaxed resting length. Stretching should not be performed beyond a range of motion that causes pain (Heyward 1998, 215).

PNF, ballistic and static stretching have all been shown to be effective (Heyward 1998, 217). However, some stretching exercises are safer than others. Studies have shown PNF stretching to be more effective in lengthening muscles than static stretching (Heyward 1998, 218). However, PNF stretches induce a higher level of perceived pain and require the aid of a partner or equipment.

Exercise specialists generally do not recommend ballistic stretching as a means of lengthening the muscles. There is a greater risk of injury associated with ballistic stretching (Heyward 1998, 218). Ballistic stretching may produce microscopic tears in the muscle and connective tissue, which may lead to greater injury (Heyward 1998, 218). Fitness experts often recommend static stretching, because it is safer than ballistic exercises and requires no partner (as in the case of PNF stretches).

Regardless of the exercise one chooses, flexibility training should be conducted three to seven days a week (Heyward 1998, 219). Each muscle group should be stretched three to five times for a duration of ten to thirty seconds per stretch (Heyward 1998, 219). A study comparing the benefits of stretching for thirty seconds and sixty seconds found that there was no significant difference (Heyward 1998, 219). Heyward recommends warming up prior to stretching (1998, 219).

Current Physical Training for Armor Crewmen

The Armor School at Fort Knox, Kentucky is the proponent for armor doctrine and training. The Armor School trains armor initial entry soldiers, noncommissioned officers and commissioned officers. Physical training in armor units is generally conducted at the company or platoon level and is usually led by noncommissioned officers. Armor leaders at all levels from company commander down are trained at the

Armor School. Noncommissioned officers are responsible for individual training within the unit. It is safe to say that the NCO Academy at the Armor School is responsible for training the trainers of the armor force.

> The mission of the United States Army Noncommissioned Officers Academy is to train today's modern Noncommissioned Officer Corps in those warfighting skills necessary to make them an invaluable asset for the Army of the twenty-first century. We provide NCOES Phase 1 and Phase 2 training for the Cavalry Scout & M1/M1A2 Abrams Armor Crewman (19D/K) in both the Basic and Advanced Noncommissioned Officer Course (BNCOC/ANCOC), the M1 Tank Systems Mechanic & Bradley Fighting Vehicle Systems Mechanic (63A/M) BNCOC, and the Primary Leadership Development Course (PLDC). (U.S. Army Armor School Noncommissioned Officer Academy 2002)

A conversation with SFC Christopher Wiesner, the Chief of Training at the Noncommissioned Officer Academy at Fort Knox, Kentucky revealed that the Armor School does not differentiate its physical training, but adheres to FM 21-20, AR 600-9, and AR 350-15 (2002). One can infer from this statement that the entire armor community is using FM 21-20 to train its soldiers.

FM 21-20, *Physical Fitness Training* is the Army's physical training doctrine. The current edition was written in 1992 (the Army published a change to the manual in 1998). It is the primary guide for training Army soldiers from every military occupational specialty. Because it applies to soldiers across a spectrum of physical requirements, the specifications are general in nature and not specific. The manual offers no best way to train according to MOS, but it outlines a methodology for commanders to assess their units and implement a physical training program based on the unit's mission.

FM 21-20 is written to "help leaders prepare their soldiers to meet the physical demands of war" (Department of the Army 1992, iii). It is a comprehensive manual which addresses the components of fitness, the principles of exercise, fitness training factors, body composition, nutrition, examples of exercises, competitive athletics, environmental and age considerations and contains a chapter on developing a unit physical training program.

Of importance to this paper are the components of exercise and how the Army advises training to improve them. The discussion on developing a physical training program is equally important. These two areas provide insight into how armor units are conducting physical training.

According to FM 21-20 there are five components of fitness: CR endurance, muscular strength, muscular endurance, flexibility and body composition (body composition will not be addressed here as it exceeds the limitations of this paper) (Department of the Army 1992, 1-3). CR endurance is defined as the "efficiency with which the body delivers oxygen and nutrients needed for muscular activity and transports waste products from the cells" (Department of the Army 1992, 1-3). To improve CR endurance, FM 21-20 advocates conducting aerobic activity at 60-90 percent of one's heart rate reserve for least twenty minutes three to five times a week (1992, 1-5). The manual devotes most of its chapter on CR endurance to various types of running exercises, Fartlek training, interval training, last-man-up running and cross country running (1992, 2-6-2-10). As would be expected in an Army PT manual, significant discussion is devoted to conducting road marches as well. Finally, FM 21-20 provides an explanation of alternative aerobic activities such as swimming, cycling, walking, cross-country skiing, rope skipping, handball and racquet sports, and exercising to music (Department of the Army 1992, 2-13-2-16).

FM 21-20 defines muscular strength as “the greatest amount of force a muscle or muscle group can exert in a single effort” (Department of the Army 1992, iii). To develop strength, the manual recommends lifting a weight that causes muscular failure in the three to seven repetition range and lifting that weight three to seven times. It recommends using one to three sets per exercise and training all the major muscle groups three times per week (Department of the Army 1992, 3-3).

FM 21-20 defines muscular endurance as “the ability of a muscle or muscle group to perform repeated movements with a submaximal force for extended periods of time” (1992, iii). The manual advocates doing one to three sets of twelve or more repetitions for every major muscle group three times a week (Department of the Army 1992, 3-3). FM 21-20 advises maximizing training time by combining muscular strength and muscular endurance development. In order to do this the manual recommends a repetition range of eight to twelve repetitions per set (Department of the Army 1992, 3-3). FM 21-20 also emphasizes the principles of overload and progression to achieve optimum strength and endurance gains (1992, 3-3-3-4). In addition to demonstrating exercises for the development of the major muscle groups using free weights and conventional machines, FM 21-20 demonstrates the use of partner resisted exercises (1992, 3-13-3-20).

FM 21-20 defines flexibility as “the ability to move the joints or any group of joints through an entire, normal range of motion” (Department of the Army 1992, iii). The manual emphasizes stretching during the warmup and cool-down phases of physical training sessions. The manual recommends the three types of stretching already visited by other texts to increase flexibility: Static stretching, passive stretching and proprioceptive neuromuscular facilitation stretching (Department of the Army 1992, 4-1).

Perhaps the most important part of the book is the chapter on developing a unit physical training plan. The authors of FM 21-20 narrowed this to a seven-step process (1992, 10-5). The first step is to analyze the physical aspects of the unit's mission. In this step the commander examines his METL with an eye for physical tasks. Next, the commander establishes fitness objectives. Fitness objectives should be specific and quantifiable. The next step is to assess the unit. FM 21-20 recommends using a diagnostic APFT, road marches or evaluated performance during ARTEPs (1992, 10-6). In the fourth step the commander determines the training requirements to move them from their present state to the commander's envisioned end state. The fifth step is to develop collective, individual and leader fitness tasks and determine the resources required for training. The commander then develops his physical training schedule as part of his training management. Finally, the leaders in the unit conduct and evaluate the training with an eye to improving their results. The manual even provides an example and walks leaders through the process (Department of the Army 1992, 10-7-10-9).

