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**THE HYBRID COUNTERINSURGENCY STRATEGY:
SYSTEM DYNAMICS EMPLOYED TO DEVELOP A
BEHAVIORAL MODEL OF JOINT STRATEGY**

THESIS

Ferdinand Maldonado, Captain, USAF
AFIT/GEM/ENV/09-M10

**DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY**

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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AFIT/GEM/ENV/09-M10

THE HYBRID COUNTERINSURGENCY STRATEGY: SYSTEM DYNAMICS
EMPLOYED TO DEVELOP A BEHAVIORAL MODEL OF JOINT STRATEGY

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

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In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Engineering Management

Ferdinand Maldonado, BS

Captain, USAF

March 2009

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EMPLOYED TO DEVELOP A BEHAVIORAL MODEL OF JOINT STRATEGY

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Abstract

Since the recent focus on the Global War on Terror, both military and civilian theorists have begun to “relearn” the intricacies of counterinsurgency warfare. We face difficult challenges when confronting non-state actors that tend to attack in the time between conventional battles and the establishment of stable governments. This research compares and contrasts current counterinsurgency strategies (Hearts and Minds and Cost Benefit Theory) by applying System Dynamics to provide insight into the influences and emergent behavior patterns of counterinsurgency systems. The information gained from the development of the models and from their simulation behaviors is used to construct a System Dynamics model of a Hybrid Counterinsurgency Strategy that combines the influential elements and behaviors from each of the previous models to obtain a more comprehensive model of the counterinsurgency system. This process yields behavior patterns that suggest that security operations, critical during the short-term, are key to disrupting insurgent organizational mechanisms that strongly influence the population’s support for the host government and the coalition. The models also demonstrate the strength of the influence of information operations on the counterinsurgency system. Finally, the construction of the models and simulation behaviors propose that harvesting host nation capacity throughout the counterinsurgency is the most influential factor for maintaining long-term stability.

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THE HYBRID COUNTERINSURGENCY STRATEGY: SYSTEM DYNAMICS EMPLOYED TO DEVELOP BEHAVIORAL MODEL OF JOINT STRATEGY

I. Introduction

“Our Air Force is essential to that difficult form of warfare that we have had to learn, or perhaps I should say relearn, in recent years. In Afghanistan ... American airmen are leading Provincial Reconstruction Teams. And many more are on the ground helping to do things like build roads and guard facilities and support local agriculture. You have been called to adapt to the demands of counterinsurgency.”

(Secretary of State Condoleezza Rice, April 14, 2008)

Background

Even though the United States has been involved in substantially more conflicts involving non-state violent actors than nation-states since the end of World War II (Barnett, 2004), it has not been until the recent focus on Operations Enduring Freedom and Iraqi Freedom that military and civilian theorists have begun to “relearn” the intricacies of this type of warfare. One estimate suggests that more has been written on the topic of counterinsurgency in the last four years than in the previous 40 (Kilcullen, 2008). Throughout the years these conflicts have been labeled military operations other than war, low-intensity conflicts, irregular warfare, and small wars; but the overriding principle has been a group of non-state actors fighting for legitimacy and influence over a given population (AFDD 2-3, 2007). While these non-state actors cannot match the military power of the United States, leaders of these groups have chosen military tactics that often involve low-tech, high-consequence actions that can lead to disastrous levels of destruction. These tactics pose an array of security, military and political challenges that

require great adaptability. Even though conventional forces sponsored by states are outmatched by the strengths of the United States military, it faces difficult challenges when confronting non-state actors that tend to attack in the time between traditional conventional battles and the establishment of stable governments. The true challenge then comes by understanding and fighting within the “seam between war and peace.” (Barnett, 2005)

The question now arises as to how the United States military should focus their attention in counterinsurgency conflict. Many publications on this topic originate from reviewing historical examples and drawing conclusion based on case-specific views. Even though past lessons provide a vital guide to begin looking at future doctrine, other analysis methods are needed to effectively construct counterinsurgency strategy that considers complex social system influences. This research will attempt to compare and contrast current counterinsurgency strategies by applying System Dynamics modeling. The goal is to construct system models that will provide insight into the emergent behavior patterns of system elements. These building blocks of the system models and the influences that tie them together will provide the necessary information to refine the models of the strategies studied in order to develop a more robust application of counterinsurgency assets.

Problem Statement

It is apparent that the insurgency process encompasses much too broad of a spectrum to discuss and analyze in its entirety. This section will outline the emergence of the two

counterinsurgency strategies that will be studied and provide a foundation for the problem definition.

This research will address the two predominant modern counterinsurgency strategies that have been derived from the reasoning of insurgency and counterinsurgency theorists. These strategies are known as Hearts and Minds and Cost Benefit Theory. The popularity of these two theories can be attributed, at least in part, to the counterinsurgency research conducted since 1958 by RAND Corporation. Long (2006) presented an excellent anthology to the creation of these contrasting strategies. Hearts and Minds focuses counterinsurgency operations on establishing modernization and economic development in an effort to increase the local government's legitimacy and gain the popular support away from the insurgents, while maintaining a military posture that is mainly designated towards ensuring security. The most notable implementations of this strategy have been the British counterinsurgency strategy during the Malayan Emergency (1948 – 1960) and the current strategy in Iraq of Clear-Hold-Build advocated by FM 3-24 (2006). This theory has been greatly supported by the lessons published by insurgents and counterinsurgency strategists like Lawrence (1935), Galula (1964), Guevara (1969), and Nagl (2002). Cost Benefit Theory, also known as Coercion, has been greatly debated as of late for its contrasting views. This approach involves the “buying” of support and insurgent cooperation through programs directed at obtaining intelligence and seeking to disrupt the insurgency by focusing the elements of military and political power on their organizational structures. The premise behind this approach is that a population reacts to inputs to the system as rational actors; measuring their

actions by considering the costs in relation to the expected outcomes. The game then becomes an effort to shift the balance away from potential benefits for continuing the insurgency. Similarly, this view has been advocated by theorists dating to and inspired by the developments of the Vietnam conflict (Zwick, et al., 1964; Leites & Wolf, 1970; Popkin; 1979). Recently the Coercion strategy has taken the form of “buying” the insurgent’s cooperation by increased threat of military force and violent retaliation to insurgent actions. One theorist suggested to "out-terrorize the insurgents, so that fear of reprisals outweighs the desire to help the insurgents" (Luttwak, 1999). Another recent interpretation of Cost Benefit Theory centers around the premise that the insurgent leaders and supporters can be “bought” through focused attention on amnesty and reward programs (Kahl, 2007) or by rehabilitation efforts that place them back into a legitimate governmental structure (Nagl, 2008).

Research Objective

There are three primary research objectives that will be addressed throughout this study. The first is to attempt to consolidate the significant counterinsurgency knowledge that has been generated by insurgent leaders and counterinsurgency experts throughout a wide range of time and geographic regions. These lessons will be used to guide the development of the system models and to provide context for their discussions. The second objective is to build System Dynamics models of the Hearts and Minds and Cost Benefit Theory strategies. These models will be generated incrementally; following the phases of assessing natural behavior, developing influence and flow diagrams, and

modularly testing and validating the system construction. The insight gained from the development of the models and from their simulated behaviors will then be utilized for the completion of the third objective. This research objective will construct a System Dynamics model of a Hybrid Counterinsurgency Strategy model by combining the influential elements and behaviors from each of the previous models in order to obtain a more comprehensive model of the counterinsurgency system.

Methodology

Much of the knowledge that exists on counterinsurgency is derived from case studies of past engagements. Modeling and simulation techniques can be employed to provide a more complete picture from which strategy can be developed. Even though other modeling techniques, such as effects-based operations and value focused thinking, have been used to describe insurgency, terrorism, and counterinsurgency problems, these are not designed to conform to the nature of complex social systems. System Dynamics takes a different approach than the previously mentioned techniques by not basing the analysis on empirical data, but focusing on developing system structures by observing individual components' basic behavior patterns. This foundational emphasis on system structure allows a System Dynamics model to rely on system influences more than on abstract formulas or case-specific data. This technique has been greatly used since its introduction by Massachusetts Institute of Technology professor Jay Forrester in the 1960s and been applied to modeling problems in the areas of natural sciences, public management, business processes, and insurgencies (Sterman, 2000).

II. Literature Review

This chapter will include an extensive summary of the thinking on counterinsurgency strategy. This section will begin with a look at the employment of insurgency tactics from the perspective of historical revolutionary figures. This will be followed by classic counterinsurgency lessons posed by combatants and theorists. Then, current counterinsurgency doctrine will be summarized and placed into the historical frameworks from which they were developed. Finally, an examination of recent counterinsurgency research conducted through the application of simulation and modeling techniques towards counterinsurgency, insurgencies, and terrorism will be outlined. It is the goal of this chapter to examine these counterinsurgency philosophies, lessons learned, doctrine, and research that will serve as a foundation for the development of the key system elements that will be employed further in this research process.

Insurgency and Counterinsurgency Strategies

A summary of the classic insurgency and counterinsurgency lessons explored for this research are demonstrated in Figure 1. The graphic depicts the range of geographic regions and historical timelines studied. This is not to say that these cases are inclusive of all lessons learned for developing effective counterinsurgency strategy, but this array has been selected due to the influence of the theories and their special and temporal diversity. The discussion of these strategies, lessons, and doctrine will attempt to

summarize the historical framework and identify the overlap and distinctions in their perspectives.

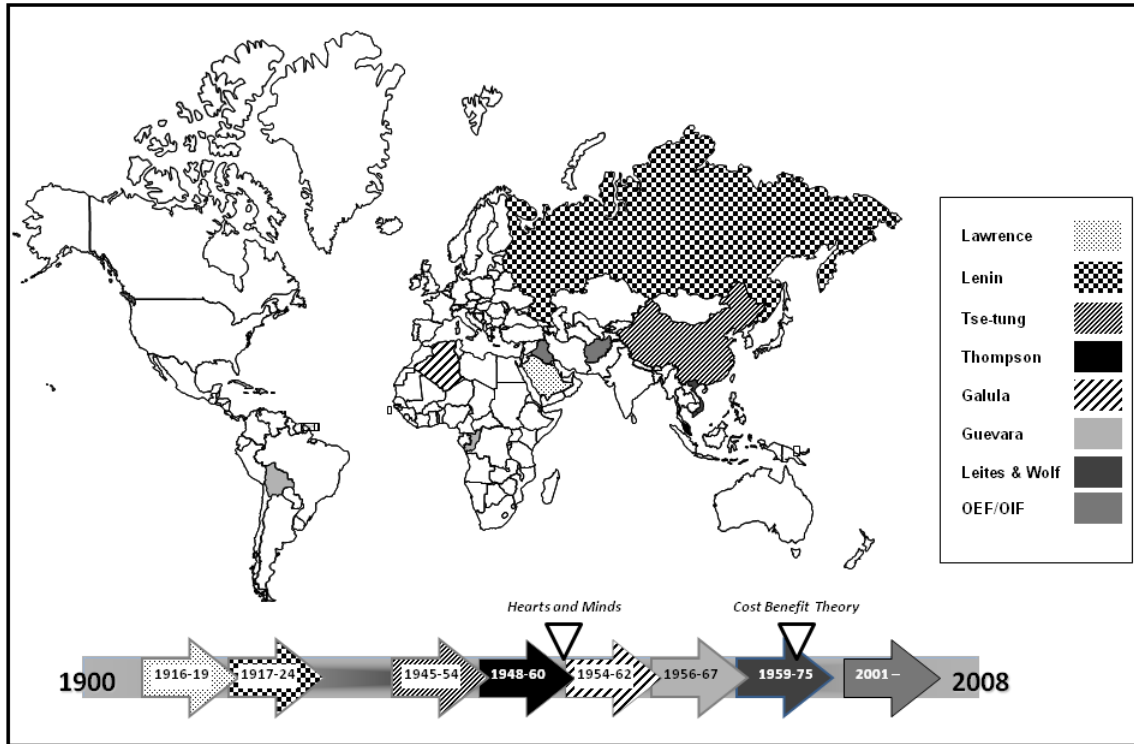


Figure 1: Map and timescale of classic counterinsurgency theories and modern counterinsurgency applications used for this study

The first major contributor to the classical study of insurgencies was British Lieutenant Colonel T. E. Lawrence’s experiences as part of the British military advisory to the Arab rebels fighting the Turkish Ottoman Empire (1916 – 1919). Lawrence, schooled in the traditional military teachings of Napoleon and Clausewitz, began to see revolution as a completely different endeavor. Before, he thought of victory as defined by the destruction of enemy forces. But, as Lawrence (1935) accounts, even though the rebellion had never defeated the Turkish army in open combat, they controlled a vast

majority of the territory and employed their limited resources in the most effective ways by attacking the larger army's weaknesses.

When Lawrence's approach is considered in the framework of modern insurgency, his methodology can be defined as a Military Focus strategy (O'Neill, 2001). In this structure, the insurgent force, Lawrence's Arab Bedouin, maintained a conventional military mindset while striking only when the situation was to their advantage. At this pace they could transition into more traditional tactics as the will of the Turkish forces was degraded through the asymmetric struggle. This approach is common to many occurrences of civil war, such as those in the United States (1861 – 1865) and in Nigeria (1967 – 1970).

Lawrence's contributions stem from the development several principals he thought were characteristic of revolutionary conflict. He suggested that the army against which the rebellion was being waged must be technologically advanced, and thus dependant on their technology. It must also be large enough to restrict their movement but not too large that they could easily control vast amounts of terrain. He also proposed that an insurgent force must hold a base of operations that is outside of the reach of the opposition and among the people from which they can gather support and supplies. On the topic of support, Lawrence states that the insurgency must count on at least some degree of passive support, if not their full involvement. He also estimates that the fighting proportion of the local population supporting the insurgency needs to only be about two percent (Lawrence, 1920; Schneider, 2005). Many that will follow Lawrence as classic revolutionary thinkers will draw on his ideas and methods to define their own

situations. But, shortly after that time period another rebellion was underway that contrasted Lawrence's theories and shaped the fundamental purpose of many revolutions that followed.

From 1917 – 1924, Vladimir Lenin led a starkly different sort of insurgency to seize control of modern-day Russia. Lenin's conspiratorial strategy sought to expel the existing government by using outsiders to the ruling elite that held key roles within the government and could mass military, political, and social support (O'Neill, 2001). Even though this type of revolution does not generally involve conventional or guerilla-scale combat, it is a widely employed form of insurgency that holds the same aim of overthrowing the current regime or forcing social reform. Lenin drew as conclusions from his rebellion that social, political, and economic discontent are necessary preconditions to begin a revolutionary movement. He also stated that if the movement was to be successful, it must be framed around an organized and conventional political party – in his case Marxism. What Lenin failed to realize, or admit in his descriptions of the factors that lead to the revolution, was that the existing government was in such a state of disorder that it would have most likely fallen to any sort of organized opposition. In the years leading up to Lenin's revolution, the Romanov czarist regime had suffered due to their ineffective and unjust governance, the perception of widespread corruption, and an overall discontent from the widely unpopular Russian involvement in World War I (O'Neill, 2001). These preconditions existed independently of Lenin's revolutionary plans and led others who believed in Lenin's social reforms to take different approaches; most notably Mao Tse-tung in China and Ernesto "Che" Guevara in Cuba.

Mao Tse-tung led the Chinese revolution in China from 1945 – 1954 and was appointed the first Chairman of the People's Republic of China from 1954 – 1959. Mao institutionalized the insurgent strategy of the Protracted Popular War. This approach focuses on establishing prolonged levels of low-intensity military strikes on government targets, while eventually evolving into a fully conventional military force that can defeat the opposition's army in conventional battle. Mao's rebellion is one of the most studied by scholars on insurgency and irregular warfare. His recommendations also focused on many of the lessons of preceding revolutions. Mao suggested that the main component of a revolution was to target the rural, oppressed, working class. Their involvement, as fighters and supporters, would define the pace of the insurgency through the phases described previously. He also proposed that strong leadership that is guided by political principals (Marxism-Leninism) was also paramount. Finally, Mao gave great credence to the belief that an armed revolution would need to transition to a conventional force in order to achieve victory (Galula, 1964). This tactic has been applied in similar manner by the North Vietnamese (1959 – 1975), Algerians (1954 – 1962), and most recently by Moqtada al Sadr's militants in Iraq (2004 – present) (FM 3-24, 2006). Retired US Army Lieutenant Colonel John Nagl (2002), a widely regarded counterinsurgency expert, suggests that Mao's greatest contribution to irregular warfare was recognizing that a rebellion must consider paramount the interdependence of the military and political components, along with the support of the populace. Even though Lawrence previously mentioned the importance of popular involvement and Lenin gave great weight to the need for politically and socially driven organization, neither connected the interrelation of these efforts into the same strategy.

Another Marxist-Leninist focused insurgency was organized in Cuba (1956 – 1967) by the Argentinean revolutionary Che Guevara and the would-be Cuban dictator Fidel Castro. Guevara, who also led revolutionary movements in Congo and Bolivia, employed a Military Focus strategy (O’Neill, 2001). But unlike Lawrence, Guevara drew on the Socialist movement for support and used Mao’s interdependent factors (military, political, and social) as the foundation for his actions. Guevara, who came from a well educated, upper-middle class upbringing, wrote extensively about his theories. From his writings three main mechanisms that he believed led to his success in the Cuban Revolution can be identified: popular forces can triumph over an unpopular conventional army; not all preconditions for a revolution need to be in place, they can be motivated by the rebellion; and the rural countryside is the basic arena in which to conduct guerilla warfare (Guevara, 1969).

Guevara and others have seemed to point out, time and again, that a popular insurgent movement can wage and win a decisive victory in irregular warfare; contrary to classic conventional strategy proposed by Clausewitz, who stated that wars by an armed populace could only serve as a defensive measure (FM 3-24, 2006). These historical examples from the perspective of different insurgency strategies provide great insight into viewing irregular conflicts from this lens. Equally important, is to study the lessons learned from the early counterinsurgents who faced these strategies. This perspective allows modern theorists and strategists to draw more direct corollaries to current and future counterinsurgency applications.

David Galula (1964), experiencing this type of conflict from the perspective of the counterinsurgent, provides one of the first perspectives in irregular warfare from this vantage point. Galula was a French Lieutenant Colonel that fought the Algerian secessionist insurgency from 1954 – 1962. The Algerian-Arab nationalists sought independence from French colonial rule and followed Mao Tse-tung's Protracted Popular War doctrine (O'Neill, 2001). Unlike in China, the Algerian insurgents were not able to make the transition to a conventional force in order to complete the cycle outlined by Mao and the Protracted Popular War strategy. Instead, they were able to adapt to this limitation and focus on the strategic stalemate phase where they engaged in guerilla attacks in an effort to frustrate the government forces, gained widespread popular support, and exploited French mistakes through propaganda campaigns (FM 3-24, 2006).

Galula suggests that popular support is as important to the counterinsurgent as it is to the insurgency. Like the insurgents, the counterinsurgent may also rely on logistical and active support from the population, but other factors such as intelligence gathering and cutting off safe-havens for the insurgents also become increasingly necessary. Galula (1964) regarded the counterinsurgent's use of popular support as needing to leverage the active minority in order to influence the neutral majority and defeat the hostile minority. This is the first instance in which a strategist defined a population in terms of their support and their relative composition. FM 3-24 (2006) echoes that thought, defining the population as being comprised of a small insurgent portion, or a sector of the population that supports the insurgency, a slightly larger portion of the populace that supports the local government, and a majority that is passive or neutral.

Galula finally proposes that popular support is conditional and can be gained and lost relative to the actions taken (Galula, 1964). This factor may not be a revelation to many who read it, but the fact that none prior to Galula had identified this point is a matter of concern. Following this aspect of Galula's theory would require insurgents and counterinsurgents to modify their tactic based on their perceived level of popular support in an effort to not lose what has already been gained.

Another important aspect from Galula's approach was his identification that a counterinsurgency must be waged from a primarily political perspective. He estimated that counterinsurgency is comprised of approximately 20 percent military and 80 percent politics (Galula, 1964). Again, this is a deviation from past traditional theories that focused on combating an insurgency with a conventional military force and adapting that force to fit a guerilla environment. As insurgents such as Mao Tse-tung have pointed out, the elements of military, political, and social power are indispensable for an insurgency to succeed; Galula draws on his experience to make the same parallel for the counterinsurgent.

Sir Robert Thompson, a British Lieutenant Colonel, provided many lessons from such an example during the British counterinsurgency campaign in Malaya from 1948 – 1960. The Malayan Emergency was started by the local Communist party looking to take control from the British colonial government following the withdrawal of the Japanese force after World War II (Nagl, 2002). The insurgency in Malaya, like those of China and Algeria, followed Mao's Protracted Popular War strategy and was focused in the rural areas of the country that allowed for insurgent training, organization, and supply

(O'Neill, 2001). Thompson sought to bring all elements of counterinsurgency power into the fight: military, economic, and political. Like Galula, he recognized that a single approach would not yield victory because the insurgents were exploiting every vulnerability possible. The Malayan counterinsurgency also employed civic action teams that led reconstruction, economic development, and spread governance throughout rural areas. Thompson also sought to cut off the insurgents from the populace by recognizing that they could hide within the rural areas, thus targeting these for government-led development. He established an "oil spot" strategy, where development took place in central locations that were cleared of insurgent presence and then improved by reconstruction, the introduction of jobs, and an increase in commerce (Thompson, 1970). This "oil spot" approach is also used in today's Global War on Terror; for example, the establishment of Afghan Development Zones led by Provincial Reconstruction in Afghanistan and the Clear-Hold-Build doctrine in Iraq (FM 3-24, 2006).

Many have used Malaya as a case study for modern counterinsurgency operations. Nagl (2002) drew comparisons from Malaya to critique the American military counterinsurgency effort in Vietnam. He proposed that the US military did not adapt to the environment of irregular warfare in the same ways the British did and that this was the deciding factor in US failure to control the North Vietnamese insurgency. While the British tailored their operations to their perceptions of the population's level of support, the American military did not embrace this tactic and relied on more conventional, effects-based targeting to conduct their operations. The case of Vietnam also added additional domestic political considerations, such as an increasing rate of demonstrations

against the conflict and the added involvement of non-military government officials in direct operational planning, that further plagued the US efforts.

This section has provided a synopsis of the development of insurgency strategies and the lessons learned from counterinsurgency efforts to combat these conflicts. The following will introduce and discuss the development of current counterinsurgency strategies that have emerged from the observation of insurgency theorists and past lessons.

Emergent Counterinsurgency Theories

To “win the hearts and minds of the people” was a term first used by Sir Gerald Templar during the Malayan Emergency to describe the British counterinsurgency approach of gaining popular support through security, reconstruction, economic development, and governance. During the period of the 1960s, what has come to be known as the Hearts and Minds theory dominated the efforts to define counterinsurgency doctrine, especially within the US military and research institutions, such as RAND Corporation. The goal of this theory is to restore governance and order by gaining popular support for the host nation government. The premise behind this doctrine is that economic instability and the insurgent’s ability to gain popular support were the key elements that caused counterinsurgencies to fail in historical examples. Kahl (2007), in reviewing FM 3-24 for *Foreign Affairs*, discussed the validity of Hearts and Minds as a clear representation of modern counterinsurgency efforts learning from lessons of the past.

As the discussion of classic insurgent strategies pointed out, the focus on popular support has been a largely dominant element of this debate. Thus, the main elements that drive Hearts and Minds doctrine are those surrounding the gaining and maintaining of popular support. Galula (1964) said that “military action is second to political” and Hearts and Minds echoes that view by driving its main military effort towards establishing security around areas where stability and the rule of law can be promoted and propagated. Here Combat Operations shares an equal role alongside developing Host Nation Security Forces, providing Essential Services, establishing good Governance and Justice, and fostering Economic Development. All of these components are encompassed under an umbrella of Information Operations aimed at countering the propaganda spread by insurgents and broadening the reach of the host nation government and its achievements (FM 3-24, 2006).

These key elements of Hearts and Minds are outlined in FM 3-24 (2006), in what the field manual refers to as logical lines of operation. Combat Operations are aimed at securing the local populace and national borders, separating the insurgency from the population, and identifying and neutralizing insurgent structures. These functions are to be conducted by integrating with the Host Nation Security Forces in an effort to train and equip these elements of the local government and transition security responsibilities to them as the situations arise. Notice that the focus is on promoting the host nation government and securing the population, not on kinetic maneuvers that come to mind when discussing combat operations in a conventional framework. The goal with developing these Host Nation Security Forces is to build, train, and equip a resilient and

stable security arm of the host nation that possesses strong leadership, adequate facilities, and are trained in planning and executing security operations. In the area of Essential Services, a direct parallel to the civic action programs Thompson described as having contributed greatly during the Malayan Emergency, the aim is to repair or establish critical infrastructure; such as transportation, water, and electricity. Other factors for development are waste and sewage, schools, medical clinics, and public offices. The Governance component of Hearts and Minds strategy seeks to gain legitimacy for the host nation leadership by developing government planning for services and administration, establishing the reach of the government throughout regional and provincial areas, and instituting judicial order in-line with local culture. Finally, Economic Development is intended to support free market initiatives, repair commercial infrastructure, and stimulate the workforce through skills-development programs and the employment of local contractors for reconstruction projects. The strategy also articulates the need to align these key components around a robust Information Operations plan. This factor is imperative in gaining information for the use of vital intelligence, countering information to quell propaganda spread through insurgent networks, and exploiting information that will boost the perception of host nation government legitimacy (FM 3-24, 2006).

Nagl (2002) described “dollars” as the new bullets in the counterinsurgency fight. He proposed that Hearts and Minds are directly targeted through programs like the Commander’s Emergency Response Program, which is aimed at providing reconstruction, introducing skilled workforce, and promoting economic development.

The rationale is that these elements will help gain credibility for the host nation government and shift support away from the insurgents, who are not capable of providing these types of social and economic improvements. An increase in popular support should also directly affect the quantity and quality of intelligence gained from the populace (Human Intelligence, or HUMINT). Finally, Nagl also suggests that focusing on the Hearts and Minds is all but impossible if the Host Nation Security Forces are not effectively trained and equipped to protect the populace. The perception that the host nation, and not outside supporters, is providing the security and services is paramount to gaining and maintaining the necessary support.

But, not all strategists subscribe to the utility of popular support and economic development as the deciding factors of a counterinsurgency. The Cost Benefit Theory of counterinsurgency, also known as Coercion, emerged in opposition to the premises of Hearts and Minds. This provided the first view of insurgencies and counterinsurgency as a complex system to which known econometric analysis tools could be applied. The developers of this strategy, RAND economists Nathan Leites and Charles Wolf Jr., proposed that counterinsurgency should be less focused on gaining intangible measures, such as popular support, and more about raising the costs associated with waging the insurgency, thus ensuring that these costs would not provide an acceptable balance of prospective benefits (Kahl, 2007).

The fundamental notion behind Cost Benefit Theory is that insurgencies can be treated as systems and that the aim of counterinsurgency is to reduce their effectiveness by raising the costs associated with insurgent actions. The proponents of this approach

also suggested that a population reacts to inputs to the system as rational actors; measuring their actions by considering the costs in relation to the expected outcomes. They also stipulated that irrational behaviors were caused by misinformation or inadequate execution of cost-control triggers. Finally, they proposed that measurable actions, such as acts of violence or terrorism, were more important evaluation factors than attitudes, such as the perception of popular support or government legitimacy that Hearts and Minds suggests (Long, 2006). The authors of this doctrine were intrigued by the difficulty in measuring and analyzing counterinsurgency when compared to other military analyses, such as nuclear doctrine. They questioned why military theorists could struggle so much with a counterinsurgency system that provides a wealth of historic examples and could be modeled using proven techniques, while tactics and procedures for nuclear conflict were very detailed and highly agreed-upon even though they lacked case data (Leites & Wolf, 1970). It can be speculated that perhaps this reasoning led to their selection of measurable factors as being fundamental to their theory in order to develop analysis models.

Leites and Wolf (1970) describe what they believed were the factors that contributed to their “alternative proposal”. From their discussion, factors such as Impeding Inputs to the Insurgency, Destroying Outputs of the Insurgency, Building Host Nation Authority Structure, Intelligence and Information, and Population Behavior can be extracted as being foundational. When considering Population Behavior, this strategy defines their actions as being based more on opportunities and the costs associated with making choices (supply) rather than needs and wants (demand). It is also suggested that

affiliation, a term which may be interpreted as behavior in support of the insurgency or the government, is determined by the progress each side has demonstrated.

Even though the majority of the elements of Cost Benefit Theory have been derived from the work of Leites and Wolf, others have followed with supporting arguments. Farmer (1964), another RAND researcher, proposed that economic development, as one of the characteristics of a successful strategy, may act to improve support for the populace, but support in itself is not the required outcome. Cost Benefit Theory differs slightly from Farmer's view in that it advises that economic development may not be an adequate input to the system because it has equal opportunity to aid the insurgents; through resources and services that can be taken from the populace or even given directly to insurgent supporters (Leites & Wolf, 1970). More recently some have suggested that the Cost Benefit Theory can be taken to the level of "out-terrorize the terrorist", in which the host nation government and the supporting forces are able to instill a sense of fear into the insurgent supporters to a degree where they no longer wish to support the revolution because of the threat of retaliation (Luttwack, 1999). Peters (2006) has also criticized the application of the "hearts and minds myth" in Iraq. He states that even though gaining popular and international support are satisfactory outcomes, the key elements to preserving national security are national respect and a feared military.

In an effort to extract commonalities from the strategies presented, Table 1 summarizes the theorists studied, their particular time period, location, insurgency theory used or witnessed, and the lessons generated from their experiences. Table 1 also

includes the characteristics of Operation Iraqi Freedom and Operation Enduring Freedom as they pertain to the discussion of the theories presented.

An important similarity identified is the mention of some form of popular support; the range of this spans Lenin's implication that the revolution must be tied to social reform, and it would be expected that this reform revolves around a popular belief, to Mao's reliance on the working class populace as the foundation for an insurgency. This element is expanded by Galula and Thompson from the viewpoint of counterinsurgents in that they must also vie for achieving some level of support. This focus proves to be the instrumental factor leading to the development and use of Heart and Minds. Another key observation is the understanding that this sort of irregular conflict involves more than just military components; social, political, economic, and informational elements have been granted much greater authority during a counterinsurgency campaign when compared to a conventional conflict.

Table 1: Table of classic theorists, time, location, insurgent strategies employed or faced, and methods or lessons contributed to the study of insurgency and counterinsurgency.

Theorist (Who)	Timeline (When)	Location (Where)	Strategy (What)	Lessons/Methods (How)
T.E. Lawrence	1916 - 1919	Saudi Arabia	Military Focus	<ul style="list-style-type: none"> ▪ Unassailable base ▪ Exploit enemy's technological dependence ▪ Out-manuever larger enemy ▪ At least passive popular support ▪ Sufficient weaponry
Vladimir Lenin	1917 - 1924	Russia	Conspiratorial	<ul style="list-style-type: none"> ▪ Lead by influential outsiders ▪ Social, economic, political discontent pre-requirement ▪ Framed around Marxist values
Mao Tse-tung	1945 - 1954	China	Protracted Popular War	<ul style="list-style-type: none"> ▪ Strong involvement of working class ▪ Leadership guided by political reform ▪ Evolve from guerilla to conventional ▪ Interdependence of military, government, populace
Robert Thompson	1948 - 1960	Malaya	Hearts and Minds	<ul style="list-style-type: none"> ▪ Must address all facets of insurgency ▪ Civic action teams ▪ Cut-off insurgents from populace ▪ "Oil spot" approach
David Galula	1954 - 1962	Algeria	Hearts and Minds	<ul style="list-style-type: none"> ▪ Popular support important for COIN ▪ Leverage active minority ▪ Popular support conditional
Ernesto Guevara	1956 - 1967	Cuba, Congo, Bolivia	Military Focus	<ul style="list-style-type: none"> ▪ Popular forces can defeat conventional army ▪ Not all preconditions for rebellion required ▪ Rural areas stage for guerilla combat
Nathan Leites & Charles Wolf	1959 - 1975	Vietnam	Cost Benefit	<ul style="list-style-type: none"> ▪ Raise costs of insurgency ▪ Guided my measurable actions ▪ Attack inputs to insurgency
FM 3-24	2001 - Present	Iraq, Afghanistan	Hearts and Minds	<ul style="list-style-type: none"> ▪ Clear-Hold-Build ▪ Focus on Neutral/Passive population

Modeling and Simulating Counterinsurgency

Modeling research geared towards insurgency and terrorism has taken on many forms.

This section will discuss several of those techniques and provide a framework for the development of a technique that will be useful to meet the goal of this research.

An example of a modeling technique applied to insurgencies is called effects-based operations. Here, the development of network flows and risk analysis has been used to identify nodes of interests or centers of gravity in the insurgent networks and to determine optimal courses of action for counterinsurgent forces (Umstead, 2005). This particular study, like many other operational research methods in insurgency and military simulation, focuses on political, economic, social, infrastructure, and information system factors. Another methodology that has been used is that of influence node analysis. This tool provides decision makers with a graphical representation of causal relationships between system actions or events and probabilistic regressions that can predict outcomes (Fatur, 2005). A variant methodology is termed Bayesian network analysis and is used to develop qualitative knowledge and probabilistic estimates of system behaviors based on expert input (Faizen & Priest, 2004). Social networks have also been applied to national stability analysis by combining simulation techniques with social interactions within the studied systems. Here social interactions and interconnections are identified and modeled in order to exploit these relationships and predict their behaviors (Renfro & Dekro, 2003). Other techniques have also been applied to the study of counterinsurgency, examples such as game theory (Pate-Cornell & Guikema, 2002) and value focused thinking (Pruitt, 2003), have presented alternative to aid decision makers in understanding these complex systems.

One modeling technique that has been very effective at simulating complex social systems, such as a counterinsurgency, and that requires very little empirical data is

System Dynamics. This method has been applied to modeling problems in the areas of natural sciences, public management, business processes, and insurgencies.

In the area of System Dynamics modeling, the first attempt to model counterinsurgency warfare came from R. G. Coyle (1985). He employed a generalized view of insurgencies based on literature from Galula, Thompson, Guevara, and others. He decided to not focus on a single scenario, such as Algeria or Malaya, for developing his system model because he thought that there was sufficient variety of information provided from different times and locations that a generalized view could be constructed into a useful model. What he did not incorporate was any prevailing strategy. When Coyle constructed his model, he did so in a gradual approach that allowed the reader to follow his logic in establishing influences. He then identified the closed influence feedback loops that governed the systems (persuasion, logistics, and compulsion loops) and determined which and how these components were influenced by each other in the system. Coyle used his model to propose policy options, which, based on the model influences, would provide insight into this complex social system. This study provides an excellent starting point for future study, because it demonstrates the applicability of this method towards the study of counterinsurgency. The methodology was limited in that the model was not simulated mathematically to study emergent behavior patterns of the system components or to determine how much government political and social support would affect insurgent strength, for example. Surprisingly, the study has not been referenced by any of the subsequent System Dynamics efforts discussed in the remainder of this section.

