Representation of cohesion in small combat unit during a combat incident

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ABSTRACT: *One of the identified needs of the Department of Defense (DoD) to meet the training and analysis goals of future models and simulations is the realistic representation of human behavior. This includes having reasonable models of the dynamics of human behavior enabling more credible representation of information yielding more robust analysis. This is of particular interest when trying to design realistic automated and semi automated force to be included in combat models.*
Currently, there are many research efforts attempting to describe and implement various human behavior aspects such as decision-making and battlefield morale. However, there are few efforts that try to examine and incorporate results of human sciences, in particular psychology. A literature research shows that in psychology the aspect of battlefield cohesion is of high importance when evaluating the efficiency and survivability of soldiers in military operations.
This paper has the resulting working assumption, that one of the crucial aspects of human behavior on the battlefield is the role of cohesion. Following the results discovered during the literature research, cohesion is the result of the psychological relationships and interactions of a combat unit during a combat incident. Cohesion also strengthens the unit. Cohesion can be described as the binding effect that holds combat units together despite the stresses of combat.
This paper will examine cohesion with respect to how important it is in the representation of human behavior in combat. It will also discuss methods and challenges that need to be met to effectively conceptualize and operationalize cohesion. Finally, it will propose a conceptual model based on accepted theories merged into a single approach. The concepts presented in this paper are part of an ongoing Ph.D. dissertation research project conducted through the Virginia Modeling and Simulation Center (VMASC) at Old Dominion University.

1. Introduction

The increasingly realistic modeling of human behavior and human factors within military simulation systems is an often-formulated requirement. The models used to reach this objective must be psychologically viable and should be based on the results of related human sciences. A crucial related aspect identified in a literature research conducted within a doctoral study at the Virginia Modeling Analysis and Simulation Center (VMASC) is that of cohesion.

This paper will examine cohesion and its effect on the psychology of soldiers in combat. It will describe the purpose and components of cohesion according to military and social literature sources. It will also attempt to conceptualize the two domains into a model to provide a useful starting point for the incorporation of the components into human behavior model of combat forces.

2. Scope

The scope of this paper is the representation of cohesion during a "Combat Incident". A "Combat Incident" is defined as an event that disrupts a soldier's senses of control and involves a perception of threat. This could include events such as a frontal charge into an enemy position or a sudden sniper fire from a hidden location during patrol. It will begin at the time of a perceived threat until the time the threat is neutralized.

All representation of factors that affect the cohesion of the unit that are not specifically related to the "Combat Incident", such as experience, training and campaign factors, will be represented implicitly.

The conceptual model presented in this paper will be applied to small units, which in our context are defined as units no larger than 40 soldiers or the platoon level. We shall now examine cohesion, its effect, its major elements and how to represent them, and Stress and its relation to the individual soldier and the group. This look at these concepts will allow the proposed conceptual model to be presented and

explained. The basic sequence of the ideas presented in this work will follow this sequence.

1. A physical event occurs on the battlefield
2. An individual soldier observes the battlefield
3. The soldier perceives the event
4. The soldier reacts to the event
5. The soldier will observe the rest of the unit
6. The reaction causes the soldier to have a behavior
7. The other members of a combat unit observe the individual soldiers behavior
8. The others in the group perceive the individual soldier's behavior
9. The group then reacts to the individual soldier's behavior
10. The group reaction drives its performance to deal with the event
11. The soldier perceives the unit's reaction
12. The soldier will react to the units reaction
13. Return to number 6

3. Cohesion

As already pointed out, the results are based on a literature survey and evaluation of psychology papers. Within this paper, researchers being experts in the domain of psychology have described cohesion as one of the most important factors in the ability of a combat unit to maintain its effectiveness during a combat incident. To understand how to apply the principles of cohesion to human representation within the context of Modeling and Simulation (M&S), we first must define cohesion and examine the parts that make it up, i.e., we need a conceptual model derived from the various findings of the papers and being suitable to be transformed into algorithms in later phases.

Beginning with Emile Drukheim's work in the 19th century, researchers has been trying to conceptualize cohesion. Durkheim divided, what he called, social solidarity into two components of the psychological identification of members within a group and the observed connections among the members of a group. His social solidarity or cohesion is primarily a synergy between the behavior of the members of a group and how the other members perceive those behaviors (Durkheim, 1933).