Chapter nine of Army Regulation 350-41, *Training in Units*, prescribes physical training for the Army (1993). According to the regulation "the objective of the Army Physical Fitness Program is to enhance combat readiness by developing and sustaining a high level of physical fitness in soldiers" (Department of the Army 1993, 9-3). Physical fitness is measured in terms of CR endurance, muscular strength and endurance, flexibility, anaerobic conditioning, competitive spirit, unit cohesion, self-discipline, a healthy lifestyle and the ability to cope with psychological stress (Department of the Army 1993, 9-3). AR 350-41 is important to this paper in establishing the expected physical training regimen of armor crewman.

The regulation specifies that Army units conduct intense physical training three to five times per week (Department of the Army 1993, 9-5). Like its counterpart, FM 21-20, AR 350-41 stresses the importance of physical training enhancing the soldiers' ability to complete individual tasks that support the unit METL. Of secondary importance is preparation for the APFT. The regulation also states that agility, balance (and controlling fear of heights), vaulting, jumping (and landing properly), marching with loads, strength development (such as pull-ups, rope climbing), crawling, and negotiating obstacles will be emphasized and trained (Department of the Army 1993, 9-3). The regulation dictates that commanders tailor their physical training to meet the challenges they expect to in combat (Department of the Army 1993, 9-3). AR 350-14 also discusses individual programs, physical fitness testing procedures, incentives and corrective action, safety, sports-related programs and uniforms (1993).

Conclusion

This body of research is not all-inclusive, but represents the works that will best serve this project. These works describe the physical requirements for armor crewmen, determine how to best prepare individuals to adapt to those requirements and reveal how physical training is conducted by armor crewmen today.

While several of the other papers referenced in the literature review are similar to this paper, this thesis is unique in its approach to the problem of training soldiers to withstand the physical rigors of war. Pemrick and O'Donnell focused on Rangers and light infantry soldiers respectively and built their arguments around the mission essential tasks conducted by the soldiers in war. The argument in this thesis is constructed from the physical requirements for armor crewmen from Army publications.

Although May's paper dealt specifically with training armor crewmen, his thesis differs from this one in its focus. While May's thesis concentrated on improving the physical strength of armor crewmen, this thesis takes a holistic approach to the physical training of armor crewmen. This paper will not only look at new developments in the area of strength training (since May's paper was written over ten years ago), but will also examine the areas of CR endurance, muscular endurance, and flexibility.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this thesis is to determine if there is a difference between how armor leaders train armor crewmen physically and how they should train them in light of Army doctrine and emerging fitness doctrine. This chapter describes the process that the author will follow to arrive at the solution to the problem. There are four steps to the research methodology of this project. The first step is determining the physical requirements for armor crewmen. The second is defining the training that armor crewmen must undergo to prepare them to meet the physical requirements. The third step is describing the state of physical training of armor crewmen today. The final step is comparing the current physical training regimen of armor crewmen in step three to the training requirements defined in step two in order to draw conclusions about how their current training should be modified, if at all. In each step the author will assess physical training by its components as defined in FM 21-20: Cardiovascular/Respiratory endurance, muscular endurance, muscular strength, and flexibility (the assessment omits body composition, in accordance with the limitations and delimitations defined in chapter one).

The first requirement is to define the physical requirements for armor crewmen. Many past theses have derived physical tasks from unit mission essential task lists (METLs). This method lends itself well to infantry units where most of the individual tasks supporting the collective tasks are physical in nature. Although many of the tasks associated with armor units are physical, most require less physical exertion than their respective counterparts in the light infantry world. That is not to say that armor crewmen do not perform demanding individual tasks during combat. Loaders must be able to load heavy tank rounds expeditiously and sometimes dismount to peer over the next intervisibility line. However, most of the physical tasks associated with armor crewmen take place during scheduled preventive maintenance checks and services and while crews upload ammunition and other supplies in preparation for combat. The author will use the applicable Army Regulations, field manuals, training circulars and technical manuals to define the physical tasks armor crewmen must be able to perform. Specifically, AR 611-201 *Enlisted Career Management Fields and Military Occupational Specialties,* which delineates physical requirements for each MOS, AR 350-41 *Training in Units*, which is the Army's Regulation for physical training, FM 21-20 *Physical Fitness Training* since it is the Army's physical training doctrine, and the technical manual for the M1A1 tank. The technical manual describes the tasks armor crewmen perform to keep their tanks operational and the frequency with which they perform their checks and services. Finally, the author will scan training-related (350-series) Army Regulations and training circulars to round out the research. The screening criteria for this search will be any work on physical training.

The physical requirements for armor crewmen will be defined in terms of cardiovascular/respiratory endurance, muscular endurance, muscular strength and flexibility. At the end of the analysis readers will understand how aerobically fit, strong and flexible armor crewmen must be to execute their duties.

The second step of this methodology is defining how armor crewmen must train in order to meet the physical requirements defined in step one. The author will rely on recently published textbooks and studies to determine the best methods of meeting the physical requirements for armor crewmen. He will also rely on Army doctrine. These sources will be used to determine how to develop cardiovascular/respiratory endurance, muscular endurance, muscular strength and flexibility.

The third step is finding out how armor leaders train tank crewmen. The author will use a survey to find out how units currently train in the Army. The author will administer the questionnaire to armor leaders attending the Command and General Staff Officer Course and the Combines Arms Services Staff School. He will also administer the survey to armor leaders and armor crewmen from armor battalions throughout the Army. The author will analyze the data with the help of Dr. Bitters of the Development and Assessment Division (DAD) using a computer program called SPSS to look for trends within the three groups of subjects and trends that transcend the groups.

The fourth step is to compare the physical training methodology prescribed by the latest science which meets the physical requirements for armor crewmen (found in step two) with the results of the survey (found in step three). The author will use gap analysis to compare the two methodologies in terms of cardiovascular/respiratory endurance, muscular endurance, muscular strength, and flexibility. The comparison should answer the primary question and is the focus of this thesis. Once the comparison is complete, the author will draw conclusions and make recommendations for implementation by the armor force. The following model (figure 1) was adapted from the Human Performance Technology Model and depicts the research method (Dessinger 2000, 3).