The next application of System Dynamics in counterinsurgency research did not occur for another twenty years. This hiatus comes in time when the Cold War and Network Centric Operations dominated military thinking and the Pentagon would rather forget about being involved in another Vietnam (Barnett, 2005), and it is not until the US launches the Global War on Terrorism that this scenario begins to receive further scrutiny. Among the efforts to study counterinsurgency that emerged during this time was a new-found focus on the applicability of System Dynamics towards irregular warfare. One such study, that originated from the Naval Postgraduate School, focused on counterinsurgency by evaluating the US military involvement in fighting Middle Eastern terrorist groups (Alcantara et al., 2005). The research considered policy interactions and how the influences within the system affected component behavior. In contrast to Coyle, this study was able to bridge the gap between conceiving influences and observing behavior by actually simulating the model. Their simulated model included relations between the US military involvement in the Middle East, the behavior of the terrorist groups, and the US allocation of resources to the Global War on Terrorism. Even though their counterinsurgency background addressed classic philosophies, they failed to include vital characteristics into their system model; host nation capabilities, popular support, and economic development were all lacking. The construction of the initial influence model also did not address why influences were selected and how strong and to what degree these influences controlled the system. This methodology could be applied in future work by considering basic system behavioral structures (Sterman, 2000) or classical component archetypes (Senge, 1990).

Shortly after the thesis by Alcantara et al. was completed, an article appeared in *Parameters*, the publication from the US Army War College, which addressed some of these concerns. Although Baker (2006) may not have heard of the work by Alcantara et al., he began his look at counterinsurgency by discussing the system structures and basic archetypes that might lead him towards an effective model. This study was also of interest because it developed an influence model based on current counterinsurgency doctrine and included characteristics like popular support, security, intelligence, and local government legitimacy. He also built the model gradually so as to rationalize the influences and maintain an appropriate level of strategic focus. Correctly aggregating system components allows only the major contributors to influence the system and keeps the model developer from adding far more detail than necessary for the analysis. Again, the major limitation of this study was not viewing the system's behavior through simulation.

The counterinsurgency philosophies and doctrine discussed in this chapter will serve as a foundation for the development of the key system elements that will be employed in the analysis. The next chapter will introduce the elements of System Dynamics and further explore its viability as an instrument to model complex social systems. The section will also demonstrate the development of the System Dynamics models throughout their stages in an effort to logically and iteratively assemble the final products, incorporating the elements of the counterinsurgency systems explored from this literature review.

III. Methods

This chapter will introduce the concepts of System Dynamics and the methodology employed in this study. First, the following sections will describe the fundamentals of System Dynamics modeling and introduce the terminology that will be used throughout this research. This section will outline and discuss the nature of the feedback loops that are present in dynamic systems and the construction of the various diagrams that will be used to model the system behavior. Finally, the methodology for sequentially and iteratively constructing System Dynamics models will be summarized.

The first concept that will be introduced is that of the reference mode. The reference mode is the notional representation of basic system behavior patterns over time. For example, a population system may initially grow slowly as it is faced with its environment, then begin to more rapidly grow as it begins to adapt, and then reach a steady state as it is limited by resources or other constraints. When a complex system, like a population, is observed in this natural state where exogenous influences are not considered, the natural behavior can be observed and its reference mode pattern can be constructed.

The reference modes can take one of several basic functions. As seen with the previous example, if the growth of a population were plotted over time, an S-Shaped curve would be expected. Similarly, systems can take on the form of a Goal Seeking or Oscillating pattern. Some of the common reference mode diagrams are seen in Figure 2.

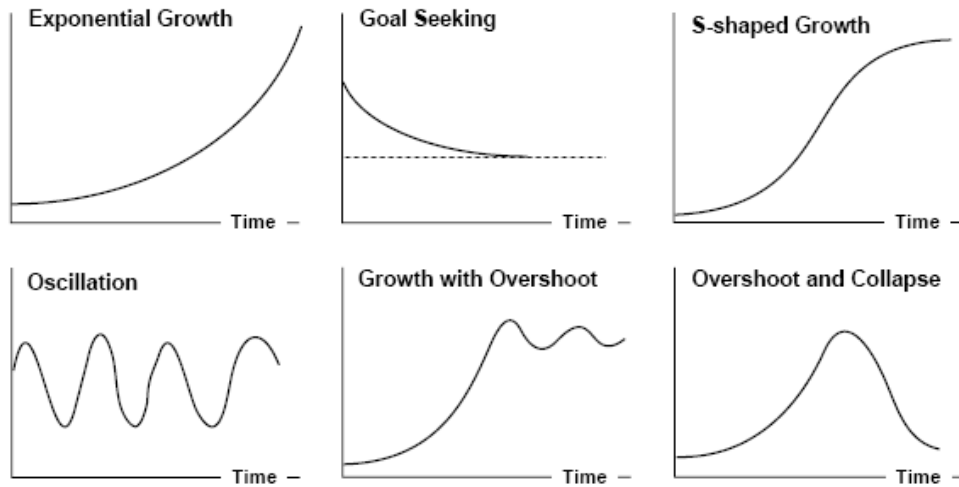


Figure 2: Common Reference Mode Diagrams, from Sterman (2000).

In all systems, a set of feedback loops work to reinforce or compensate the actions within the system. In the case of a Reinforcing Loop, an action sets in motion a reaction that escalates the original action. Several simple examples of this phenomenon are funds growing in a bank account as interest compounds or a snow ball rolling down hill and increasing in size. On the other hand, a Compensating Loop works to balance the system behavior and keep an action from intensifying.

As a matter of example, the *Popular Support* variable that will be a central part of the Hearts and Minds model will be analyzed in this manner. First, the reference mode for the variable is considered. When *Popular Support* is examined as a stand-alone entity, it is intuitive to suggest that its natural behavior will cause a drain in support for the insurgency or counterinsurgency over time until all of the support is dissipated. This

1st Order Draining nature is only observed in a theoretical sense because of the definition of the reference mode that no other aspects of the system are influencing it; in other words, the government, insurgency, or a coalition force are not acting to influence support one way or another. Thus the reference mode of this natural behavior can be represented by the graphic in Figure 3.

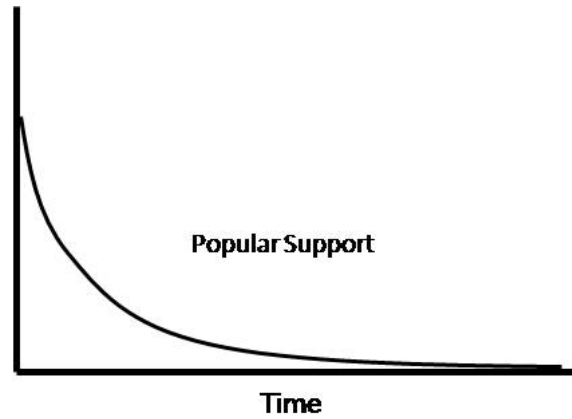


Figure 3: Reference Mode Diagram of Natural Behavior of *Popular Support* in the Hearts and Minds model.

For this reference mode diagram, a particular influence diagram is defined that relates to this behavior. An influence diagram illustrates a combination of system elements and their relations to one another. In the case of the *Popular Support* variable as applied to the Heart and Minds model, the influence diagram is demonstrated in Figure 4. The generic 1st Order Draining Structure shows the compensating behavior that is inherent in this structure.

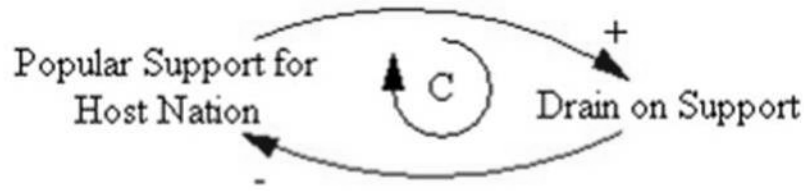


Figure 4: Influence Diagram of Natural Behavior of *Popular Support* in Hearts and Minds model.

During the model's construction, the procedure for developing the reference mode and influence diagrams would continue for each system element. This process would continue to follow the intuitive approach of designating the natural component behavior that best matches the characteristics of the given variable and associating this behavior with a known influence. At this point the system can begin to take shape as individual elements are connected to reveal reinforcing or compensating loops that have formed from the composition of the system.

Following the convention of iterative and sequential construction, when the model is ready to be operationalized mathematically, the system elements are then constructed individually in order to validate natural system behavior and then connected incrementally. The influence diagrams are operationalized into flow diagrams where stocks and flows are explicitly identified. A stock is a model state variable that has an accumulating or draining value over time as influenced by its associated inflows and outflows.

In the current example, *Popular Support* is the stock that is influenced by the flow of *Drain on Support*. The remaining element identified in the flow diagram, the *Popular Support Flow Factor*, serves as parameters to physically constrain the model to the limits envisioned in the development of the reference mode and influence diagram and to serves as a converter or coefficients that links other potential influences together. The flow diagram and model behavior associated with the *Popular Support* element are shown in Figure 5.

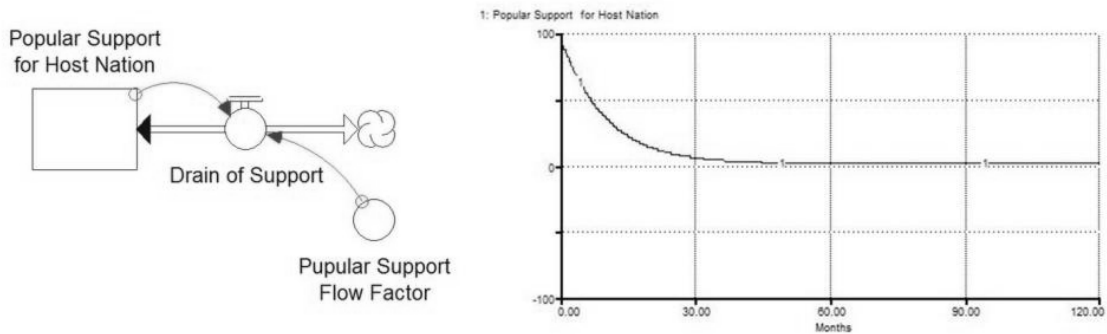


Figure 5: Flow Diagram and behavior of *Popular Support* in Hearts and Minds model simulated in STELLA 9.

Now the system can begin to interact among all of the elements that would be taken to the flow diagram stage. This step of sequentially connecting system elements, as with all other steps, is done incrementally, and the behavior is observed after each step in order to validate the system structure as the model is constructed. This emergent behavior is compared to the assumed behavior pattern hypothesized after the influence diagrams for each element are connected to complete system. Unexpected behavior can lead to the

detection of flaws in the model or to the realization of true system behavior that provides better insight into the system's behavior.

Thus far the model has been constructed in a systematic manner by starting with a reference mode behavior for the basic components of the system and developing those further into an influence diagram and a flow diagram in the simulation software. Equally important to this procedure is a thorough validation process that tests the model's structure, behavior, and boundary. This step accumulates confidence in the model's development and utility as a simulation tool of the actual event. As stated before, in System Dynamics models, statistical analysis tests are not generally applicable due to the cause-and-effect nature of System Dynamics as opposed to the correlation nature of a statistical approach.

The first set of testing to be conducted on the model will focus on the model structure. These tests, the Structure Verification, Parameter Verification, Extreme Conditions and Boundary Adequacy tests, are compared to the descriptive knowledge of the system. Both the Structure and Parameter Verification tests are conducted throughout the construction of the model. Along every point in the model where system components are constructed, the system structure and parameters are carefully considered for their physical significance. The Extreme Conditions test is applied to the system model in order to examine the model's performance under conditions beyond the normal operating range. The Boundary Accuracy test focuses on determining that the model has the correct level of aggregation, while still including all relevant system components. Figure 6 illustrates the correct aggregation level of System Dynamic models that consider a

balance of breadth and depth. As the figure shows, the challenge is to avoid widening the breadth of the system boundary before reaching an appropriate level of aggregation.

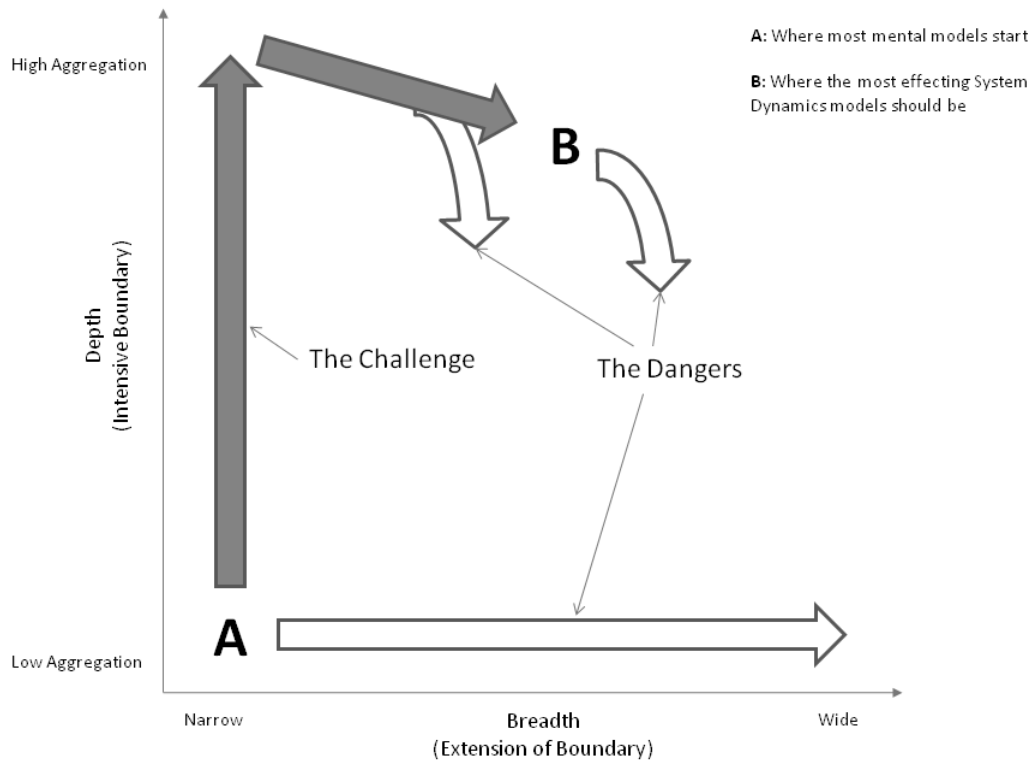


Figure 6: Effective level of aggregation for System Dynamics modeling, from IThink (2001).

The next series of tests focus on the model's behavior. These tests attempt to compare the simulated behavior to the observed or intuitive behavior of the actual event. These first tests are the Behavior Reproduction Test, the Behavior Anomaly Test, the Family Member Test, and the Boundary Adequacy Test. All of these tests are conducted by observing the emergent behavior of the model during constructing and tracing anomalous

or undesired behavior back to a structural component of the model. It is important to note that the main cause of model failures due to behavior is because of exogenous influences built into the model to “force” a certain behavior pattern, instead of the patterns being directly associated with a clear and physically meaningful system structure. The behavior test that will be conducted after the system is constructed is the Behavior Sensitivity Test. This test explores the range of parameters in which the model can maintain a reasonable behavior pattern.

This validation process serves to gain more insight into the model construction and allow for more confidence in the research methodology. The model construction and validation is conducted in stages and sequentially iterated to avoid unexpected behavior or flawed system structure. The validation does not focus on conducting statistical analysis of the model’s output against historical data. This would lead to forcing the model to fit constrained regressions developed with empirical data that would reduce the validity and usefulness of the System Dynamics model. Rather, the validation focuses on ensuring the system structure, behavior, and boundary are correctly constructed, adequately aggregated, and sequentially verified against the dynamic hypothesis.

The next chapter will demonstrate the development of the system models of the Hearts and Minds and Cost Benefit Theory counterinsurgency strategies. The chapter will also draw from the insight gained from both models’ influences and behaviors to determine the preferred method for generating the Hybrid Counterinsurgency Strategy model that will address the lessons learned during the study of the previous models.

IV. Analysis and Results

The previous chapters of this research have served to establish the framework of the study by detailing the need for developing a counterinsurgency strategy model, the background and historic influences that guide its construction, and the methodology that will be employed. This chapter explains in detail the incremental process for developing each of the components of a System Dynamics model and replicates that procedure for the various models that will be evaluated, tested, validated, and simulated. This section will also discuss the expected and emergent behavior patterns that are viewed throughout the development of these models. Finally, this section will use the information and insight gained from the models' behaviors to yield a comprehensive counterinsurgency model that can aid policy makers in understanding the elements and influences that guide this level of warfare.

Reference Modes and Natural Behaviors of the Hearts and Minds Model

As outlined in Chapter 3, the general modeling process starts by examining all of the model elements for their viability as having a reference mode behavior. This implies that not all of the model's components will fall into a basic category of natural behaviors that can be identified by a reference mode behavior pattern. Some elements will function as stand-alone parts of the overall model. Other elements may also seem to exhibit a natural behavior that does not conform to the standard reference mode patterns, and, in these cases, it is very likely that the elements can be further disaggregated into more basic components. For the purposes of the Hearts and Minds model, and subsequently the Cost

Benefit Theory model, the model's elements were seen to have a natural behavior that follows the standard reference modes or did not demonstrate a natural behavior. The elements of the Hearts and Minds model as well as their natural behavior are summarized in Table 2.

Table 2: Elements and Natural Behaviors of Hearts and Minds model.

Model Element	Natural Behavior
Popular Support	1st Order Draining
Coalition Combat Operations	Oscillation
Host Nation Security Forces	Oscillation
Essential Services	S-Shaped
Governance	S-Shaped
Host Nation Economy	S-Shaped
Information Operations	No Natural Behavior
Resentment	No Natural Behavior
Coalition Investment	No Natural Behavior

The first element studied for the Hearts and Minds model is that of *Popular Support*. Insurgency and counterinsurgency theorists dating back to Lawrence (1935), and most notably Galula (1964), have deemed support from the local populace as a necessity for successful counterinsurgency. From an insurgent's perspective, *Popular Support* provides logistical advantages, safe havens for organizing forces and evading government forces, and as a pool for recruiting for their cause. Whereas, for the counterinsurgent, support conveys added intelligence and a limitation of the supplies, hideouts, and recruiting that insurgencies require. (FM 3-24, 2006)

Human nature can attest to a behavior of gaining and losing interest in a particular subject; *Popular Support* gained or lost for the insurgency functions in much the same

way. If, for example, a situation exists in which *Popular Support* is high for one side as an initial condition, then lack of action from that side, which is a condition for observing the natural behavior, would cause a loss in interest for that particular side. This does not conclude that a loss of support for one side equates to a gain to the other, but more specifically a trend towards neutrality. This natural behavior model can be described by a simple 1st Order Draining structure that gradually declines to zero. An example of the reference mode diagram and the graphical depiction of the behavior are shown in Figure 7 (Shelley, 2008).

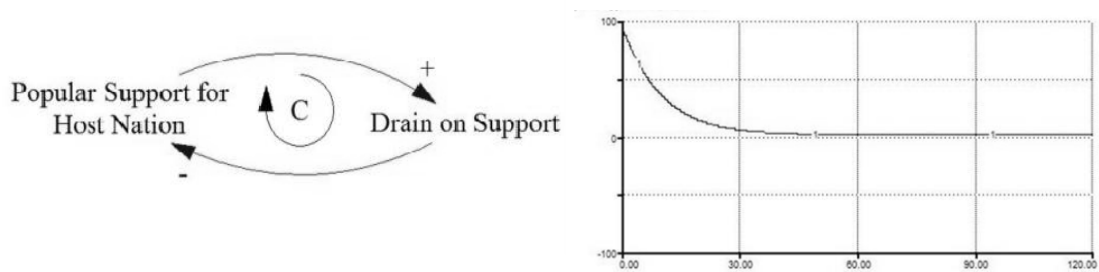


Figure 7: Reference Mode Diagram and graph of Natural Behavior of Draining Structure.

The next two elements of the Hearts and Minds model that will be evaluated are *Coalition Combat Operations* and *Host Nation Security Forces*. These elements are merged in the environment of counterinsurgency because of their dynamic interactions and synergistic opportunities. Nagl (2008) stated that “foreign forces can’t win a counterinsurgency campaign, only local forces can do that.” It is the local government’s security forces, military and law enforcement, augmented and trained by their foreign allies that can approach the local populace and maintain the presence of security without allowing their actions to seem like an invasion. Thus, when observing these two

elements from the perspective of their natural behavior, it is apparent that their levels are strongly dependent and complementary; as more coalition forces train and equip the host nation's forces, then less coalition troops are required, until the level of host nation personnel begins to fall again. This behavior follows an Oscillating reference mode construction and can be described by the diagram and graph in Figure 8.

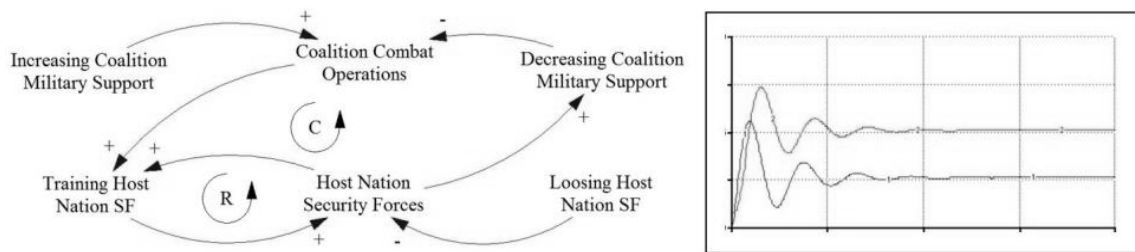


Figure 8: Reference Mode Diagram and graph of Natural Behavior of Oscillating Structure.

The next category of elements of the Hearts and Minds model are those that display an S-Shaped reference mode behavior: *Essential Services, Governance, and Host Nation Economy*. These elements, which entail all of the water, power, sanitation, and transportation infrastructure, the local and national government facilities and organization, and the state of an individual's and the nation's finances, are unmistakably major contributors to the counterinsurgency efforts. Galula (1964) stipulated that it was these elements, the political side of counterinsurgency, which made up 80 percent of the contribution. Initially, one can speculate that the three elements could be combined into a single local governmental factor. But upon study of the Hearts and Minds theory and reflection upon their individual contributions, the model features these components as

separate entities that interact differently within the model and yield different weights to and from the influencing factors.

When the natural tendencies for these elements are observed independently, it can be seen that they exhibit an initial exponential growth period and a finite level that is bounded by resources or other environmental constraints. Initially, the growth would be more subtle; as economic development is set in motion or the local government matures. This initial stage is followed by a period of greater expansion when the forces that act within each of these elements become more efficient and capable. Finally the transition to their steady state again occurs gradually. At this point services are established at required levels and economic independence is solidified. These characteristics make up the S-Shaped behavior that is shown in Figure 9.

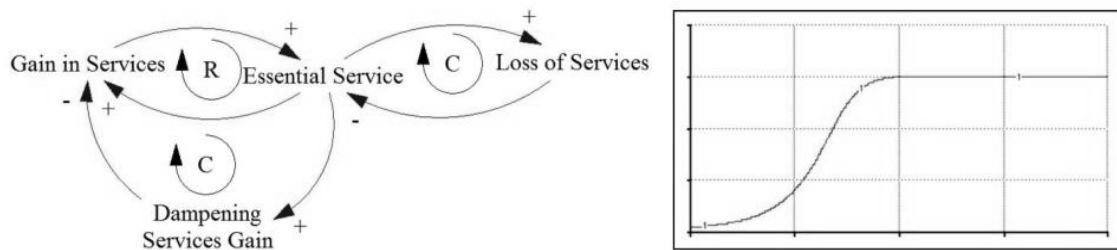


Figure 9: Reference Mode Diagram and graph of Natural Behavior of S-Shaped Structure.

Finally, *Information Operations*, *Resentment*, and *Coalition Investment* do not demonstrate independent natural behavior. These elements all seem to share characteristics that would suggest they are 1st Order Draining structures, but because those drains are only apparent when they are influenced by other elements, then the

requirements for assigning a natural behavior are not met. Nonetheless, the elements continue to be important aspects of the counterinsurgency system and their lack of independent behavioral characteristics does not diminish the weight of their contributions.

Through the development of an initial System Dynamics model, Baker (2006) suggested that poor intelligence was a contributing factor in negating the efforts that security and the rule of law could provide for the counterinsurgency. This study broadens the reach of *Information Operations* to not only include intelligence, but an integrated use of electronic warfare, computer network operations, psychological operations, military deception, and operations security (JP 3-13, 2006). FM 3-24 (2006) emphasizes the need for effective *Information Operations* to broadcast government and counterinsurgent actions and successes in an effort to counteract insurgent propaganda. Second, *Resentment* is a key component of the model that describes the sentiments of the population towards foreign combat forces. These feelings stem from perceptions of indiscriminate military action, excess collateral damage, or just the presence of an occupying force. Finally, *Coalition Investment* is the element that considers all of the resources from the allies that supports the local government's fight against the insurgency. All of these elements, even though distinct and independent in the context of their influences, share their structural tendency to drain information, feelings of resentment, or resources once they are acted upon from other influences of the model. If a population begins with a high level of *Resentment*, for example, then only the interjection of information pertaining to the merits of the local government and

contributions of the coalition will deplete their position towards having no ill feelings at all.

Influence Diagrams of the Hearts and Minds Model

Individually, all of the independent influence structures of each element arising from each reference mode behavior pattern form the building blocks of the complete model's influence diagram. Here the model influences are identified and their relative influence directions determined. Initially, the blank canvas of the influence diagram, as shown in Figure 10, is nothing more than the collection of each independent influence structure of the elements that make up their natural behaviors.

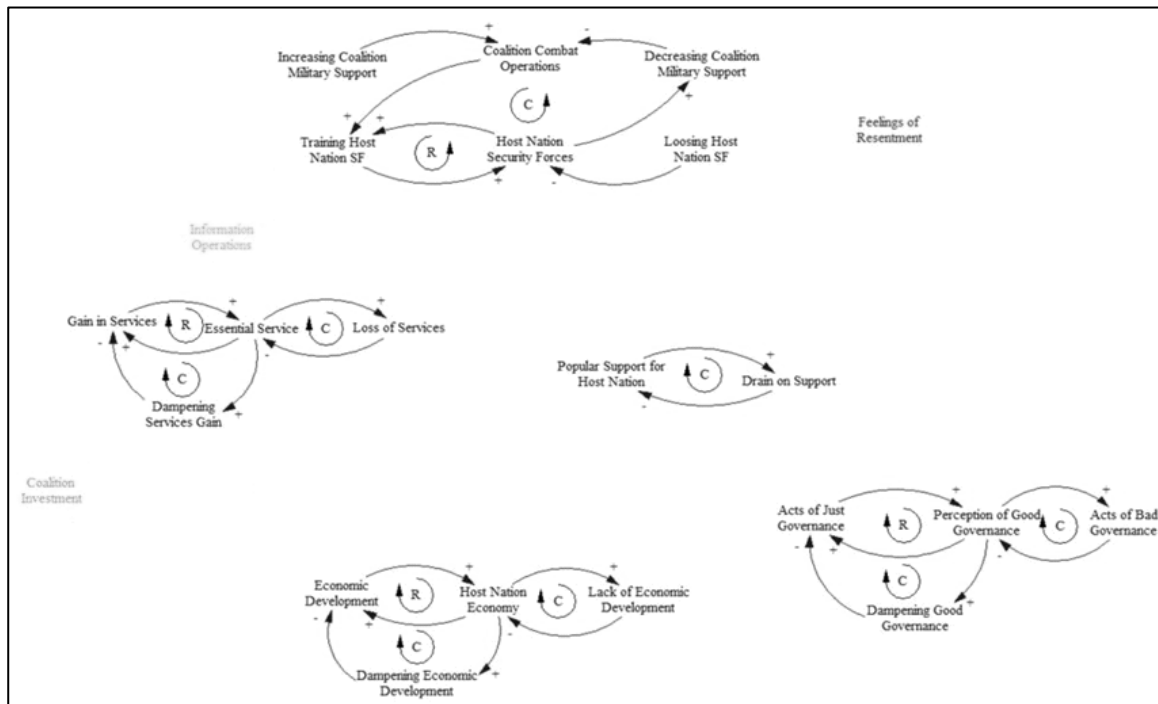


Figure 10: Influence Diagram of Hearts and Minds model showing independent influence structures of individual elements.

The first collection of influences that are identified and depicted in the diagram are those affecting *Popular Support*. Most of the elements are affected directly by *Popular Support* and, in turn, provide feedback in the form of a Reinforcing Loop. In the example of *Host Nation Security Forces*, *Popular Support* will work to diminish the loss of *Host Nation Security Forces* through increasing recruiting and lowering attrition. When this losing factor is acted upon in a negative fashion by *Popular Support*, the result is an increase in the net level of *Host Nation Security Forces*. This increased level of local military and law enforcement increases the *Popular Support* for the Host Nation by providing the populace with a stable and secure environment that directly reflects the government's policies and actions. The loop will continue its reinforcing nature. Similar arguments suggest the same reinforcing nature also exists for the elements of *Governance*, *Essential Services*, and *Host Nation Economy*. These influences are shown in Figure 11. As a matter of notation and in order to simplify the final influence diagram, the flows that cause gains or reductions to the element's stocks have not been showed. But it is important to understand that it is these flow structures that manage the magnitude and direction of the influences and that they must be present and effectively described during the development of the flow diagram.

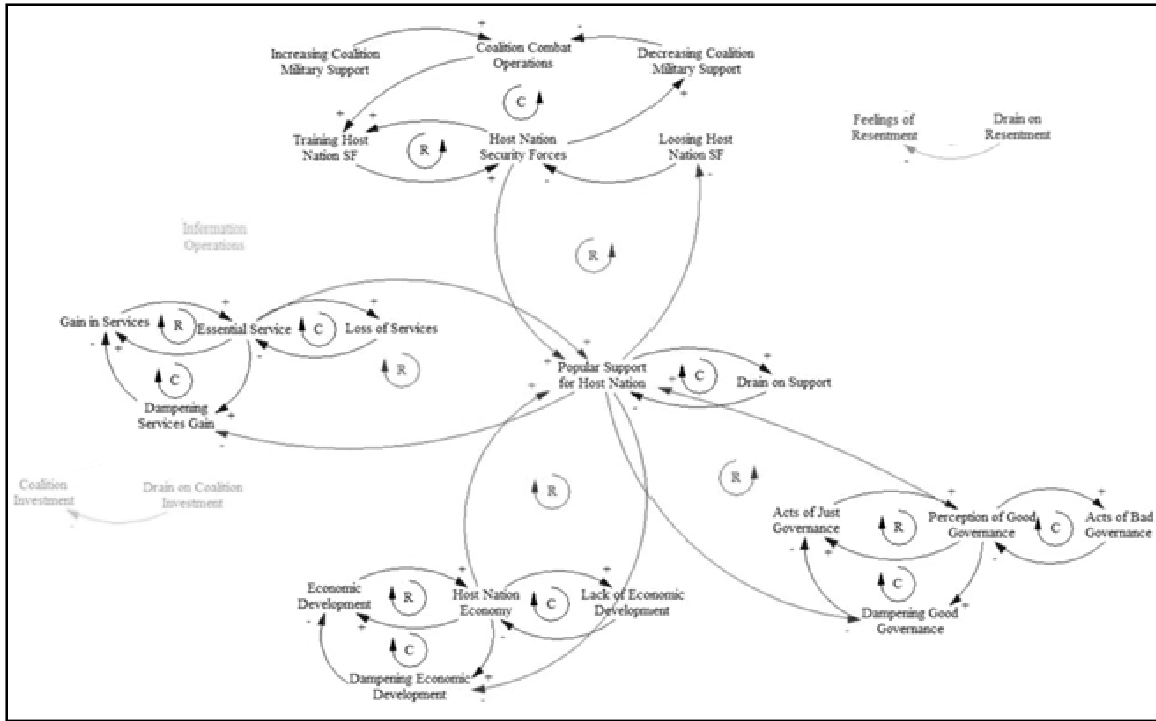


Figure 11: Influence Diagram of Hearts and Minds model showing influences of *Popular Support* with *Host Nation Security Forces*, *Essential Services*, *Host Nation Economy*, and *Governance*.

The influence of *Popular Support* on *Resentment* is similar to the previous elements. In this case the feedback from *Resentment* flows back directly into decreasing *Popular Support* and is also indirectly seen through *Resentment's* influence on *Host Nation Security Forces*. In this case, an increase in *Popular Support* would directly result in a decrease in the *Resentment* felt by the populace because of their gains in confidence in the Host Nation. For the direct influence, this results in a gain in *Popular Support* and a reinforcing loop. In the case of the indirect influence, reduced *Resentment* causes a direct reduction in the losses of *Host Nation Security Forces*. Like before, the losses are attributed to recruiting and retention of security personnel; positive gains in *Resentment*

would decrease recruiting and retention efforts, whereas lower feelings of *Resentment* increase these trends. Again, as seen before, these factors then cause increases to the levels of *Host Nation Security Forces* and, subsequently, increases to *Popular Support*.

The other influences that are present with *Popular Support* are those affecting *Information Operations* and *Coalition Investment*. In both of these cases *Popular Support* serves as an input to their dynamics and only feeds back into *Popular Support* through aggregated or obscure mediators. In the case of *Information Operations*, *Popular Support* serves as a source of intelligence, particularly Human Intelligence (or HUMINT), that can be exploited for use with kinetic operations and to survey the effectiveness of local government and coalition policies. But, unlike in the previous examples, it is not logical to suppose that *Information Operations* themselves affect *Popular Support*. Some may say that propaganda of coalition and government policies and actions would directly affect *Popular Support*. But, in fact, this feedback occurs through various mediating factors such as an increase in the *Perception of Good Governance* and through a reduction in *Feelings of Resentment*. More on the influences of *Information Operations* will be discussed further in this section.

Finally, *Popular Support* also directly affects the level of *Coalition Investment* that is being allocated to the counterinsurgency. Unlike for the case of *Information Operations*, here *Popular Support* acts as a drain on the level of *Coalition Investment*. *Popular Support* is seen as a metric for which the coalition judges the success of the counterinsurgency; as *Popular Support* rises, then the coalition can begin withdrawing its efforts and its investment.

The effects of *Popular Support* on all of the elements discussed up to this point are shown in Figure 12.