In the 1950's Leon Festinger coined the classical definition for cohesion. He defined cohesion as the sum of the forces that cause a group to remain together. These forces keep groups together by moderating the anxiety or stress reactions to forces that act upon them. If a group can cope with the internal and external strife of situation they will accomplish any task that they are entrusted to do (Festinger, 1950).

Military sociologists have been examining this aspect of cohesion since the end of World War II when Schield and Janowitz discovered the links of cohesion to performance when they interviewed German POWs during the last phases of the war. They found that the average soldier did not fight primarily for ideology or cause but for the comrades in a unit during combat. Units with members that had lived and fought together performed well and units that had been rapidly put together in a hodgepodge fashion performed poorly (Shils and Janowitz, 1948). Along with subsequent studies in Korea, Vietnam and by the Israeli army in Lebanon, it has been shown that the ties bind soldier's psyches in such a way that they would stay in the face of danger to show his comrades that he was with them (Stouffer, 1949).

William Henderson defines cohesion as individual soldiers, each giving their loyalty to the group so that it trains and fights as a unit willing to risk death to achieve a common objective. This loyalty results in the primary function of cohesion, which is to sustain individuals and groups under stress. Stress can be described as the physical and psychosocial threats to a group that occur inside and outside of a group. The mitigation of stress caused by the relationship support of members of the unit is important in the prevention of unit disintegration under combat (Henderson 1985).

How cohesion sustains individuals when they are experiencing stress reaction from and incident such as combat, is a function of the elements of cohesion. These elements have been defined by G. Siebold of the U.S. Army Research Institute for Social and Behavioral Science, who defines the following three types of cohesion:

- **Horizontal**- deals with the relationships between peers
- **Vertical**- is concerned with the relationships between subordinates and their superiors.
- **Organizational**- refers to the relationship to the military as an organizational unit.

Nora Stewart adds one more type of cohesion. The fourth type of cohesion is known as **Societal Cohesion**, which represents the relationship, the military and the individual has with the society at large. Societal cohesion comes in the form of loyalty to a nation and its values, patriotism and cultural concepts of valor, heroism and masculinity (Stewart, 1982).

These four types of cohesion have been accepted by most military behavioral scientists as the elements that comprise cohesion. To include them into the behavioral model of soldiers during a combat incident, each type must be examined and a method to operationalize them should be devised.

Research to date has been of explanatory nature and is not descriptive. However, the concept that cohesion is influenced by stress is common to all descriptions leading to the concept that cohesion can be modeled by states and stress should be captured in input parameters. In the next sections we will describe the cohesion types in more detail and propose a method to use them to give the necessary detail to the conceptual model.

3.1 Horizontal Cohesion

As mentioned by many social and military sociologists, cohesion is primarily a function of the interrelations of the members of a group. The question to be asked is how to represent and measure these interrelations.

Early attempts to represent cohesion such as the Winship and Granovetter models use network analysis to describe the connection between members of a group. These models indicated that there are definite ties between group members and the strength of those ties affect the performance of the group's activities. The models fall short of a method to operationalize cohesion since they did not present quantitative measures that reflects the interactions of the individual within a group.

More recent research by Moody and White expands on the concept of network representations of cohesion. They introduce a methodology that allows researchers to identify cohesive substructures in a network and simultaneously identify the relative associations of such substructures within a group. Moody and White define cohesion as:

A group's cohesion is equal to the minimum number of members who, if removed from the group, would disconnect the group.

In other words, in a group represented by a network of nodes, where each member is reachable from every other member, the path that links two adjacent members must pass through a given subset of other members. These members if removed would disconnect and break the network into pieces.

White and Harary use these definitions to propose a measure of cohesion. They define the concept of connectivity and conditional density, which are combined into a single measure of cohesion.

They define the concept of connectivity as the minimum number k of its actors whose removal would not allow the group to remain connected or would reduce the group to a single member. This measures the cohesion of a group at a general level. They introduce the concept of conditional density to measure the proportions of ties beyond that required by a graph's connectivity *k* over the number of ties that would force it to *k+1*.

