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THESIS

AN APPLICATION OF THE MCES TO THE
POLITICAL ASPECTS
OF SDI

by

Colleen McFadden

September 1987

Thesis Advisor Michael G. Sovereign

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An Application of the Modular Command and Control
Evaluation Structure (MCES) to the Political Aspects
of the Strategic Defense Initiative (SDI)

by

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Lieutenant, United States Navy
B.S., United States Naval Academy, 1981

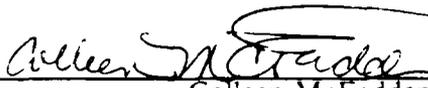
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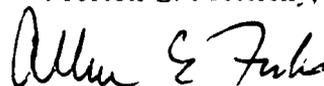
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TABLE OF CONTENTS

I.	INTRODUCTION	9
	A. BACKGROUND	9
	B. THESIS STRUCTURE	10
II.	THE SOVIET VIEW OF DETERRENCE	12
	A. CULTURAL AND CONTEXTUAL FACTORS	12
	B. SOVIET MILITARY STRATEGY	14
	C. SOVIET VIEW OF SDI	17
	D. SOVIET TECHNOLOGICAL AND MILITARY RESPONSES	19
	1. Emulation of U.S. Defensive Capabilities	19
	2. Evasion of Selected SDI Components, Including Passive Means	23
	3. Rendering SDI Ineffective by Active Means	24
	E. SOVIET POLITICAL RESPONSES TO SDI	24
	1. Soviet Propaganda Campaign	25
	2. Economic Factors	26
	3. Arms Control Negotiations	27
	4. Wait and See	27
	F. SUMMARY	28
III.	MCES BACKGROUND	29
	A. WHAT IS THE MCES?	29
	B. MODULE 1: PROBLEM FORMULATION	30
	C. MODULE 2: C2 SYSTEM BOUNDING	30
	D. MODULE 3: PROCESS DEFINITION	30
	E. MODULE 4: INTEGRATION OF STATICS AND DYNAMICS	31
	F. MODULE 5: SPECIFICATION OF MEASURES	31
	G. MODULE 6: DATA GENERATION	33

	H.	MODULE 7: AGGREGATION OF MEASURES	33
	I.	SUMMARY: WHY THE MCES?	33
IV.		APPLICATION OF THE MCES TO OVERALL SDI ISSUES	34
	A.	INTRODUCTION	34
	B.	MODULE 1: PROBLEM FORMULATION	34
	1.	Workshop Results	34
	2.	Effects of Soviet Ideology and New Results	36
	C.	MODULE 2: SYSTEMS BOUNDING	37
	1.	Workshop Results	37
	2.	Effects of Soviet Ideology and New Results	39
	D.	MODULE 3: PROCESS DEFINITION	40
	1.	Workshop Results	40
	2.	Effects of Soviet Ideology and New Results	42
	E.	MODULE 4: INTEGRATION OF STATICS AND DYNAMICS	43
	1.	Workshop Results	43
	2.	Effects of Soviet Ideology and New Results	44
	F.	MODULE 5: SPECIFICATION OF MEASURES	45
	1.	Workshop Results	45
	2.	Effects of Soviet Ideology and New Results	46
	G.	MODULE 6: DATA GENERATION	47
	H.	MODULE 7: AGGREGATION OF MEASURES	48
	I.	SUMMARY	49
V.		DEVELOPMENT OF MEASURES	50
	A.	INTRODUCTION	50
	B.	PERCEPTION - THE PROPAGANDA CAMPAIGN	51
	C.	STABILITY - ECONOMIC SHIFTS	52
	D.	LEVERAGE - ARMS CONTROL NEGOTIATIONS	54
	E.	SUMMARY	54
VI.		CONCLUSIONS AND RECOMMENDATIONS	56
	A.	CONCLUSIONS	56
	B.	RECOMMENDATIONS	56

APPENDIX: MCES FIGURES	58
LIST OF REFERENCES	66
INITIAL DISTRIBUTION LIST	68

I. INTRODUCTION

A. BACKGROUND

From the moment President Ronald Reagan announced the "Star Wars" concept in 1983, numerous evaluation issues concerning the Strategic Defense Initiative (SDI) have been discussed, including measures of force effectiveness, policy or political effectiveness, effectiveness, and performance. In this regard, a workshop was held from 9 - 11 September 1986 to discuss the evaluation problems. Participants included both SDI and Modular Command Control Evaluation Structure (MCES) experts, who were charged with "using the MCES to develop measures for evaluation within four critical SDI arenas:

- 1) Overall SDI Architecture
- 2) Key Architectural Trade - offs
- 3) B.M. C3 Systems
- 4) SDI Software

[Ref. 1: p. i].

The workshop established, from its very beginnings, that the current goal and primary measure of policy effectiveness of the SDI research program is deterrence [Ref. 1: p. i]. A logical extension, then, is that the primary goal is to deter the Soviet Union and the spread of communism. In this sense, it is imperative that the idea of deterrence be approached, not from the point of view of the United States, but from the point of view of the Soviet Union. The decision and policy makers in the Soviet Union, because of their historical perspective, cultural environment, contextual and political system differences, and their basic ideological differences, view deterrence not as Mutually Assured Destruction (MAD.) or even as defense against MAD, as the United States does. Rather, the Soviet political machine views deterrence as their ability to possess adequate military strength to maintain an offensive capability, in order to retain their ideology and continue to instil world communism. [Ref. 2]

It is with this mindset that the efforts begun by the Overall SDI Architecture working group, under the leadership of Dr. Thomas P. Rona, Office of Science and Technology Policy, and composed of this author, Dr. Ricki Sweet, of Sweet Associates, CAPT K.M. Duff, USN, of Naval Space and Warfare Command (NAVSPAWAR), MAJ

Bernard Galing, USA, of TRADOC Research and Education Management (TREM), CAPT Ingabee Stone, USAF, of HQ SAC SICCP, Offutt AFB, and Dr. Michael Melich, of the Naval Postgraduate School, will be continued in this thesis. The MCES will be applied to the overall political aspects of SDI, working towards the development of political effectiveness measures. Since none of the working group members are Sovietologists, it is logical that they approached these measures from standpoint of U.S. national goals and decision makers objectives, developing possible measures of political effectiveness in their infancy. The decision makers referred throughout the workshop, as well as throughout this thesis, were assumed to be those members of the SDIO staff who will recommend development nondevelopment of the SDI system, to Congress in 1990. This thesis will present the results of the workshop, modified to reflect the Soviet political and technological strategy. With these results, this thesis will attempt to quantify at least one of the five Workshop MOPEs, perception, through a surrogate measure of effectiveness, the success of the Soviet U.S. propaganda campaign. Surrogate measures will also be developed for the stability and leverage MOPEs, with further discussion on means of quantifying each. The expected outcome, then, of this thesis is at least one quantitative or qualitative measure of effectiveness, designed to assist the SDI decision makers with the 1990 development decision. It is imperative to keep in mind that SDI is only a research program at this time, and if as such it is forcing Soviet responses, political and or technological, then it has some measure of effectiveness, simply as a policy making tool. While the political effectiveness of a prolonged research program in the area of ballistic missile defense, without any commitment to development, will eventually fade, it could be sufficient to convince Congress to allocate appropriate funding, allowing development to follow.

B. THESIS STRUCTURE

The remainder of this thesis will be structured as follows. Chapter 2 will provide a background on: Soviet contextual, ideological, and political differences as they apply to the Soviet view of deterrence; the Soviet concept, as opposed to the U.S. concept, of SDI; and Soviet political/technological responses to SDI. Chapter 3 will present the current evolution of the MCES methodology. In Chapter 4, the MCES methodology will be applied to the political aspects of SDI, modifying the workshop results as necessary to incorporate the Soviet background information presented in Chapter 2. The outcome of this chapter will be five MOPE's, along with three surrogate measures.

Chapter 5 will further develop three of the measures presented in Chapter 4, and will present a means of quantifying these measures. Chapter 6 will contain conclusions and recommendations.

II. THE SOVIET VIEW OF DETERRENCE

This chapter is designed to provide background knowledge concerning: the psychological factors that affect Soviet military strategy; what the current Soviet military strategy is; how this affects the Soviet interpretation of SDI; and possible Soviet political and technological responses to SDI. Several of these issues will be discussed in greater detail in later chapters.

A. CULTURAL AND CONTEXTUAL FACTORS

Beneath every nation's military strategy, at the most basic level, is the psychological makeup of the men that determine the strategy. Given a culture and political system as radically different from ours as the Soviet Union's is, it becomes even more important to avoid "mirror imaging," particularly when considering a topic like deterrence. Therefore, in order to fully comprehend the Soviet concept of deterrence, it is essential to understand the Soviet mentality that produces its military strategy.

One reason why the U.S. has such great difficulty understanding the Soviet Union, and therefore the Soviet military strategy, is that the U.S. and Soviet societies are based on vastly different contextual concepts. The U.S. society has always been an individualistic one. Personal goals and a free lifestyle are essential to the American society. As such, the individualistic nature lends itself to a rather quick decision making process, in both the civilian and military arenas. The U.S. society has been termed a "low - context" society. Conversely, the Soviet society is a collective one, where interrelationships are of key importance. Instead of working towards personal goals, the Soviet society tends to "pull together" in order to fulfill the larger goals of socialism. The decision making process is slow, thoughtful, and binding. After a decision has been made, there is no contention from either the civilian or military sectors. The term applied to this type of culture is "high - context" society.