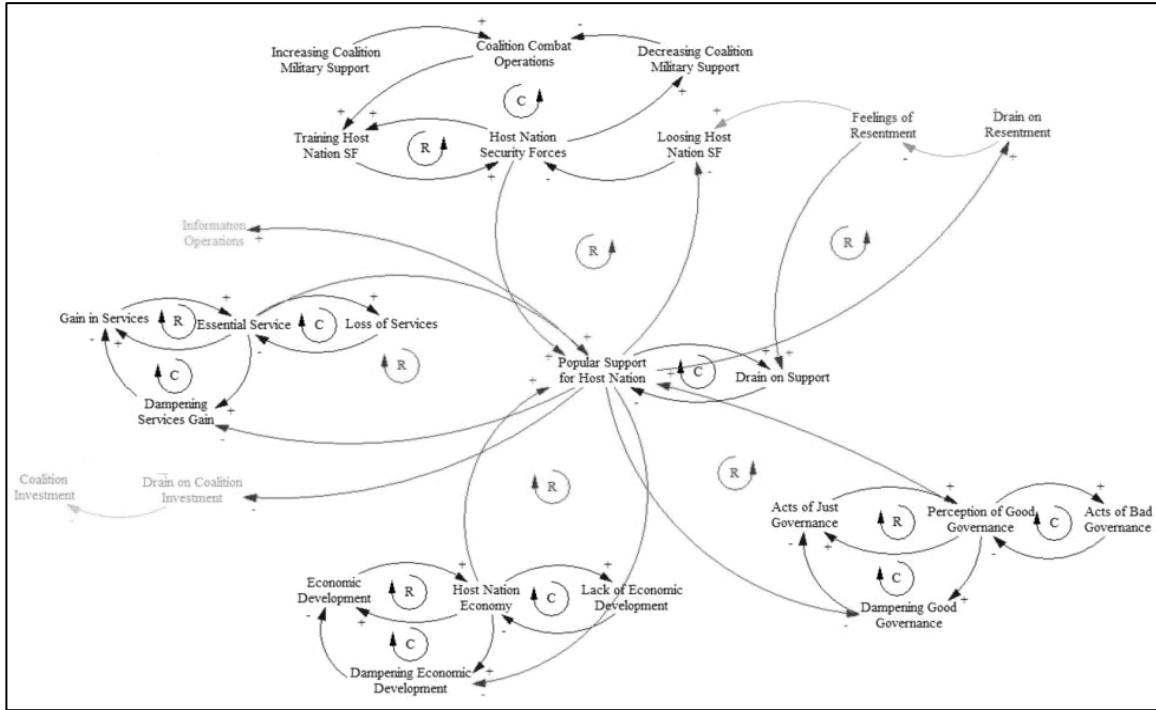


Figure 12: Influence Diagram of Hearts and Minds model showing the influences of *Popular Support*.

The next influence element that will be connected to the model will be *Resentment*. *Resentment*, like the other elements that have a Draining reference mode, will simply dissipate if left alone. But, when placed in the context of the counterinsurgency system, it will react to the influences within the system. In the case of *Resentment*, it is the presence of *Coalition Combat Operations* that supplies the building of these feelings by the populace. The reinforcing feedback caused by this influence is channeled back through *Resentment's* control over *Host Nation Security Forces*, which is in an Oscillating structure with *Coalition Combat Operations*. The other influence that is present with *Feelings of Resentment* is a direct negative relationship with *Perception of*

Good Governance. As these feelings continue to grow because of the presence of foreign troops and their conduct of military operations, then the populace will lose faith in the reach of the local government. It is true that these feelings can be mitigated and that influence will be discussed further in this section. The influences of Resentment on the system components are depicted in Figure 13.

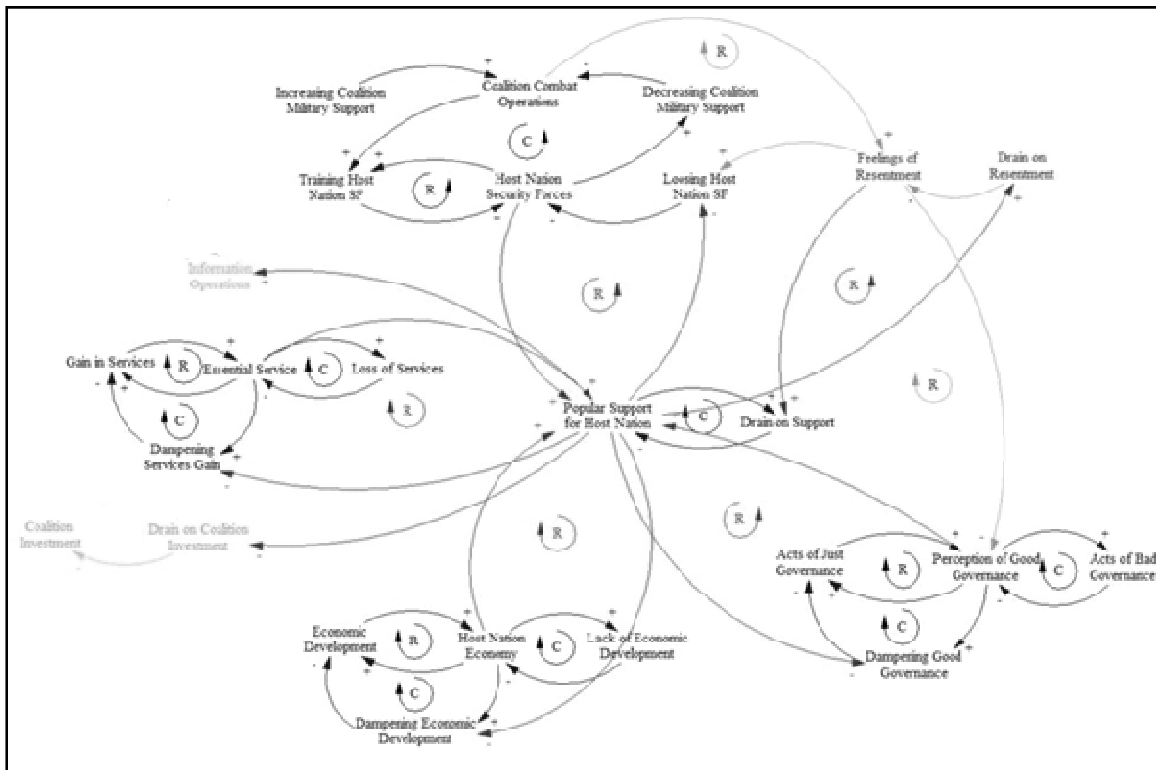


Figure 13: Influence Diagram of Hearts and Minds model showing the influences of *Resentment*.

Now the influences pertaining to *Information Operations* can be described and added to the model. Here two reinforcing loops are present, caused by the *Host Nation Economy* and *Governance*. Both of these elements offer ammunition to *Information Operations* in the form of media coverage of government events and the state of the economy. They

also both receive feedback from *Information Operations* to reinforce their growth; when investors, for the example of the *Host Nation Economy*, are introduced to positive news about the economic conditions, then they are more likely to invest further. Similarly, *Essential Services* feed the stock of *Information Operations* with positive media coverage, but does not receive the same feedback influence; positive news of previous successes will not alter the plans for developing these services, they will be managed based on the needs of the population. *Information Operations* also play a role in diminishing the *Feelings of Resentment* that is caused by the presence of coalition forces. Greater sources of information reduce the likelihood of collateral damage, unnecessary raids, or targeting innocents that are suspected of cooperating with the insurgents. *Information Operations* also reduce the anxiety that the public can feel during the insurgency by reinforcing the position of the government and the actions that the local leaders and the coalition have taken to improve the infrastructure and economy. The influences of *Information Operations*, which are shown in Figure 14, have been found to be of great importance to the system because of their reach and diversity and will be discussed in greater detail later in this chapter and during the findings of the study.

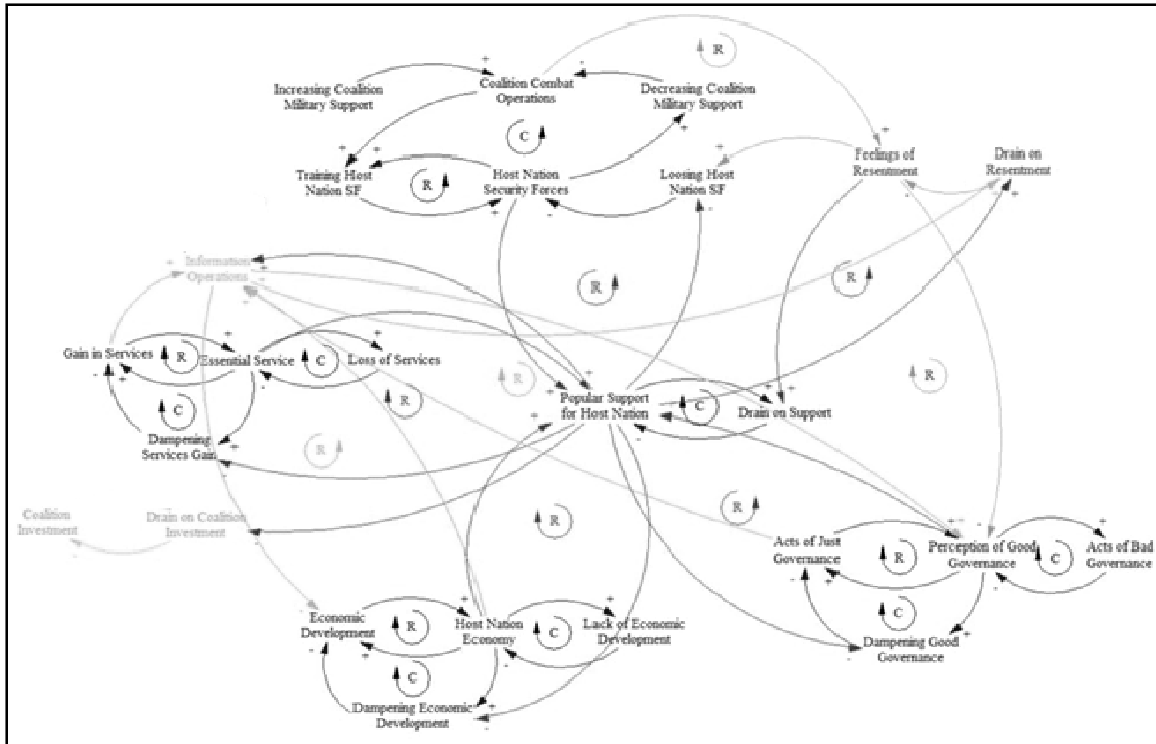


Figure 14: Influence Diagram of Hearts and Minds model showing the influences of *Information Operations*.

The final elements that will be connected are those that are supplied by *Coalition Investment*. It is assumed that an external coalition will support the local government against the insurgency not only with military, economic, and political support, but also with resources. These resources take the form of financial support, personnel, equipment, and logistics and are required for starting all of the coalition counterinsurgency elements: *Coalition Combat Operations*, *Information Operations*, *Essential Services*, and *Economic Development*. These influences also introduce very necessary Compensating Loops into the system. These loops work to stabilize the reinforcing influences that have dominated the environment to this point. The compensating nature effectively reduces the Host

Nation's dependency on the coalition as conditions improve. For this to work, the government then needs to take over these resources once the coalition has begun to withdraw. Thus, influences from *Governance* to these elements, in this case *Host Nation Security Forces, Economic Development, and Essential Services*, emerge.

The complete depiction of the influence diagram that describes the Hearts and Minds counterinsurgency model is shown in Figure 15.

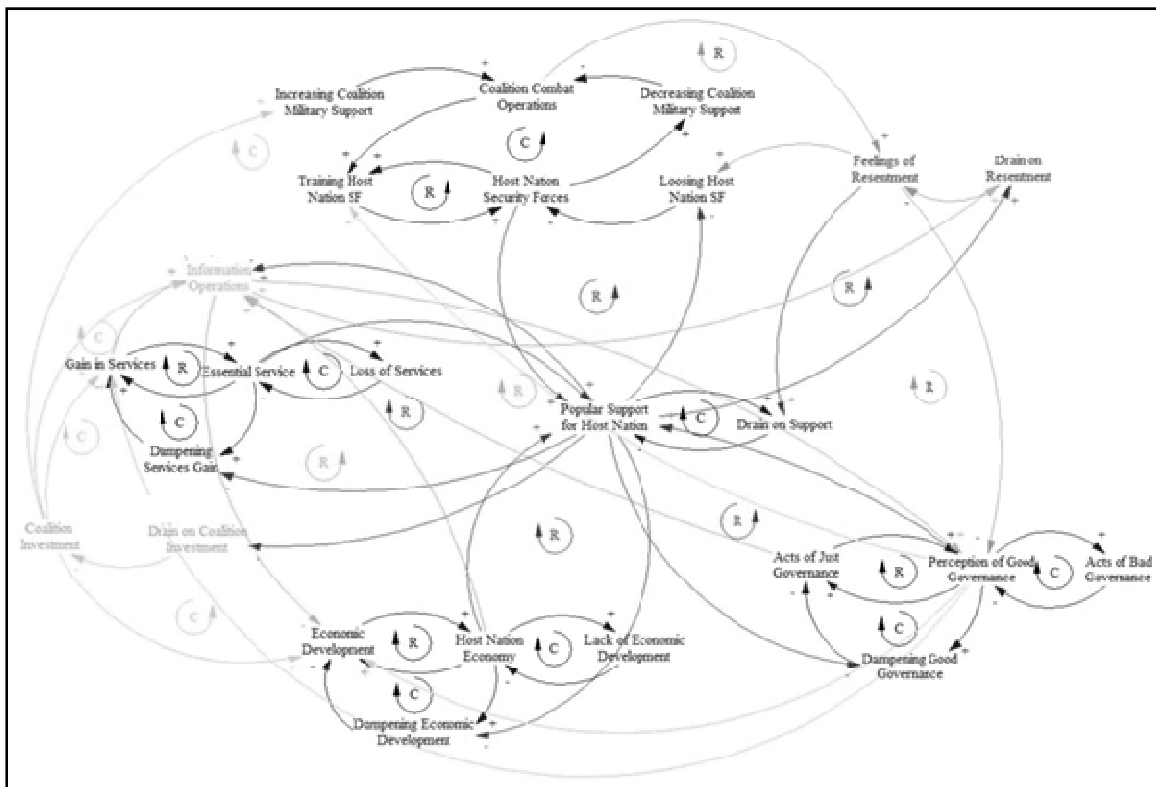


Figure 15: Influence Diagram of Hearts and Minds model.

Flow Diagrams of the Hearts and Minds Model

The process of operationalizing the influence diagram through simulation is done with the aid of System Dynamics software. STELLA[®] (version 9.0.2, by ISEE, Inc) is used

for this study because of its widespread acceptance among System Dynamics proponents. The following section will detail the process that converts the logical development of system influences into graphical representations of system behavior.

The first step in establishing the framework for developing the flow diagram is to establish the general requirements for the model simulation. First the length and time interval of the simulation is determined. Following past examples of counterinsurgencies, we have seen that the conflict in Algeria lasted eight years, and the Malayan Emergency, the conflict that gave birth to the concept of Heart and Minds, had a duration of 12 years (O'Neill, 2001). Recently, Nagl (2008) suggested that the average counterinsurgency campaign is approximately 10 years. These estimates provide a starting point for establishing the length of the simulation. In an effort to keep the modeling and simulation as uncomplicated as practical, a length of 10 years is selected; which will be expressed in terms of months, thus giving the simulation a range from zero to 120 months. As explained before, the exact timescale of a month is not important for this type of complex social model and the interpretation must not focus on relative behavior over the course of one or two months, but in terms of short-, medium-, and long-term horizons.

The modeling can now proceed to translating the individual reference mode influence diagrams into flow diagrams and then incrementally connecting the elements in the same manner as the influence diagram that was previously developed. The goal is to initially establish the range of values of coefficients that operationalize each of the elements so that they mirror the natural behavior and can continue to exert the same level

of influence as other system influences come to bear on the elements. It is apparent that the initial step of establishing the individual flow diagrams and connecting them incrementally is critical to the usefulness and validity of the model.

As with the case of the natural behaviors and the influence diagrams, the flow diagram development process will begin with *Popular Support*. *Popular Support*, on an individual basis, can exist as being achieved by one side or another, or can also take the form of a neutral or passive support (FM 3-24, 2006). But, simulating behavior at the level of individual members of a population and attempting to judge their perception as to falling in one of three categories of support would lead to far more detail than this study requires. In an effort to take a more elevated view of the system and maintain an adequate level of aggregation, a convention of positive and negative support will be adopted. When *Popular Support* is positive, the support resides with the counterinsurgents and the local government; a negative value of *Popular Support* indicates strengthening on the insurgent's part. And, as observed from the natural behavior, if none of the forces are acting to a greater degree than the other, then *Popular Support* will tend towards neutrality. The flow diagram and the graphical output of *Popular Support's* natural behavior are shown in Figure 16.

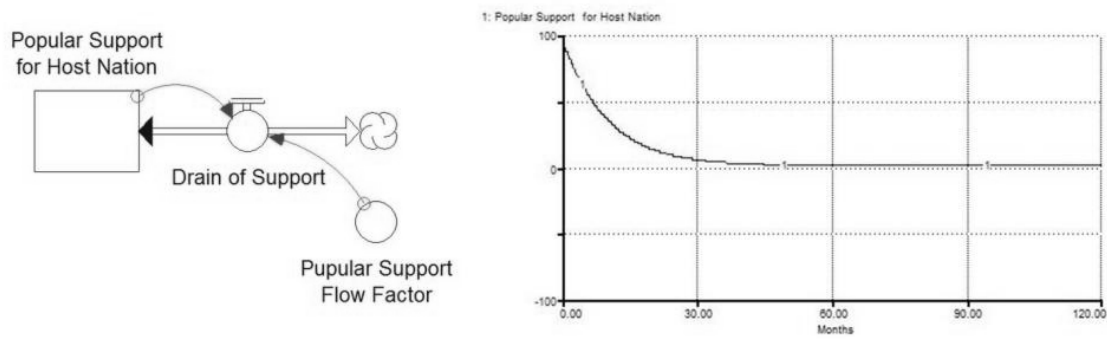


Figure 16: Flow Diagram and graph of natural behavior of the *Popular Support* element in the Hearts and Minds model.

The next elements that will be studied via the flow diagramming process are *Coalition Combat Operations* and *Host Nation Security Forces*. This reference mode is more complex than the simple Draining Structure seen for *Popular Support*, *Coalition Investment*, *Information Operations*, and *Resentment*. Also, the boundaries of these behaviors require a different approach as seen before; Popular Support arbitrarily started at 100 (or -100) and was only required to dissipate to zero. In this case the maximum spike and the steady state values of forces are of importance. Following the most recent example of Operation Iraqi Freedom, the maximum number of coalition military forces was 164,000 (Baker & Hamilton, 2006), which would, according to estimates of initial planning metrics, be maintained at a level of 30,000 to 40,000 (Global Security, 2008). The Iraqi Security Forces numbered at it greatest level at approximately 300,000 (Baker & Hamilton, 2006) and would finish with an end-state value of approximately 137,000 (DoD, 2006). These values only provide a reference from which to begin the modeling process and should not be interpreted as exact or required for the model to be valid.

The flow diagram and the graphical output of the natural behavior of *Coalition Combat Operations* and *Host Nation Security Forces* are shown in Figure 17.

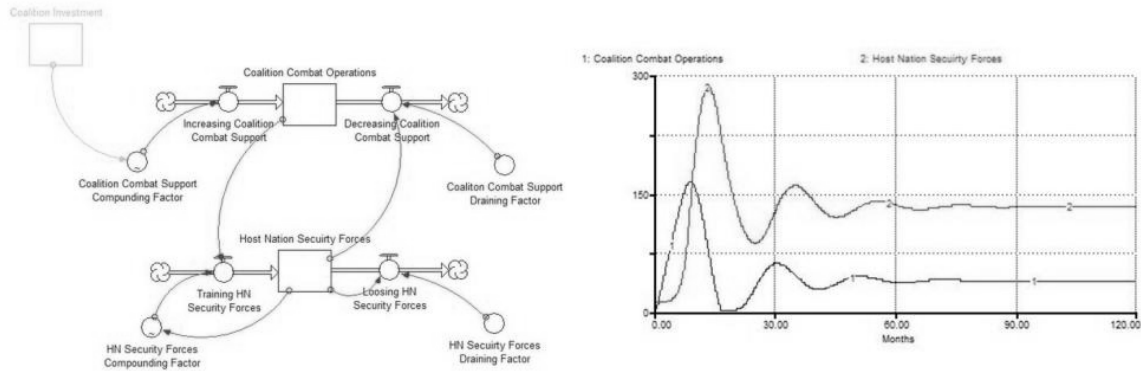


Figure 17: Flow Diagram and graph of natural behavior of the *Coalition Combat Operations* and *Host Nation Security Forces* elements in the Hearts and Minds model.

The graphical representation of the natural behavior of these elements does have one characteristic that should be discussed. The level of *Coalition Combat Operations* begins to steadily increase and reaches its maximum value of approximately 160 (representing thousands of coalition troops). Then, as expected, the level of *Host Nation Security Forces* continues to increase and the level of coalition support now decreases proportionally. Then a low of zero is reached by the level of *Coalition Combat Operations*, before it then begins to rise again in response to the diminished value of *Host Nation Security Forces*. This does not imply that after the initial surge the coalition should remove its troops, only to bring them back several months later. The dampened oscillation that is observed from the structure is a function of the boundary values and steady state objective of the structure and serves to represent physical constraints of the elemental stocks. In a standard oscillating structure, one that is not dampened by the

physical constraints of the model, the pure oscillation would maintain a slightly different characteristic behavior. But the requirements of this particular model, in this case the addition of the *Host Nation Security Forces Compounding Factor* which represents the local forces ability to train their own once they are established, is necessary for the model's development and an addition to the standard structure.

The final set of reference modes that will be operationalized into a flow diagram are the S-Shaped structures of *Governance*, *Essential Services*, and *Host Nation Economy*. Since these factor have such variability across regions and time, it would be impractical to estimate values for these elements that would relate to actual examples or events. The important aspect of developing these flow diagrams is to obtain an acceptable reference mode behavior and not a designated set of values. Thus, for all of these elements a standard steady state value of 100 was selected as the maximum and the value will be achieved at approximately the half way point in the simulation; 60 months for this model.

The flow diagram and the graphical output of *Essential Services*' natural behavior are shown in Figure 18. The flow diagram and graph of *Host Nation Economy* are not shown because they are identical to those of *Essential Services*. The flow diagram and the graphical output of *Governance*'s natural behavior are shown in Figure 19.

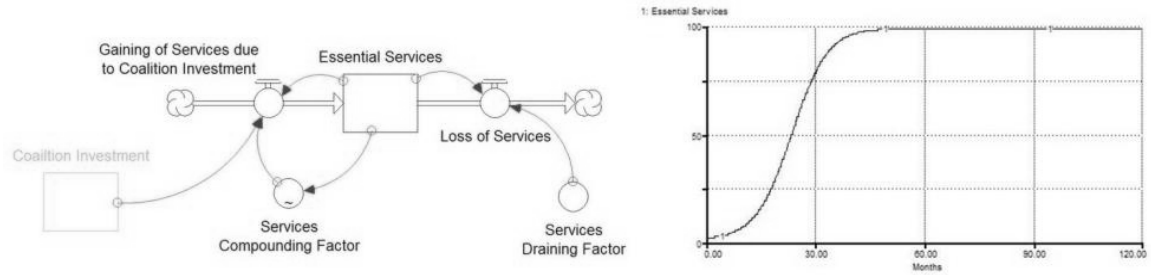


Figure 18: Flow Diagram and graph of natural behavior of the *Coalition Essential Services* element in the Hearts and Minds model.

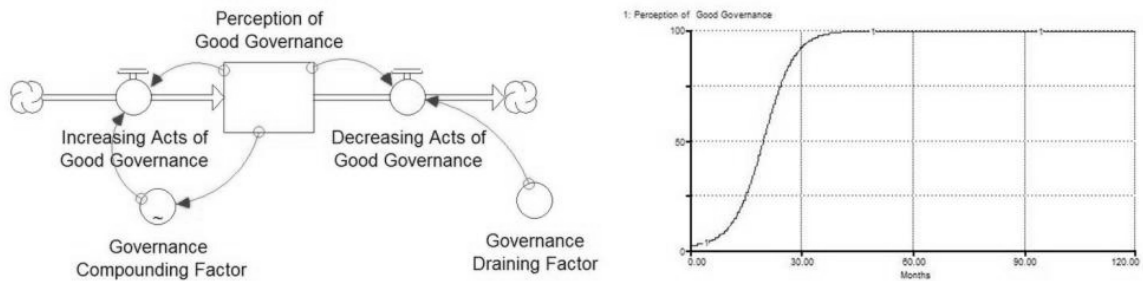


Figure 19: Flow Diagram and graph of emergent behavior of *Governance* element in the Hearts and Minds model.

The next step in the process of developing the Hearts and Minds model is to begin to incrementally combine the individual flow diagrams that depict each of the elemental reference modes. Only when anomalous behavior patterns are spotted, should the previously established coefficient values and modeling parameters be changed. This ensures that the model is not altered during the modeling process to fulfill a previously derived conclusion.

The following process will only demonstrate key examples or unusual modeling circumstances because of the numerous steps in the procedure. For example, in order to connect *Popular Support* to *Host Nation Security Forces* through the previously

established influence, the modeler must first connect the stock of *Popular Support* to the flow of *Losing HN Security Forces* through the *HN Security Forces Draining Factor*. The emergent behavior is then observed and compared to the expected pattern. In this case, it is expected that an increased level of *Popular Support* would decrease the losses associated with *Host Nation Security Forces* and would cause this element to peak at a higher maximum and reach a higher steady state value. If this behavior is seen, as it was with this case, then the connection is removed and the complementing influence is tested. Now the level of *Host Nation Security Forces* will add to the stock of *Popular Support*. The emergent behavior, both the anticipated and the observed after making this connection, shows that *Popular Support* does not drain completely to zero. Finally both connections are made and the behavior of the new flow diagram is observed. In this case the level of *Popular Support* drops initially, but maintains a higher level than without the influence of *Host Nation Security Forces*. For their part, the level of *Host Nation Security Forces* is maintained at a slightly higher level thanks to the decrease in loss associated with *Popular Support's* influence. The flow diagram showing the influence feedback between these two elements is shown in Figure 20.

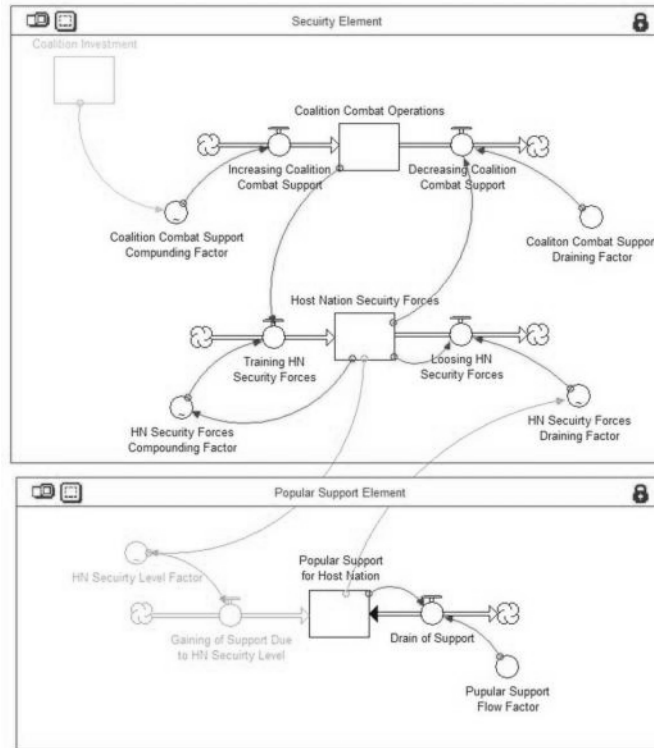


Figure 20: Flow Diagram of interaction between the *Popular Support* element and the *Coalition Combat Operations* and *Host Nation Security Forces* elements in the Hearts and Minds model.

Continuing to incrementally add the remaining influence elements into the Hearts and Minds model yields the completed version of the flow diagram (Figure 21). Also, Table 3 summarizes the names, values, and units of the coefficients that have been described during the construction of this flow diagram.

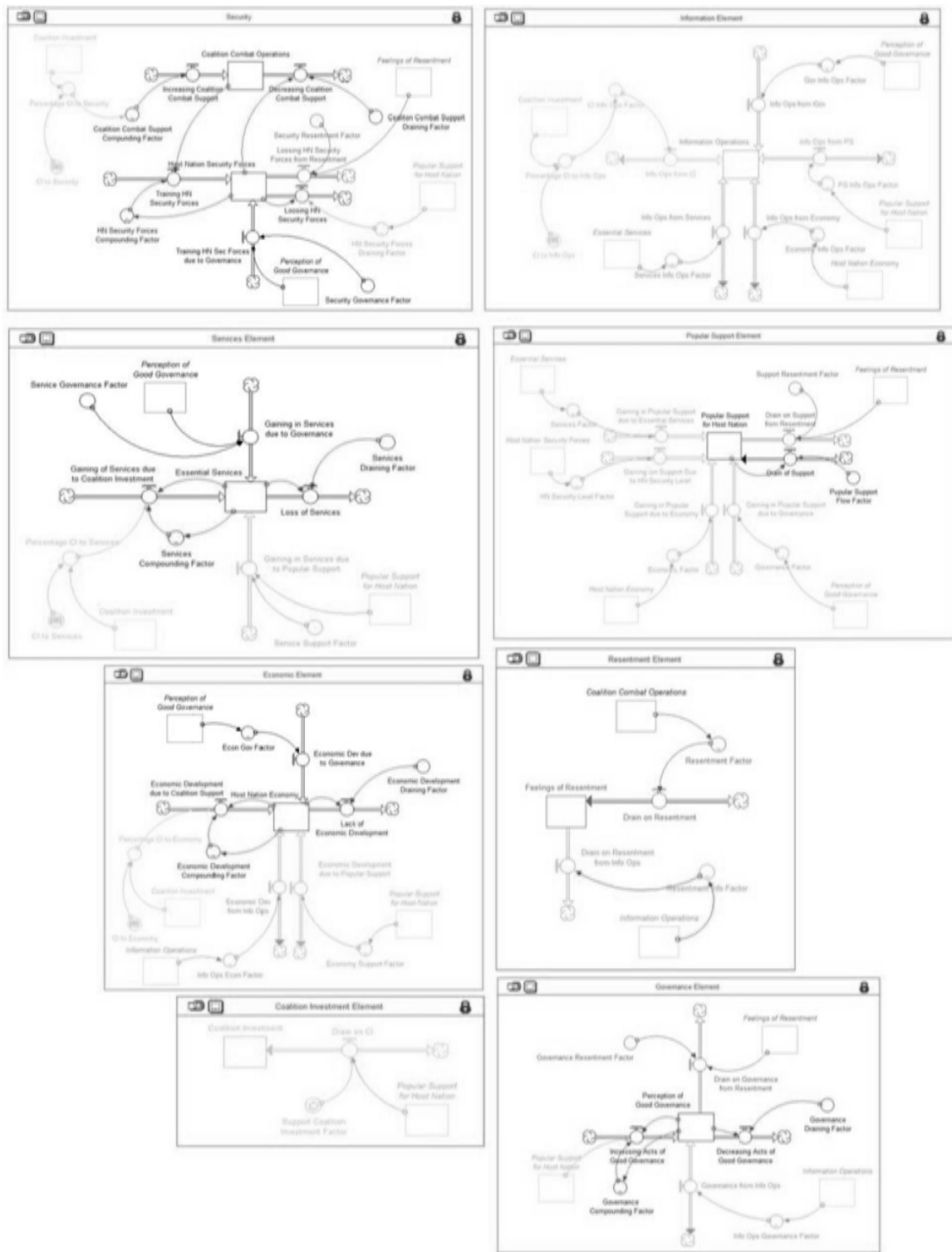


Figure 21: Flow Diagram of Hearts and Minds model.

Table 3: Names, values, and units of coefficients used in the development of the Hearts and Minds model Flow Diagram.

Coefficient Name	Coefficient Value	Coefficient Units
Popular Support Flow Factor	0.1	1/month
Coalition Combat Support Compounding Factor	$\alpha = \beta$ $x = \text{Percentage Coalition Investment to Security}$	Coalition Combat Operations/month
Coalition Combat Support Draining Factor	0.19	Coalition Combat Operations/(HN Security Forces*month)
HN Security Forces Compounding Factor	$\alpha = 0.005\beta$ $x = \text{HN Security Forces}$	HN Security Forces /(Coalition Combat Operation*month)
HN Security Forces Draining Factor	$\alpha = -0.0033\beta < 0$ $\alpha = -0.00062\beta > 0$ $x = \text{HN Security Forces}$	1/month
Services Compounding Factor	$\alpha = -0.0001\beta$ $x = \text{Essential Services}$	1/month
Services Draining Factor	0.05	1/month
Economic Development Compounding Factor	$\alpha = -0.0001\beta$ $x = \text{Host Nation Economy}$	1/month
Economic Development Draining Factor	0.05	1/month
Governance Compounding Factor	$\alpha = -0.001\beta$ $x = \text{Perception of Good Governance}$	1/month
Governance Draining Factor	0.05	1/month
Services Factor	$\alpha = 0.067\beta$ $x = \text{Essential Services}$	Popular Support/month
HN Security Level Factor	$\alpha = 0.05\beta$ $x = \text{HN Security Forces}$	Popular Support/month
Economic Factor	$\alpha = 0.067\beta$ $x = \text{Host Nation Economy}$	Popular Support/month
Governance Factor	$\alpha = 0.067\beta$ $x = \text{Perception of Good Governance}$	Popular Support/month
Support Resentment Factor	0.25	1/month
Security Resentment Factor	0.1	HN Security Forces/(Resentment*month)
Security Governance Factor	0.025	HN Security/(Governance*month)
Services Governance Factor	0.05	Services/(Governance*month)
Services Support Factor	0.1	Services/(Popular Support*month)
Econ Gov Factor	$\alpha = 0.05\beta - 0.5 < 10$ $\alpha = 0.005\beta - 0.05 > 10$ $x = \text{Perception of Good Governance}$	Economic Development/month
Econ Info Ops Factor	$\alpha = 0.15\beta - 1.0 < 10$ $\alpha = 0.5\beta > 10$ $x = \text{Information Operations}$	Economic Development/month
Economy Support Factor	$\alpha = 0.1\beta$ $x = \text{Popular Support}$	Economic Development/month
Governance Resentment Factor	0.0075	Governance/(Resentment*month)
Governance Info Ops Factor	$\alpha = 0.15\beta - 1.0 < 10$ $\alpha = 0.5\beta > 10$ $x = \text{Information Operations}$	Governance/month
Resentment Factor	$\alpha = -0.16\beta + 6$ $x = \text{Coalition Combat Operations}$	Resentment/month
Resentment Info Factor	$\alpha = 0.1\beta$ $x = \text{Information Operations}$	Resentment/month
Support Coalition Investment Factor	0.003	Coalition Investment/(Popular Support*month)
Info Ops Services Factor	$\alpha = 0.2\beta - 0.1 < 10$ $\alpha = 0.1\beta > 10$ $x = \text{Essential Services}$	Information Operations/month
Info Ops Economy Factor	$\alpha = 0.4\beta - 0.15 < 10$ $\alpha = 0.25\beta > 10$ $x = \text{Host Nation Economy}$	Information Operations/month
Info Ops Support Factor	$\alpha = 0.004\beta$ $x = \text{Popular Support}$	Information Operations/month
Info Ops Governance Factor	$\alpha = 0.4\beta - 0.15 < 10$ $\alpha = 0.25\beta > 10$ $x = \text{Perception of Good Governance}$	Information Operations/month

Results and Discussion of Hearts and Minds Model Simulation

The flow diagram presented in Figure 21 demonstrates the relevant influences that, according to the historical review of the theory's development and applications, are crucial in defining the Hearts and Minds counterinsurgency strategy. During the development of the model, several key factors have begun to emerge as important to the discussion of this theory. First, the influence diagram and the flow diagram both demonstrate the strength of the influence of *Information Operations* on the system; *Popular Support*, the predominant element in the system and the measure of greatest importance, is the only other element to have as many influences external to its natural behavior.