A graph is defined as $G = (n, m)$ which consists of *n* nodes or vertices and *m* edges each joining a pair of nodes. The graph is described as *G* has an order *n* and size *m*. The connectivity of the graph is denoted by $\kappa(G)$ and is defined as the smallest number of nodes that when removed from graph *G* leave a discontinuity or a set of smaller graphs. The density of the graph is denoted by $\rho(G)$ and is defined as the ratio of the difference between *m* and the maximum number of *m1* of edges of a graph *G* of order *n*. As $m1 = n(n-1)/2$ gives $\rho(G)$ to be equal to $2m/n(n-1)$(See figure 1).

White and Harary demonstrate that connectivity and density are two aspects of cohesion and are tightly bound together. They take advantage of this interdependence to combine and unify them into a single measure of cohesion, which is denoted at $\kappa+\rho(G:\kappa)$ (White and Harary, 2000).

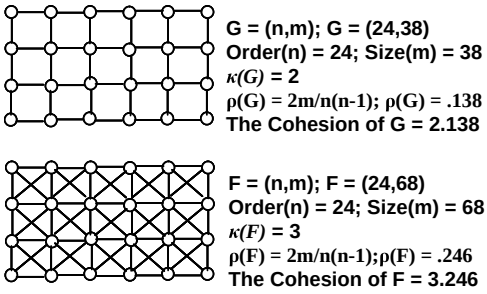

Figure 1. Example of graphs G and F and their definition based on White and Harary. *It can be observed that the interactions increase makes the connectivity and density increase therefore increasing the cohesion of the graph.*

The measures that White and Harary have produced can now be used to describe a military unit and the relationships among its soldiers. This implies that a properly defined combat unit could have its horizontal cohesion incorporated into a model that shows all the factors that sustain that unit during a combat incident.

Although the network cohesion model represents the relationships of the peers it must be coupled with a representation of vertical cohesion, which shall be examined in the next section.

3.2 Vertical Cohesion

The relationships between the members of a group are of primary importance. Leaders are the key factor in the cohesion of a combat unit. During combat the leader influences cohesion through personal example and by enabling and ensuring communication and flow of information. This communication reduces the soldier's isolation on the battlefield and allows the soldier to manage fear and remain with the unit, thus provide reliability and reassurance to other members of the unit (Henderson 1989, Spiszer 1999).

The leader is a crucial factor in protecting the soldier from overwhelming battle stress. A commander can be characterized as a lens that is either magnifying or minimizing the impact of the stressors and the appraisal process during a combat incident (Gal, 1996).

The performance of a group in meeting organizational goals is largely dependent upon the effectiveness of the leader. The effectiveness of a leader is directly tied to the vertical relationships or cohesion with the soldiers under their command. A capable leader can manipulate group members in order to accomplish the organizational objectives. Soldiers in a combat group must have confidence in their leaders. The soldiers must be convinced that the leader has their welfare in mind, and must continually

demonstrate expertise and set an example in adhering to the group norm before soldiers will follow them (Henderson, 1985).

A leader's effectiveness in protecting soldiers from battlefield stress is based on the decision quality of the leader and the decision acceptance of the followers. The followers seeing a leader as either supporting or endangering the well being of the individual will determine the decision quality. The decision acceptance will be based on how much the followers trust in the leader's decision (Yukl, 1998).

Leadership, although important in mitigating a soldier's stress during a combat incident, can sometimes be neutralized due to certain situations on a battlefield. If the relationship of the leader with a unit is not optimal and the unit is extremely cohesive, the unit's characteristic will make it ignore the leader and the effectiveness will suffer. Incidences such as mass desertions or unit behavior that does not coincide with the culture at large are times when the unit's characteristics substitute for the leader's role. Similarly, if the leader is killed during a combat incident or is not directly visible, the leaders effectiveness will be impaired and the unit will revert back to whatever characteristics it may have (Yukl 1998).

What has to be taken into account during the combat incident is whether the soldiers in the unit have trust in the commander or if they will disregard his influence and act in their best interest. The analogy to a lens that Gal describes is the best concept to incorporate into a model of cohesion. The specific expertise and quality of the leader figure should be devised at the time of the model set up and provide a plus or minus effect to the stress level and thus the cohesion of the unit. If the leader is removed, the unit should still be able to function as per the definition of the relationship established when the unit is specified.

The definition of a unit's characteristics needs to take into account the organizational societal variables that will represent that unit. In section 3.3, some of those variables, how they affect cohesion and how to incorporate them in the conceptual model will be examined.