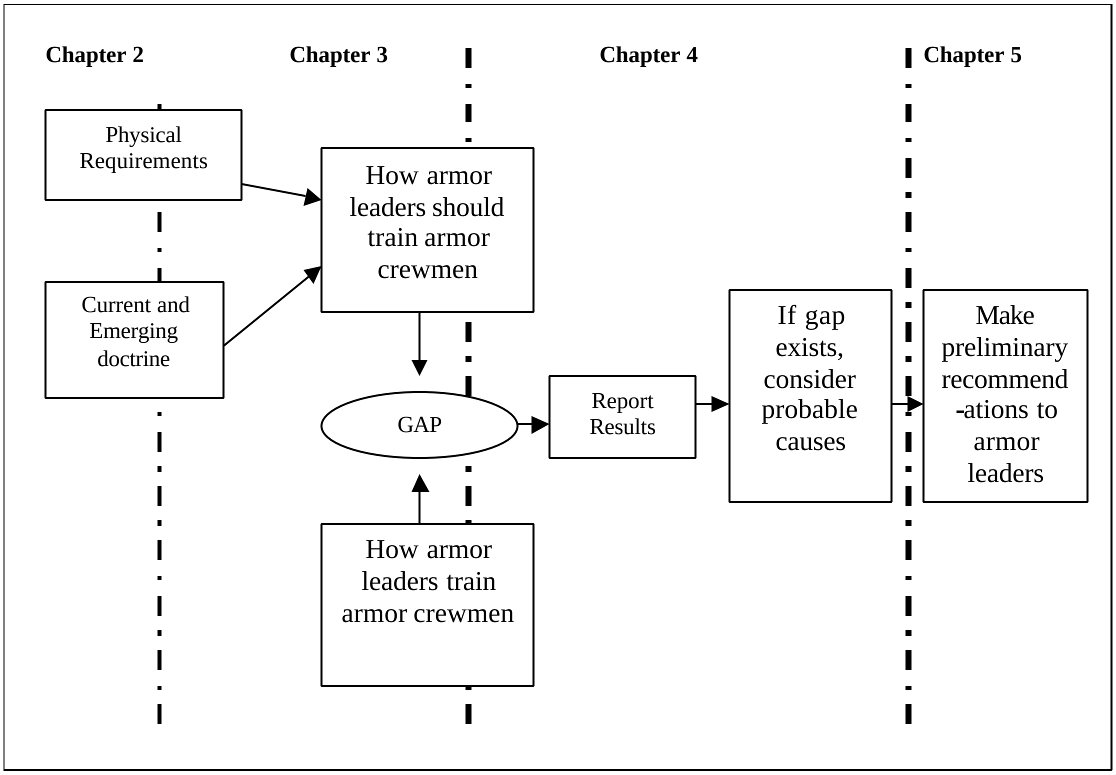


Figure 1. Research Methodology. Adapted from the Human Performance Technology Model (Dessinger 2000, 3).

Threats to Internal Validity

The author recognizes that there may be several other threats to internal validity, but will address the most immediate. In designing the questionnaire, or through the method of delivery, the author may have prompted the subjects to guess what he was trying to examine and answer the questions accordingly. Similarly the author may have prompted the subjects to give the "right" answer instead out of a desire to look knowledgeable. Finally, the author is only using one survey, which introduces mono-method bias.

CHAPTER 4

ANALYSIS AND CONCLUSIONS

This chapter is divided into four sections. The first section answers the question, "What are the physical requirements for armor crewmen in combat?" The second section answers the question, "In light of the physical requirements for combat, how should we train armor crewmen?" The third section answers the question, "How do armor crewmen currently train?" The last section compares how armor crewmen currently train with how they should train in light of current and emerging physical fitness doctrine.

The author used AR 611-201 and the operators' technical manual to determine the physical requirements for armor crewmen. Army Regulation 611-201 lists the specific physical requirements for armor crewmen. Since many of the physically challenging tasks associated with combat are maintenance related, the technical manual assisted not only in defining those tasks, but also in establishing the frequency with which they are conducted. Finally, the author drew on personal knowledge and the insight of Major Andy Groeger, a student at the CGSOC, to determine physical tasks that armor crewmen will have to accomplish in combat.

The author analyzed the data from the latest research in exercise physiology to determine the best way to train armor crewmen based on their physical requirements in combat. He divided the research into four general categories: Muscular strength, muscular endurance, flexibility, and CR endurance.

The author determined how armor crewmen currently train for combat through a survey distributed to CGSOC students, CAS3 students and armor battalions throughout the Army.

Finally, the author compared the training methods from section two of this chapter with the physical training conducted by the armor community. The author merely compared the two training methodologies in this chapter; he will present his recommendations based on this comparison in the following chapter.

Physical Requirements of Armor Crewmen in Combat

In his attempt to distill the physical requirements, the author examined AR 611-201 and TM 9-2350-264-10. The author selected tasks based on their physical demands and the frequency with which they are employed (see table 4-1). The tasks he selected were: Frequently climb nine feet, frequently lift 125 pounds one foot, occasionally lift and carry 130 pounds 150 feet, connect/disconnect track, check track assembly, open hatches, hull access covers and track skirts, load main gun, upload tank (CL 1, 3, 4, 5, weapons, camouflage, tentage), evacuate casualty, clear intervisibility line and operate in Mission Oriented Protective Posture (MOPP) Three or Four. The author consulted with LTC John Schoen, who holds a Master of Science Degree in Physical Education and is pursuing a Doctor of Philosophy in Exercise Physiology, to determine the relative use of CR endurance, muscular endurance, muscular strength, and flexibility in each of the tasks. The author assigned a number to each fitness component based on its relative involvement in the task. He used a subjective scale from zero to three where three is the greatest involvement of a given fitness component (see Table 1).

The first three tasks come from the armor crewman physical requirements prescribed in AR 611-201. For the task, frequently climb nine feet, the author found muscular endurance and strength to be the most utilized fitness components. Similarly, the task, frequently lift 125 pounds one foot, required both muscular endurance and strength. Muscular strength was employed most in the task, occasionally lift and carry 130 pounds 150 feet.

The author added connect and disconnect track since it is a physically demanding task armor crewmen must routinely do. Armor crewmen exercise this task whenever they replace any section of track (from individual track shoes to entire sides of track) and are often forced do this when the tank throws track. The physical aspects of this task are: Heavy lifting (number one skirt), pounding on the track components with sledge and ball peen hammers, pumping the end connector puller, and using various wrenches to tighten and loosen bolts. Connecting and disconnecting track requires great muscular endurance, followed by muscular strength.

Crewmen check track assembly after operating the tank or at maintenance halts as prescribed by the TM. Checking track assembly involves opening the skirts and inspecting every track shoe and its associated parts for damage or looseness. Crews replace damaged track shoes, centerguides and end connectors and tighten loose wedge bolts and centerguides. In terms of physical activity, crews use a ball peen hammer to check for damaged or loose parts and use wrenches to tighten bolts. The task, check track assembly, rates highest in muscular endurance followed closely by strength.

As one might expect, the entire tank is shrouded in heavy steel. Every time a crewman enters the tank or performs maintenance on the tank, he must open hatches, covers or skirts. Although the armor is thinnest on the top of the tank, the hatches and access covers are relatively heavy. The turret hatches require overhead arm strength to lift from the inside and arm and back strength to lift from the outside.

Access covers on the back deck of the tank protect the engine, transmission, batteries and precleaners. It follows that anytime any of these components is checked (during or after operations as prescribed by the TM), crewmen lift or remove access covers in addition to performing maintenance tasks.

The opening and closing of tank skirts has already been discussed in the section describing connecting and disconnecting track. Crewmen use primarily muscular strength in opening and closing hatches, access covers and skirts.

The M1A1 is not equipped with an automatic loader. A tank crewman, the loader, loads every round the tank fires. The M1A1 carries forty main gun rounds each weighing between forty and fifty-three pounds (May, 1992, 4). Depending on the tactical situation, the loader may need to load many of those rounds in a short time. A good loader can load a round in three seconds and sustain that rate until the ammunition ready rack is empty. To perform at that level, loaders must have great muscular endurance followed closely by muscular strength.

Tankers carry a lot of equipment into battle. Crewmen must upload ammunition, food and water, extra fuel and petroleum products, camouflage nets and tents, wire obstacle material, tools, spare parts (extra roadwheel and track shoes), and small arms weapons (M2 and M240s). Some of this equipment, such as the M2, main gun ammunition, water jugs (five gallons) and tools are cumbersome and heavy. In each case, a crewman lifts supplies and equipment from the ground or the back of another vehicle to a crewman on the hull of the tank who either stows them himself on the outside of the turret or passes them to another crewman inside the turret for stowage. In terms of frequency, tankers upload food, water, ammunition, and petroleum products daily. As one can imagine, this task stresses muscular endurance followed by muscular strength.