This finding suggests that *Information Operations* may merit equal ranking in terms of resource allocation towards the counterinsurgency campaign. While historical attention has been given to the division of resources between the military and political components, such as Galula's 80/20 Theory (1964), the value of information superiority and exploitation now introduces an entirely different approach to this debate. Even recent discussion on Hearts and Minds theory has allocated very little attention (or even none at all) to the influences of *Information Operations*.

Nagl (2002), Long (2006), and Kahl (2007) provide excellent discussions on the origins and implications of Hearts and Minds. Yet, none of them mention *Information Operations* or the need for controlling or managing information as a part of the strategy. Kilcullen (2008) is more eager to mention the necessity of bolstering information assets in successful counterinsurgency efforts, but falls short of making substantial arguments as

to the validity of his suggestions or recommendations for the relative importance of *Information Operations* when compared to the traditional counterinsurgency tools. The Counterinsurgency Field Manual (2006), on the other hand, is probably the best proponent of the use of information as a key role in its strategy. FM 3-24 details its Logical Lines of Operations as being encompassed around wide ranging information exploitation. Other recent proponents of *Information Operations* are those that view this factor from a technological stand point. Even though Intelligence, Surveillance, and Reconnaissance conducted by air and space platforms are indispensable assets in modern warfare, counterinsurgency included, (Dunlap, 2007) this is only a portion of the total *Information Operations* arsenal. A discussion on the importance of information to counterinsurgency must be inclusive of its technical (Signal's Intelligence, Surveillance, and Reconnaissance) and non-technical (Human Intelligence and Psychological Operations) aspects. The construction of this model, and subsequent exploration of its emergent behavior patterns, will add greatly to this debate.

The Hearts and Minds model is constructed in such a manner that the emergent behavior patterns of all of its elements can be explored under a variety of situations. First, the model was designed to allow the researcher to manipulate the amount of *Coalition Investment* that is allocated to each of the counterinsurgency resources it feeds: *Coalition Combat Operations*, *Essential Services*, *Host Nation Economy*, and *Information Operations*. This feature provides this model with the flexibility to study the variability of the strategy's success by altering the combination of resources and observing the behavior of key indicators, such as the behavior of *Popular Support*, *Resentment*, or

Governance. The model is also capable of adjusting the rate at which *Coalition Investment* responds to a shift in *Popular Support*. With this, the model is able to provide guidance to policy makers as to how quickly the coalition can transition authority to the local government without facing unacceptable risk to the mission. This Hearts and Minds model can also phase operations that could shift the mix of resources to other elements during different stages of the timeline. This would allow decision makers to model various approaches that focus on different areas, such as focusing on security during the short-term and then shifting their efforts to developing essential services and the economy in later stages. The following section will explore several of these situations in order to demonstrate the validity and flexibility of the simulation. However, it is not the intention of this research to explore all of the possible alternatives of this theory or determine optimal operating conditions. Further research will be recommended in Chapter 5 that further reinforces the findings of the models developed during this study.

During the model's construction, one of the design factors used to develop and test model influences and interactions was the determination of the starting value of *Coalition Investment*. Like all elements, *Coalition Investment* is expressed in terms of some unit of measure; time, number of people, and amount of dollars are all common. For this case the amount of *Coalition Investment* is not as important as the relative allocation of the resources. Thus, the stock in question is designated as having an initial value of 100 with a percentage unit of measure assigned. In this manner distribution of resources can be simply quantified as a portion of 100 percent. Initially the logical development of the model suggested that equally distributing *Coalition Investment*

among the four elements it drives (*Coalition Combat Operations, Information Operations, Essential Services, and Host Nation Economy*) would provide an adequate starting point for observing the model's behavior. This baseline emergent behavior plot is shown in Figure 22.

The plots depicted in Figure 22 through Figure 26 show the behavior patterns of the main indicators of the Hearts and Minds model: (1) *Popular Support*, (2) *Coalition Investment*, (3) *Resentment*, (4) *Coalition Combat Operations*, and (5) *Host Nation Security Forces*. The plot is scaled for a range of values from zero to 300 for *Popular Support*, *Coalition Combat Operations*, and *Host Nation Security Forces* and from zero to 100 for *Coalition Investment* and *Resentment*. These ranges of values are designed to provide the greatest appreciation for the detail of the behavior patterns and may be changed in order to appreciate behavioral details.

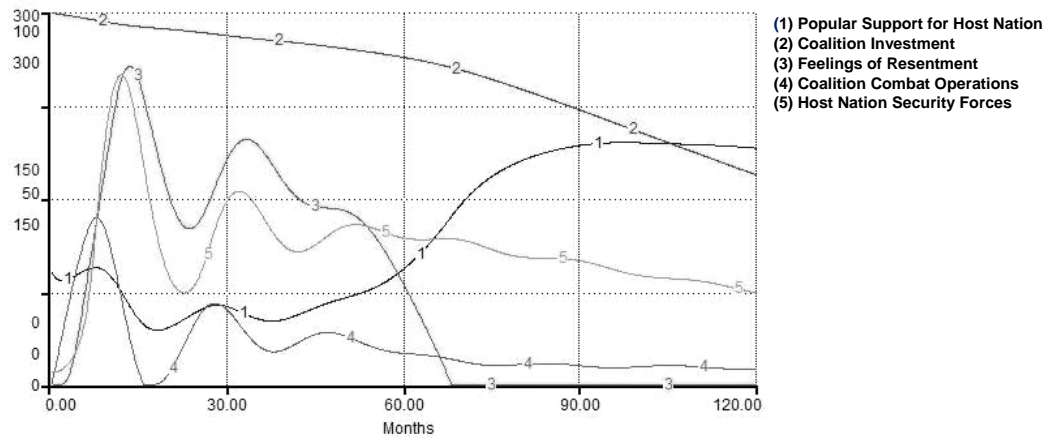


Figure 22: Emergent Behavior of Hearts and Minds model given even allocation of *Coalition Investment* to *Security, Economy, Services, and Information Operations*.

Figure 22 provides great insight and a positive outlook into the viability of the Hearts and Minds model. The first indicator, *Popular Support*, was designed to maintain positive

values for situations in which the support was given to the local government and that the magnitude of these values would determine their relative support. Here, *Popular Support* begins to drop during the initial stages of the campaign, but this level does not drop into negative values. The initial decline of *Popular Support* is attributed to the heightened *Feelings of Resentment* that begin to spike during this time. Since the short-term phase introduces many coalition troops which will cause an increase in *Resentment* and *Information Operations* have not had time to fully develop, then this reaction by the population is normal and expected. In the later stages of the counterinsurgency, as troop levels decrease because of added security, development of critical infrastructure and the economy, and a growing information campaign, then *Resentment* begins to diminish until it no longer influences the system and *Popular Support* is able to stabilize at a relatively high and steady level. Throughout this entire time, *Coalition Investment* has reacted to the level of *Popular Support*; initially dropping gradually with the positive support trend and decreasing more rapidly as *Popular Support* reaches its positive, stable value.

Equally distributing Coalition Investment among the four elements provides an excellent baseline from which to evaluate other combinations of resources. With this model, policy makers can test different scenarios that focus resources on one or more elements, providing great insight into the complexities of the Hearts and Minds strategy. The first of these scenarios that will be considered is the one proposed by Galula (1964). The French counterinsurgent suggested that fighting an insurgency was 20 percent military and 80 percent political. To test this theory the model was adjusted to provide the *Coalition Combat Operation's* element with 20 percent of the coalition's resource,

while the remaining 80 percent will be divided equally among the remaining factors. The plot demonstrating this behavior is shown in Figure 23.

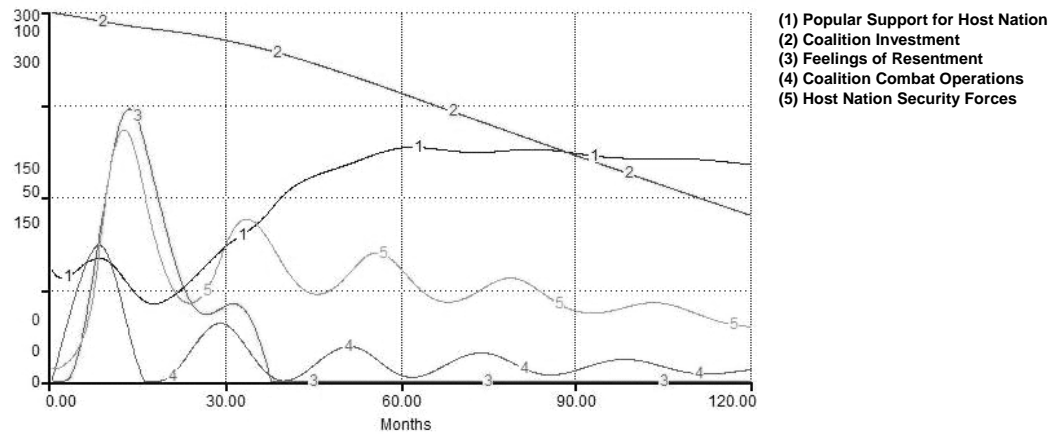


Figure 23: Emergent Behavior of Hearts and Minds model given allocation of *Coalition Investment* following Galula’s 80/20 Theory (1964): 20% to *Security* and 80% equally to *Economy, Services, and Information Operations*.

The behavior shown in Figure 23 depicting Galula’s 80/20 Theory (1964) has several key distinctions compared to the baseline behavior model. First, *Popular Support* seems to stabilize much quicker, but at a cost of not reaching the same level as before. In many ways this scenario proves to be more beneficial because the level of *Popular Support* is still maintained in the positive region throughout the simulation, but the lack of turbulence during the initial stages allows planners to reduce *Coalition Investment* at a greater rate earlier in the timeline. The implication of providing less resources to the combat aspects, 20 percent instead of 25 percent, allows initial foreign troop levels to stay lower and not cause the spikes in *Resentment* that were seen before. The simulation suggests that effective training of *Host Nation Security Forces* would be more successful than employing large quantities of coalition troops towards security operations. One way

to support this finding is to adjust the model once again and, this time, focus the coalition's resources on *Coalition Combat Operations*; thus testing the opposed theory. The results of this simulation are shown in Figure 24 and Figure 25. Figure 24 demonstrates the model's behavior according to the newly adjusted parameters on the same scale that has been used in the previous examples. In order to view the relative behaviors more clearly, Figure 25 expands the viewing range of the plot's scale.

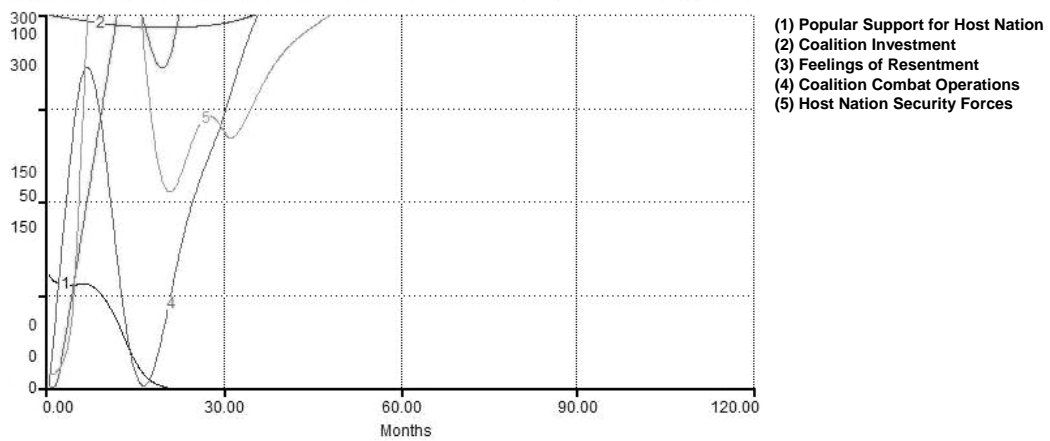


Figure 24: Emergent Behavior of Hearts and Minds given allocation of *Coalition Investment* following *Combat Operations*-focused strategy: 55% to *Security* and 45% equally to *Economy*, *Services*, and *Information Operations*.

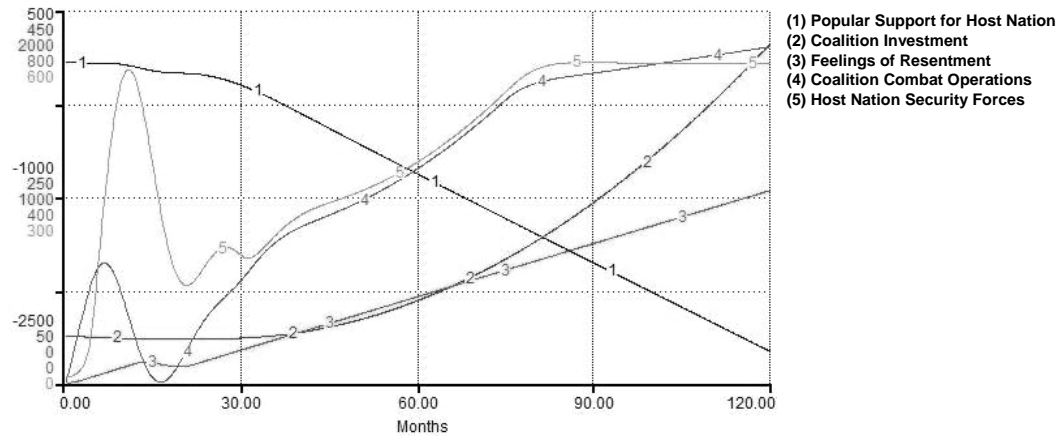


Figure 25: Emergent Behavior of Hearts and Minds given allocation of *Coalition Investment* following *Combat Operations*-focused strategy: 55% to *Security* and 45% equally to *Economy*, *Services*, and *Information Operations*. The plot has been re-scaled from standard view in order to observe behavior patterns.

These two figures demonstrate the dangers of allocating too many resources towards combat operations because of the high risk of increasing *Feelings of Resentment* to such a point that *Popular Support* shifts to levels that cannot be regained.

The final comparison that will be made at this stage of the research will be to explore the initial intuition regarding the importance of *Information Operations*. Due to its reach of influence with the greatest number of the model elements, it is expected that not granting this factor the adequate amount of recourses would be detrimental to the counterinsurgency. This assumption is confirmed by the behavior shown in Figure 26. This figure has also been scaled to allow the observer to appreciate the behavior of the model's elements beyond the original plotted scale.

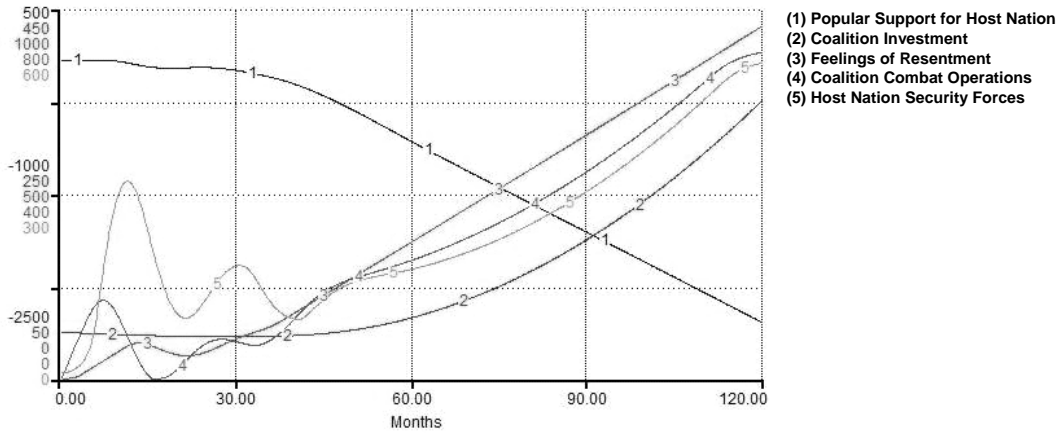


Figure 26: Emergent Behavior of Hearts and Minds given allocation of *Coalition Investment* following strategy that does not consider *Information Operations*: 0% to *Information Operations* and 100% equally to *Security*, *Economy*, and *Services*. The plot has been re-scaled from standard view in order to observe behavior patterns.

The behavior in Figure 25 can be attributed to the growth of *Resentment* and the counterinsurgent's attempt to employ more *Coalition Combat Operations* to increase *Popular Support*; which reinforced the downward spiral of *Resentment* and negative support. But, that same trend is not apparent in Figure 26. Even though *Resentment* grows, it only reaches approximately half the maximum level over the same timeline. Thus, it can be concluded that the elimination of *Information Operations* (the only drain on *Resentment* other than its loss due to increased *Popular Support*) causes the system to not react as negatively to the continued *Coalition Investment* in security, infrastructure, and the economy.

The insight gained from the development of the Hearts and Minds model provides a necessary first step in exploring the requirements of today's military planners. But, this theory, and the model that describes it, fails to address some key aspects that have lead to

its criticism by military officials and scholars alike. The other counterinsurgency theory that will be evaluated is the Cost Benefit Theory.

Reference Modes and Natural Behaviors of the Cost Benefit Theory Model

Developed during the Vietnam conflict, Cost Benefit Theory focuses its strategy around the quantifiable objectives of *Insurgent Activities* and *Insurgent Organizational Mechanisms*. With these factors being the targets of the counterinsurgency, then the *Population's Behavior*, and not its feelings like in Hearts and Minds, serves as the indicator of the counterinsurgency effectiveness (Leites & Wolf, 1970). In this case *Population Behavior* is the action that the population takes in favor of the host government; voting in the elections, respecting the rule or law, and paying taxes are examples of this measure. While similar to *Popular Support* from the Hearts and Minds model, *Population Behavior* accounts for the measurable acts of the locals and not their general attitudes towards the government. Also, like *Popular Support*, *Population Behavior* exhibits a Draining structure as its natural behavior. As before, the elements of the Cost benefit Theory model as well as their natural behavior are summarized in Table 4.

Table 4: Elements and Natural Behaviors of Cost Benefit Theory model.

Model Element	Reference Mode
Population Behavior	1st Order Draining
Coalition Combat Operations	S-Shaped
Host Nation Capacity	S-Shaped
Insurgent Activities	Stock Adjustment – Approach to Steady State
Insurgent Organizational Mechanisms	No Natural Behavior
Coalition Investment	No Natural behavior
Information Operations	No Natural Behavior
Internal Resources	No Natural Behavior
External Resources	No Natural Behavior

Insurgent Activities encompasses all of the actions that the insurgency takes in order to meet its military and political objectives. These activities are not limited to acts of violence alone, but also consist of anti-government propaganda, recruiting, and attempts at exerting religious or social influence over the population. When observing these activities, the natural behavior of this element can be seen as a rapid increase from the beginning that tapers off to a level state once objectives are reached or they are limited by the available resources. The quick initial increase in activities can be seen in historic examples where a large event or a series of incidents trigger the start of the insurgency, rather than a slow progression towards revolt. (O’Neill, 2001) This behavior may seem to mimic an S-Shaped Structure, but since the initial increase is rapid rather than gradual, then the behavior is categorized as a Stock Adjustment Structure (or an Approach to Steady State Structure). An example of this pattern can be seen in Figure 27.

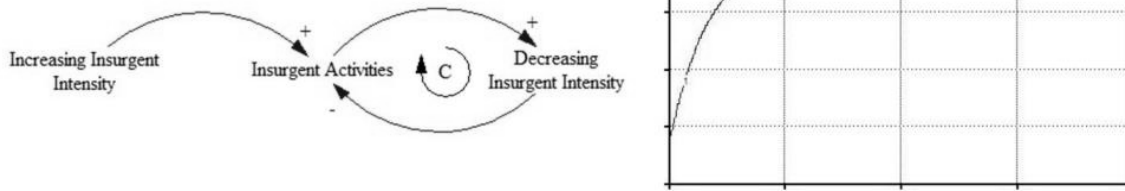


Figure 27: Reference Mode Diagram and graph of Natural behavior of Approach to Steady State Structure.

In order to accomplish these activities, the insurgency needs strong organization.

Insurgent Organizational Mechanisms represent the insurgency’s leadership, military, recruiting, and propaganda structures (Leites & Wolf, 1970). This element is structurally unique in that it does not experience a natural behavior. It is not logical to attempt to observe this element outside of the context of the system as a whole and thus its natural tendencies cannot be hypothesized. This type of model element is not uncommon, but, in general terms, it is more desirable for the modeler to make every attempt to attribute a natural behavior to the prominent stocks. Other elements in this model that also do not have natural behaviors that could be determined are the *Internal and External Resources*, *Information Operations* and *Coalition Investment*; which will be discussed further in this section.

By challenging the organizational and active elements through *Coalition Combat Operations* and *Information Operations*, the coalition and local government seek to disrupt the insurgency’s ability to conduct activities and negatively affect the population. Even though these elements are shared with Hearts and Minds, this philosophical difference in their influence directly contrasts the logic used to develop the Hearts and

Minds model; while Hearts and Minds employed security, information, and the local government to boost *Popular Support*, Cost Benefit Theory directly seeks to disrupt insurgent structures and reduce their capacity to conduct operations (Peters, 2006). The *Coalition Combat Operations* element, as opposed to its representation in Hearts and Minds, includes the forces that are also provided by the host nation and thus does not exist in the same structure as the previous model. Here the element behaves as a resource that begins gradually as forces are built up and reaches a maximum level as defined by the available resources. This behavior aligns with the classic S-Shaped Structure seen before. As opposed to those behaviors, the construction of this structure has a subtle difference. Other elements that have an S-Shaped behavior, such as the *Host Nation Capacity* element in this model, manager their growth by limiting its ability for continued growth based on their resources. In the case of *Coalition Combat Operations*, the growth is a function of the requirement to continue targeting the insurgency and is adjusted by a decreased need for additional combat support. These subtle differences can be seen in their natural influence diagrams shown in Figure 28 and their natural behavior is S-Shaped as seen in Figure 9.

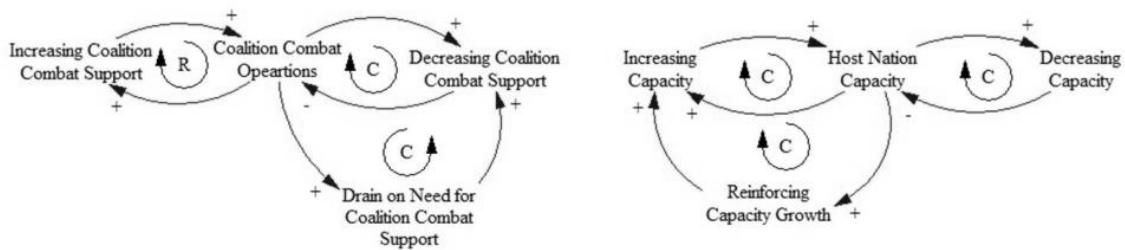


Figure 28: Reference Mode Diagrams of S-shaped Structures.

Leites and Wolf (1970) identify several other key components that distinguished Cost Benefit Theory from the previous strategy. This involves their emphasis on the importance of targeting the resources used by the insurgency. They believed that if the cost in obtaining resources, both internal and external, were forced to be higher than their expected benefit, then the insurgency would not be successful. The elements, *Internal Resources* and *External Resources*, are added to the model in order to account for this component of the theory. It is important to note that the elements have been chosen to remain separate because of their distinction in availability and their ability to be disrupted by the coalition. *Internal Resources* are more available to the insurgency, but they can also be limited by increased security and information. *External Resources* are more scarce, but cannot be cut off by the coalition; hence their distinction as being external to the system. These external resources become more prominent as technology, more specifically information technology, expand the reaches of the insurgency's efforts beyond the borders of the conflict.

With the natural behaviors identified and the associated influence diagrams of all of the theory's elements constructed, the process now focuses on developing the comprehensive influence diagram.

Influence Diagrams of the Cost Benefit Theory Model

The reference mode diagrams developed in the previous section are the first step in identifying the individual influences and building the influence diagram. These individual diagrams can be seen in Figure 29.

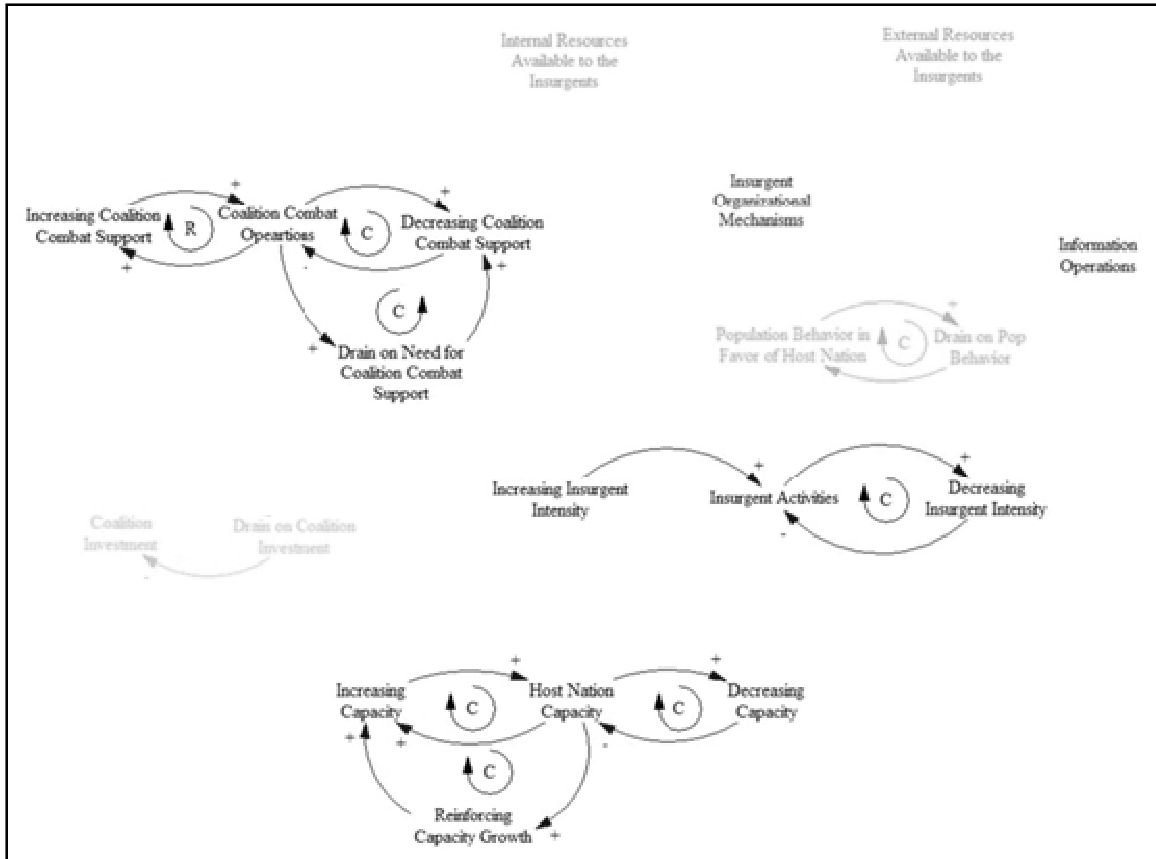


Figure 29: Influence Diagram of Cost Benefit Theory model showing the independent influence structures of individual elements.

The first influence element that will be considered is the *Insurgent's Organizational Mechanism*. This factor is primarily responsible for organizing and directing *Insurgent Activities*. Thus, a direct, positive influence can be traced from the insurgent's leadership to their ability to conduct operations. During the development of this model it is noteworthy that most of the feedback influences that generate reinforcing or compensating behavioral loops are mediated through other elements; this is an example of this observation. As *Insurgent Organizational Mechanisms* increase, then more *Insurgent Activities* can be managed. This causes a drop in *Population Behavior*

supportive of the local government. As this behavior tends away from the government, the *Insurgent Organizational Mechanisms*, which rely on a population being susceptible to recruiting and propaganda, will further be reinforced. This Reinforcing Loop and the influences that work to increase (*Internal Resources* and *External Resources*) or decrease (*Coalition Combat Operations* and *Information Operations*) *Insurgent Organizational Mechanisms* are shown in Figure 30.

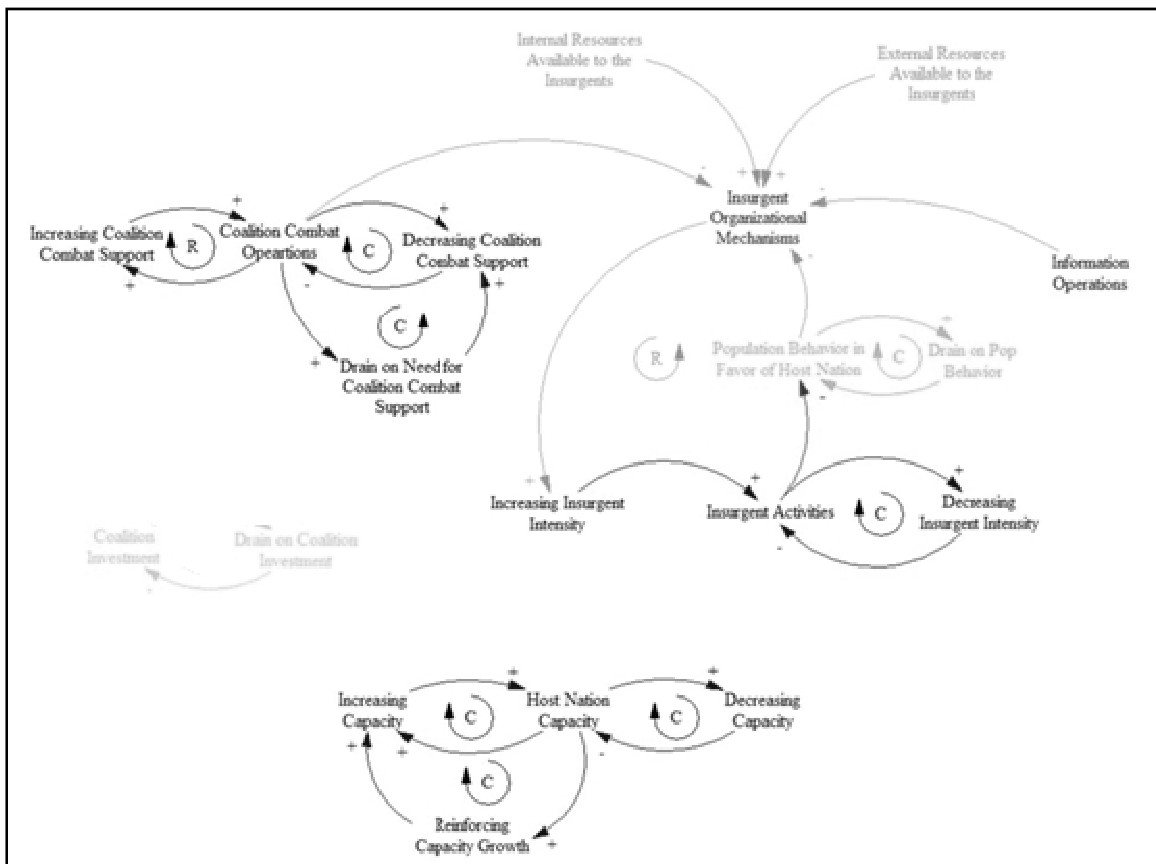


Figure 30: Influence Diagram of Cost Benefit Theory model showing influences of *Insurgent Organizational Mechanisms*.

Next, the influences added by *Insurgent Activities* will be identified and incorporated into the influence diagram. This element possesses two opportunities for reinforcing behavior. First, as insurgent operations rise, they work to increase the availability of *Internal Resources*. These are critical to improving organization and, as a result, further escalate *Insurgent Activities*. The next Reinforcing Loop that is formed by *Insurgent Activities* comes from its effect on *Host Nation Capacity*. The insurgency directly attacks the local government's ability to govern, which causes a reduction in the *Population's Behavior in Favor of the Host Nation* and further increases in the insurgency's organizational structures and operational capability. Finally, *Insurgent Activities* are dampened by the intervention of *Coalition Combat Operations*. Security support is fed by the increased level of *Insurgent Activities*. The coalition responds by targeting the *Insurgent Organizational Mechanisms*, and the availability of resources, which balance the insurgent's unity and capacity to conduct operations. These influences are shown in the influence diagram in Figure 31.