Considering its Marxist - Leninist ideology, it is reasonable that the Soviet Union is a high - context society, both psychologically and culturally. Everything that is done in life is done for the good of the collective, whether the collective is merely a village, a town, or the Communist Party itself. Mirror imaging would lead us to believe that the

actual people of the Soviet Union are very much like the people of the U.S. We assume the people are loyal Russians, that they love their country, relationships, villages. In reality, though, the loyalty we perceive is more of a fear of challenging the political system. In daily life, possibly the strongest feelings are ones of survival, a desire not to stand out in a crowd. In general, feelings of paranoia pervade. [Ref. 3]

These paranoid attitudes are as deeply rooted in the Soviet political system as they are in daily life. Soviet history is full of attacks from foreigners, but selectively omits Soviet invasions of other lands. The Soviets believe Europe owes its progress to Russia, for absorbing the Tartar attacks. Likewise, the Soviets see the allied victory in Europe during World War II as being completely due to Russian blood, shed on Russian soil. History has basically been rewritten to ensure the concept of loyalty to the motherland is passed from generation to generation.

The value of human life is radically different in the Soviet Union. One reason why survival is essential is that throughout history the Soviets have killed hundreds of thousands of their own people through purges. Additionally, from the point of view of the average soldier, schooled from birth in Marxist - Leninist ideology, it is much easier to die for the survival of the collective than to die as an individual. As a result, the Soviet soldier is able to perform his duties under conditions of which an American couldn't dream. Morale is seen not as concerning health, welfare, and attitude of the individuals comprising the armed forces, as in the U.S., but rather as the ability to perform the mission in the most adverse situations, including the face of death. At the same time, while the Soviets appear so callous about the value of human life, they are appalled by the U.S.'s extensive use of bombing in a wartime situation and the "useless" deaths of civilians. These attitudes will greatly affect how a war is planned for, and how those plans are executed.

Two other areas of perceptual differences between the U.S. and the Soviet Union are space, or territory, and time. The question of space translates to what will be defended in the event of war. To the Soviets, it is clear that the motherland must survive. The U.S. is more fractionated. Not only do the continental states, Hawaii, and Alaska need defending, but also U.S. territories and allied nations, particularly those in the NATO alliance. However, with the clear objective of motherland defense in mind, the Soviet Union can take the time required to thoroughly plan its strategy and doctrine. In a high context society like the Soviet Union, there is no time limit. War is planned for as an event of the future, in such a way that doctrine or strategy presently being written indicates technology trends for the future.

Soviet military doctrine is affected greatly by political culture, space, time, human life value, history, and survival of the mother Russia. Soviet planners consider these aspects extensively when determining how to fight a war. While this section provided a framework for the psychological makeup of those determining the military strategy, the next section will discuss the actual evolution of modern Soviet military strategy.

B. SOVIET MILITARY STRATEGY

Marxist - Leninist ideology is at the very soul of Soviet military strategy. One of Marx's fundamental beliefs was that all wars are political. The study of war begins with the study of classes and economic status. War is dictated by politics. Marx also believed that there is a scientific approach to fighting and winning a war. As such, the Soviets classify wars according to:

- 1) political nature - just (furthering the spread of communism) or unjust (any capitalistic provoked war.)
- 2) class makeup of belligerent sides - all wars are class wars.
- 3) size of conflict.
- 4) means of armed struggle [Ref. 2: p. 75].

The ideological side of Soviet strategy has changed little since the days of Lenin.

In fact, the only significant changes in Soviet military strategy occurred after the death of Stalin in 1953. Stalin maintained that the way to win a war was through conventional strength, meaning a large, well equipped army and a modern navy with large ships. After his death, though, Khrushchev was quick to deemphasize the conventional aspect of war and shift Soviet military strategy to the nuclear realm. Marshal Sokolovsky has been credited with writing Khrushchev's new strategy in his "Strategia." The major strategic concepts presented by Sokolovsky include:

- 1) surprise, global, unlimited, short nuclear war
- 2) theater war escalates quickly to nuclear war
- 3) no significance of economy of force
- 4) no partial victory
- 5) strategic deployment is impossible
- 6) maneuver only to consolidate victory
- 7) troop control is problematical
- 8) Soviets have a disadvantage in logistics, weaponry
- 9) reserves used only to consolidate victory
- 10) strategic offense, surprise nuclear strikes mandatory
- 11) strategic defense translates to guaranteed defeat [Ref. 4.]

During Breshnev's era, significant strategic changes again occurred in the concepts of conventional phases and strategic defense. Col. Gen. Gareyev published these changes in his M.V. FRUNZE: MILITARY THEORIST, arguing that:

- 1) conventional phase occurs before or after nuclear strike
- 2) long, conventional phase possible in theater war
- 3) economy of force necessary for reserves, deterrence
- 4) partial victory significant since can lead to strategic win
- 5) strategic deployments necessary, must be solved
- 6) rapid, deep maneuver groups required
- 7) new methods of troop control required
- 8) logistics weapons are a Soviet advantage in conventional war
- 9) reserves are essential echelon back - ups
- 10) strategic offense should be three dimensional
- 11) strategic defense is significant [Ref. 5.]

The Soviet commitment to strategic defense can actually be traced back to two years after the Cuban missile crisis, when MAJ GEN Nikolai Talenskii stated that "when the security of a state is based only on mutual deterrence by means of powerful nuclear missiles, it is directly dependent on the good will and designs of the other side, which is a hugely uncertain premise. It would hardly be in the interests of any peaceloving state to forgo the creation of it's own effective means of defense against nuclear - missile aggression [Ref. 6: p. 16]." Strategic defense, while not considered an independent wartime mission, is considered to be "an independent form of combat...(and) as an integral part of the broader Soviet 'all - arms' philosophy, which insists that no single service or weapon can, by itself, secure victory [Ref. 6: p. 12]." The Soviet National Air Defense Forces (PVO), according to Marshal Kulikov, "must ensure the protection of the country and armed forces from air and nuclear - missile attack...and prevent strikes on the most important objectives [Ref. 6: p. 13]."

These published accounts of Soviet strategy give clear evidence that the Soviet Union fights a war in order to win. Whereas the U.S. and NATO will tend either to fight to a certain point, gaining superiority, then negotiate for peace, or stop fighting after a nuclear exchange, the Soviet Union plans to begin fighting after the allied forces stop. Since the Soviets believe any war between the superpowers will be the final battle between socialism and capitalism, and therefore will be a fight to the finish in which nuclear war is inevitable, they have planned their strategy to include a post - nuclear exchange.

The key points of Soviet military strategy can be summarized as follows:

- 1) A war between the West and Soviets will be decisive and for the domination of the World. The failure of deterrence is inevitable and nuclear escalation will eventually result.
- 2) The "Law of Victory" is the objective of war.
- 3) Victory is achieved only by decisively defeating the enemy militarily, by destroying his armed forces with decisive blows executed according to a single strategic concept by all available forces and weapons.
- 4) To win the Soviets must limit damage to the USSR homeland, with counterforce strikes by strategic defense forces - air, missile, space, ASW, and civil defense - which are designed to ensure the viability of assets required to prosecute the war after the first strike. The U.S. NATO alliance must be broken.
- 5) The war may be started by a surprise attack, either conventional or nuclear, and most likely the war will be brief.
- 6) It would be a just war for the Soviets and an unjust war for the West. While the Soviets reject the idea of their attacking out of the blue, they do believe that victory in a nuclear war is best ensured by preempting the enemy's nuclear attack.
- 7) Victory is a feasible outcome of a nuclear war. [Ref. 7]

Deterrence, then, in light of the Soviet military strategy, put forth in [Ref. 2] and [Ref. 7.] has a different meaning in the U.S. than in the Soviet Union. The U.S. views deterrence as each side possessing the ability to destroy the other, and therefore neither will, making deterrence a two - sided effort. As described in [Ref. 2,] [Ref. 3.] and [Ref. 7,] the Soviets see deterrence as one - sided. The Soviet view of war as never ending, until capitalism and its forces have been defeated, dictates that the Soviet military must make war unprofitable for the coalition of U.S. and NATO forces. The Soviets, though, have historically seen themselves as technologically inferior to the Western world, and now maintain the belief that only by achieving superiority in nuclear and non - nuclear forces can the U.S./ NATO alliance be deterred from attacking. As described in [Ref. 7.] the Soviets see this superiority, and therefore stability, as attainable only through a constant massing of troops and weapons. Given the pervading paranoia of Soviet decision makers, it is clear that the Soviets will never accept that they have attained equanimity, let alone superiority, in the arms race. In fact, SDI greatly threatens the stability of deterrence from the Soviet point of view, as will be explained in the next section.

C. SOVIET VIEW OF SDI

COL M. Sergeyev, writing in AVIATSIYAI KOSMONAVTIKA, the Soviet equivalent of AVIATION WEEK AND SPACE TECHNOLOGY, declared "the aggressive plan to militarize space announced by U.S. President Ronald Reagan represents a serious danger to mankind...according to this sinister strategy, plans to build a total anti - ballistic missile (ABM) defense system are being devised [Ref. 8]." Obviously the Soviets do not accept SDI as a research or technical feasibility study, as stated in the President's initial proposal. Rather, the Soviets see SDI as a U.S. attempt to develop a system that would enable "a nuclear first strike capability against the Soviet Union [Ref. 6: p. 3]." Furthermore, the Soviets discount U.S. claims that SDI is designed to eliminate the need for nuclear weapons worldwide. Instead, they believe SDI is aimed at depriving the Soviet Union of any retaliatory capability, and thus any deterrent to vouchsafe its own security [Ref. 6: p. 5]."