Although tankers may not have to evacuate a casualty from a tank often, it is a task that requires great physical strength. Armor crewmen must be prepared to pull their crewmates from the tank in the event they are injured. Although evacuating a casualty is usually a two-person task, one can imagine a scenario in which one crewmember must act quickly to save another crewmember or the rest of the crew. Crewmen must be able to lift their injured counterpart, manipulate him through the hatches of the turret or out of the driver's compartment and transport him to a medic vehicle (which will usually pull alongside the tank). In the case of a fire, crewmen may have to evacuate those who are unable to help themselves to a safe distance from the tank to avoid exploding ammunition and toxic fumes. For the purpose of this paper the assumption is that the a crew need only pull the injured crewman from the tank and transport him to a nearby medic track, which will be the case with most injuries. Tankers use muscular strength most in this task followed by flexibility.

Clearing intervisibility lines (folds in the terrain that impede vision) can often be done using binoculars from the tank commander's (TC's) hatch or by standing on the turret (a dangerous proposition). It is better in some cases to dismount a loader to clear the intervisibility line. This task involves dismounting a loader and having him sprint to the point where he can observe the far side of the intervisibility line to ensure that it is clear of enemy. The loader then sprints back to the tank and quickly climbs back into the loader’s hatch. A loader may execute this task several times during an operation depending on the mission, the tactical scenario and his tank’s position during movement. This task involves muscular strength, muscular endurance and CR endurance equally, followed by flexibility.

Operating in MOPP Three or Four makes every task much more difficult because of stress placed on the lungs from drawing breath through NBC filters and because of the cumbersome equipment. At MOPP Three, armor crewmen wear their protective overgarments, their overboots and protective mask. At MOPP Four, they wear the former items and their protective gloves. Soldiers must be in good CR condition to operate in MOPP Three or Four.

Once the author assigned scores to each fitness component based on its relative involvement in the tasks, he found the sum of each category. The sum of each component of fitness indicates its overall involvement in combat. The greater the score, the greater the involvement of that component. Muscular strength had a raw score of twenty-five and was closely followed by muscular endurance which had a score of twenty-three. Flexibility was next with a score of thirteen, followed closely by CR endurance with a score of eleven (see Table 1). Although the scores are subjective, minor adjustments in the numbers would not have a great impact on their relative scores.

Table 1. Relative Weights of Physical Components by Task

Tasks	**CR Endurance**	**Muscular Endurance**	**Muscular Strength**	**Flexibility**
Frequently climb 9 ft	1	2	2	1
Frequently lift 125 lbs 1 foot	0	1	3	1
Occasionally carry 130 lbs 150 feet	1	3	3	2
Connect/Disconnect track	1	3	2	1
Check track assembly	1	3	2	1
Open hatches, hull access covers, track skirts	0	1	3	1
Load main gun	1	3	2	1
Upload Tank (CL 1, 3, 4, 5, weapons, camouflage, tentage)	1	3	2	1
Evacuate casualty	0	1	3	2
Clear IV line	2	2	2	1
Operate in MOPP 3 or 4	3	1	1	1
Total	**11**	**23**	**25**	**13**

Training to Meet the Requirements

Although each component of fitness is important, the analysis in the last section demonstrated that muscular strength is the most critical component of fitness for tankers followed very closely by muscular endurance and then flexibility, and CR endurance. The author concluded that a training plan for armor crewmen should emphasize strength and muscular endurance. Of course, all components of fitness are important and overall fitness is holistic in nature, but tankers require strength and muscular endurance above all. The foundation of a fitness regimen for armor crewmen must be the development of muscular strength and muscular endurance.

Armor crewmen develop strength by working the muscles at high intensity for few repetitions. Trainers should develop strength training programs within a range of three to eight repetitions (Baldwin et al. 2000, 431; Department of the Army 1992, 3-3). Fewer repetitions may not be as effective as the prescribed range and may increase the chance of injury. Conversely, more repetitions will not necessarily improve strength, since the subject will necessarily not be able to work at as high an intensity.

The optimal intensity to elicit improvement in strength is from 80 percent of one repetition maximum load to a load that causes momentary muscular failure during the concentric phase of the exercise within the three to eight repetition range advocated by the author (Foran 2001, 75). Depending on the number of times armor crewmen exercise a muscle group in a week, trainers should alter the intensity to prevent overtraining. For instance, if armor crewmen are using one full-body workout each week, there is probably little chance of overtraining. However, if the same armor crewman is subjecting himself to three full-body workouts per week at maximum intensity, he may experience overtraining and a subsequent loss of strength.

There are a couple ways of reducing the risk of overtraining. One method is to alternate between heavy and light days. An armor crewman might train to failure one day, reduce the intensity by 20 percent during the next session and increase the intensity during the next. Periodization is another method that delivers increased strength with little risk of overtraining. Although most periodized schedules are measured in months so that athletes peak at the championship, armor leaders can establish two or three week minicycles. In either case, armor leaders design the schedule with the ultimate goal of improving the armor crewman's strength. The author suggests using two-week minicycles, because a shorter cycle makes it easier to map an armor crewman's progress. Trainers using such a scheme will see improvement in the strength of their crewmen (particularly the previously untrained) by using the heavy and light day scheme or by using progressive five or ten pound increments each session. That means that the first week, crewmen are likely working below 80 percent intensity for the first couple workouts, but the next week they are working at levels in the 90 to 100 percent range. Trainers design the workouts so that every couple of weeks armor crewmen add five to ten pounds to their previous best lifts. While this may not sound like much, an armor crewman who added five pounds to his maximum every two weeks could conceivably go from squatting 175 pounds to squatting 305 pounds in a year.

Experts disagree over the ideal number of sets one should use to develop strength. The confusion lies in a number of conflicting studies. Several studies have shown that there in no difference between the strength gains elicited by using one or three sets in previously untrained individuals (Baldwin et al. 2000, 432, 433). A study conducted by J. Kramer, et al. comparing two groups of previously trained subjects using training regimens of one set to failure or three sets using a light/heavy day approach concluded that three sets developed strength more rapidly than one (Kramer, et al. 1997, 143-147). A more recent study conducted at the University of Florida found no significant statistical difference in strength gains between experienced recreational weight lifters who conducted either one or three sets to failure (National Council for Exercise Standards

2003). If time is an issue, armor crewmen should use the one set approach. It may deliver the same results as using several sets. If time is not an issue, then armor crewmen can use the multi-set approach. The preponderance of information indicates that the number of sets is not as important as conducting strength training regardless of preference.

More is not necessarily better when it comes to strength training frequency. If trainers do not allow time for adequate recovery, strength gains will eventually cease and the armor crewman may begin losing strength. At the opposite end of the spectrum, are those who do not train often enough and never are able to realize their potential. Crewmen should strength train each muscle group a minimum of once per week and a maximum of three times per week. Using a logical training split, armor crewmen may train five or more days a week without overtraining so long as they train each muscle group one to three times a week (Heyward 1998, 124).

Muscular endurance is developed through low intensity, high repetition work. Armor crewmen should exercise using a repetition range of fifteen or more at an intensity of 60 percent of one repetition maximum (Heyward 1998, 124). Armor crewmen should do three to six sets and exercise each muscle group one to three times per week (Heyward 1998, 124; Foran 2001, 75).