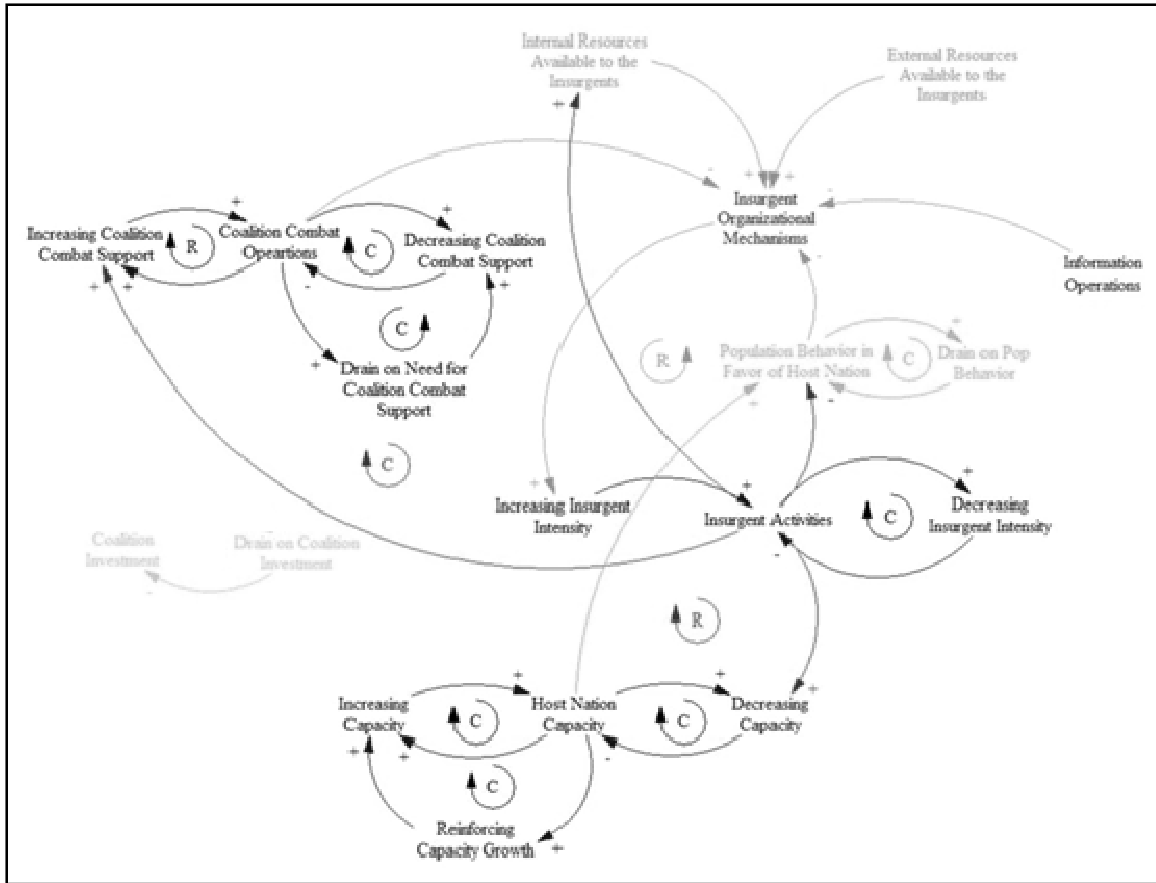


Figure 31: Influence Diagram of Cost Benefit Theory model showing influences of *Insurgent Activities*.

Two more sets of Compensating Loops can now be identified in the influence diagram and originate from *Coalition Combat Operations* and *Host Nation Capacity*, but they have very different effects on the system. The first loop is formed by *Coalition Combat Operations* and it functions in much the same manner as the previous loop in which this element was involved. This time the target of the security forces is not the insurgency directly, but their access to *Internal Resources*. This influence causes a reduction in *Insurgent Organization Mechanisms* and *Insurgent Activities*, which result in a lower need for continued combat support. Another element that influences the availability of

Internal Resources is *Host Nation Capacity*, which is the other element that generates a Compensating Loop. In this case, as the local government's capacity increases the host nation is able to produce more resources and, as an unintended consequence, make more resources available to the insurgency. Even though the government also strives to make sure these resources are distributed appropriately, it is not likely that the total available resources would increase without a proportionate increase in resources going to the insurgency. This causes a strengthening in the insurgent's leadership structure and activities and a reduction in *Host Nation Capacity*. These influences are shown in the diagram in Figure 32.

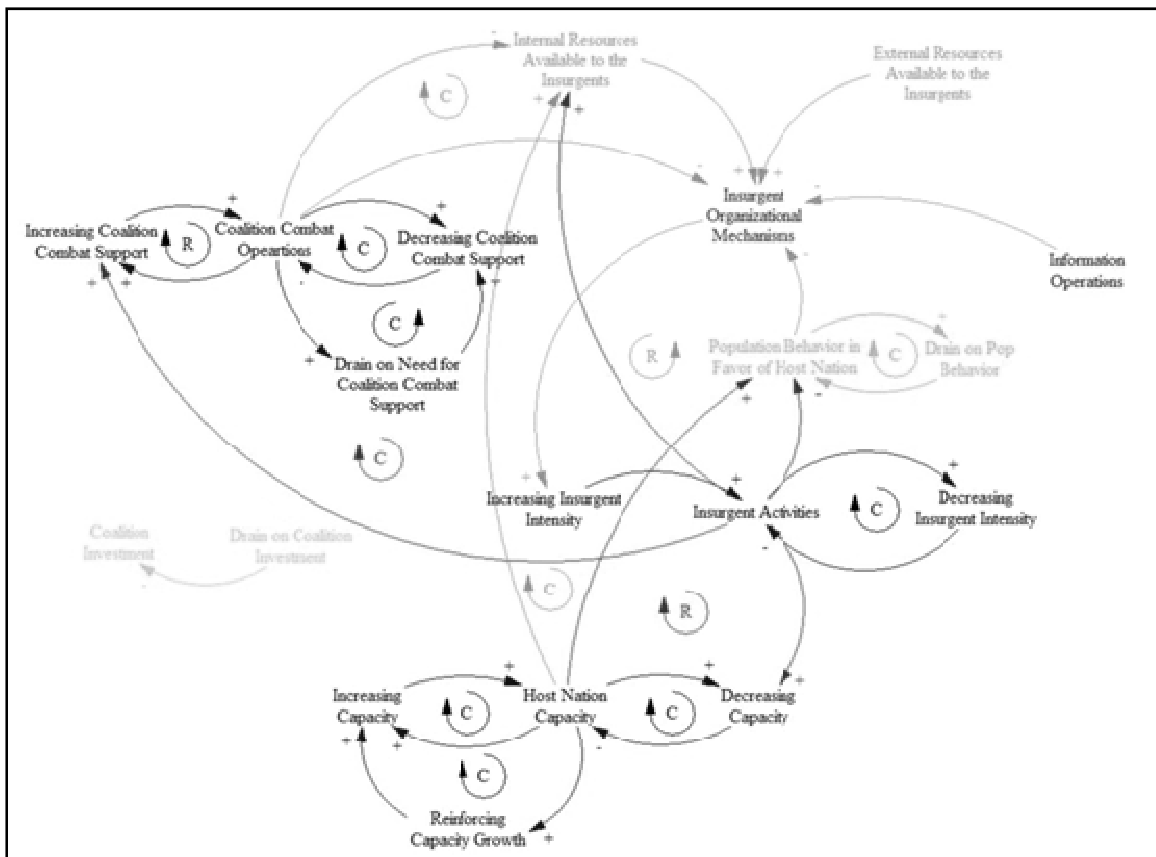


Figure 32: Influence Diagram of Cost Benefit Theory model showing influences of *Coalition Combat Operations* and *Host Nation Capacity*.

Finally, the reinforcing influences of *Information Operations*, which reinforce the *Host Nation's Capacity* for growth and reduce the availability of *Internal Resources*, and the controls of *Coalition Investment* are added to the model. Like in the previous model, *Coalition Investment* is essential to feeding the counterinsurgency assets: *Coalition Combat Operations*, *Information Operations*, and *Host Nation Capacity*. The element that guides *Coalition Investment* and adjusts its overall contribution to the campaign is *Population Behavior*. *Population Behavior* was chosen as the indicator that guides coalition resources because it provides a more accurate picture of the state of the local government. The goals of the counterinsurgency are to obtain security and stability in a country (Nagl, 2002). *Population Behavior* accounts for actions such as participating in local elections and sending the children to school. If the security portion of this mission is not accomplished, then the people will be afraid of being affiliated with the local government or of letting their children leave their homes. But the opposite is not necessarily correct. Just because the region is secure, as measured by low *Insurgent Activities*, this does not mean that the government is capable of governing its population. Thus the behavior of the locals is the better indicator that both the security and stability portions of the counterinsurgency mission have been achieved.

With the addition of the final elements and their effects on the system, the influence diagram for Cost Benefit Theory is fully developed (Figure 33) and the process can proceed to building the flow diagram.

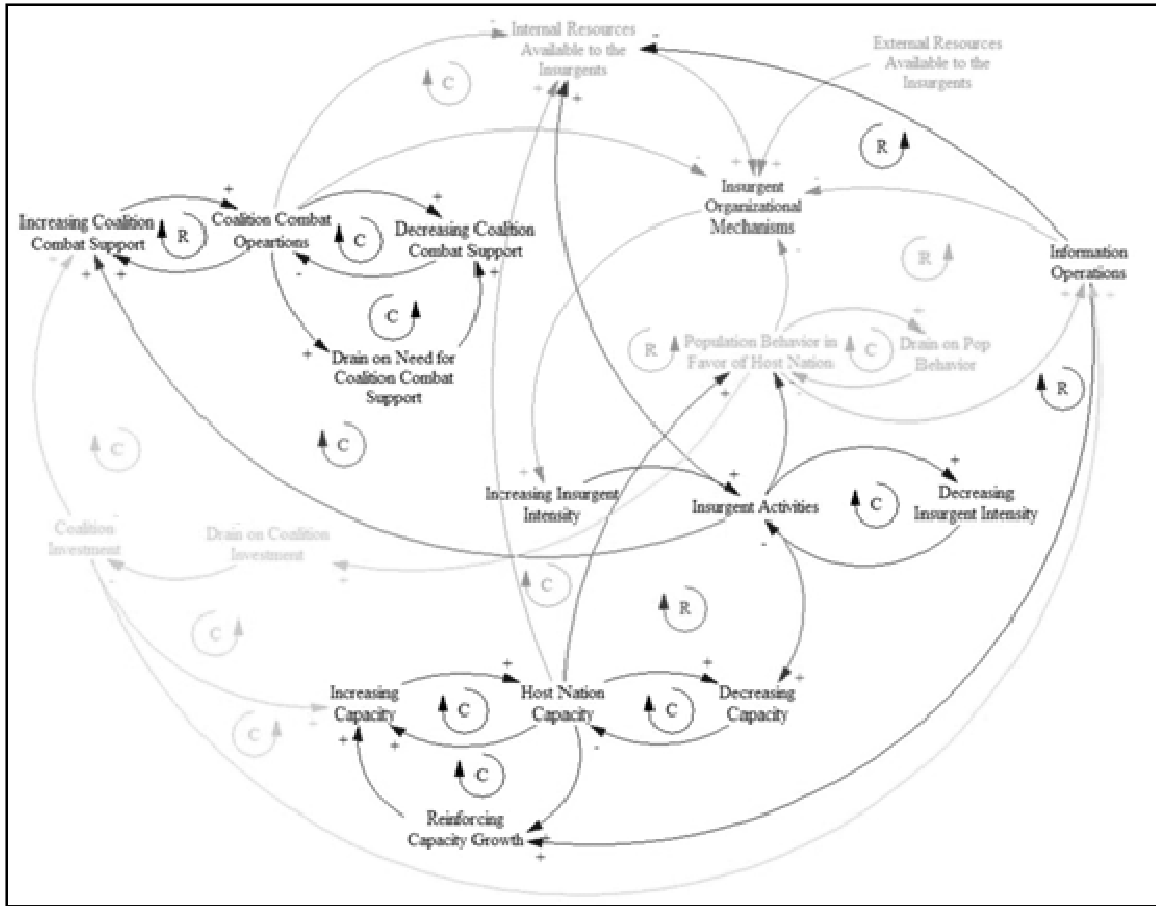


Figure 33: Influence Diagram of Cost Benefit Theory model.

Flow Diagrams of the Cost Benefit Theory Model

As before, establishing the flow diagram parameters for this model is the first step in this phase of the process. In order to maintain standard simulation parameter that will help in comparing this model to the Hearts and Minds model, the timeline has been maintained as before. Similarly, all of the factors that establish the model's behavior will be determined by using the same procedures.

The first element that will be developed into the flow diagram is *Population Behavior*. As previously discussed, the behavior of this element is very similar to that of *Popular Support* from the Hearts and Minds model. The Draining Structure's behavior is controlled, as seen before by a flow coefficient, the *Pop Behavior Drain Factor*. The behavior pattern and flow diagram for *Population Behavior* are shown in Figure 34.

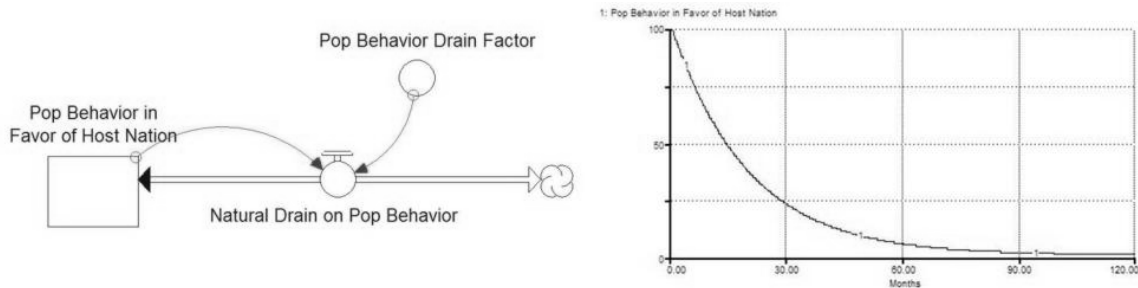


Figure 34: Flow Diagram and graph of natural behavior of the *Population Behavior* element in the Cost Benefit Theory model.

The next structure that will be evaluated is the Stock Adjustment Structure of *Insurgent Activities*. When this element was developed during the influence diagram phase of the process, the model was able to capture its behavior and describe it independently of any other factor. When this model is operationalized, the introduction of the influence from *Insurgent Operational Mechanisms* is key; much the same way that *Coalition Investment* was introduced into the individual flow diagrams for several factors of the Hearts and Minds model. In this case, two factors control the rate of growth and maximum value of the element's behavior; one for the drain and the other for the gain associated with *Insurgent Operational Mechanisms*. The value of both of these factors was determined to be 0.1. This allows both constraints to meet the standards of simplicity in the

development and provide the expected behavior, which is shown along with the flow diagram in Figure 35.

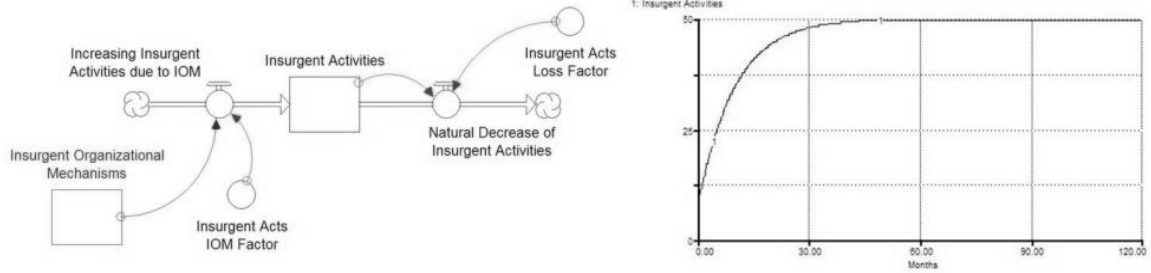


Figure 35: Flow Diagram and graph of natural behavior of the *Insurgent Activities* element in the Cost Benefit Theory model.

The other two natural behaviors that will be discussed in this section are those of *Coalition Combat Operations* and *Host Nation Capacity*. As explained before, both of these elements exhibit the same behavior pattern, S-Shaped Structure, but differ in their basic construction. One, *Coalition Combat Operations*, is adjusted by a compensating force on its draining loop, and the other on its gaining flow. Figure 36 and Figure 37 demonstrate the differences in the construction of these flow diagrams and the similar behavior patterns of each.

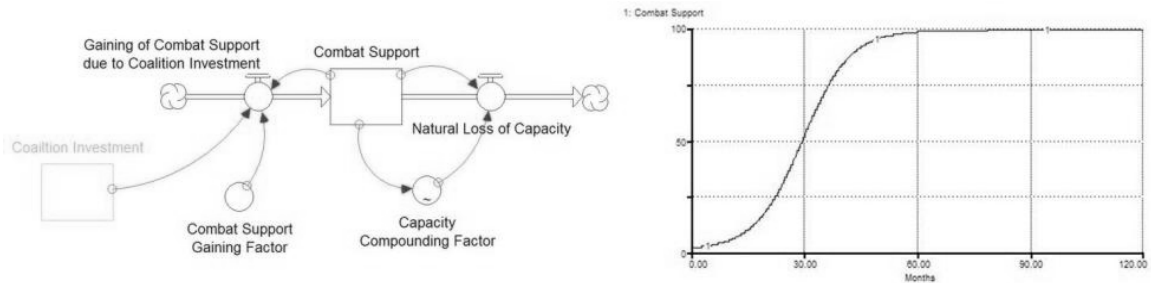


Figure 36: Flow Diagram and graph of natural behavior of the *Combat Support* element in the Cost Benefit Theory model.

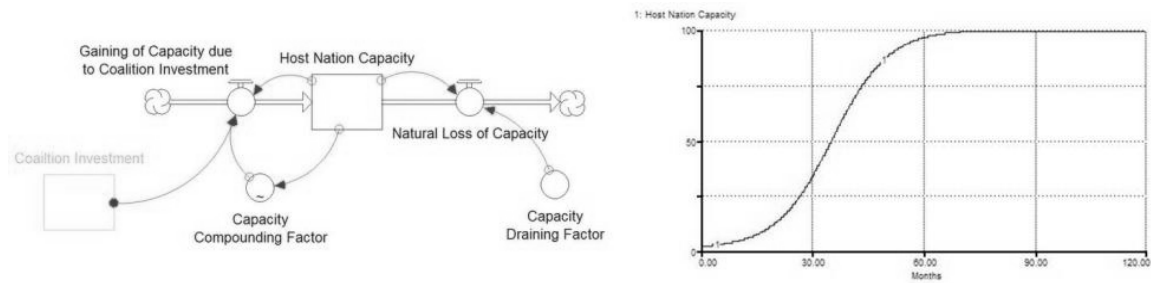


Figure 37: Flow Diagram and graph of emergent behavior of *Host Nation Capacity* element in the Cost Benefit Theory model.

The procedure for connecting the individual flow diagrams following the influences identified in the influence diagram proceeds as with the previous model. The process incrementally connects the individual elements and compares their emergent behavior to expected outcomes based on the logic of their influences and the experience of the modeler. Figure 38 shows the fully developed flow diagram for this model and Table 5 summarizes the names, values, and units of the coefficients used during the model's development.

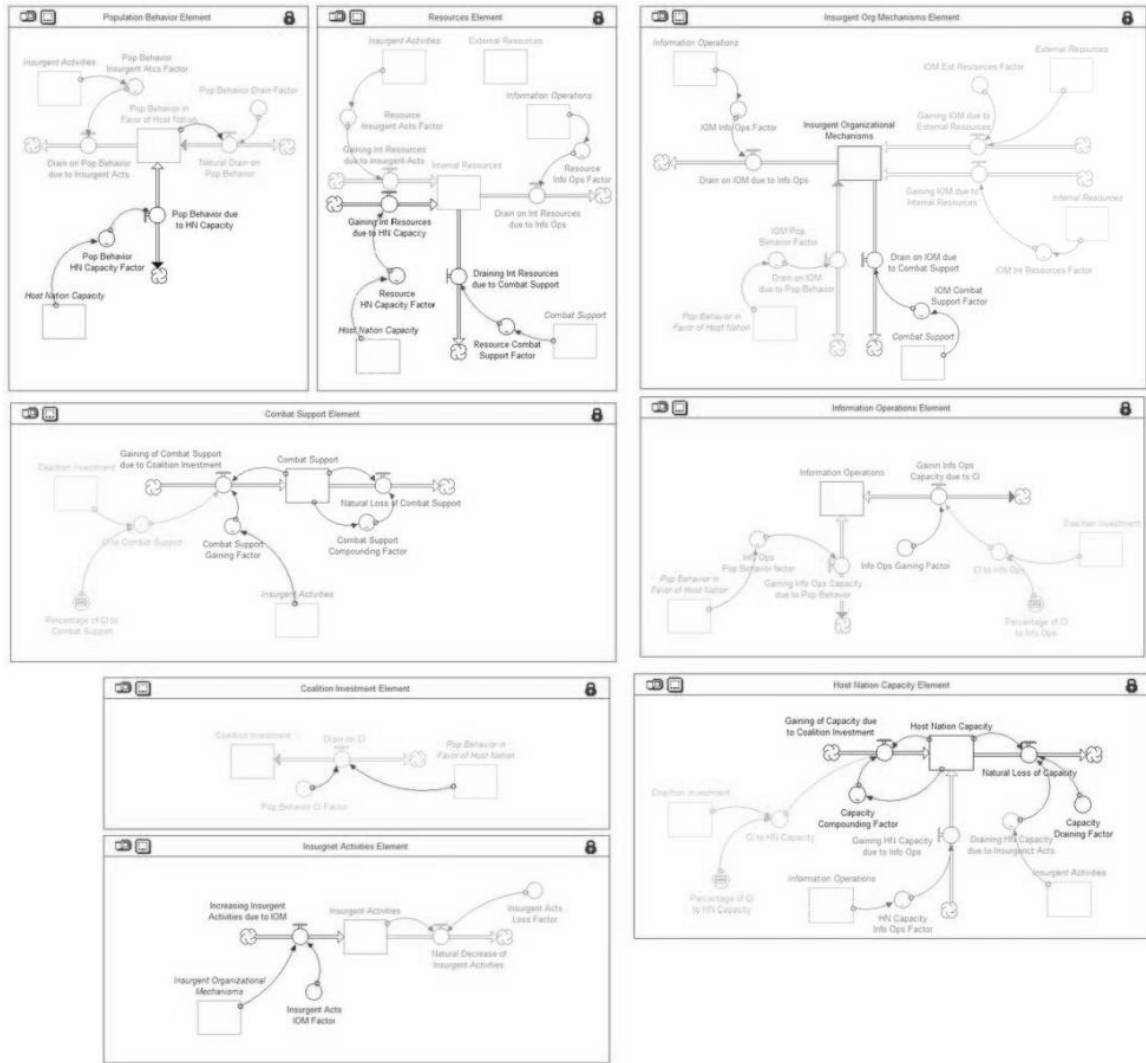


Figure 38: Flow Diagram of Cost Benefit Theory model.

Table 5: Names, values, and units of coefficients used in the development of the Cost Benefit Theory model Flow Diagram.

Coefficient Name	Coefficient Value	Coefficient Units
Pop Behavior Drain Factor	0.005	1/month
Combat Support Gaining Factor	$\alpha = 0.0002$ $x = \text{Insurgent Activities}$	$1/(\text{Coalition Investment} * \text{month})$
Combat Support Compounding Factor	$\alpha = 0.0016$ $x = \text{Combat Support}$	1/month
Insurgent Acts Loss Factor	0.1	1/month
Capacity Compounding Factor	$\alpha = -0.0004$ $x = \text{Host Nation Capacity}$	$1/(\text{Coalition Investment} * \text{month})$
Capacity Draining Factor	0.031	$1/(\text{Insurgent Activities} * \text{month})$
Pop Behavior Insurgent Acts Factor	$\alpha = 0.02$ $x = \text{Insurgent Activities}$	Population Behavior/month
Pop Behavior HN Capacity Factor	$\alpha = 0.015$ $x = \text{Host Nation Capacity}$	Population Behavior/month
Pop Behavior CI Factor	0.05	Coalition Investment/(Population Behavior/month)
Insurgent Acts IOM Factor	0.1	Insurgent Activities/(Insurgent Organizational Mechanisms*month)
HN Capacity Info Ops Factor	$\alpha = 0.1$ $x = \text{Information Operations}$	Host Nation Capacity/month
Draining HN Capacity due to Insurgent Acts Factor	$\alpha = 0.04 + 1$ $x = \text{Insurgent Activities}$	Insurgent Activities
Resource Insurgent Acts Factor	$\alpha = 0.015$ $x = \text{Insurgent Activities}$	Resources/month
Resource HN Capacity Factor	$\alpha = 0.01$ $x = \text{Host Nation Capacity}$	Resources/month
Resource Combat Support Factor	$\alpha = 0.02$ $x = \text{Combat Support}$	Resources/month
Resource Info Ops Factor	$\alpha = 0.04$ $x = \text{Information Operations}$	Resources/month
IOM Info Ops Factor	$\alpha = 0.01$ $x = \text{Information Operations}$	Insurgent Organizational Mechanisms/month
IOM Pop Behavior Factor	$\alpha = 0.005$ $x = \text{Population Behavior}$	Insurgent Organizational Mechanisms/month
IOM Combat Support Factor	$\alpha = 0.02$ $x = \text{Combat Support}$	Insurgent Organizational Mechanisms/month
IOM Int Resources Factor	$\alpha = 0.005$ $x = \text{Internal Resources}$	Insurgent Organizational Mechanisms/month
IOM Ext Resources Factor	0.005	Insurgent Organizational Mechanisms/(Resources*month)
Info Ops Pop Behavior Factor	$\alpha = 0.005$ $x = \text{Population Behavior}$	Information Operations/month
Info Ops CI Factor	0.0225	Information Operations/(Coalition Investment*month)

Results and Discussion of Cost Benefit Theory Model Simulation

At this point, without focusing on the results of the simulation, several observations can be made from the model's construction. First, by looking at the number of influences and their nature, the elements of major importance to this system can be quickly identified:

Insurgent Organizational Mechanisms and *Internal and External Resources*. *Insurgent Organizational Mechanisms* possesses the majority of the influences that are directly tied to *Coalition Investment* (*Coalition Combat Support* and *Information Operations*). It also relies on a number of elements to provide fuel for its growth. The fact that this organizational structure, and not the operations conducted by the insurgency, is the target of interest in this strategy represents a drastic shift from the mentality of Hearts and Minds. The previous model did not contain any elements that directly focused on insurgent force structures or that was guided by their activities; it relied on *Popular Support* to be both the target of the coalition and the local government and their indicator for progress. By focusing on the insurgents directly, in military and political terms, then a new opportunity for expanding the natural bounds of this system emerges. Another factor of interest with regard to *Insurgent Organizational Mechanisms* is its reliance on *Internal and External Resources* for continued growth.

The identification of the resources that provide for the insurgency in Cost Benefit Theory is another aspect that sets it apart from the previous model. While one of the objectives of increasing the *Host Nation's Capacity* is to be able to produce more for the citizenry, the insight this flow diagram provides allows policy makers to also view these resources as instrumental to the insurgency. *Internal Resources*, in particular, are of interest to the counterinsurgents because of their ability to secure its generation and control distribution so it is less likely to fall into the hands of the insurgency. As some have recently stipulated (Long, 2006; Nagl, 2008), a counterinsurgency rests on the ability to cut off the insurgents from resources across national borders. Thus, the

External Resources' contributions, with adequate combat support and improving technology, could be reduced to the point its effects are negligible when compared to the overall effects of a single *Resource* element.

The final comment about the construction of this model is directed to the generalized element of *Host Nation Capacity*. This model component is intended to encompass the local government's ability to manage the country, much in the same way that *Insurgent Organizational Mechanisms* manage the insurgency. The *Host Nation Capacity* element, which is fed by *Coalition Investment*, conducts the governmental, economic, and infrastructure tasks that are broken out into individual elements in the Hearts and Minds model. It may then seem logical to question the reasoning behind Hearts and Minds focus on these elements as individuals rather than dedicating its resources to the principal of sound governance through a single, measurable stock.

Even though these observations help to provide insight into the system, the simulation of the model and the information gained from its emergent behaviors solidify the theory's contributions. As before, this model is designed to be adjustable to a wide range of study variables. But, the purpose of this research remains the development of counterinsurgency strategy from this and the previous model and not the employment of these models towards test scenarios. The simulations that will be discussed serve the purpose of testing the model's effectiveness and validity.

The first graph describing the emergent behavior of the system is shown in Figure 39. This behavior pattern establishes a baseline for comparing the remaining scenarios and, as before, does not represent current doctrine nor is intended to characterize optimal

behavior. The graph demonstrates that *Population Behavior* and *Host Nation Capacity* both grow throughout the length of the simulation. As before, positive and growing behavior is the desired outcome of this model and not a particular value along the scale. The growth of these elements is attributed to the steady contribution of *Coalition Investment* as *Population Behavior* is still growing and to the heavy contribution of *Combat Support*. Structurally this model differs from the development of the Hearts and Minds model in that the security component is able to complete its objectives (mitigating insurgent leadership and forces structures) without facing resistance by the people (in the form of *Feelings of Resentment*). Since Cost Benefit Theory refuses to allocate resources to immeasurable indicators, such as *Resentment*, this model continues to stand as a valid indicator of the theory's intentions, but may not be practical in terms of execution because Hearts and Minds proves to be an excellent justification for accounting for these emotions.

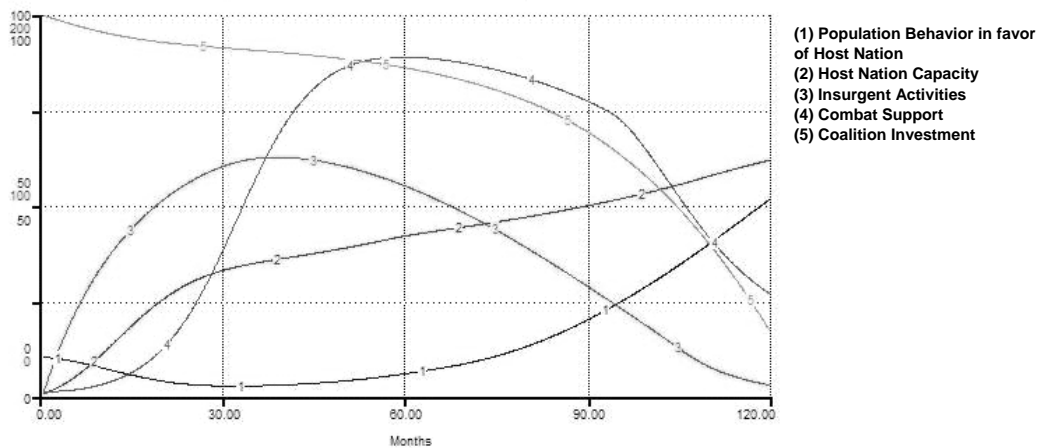


Figure 39: Emergent Behavior of Cost Benefit Theory given even allocation of *Coalition Investment* to *Combat Support*, *Host Nation Capacity*, and *Information Operations*.

Further understanding of the dynamics of the system comes from observing the behavior when Galula's 80/20 Theory (1964) is simulated. During this simulation of the Hearts and Minds model, this scenario proved to be an improvement to the equally distributed allocation of resources. This was due to the adverse effects that are present from the influence of *Resentment on Coalition Combat Operations*. In the Cost Benefit Theory model these effects are not present and thus security plays a much more important role. It is then expected that reducing the percentage of *Coalition Investment* allocated to security from 33 percent to 20 percent will result in a less satisfactory outcome in terms of the growth or *Population Behavior* and the reduction of *Insurgent Activities*. These effects are demonstrated by the emergent behavior pattern shown in Figure 40.

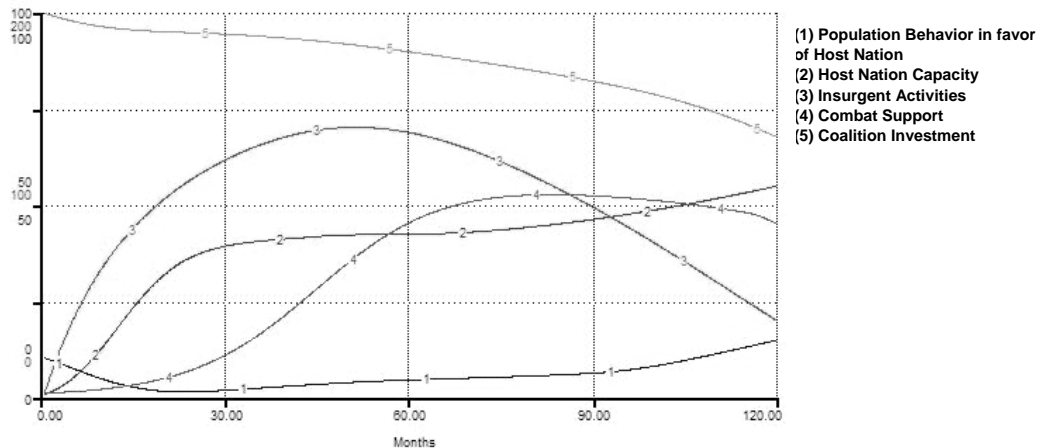


Figure 40: Emergent Behavior of Cost Benefit Theory model given allocation of *Coalition Investment* following Galula's 80/20 Theory (1964): 20% to *Combat Support* and 80% equally distributed to *Host Nation Capacity*, and *Information Operations*.

Another demonstration of the model's reaction to shifting resources away from security is seen by simulating a strategy focused on building *Host Nation Capacity*. It would be

logical to assume that since this element is a clear indicator of the strength of the government, then focusing on this element's development would yield more positive results. The problem with this logic again lies with the construction of the model and its focus on *Coalition Combat Operations*. When this situation is simulated, the behavior appears to respond well in the short term; *Host Nation Capacity* increases dramatically even though *Population Behavior* does not respond as rapidly as before. But as the simulation progresses into the mid- and long-term, the effects of not investing in adequate security forces becomes apparent as *Insurgent Activities* rapidly increase and work to keep *Population Behavior* low and slowly diminish the efforts of *Host Nation Capacity*. This behavior is shown on the plot of Figure 41.

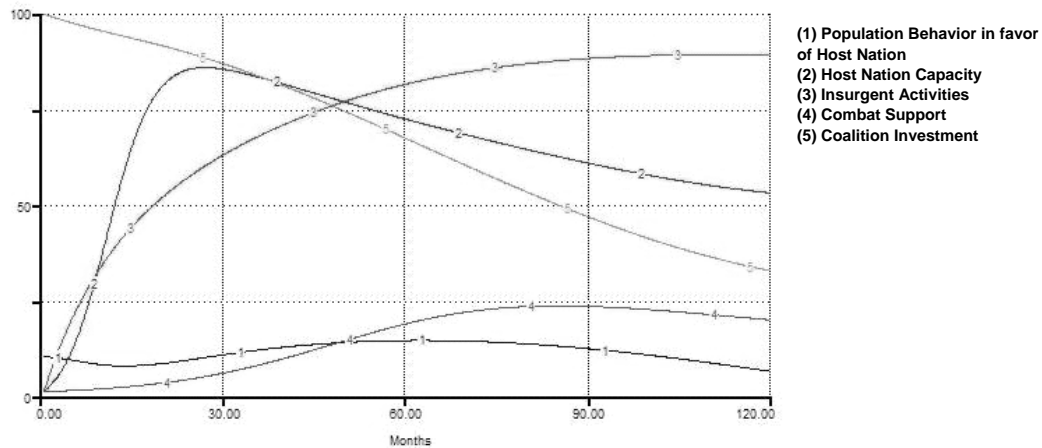


Figure 41: Emergent Behavior of Cost Benefit Theory given allocation of *Coalition Investment* following *Host Nation Capacity*-focused strategy: 60% to *Host Nation Capacity* and 40% equally to *Combat Support*, and *Information Operations*.