3.3 Organizational and Societal Cohesion

Organizational cohesion is where the concepts of loyalty, patriotism and unit history are to be taken into account. A military organization's concepts of valor, heroism or masculinity all have an impact on the performance of a unit in combat. If the unit is highly trained but has never been in combat, the relationships among the soldiers will be strained and their performance as well as their cohesion will suffer (Stewart, 1982).

Societal cohesion is where cultural norms, organization of the military, doctrine, strategy, training and logistics contribute to the unit cohesion. If a unit is trained and cohesive but does not have adequate supplies its effectiveness and confidence will diminish. This loss of confidence will increase stress within a unit and cohesion will suffer.

These factors should be taken into account implicitly. They should be part of the definition of the combat unit to be specified for a simulation. Each combat unit to be represented should be defined based on their societal and organizational specification but should affect the unit in the resolution of calculations with in the models of their cohesion. Within the conceptual model, this is done by introducing state parameters which can be used to reflect the findings of human sciences within the model.

The next section of this paper will investigate the individual soldier and how their psychological state can be determined to define the relational connection of a cohesion network. An explanation of stress and how it relates to the individual, as well as the unit cohesion and how to incorporate the concepts into the model will be discussed.

4. Stress

Before we examine how stress affects cohesion we must define stress. Stress is defined according to the U.S. Army Field manual FM22-51 as the internal process of preparing to deal with any event or situation, which requires a non-routine change in adaptation or behavior. Stress involves the physiological reflexes that ready the body for fight or flight. Examples of those reflexes are:

- Increased nervous system arousal
- Release of adrenaline into the bloodstream
- Increased heart rate

Stress involves physical and mental processes that, at times, suppress arousal and anxiety. Stress involves the automatic perceptual and cognitive processes for evaluating the uncertainty or threats and the accompanying emotional responses. These automatic processes may be instinctive or learned.

Events and situations that initiate stress process are known as stressors. Combat stressors are any stressors occurring during the course of combat-related duties, whether due to enemy action or other sources.

Stress may or may not involve conscious awareness of the threat, but the stressor must be perceived at some level to cause stress. The amount of stress experienced depends much on the individual's appraisal of the stressor and its context, even if that appraisal is wrong. The stress process includes psychological defenses which may filter the perception and appraisal to shield the individual from perceiving more threat than he is ready to tolerate.

Stress behaviors are stress-related actions that can be observed by others; for example, moving or keeping still, speaking or not speaking. The behaviors may be intended to overcome and turn off a stressor, to escape it, or to adapt to it. They may simply reflect or relieve

the tension generated by the internal stress process. Any of these different types of stress behavior may be successful, unsuccessful, or not influence the stressful situation at all. They may make the stressor worse. They may resolve one stressor but create new stressors.

Stress is an internal process that presumably evolves because it helps the individual to function better, stay alive, and cope successfully with stressors. However, there is an optimal range of arousal (or motivation or stress) for any given task.

If there is too little arousal, the job is done haphazardly or not at all because the individual is easily distracted, makes errors of omission, or falls asleep. If arousal becomes too intense, the individual may be too distractible or too focused on one aspect of the task. He may have difficulty with fine motor coordination (see figure 2) and with discriminating when and how to act.

4.1 Stress Representation

Now that stress has been defined how can these concepts be represented? The concept of optimal stress was first presented graphically by Yerkes-Dodson (1909). The basic idea is that in any given situation there is a given amount of stimuli to which a person can attend. A person will respond to these stimuli either by performing at an optimal level or by seeking more or less stimulation. Therefore, every situation is more or less stressful.

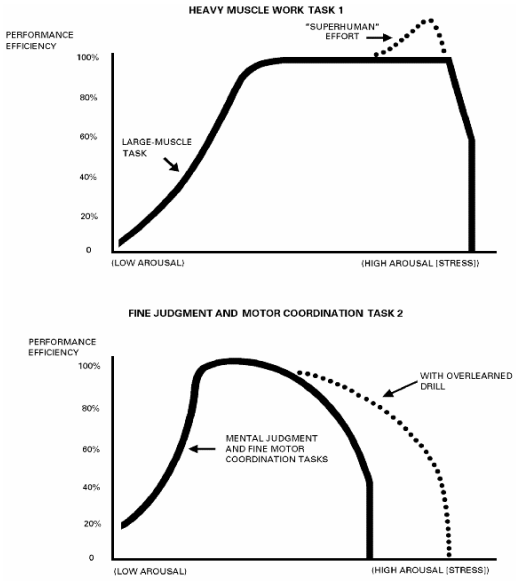

Figure 2. Change in performance with increasing arousal (stress) for two types of tasks. *Curves are based on the Yerkes-Dodson and are taken from FM 22-51.*