It is difficult to design a training program to develop muscular strength and endurance simultaneously. Training time is limited. Training one muscle group on Monday for strength and again for endurance on Tuesday interferes with the recovery of the muscle and is counterproductive. There are a couple of strategies one can use in this situation.

One option is to compromise between the ideal repetition ranges to develop strength and endurance. FM 21-20 recommends working in the eight to twelve repetition range in order to improve both components simultaneously (Department of the Army 1992, 3-3). Another option is to train muscular endurance after strength training. While strength training may prevent optimal performance in muscular endurance activities, it will still allow the armor crewman to do both and properly recover. Yet another option is to cycle muscular endurance training into the armor crewman's strength training regimen.

There are a couple of options in doing so. The first is to inject muscular endurance into every other training session. The second is to alternate two- or three-week strength cycles with two- or three-week muscular endurance cycles. Regardless of technique, tankers must develop muscular strength and muscular endurance to be able to perform well.

Flexibility training should be conducted using PNF or active or passive static stretches (ballistic stretching is effective but increases the risk of injury) (Baldwin et al. 2000, 453). Flexibility training should be done at an intensity below the pain threshold for three or more 10 to 30-second stretches (Baldwin et al. 2000, 453; Heyward 1998, 219). Armor crewmen should conduct flexibility training at least three days per week; there are no negative side effects associated with training more often (Department of the Army 1992, 1-5; Foran 2001, 53).

Flexibility training should be conducted after the muscles are warm. Typically, soldiers warm up and then stretch before exercise and then again as part of the cool down at the end of a physical training session. While the author found evidence that flexibility training reduced the chance of injury, he did not find evidence that stretching before exercise had anything to do with the incidence of injury. Since the muscles should be warm prior to stretching, the logical time to stretch is following exercise, in accordance with the current guidance from the American College of Sports Medicine (American College of Sports Medicine 2003; Baldwin et al. 2000, 454). Trainers can save valuable training time by stretching at the end of a physical training session instead of at both the beginning and end.

CR endurance is developed by continuous aerobic exercise for twenty minutes or more three to five days a week (Baldwin et al. 2000, 331; Heyward 1998, 84; Department of the Army 1992, 1-5). Trainers should ensure that armor crewmen are exercising at an intensity of 60 to 100 percent of maximum heart rate (Foran 2001, 229-230; Heyward 1998, 84). If conducting aerobic training five days a week, the training intensity can be cycled so that armor crewmen have time to recover from strenuous bouts of aerobic activity.

Aerobic training can have a deleterious effect on strength training. It is important for trainers to keep this in mind when they design training programs for their soldiers. A run at near maximum heart rate the day after a session of strength training the legs will adversely affect recovery of the leg muscles. The same run scheduled immediately following leg training with adequate rest before the next training session would be better advised.

How Armor Leaders Currently Train Armor Crewmen

The author used a survey to determine how leaders currently train armor crewmen. He contacted the training officers of twenty-two armor battalions/squadrons and four heavy brigades to determine their interest in assisting with the project. Five battalion/squadron training officers agreed to participate. The low response was probably due to the deployment to Kuwait for Operation Iraqi Freedom (a threat to external validity). For those who agreed to participate, the intent was to get twenty tankers (rank immaterial) from each battalion/squadron to fill out the surveys. In all, the tankers of the units completed forty-five questionnaires.

The sample is not representative of the entire armor force, but may provide insights into how armor force trains its tank crewmen. For the purposes of this paper, the author will assume that the trends in the sample reflect the armor force in general.

Additionally, the author sent the email survey to the sixty armor CGSOC students and six CAS3 students. Fifty-seven percent of CGSOC students and 17 percent of the CAS3 students responded to the questionnaire. One might conclude that the percentage of CGSOC responses may be representative of the armor student CGSOC population at the time of the survey, but that the percentage of CAS3 responses is probably not representative of the armor population of that CAS3 class.

The survey consisted of four parts (see Appendix A). The first part was general demographic information. The second part dealt with how units establish and measure physical readiness goals. The third part of the survey asked respondents to describe the relative frequency that units trained the components of fitness and asked them to describe the relative importance of each component. This section did not get into the details of training (such as intensity, repetitions, and sets) because the author wanted to keep the survey as simple and as short as possible so that more tankers would participate. The fourth part of the survey was qualitative and asked respondents to describe how they would change armor crewmen physical training.

The author enlisted the assistance of Dr. Bitters of the Development and Assessment Division (DAD) at the CGSOC to sort through the data and identify trends. Dr. Bitters used SPSS, a statistical research tool to aid him. The author used a cutoff of 75 percent or greater to identify trends in quantitative answers and 15 percent or greater to identify trends in qualitative responses.

In terms of demographics, 57 percent of the respondents were from active duty armor battalions or heavy cavalry squadrons and 43 percent were from CGSOC or CAS3. Forty-five percent of the respondents were field grade officers, 23 percent company grade officers, 15 percent were NCOs, and 18 percent were lower enlisted.

Eighty-six percent of the respondents said that their battalion or company commander or platoon leader established unit fitness objectives. Seventy-nine percent defined fitness objectives in terms of APFT average. Even more significantly, 83 percent assessed physical readiness through the unit APFT average. Only 44 percent of those surveyed said that their unit fitness objectives were tied to their unit's METL. This indicates that leaders are basing their physical readiness on the Army's generic APFT instead of relating physical training goals to the missions their soldiers are expected to perform in combat. "Our physical training programs must do more for our soldiers than just get them ready for the semiannual Army Physical Fitness Test" (Department of the Army 1992, iii). Even so, it appears that a great deal of effort is being invested in preparing specifically for the APFT as indicated in the following paragraphs.

Most of the respondents (71 percent) indicated that units conducted physical training at the platoon level and their units conducted PT four or more times in an average week (92 percent). In terms of frequency of exercises, 63 percent said that they worked on sit-up improvement three or more times a week and 72 percent said that they worked on push-up improvement three or more times a week. An overwhelming 92 percent said that they ran three or more times each week. Respondents also indicated that they do little else in terms of CR conditioning.

The author's analysis in the first part of this chapter showed that the most important component of fitness was muscular strength, yet 42 percent of the respondents said that they did not do any strength training besides push-up improvement during an average week. In fact, only 4 percent indicated they were doing strength training (other than push-up improvement) more than twice a week. Meanwhile, armor crewmen are tearing up the physical training track. Fifty-six percent of the respondents said that they ran an average of eight or more miles each week. Also, 52 percent of the respondents indicated that they conduct flexibility training two times in an average week or less.

The third section of the survey revealed that fully 87 percent of the respondents agreed or strongly agreed (34 and 53 percent respectively) that CR endurance was the overall focus of their unit's physical readiness program. By comparison, only 48 percent of the respondents agreed or strongly agreed (40 and 8 percent respectively) that muscular strength was the overall focus of their unit's physical readiness program. Seventy-eight percent agreed or strongly agreed (64 and 14 percent respectively) that muscular endurance was the overall focus of their unit's physical readiness program. Thirty-eight percent agreed or strongly agreed (34 and 4 percent respectively) that the overall focus of their unit's physical readiness program was flexibility.