The development of this model, along with the information gained from its construction and simulation, provide a wealth of knowledge that will serve to create a comprehensive

counterinsurgency strategy model that incorporates the lessons of the two observed theories. The next sections of this research will explore the elements that will make the greatest contributions to this Hybrid Counterinsurgency Strategy, the influences that will dictate its behavior, and the construction of its basic components.

Hybrid Counterinsurgency Strategy Model

The goal of establishing a Hybrid Counterinsurgency Strategy based on the lessons from Hearts and Minds and Cost Benefit Theory is to incorporate the most influential elements and the soundest reasoning from each of the contrasting models in order to gain a better perspective on the dynamics of this system. In accomplishing this task, the process for developing the System Dynamics model will proceed in the same manner as with the previous models. Several steps will not be described in great detail because they will be repetitive of the tasks that have already been performed; such as determining and describing the natural behaviors of the elements.

The first step is to determine which elements will meaningfully contribute to the validity of the model. Since, to this researcher's knowledge, there is no precedent in the System Dynamics arena for developing a hybrid structure based on two distinct system models, this process will be preceded by evaluating several options for completing this task. One approach that can be considered is to determine which elements fail to contribute to their model's dynamics and exclude them from the new environment. It is difficult, if not impossible, to make a reasonable case for dismissing the effects on any of the elements from their respective models. Another is to identify similar elements that

may be interchanged between the models and use these elements as the bridge that combines the two models. In this case, *Popular Support* and *Population Behavior* are excellent examples of very similar elements that could effectively serve as a link between the two models. But, if this approach were taken, then other similar elements would coexist within the same boundary. After considering these options, a subtle modification to the latter alternative will be implemented for combining these models.

First, similar elements are selected from each of the models and considered for either direct substitution or aggregation. In the case of *Popular Support* and *Population Behavior*, the exchange can occur directly. For *Coalition Combat Operations*, the debate over its transition and combination is complex. Because System Dynamics seeks to achieve greater levels of aggregation in a model, the choice of accepting the construction of this element as designed for the Cost Benefit Theory model would appear to be more desirable. But, the justification that Hearts and Minds advocates provide about the value of *Host Nation Security Forces* is far too influential to dismiss. Thus, in this case, the less aggregated oscillating security element from Hearts and Minds is favored. On the other hand, the case for aggregation proves to be more formidable when considering maintaining *Host Nation Capacity* as a reasonable substitute for the *Essential Services*, *Host Nation Economy*, and *Governance* components. During the development of the Hearts and Minds model, these three elements showed identical natural behaviors, very similar influences, and no noticeable divergence in their emergent behavior patterns when they were simulated.

The remaining elements that will form the structure for the new model are the ones that are common to both systems (*Coalition Investment* and *Information Operations*) and those that were specific to each theory. The relationship between *Insurgent Organizational Mechanisms* and the indicators that drove the Cost Benefit Theory (*Population Behavior* and *Insurgent Activities*) proved to be of unexpected value to the discussion of counterinsurgency dynamics. Typically Hearts and Minds proponents stay away from suggesting the importance of directly targeting insurgent structures because they favor the political and stabilization factors of the strategy. But their reluctance to grant this factor the value it deserves is not justification enough to exclude its effectiveness. With this stated, an element identified by the Hearts and Minds model that balances an overemphasis on military solutions will also be required for building the combined model. The *Resentment* element will help mitigate this tendency by its negative influence on *Popular Support* when the coalition military level rises to greater levels. Finally, the last element that will be incorporated into the Hybrid Counterinsurgency Strategy model will be the *Resources Available to the Insurgency*. Originally this element was divided into two separate factors; internal and external. But, as described before, further development of surveillance and information technology and a focus on border security can negate the proportion of resources that are outside of the counterinsurgents ability to control and thus it is more reasonable to treat these elements as a single factor with equal influences. A summary of the elements that have been discussed are shown with their natural behaviors in Table 6 and as independent influences structures in Figure 42.

Table 6: Elements and Natural Behaviors of Hybrid Counterinsurgency Strategy model.

Model Element	Reference Mode
Popular Support	1st Order Draining
Coalition Combat Operations	Oscillation
Host Nation Security Forces	Oscillation
Host Nation Capacity	S-Shhaped
Insurgent Activities	Stock Adjustment – Approach to Steady State
Insurgent Organizational Mechanisms	No Natural Behavior
Coalition Investment	No Natural Behavior
Information Operations	No Natural Behavior
Resentment	No Natural Behavior
Resources	No Natural Behavior

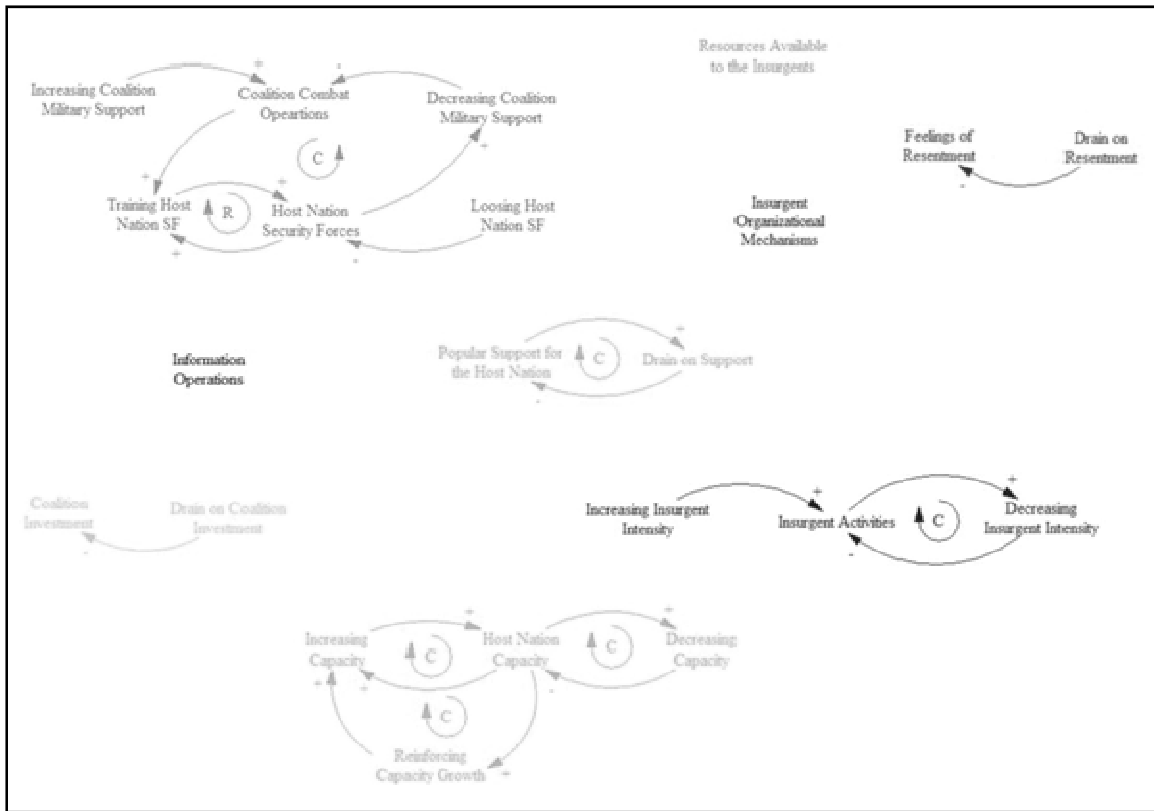


Figure 42: Influence Diagram of Hybrid Counterinsurgency Strategy model showing independent influence structures of individual elements.

The first influences that will be identified and added to the influence diagram are those of *Popular Support*. The Reinforcing Loops that influence *Popular Support*'s relationships with *Host Nation Security Forces* and *Resentment* are that same as described in the Hearts and Minds model. Similarly, the influence loops created between *Popular Support* and *Host Nation Capacity* mimics the connections with the *Services, Economy, and Governance* element that this factor replaces. Also, there exists another Reinforcing Loop between *Popular Support* and *Insurgent Organizational Mechanisms* that is mediated through *Insurgent Activities*. This influence is the same as the one described in the Cost Benefit Theory model involving *Population Behavior*. These influences are shown in Figure 43.

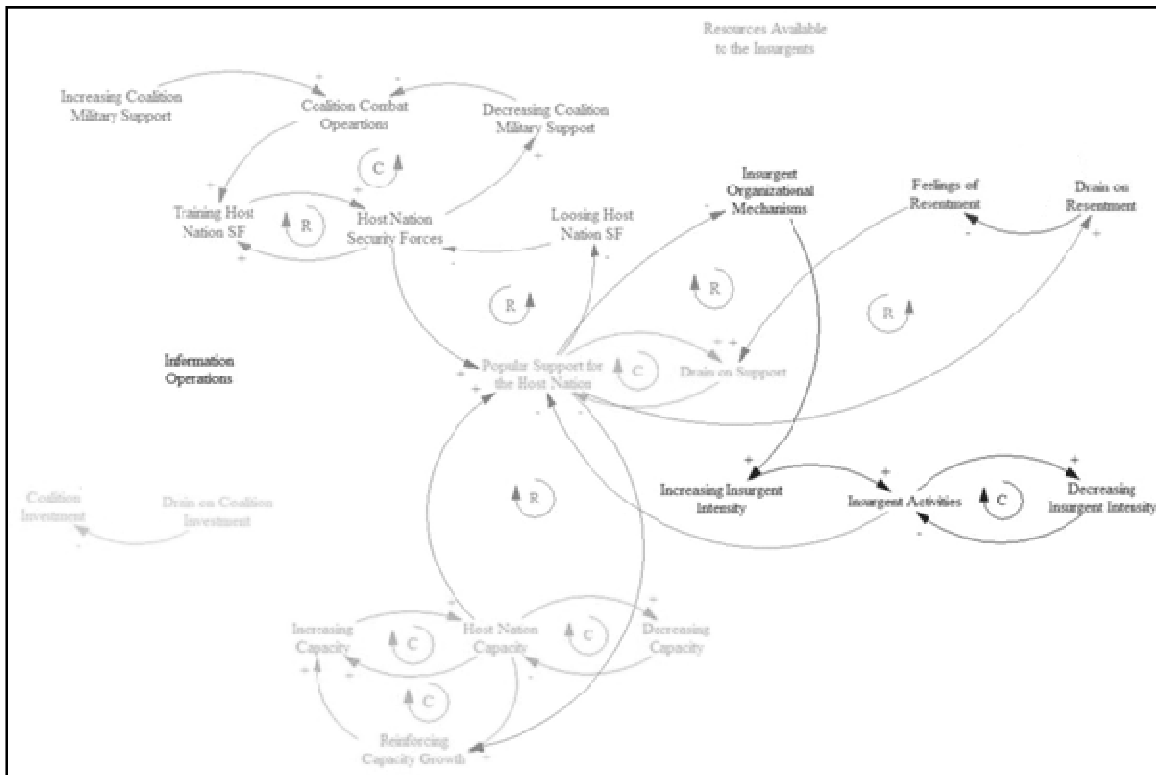


Figure 43: Influence Diagram of Hybrid Counterinsurgency Strategy model showing influences of *Popular Support*.

The next influences considered are those that relate to *Coalition Combat Operations*. This element forms two Compensating Loops with *Insurgent Organizational Mechanisms* and *Resources* and a Reinforcing Loop with *Resentment*. The Compensating Loops are both mediated through *Insurgent Activities*; reducing *Insurgent Organizational Mechanisms* and *Resources* available will work to decrease the amount of *Insurgent Activities* and reduce the need for security operations. The *Resentment* loop is part of the *Popular Support* influence loop that affects the level of *Host Nation Security Forces* and the coalition's requirement to train and augment more local forces. These influences are shown in Figure 44.

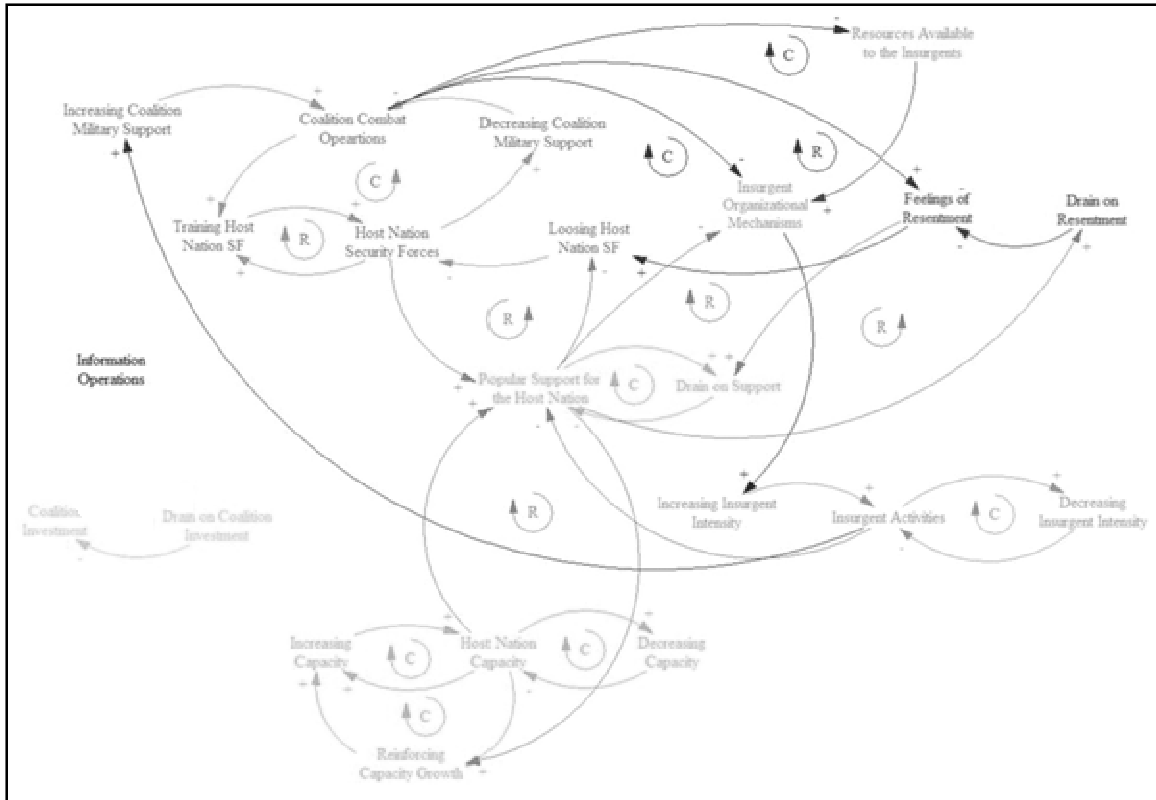


Figure 44: Influence Diagram of Hybrid Counterinsurgency Strategy model showing influences of *Coalition Combat Operations*.

Information Operations, for its part, influences the system by adding four more Reinforcing Loops that help to bolster the *Host Nation Capacity* and *Popular Support* and attempts to reduce *Feelings of Resentment* and *Resources Available to the Insurgency*. These influences are highlighted in Figure 45.

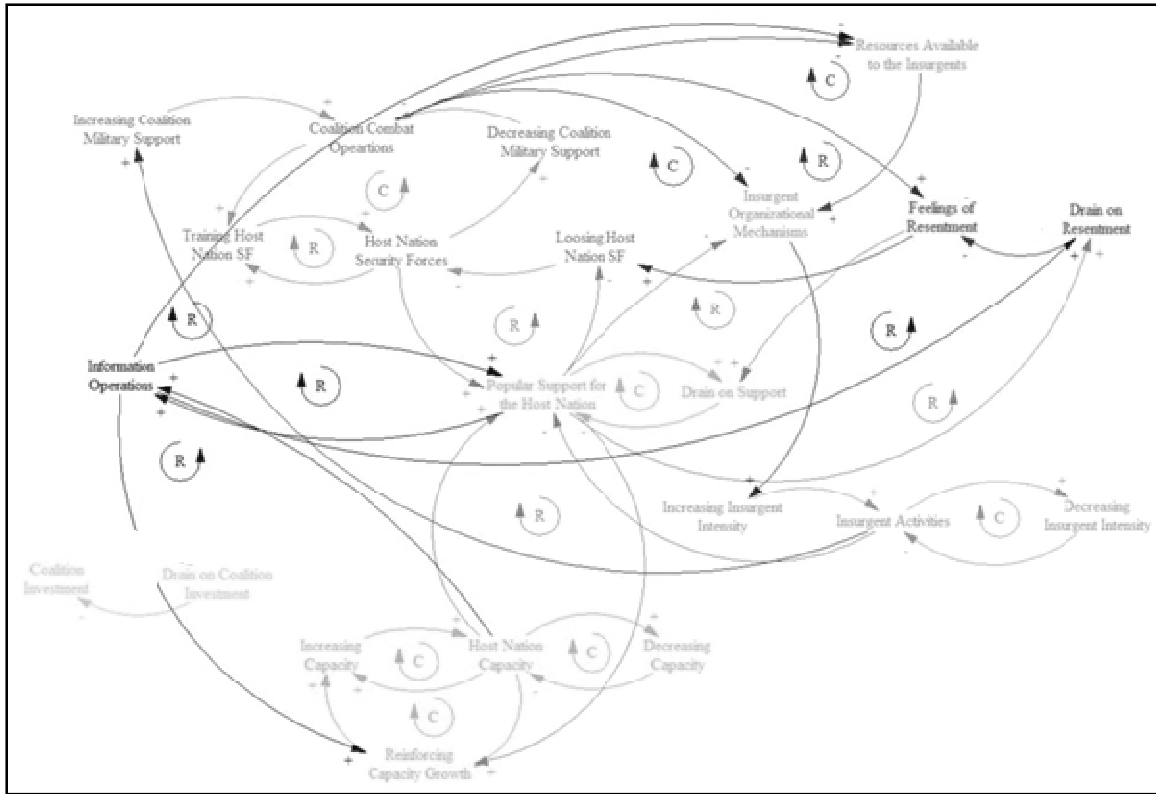


Figure 45: Influence Diagram of Hybrid Counterinsurgency Strategy model showing influences of *Information Operations*.

The final sources of influence originate from the effects of *Coalition Investment* and *Host Nation Capacity*. Both of these elements generate resources that control the progress of the counterinsurgency. *Coalition Investment*, as seen before, feeds the *Coalition Combat Support*, *Information Operations*, and *Host Nation Capacity* elements. *Host Nation Capacity* is responsible for providing resources for conducting training of local military and law enforcement. This influence is of importance because it indicates that when *Coalition Investment* decreases due to rising *Popular Support*, the training is not stagnated because of decreased levels of coalition troops. The completed influence diagram of the Hybrid Counterinsurgency Strategy model can be seen in Figure 46.

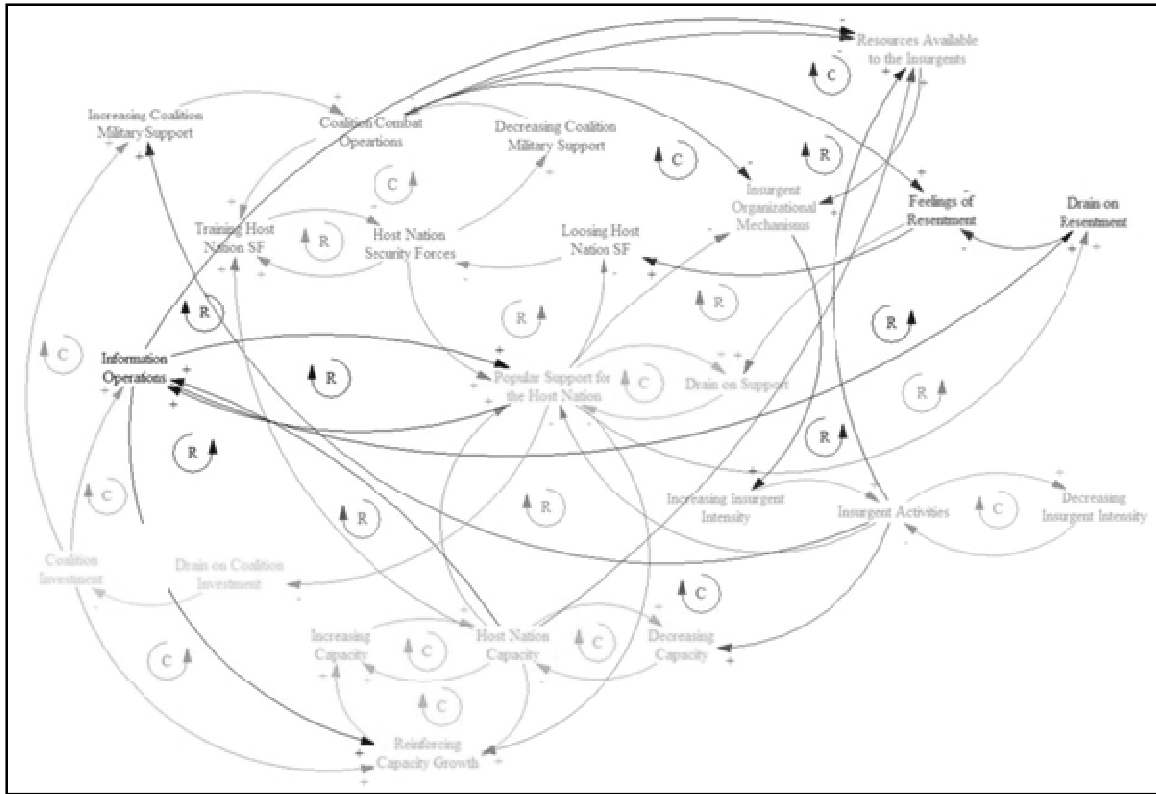


Figure 46: Influence Diagram of Hybrid Counterinsurgency Strategy model.

These elements are now operationalized into the simulation software, STELLA 9, and converted into flow diagrams. First, the reference mode diagrams of the individual elements are modeled independent of the system influences and then incremental relationships are added and tested until the completed system is developed. Figure 47 through Figure 50 demonstrate the flow diagrams and behavior patterns of the *Coalition Combat Operations* and *Host Nation Security Forces*, *Popular Support*, *Host Nation Capacity*, and *Insurgent Activities* elements.

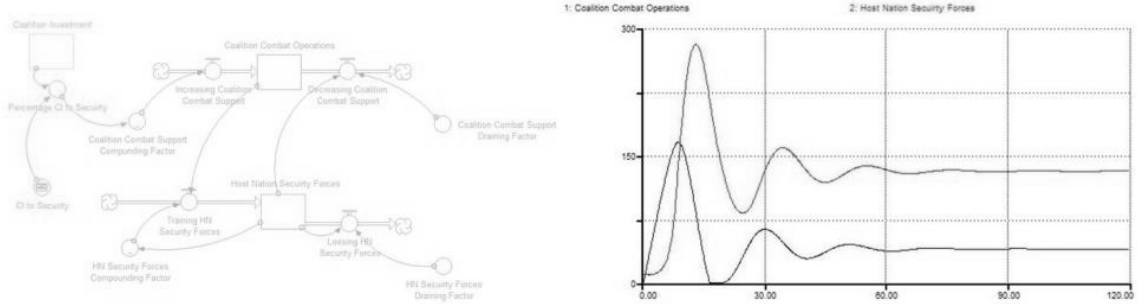


Figure 47: Flow Diagram and graph of natural behavior of the *Coalition Combat Operations* and *Host Nation Security Forces* element in the Hybrid Counterinsurgency Strategy model.

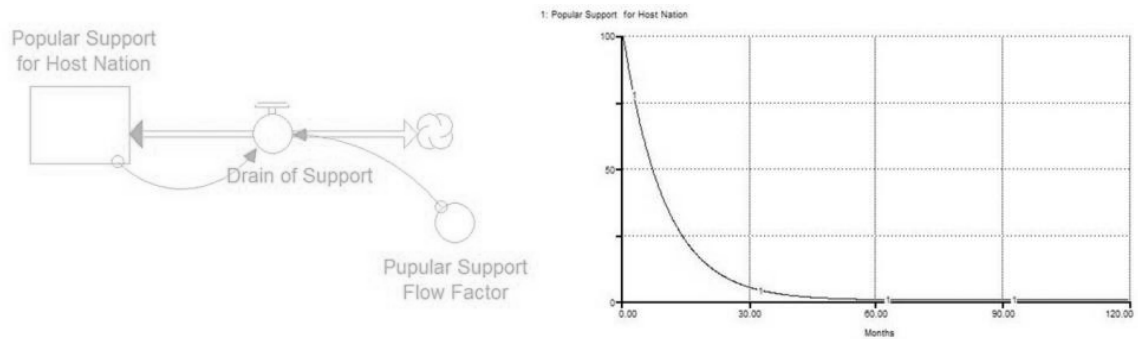


Figure 48: Flow Diagram and graph of natural behavior of the *Popular Support* element in the Hybrid Counterinsurgency Strategy model.

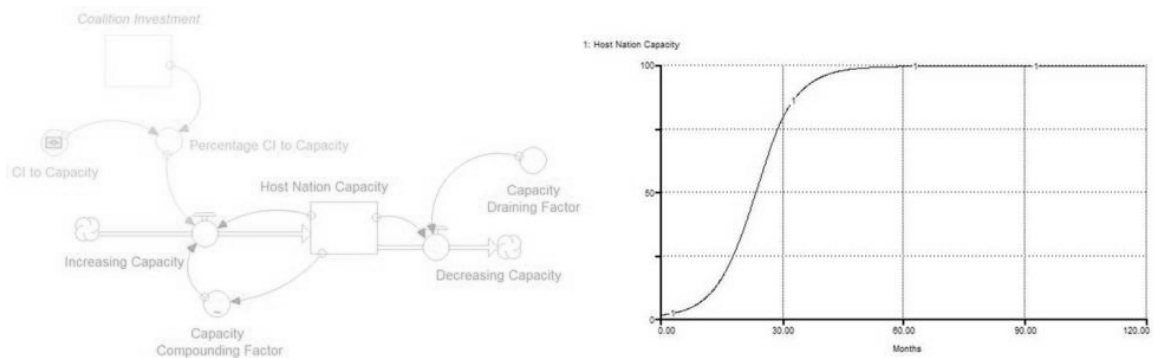


Figure 49: Flow Diagram and graph of natural behavior of *Host Nation Capacity* element in the Hybrid Counterinsurgency Strategy model.

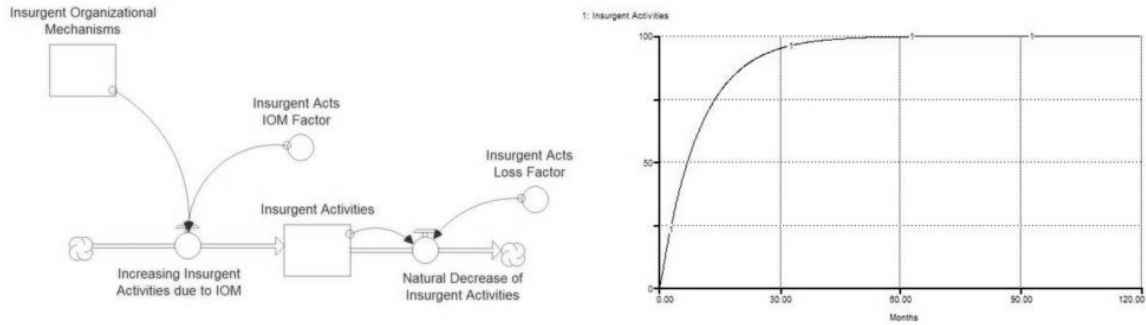


Figure 50: Flow Diagram and graph of natural behavior of *Insurgent Activities* element in the Hybrid Counterinsurgency Strategy model.

The construction of the flow diagram progresses by incrementally adding the influences of the individual elements in the same manner as they were identified during the development of the influence diagram. The complete construction of the flow diagram of the Hybrid Counterinsurgency Strategy model depicts all of the influences identified during the model's development. This diagram can be shown in Figure 51. Table 7 also summarizes the names, values, and units of the coefficients that were used to develop the Hybrid Counterinsurgency Strategy model.

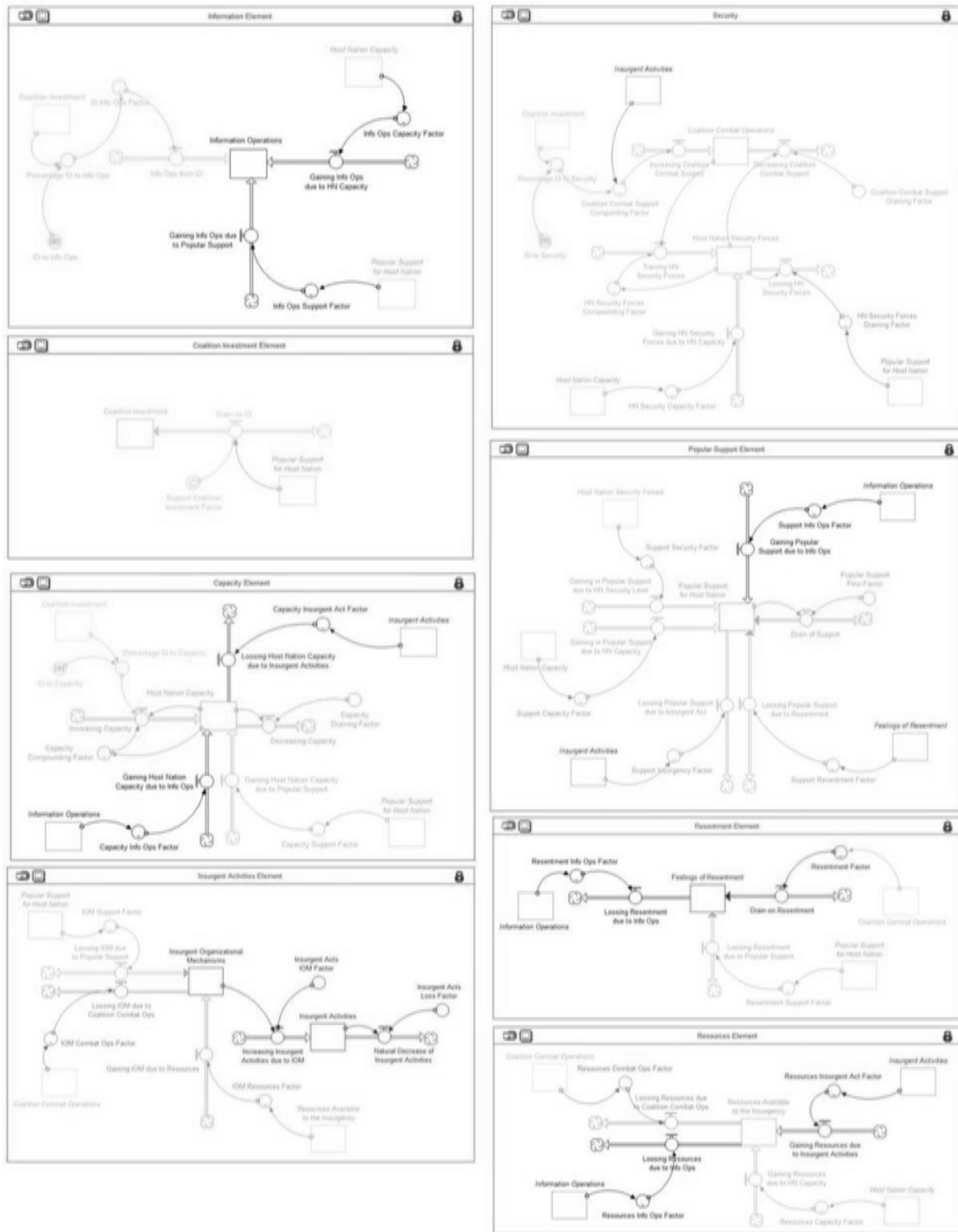


Figure 51: Flow Diagram of the Hybrid Counterinsurgency Strategy model.

Table 7: Names, values, and units of coefficients used in the development of the Hybrid Counterinsurgency Strategy model Flow Diagram

Coefficient Name	Coefficient Value	Coefficient Units
Popular Support Flow Factor	0.1	1/month
Coalition Combat Support Compounding Factor	$\alpha = 0.025$ $x = \text{Percentage Coalition Investment to Security} * \text{Insurgent Activities}$	Coalition Combat Support/month
Coalition Combat Support Draining Factor	0.19	Coalition Combat Support/(Host Nation Security Forces*month)
HN Security Forces Compounding Factor	$\alpha = 0.005$ $x = \text{Host Nation Security Forces}$	Host Nation Security Forces/(Coalition Combat Operations*month)
HN Security Forces Draining Factor	$\alpha = -0.0033$ $\alpha = -0.0012$ $x = \text{Popular Support}$	1/month
Capacity Compounding Factor	$\alpha = 0.00064$ $x = \text{Host Nation Capacity}$	1/(Coalition Investment*month)
Capacity Draining Factor	0.049	1/month
Insurgent Acts Loss Factor	0.1	1/month
Insurgent Acts IOM Factor	0.1	Insurgent Activities/(Insurgent Organizational Mechanism*month)
Support Security Factor	$\alpha = 0.05$ $x = \text{Host Nation Security Forces}$	Popular Support/month
Support Capacity Factor	$\alpha = 0.05$ $x = \text{Host Nation Capacity}$	Popular Support/month
Support Insurgency Factor	$\alpha = 0.06 - 1$ $x = \text{Insurgent Activities}$	Popular Support/month
Support Resentment Factor	$\alpha = 0.06 - 1$ $x = \text{Feelings of Resentment}$	Popular Support/month
Support Info Ops Factor	$\alpha = 0.05$ $x = \text{Information Operations}$	Popular Support/month
HN Security Capacity Factor	$\alpha = 0.05$ $x = \text{Host Nation Capacity}$	Host Nation Security Forces/month
Info Ops CI Factor	$\alpha = 0.015$ $x = \text{Percentage Coalition Investment to Information Operations}$	Information Operations/month
Info Ops Support Factor	$\alpha = 0.005$ $x = \text{Popular Support}$	Information Operations/month
Info Ops Capacity Factor	$\alpha = 0.005$ $x = \text{Host Nation Capacity}$	Information Operations/month
Support Coalition Investment Factor	0.002	Coalition Investment/(Popular Support*month)
Capacity Info Ops Factor	$\alpha = 0.05$ $x = \text{Information Operations}$	Host Nation Capacity/month
Capacity Support Factor	$\alpha = 0.05$ $x = \text{Popular Support}$	Host Nation Capacity/month
Capacity Insurgent Act Factor	$\alpha = 0.05$ $x = \text{Insurgent Activities}$	Host Nation Capacity/month
Resentment Info Ops Factor	$\alpha = 0.05$ $x = \text{Information Operations}$	Feelings of Resentment/month
Resentment Support Factor	$\alpha = 0.025$ $x = \text{Popular Support}$	Feelings of Resentment/month
Resentment Security Factor	$\alpha = -0.16 + 6$ $x = \text{Coalition Combat Operations}$	Feelings of Resentment/month
Resources Combat Ops Factor	$\alpha = 0.01$ $x = \text{Coalition Combat Operations}$	Resources/month
Resources Info Ops Factor	$\alpha = 0.005$ $x = \text{Information Operations}$	Resources/month
Resources Capacity Factor	$\alpha = 0.0025$ $x = \text{Host Nation Capacity}$	Resources/month
Resources Insurgent Act Factor	$\alpha = 0.01$ $x = \text{Insurgent Activities}$	Resources/month
IOM Support Factor	$\alpha = 0.025$ $x = \text{Popular Support}$	Insurgent Organizational Mechanism/month
IOM Security Factor	$\alpha = 0.005$ $x = \text{Coalition Combat Operations}$	Insurgent Organizational Mechanism/month
IOM Resources Factor	$\alpha = 0.02$ $x = \text{Resources}$	Insurgent Organizational Mechanism/month

Results and Discussion of Hybrid Counterinsurgency Strategy Model Simulation

From the model's construction it is apparent that the goal of this strategy is to incorporate all of the available knowledge on counterinsurgency into the most robust definition of doctrine possible. The combination of elements from Hearts and Minds and Cost Benefit Theory provides a noticeable difference in the model's structure; more influences exist among a wider range of elements than in the previous models. This leads to a more balanced approach to counterinsurgency, where even radical shifts in focus of *Coalition Investment* would still be expected to yield similar behaviors. This expectation is supported by observing the emergent behavior patterns from the model's simulation. The first simulation, Figure 52, demonstrates that standard allocation of coalition resources evenly among *Coalition Combat Operations*, *Host Nation Capacity*, and *Information Operations*.