Using this "u-curve", we could represent the stress state of an individual if we could devise a method of assigning quantity levels to the amount of arousal or stress they perceive. In he next section we will explore a method of quantifying stress so that we can use it for determining the behavior of the individual in a unit.

4.2 Measure of Stress

We have seen a representation of cohesion and that cohesion is related to stress. Now, we need a method of quantifying stress in the individual soldier.

As mentioned before, the stress reaction is accompanied by certain physical and psychological reactions. When an individual is exposed to stressors, the body produces stress hormones which result in raised heart rate, and faster reaction time. That is known as the alarm phase. If the stressors are not removed, the body enters the resistance phase where the alarm responses are maintained and the body conserves energy. This equates to the optimum stress level mentioned in pervious sections.

If the stress continues without resolution eventually an exhaustion phase sets in and the individual will suffer a physical and mental breakdown. This process is known as the General Adaptation Syndrome. (Selye, 1952).

Recent research has shown a correlation to these phases to the individual heart rate. It has been found that at various stages of a stressful situation the heart will beat within a certain rate. Within these rates certain physical reactions have been observed that can indicate the Stress State of the individual (Siddle, 1998).

Bruce Siddle equated the following heart rate level with following physical reactions:

Effects to Motor Skills

- *At 115 beats per minute (bpm)* - Most people will loose fine complex motor skills such as finger dexterity, eye hand coordination, multi tasking becomes difficult.
- *At 145 bpm* - Most people will loose complex motor skills (3 or more motor skills designed to work in unison).

Effects to Visual System

- *At approximately 175 bpm* - A person will experience an eye lift; their pupils will dilate and flatten. As this reaction takes place, a person will experience visual narrowing (commonly known as tunnel vision). This is why it is very common for a person to back away from a threat in order to see, through this tunnel.
- *Above 175 bpm* - Visual tracking becomes difficult This is very important when it comes to multiple threats. During multiple threats, the brain will want the visual system to stay with what it sees to be the primary threat. Once this threat has been neutralized, the brain and visual system will then find its next threat. This is commonly known as the "light house" effect. Studies have found that a person experiencing survival stress reaction will experience on average about a 70% decrease in their visual field. At this heart rate a person will also find it difficult to focus on close objects. A

person in a combat situation will become far sighted rather than near sighted.

Effects to the auditory system

- *At approximately 145 bpm* - The part of the brain that deals with hearing, shuts down during survival stress reaction. This is one reason why it is not uncommon for people in combat situation to say, " I didn't hear that", " I heard voices but I couldn't understand what they were saying" or " I didn't hear a gun shot".

Effects to the brain

- *At approximately 175 bpm* - It is not uncommon for a person to have difficulty remembering what took place or what they did during a confrontation. This recall problem is known as " Critical Stress Amnesia". After a critical incident, it is not uncommon for a person to only recall approximately 30% of what happened in the first 24hrs, 50% in 48 hrs and 75-95 % in 72-100 hrs.
- *At 185-220 bpm* - Most people will go into a state of "hypervigilance" this is also commonly known as the "deer in the headlights" mode. It is not uncommon for a person to continue doing things that are not effective (known as a feedback loop) or to show irrational behavior such as leaving cover. This is also the state in which people find themselves in what they describe that they can not move, yell, scream. Once caught in a state of hypervigilance, information of the threat is reduced to the brain, which leads to increased reaction time. This increased reaction time then leads to a heightened state of stress, which further plunges one into a deeper state of hypervigilance.

Effects to motor skill performance

- *At approximately 115 bpm* – Fine complex motor skills are decreased (pulling a trigger, handling a knife), but gross motor skills turn on and become optimized.

It should also be noted, that there are many causes for an increased heart rate but, it is the stress reaction caused by combat that will produce the described results. Other factors such as exercise, temperate and humidity cause slow increases in the heart rate, with an increase of no more than 10 beats per minutes over the span of hours. The stress caused by acute stressful events can jump an individual's heart rate from approximately 100 to near 200 in a few seconds.