Considering the Soviet inferiority complex, their interpretation of the intent of SDI could have been anticipated, had Reagan's announcement not surprised both the U.S. and Soviet buracracies. Beyond the anti - U.S. rhetoric, however, the Soviets are genuinely threatened by SDI, believing that SDI is an actual weapon system development project, rather than the research program the U.S. claims it is. This point of contention is significant since the 1972 ABM treaty allows research in the area of ballistic missile defense. While the Soviets cannot contest this issue, they can and are protesting any development or testing of an actual SDI system, or system components, as a blatant treaty violation. The Soviet view is supported in [Ref. 8] by COL Sergeyev's description of the SDI system. The article is paraphrased in the following five paragraphs, as it provides a framework for the Soviet perception of the system that will drive their political and technological responses.

The Soviet article states that, according to Pentagon strategists, the "space echelon" of an ABM defensive system will be assigned the primary mission of destroying targets at several points. Missiles would be destroyed in the powered flight phase, essentially over the Soviet homeland; in the trajectory phase, where warhead separation occurs; and in the mid - course phase of the flight trajectory, above the atmosphere. The degree of effectiveness projected for this system is estimated to include a ninety nine percent intercept rate of launched warheads. Space weapons strike systems, based on new physical principles and with advanced means of target surveillance, tracking, and selection, will be heavily used.

Based on reports in the foreign press, the Soviets believe the "space echelon" will be based on orbital combat stations at altitudes ranging from a few hundred to a few thousand kilometers (km.) Laser and beam weapons, electromagnetic cannons, conventional warhead missiles and orbital mirrors for the redirection of electromagnetic waves will be carried on the combat stations. They estimate one hundred orbital combat stations, each with the capability of destroying fifty to one hundred targets, will be sufficient to insure the interception of missiles during the powered and mid - course flight phases. Of these one hundred stations, the Soviets estimate between fifteen and thirty percent of them will be over enemy territory at any given time. The remainder will be out of detection range of the intercontinental ballistic missile (ICBM) deployment areas, to be used primarily for intercepting submarine launched ballistic missiles (SLBMs) and separate ICBM warheads.

The Soviet article states that an X - ray laser with a nuclear initiator charge that forms and shapes beamed coherent X - ray emissions will be carried on an orbital combat station. A system to detect targets and direct the beams to the targets will also be carried. In addition to the X - ray laser development being conducted at the Livermore Radiation Laboratory, accelerated efforts are underway to develop infrared - band chemical lasers. The chemical lasers can be used repeatedly, an advantage over the X - ray lasers, which self - destruct from the the detonation of the nuclear initiator charge. Plans also exist to test free - electron lasers, to be used in conjunction with a system of space mirrors.

The article cites development efforts underway at Los Alamos on the development of space - based accelerator weapons. Beams of neutral particles, possibly hydrogen particles, produced by compact orbital - based accelerators, will be able to destroy satellites, ballistic missiles, and their warheads, at ranges in excess of 1000 km. By the early 1990's, the accelerator size could be sufficiently reduced to enable its placement in orbit. In order to destroy warheads in the mid - course phase, the electromagnetic cannon, based on an electro - dynamic mass accelerator (EDMA) will be used. A space - based EDMA, weighing between twenty five and one hundred fifty tons, might be capable of firing one projectile per second. This technology, contracted to Westinghouse, Aerojet, and General Dynamics, has produced experimental EDMA's with accelerated projectiles of up to 4.5 km/s.

The article concludes with brief statements on the use of the Space Shuttle for orbital placement of the system components and the development of new technology in

surveillance, target detection, discrimination, selection, aiming, and guidance of orbital interceptors. Additionally, comments are made on infrared detectors, highly sensitive radiometric and spectrometric sensors, optical detecting devices, synthetic - aperture microwave radars, and ultra - violet detection and ranging equipment to perform target tracking and selection. [Ref. 8]

While the article is certainly not the most accurate portrayal of ongoing research in the SDI field, it is significant for several reasons. First, it publicly states the Soviet view of SDI technology being explored. Second, it relates research development projects that, when operational, will be clearly in violation of the ABM treaty. The Soviet culture, which has a way of rationalizing their own illegal efforts, may accept this research as a validation of their own treaty breaking programs. Finally, it provides the framework for the technological and political responses discussed in the next sections.

D. SOVIET TECHNOLOGICAL AND MILITARY RESPONSES

This section provides background information on actual and predicted Soviet technological responses to a greater perceived threat from the U.S. The information is provided primarily as an indication of actual Soviet intentions, despite their rhetoric. The Soviet Union is clearly "not sitting idly by while the U.S. strives to gain strategic superiority [Ref. 6]."

Given the SDI conceptual background, a great deal of speculation on or interpretation of Soviet responses could be undertaken. However, in an attempt to focus on the ongoing development efforts with ties to the SDI research program, this section will discuss the following technological and military responses, grouped into the following categories by [Ref. 9.] The categories are: emulation of U.S. defensive capabilities; evasion of selected SDI components, including passive means; and rendering U.S. SDI ineffective by active means. It should be noted that, while all of these are possible responses, they are not all equally likely. Speculation by U.S. analysts does not necessarily consider the Soviet view of deterrence, or the avowed position that the Soviets will not let the U.S. determine their military budget.

1. Emulation of U.S. Defensive Capabilities

a. Space - based Components, Especially DABM

Moscow's determination to match any U.S. use of space for expanded strategic defense purposes justifies, in their minds, Soviet efforts to procure a major space - based defensive system. The Soviet defensive antiballistic missile (DABM)

system, however, would be different from SDI for several reasons. U.S. quality control and technological superiority would be most evident in the space arena. Some estimates predict the Soviet DABM system would have more of a manned component. Secondly, the ballistic missile threats of the two systems are different. While the U.S. ICBM force is less fractionated than the Soviet Rocket Force, the U.S. SLBM threat is highly MIRVed, and Trident II will provide ICBM like accuracy and range, combined with the appearance of possibly twenty deployed missile fields, in separate locations. Unless U.S. offensive posture radically changes before the turn of the century, the Soviets are expected to pursue a kinetic energy type DABM. Since a necessary corollary to DABM would be a capability to immediately track missile plumes with a high degree of accuracy, the problem of partially unloading an SLBM would be aggravated. [Ref. 9]

One other space - based component worthy of discussion is the antisatellite (ASAT.) While the Soviet Union goes to great efforts to demonstrate that the U.S. is involved in more than research for SDI, typically citing the ongoing testing of the F - 15 ASAT prototype, they neglect to mention their own pacesetting work in ASAT technology, and specifically that they currently maintain the only existing operational ASAT. In fact, "the Soviet Union has had an operational capability to intercept and destroy satellites in low orbit since the 1970's [Ref. 6]." The Soviet ASAT is coorbital, usually requiring one to four orbits to position itself near the target, therefore taking between one and five hours to achieve lethal positioning. It then detonates, similar to a space mine. While it is purportedly behind the U.S. in technology, it is deployed on two launch sites at the Tyuratam Missile Test Center, and does pose a threat to low earth orbiting satellites.

b. Defense against U.S. Air - Breathing Threats

In the area of defense against U.S. air - breathing threats, all publicly available evidence suggests that the Soviet IL - 76 based air defense system Mainstay is much less capable than either the E - 3A Sentry or the E - 2C Hawkeye. The Mainstay has been compared to the EC - 121 early warning system, rather than to a second generation AWACS system. Given this, the main technical changes facing Soviet air defenses are : reduced signatures; increased penetrativity and standoff range posed by missile carrying aircraft; and increasingly deadly defense suppression capabilities. The use of air defense lasers, very long - range interceptors and SAMs, and high value interceptors, all of which are currently in development, will help in the fulfillment of these goals. [Ref. 9]

c. Ground Based ABM Capabilities

While the Soviet Union is quick to criticize the U.S. SDI research program, they neglect to point out that their own ABM program has been ongoing since 1957. Khrushchev stated in September 1961 that "at the same time we told our scientists and engineers to develop intercontinental rockets, we told another group to work out a means to combat such rockets [Ref. 6]." Initial tests of the first - generation Soviet ABM began in 1957, the same year the Soviet Union launched its first ICBM. Marshall Malinovskii announced at that 22nd Party Congress that "the problems of destroying missiles in flight...has been successfully solved" [Ref. 6.]