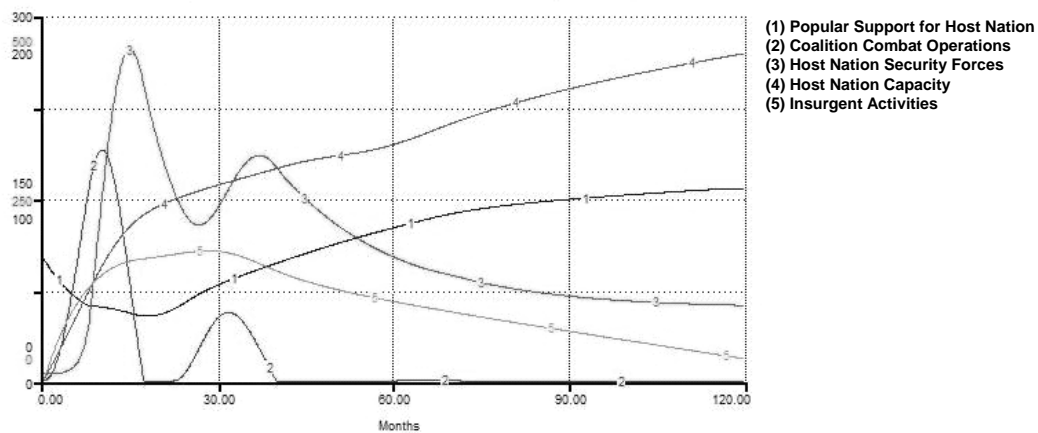


Figure 52: Emergent Behavior of the Hybrid Counterinsurgency Strategy given even allocation of *Coalition Investment* to *Coalition Combat Operations*, *Host Nation Capacity*, and *Information Operations*.

The plot of emergent behavior suggests promising results for the validity of the Hybrid Counterinsurgency Strategy. The emergent behavior shows that *Popular Support*, after undergoing an expected initial decline, began to rise steadily after the initial stages. This initial decrease is due to the high levels of *Coalition Combat Operations* that are present early and the *Resentment* that results from this initial surge. The heightened focus on security operations early is critical to the development of two key elements. First, this initial increase in foreign combat forces jumpstarts the *Host Nation Security Forces* training during the short-term phase and allows this local force to take over the security responsibilities over the mid- and long-term. The other important aspect about the high initial spike in combat troops is to control the rise of *Insurgent Activities* by disrupting *Insurgent Organizational Mechanisms* and cutting off access to *Resources*. Thus, the adverse effects of heightened *Coalition Combat Operations* (in the form of *Resentment*) are outweighed by the benefits of increased training and lower insurgent operations. The other key component that this behavior demonstrates is the steady increase of *Host Nation Capacity* due to the balanced allocation of resources by the coalition and the multiplying effects that this element causes on the system: increasing *Popular Support*, *Host Nation Security Forces*, and the capability of *Information Operations*.

The next plot demonstrates the simulation of Galula's 80/20 Theory (1964) on the Hybrid Counterinsurgency Strategy. The plot of the system's behavior can be seen in Figure 53. As described before, it is expected that reasonable changes to the resource allocation will have minimal effects on the outcome of the emergent behaviors patterns, even though the overall level of each elements seems to have been slightly reduced. The

first plot (Figure 52) allocates 33 percent *Coalition Investment* to *Coalition Combat Operations* and yields a higher initial spike in combat troops and higher long-term level of *Popular Support* when compared to Figure 53.

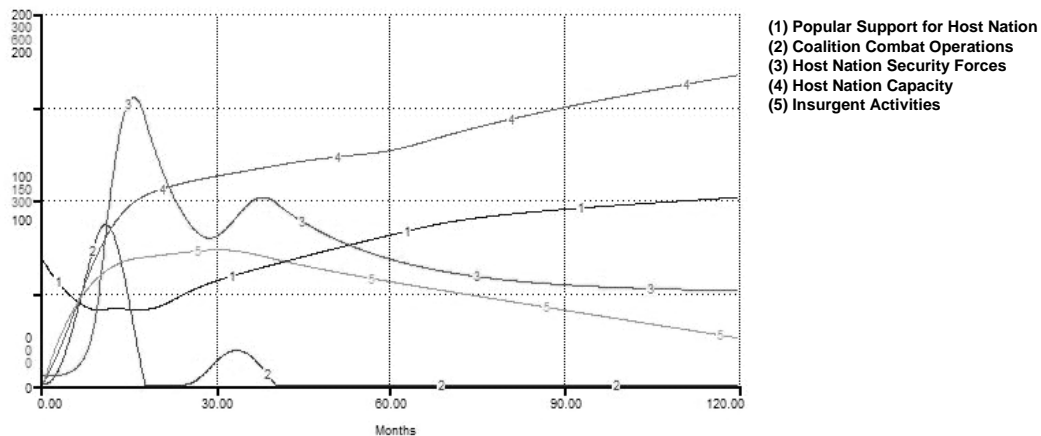


Figure 53: Emergent Behavior of the Hybrid Counterinsurgency Strategy model given allocation of *Coalition Investment* following Galula's 80/20 Theory (1964): 20% to *Combat Support* and 80% equally to *Host Nation Capacity*, and *Information Operations*.

A very interesting point surfaces from looking at these two plots. The long-standing assumption presented by Galula suggests that the political component of counterinsurgency would be more influential than the military element. But the simulation of the Hybrid Counterinsurgency Strategy model proposes that this is not the case during the short-term where subduing the *Insurgent Organizational Mechanisms* and limiting *Insurgent Activities* take priority.

The question also remains as to what exactly is a reasonable change in resource allocation. In the Hearts and Minds model, a study of resource allocation towards *Coalition Combat Operations* yielded that any percentage distribution greater the 25

percent towards security would cause irreversible harm to the level of *Popular Support*. But, because of the nature of the Hybrid Counterinsurgency Strategy, this behavior is not expected. As explained before, even though *Feelings of Resentment* are still present in this model, and have the same parameterized influence weights, the added influences of *Coalition Combat Operations* on *Insurgent Organizational Mechanisms* and *Resources* insert new balance to the system. Thus, this model does not react adversely to increases in the allocation of resources to *Coalition Combat Operations* up to 75 percent. Figure 54 is a comparative plot that graphs *Popular Support* as *Coalition Investment* is adjusted from five to 75 percent towards *Coalition Combat Operations*. Figure 55 shows the system behavior for a *Coalition Investment* of 55 percent towards *Coalition Combat Operations*. These plots shows that the system is able to self-regulate its behavior; even though *Coalition Combat Operations* is vastly over-funded when compared to *Host Nation Capacity* and *Information Operations*, the value of the security element still reduces drastically after the short-term and is only present in relatively low quantities throughout the mid-term. But, *Popular Support* and *Host Nation Capacity* are still able to rise considerably and *Insurgent Activities* are virtually eliminated by the end of the simulation.

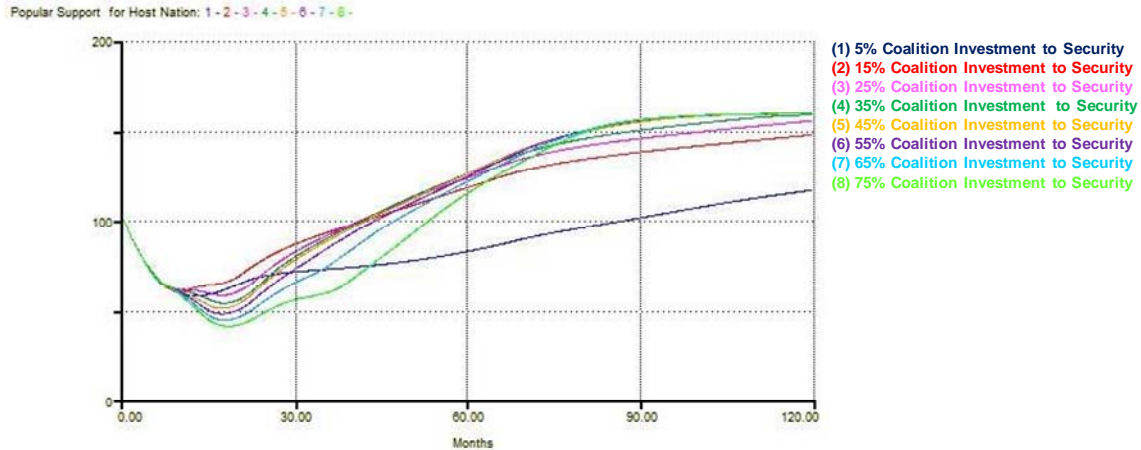


Figure 54: Comparative Plot of the behavior of *Popular Support* in the Hybrid Counterinsurgency Strategy model given incrementally increasing allocation of *Coalition Investment to Combat Operations*. The plot ranges from 5% to 75% allocation towards *Combat Operations* and the remainder is equally distributed to *Host Nation Capacity*, and *Information Operations*.

Careful observation of the behaviors shown in Figure 54 provides insight into the balance between the military and political components that has been discussed throughout this section. First, it is apparent that one behavior pattern in the plot, the one pertaining to five percent allocation of *Coalition Investment to Coalition Combat Operations*, does not follow the same trace as the others. This is explained by the growth of *Insurgent Activities* that drives down *Popular Support* because enough *Coalition Combat Operations* are not working to limit the insurgent's direct negative effects over the population. But, even though this plot does not reach the same levels as the others in this graph, it still maintains positive values of *Popular Support* and positive growth. This is attributed to the structure of the Hybrid Counterinsurgency Strategy model that, in contrast to the other models, adjusts the need for *Coalition Combat Operations* based on multiple factors: *Coalition Investment* and *Insurgent Activities*. What is essentially

occurring is that even though the initial planning requirements called for lower levels of combat troops, the heightened level of *Insurgent Activities* has triggered a redistribution of resources to introduce more troops as a response. This introduction of coalition forces afterwards helps to eventually grow *Popular Support*, but the timeline is substantially delayed because of the initial miscalculation.

From the remaining plots in Figure 54 we can see that higher initial allocation of *Coalition Investment* towards *Coalition Combat Operations* causes a short-term decrease in *Popular Support* that is attributed to the emergence of *Feelings of Resentment*. But, as was seen in the Hearts and Minds model, these feelings are primarily mitigated by the introduction of effective *Information Operations*. Also, those higher initial levels of combat troops lead to a quicker reduction of *Insurgent Activities* and prolonged growth of *Host Nation Capacity* and *Popular Support* during the mid- and long-term periods.

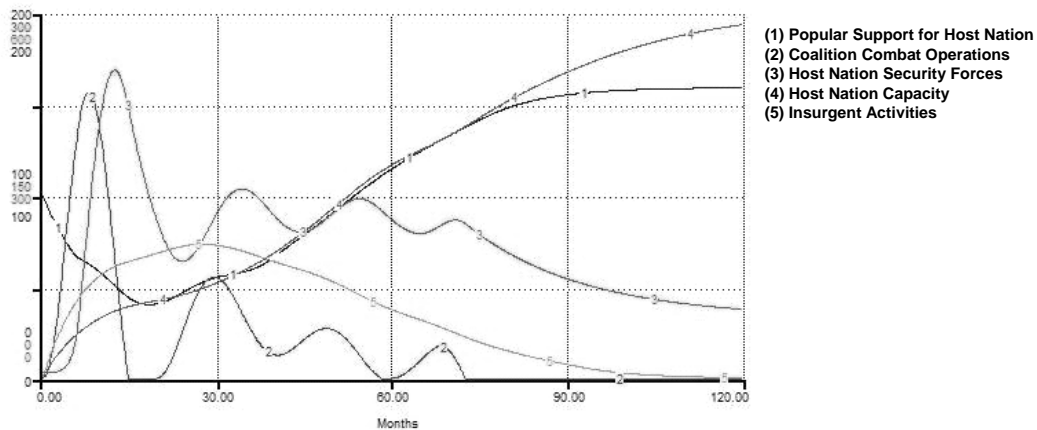


Figure 55: Emergent Behavior of the Hybrid Counterinsurgency Strategy, given allocation of *Coalition Investment* following *Security-focused* strategy: 55% to *Coalition Combat Operations* and 45% equally to *Host Nation Capacity* and *Information Operations*.

The results of these simulations and the observations gained from the construction of this and the other models provide a great addition to the body of counterinsurgency knowledge. The next chapter will further discuss the findings and recommendations that can be derived from this study. Furthermore, it proposes additional research areas that will serve to further this topic's understanding.

V. Discussion and Conclusions

The models developed during this research add to the existing body of knowledge on counterinsurgency and contribute greatly to the information available to the policy makers tasked with our nation's security. This study has aggregated a wide depth and breadth of counterinsurgency lessons in order to generate models for two classic approaches: Hearts and Minds and Cost Benefit Theory. The methodology employed in generating the system models for these strategies provided insight into their structures and behavior that enabled the construction of the Hybrid Counterinsurgency Strategy model. This new perspective on the issues of counterinsurgency combines Hearts and Minds' focus on gaining support from the local population by emphasizing the political components of the fight, while incorporating the accountability principals from Cost Benefit Theory that center on eliminating resources that are useful to the insurgency and diminishing the benefits of their actions. From this model, the elements of security, information superiority, and harvesting the local government's capacity have come to the forefront as the most important attributes of the Hybrid Counterinsurgency Strategy.

It is equally important to note that this model serves only as a representation of the system's behavior. It is unreasonable for a decision maker to expect definitive timelines or values from this or any other System Dynamics model. The true benefits of the model come from understanding the system's construction and the influences that tie each of the model's elements together; it is these influences that give the model its characteristic behavior and value.

Many have proposed ways in which current counterinsurgency strategy can be improved; such as reorganizing the counterinsurgency force around the Provincial Reconstruction Team construct (Long, 2006), establishing permanent advisory specialties (Nagl, 2007), or utilizing a wide range of airpower assets more effectively (Dunlap, 2007). But, most seem to agree there is no “silver bullet” response to the counterinsurgency issue. This research does not intend to be a definitive solution for counterinsurgency strategic planning or a tool to measure perceived support for a certain amount of investment. Rather, the purpose of this discussion is to add to the knowledge that exists on counterinsurgency strategy and for each of the recommendations that have been derived from the study to be able to contribute to the decision making process. The insight gained from the construction of these models, the identification of the system influences, and the emergent behavior patterns fulfill this goal.

Security is Key

The first section of recommendations will focus on the military component of the counterinsurgency fight. Attempting to determine the most optimum relationship between this and the political elements has been highly debated throughout the history of counterinsurgency. Revolutionaries and counterinsurgents alike have time and again made suggestions that seem to downplay the role of conventional military operations in the irregular environment (Galula, 1964; O’Neill, 2001). This assumption has been continually promoted by current doctrine and demonstrated by ongoing operations (FM 3-24, 2006). But, as at least one war fighter’s example, suggests that these guidelines

may not always apply. The case of the First Armored Division's evolving mission during 2007 serves as an excellent example of how these long-standing metrics may require a closer look. This unit initially estimated that only 30 percent of their missions would involve combat operations and they entered Northern Iraq structured around this assumption. But, as the fighting in the north began to intensify because of migration of insurgent forces from Baghdad and other former strongholds, the commanders shaped their force structure to meet these challenges (Shaker, 2009).

The example of the First Armored Division in Iraq underscores one of the recommendations that can be extracted from the development of the Hybrid Counterinsurgency Strategy. While the Hearts and Minds model demonstrated that a combat-focused strategy would fail to gain the necessary popular support because of the emergence of resentment among the locals, the Hybrid Counterinsurgency Strategy suggests that the long term implications of popular support are less dependent on the amount of security forces employed during an operation, but more so on the timeline associated with their deployment. The Hybrid Counterinsurgency Strategy model's simulation proposes that combat forces employed during the short-term period provides the greatest effects on training host nation personnel for ongoing security and disrupting the insurgent's organizational structures and availability to resources that will permit the growth of the local government's capacity during the long-term. This model, which was not developed by focusing on any particular conflict or range of operational conditions, mimics the "surge" conditions implemented in Iraq in early 2007 that have led to improved security and stabilization efforts (Nagl, 2002; Downey, et al., 2008). The

development of the Hybrid Counterinsurgency Strategy model also suggests that security operations must be conducted by focusing on developing host nation security forces, and establishing and maintaining effective border security.

The Hybrid Counterinsurgency Strategy maintains the contribution of Baker's (2006) initial development of the Hearts and Minds model that included resentment as the defining element that countered the balance that existed between popular support and the military and political elements. This model takes that premise one step further and combines it with the theory that host nation security forces would not encourage the development of these feelings (Nagl, 2008). The Hybrid Counterinsurgency Strategy advocates for a strong reliance on training host nation security forces in order to limit the effects of resentment on popular support and to aid in the building of host nation capacity. Some have suggested that this can be best accomplished by reorganizing the military's advisory role into a formal military specialty (Nagl, 2007), but with care to not tip the balance of power away from maintaining future force structure requirements for emerging conventional and irregular threats (Haddick, 2008). Others have also advocated that this advisory mission is the ideal source of cross-service integration of expertise and assets into the joint counterinsurgency arsenal. Kostelnik (2006) and Brown (2008) suggest that Air Force Security Force and Civil Engineers have specialized skill sets that have been de-emphasized by their Army and Marine Corp counterparts and that these would serve to greatly increase the training capability of host nation forces and the local government's capabilities.

Hybrid Counterinsurgency Strategy also suggests that an increased stance on border security is critical to limiting the resources that are available to the insurgency, and thus their ability to organize and conduct operations. This element stems from the construction of the Cost Benefit Theory model and has also been advocated by other studies (Long, 2006). This research suggests that insurgent organizational mechanisms depend on inputs from internal and external resource suppliers. Even though some of the resources that can be made available to the insurgency come directly from the host nation or coalition in the form of aid intended for the population, the Hybrid Counterinsurgency Strategy model proposes that effective security combined with intelligence and information operations can substantially diminish the availability of local and foreign resources. The topic of information operations opens the discussion into the next area of recommendations suggested by this study.

Focus on Information

Perhaps one of the most unexpected findings of this research was the importance of information operations on counterinsurgency systems. Every strategy modeled maintained some influence from information operations, but the lack of literary and doctrinal focus on this element seemed to imply that very little weight has been given to its contribution. Prior to 2006, with the publication of FM 3-24, none of the classic proponents or emerging strategies focused around maintaining a robust information operations structure. But the Hybrid Counterinsurgency Strategy proposes that information operations is the single most influential element in the counterinsurgency

system. The model's construction and simulations demonstrate information operations influences on reducing resentment, bolstering the effects of the local government's capacity, enabling the limitation of resources available to the insurgency and projecting the reach of the host nation and coalition directly to the population in an effort to gain their support. This element of the Hybrid Counterinsurgency Strategy model relied heavily on the information obtained from constructing the Hearts and Minds model. Simulation from this initial development suggested that if a strategy lacked the inclusion of information operations, then the added investment going towards the security and capacity-building elements would not be enough to counteract the effects of the insurgency and the emergence of the population's resentment.

Recently several perspectives on the value of information in counterinsurgency have begun to surface. Steele (2006) suggested that information operations have recently come to the forefront of national strategic planning and that its contributions are especially critical to the development of early warning, peacekeeping, and stabilization and reconstruction. He also advocated for the development of a National Information Council to serve at the same level as the National Security Council. With regards to the specific contributions of information operations to counterinsurgency, Helmus (2007) proposed that the methods with which a campaign's effectiveness is communicated to the population are just as important as the actions themselves. This RAND study focuses on utilizing the current elements of information operations, such as public affairs and psychological operations, and applying the principles developed for business marketing by managing expectation, tailoring stabilization efforts to meet individual "customer"

needs, and obtaining feedback from the population in order to measure the counterinsurgency's effectiveness. When marketing security, reconstruction, and stabilization, like in marketing for a business, the information disseminated must be factual and valuable to the audience.

Build Capacity

An unknown author said: "Give a man a fish; you have fed him for today. Teach a man to fish; and you have fed him for a lifetime." Building the host nation's capability is not about introducing humanitarian assistance and investing in new buildings or infrastructure for the sake of spending money towards reconstruction. This factor, as designed into the Hybrid Counterinsurgency Strategy model, originates from the individual focuses from Hearts and Minds on reestablishing essential services, stabilizing the host nation's economy, and gaining legitimacy for the government. This broad area must be addressed by a multifaceted approach that addresses the individual needs of each component (Thompson, 1970). Referring back to the fishing proverb, it can now be said that: "Build a school during a counterinsurgency and it will be attacked. Teach the community how to build that school and they will have it for a lifetime."

This statement underscores two points that are addressed by the Hybrid Counterinsurgency Strategy. First, the model suggests that more influence is given to popular support when the investment comes in the form of action by the host nation's government rather than the foreign coalition's support. As discussed before, the elements of host nation security forces and local government's capacity directly influence positive

growth of popular support, whereas the coalition's combat involvement may diminish support as a consequence of increasing feelings of resentment. Also, information operations work to directly influence support from the population but requires input from the host nation's actions in order to spread the word of stabilization and progress. Second, there exists a sense of accomplishment and pride when the work is completed by the merits and hard work of the population itself. This factor, which is seldom accounted for in studies and strategies, contributes to the capacity of the host nation.

Another issue that has recently been discussed and also falls under the category of building capacity is the diplomatic effort that must be present throughout the counterinsurgency campaign. Typically strategists do not consider this to be a military role, but one better suited for civilian diplomats. But this assumption may require serious reconsidering. Long (2006) suggested that amnesty and reward programs directed at employing former insurgents to work for the host nation government should become an integral part of irregular warfare planning. He warned that a prolonged battle of attrition would be counterproductive to the overall efforts of the counterinsurgency. He also suggested that reward programs target information gathering that can lead to the capture of insurgents, bomb-makers, and criminals. The effects would again institute a certain level of pride in the population that their efforts are contributing to the stabilization of their country while being supplemented by a monetary reward. Along with the rapid increase in troop levels in Iraq that occurred in 2007, the commanders also instituted a limited amnesty program that brought former militants under the influence of the local

government for an investment of approximately ten dollars per day and created essentially a “neighborhood watch on steroids.” (Nagl, 2008)

Suggested Future Research

Throughout the development of these models, the goal has been to simulate the model behaviors in order to understand their construction and determine their emergent behavior patterns. This processes served to achieve the objectives of this research: to consolidate counterinsurgency knowledge, to then use that knowledge in developing the models of current strategies, and finally to develop a comprehensive hybrid strategy with the insight gained from the prior models’ influences and behaviors. One recommendation to further the counterinsurgency body of knowledge would be to apply these models, particularly the Hybrid Counterinsurgency Strategy model, towards historical or notional examples of a counterinsurgency operation in order to obtain an optimal allocation of resources or to determine the preferred investment allocation balance according the short-, mid-, and long-term phases. This type of experimentation with the model’s functionality would also lend itself to multidimensional analysis of the model’s investment allocation elements. Another application of this research is to conduct a budgetary analysis of resources to add to the information that will determine investment allocation, operational phasing timelines, and the rate of investment withdrawal in response to improving conditions.

Conclusion

The initial discussion about the counterinsurgency body of knowledge included one author's approximation on the enhanced attention that the study of counterinsurgency has received as of late. The introduction stated that Dr. David Kilcullen, a senior counterinsurgency advisor for the US Department of State, estimates that more has been written on the topic of counterinsurgency in the last four years than in the previous 40. But the questions still remains unanswered: Why, even with all that has been documented, are we still struggling to understand this type of warfare? In developing this research, one line of reasoning that helps to address that question has emerged. Perhaps the lack of understanding has not been due to the lack of study, but to the way that the vast majority have sought to analyze the problem.

This research approaches the study of counterinsurgency from a drastically different point of view. Whereas most studies and references have focused on case examples or have attempted to develop predictive models from past conflicts in order to suggest what approach can be taken in another. In the case of this research, System Dynamics has allowed this study to focus on the mechanics of counterinsurgencies as complex social systems that have demonstrated consistent behavior patterns and influences at the structural and elemental levels that are not dependent on the particular conflict or geographic region. This research provides a critical step forward in the prolonged understanding of irregular warfare and serves as a key contribution to the wealth of counterinsurgency knowledge.

Appendix A: Equations for Flow Diagram of Hearts and Minds Model

Coalition Investment Element

- Coalition_Investment(t) = Coalition_Investment(t - dt) + (- Drain_on_CI) * dt
 INIT Coalition_Investment = 100
 OUTFLOWS:
 ☞ Drain_on_CI = Popular_Support_for_Host_Nation*Support_Coalition_Investment_Factor
 Support_Coalition_Investment_Factor = 1/500

Economic Element

- Host_Nation_Economy(t) = Host_Nation_Economy(t - dt) +
 (Economic_Development_due_to_Coalition_Support +
 Economic_Development_due_to_Popular_Support + Economic_Dev_from_Info_Ops +
 Economic_Dev_due_to_Governance - Lack_of_Economic_Development) * dt
 INIT Host_Nation_Economy = 1
 INFLOWS:
 ☞ Economic_Development_due_to_Coalition_Support =
 Host_Nation_Economy*Economic_Development_Compounding_Factor*Percentage_CI_to_Economy
 ☞ Economic_Development_due_to_Popular_Support = Economy_Support_Factor
 ☞ Economic_Dev_from_Info_Ops = Info_Ops_Econ_Factor
 ☞ Economic_Dev_due_to_Governance = Econ_Gov_Factor
 OUTFLOWS:
 ☞ Lack_of_Economic_Development =
 Host_Nation_Economy*Economic_Development_Draining_Factor
 CI_to_Economy = .25
 Economic_Development_Draining_Factor = .05
 Percentage_CI_to_Economy = Coalition_Investment*CI_to_Economy
 Economic_Development_Compounding_Factor = GRAPH(Host_Nation_Economy)
 (0.00, 0.01), (10.0, 0.0091), (20.0, 0.00805), (30.0, 0.00695), (40.0, 0.00595), (50.0, 0.005), (60.0, 0.00395), (70.0, 0.003), (80.0, 0.0019), (90.0, 0.00095), (100, 0.00)
 Economy_Support_Factor = GRAPH(Popular_Support_for_Host_Nation)
 (-100, -10.0), (-80.0, -8.00), (-60.0, -6.00), (-40.0, -4.00), (-20.0, -2.00), (0.00, 0.00), (20.0, 2.00), (40.0, 4.00), (60.0, 6.00), (80.0, 8.00), (100, 10.0)
 Econ_Gov_Factor = GRAPH(Perception_of_Good_Governance)
 (0.00, -0.5), (10.0, 0.00), (20.0, 0.05), (30.0, 0.105), (40.0, 0.16), (50.0, 0.21), (60.0, 0.26), (70.0, 0.315), (80.0, 0.375), (90.0, 0.44), (100, 0.5)
 Info_Ops_Econ_Factor = GRAPH(Information_Operations)
 (0.00, -1.00), (10.0, 0.5), (20.0, 0.5), (30.0, 0.5), (40.0, 0.5), (50.0, 0.5), (60.0, 0.5), (70.0, 0.5), (80.0, 0.5), (90.0, 0.5), (100, 0.5)

Governance Element

- Perception_of_Good_Governance(t) = Perception_of_Good_Governance(t - dt) +
 (Increasing_Acts_of_Good_Governance + Governance_from_Info_Ops -
 Decreasing_Acts_of_Good_Governance - Drain_on_Governance_from_Resentment) * dt
 INIT Perception_of_Good_Governance = 1
 INFLOWS:
 ☞ Increasing_Acts_of_Good_Governance =
 Perception_of_Good_Governance*Popular_Support_for_Host_Nation*Governance_Compounding_Factor
 ☞ Governance_from_Info_Ops = Info_Ops_Governance_Factor
 OUTFLOWS:
 ☞ Decreasing_Acts_of_Good_Governance =
 Perception_of_Good_Governance*Governance_Draining_Factor
 ☞ Drain_on_Governance_from_Resentment =
 Feelings_of_Resentment*Governance_Resentment_Factor
 Governance_Draining_Factor = .061
 Governance_Resentment_Factor = .0075
 Governance_Compounding_Factor = GRAPH(Perception_of_Good_Governance)
 (0.00, 0.1), (10.0, 0.09), (20.0, 0.08), (30.0, 0.07), (40.0, 0.0595), (50.0, 0.05), (60.0, 0.04), (70.0, 0.0295), (80.0, 0.02), (90.0, 0.01), (100, 0.00)
 Info_Ops_Governance_Factor = GRAPH(Information_Operations)
 (0.00, -1.00), (10.0, 0.5), (20.0, 0.5), (30.0, 0.5), (40.0, 0.5), (50.0, 0.5), (60.0, 0.5), (70.0, 0.5), (80.0, 0.5), (90.0, 0.5), (100, 0.5)

Information Element

Information_Operations(t) = Information_Operations(t - dt) + (Info_Ops_from_PS + Info_Ops_from_CI + Info_Ops_from_Services + Info_Ops_from_Economy + Info_Ops_from_Gov) * dt

INIT Information_Operations = 10

INFLOWS:

- ☞ Info_Ops_from_PS = PS_Info_Ops_Factor
- ☞ Info_Ops_from_CI = CI_Info_Ops_Factor
- ☞ Info_Ops_from_Services = Services_Info_Ops_Factor
- ☞ Info_Ops_from_Economy = Economy_Info_Ops_Factor
- ☞ Info_Ops_from_Gov = Gov_Info_Ops_Factor

- CI_to_Info_Ops = .25
- Percentage_CI_to_Info_Ops = Coalition_Investment*CI_to_Info_Ops
- CI_Info_Ops_Factor = GRAPH(Percentage_CI_to_Info_Ops)
(0.00, -0.1), (2.50, -0.04), (5.00, 0.02), (7.50, 0.08), (10.0, 0.14), (12.5, 0.2), (15.0, 0.26), (17.5, 0.32), (20.0, 0.38), (22.5, 0.44), (25.0, 0.5)
- Economy_Info_Ops_Factor = GRAPH(Host_Nation_Economy)
(0.00, -0.15), (10.0, 0.25), (20.0, 0.25), (30.0, 0.25), (40.0, 0.25), (50.0, 0.25), (60.0, 0.25), (70.0, 0.25), (80.0, 0.25), (90.0, 0.25), (100, 0.25)
- Gov_Info_Ops_Factor = GRAPH(Perception_of_Good_Governance)
(0.00, -0.15), (10.0, 0.25), (20.0, 0.25), (30.0, 0.25), (40.0, 0.25), (50.0, 0.25), (60.0, 0.25), (70.0, 0.25), (80.0, 0.25), (90.0, 0.25), (100, 0.25)
- PS_Info_Ops_Factor = GRAPH(Popular_Support_for_Host_Nation)
(-100, -0.3), (-80.0, -0.22), (-60.0, -0.14), (-40.0, -0.06), (-20.0, 0.02), (0.00, 0.1), (20.0, 0.18), (40.0, 0.26), (60.0, 0.34), (80.0, 0.42), (100, 0.5)
- Services_Info_Ops_Factor = GRAPH(Essential_Services)
(0.00, -0.1), (10.0, 0.1), (20.0, 0.1), (30.0, 0.1), (40.0, 0.1), (50.0, 0.1), (60.0, 0.1), (70.0, 0.1), (80.0, 0.1), (90.0, 0.1), (100, 0.1)

Popular Support Element

Popular_Support_for_Host_Nation(t) = Popular_Support_for_Host_Nation(t - dt) + (Gaining_in_Popular_Support_due_to_Essential_Services + Gaining_in_Popular_Support_due_to_Economy + Gaining_in_Support_Due_to_HN_Security_Level + Gaining_in_Popular_Support_due_to_Governance - Drain_of_Support - Drain_on_Support_from_Resentment) * dt

INIT Popular_Support_for_Host_Nation = 90

INFLOWS:

- ☞ Gaining_in_Popular_Support_due_to_Essential_Services = Services_Factor
- ☞ Gaining_in_Popular_Support_due_to_Economy = Economic_Factor
- ☞ Gaining_in_Support_Due_to_HN_Security_Level = HN_Security_Level_Factor
- ☞ Gaining_in_Popular_Support_due_to_Governance = Governance_Factor

OUTFLOWS:

- ☞ Drain_of_Support = Popular_Support_for_Host_Nation*Popular_Support_Flow_Factor
- ☞ Drain_on_Support_from_Resentment = Feelings_of_Resentment*Support_Resentment_Factor