The final question on the survey asked respondents, "What, if anything, would you change about physically training armor crewmen?" Again, the author determined that if 15 percent or more of the respondents recommended the same or nearly the same change, it would be considered a trend. There were three trends. Twenty-six percent of those surveys recommended that physical training be METL focused and based on real-world missions. Over 23 percent recommended that physical training for armor crewmen focus more on strength training. Fifteen percent recommended that more variety be added to physical readiness programs. Of lesser significance, 12.5 percent recommended more organized athletics for esprit de corps and development competitive spirit and 10 percent recommended either focusing less on the APFT or changing the APFT to more closely match the skills armor crewmen must have.

Comparison of Recommended Training with Current Training

In the first section of this chapter, the author concluded that when it comes to training armor crewmen for combat, strength should be emphasized, followed closely by muscular endurance, and less closely by flexibility, and CR endurance. The respondents of the survey indicated that unit physical readiness programs focused on CR endurance, followed by muscular endurance, muscular strength, and flexibility. While the intimate details of unit physical readiness training such as intensity, repetitions and sets were beyond the scope of the author's survey, the survey provides information about how units are training in general.

Units are not emphasizing muscular strength. Not only did it rank third behind CR and muscular endurance in perceived importance, but 42 percent of the respondents reported that this component is not trained in an average week of training (aside from push-up and sit-up improvement, which is probably more geared toward muscular endurance anyway). It should be noted that 54 percent reported that they conducted strength training one or two times in an average week; only four percent reported doing strength training more frequently. So long as those workouts included the musculature of the entire body in one or both sessions, this would be sufficient since each body part should be trained one to three times per week. However, even if the group that reported conducting strength training one or more times a week executed the training with the proper intensity, repetitions and sets, it still means that only 58 percent of those surveyed are actually doing it.

One can conclude from the survey data that units are probably not emphasizing muscular endurance except in the area of push-up and sit-up improvement. Although 78 percent of the respondents agreed or strongly agreed (64 and 14 percent respectively) that muscular endurance was the overall focus of their unit's physical readiness program, 23 percent said they are not doing any type of muscular endurance training other than push-up and sit-up improvement. Since the author determined that this was the second most important component of fitness, the fact that such a high percentage of respondents indicated that their units completely neglected to train this component (other than in preparation for the APFT) demonstrates that units are not emphasizing it enough.

Units are underemphasizing flexibility training. Although nearly half of the respondents indicated that their units conducted flexibility training in the recommended range of three or more times per week, over half said theirs did not. In fact, 28 percent indicated that they did not participate in flexibility training during an average week of physical training.

Units are emphasizing CR endurance properly. Although it appears that units are overemphasizing CR endurance based on the overwhelming majority of respondents who said that CR endurance was the focus of their units' physical readiness program, over 90 percent said they were conducting CR endurance training within the recommended range of three to five times per week. However, units may be running too often and perhaps too much (U.S. Army Physical Fitness School 2002, 2-3). Nearly 40 percent of the respondents indicated that their units engaged in no other CR endurance exercise besides running and 56 percent said their units ran eight or more miles each week.

Additionally, in terms of training focus, it appears that units are preparing their armor crewmen for the APFT instead of for combat related tasks. While the two are not mutually exclusive, FM 21-20 cautions "mission-essential tasks, not the APFT, should drive physical training" (Department of the Army 1992, 14-1). The current APFT measures muscular endurance and CR fitness - not muscular strength (Department of the Army 1992, 14-1). The implication is that if a unit concentrates on developing the components of muscular and CR endurance for the APFT, it may be neglecting the component most important to armor crewmen in combat.

In terms of comparison, 63 percent said their units conducted sit-up improvement three or more times each week, over 70 percent said their units conducted push-up improvement three or more times each week and over 90 percent said that they ran three or more times each week. In contrast, 4 percent reported doing any strength training three or more times a week.

In conclusion, armor leaders are designing physical training regimens that underemphasize overall muscular strength and endurance and flexibility, but are properly emphasizing CR endurance. Armor leaders may be advocating running too often and perhaps for too long. Additionally, armor leaders are allowing the APFT to drive training instead of basing training on mission-essential physical tasks.

CHAPTER 5

RECOMMENDATIONS

In chapter 4 the author concluded that armor leaders are overemphasizing training for the APFT at the expense of battle focused training. As a result, physical training programs lacked variety and usually consisted of pushup and situp improvement exercises and lots of running--perhaps too much. He also concluded that armor leaders were not adequately addressing the components of muscular strength and endurance and flexibility in their training regimens. The following paragraphs will address these areas and provide solutions to the problems.

Prior to implementing any of the author's proposed solutions, the Army should commission the Army Research Institute (ARI) or the U.S. Army Physical Fitness School (USAPFS) to ensure that the sample population of this pilot study actually represents the entire armor force. The Army should also conduct a more thorough study that captures the finer details of unit physical training such as intensity, repetitions, sets and duration to provide a clearer picture of how armor crewmen are trained. A survey may not be the best vehicle for such a study. The Army would be better served using a small team of experts in exercise science to observe physical training throughout the armor force in order to capture the current state of training.

One of the primary reasons for leaders allowing the APFT to drive their physical readiness programs is because rewards are tied to performance on the test. Soldiers earn promotion points and leaders earn bragging rights based on APFT results. The net result is that leaders have come to equate physical readiness with the APFT. While the APFT may be a good measure of CR endurance and muscular endurance for those muscle groups targeted, it is not a measure of strength, flexibility or muscular endurance for other important muscle groups (i.e. the muscles of the back). The problem is not so much the test itself, but the emphasis placed on it. Naturally if there are rewards associated with performance on the test, leaders and soldiers will train harder to master those skills. Units should establish goals that measure performance of combat tasks and provide rewards for those in addition to the existing incentives to do well on the APFT.

An example of this might be a timed Armor Obstacle Course. One could put together any number of courses in the motor pool. For instance, an obstacle course might have tank crews manually piece together a ten-block section of track, move ten road wheels from a maintenance point to the back deck of a tank, mount the small arms weapons, have the loader load ten dummy main gun rounds and then have the crew extract the "injured" loader from turret to a nearby medic track. The crews with the fastest times could be given extra privileges, passes or other incentives. Such a program would take the emphasis off the APFT and place it on mission-essential physical tasks.

Unfortunately, the Army is no longer training Master Fitness Trainers (MFTs). Perhaps one of the main reasons is that MFTs were unable to effect change in the Army, because many leaders are self-proclaimed experts when it comes to physical training. A way to ensure that they really are experts and that they understand physical training is to incorporate MFT coursework in the Army's schools. The course could be integrated into the current Officer and Noncommissioned Officer Education Systems, but tailored to meet the branch/MOS needs of the individual. Much of this training could be conducted on-line (although there is nothing better than actually experiencing the training).

Additionally, the USAPFS could add a page to their website where the fitness school and Army leaders could share TTPs and advice for creating strong, METL-based physical readiness programs.

In addition to providing important information, the course would emphasize the importance of using the same care in planning physical training as is used in planning other training. Too often physical training is not properly prepared or resourced. The scenario where a Sergeant is told to lead physical training minutes before it is scheduled to begin is too often the norm. Physical training must be given the same priority as other training. Gymnasiums, pools, obstacle courses or other resources need to be scheduled and leaders need to develop a plan and prepare themselves to execute it. Leaders at all levels must ensure that their subordinates are adding their specific training ("Platoon PT" is not acceptable) to the training schedule and executing the training as planned.