The Breshnev regime authorized full - scale development of an ABM site around Moscow, and by 1968, the Soviet Union could claim the world's first functioning ABM, with the initial operation capability of the GALOSH system. Construction, however, was stopped with Soviet interest in Strategic Arms Limitation Talks (SALT) with the United States, and indications are that there were serious doubts about the operational prospects of GALOSH, specifically when compared to the U.S. more sophisticated, two - layered ABM based on Spartan and Sprint. (The U.S. Mickelson ABM complex at Grand Forks, South Dakota, was dismantled in 1975, soon after completion, due to cost constraints.) Construction was resumed in 1971 on the Moscow ABM and, prior to the conclusion of SALT I, it was deployed with sixty four launchers. The system consisted of the ABM - 1B, deployed around Moscow in four complexes of sixteen reloadable launchers. The reload capability, however, was so slow that it would not be of much use in combat. The Moscow ABM system provided a single - layered defense of the Moscow NCA against a light ballistic missile attack. Despite the deactivation of half the launchers in recent years, the system has undergone constant technological upgrades since 1980, and when completed, will offer a two layered defense consisting of a total of one hundred improved ABM - 1 exoatmospheric interceptors and ABM - X - 3 endoatmospheric interceptors, both of which will be silo based with an expected reload capability. [Ref. 6]

The Moscow ABM system is supported by an extensive layered warning network. The first level is composed of missile launch detection satellites that can provide up to thirty minutes warning of impending attack. The second level consists of a line of over - the - horizon (OTH) radars directed toward U.S. ICBM fields. This level can also provide up to thirty minutes warning. Both systems are backed up by six peripheral phased array radars for attack characterization. Additionally, construction

is underway on a large phased array radar in Siberia to fill any holes in the existing coverage capability.

Soviet testing of the SA - 10 and SA - X - 12 missiles suggest possible ABM applications, and while they do not provide a significant threat to U.S. ICBMs because of their limited capability against high speed reentry targets, they could be able to intercept SLBM warheads that are slower and present larger radar signatures. The SA - X - 12 has been successfully tested against the Soviet SS - 4 Medium Range Ballistic Missile (MRBM.) [Ref. 6]

Along with the pioneering work in the ABM field, the Soviet Union has shown considerable interest in the long term potential of lasers and directed energy. LCOL O. Andreev stated in "Possible Military and other uses of Lasers," published in 1965, that "if a method of focusing large amounts of energy over considerable distances is developed, it will be possible to resolve many scientific and technical questions, and especially the problem of destroying intercontinental missiles [Ref. 6]."

Soviet laser research can be traced to at least the early 1960's. The USSR currently maintains approximately six research and development facilities and test ranges dedicated exclusively to laser research. Intelligence reports indicate work on gas dynamic, electric discharge, and chemical lasers, and their potential weapons applications. A ground based laser exists at the Sary Shagan BMD test center, capable of interfering with U.S. satellites in low earth orbits [Ref. 6.] In addition to the laser development efforts, the Soviets have ongoing research into kinetic energy concepts with a potential BMD role.

d. Other Areas

Additional areas of emulation are Civil Defense, anti - submarine and anti - maritime capabilities, and special forces attacks. Of these, civil defense and special forces are the most significant. A comprehensive civil defense plan currently exists for the Moscow area, and while it would need significant revision, would enable the Soviets to regroup even after the effects of SDI. The Soviet Union enjoys a tremendous advantage, compared to the U.S., in the areas of population protection (by a combination of sheltering and dispersal,) industrial hardening, and redundancy, therefore allowing the nation to survive "a major nuclear campaign with significant percentages of leadership, military control, and labor forces intact, even in the face of deliberate U.S. responsive targeting strategies [Ref. 9]." Despite the fact that the U.S. has an advantage in the areas of transportation, food, and medical supply availability,

our low - context society would yield individual civil defense plans rather than collective.

Given the nature of security surrounding the perimeters of the Soviet Union and United States, the Special Forces of the Soviet Union would have a greater advantage in the area of border penetration, weapons infiltration, and peacetime covert or terrorist type operations [Ref. 9.] Covert forces could then gain access to U.S. defensive forces prior to their deployment, in line with the Soviet preemption strategy. Considerable speculation has been made concerning the possible Soviet covert role in the launch problems plaguing the U.S. space program.

2. Evasion of Selected SDI Components, Including Passive Means

a. Neutralizing a Joint U.S. Offense/SDI Posture

Since the Soviets believe the U.S. will launch a first strike and that SDI is not a defensive system, they seek to escape this scenario in several ways. These include: a propaganda campaign during SDI development culminating in program delay or cancellation; concealment of the location, number, and type of offensive forces; superhardening, mobility, and concealment; active defense of Soviet offensive forces; preemptive attack against U.S. offenses.defenses, particularly as SDI is being deployed; and the adoption of a launch - on warning doctrine. [Ref. 9]

b. Evading SDI with Long Range Missiles/Alternate Attack Means

SDI can also be evaded by Soviet employment of a program to combine ICBM hardening; the used of decoys, chaff, and aerosols; rotation of boosters during climb out phase; increasing reflectivity of boosters; fast booster burn; depressed trajectories; fractional orbits; and many others. The possibility also exists that alternate delivery concepts not vulnerable to the boost phase intercept defense now envisioned could be developed. The Soviets appear to be moving in this direction with the development of single RV mobile ICBMs, new sea - based ballistic missiles, the Blackjack bomber, and air and sea - based cruise missiles. [Ref. 9]

c. Evading SDI as a Whole

A final way of evading SDI by passive means is proliferating offensive forces. If developing a defense system costs too much, given the already strained Soviet economy, the Soviets might opt instead to buy enough extra weapons to render SDI less effective.

3. Rendering SDI Ineffective by Active Means

a. Interfering with SDI Deployment

Since the deployment of such a complex system as SDI will take considerable time, there will be a period during which major gaps in defense will exist. During this time, Soviet attacks as a part of a preventive campaign could be expected, as their military strategy allows for preemptive strikes. The possibility of an all out nuclear attack, however, is slim, but cannot be discounted. Attacks on U.S. space launch facilities would be feasible, as well, and could conceivably already be underway. Attacks on key facilities during the acquisition phase would also be possible, as would covert attacks on antennas, radars, propellant facilities, assembly areas, etc., which could be sufficiently masked to prevent being traced back to the Soviet Union, thereby evading U.S. reprisals. [Ref. 9] Perhaps the most likely interference from the Soviet Union would be ASAT or space mine attacks on research and development platforms during the SDI testing phase. These attacks would deter or greatly inhibit deployment. The expected U.S. response, in the eyes of the Soviets, would be nil, since no human lives would be involved.

b. Suppressing U.S. Defensive Weapon Satellites

While this type of action is a function of the particular type of weapons platforms deployed, it is reasonable to expect some "hole - poking" in the defense. If the weapons are only operational over intended targets, the Soviets could disable part of the DABM constellation and then exploit these gaps by launching strikes through the holes. [Ref. 9]

c. Other Possibilities

Other possible areas of actively defeating SDI prior to its full deployment are highly speculative. However, such areas as disrupting battle management, command and control; the gradual degradation of U.S. strategic defenses; disrupting SDI exercises; diverting SDI assets away from strategic defense; and sabotage [Ref. 9] could be exploited by the Soviet Union with existing or future technology.

E. SOVIET POLITICAL RESPONSES TO SDI

The very nature of the Soviet closed society makes it difficult for the West to learn of Soviet political shifts. However, the Soviets, uncharacteristically, have been overwhelmingly vocal about SDI, enabling some measure of the Soviet political response to be made. This section will provide background information on the trends

observed so far concerning the areas of propaganda, economics, technological infeasibilities for the U.S., and arms control negotiations. In later chapters, the application of the MCES to the overall SDI political issues, with several of these issues expanded upon as necessary, will yield possible measures of political effectiveness.

1. Soviet Propaganda Campaign

By far the most observable Soviet response to SDI has been their propaganda campaign. The Soviets have mounted an almost unprecedented anti - SDI propaganda campaign, aimed at destroying SDI in the conceptual phase, prior to its becoming a tangible threat. The campaign is designed not only to "foment domestic opposition to SDI both within and outside the U.S. defense community," but also to drive a wedge between the U.S. and NATO allies [Ref. 6: p. 39].

For the Americans, the Soviet propaganda barrage is playing on our traditional peacetime values and anti - military sentiments. The United States has, throughout history, been a nation that almost completely demobilizes after a major war, only to arm ourselves again in the face of the next major crisis. Some sectors of the American public have already had great difficulty accepting Reagan's massive military growth programs. Taking advantage of this, Soviet propagandists have exploited the SDI research program, going to great lengths to prove that the program has gone beyond research, thereby constituting a violation of the 1972 ABM treaty [Ref. 6: p. 6]. Additionally, recognizing the American public's acceptance of "arms control" as an inherently good concept, the Soviets have caused dissent by stating that SDI will bring the world closer to nuclear war through an "intensified arms race affecting the stability of the strategic balance [Ref. 6: p. 4]." Such rhetoric has resulted in significant public questioning on whether SDI really is a system to develop world peace or whether it will instead lead to world instability.

While the Soviet's American propaganda campaign is designed to appeal to the public's conscience, the European campaign is designed to misrepresent SDI in order to incite the fears of the NATO allies. In addition to providing publicity to American SDI critics like Kostas Tsipis, Carl Sagan, Hans Bethe, and Paul Warnke [Ref. 6: p. 7], the Soviets are repeatedly publicizing European concerns that an effective ABM system will decouple the U.S. nuclear deterrent from Europe's defense. Vladimir Bogachev stated in TASS that the Europeans would pay a "dark price, while the U.S., under the umbrella of a space - based ABM system would survive Armageddon [Ref. 6: p. 7]." Another Soviet author, Valentin Falin, pointed out that

SDI conveniently ignores the tactical and operational, implying theater, nuclear weapons, because these threats do not "pain American hearts [Ref. 6: p. 7]." The Soviet propaganda barrage not only emphasizes European vulnerability because of the SDI umbrella, but amplifies the threat by indicating that involvement with SDI will threaten Europe's "good relations" with the Soviet Union [Ref. 6: p. 39]. It should be noted, however, that the Soviets are approaching the European campaign carefully, remembering the backfiring of the Soviet campaign against the INF deployments.