- Popular_Support_Flow_Factor = .1
- Support_Resentment_Factor = .25
- Economic_Factor = GRAPH(Host_Nation_Economy)
(0.00, 0.00), (7.50, 0.5), (15.0, 1.00), (22.5, 1.50), (30.0, 2.00), (37.5, 2.50), (45.0, 3.00), (52.5, 3.50), (60.0, 4.00), (67.5, 4.50), (75.0, 5.00)
- Governance_Factor = GRAPH(Perception_of_Good_Governance)
(0.00, 0.00), (7.50, 0.5), (15.0, 1.00), (22.5, 1.50), (30.0, 2.00), (37.5, 2.50), (45.0, 3.00), (52.5, 3.50), (60.0, 4.00), (67.5, 4.50), (75.0, 5.00)
- HN_Security_Level_Factor = GRAPH(Host_Nation_Security_Forces)
(0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- Services_Factor = GRAPH(Essential_Services)
(0.00, 0.00), (7.50, 0.5), (15.0, 1.00), (22.5, 1.50), (30.0, 2.00), (37.5, 2.50), (45.0, 3.00), (52.5, 3.50), (60.0, 4.00), (67.5, 4.50), (75.0, 5.00)

Resentment Element

Feelings_of_Resentment(t) = Feelings_of_Resentment(t - dt) + (- Drain_on_Resentment - Drain_on_Resentment_from_Info_Ops) * dt

INIT Feelings_of_Resentment = 1

OUTFLOWS:

- ☞ Drain_on_Resentment = Resentment_Factor
- ☞ Drain_on_Resentment_from_Info_Ops = Resentment_Info_Factor

- Resentment_Factor = GRAPH(Coalition_Combat_Operations)
(0.00, 6.00), (10.0, 4.40), (20.0, 2.80), (30.0, 1.20), (40.0, -0.4), (50.0, -2.00), (60.0, -3.60), (70.0, -5.20), (80.0, -6.80), (90.0, -8.40), (100, -10.0)
- Resentment_Info_Factor = GRAPH(Information_Operations)
(0.00, 0.00), (10.0, 0.1), (20.0, 0.2), (30.0, 0.3), (40.0, 0.4), (50.0, 0.5), (60.0, 0.6), (70.0, 0.7), (80.0, 0.8), (90.0, 0.9), (100, 1.00)

Security

- Coalition_Combat_Operations(t) = Coalition_Combat_Operations(t - dt) + (Increasing_Coalition_Combat_Support - Decreasing_Coalition_Combat_Support) * dt
INIT Coalition_Combat_Operations = 1
INFLOWS:
 ↻ Increasing_Coalition_Combat_Support = Coalition_Combat_Support_Compounding_Factor
OUTFLOWS:
 ↻ Decreasing_Coalition_Combat_Support = Coalition_Combat_Support_Draining_Factor*Host_Nation_Security_Forces
- Host_Nation_Security_Forces(t) = Host_Nation_Security_Forces(t - dt) + (Training_HN_Security_Forces + Training_HN_Sec_Forces_due_to_Governance - Loosing_HN_Security_Forces - Loosing_HN_Security_Forces_from_Resentment) * dt
INIT Host_Nation_Security_Forces = 10
INFLOWS:
 ↻ Training_HN_Security_Forces = HN_Security_Forces_Compounding_Factor*Coalition_Combat_Operations
 ↻ Training_HN_Sec_Forces_due_to_Governance = Perception_of_Good_Governance*Security_Governance_Factor
OUTFLOWS:
 ↻ Loosing_HN_Security_Forces = HN_Security_Forces_Draining_Factor*Host_Nation_Security_Forces
 ↻ Loosing_HN_Security_Forces_from_Resentment = Feelings_of_Resentment*Security_Resentment_Factor
- CI_to_Security = .25
 Coalition_Combat_Support_Draining_Factor = .19
 Percentage_CI_to_Security = Coalition_Investment*CI_to_Security
 Security_Resentment_Factor = .1
 Security_Governance_Factor = .025
 Coalition_Combat_Support_Compounding_Factor = GRAPH(Percentage_CI_to_Security)
 (0.00, 0.00), (10.0, 10.0), (20.0, 20.0), (30.0, 30.0), (40.0, 40.0), (50.0, 50.0), (60.0, 60.0), (70.0, 70.0), (80.0, 80.0), (90.0, 90.0), (100, 100)
 HN_Security_Forces_Draining_Factor = GRAPH(Popular_Support_for_Host_Nation)
 (-100, 0.5), (-80.0, 0.444), (-60.0, 0.376), (-40.0, 0.314), (-20.0, 0.248), (0.00, 0.17), (20.0, 0.152), (40.0, 0.142), (60.0, 0.13), (80.0, 0.118), (100, 0.108)
 HN_Security_Forces_Compounding_Factor = GRAPH(Host_Nation_Security_Forces)
 (0.00, 0.00), (10.0, 0.05), (20.0, 0.1), (30.0, 0.15), (40.0, 0.2), (50.0, 0.25), (60.0, 0.3), (70.0, 0.35), (80.0, 0.4), (90.0, 0.45), (100, 0.5)

Services Element

- Essential_Services(t) = Essential_Services(t - dt) + (Gaining_of_Services_due_to_Coalition_Investment + Gaining_in_Services_due_to_Popular_Support + Gaining_in_Services_due_to_Governance - Loss_of_Services) * dt
INIT Essential_Services = 1
INFLOWS:
 ↻ Gaining_of_Services_due_to_Coalition_Investment = Essential_Services*Services_Compounding_Factor*Percentage_CI_to_Services
 ↻ Gaining_in_Services_due_to_Popular_Support = Service_Support_Factor*Popular_Support_for_Host_Nation
 ↻ Gaining_in_Services_due_to_Governance = Perception_of_Good_Governance*Service_Governance_Factor
OUTFLOWS:
 ↻ Loss_of_Services = Essential_Services*Services_Draining_Factor
- CI_to_Services = .25
 Percentage_CI_to_Services = Coalition_Investment*CI_to_Services
 Services_Draining_Factor = .05
 Service_Governance_Factor = .05
 Service_Support_Factor = .1
 Services_Compounding_Factor = GRAPH(Essential_Services)
 (0.00, 0.01), (12.5, 0.009), (25.0, 0.008), (37.5, 0.00705), (50.0, 0.00605), (62.5, 0.00505), (75.0, 0.00415), (87.5, 0.00295), (100, 0.00195), (113, 0.0009), (125, 0.00)

Not in a sector

Appendix B: Equations for Flow Diagram of Cost Benefit Theory Model

Coalition Investment Element

- Coalition_Investment(t) = Coalition_Investment(t - dt) + (- Drain_on_CI) * dt
 INIT Coalition_Investment = 100
 OUTFLOWS:
 ☞ Drain_on_CI = Pop_Behavior_in_Favor_of_Host_Nation*Pop_Behavior_CI_Fa
 Pop_Behavior_CI_Factor = .05

Combat Support Element

- Combat_Support(t) = Combat_Support(t - dt) +
 (Gaining_of_Combat_Support_due_to_Coalition_Investment - Natural_Loss_of_Comb
 dt
 INIT Combat_Support = 1
 INFLOWS:
 ☞ Gaining_of_Combat_Support_due_to_Coalition_Investment =
 Combat_Support*Combat_Support__Gaining_Factor*CI_to_Combat_Support
 OUTFLOWS:
 ☞ Natural_Loss_of_Combat_Support =
 Combat_Support*Combat_Support_Compounding_Factor
 CI_to_Combat_Support = Coalition_Investment*(Percentage_of_CI_to_Combat_Sup
 Percentage_of_CI_to_Combat_Support = 33
 Combat_Support_Compounding_Factor = GRAPH(Combat_Support)
 (0.00, 0.00), (12.5, 0.02), (25.0, 0.04), (37.5, 0.06), (50.0, 0.08), (62.5, 0.1), (75.0, 0.12),
 (100, 0.16), (113, 0.18), (125, 0.2)
 Combat_Support__Gaining_Factor = GRAPH(Insurgent_Activities)
 (0.00, 0.00), (2.50, 0.0005), (5.00, 0.001), (7.50, 0.0015), (10.0, 0.002), (12.5, 0.00248),
 (17.5, 0.0035), (20.0, 0.004), (22.5, 0.0045), (25.0, 0.005)

Host Nation Capacity Element

- Host_Nation_Capacity(t) = Host_Nation_Capacity(t - dt) +
 (Gaining_of_Capacity_due_to_Coalition_Investment + Gaining_HN_Capacity_due_to
 Natural_Loss_of_Capacity) * dt
 INIT Host_Nation_Capacity = 1
 INFLOWS:
 ☞ Gaining_of_Capacity_due_to_Coalition_Investment =
 Host_Nation_Capacity*Capacity_Compounding_Factor*CI_to_HN_Capacity
 ☞ Gaining_HN_Capacity_due_to_Info_Ops = HN_Capacity__Info_Ops_Factor
 OUTFLOWS:
 ☞ Natural_Loss_of_Capacity =
 Host_Nation_Capacity*Capacity__Draining_Factor*Draining_HN_Capacity_du
 t_Acts
 Capacity__Draining_Factor = .031
 CI_to_HN_Capacity = Coalition_Investment*(Percentage_of_CI__to_HN_Capacity/10
 Percentage_of_CI__to_HN_Capacity = 33
 Capacity_Compounding_Factor = GRAPH(Host_Nation_Capacity)
 (0.00, 0.005), (12.5, 0.0045), (25.0, 0.004), (37.5, 0.0035), (50.0, 0.003), (62.5, 0.0025),
 (87.5, 0.0015), (100, 0.001), (113, 0.0005), (125, 0.00)
 Draining_HN_Capacity_due_to_Insurgent_Acts = GRAPH(Insurgent_Activities)
 (0.00, 1.00), (10.0, 1.40), (20.0, 1.80), (30.0, 2.20), (40.0, 2.60), (50.0, 3.00), (60.0, 3.40)
 (80.0, 4.20), (90.0, 4.60), (100, 5.00)
 HN_Capacity__Info_Ops_Factor = GRAPH(Information_Operations)
 (0.00, 0.00), (5.00, 0.5), (10.0, 1.00), (15.0, 1.50), (20.0, 2.00), (25.0, 2.50), (30.0, 3.00),
 (40.0, 4.00), (45.0, 4.50), (50.0, 5.00)

Information Operations Element

- Information_Operations(t) = Information_Operations(t - dt) + (Gainin_Info_Ops_Capac Gaining_Info_Ops_Capacity_due_to_Pop_Behavior) * dt
INIT Information_Operations = 10
INFLOWS:
 ↔ Gainin_Info_Ops_Capacity_due_to_CI = Info_Ops_Gaining_Factor*CI_to_Info,
 ↔ Gaining_Info_Ops_Capacity_due_to_Pop_Behavior = Info_Ops__Pop_Behavi
- CI_to_Info_Ops = Coalition_Investment*(Percentage_of_CI__to_Info_Ops/100)
 Info_Ops_Gaining_Factor = .0225
 Percentage_of_CI__to_Info_Ops = 33
 Info_Ops__Pop_Behavior_factor = GRAPH(Pop_Behavior_in_Favor_of_Host_Nation)
 (-100, -0.5), (-80.0, -0.4), (-60.0, -0.3), (-40.0, -0.2), (-20.0, -0.1), (0.00, 0.00), (20.0, 0.1),
 (60.0, 0.3), (80.0, 0.4), (100, 0.5)

Insurgent Org Mechanisms Element

- Insurgent_Organizational_Mechanisms(t) = Insurgent_Organizational_Mechanisms(t - dt) + (Gaining_IOM_due_to_Internal_Resources + Gaining_IOM_due_to_External_Resourc Drain_on_IOM__due_to_Pop_Behavior - Drain_on_IOM_due_to_Combat_Support - Drain_on_IOM_due_to_Info_Ops) * dt
INIT Insurgent_Organizational_Mechanisms = 50
INFLOWS:
 ↔ Gaining_IOM_due_to_Internal_Resources = IOM_Int_Resources_Factor
 ↔ Gaining_IOM_due_to_External_Resources = External_Resources*IOM_Ext_Resources_Factor
OUTFLOWS:
 ↔ Drain_on_IOM__due_to_Pop_Behavior = IOM_Pop__Behavior_Factor
 ↔ Drain_on_IOM_due_to_Combat_Support = IOM_Combat__Support_Factor
 ↔ Drain_on_IOM_due_to_Info_Ops = IOM_Info_Ops_Factor
- IOM_Ext_Resources_Factor = .005
 IOM_Combat__Support_Factor = GRAPH(Combat_Support)
 (0.00, 0.00), (5.00, 0.1), (10.0, 0.2), (15.0, 0.3), (20.0, 0.4), (25.0, 0.5), (30.0, 0.6), (35.0, 0.7),
 (40.0, 0.8), (45.0, 0.9), (50.0, 1.00)
 IOM_Info_Ops_Factor = GRAPH(Information_Operations)
 (0.00, 0.00), (5.00, 0.05), (10.0, 0.1), (15.0, 0.15), (20.0, 0.2), (25.0, 0.25), (30.0, 0.3), (35.0, 0.4),
 (40.0, 0.45), (45.0, 0.45), (50.0, 0.5)
 IOM_Int_Resources_Factor = GRAPH(Internal_Resources)
 (0.00, 0.00), (10.0, 0.05), (20.0, 0.1), (30.0, 0.15), (40.0, 0.2), (50.0, 0.25), (60.0, 0.3), (70.0, 0.4),
 (80.0, 0.45), (90.0, 0.45), (100, 0.5)
 IOM_Pop__Behavior_Factor = GRAPH(Pop_Behavior_in_Favor_of_Host_Nation)
 (-100, -0.5), (-80.0, -0.4), (-60.0, -0.3), (-40.0, -0.2), (-20.0, -0.1), (0.00, 0.00), (20.0, 0.1),
 (60.0, 0.3), (80.0, 0.4), (100, 0.5)

Insurgent Activities Element

- $\text{Insurgent_Activities}(t) = \text{Insurgent_Activities}(t - dt) + (\text{Increasing_Insurgent_Activities_due_to_IOM} - \text{Natural_Decrease_of_Insurgent_Activities}) * dt$
INIT $\text{Insurgent_Activities} = 1$
INFLOWS:
 $\text{Increasing_Insurgent_Activities_due_to_IOM} = \text{Insurgent_Organizational_Mechanisms} * \text{Insurgent_Acts_IOM_Factor}$
OUTFLOWS:
 $\text{Natural_Decrease_of_Insurgent_Activities} = \text{Insurgent_Activities} * \text{Insurgent_Acts_Loss_Factor}$
 $\text{Insurgent_Acts_IOM_Factor} = .1$
 $\text{Insurgent_Acts_Loss_Factor} = .1$

Population Behavior Element

- $\text{Pop_Behavior_in_Favor_of_Host_Nation}(t) = \text{Pop_Behavior_in_Favor_of_Host_Nation}(t - dt) + (\text{Pop_Behavior_due_to_HN_Capacity} - \text{Natural_Drain_on_Pop_Behavior} - \text{Drain_on_Pop_Behavior_due_to_Insurgent_Acts}) * dt$
INIT $\text{Pop_Behavior_in_Favor_of_Host_Nation} = 10$
INFLOWS:
 $\text{Pop_Behavior_due_to_HN_Capacity} = \text{Pop_Behavior_HN_Capacity_Factor}$
OUTFLOWS:
 $\text{Natural_Drain_on_Pop_Behavior} = \text{Pop_Behavior_Drain_Factor} * \text{Pop_Behavior_in_Favor_of_Host_Nation}$
 $\text{Drain_on_Pop_Behavior_due_to_Insurgent_Acts} = \text{Pop_Behavior_Insurgent_Acts_Factor}$
 $\text{Pop_Behavior_Drain_Factor} = .005$
 $\text{Pop_Behavior_Insurgent_Acts_Factor} = \text{GRAPH}(\text{Insurgent_Activities})$
 (0.00, 0.00), (5.00, 0.1), (10.0, 0.2), (15.0, 0.3), (20.0, 0.4), (25.0, 0.5), (30.0, 0.6), (35.0, 0.7), (40.0, 0.8), (45.0, 0.9), (50.0, 1.00)
 $\text{Pop_Behavior_HN_Capacity_Factor} = \text{GRAPH}(\text{Host_Nation_Capacity})$
 (-100, -1.50), (-80.0, -1.20), (-60.0, -0.9), (-40.0, -0.6), (-20.0, -0.3), (0.00, 0.00), (20.0, 0.3), (40.0, 0.6), (60.0, 0.9), (80.0, 1.20), (100, 1.50)

Resources Element

- $\text{External_Resources}(t) = \text{External_Resources}(t - dt)$
INIT $\text{External_Resources} = 100$
 $\text{Internal_Resources}(t) = \text{Internal_Resources}(t - dt) + (\text{Gaining_Int_Resources_due_to_HN_Capacity} + \text{Gaining_Int_Resources_due_to_Insurgent_Acts} - \text{Draining_Int_Resources_due_to_Combat_Support} - \text{Drain_on_Int_Resources_due_to_Info_Ops}) * dt$
INIT $\text{Internal_Resources} = 100$
INFLOWS:
 $\text{Gaining_Int_Resources_due_to_HN_Capacity} = \text{Resource_HN_Capacity_Factor}$
 $\text{Gaining_Int_Resources_due_to_Insurgent_Acts} = \text{Resource_Insurgent_Acts_Factor}$
OUTFLOWS:
 $\text{Draining_Int_Resources_due_to_Combat_Support} = \text{Resource_Combat_Support_Factor}$
 $\text{Drain_on_Int_Resources_due_to_Info_Ops} = \text{Resource_Info_Ops_Factor}$
 $\text{Resource_Combat_Support_Factor} = \text{GRAPH}(\text{Combat_Support})$
 (0.00, 0.00), (10.0, 0.2), (20.0, 0.4), (30.0, 0.6), (40.0, 0.8), (50.0, 1.00), (60.0, 1.20), (70.0, 1.40), (80.0, 1.60), (90.0, 1.80), (100, 2.00)
 $\text{Resource_HN_Capacity_Factor} = \text{GRAPH}(\text{Host_Nation_Capacity})$
 (0.00, 0.00), (5.00, 0.05), (10.0, 0.1), (15.0, 0.15), (20.0, 0.2), (25.0, 0.25), (30.0, 0.3), (35.0, 0.35), (40.0, 0.4), (45.0, 0.45), (50.0, 0.5)
 $\text{Resource_Info_Ops_Factor} = \text{GRAPH}(\text{Information_Operations})$
 (0.00, 0.00), (5.00, 0.2), (10.0, 0.4), (15.0, 0.6), (20.0, 0.8), (25.0, 1.00), (30.0, 1.20), (35.0, 1.40), (40.0, 1.60), (45.0, 1.80), (50.0, 2.00)
 $\text{Resource_Insurgent_Acts_Factor} = \text{GRAPH}(\text{Insurgent_Activities})$
 (0.00, 0.00), (5.00, 0.075), (10.0, 0.15), (15.0, 0.225), (20.0, 0.3), (25.0, 0.375), (30.0, 0.45), (35.0, 0.525), (40.0, 0.6), (45.0, 0.675), (50.0, 0.75)

Not in a sector

Appendix C: Equations for Flow Diagram of Hybrid Counterinsurgency Strategy Model

Capacity Element

- $Host_Nation_Capacity(t) = Host_Nation_Capacity(t - dt) + (Increasing_Capacity + Gaining_Host_Nation_Capacity_due_to_Popular_Support + Gaining_Host_Nation_Capacity_due_to_Info_Ops - Decreasing_Capacity - Losing_Host_Nation_Capacity_due_to_Insurgent_Activities) * dt$
 INIT $Host_Nation_Capacity = 1$
 INFLOWS:
 \rightarrow $Increasing_Capacity = Host_Nation_Capacity * Capacity_Compounding_Factor * Percentage_CI_to_Capacity$
 \rightarrow $Gaining_Host_Nation_Capacity_due_to_Popular_Support = Capacity_Support_Factor$
 \rightarrow $Gaining_Host_Nation_Capacity_due_to_Info_Ops = Capacity_Info_Ops_Factor$
 OUTFLOWS:
 \rightarrow $Decreasing_Capacity = Host_Nation_Capacity * Capacity_Draining_Factor$
 \rightarrow $Losing_Host_Nation_Capacity_due_to_Insurgent_Activities = Capacity_Insurgent_Act_Factor$
- $Capacity_Draining_Factor = .049$
- $CI_to_Capacity = 33$
- $Percentage_CI_to_Capacity = Coalition_Investment * CI_to_Capacity * (1/100)$
- $Capacity_Info_Ops_Factor = GRAPH(Information_Operations)$
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- $Capacity_Insurgent_Act_Factor = GRAPH(Insurgent_Activities)$
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- $Capacity_Support_Factor = GRAPH(Popular_Support_for_Host_Nation)$
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- $Capacity_Compounding_Factor = GRAPH(Host_Nation_Capacity)$
 (0.00, 0.0075), (12.5, 0.00675), (25.0, 0.006), (37.5, 0.00525), (50.0, 0.0045), (62.5, 0.00375), (75.0, 0.003), (87.5, 0.00225), (100, 0.0015), (113, 0.00075), (125, 0.00)

Coalition Investment Element

- $Coalition_Investment(t) = Coalition_Investment(t - dt) + (- Drain_on_CI) * dt$
 INIT $Coalition_Investment = 100$
 OUTFLOWS:
 \rightarrow $Drain_on_CI = Support_Coalition_Investment_Factor * Popular_Support_for_Host_Nation$
- $Support_Coalition_Investment_Factor = 1/50$

Information Element

- $Information_Operations(t) = Information_Operations(t - dt) + (Info_Ops_from_CI + Gaining_Info_Ops_due_to_Popular_Support + Gaining_Info_Ops_due_to_HN_Capacity) * dt$
 INIT $Information_Operations = 10$
 INFLOWS:
 \rightarrow $Info_Ops_from_CI = CI_Info_Ops_Factor$
 \rightarrow $Gaining_Info_Ops_due_to_Popular_Support = Info_Ops_Support_Factor$
 \rightarrow $Gaining_Info_Ops_due_to_HN_Capacity = Info_Ops_Capacity_Factor$
- $CI_to_Info_Ops = 33$
- $Percentage_CI_to_Info_Ops = Coalition_Investment * CI_to_Info_Ops$
- $CI_Info_Ops_Factor = GRAPH(Percentage_CI_to_Info_Ops)$
 (0.00, 0.00), (3.30, 0.05), (6.60, 0.1), (9.90, 0.15), (13.2, 0.2), (16.5, 0.25), (19.8, 0.3), (23.1, 0.35), (26.4, 0.4), (29.7, 0.45), (33.0, 0.5)
- $Info_Ops_Capacity_Factor = GRAPH(Host_Nation_Capacity)$
 (0.00, 0.00), (10.0, 0.05), (20.0, 0.1), (30.0, 0.15), (40.0, 0.2), (50.0, 0.25), (60.0, 0.3), (70.0, 0.35), (80.0, 0.4), (90.0, 0.45), (100, 0.5)
- $Info_Ops_Support_Factor = GRAPH(Popular_Support_for_Host_Nation)$
 (-100, -0.5), (-80.0, -0.4), (-60.0, -0.3), (-40.0, -0.2), (-20.0, -0.1), (0.00, 0.00), (20.0, 0.1), (40.0, 0.2), (60.0, 0.3), (80.0, 0.4), (100, 0.5)

Insurgent Activities Element

- $\text{Insurgent_Activities}(t) = \text{Insurgent_Activities}(t - dt) + (\text{Increasing_Insurgent_Activities_due_to_IOM} - \text{Natural_Decrease_of_Insurgent_Activities}) * dt$
 INIT Insurgent_Activities = 1
 INFLOWS:
 ↳ Increasing_Insurgent_Activities_due_to_IOM =
 Insurgent_Organizational_Mechanisms*Insurgent_Acts_IOM_Factor
 OUTFLOWS:
 ↳ Natural_Decrease_of_Insurgent_Activities =
 Insurgent_Activities*Insurgent_Acts_Loss_Factor
- $\text{Insurgent_Organizational_Mechanisms}(t) = \text{Insurgent_Organizational_Mechanisms}(t - dt) + (\text{Gaining_IOM_due_to_Resources} - \text{Loosing_IOM_due_to_Popular_Support} - \text{Loosing_IOM_due_to_Coalition_Combat_Ops}) * dt$
 INIT Insurgent_Organizational_Mechanisms = 100
 INFLOWS:
 ↳ Gaining_IOM_due_to_Resources = IOM_Resources_Factor
 OUTFLOWS:
 ↳ Loosing_IOM_due_to_Popular_Support = IOM_Support_Factor
 ↳ Loosing_IOM_due_to_Coalition_Combat_Ops = IOM_Combat_Ops_Factor
- Insurgent_Acts_IOM_Factor = .1
 Insurgent_Acts_Loss_Factor = .1
 IOM_Combat_Ops_Factor = GRAPH(Coalition_Combat_Operations)
 (0.00, 0.00), (5.00, 0.25), (10.0, 0.5), (15.0, 0.75), (20.0, 1.00), (25.0, 1.25), (30.0, 1.50), (35.0, 1.75), (40.0, 2.00), (45.0, 2.25), (50.0, 2.50)
 IOM_Resources_Factor = GRAPH(Resources_Available_to_the_Insurgency)
 (0.00, 0.00), (10.0, 0.22), (20.0, 0.4), (30.0, 0.6), (40.0, 0.8), (50.0, 1.00), (60.0, 1.20), (70.0, 1.40), (80.0, 1.60), (90.0, 1.80), (100, 2.00)
 IOM_Support_Factor = GRAPH(Popular_Support_for_Host_Nation)
 (-100, -2.50), (-80.0, -2.00), (-60.0, -1.50), (-40.0, -1.00), (-20.0, -0.5), (0.00, 0.00), (20.0, 0.5), (40.0, 1.00), (60.0, 1.50), (80.0, 2.00), (100, 2.50)

Popular Support Element

- $\text{Popular_Support_for_Host_Nation}(t) = \text{Popular_Support_for_Host_Nation}(t - dt) + (\text{Gaining_in_Popular_Support_due_to_HN_Security_Level} + \text{Gaining_in_Popular_Support_due_to_HN_Capacity} + \text{Gaining_Popular_Support_due_to_Info_Ops} - \text{Drain_of_Support} - \text{Loosing_Popular_Support_due_to_Resentment} - \text{Loosing_Popular_Support_due_to_Insurgent_Act}) * dt$
 INIT Popular_Support_for_Host_Nation = 100
 INFLOWS:
 ↳ Gaining_in_Popular_Support_due_to_HN_Security_Level = Support_Security_Factor
 ↳ Gaining_in_Popular_Support_due_to_HN_Capacity = Support_Capacity_Factor
 ↳ Gaining_Popular_Support_due_to_Info_Ops = Support_Info_Ops_Factor
 OUTFLOWS:
 ↳ Drain_of_Support = Popular_Support_for_Host_Nation*Popular_Support_Flow_Factor
 ↳ Loosing_Popular_Support_due_to_Resentment = Support_Resentment_Factor
 ↳ Loosing_Popular_Support_due_to_Insurgent_Act = Support_Insurgency_Factor
- Popular_Support_Flow_Factor = .1
 Support_Capacity_Factor = GRAPH(Host_Nation_Capacity)
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
 Support_Info_Ops_Factor = GRAPH(Information_Operations)
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
 Support_Insurgency_Factor = GRAPH(Insurgent_Activities)
 (0.00, -1.00), (10.0, -0.4), (20.0, 0.2), (30.0, 0.8), (40.0, 1.40), (50.0, 2.00), (60.0, 2.60), (70.0, 3.20), (80.0, 3.80), (90.0, 4.40), (100, 5.00)
 Support_Resentment_Factor = GRAPH(Feelings_of_Resentment)
 (0.00, -1.00), (10.0, -0.4), (20.0, 0.2), (30.0, 0.8), (40.0, 1.40), (50.0, 2.00), (60.0, 2.60), (70.0, 3.20), (80.0, 3.80), (90.0, 4.40), (100, 5.00)
 Support_Security_Factor = GRAPH(Host_Nation_Security_Forces)
 (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)

Resentment Element

- Feelings_of_Resentment(t) = Feelings_of_Resentment(t - dt) + (- Drain_on_Resentment - Loosing_Resentment_due_to_Popular_Support - Loosing_Resentment_due_to_Info_Ops) * dt
INIT Feelings_of_Resentment = 1
OUTFLOWS:
 - ↔ Drain_on_Resentment = Resentment_Factor
 - ↔ Loosing_Resentment_due_to_Popular_Support = Resentment_Support_Factor
 - ↔ Loosing_Resentment_due_to_Info_Ops = Resentment_Info_Ops_Factor
- Resentment_Factor = GRAPH(Coalition_Combat_Operations)
 - ↘ (0.00, 6.00), (10.0, 4.40), (20.0, 2.80), (30.0, 1.20), (40.0, -0.4), (50.0, -2.00), (60.0, -3.60), (70.0, -5.20), (80.0, -6.80), (90.0, -8.40), (100, -10.0)
- Resentment_Info_Ops_Factor = GRAPH(Information_Operations)
 - ↘ (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- Resentment_Support_Factor = GRAPH(Popular_Support_for_Host_Nation)
 - ↘ (-100, -2.50), (-80.0, -2.00), (-60.0, -1.50), (-40.0, -1.00), (-20.0, -0.5), (0.00, 0.00), (20.0, 0.5), (40.0, 1.00), (60.0, 1.50), (80.0, 2.00), (100, 2.50)

Resources Element

- Resources_Available_to_the_Insurgency(t) = Resources_Available_to_the_Insurgency(t - dt) + (Gaining_Resources_due_to_HN_Capacity + Gaining_Resources_due_to_Insurgent_Activities - Loosing_Resources_due_to_Coalition_Combat_Ops - Loosing_Resources_due_to_Info_Ops) * dt
INIT Resources_Available_to_the_Insurgency = 100
INFLOWS:
 - ↔ Gaining_Resources_due_to_HN_Capacity = Resources_Capacity_Factor
 - ↔ Gaining_Resources_due_to_Insurgent_Activities = Resources_Insurgent_Act_Factor
- Resources_Capacity_Factor = GRAPH(Host_Nation_Capacity)
 - ↘ (0.00, 0.00), (10.0, 0.025), (20.0, 0.05), (30.0, 0.075), (40.0, 0.1), (50.0, 0.125), (60.0, 0.15), (70.0, 0.175), (80.0, 0.2), (90.0, 0.225), (100, 0.25)
- Resources_Combat_Ops_Factor = GRAPH(Coalition_Combat_Operations)
 - ↘ (0.00, 0.00), (5.00, 0.0525), (10.0, 0.1), (15.0, 0.147), (20.0, 0.2), (25.0, 0.25), (30.0, 0.295), (35.0, 0.348), (40.0, 0.398), (45.0, 0.455), (50.0, 0.5)
- Resources_Info_Ops_Factor = GRAPH(Information_Operations)
 - ↘ (0.00, 0.00), (10.0, 0.05), (20.0, 0.1), (30.0, 0.15), (40.0, 0.2), (50.0, 0.25), (60.0, 0.3), (70.0, 0.35), (80.0, 0.4), (90.0, 0.45), (100, 0.5)
- Resources_Insurgent_Act_Factor = GRAPH(Insurgent_Activities)
 - ↘ (0.00, 0.00), (5.00, 0.0525), (10.0, 0.1), (15.0, 0.147), (20.0, 0.2), (25.0, 0.25), (30.0, 0.295), (35.0, 0.348), (40.0, 0.398), (45.0, 0.455), (50.0, 0.5)

Security

- Coalition_Combat_Operations(t) = Coalition_Combat_Operations(t - dt) + (Increasing_Coalition_Combat_Support - Decreasing_Coalition_Combat_Support) * dt
INIT Coalition_Combat_Operations = 1
INFLOWS:
 - ↔ Increasing_Coalition_Combat_Support = Coalition_Combat_Support_Compounding_Factor
- Host_Nation_Security_Forces(t) = Host_Nation_Security_Forces(t - dt) + (Training_HN_Security_Forces + Gaining_HN_Security_Forces_due_to_HN_Capacity - Loosing_HN_Security_Forces) * dt
INIT Host_Nation_Security_Forces = 10
INFLOWS:
 - ↔ Training_HN_Security_Forces = HN_Security_Forces_Compounding_Factor*Coalition_Combat_Operations
 - ↔ Gaining_HN_Security_Forces_due_to_HN_Capacity = HN_Security_Capacity_Factor
- Coalition_Combat_Support_Draining_Factor = .19
- Percentage_CI_to_Security = Coalition_Investment*CI_to_Security*(1/100)
- Coalition_Combat_Support_Compounding_Factor = GRAPH(Percentage_CI_to_Security*Insurgent_Activities*(1/20))
 - ↘ (0.00, 0.00), (10.0, 5.00), (20.0, 10.0), (30.0, 15.0), (40.0, 20.0), (50.0, 25.0), (60.0, 30.0), (70.0, 35.0), (80.0, 40.0), (90.0, 45.0), (100, 50.0)
- HN_Security_Forces_Draining_Factor = GRAPH(Popular_Support_for_Host_Nation)
 - ↘ (-100, 0.5), (-80.0, 0.444), (-60.0, 0.376), (-40.0, 0.314), (-20.0, 0.248), (0.00, 0.17), (20.0, 0.14), (40.0, 0.118), (60.0, 0.095), (80.0, 0.0748), (100, 0.05)
- HN_Security_Capacity_Factor = GRAPH(Host_Nation_Capacity)
 - ↘ (0.00, 0.00), (10.0, 0.5), (20.0, 1.00), (30.0, 1.50), (40.0, 2.00), (50.0, 2.50), (60.0, 3.00), (70.0, 3.50), (80.0, 4.00), (90.0, 4.50), (100, 5.00)
- HN_Security_Forces_Compounding_Factor = GRAPH(Host_Nation_Security_Forces)
 - ↘ (0.00, 0.00), (10.0, 0.05), (20.0, 0.1), (30.0, 0.15), (40.0, 0.2), (50.0, 0.25), (60.0, 0.3), (70.0, 0.35), (80.0, 0.4), (90.0, 0.45), (100, 0.5)

Not in a sector

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Vita

Biographical Sketch

Captain Ferdinand Maldonado graduated from Thomas Armstrong High School in Ponce, Puerto Rico. He then was accepted to the University of Puerto Rico, Mayaguez Campus for his undergraduate studies, where he graduated *Cum Laude* with a Bachelors of Science in Mechanical Engineering. In January 2004, he was commissioned as a Second Lieutenant in the United States Air Force through the Air Force Reserve Officer Training Corps as a Distinguished Graduate.

His first duty station was to the 27th Civil Engineer Squadron, Cannon Air Force Base, New Mexico where he was assigned the duties for Project Programmer, Community Planner, and Deputy Engineering Flight Commander. While at this assignment, he was deployed for a 365-day tour as Civil Affairs, Engineer Team Leader to Provincial Reconstruction Team - Qalat, Zabul Province, Afghanistan. Captain Maldonado was selected as the Air Force's 2007 recipient of the Major General Eugene A. Lupia Award for outstanding military manager. He was also chosen to complete his Master of Science degree in Engineering Management at the Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, where he is expected to graduate in March 2009.

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