Implementation of these recommendations will go a long way toward addressing the lack of focus on muscular strength, muscular endurance, flexibility and variety. Many leaders contend that the Army lacks the resources to develop muscular strength during physical training. Many senior leaders have closed gyms during PT hours, because they see too much wasted time. There are many ways to make time in the gym profitable, but leaders must have a very clear plan. One of the better methods is the use of circuit training. Each soldier in a platoon grabs a piece of equipment and rotates through the circuit at the command of the leader. This is a great full-body workout. If there is not enough equipment, then extra personnel can spot their platoonmates. If the gym is crowded, leaders can look into scheduling their PT in the afternoon instead of the morning.

Although the Army's gymnasiums are a great place to develop strength, soldiers can develop strength without a gym. One of the best and most portable exercise forms is partner-resisted exercise (PRE). Another great way to develop strength is through log drills. Creative leaders can find any number of ways to develop the strength of their soldiers. There are plenty of heavy tools and parts in all tank motor pools.

Leaders must concentrate on more than just the pectorals, triceps and the iliopsoas when developing muscular endurance training. Leaders should think in terms of balance. Each muscle group in the body must be developed – not just those used for doing push-ups and sit-ups. They should incorporate flexibility training at the end of every PT session and should consider devoting more time to it on "light" days or on days after particularly vigorous exercise.

Leaders should consider decreasing the number of days they run and proportionally increase the number of days they do alternative aerobic work. Finding alternatives to running injects variety into training and may also improve overall muscular endurance. Swimming, road marches, exercise to music, cycling, Nordic skiing are some of the alternatives recommended by FM 21-20 (Department of the Army 1992, 2-13-2-16). Grass drills and guerilla drills can also be used to add variety while improving CR and muscular endurance.

If Armor is to be the decisive arm of combat in the future, armor crewmen must be in top physical condition. Armor leaders must apply the same battle focus to physical training as they do to other training. The days of physical training without focus and purpose must end. Training armor crewmen to meet the requirements for a generalized APFT will not develop the all the physical skills that armor crewmen must possess to fight and win decisive battles. Leaders must take the time to carefully develop physical training regimens that will allow their soldiers to develop the strength, muscular endurance, cardiorespiratoy endurance and flexibility that will be critical to their survival in combat. Leaders of the future must take every opportunity to make physical training as mission specific and realistic as possible.

APPENDIX A

ARMOR PT SURVEY

The purpose of this survey is to gain a better understanding of how armor leaders train tank crewmen physically through their unit PT programs. This survey is part of research conducted as work toward a Master of Military Arts and Sciences Degree through the U.S. Army's Command and General Staff Officers Course at Fort Leavenworth. Please take a few minutes to fill out this survey (it should take about 15 minutes to complete). The data obtained through the survey will be used for the sole purpose of drawing conclusions about PT within the armor community for a research paper – no personal information will be disclosed to third parties. Anyone desiring to see the results of this study may email the author directly at shane.baker@us.army.mil or call him at (913) 682-8900.

Please type your response in the answer block

1. What is your rank?	
2. Indicate your unit (or CAS3, CGSOC for students)	

Please answer the following yes/no questions by typing y or n in the answer block.

3. Did your battalion, company commander or platoon leader establish fitness objectives?	
4. Were your fitness objectives defined in terms of unit APFT Average (i.e. the unit has a goal of scoring an average of 240 on the PT test)?	
5. Were your fitness objectives defined in terms of unit METL Focus?	
6. Were your fitness objectives defined in terms of a specific training event or deployment?	
7. Does (did) your unit assess physical readiness in terms of unit APFT average (average APFT score)?	
8. Does (did) your unit assess physical readiness through commander's assessment?	
9. Does (did) your unit assess physical readiness another way? If so please indicate here. ____	

For questions 10 through 20, type the appropriate letter in the answer block

Indicate the level at which PT is normally conducted (A=Battalion, B=Company, C=Platoon, D=Section).

10. What level is (was) PT conducted in your battalion?	

Indicate how often your unit assesses physical readiness (A=weekly, B=monthly, C=quarterly, D=semiannually).

11. How often does (did) your unit assess physical readiness?	

Indicate the number of times per week you unit conducts PT (A=0-2 times, B=3 times, C=4 times, D=5 or more times)

12. How often does (did) your unit conduct PT each week?	

Indicate the number of miles your unit runs (A=0-4 miles, B=4-8 miles, C=8-12 miles, D= 12 or more miles).

13. How many miles does (did) your unit run in an average week?	

Indicate the number of times in an **average week** an exercise is (was) conducted

(A=0 times, B=1-2 times, C=3 times, D=4 times, E=5 or more times).

14. Sit-up improvement?	
15. Push-up improvement?	
16. Low intensity (low weight), high repetition workouts other than push-up/sit-up improvement?	
17. High intensity (high weight), low repetition workouts other than push-up/sit-up improvement?	
18. Flexibility training?	
19. Running/jogging?	
20. Aerobic exercise other than running?	

Indicate to what degree you agree with the following statements (A= Strongly agree, B= Slightly agree, C= Undecided, D= Slightly disagree, E= Strongly disagree).

21. The overall focus of your unit's physical readiness program is (was) **cardiorespiratory endurance**?	
22. The overall focus of your unit's physical readiness program is (was) **muscular strength**?	
23. The overall focus of your unit's physical readiness program is (was) **muscular endurance**?	
24. The overall focus of your unit's physical readiness program is (was) **flexibility**?	

25. What, if anything, would you change about physically training armor crewmen?

____

____

____

CGSOC Survey Control Number 03-022

Thank you for participating in this survey!

APPENDIX B

SURVEY DATA

Frequencies

Statistics

		1. What is your rank?	2. Indicate your unit (or CAS3, CGSOC for students)
N	Valid	80	80
	Missing	0	0

Frequency Tables

1. What is your rank?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1LT	5	6.3	6.3	6.3
	2LT	5	6.3	6.3	12.5
	CPT	8	10.0	10.0	22.5
	CSM	1	1.3	1.3	23.8
	MAJ	36	45.0	45.0	68.8
	PFC	3	3.8	3.8	72.5
	PV1	2	2.5	2.5	75.0
	SFC	1	1.3	1.3	76.3
	SGM	1	1.3	1.3	77.5
	SGT	3	3.8	3.8	81.3
	SPC	10	12.5	12.5	93.8
	SSG	5	6.3	6.3	100.0
	Total	80	100.0	100.0	

2. Indicate your unit (or CAS3, CGSOC for students)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-34AR	15	18.8	18.8	18.8
	1-66AR	9	11.3	11.3	30.0
	1-68AR	20	25.0	25.0	55.0
	2/3 ACR	1	1.3	1.3	56.3
	2/3 ACR	1	1.3	1.3	56.3
	CAS3	1	1.3	1.3	57.5
	CAS3	1	1.3	1.3	57.5

	CGSOC	34	42.5	42.5	100.0
	Total	80	100.0	100.0	

Tables (expressed in percent)

	Enlisted	NCO	Company Grade	Field Grade
Rank Category	18	15	23	45

	Maneuver	CGSOC
Unit Category	57	43

Tables (expressed in percent)

	Yes	No
3. Battalion, company commander or platoon leader established fitness objectives.	86	14
4. Fitness objectives were defined in terms of unit APFT Average.	79	21
5. Fitness objectives were defined in terms of unit METL Focus.	44	56
6. Fitness objectives were defined in terms of a specific training event or deployment.	28	73
7. Unit assessed physical readiness in terms of unit APFT average (average APFT score).	83	18
8. Unit assessed physical readiness through commander's assessment.	68	33
9. Unit assesses physical readiness another way.	13	87