Due to the many causes of heart rate increase, whether slow or fast heart rate increase is nothing more than a "thermostat" or "indicator" of a perceived stress level, and is "not" the driving force of performance deterioration (Luar, 1996).

Now that we can use the heart rate as a stress level indicator, the factors that would increase that heart rate during a combat incident should be mentioned. Davis Grossman in his studies of the science of killing delineates five factors that affect the stress level of a soldier in combat:

- The degree of malevolence, human intent behind the threat
- The perceived level of threat, ranging from risk of injury to the potential for death; the time available to response
- The level of confidence in personal skills and training
- The level of experience in dealing with the specific threat
- The degree of physical fatigue that is combined with the anxiety

Now, that we have a measure of cohesion, a measure of stress we can incorporate them into a conceptual model that represents these concepts. This model will be presented in the next section (Grossman 2002).

Stress, heart rate and the cohesion of a unit

As mentioned before, cohesion is the sum of the forces that causes a group to remain together. Those forces are what needs to be defined to produce a conceptual model of cohesion.

These forces have been described by military men, such as Henderson and Stouffer, as the relationships that have been formed among the members of a combat unit. These relationships will mitigate the stress of a combat incident. However, the stress mitigating aspect of cohesion is based on the trust that an individual has in the individual next to them. If the stress level of an individual rises to a level that their effectiveness is perceptibly noticeable, the effect will be that the trust that exists with that individual will become reduced.

An illustration of this would be a situation in which an individual's stress level rises to such a state that it manifests itself as a heart rate of around 220 bpm. If the stressed individual then has a stress reaction such as "run from cover" or freeze at a crucial point in combat, the stress level of the rest of the group would be impacted and they will have a stress reaction.

The connectivity of the individual to the rest of the group becomes weakened and the ability of the unit to function cohesively suffers. If the impact of the stress reactions individuals is such that is drives the stress level of the other members in the unit to a detrimental stress state, the unit could become ineffective or breakup.

This illustration forms the basis of the conceptual model that will be presented in the next section. The individual stress model will be described to illustrate how events occurring on the battlefield affect the stress a soldier's stress state. The stress state of the individual soldier will drive a stress reaction that will be perceived by the unit and its effects will be incorporated into the cohesion network that has been defined for the unit.

5. Conceptual Model

Using the stress and cohesion representations, we can define a conceptual model of a small combat unit during a combat incident. The model shall be comprised of two parts: The individual soldiers and the networks of relation with the rest of the unit. The model will follow the sequence delineated in section 2.

To conceptualize this sequence into a cohesion model we have to group the concepts we have described into two parts. The first part is the model of the individual soldier that will react to the battlefield events and influence the other member of the unit. The second part is the network of individuals that would define the unit and base the unit cohesion on the sum of the reactions of the individuals.

5.1 The Individual Soldier Model

The individual model is made up of the following six parts (See Figure 3):

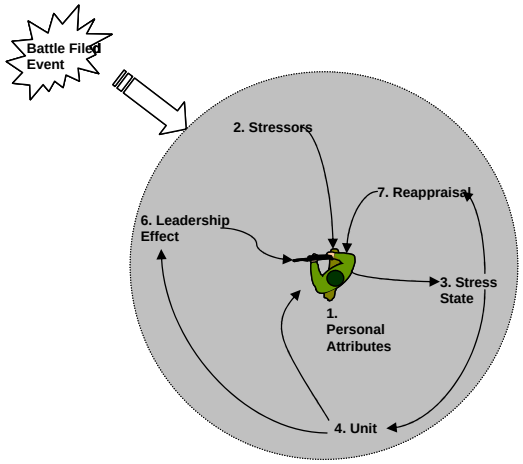

Figure 3. Individual Soldier Model. *This model will determine the Stress State of the soldier based on the perception of the threat and the overall reaction of the members of the unit that are connected by defined relationships.*

5.1.1 The Individual Attributes

Theses are the characteristics and qualities that the individual soldier possesses at the time of a combat incident. They are based on the cultural, organizational and physical definition of the soldier and should be defined before the soldier model is involved in combat. Some examples of these are:

- Loyalty to the nation
- Patriotism
- Social status
- Training
- Equipment
- Physical attributes
    a. Physical stature
    b. Health
    c. Heart rate range