A more sophisticated, subtle propaganda scheme is being conducted with the goal of portraying Prime Minister Gorbachev as a Soviet version of John F. Kennedy. Gorbachev has openly stated, contrary to all observable technological and strategic policy trends, that the Soviets have forsworn interest in strategic defense and accepted MAD as the basis for Soviet security. Gorbachev has announced plans for a new "openness" in the Soviet Union, but has yet to take any decisive action along those lines. Additionally, Gorbachev and his wife are being treated as celebrities, role models, and basically as the vogue political couple of the decade. These actions are designed to lull the U.S. (and their NATO allies) into a state of mirror imaging, where we see the Soviets to be like us, respecting arms control and seeking peace.

2. Economic Factors

The current economic situation of the Soviet Union must be considered as one of the driving forces behind any response to SDI. The Gorbachev administration has identified economic reform as one of its most urgent priorities. Indeed, reform is imperative if the Soviet Union plans to remain a competitive superpower in the next century [Ref. 6: p. 48]. After twenty years, the Soviets must now accept that there are "real limits" to attainable military growth [Ref. 6: p. 3].

As such, SDI threatens the twenty year investment the Soviets have made in hard - target ICBM deployment, because it increases the uncertainty of the success of those missiles. The comprehensive nature of SDI may force the already strained Soviet resources to be allocated in defensive directions, since cheaper solutions like increasing the number of warheads on ICBMs would not provide enough confidence to ensure the continued Soviet advantage required by their definition of deterrence. SDI also threatens the research and development budget of the Soviet Union, since it poses a significant technological challenge that the Soviets may or may not be in a position to meet.

While the economic pressures cannot be completely denied, the Soviets are stressing that they will not allow SDI to force a "military investment path preferred for us by the United States," but will instead respond to SDI with a view to their own security interests [Ref. 6: p. 35]. Georgii Arbatov has stated in an interview in the Los Angeles Times that "we have to increase our armaments, and we won't go the way the Americans want us to go, spending just as much money as you do on nothing in a mirror image of your efforts. We will work on weapons to counter this SDI [Ref. 6: p. 35]." Regardless of the direction of spending, whether offensive or defensive in nature, a viable SDI system will force the already overtaxed Soviet economy to spend even more in order to counter the increased threat.

3. Arms Control Negotiations

SDI can be held out as a bargaining chip by either side in future negotiations. From the Soviet point of view, the ABM treaty can be exploited to the fullest, in order to prevent testing of the SDI system, or its components, thereby limiting the amount of U.S. confidence in the ability of the costly system's capabilities. The Soviets could work towards prohibiting deployments by comparing SDI to an ASAT system, and therefore subjecting certain components to ASAT restrictions. Finally, by exploiting the conflict between Reagan's announcement that SDI will remove the need for nuclear weapons, and his major offensive force buildup, the Soviets might elect to limit U.S. offensive growth and allow the possibly futile SDI research to continue [Ref. 9: p. 48].

On the other hand, the U.S. has openly stated that research and testing permitted by the ABM treaty will not be negotiated. Arms control experts, though, must recognize the potential value of making concessions in SDI, subjecting Soviet ABM research and development to those same constraints, while imposing constraints on Soviet ICBM development in the areas of improved accuracy and increased MIRV fractionation, not to mention verification [Ref. 6: p. 44].

4. Wait and See

The U.S. has a history of inability to sustain defensive initiatives over a long period of time, due to changing administrations, multiple budgetary cycles, lack of public support, and complex technology. The Reagan administration will be out of office in 1988, and is currently facing severe defense budget pressures from the Democratic Congress and Senate. The SDI budget has already suffered cutbacks at the hands of the Gramm - Rudman - Hollings amendment. A possible, though unlikely, response given the paranoid Soviet political culture would be for the Soviet

Union to simply wait and see if SDI continues to be a threat in 1988. This would allow Soviet economic reforms to continue without the stress of responding, possibly needlessly, to the SDI program. This is unlikely, though, since Soviet mirror imaging would suggest that a system with as much potential as SDI would be above budgetary problems. In the Soviet Union, despite the great economic hardships faced by the public, a potential system like SDI would enjoy almost limitless funding. The Soviets, looking for a way to rationalize their own phenomenal military spending, would probably project the same attitudes on the U.S. SDI program.

F. SUMMARY

This chapter has presented several factors contributing to the Soviet view of deterrence and ultimately the Soviet view of SDI. Current and predicted Soviet political and technological solutions to SDI have also been examined, in order to demonstrate that SDI has indeed provoked a measurable response. This background information will be incorporated into the analysis of SDI's political effectiveness in Chapter 4, as the methodology described in the next chapter is applied.

III. MCES BACKGROUND

A. WHAT IS THE MCES?

In the book *MANAGEMENT SYSTEMS*, Blaise Pascal is quoted as saying "I find as impossible to know the parts without knowing the whole, as to know the whole without knowing the parts [Ref. 10: p. 3]." Additionally, *MANAGEMENT SYSTEMS* contrasts the systems approach, or viewing of the problem as a whole, with the analytical method, or segmenting the whole into smaller parts to provide better understanding of the whole. The Modular Command and Control Evaluation Structure (MCES) is an analytical system that provides a greater understanding of the overall problem. Generically speaking, the MCES can be seen as:

- 1) a structure to direct the evaluation of C2 architectures;
- 2) a paradigm to select and integrate from among existing tools;
- 3) a methodology which itself may be used for evaluation, employing a common structured treatment [Ref. 11: p. 6].

The MCES is an evolving tool that claims to "expedite the analytic foundations for system design requirements, interface and interoperability documents, critical issues reports, operational concepts, and prototype and full system evaluations [Ref. 12]." The MCES is described as having two components. The first, a managerial system, focuses on the complete specification of the problem to be solved. By doing so, it eases the burden on the decision maker by enhancing direction and reducing the time and personnel needed for further analysis of the problem. The second component, an analytical system, "identifies, integrates and coordinates appropriate methodologies for the solution of the specified problem [Ref. 12]," enabling analysts using the tool to provide supporting data (in this case MOPE's) to the decision maker.

The MCES is composed of seven "modules:" problem formulation system bounding; process definition; integration of statics and dynamics; specification of measures; data generation; and aggregation of measures. Each module will be discussed separately. of the Appendix shows the MCES structure, with each module identified. [Ref. 11]

B. MODULE 1: PROBLEM FORMULATION

Module 1, problem formulation, addresses the question of the decision makers needs and objectives in a specific problem. For a military system, these could include the concept definition and development, system design, acquisition, operations, the lifecycle of a military (C2) system, and the level of analysis prescribed [Ref. 11: p. 11]. The output of this module is a more precise statement of the problem being addressed. Once accomplished, the problem statement can be translated into objectives. These objectives need to be identified as "real" goals or "stated" goals, and when identified, need to be operationalized. The appropriate threat, operational and deployment concepts, scenarios and underlying assumptions in the evaluation are made clear in this module. Appendix Figure 2 depicts the expanded problem formulation module [Ref. 11.]

C. MODULE 2: C2 SYSTEM BOUNDING

Module 2 is the systems bounding block, used for identifying relevant quantities including:

- 1) physical entities, (equipment, software, people, and their associated facilities)
- 2) structure (organization, concepts of operation, including procedures and protocols, and information flow patterns)
- 3) C2 process (the functionality or what the system is doing) [Ref. 11: p. 12]."
- 4) Boundaries of the subsystem, system, own forces, environment, and rest of world.

The module focuses on the physical entities and structure, resulting in the identification and categorization of the system elements of the problem formulated in Module 1. Figure 3 of the Appendix depicts the expanded systems bounding module. Figure 4 of the Appendix depicts the "onion skin" that describes the MCES systems bounding. The onion skin breaks the system into environment, forces, C2 system, subsystem, and element. MANAGEMENT SYSTEMS relates boundaries to the environment by stating "...the boundary demarcates the system from its environment [Ref. 10]." The environment includes everything outside the system's control and everything that determines how the system performs.

D. MODULE 3: PROCESS DEFINITION

Module 3, the process definition module, takes a given system configuration (i.e. a specific scenario and mission) and defines the processes needed to fulfill the mission. It maps the processes needed to a Lawson - like loop system configuration, shown in Figure 5 of the Appendix. The concept focuses attention on the:

- 1) "the environmental initiator of the C2 process, which results from a change from the desired state
- 2) the internal C2 process functions that characterize what the system is doing (sense, assess, generate, select, plan, and direct)
- 3) the input to and output from the internal C2 process and environment, including enemy forces, own neutral forces, and usual environmental components [Ref. 11: p. 19]."

Figure 6 of the Appendix represents the expanded process definition module.