	Company	Platoon	Section
10. What level is (was) PT conducted in your battalion?	14	71	14

	Weekly	Monthly	Quarterly	Semi-annually
11. How often does (did) your unit assess physical readiness?	9	13	39	39

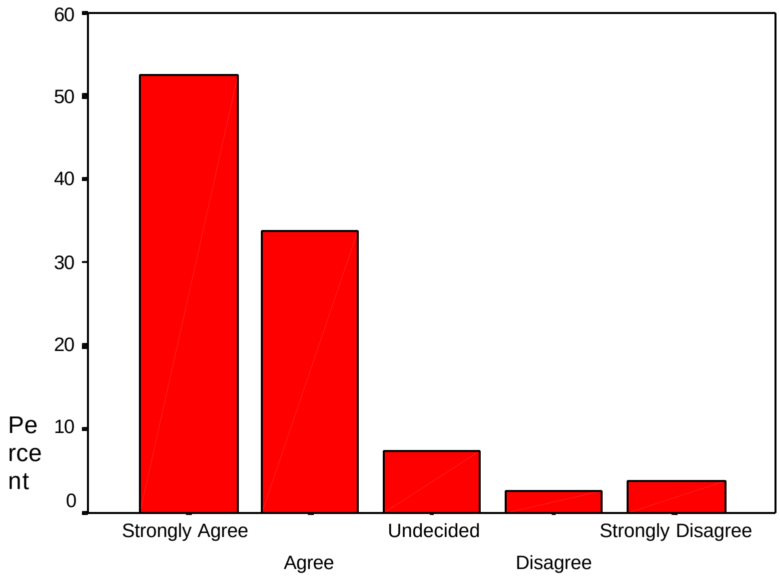
	3 Times	4 Times	5 or More Times
12. How often does (did) your unit conduct PT each week?	8	51	41

	0-4 Miles	4-8 Miles	8-12 Miles	12 or More Miles
13. How many miles does (did) your unit run in an average week?	18	28	38	18

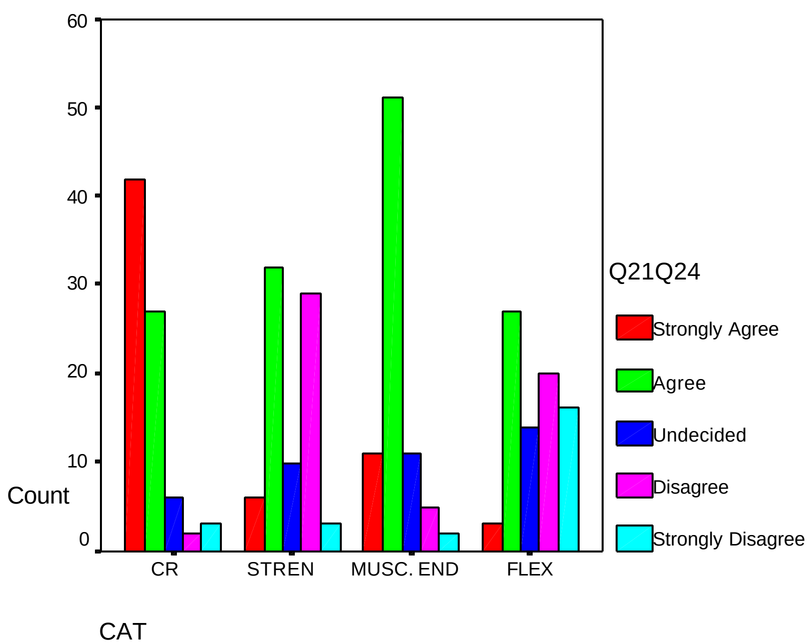
	0 Times	1-2 Times	3 Times	4 Times	5 or More Times
14. Sit-up improvement?	0	38	46	14	3
15. Push-up improvement?	0	29	50	19	3
16. Low intensity (low weight), high repetition workouts other than push-up/sit-up improvement?	23	63	12	3	0
17. High intensity (high weight), low repetition workouts other than push-up/sit-up improvement?	42	54	1	3	0
18. Flexibility training?	28	24	13	22	14
19. Running/jogging?	0	9	24	38	30
20. Aerobic exercise other than running?	38	52	3	6	1

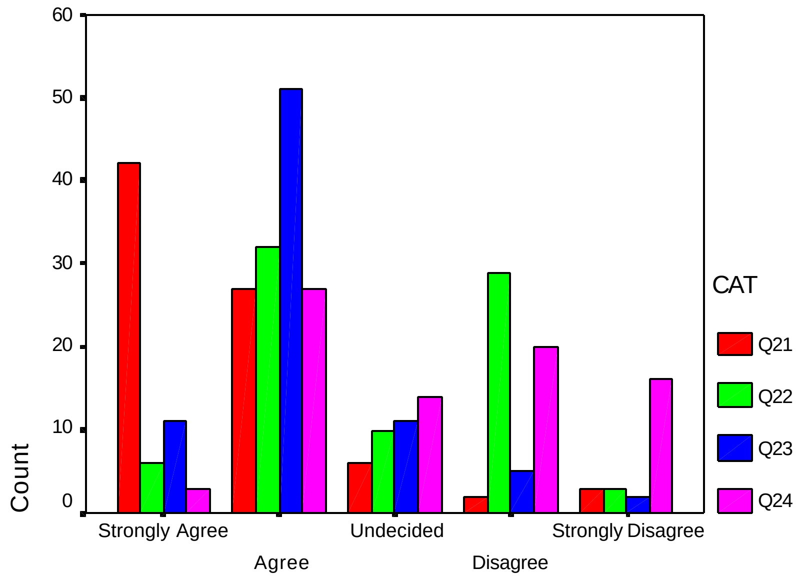
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
21. The overall focus of my unit's physical readiness program is (was) cardiorespiratory endurance?	53	34	8	3	4
22. The overall focus of my unit's physical readiness program is (was) muscular strength?	8	40	13	36	4
23. The overall focus of my unit's physical readiness program is (was) muscular endurance?	14	64	14	6	3
24. The overall focus of your unit's physical readiness program is (was) flexibility?	4	34	18	25	20

Graphs



21. The overall focus of my unit's physical readiness program is (was) CR end




60
50
40
30
20
10
0
Count
Strongly Agree
Agree
Undecided
Disagree
Strongly Disagree
CAT
Q21
Q22
Q23
Q24

Q21Q24

GLOSSARY

Tank skirt. A series of armored panels that protect a tank's suspension.

Road wheel. Wheels that support a tank's weight and roll along its track.

Cardiorespiratory (CR) Endurance. "The efficiency with which the body delivers oxygen and nutrients needed for muscular activity and transports waste products from the cells" (Department of the Army 1992, iii).

Muscular Strength. "The greatest amount of force a muscle or muscle group can exert in a single effort" (Department of the Army 1992, iii).

Muscular Endurance. The ability of a muscle or muscle group to perform repeated movements with a sub-maximal force for extended periods of time" (Department of the Army 1992, iii).

Flexibility. The ability to move the joints (for example, elbow, knee) or any group of joints through an entire, normal range of motion" (Department of the Army 1992, iii).

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