5.1.2 The Stressors

These are the factors that would influence the soldier's reaction to the situation. These factors in conjunction with individual attributes will determine the *Stress State* of the individual. The stressors will be as seen in the following (see section 4.2):

- Malevolence or intent of the threat.
- Perception of the level of the threat
- Time the soldier perceived to deal with the threat
- Confidence in overcoming the threat
- Experience in dealing with the threat
- Physical state or in other words whether the soldier is fatigued or injured

5.1.3 Stress state

As the individual soldier assesses the stressors, those factors will increase or decrease the heart rate that is defined in the individual attributes. The ranges and the specific Stress State are as follow:

- In control (4): 60-115 beats per second (BPS) heartbeat
- Optimal(3): 115-145 BPS heartbeat
- Deterioration(2): 145-175 BPS heartbeat
- Irrational(1): 175 + BPS heartbeat
- Death(0): 220+ BPS heartbeat

5.1.4 The Unit effect

This effect will be a summation of the stress states of individuals in the unit that are defined as having relational ties with the soldier. This is the effect the cohesion of the unit has on the individual soldier.

5.1.5 The Leader Effect

This is the benefit or liability that the leader can introduce to the unit. The leader will be similar to the individual soldiers but with the additional attributes of leader quality and command experience. These attributes will either add or subtract to the *Stress State* of those soldiers that are affected by the leader.

5.1.6 Reappraisal

Since the situation during a combat incident is dynamic, the individual soldier needs to reappraise the situation every cycle of the simulation. The specific situation will determine the combination of factor at that time and affect the hear rate of the soldier. The reaction reflected by the heart rate would in turn affect the other soldiers who will be re-appraising the situation at the same time.

5.2 The Unit model

The individual models of the soldier connected in a relationship network shall comprise the Unit model. Each soldier that is dependent on another for support will be connected and thus add or detract from the stress state of other soldiers. In other words, if the Stress State of the neighboring soldiers is positive they will receive a benefit. Likewise, if the Stress State is negative, the soldier will receive a detrimental effect upon their stress state.

These relationship connections will be used to calculate the connectivity and conditional density of the unit. These two numbers will be used to create the cohesion index for the unit (see Figure 4). As the relationship connections are removed though death or having a soldier run away the cohesion index will be adjusted.

As the unit takes losses through death or members becoming disconnected there should be a point that the unit will either break or become ineffective on the battlefield. The cohesion index at that point should indicate the effect of the cohesion of that unit.

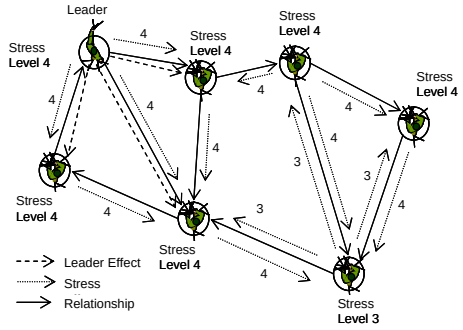

Figure 4. Unit Cohesion Model. *The individual models of the soldier connected in a relationship network shall comprise the Unit model. Each soldier that is dependent on another for support will be connected and thus add or detract from the stress state of other soldiers.*

6. Conclusion

Although the underlying work is still in its beginning phase, some valuable conclusions can be already drawn. The representation of cohesion must focus on the individual and the effect of the group on that individual. This is because cohesion is a mitigating force on the stress that is experienced on the battlefield. The way a soldier handles stress is of major concern in the increase of performance in combat.

The measures of stress, though the simulation of heart rate, as well as the calculation of cohesion, though the connectivity and conditional density, show promise as a framework to investigate the phenomenon of cohesion.

However, the tentative results and models presented here are yet to be implemented and tested. This will be done as part of continuing Ph.D. research work at VMASC, which currently is in the implementation phase.

The intent of future testing is to recreate a historical situation where historians have identified cohesion as an important aspect. A series of experiments will be run to see if historical results can be achieved by applying the conceptual model described in this paper.

Acknowledgments

I would like to acknowledge the members of my dissertation committee who have been invaluable in the production of this work: Dr. Andreas Tolk, Dr. Bowen Lofin, Dr. James Bliss, and Dr. Russell Rockefeller.

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