E. MODULE 4: INTEGRATION OF STATICS AND DYNAMICS

Module 4, the integration of statics and dynamics module, relates the data information flow and process functions to the organizational structure as well as relating the physical entities to the process functions. The terms statics and dynamics address the various architectures that are being analyzed. Statics refer to the physical entities and structure, since the structure changes very slowly over time. Dynamics, then, can be compared to the process function, which changes rapidly [Ref. 11: p. 40]. The flow through the C2 process model can be depicted through the use of Petri Nets, Data Structure Diagrams (DSDs) or Data Flow Diagrams (DFDs) [Ref. 11: p. 16]. Considering the specific application of the MCES in this thesis, though, DFDs are more appropriate. Input/output flow arrows identify information flow to and from the separate process functions, as required by the specific mission. The information flows result in "hierarchical relationships between the individual C2 functions...resulting in a hierarchical structure...of the information flow [Ref. 11: p. 16]." From that point, an organizational structure can be derived, followed by those physical entities which perform functions being mapped to the output. This process results in "a synthesis of the statics and dynamics defining a C2 system." Figure 7 of the Appendix is a diagram of the expanded integration module.

F. MODULE 5: SPECIFICATION OF MEASURES

Module 5, the specification of measures or criteria module, tracks the four prior modules in order to specify the measures necessary to address the problem of interest. Table 1 taken from [Ref. 11: p. 19], provides a list of desired characteristics for evaluation measures, along with definitions of these characteristics, used in order to produce a reasonable set of "possible" working measures of effectiveness.

From these working measures, one or more measures, suitable to the specific problem and or the data collection system, are identified, becoming the "critical" or

TABLE 1
DESIRED CHARACTERISTICS FOR EVALUATION MEASURES

Characteristics	Definition
mission oriented	relates to force/system mission
discriminatory	identifies differences between alternatives
measurable	can be computed or estimated
quantitative	can be assigned numbers or ranked
realistic	relates realistically to the C2 system and associated uncertainties
objective	can be defined or derived, independent of subjective
appropriate	relates to acceptable standards and analysis objectives
sensitive	reflects changes in system variables
inclusive	reflects those standards required by analysis objectives
independent	is mutually exclusive with respect to other measures
simple	is easily understood by the user

minimum essential set of measures for the problem at hand. The final set of measures selected are classified as to their level of measurement, i.e., "measures of performance (MOPs.) measures of effectiveness (MOEs,) measures of force effectiveness (MOFEs) [Ref. 11: p. 20], or measures of policy effectiveness (MOPEs.)" The names chosen also link to the kind of conclusion that can be drawn in an analysis to which the measures are applied [Ref. 11: p. 20]. The outcome of this module is the specification of a set of measures based on the C2 process functions or static components [Ref. 11: p. 21]. Figure 8 of the Appendix represents the expanded specifications module.

G. MODULE 6: DATA GENERATION

Module 6 encompasses data generation by exercise, simulation, experiment, and/or subjective judgements. The data generator, for the specific problem, outputs values associated with the measures specified in Module 5, which are either direct or derived values [Ref. 11: p. 21].

Some suggested SDI data generation techniques include: the Delphi method, as a means of determining risk in a variety of dimensions, such as affordability, time constraints, domestic tranquility; formal security modeling and evaluations; clandestine vulnerability analyses; operational communications accreditation via appropriate agencies; security related test and evaluation; scenario exercises; and technology validation. Figure 9 in the Appendix shows the expanded data generation module.

H. MODULE 7: AGGREGATION OF MEASURES

Module 7 is the aggregation of measures and interpretation module. "The implementation of this module provides the analysis results addressing the specific problem initially posed by the decision maker in the problem formulation module [Ref. 11: p. 22]." Module 7, taken together with Modules 5 and 6, provides a means for determining that the plans are being executed as originally conceived. If not, they should also provide a way for determining where the problem or change occurred. Appendix Figure 10 depicts the expanded aggregation module.

I. SUMMARY: WHY THE MCES?

There are several advantages to using the MCES as an analytical structure that make it a more appropriate choice for the evaluation of the political effectiveness of SDI. Given the complex nature of the SDI issue, along with the changing political and budgetary situations SDI is facing, the fact that the MCES allows interaction by the decision maker at any point in the analysis is a great advantage, as it provides the identification of errors in assumptions, bounding, etc. Additionally, the MCES will provide an explicit statement of underlying assumptions, while forcing a set of standard definitions within the SDI community. Finally, as will be seen in the next two chapters, the MCES does provide a framework for deriving and measuring the effectiveness of SDI as a political concept, along with bringing out future requirements in order for that effectiveness to be maintained.

IV. APPLICATION OF THE MCES TO THE OVERALL SDI ISSUES

A. INTRODUCTION

In order to determine the effectiveness of SDI, both politically and technologically, a methodology needed to be chosen. The MCES, discussed in the preceding chapter, afforded analysis capabilities applicable not only to the policy goals and ensuing measures, but also to the engineering and system goals and measures. As such, it was the logical choice of methodology for the 1986 SDI Measures of Effectiveness Workshop.

This chapter will tie Chapters 2 and 3 together, with the application of the MCES to the political policy goals of SDI, taking into consideration the Soviet ideology that led to the Soviet concept of deterrence. As each module is applied, the process will be discussed first from the point of view of what was accomplished at the 1986 workshop by the policy overall SDI working group, whose members were identified in Chapter 1. Secondly, the results of the workshop will be amended or modified as required, when the Soviet background information presented in Chapter 2 is incorporated into the analysis. The working group members, drawing on personal experience and taking advantage of the diversity of their backgrounds, reviewed each generic module and then applied it to the SDI political concept. After considerable group discussion, and with Dr. Rona's guidance, a consensus was reached concerning the output of each module. It is that consensus that will be presented in this thesis.

At this point, it should be noted that Modules 6 and 7, data generation and aggregation of measures, were not applied at the workshop, due to time constraints. These two modules will not be specifically applied in this thesis, either, because of resource constraints. However, Modules 6 and 7 will be discussed and possible applications anticipated results presented, as well as recommendations for future studies in this area.

B. MODULE 1: PROBLEM FORMULATION

1. Workshop Results

Module 1, the problem formulation block, addresses the question of the decision maker's needs and objectives in a specific problem. In terms of the SDI workshop, the first difficult task facing the working group members was the

determination of exactly what the decision makers really want the overall SDI system to do. Drawing on the decision making experience of the more senior working group members, and addressing the question as if each working group member was on the decision making SDIO staff, several assumptions were made framing the overall SDI program, in order to facilitate the problem formulation:

- 1) SDI was assumed to be a generically different system from any other weapon system development program because: it attempts to modify Soviet strategy, doctrine, and behavior; the "threat" SDI responds to is generalized and includes large scale Soviet tactics; and SDI is a multi - service, multi - agency system.
- 2) The evaluation criteria at any level may need different emphasis for different evolutionary phases of the ultimate operational system.
- 3) Because of its nature, SDI must interact directly with top level national goals.
- 4) The SDI research program itself is feasible, affordable, and will be productive enough to provide technology that reinforces the political threat.
- 5) The SDI research and development program will be compatible with existing treaties.
- 6) SDI not only represents a major change in U.S. strategy, but that change will be accepted by our allies and the Soviet Union, and, once accepted, will make a safer world.
- 7) Finally, a hypothetical baseline architecture, measurable and representative of the future SDI system, can be defined.

Using their list of framing assumptions, the working group members developed a list of objectives criteria, as an extension of the previous list, by which the decision maker would judge the political effectiveness of SDI. This list included:

- Popular support of U.S. and allied public, as this will influence the available funding.
- Early availability to ensure continued interest given the history of U.S. long term technology programs. It is easier to sell a product if that product physically exists.
- Credibility of SDI to the U.S. population, morally as well as technically.
- Low technology risk in order to ensure continued interest and to foster a "can do" attitude.
- High visibility to the Soviets to demonstrate U.S. commitment to strategic defense.
- Incentive to Soviets to switch from MAD to defense in order to control the arms race.
- Support of allies in the areas of funding, political support.
- Create uncertainty for Soviet planners, forcing a change in strategy.

- Compatibility with arms control treaties, since U.S. policy makers and public see these as legally and morally binding.
- Affordability in the eyes of the population and Congress.
- Effective city defense as a means of ensuring population survival.
- Effective military target defense as a means of ensuring a second strike capability.
- Multiple engagement effectiveness to protect against a Soviet second strike.
- No collateral U.S. damage demonstrating that SDI really will defend.
- Crisis stability, both domestic and international, particularly after a nuclear exchange.
- Transient phase stability, to defend the U.S. during the transition from MAD to defense.
- Compatibility with NCA structure to ensure the C3 system functions operate smoothly under wartime conditions.

While some of these objectives clearly relate to the technological development aspects of SDI, others are clearly politically motivated, and are of greater interest to this thesis, as will be seen in later sections.

2. Effects of Soviet Ideology and New Results

Considering the Soviet background information provided in Chapter 2, three of the assumptions made by the working group, as well as two objectives that evolved from those assumptions, need modification. The remaining assumptions and objectives are valid after the analysis of the Soviet background information. First, SDI was assumed to be a generically different weapon system because it attempts to modify Soviet strategy, doctrine, and behavior. The basic Soviet strategy of ensuring Soviet and socialist survival by deterring the enemy through an overwhelming ability to defeat the enemy has not changed since the days of Lenin. What has changed is the means of carrying out that doctrine - from conventional might to nuclear might to a conventional nuclear mix. As stated in Chapter 2, the Soviets have firmly stated that they will not allow the U.S. to drive Soviet strategy through the SDI research program. A more appropriate assumption, then, would be that SDI is an attempt to modify Soviet economic and military behavior.

The second assumption requiring modification states SDI will be compatible with existing arms control treaties. Due to the vast cultural and political differences between the U.S. and Soviet Union, the ABM treaty, as well as others in question, have different meanings dependent upon interpretation. Each country will derive their

own meaning as to what is and is not permitted, manipulating words, phrases, and clauses as required in order to support the desired position. The clause the U.S. interprets as allowing certain kinds of research and development can be interpreted by the Soviets as prohibiting the same. This assumption, then, should be rephrased to say that SDI will be compatible with U.S. Allied interpretations of the treaties.

Finally, the assumption was made that SDI not only represents a major change in U.S. strategy, but that the Soviets will also accept this change and a safer world will result. While from the U.S. perspective this is a logical conclusion, it is completely opposite all known Soviet views. Not only have the Soviets never accepted MAD as strategy, they have blatantly stated that SDI will force them to search for alternate means of defeating the system, in order to continue deterrence from the Soviet point of view. Again, this assumption should be modified to include the possibility that the Soviets may or may not accept the change in strategy, but the decision makers are willing to take the risk anyway.

Two objectives require modification. The objective "incentive for Soviets to shift from MAD to defense" is, given the avowed Soviet position, unrealistic. What SDI can do, though, is cause a Soviet search for an alternate means of deterrence, therefore creating greater economic strain and even dissention in the military leadership as the new course of action is contemplated. The objective should then be rewritten as "economic strain, government confusion as responses to SDI are pursued." The second objective requiring modification is "compatibility with arms control treaties." As stated in the paragraph on the assumption that led to this objective, it should be reworded to indicate "compatibility with arms control treaties and U.S. Allied interpretation of the treaties."

As stated above, the remainder of the assumptions and objectives identified by the working group are valid after the inclusion of Chapter 2 information. Having completed the problem formulation module, the next step is to apply module 2, the systems bounding block.

C. MODULE 2: SYSTEMS BOUNDING

1. Workshop Results

Module 2 is the systems bounding block, and is used for identifying relevant quantities, including physical entities, structure, and boundaries of the subsystem, system, own forces, environment, and rest of the world. The effort to bound the system at the SDI workshop stemmed from one of the assumptions made during the

problem formulation module. It was assumed that a hypothetical baseline architecture, measurable and representative of the future SDI system, could be defined. Further defining this abstract concept, the working group developed a definition and purpose of the baseline architecture. It was defined as a means of specifying the system's functional objectives by:

- 1) providing a broad description of the "family of systems" assembled for a common purpose
- 2) existing at a level above the more technical "engineering description"
- 3) including all major constituents and functional relationships
- 4) and providing for future evolutionary features.

The purpose of the architecture is twofold. First, it should communicate to the decision makers the value or merit of the proposed concept in terms of the goals and objectives identified through Module I. Second, but equally important, the hypothetical baseline architecture should offer a framework to the system and functional level definition of evaluation criteria, thereby enabling the system to be bound.

When the working group, after generically defining the hypothetical baseline architecture and its purpose, began the task of actually putting the architecture onto paper, a discussion lasting several hours ensued, with no concensus ever being reached beyond the essential constituents of the architecture. The essential constituents were identified as being:

- 1) the mission objectives and tasks for various conflict scenarios
- 2) the functions to be accomplished
- 3) the major hardware, software, connections, interfaces, and logistics support capabilities
- 4) all personnel associated with the system, including decision makers, operators, maintenance personnel, etc.
- 5) and the employment concepts and doctrine, if unchanging in nature.

The working group then compared these aspects of the hypothetical architecture with the list of objectives produced by Module I, and determined that each and every objective had specific time limitations that affected its relative importance to the decision maker. As a result, initial boundaries were established for the SDI system between the preoperational and operational phases. The working group defined the preoperational phase as including all stages phases prior to the actual wartime operation of the SDI system. The operational phase would begin with the first actual

military engagement, continuing until the system was rendered inoperational for whatever reason. These boundaries will be further refined in the process module.

2. Effects of Soviet Ideology and New Results

The effects of the Soviet conceptual differences are somewhat more subtle in this case than in the previous module. During the definition of the hypothetical baseline architecture constituents, it is important to consider the Soviet view of each component of the SDI system. As stated in Chapter 2, the Soviets view SDI not as a defensive system, but as a high - technology, aggressive offensive weapon system with links to an overall strategic offensive defensive capability, designed to ensure U.S. superiority and prohibit a Soviet second strike capability. From the Soviet point of view, there is really only one possible conflict scenario for the employment of SDI, and that is one to support a U.S. imperialistic first strike against the good and just causes of socialism.

From the Soviet point of view, the functions to be accomplished, major hardware and software components, personnel associated with the system, and the employment concepts all share the common purpose of defeating and destroying the Soviet Union. Therefore, Soviet efforts to prevent the system from ever reaching the deployment phase are of the utmost importance and have the greatest priority. These efforts, ranging from propoganda and manipulation to covert attacks on the system components and possibly even to a preemptive strike before deployment of the system has been completed, force another look at the boundaries established by the working group. While the concept of preoperational and operational phases is basically valid, emphasis needs to be made by the decision makers on the preoperational phase as it is a very real possibility that the SDI system will never reach the operational phase. The decision makers, then, need to maximize the effects of the objectives in the preoperational phase. Any U.S. political gains achieved during this period as a result of SDI will be of even greater value should SDI become defunct, for whatever reason.

Therefore, having established two phases as boundaries, preoperational and operational, and determining that, given the Soviet determination to prevent deployment of the SDI system, emphasis should be placed on the preoperational phase, these phases can now be further refined by the application of the process module.

D. MODULE 3: PROCESS DEFINITION

1. Workshop Results

Module three, the process definition module, takes a given system configuration, such as a specific scenario and mission, and defines the processes needed to fulfill the mission. The working group, considering the two boundary phases and the list of decision maker objectives, first evaluated the importance of each objective in terms of the lifecycle of the SDI system. Objectives like popular support, credibility to U.S. population, early availability, visibility to the Soviets, and incentive for Soviets to shift strategy, were determined to be of importance during the early part of the development cycle, while other objectives, such as effective military target defense and compatibility with NCA structure, were essential to later phases. Using these determinations, the working group then developed several categories relating to the original boundaries, as follows:

- 1) Preoperational
 - a) preconceptual - that period beginning with President Reagan's announcement and continuing until the public recognizes a tangible SDI system.
 - b) concept definition - the period during which the abstract concept is refined and researched, with regards to current and future technology, and afeasible system results.
 - c) Development, test, deployment - the period of actual system construction, testing, and deployment.
 - d) Initial operational capacity (IOC) through full operational capacity (FOC) - the period lasting from initial deployment of the first system components until the complete system is available for military operations. This can be seen as a protracted research and development phase.
- 2) Operational
 - a) operation military engagement - the period of actual military engagement and wartime operations.
 - b) postoperational - the period following the first nuclear exchange.

Using their revised boundaries, the working group members then reevaluated the criteria of the decision makers, developed in Module 1, individually then collectively, determining which objectives were really of value, and at what point in the development cycle that value occurred. Their combined results produced a general consensus of the majority, shown in Table 2.

TABLE 2
RANKING OF DECISION MAKER'S CRITERIA

Criteria	When Important
Popular support	preconcept, concept definition, development, IOC - FOC
Early availability	development
Credibility	preconcept, development, IOC - FOC
Low technical risk	development
Visibility	preconcept, concept definition, IOC - FOC
Incentive to shift	preconcept, concept definition, development, IOC - FOC
Support of allies	(none)
Create uncertainty	operation
Treaty compatibility	preconceptual
Affordability	concept definition, development, IOC - FOC
Eff. city def.	(none)
Eff. target def.	IOC - FOC, operation
Eff. mult. engage.	operation
No U.S. damage	operation
Crisis Stability	preconcept, concept definition, development, postoperational
Transient stability	(none)
Compatibility w/NCA	IOC - FOC, operation

It is clear that the objectives relating to political issues fall into the preoperational category and its subcategories, emphasizing again the significance of SDI in the early phases as a policy making tool. These results were then used to develop the national goals of SDI, through the application of Module 4, the integration of statics and dynamics module.

2. Effects of Soviet Ideology and New Results

The main objective of the Soviet anti - SDI campaign, to defeat the system prior to full deployment and operational capability in order to maintain the Soviet view of deterrence, necessitates a second look at the assignment of time period value to several categories. Popular support, early availability, credibility to U.S. population, low technical risk, visibility to Soviets, economic strain government confusion, compatability with arms control treaties, affordability, and uncertainty for Soviet planners need to be emphasized throughout the entire preoperational phase, not just certain periods of the preoperational phase.

The key differences, however, result from consideration of the Soviet ideological differences. The first concerns the support of allies objective. The working group determined that this objective was not critical during any phase. The Soviets, however, see allied support as a critical aspect and are spending considerable time and money on a carefully designed propaganda campaign attempting to incite NATO fears that SDI will decouple the nuclear security umbrella over Europe. Since a major point of Soviet military strategy is to decouple the U.S. NATO alliance, forcing U.S. withdrawal from Europe, their ability to prohibit NATO support for SDI will further this strategy. Lack of NATO support will also affect the funding SDI receives from outside U.S. government sources. NATO fears can possibly color their interpretations of the arms control treaties, again dealing a blow to the U.S. SDI program. As a result, the support of allies objective needs to be considered critical throughout the preoperational phase.

A second issues arises from the transient phase stability objective, which again was determined by the working group not to be important in any phase. However, since the Soviets want to prevent a viable SDI system from ever becoming operational, attacks on the SDI system during the transient phases of deployment and initial operational capacity are possible, should all other preventive means fail. The outcomes of such a scenario are varied, but all point to a risk in terms of national security and economic stature. Therefore, transient phase stability should be considered as critical during the latter part of the preoperational phase. The remainder of the objectives/criteria and their value during the development cycle are not affected by the Soviet background information.

Using Module 3, the decision makers' objectives have been weighed with regards to the SDI system boundaries and subdivisions. Module 4, the integration module, can now be applied.

E. MODULE 4: INTEGRATION OF STATICS AND DYNAMICS

1. Workshop Results

Module 4, the integration of statics and dynamics module, relates the information flow and process functions to the organizational structure, as well as relating the physical entities to the process functions. At the SDI workshop, Module 4 was used to tie the results of the three previous modules to the national goals of SDI. The working group, using the previously developed decision maker's objectives and their relative importance and location within the system boundaries, and considering the influence of the hypothetical baseline architecture, determined the national goals to be:

- 1) Eliminate the use of force in conflict resolution
- 2) Preserve and enhance domestic societal cohesion
- 3) Preserve and enhance the cohesion of U.S. alliances;
- 4) Maintain leadership in science and technology;
- 5) Provide for stable growth of U.S. economy.

Furthermore, the working group decomposed each national goal into subgoals, as follows:

- 1) Eliminate use of force in conflict resolution
 - a) deter nuclear conflicts
 - b) deter conventional conflicts with escalation potential
 - c) negotiate institutional restraints
 - d) provide effective city defense
 - e) provide effective defense of military assets
 - f) modify Soviet goals and strategy
 - g) provide incentives for deescalation
 - h) slow down arms race
 - i) assure crisis stability at all levels.
- 2) Preserve and enhance domestic societal cohesion
 - a) increase, strengthen educational base
 - b) ensure the integrity and effectiveness of domestic communications
 - c) publicize the merits of U.S. political system
 - d) communicate effectively the U.S. goals and objectives
 - e) provide effective city defense
 - f) provide effective defense of military assets
 - g) maintain effective propaganda and counterpropaganda activities.

- 3) Preserve and enhance the cohesion of U.S. alliances
 - a) promote joint U.S. - Allied military research and development
 - b) increase/strengthen educational base
 - c) publicize the merits of U.S. political system
 - d) communicate effectively the U.S. goals and objectives
 - e) provide effective defense of military assets
 - f) modify Soviet goals and strategy
 - g) maintain effective propaganda and counterpropaganda activities.
- 4) Maintain leadership in science and technology
 - a) invest in technology base
 - b) increase/strengthen educational base
 - c) stimulate private investment in advanced technologies.
- 5) Provide for stable growth of U.S. economy
 - a) invest in technology base
 - b) stimulate private investment in advanced technologies
 - c) provide for effective federal budget control process.

As can be seen in the preceding lists, some of the subgoals are shared by different national goals. For example, the subgoal maintain effective propaganda and counterpropaganda activities appears in both the preserve and enhance domestic societal cohesion and preserve and enhance the cohesion of U.S. alliances national goals. It is from these areas of overlap of the national goals subgoals that led to the working group development of possible MOPEs.

2. Effects of Soviet Ideology and New Results

The differences between U.S. and Soviet perceptions are perhaps most clearly exhibited in the area of national goals. From the list provided above, it is obvious that the U.S. sees, and wants to project, SDI as a defensive weapons system leading to a situation in which world peace exists. The Soviets also want world peace, but to them world peace means the capitalists have been defeated and socialism has been installed as the system of world government. While the U.S. accepts deterrence as a stable situation, the Soviets see deterrence as inevitably breaking down, eventually leading to nuclear escalation.

Of the national goals and subgoals, only two subgoals require modification to reflect Soviet ideological differences. SDI will not, from the Soviet point of view, modify Soviet goals and strategy, nor provide incentives for Soviet

deescalation/stability. What SDI will do, though, is provide a tool that modifies Soviet behavior, as stated previously in Module 1. SDI will also provide a negotiation chip, that, used correctly, can lead to deescalation in specific areas, resulting from concessions made by the U.S. as well as the Soviet Union.

While the effects of the Soviet background made minimal changes in the workshop results, it is essential that the Soviet view of our national goals for SDI be kept in mind during the development process, because it is that viewpoint that drives the Soviet response, and that response greatly affects the success or failure of SDI. The next module, specification of measures, will demonstrate the counter effects of Soviet ideology on SDI effectiveness.

F. MODULE 5: SPECIFICATION OF MEASURES

1. Workshop Results

Module 5, the specification of measures module, tracks the four prior modules in order to specify measures necessary to address the problem at hand. At the workshop, Module 5 was used to produce possible measures for determining whether or not SDI is successful, based on the national goals, broad policy issues, and the objectives of the decision makers, developed in earlier sections. The objectives, combined with the redundancy among the subgoals, were mapped into the national goals to produce the following five interdependent derivative measures of policy effectiveness:

- 1) Affordable Risk - measure of acceptable risk in areas of arms control, technology, damage to U.S.
- 2) Leverage - measure of how well SDI drives Soviet policy in directions the U.S. wants.
- 3) Operational Effectiveness - measure of how well SDI really defends U.S.
- 4) Perception - measure of how SDI is accepted in the U.S., by allied nations and the Soviet Union.
- 5) Stability - measure of economic, political, and military stability.

The working group determined that the derived measures relate to the national goals as:

- 1) Eliminate the use of force in conflict resolution measurable by perception, stability, and leverage
- 2) Preserve and enhance domestic societal cohesion measurable by affordable risk, leverage, operational effectiveness, perception, and stability

- 3) Preserve and enhance the cohesion of U.S. alliances, measurable by stability, affordable risk, perception
- 4) Demonstrate leadership in science and technology, measurable by stability, affordable risk, perception, operational effectiveness
- 5) Provide for stable growth of U.S. economy, measurable by perception, stability, affordable risk.

A good example of how the objectives were tied to the MOPEs by the working group can be seen with the popular support objective. Popular support is critical in the preoperational phase, particularly in the preconceptual, concept definition, and system deployment stages. The working group found it to be essential to all five of the national goals. Popular support translates to one component of the perception MOPE. Means of measuring popular support, discussed at the workshop include:

- 1) election results, particularly those of congressional, senatorial or presidential races, where SDI was a strong issue
- 2) amount of congressional funding available to SDIO and associated research
- 3) amount of positive/negative SDI press coverage from all media sources.

Most of the other objectives could be traced through the modules, associated with one of the five derivative MOPEs, to produce a more specific surrogate measure of effectiveness. It was at this point that the time and resource constraints of the workshop surfaced, and the application of the MCES was halted.

2. Effects of Soviet Ideology and New Results

The primary effect of Soviet ideology on the development of measures is not semantic, as in the previous cases. At this point, the Soviet responses to the SDI program begin to take effect and therefore must be included as a factor in any measurement process. Continuing the example begun in the last section, the means of measuring popular support/perception must take into consideration the effects of the Soviet disinformation propaganda campaign. This campaign affects not only the average American or European watching television or reading the newspaper, but through them the results of elections, congressional votes, and available funding. As for other examples, the Soviet willingness to allow SDI to be used as a bargaining chip in arms control negotiations determines the effectiveness of the leverage MOPE. The economic strains endured by the Soviet government as it searches for alternate means of defeating SDI and maintaining their idea of deterrence are reflected in the stability MOPE.

These factors must be taken into consideration during the development of more specific MOPEs. Based on the Soviet background information, as well as the results of the MCES application thus far, more specific surrogate measures could be developed and possibly quantified in the areas of arms control, economic shifts, and propaganda campaigns. These will be expanded upon in the next chapter. The possible applications of Modules 6 and 7 will now be discussed, even though resource constraints prevent their actual applications.

G. MODULE 6: DATA GENERATION

Module 6 encompasses data generation by exercise, simulation, experiment, and or subjective judgements. In terms of the overall political effects of SDI, and the derived measures developed at the workshop, several means exist for the generation of data. Affordable risk data generation could come from computer simulation programs, varying from the acceptable number of losses from weapons strikes to the number of dollars that can be invested in SDI research without knowing whether or not a viable weapons defense system will be produced. Operational effectiveness data, at this point, will be restricted to data from computer simulations, such as the Alphatech BM C3 Architecture Evaluation Model, which is under contract to the Naval Air Development Center (NADC) through funding from SDIO. This model is designed to evaluate the BM C3 effectiveness of the five "horserace" architectures being considered by SDIO. Data can also be generated at the National Test Bed Facility, however, treaty restrictions on types of testing permitted will limit this option. Data generation on perception can take many forms, ranging from polls, surveys, and their subsequent statistical analysis, to the rather tedious collection and evaluation of election results, letters to the editor, or the volume of media resources allocated to SDI. As mentioned in the last section, data of this type can be used to measure the surrogate perception measure of the success of the U.S. Soviet propaganda campaign. Leverage data generation would be somewhat more elusive, as it is difficult to determine whether or not a country is adhering to arms control treaties. Again, data generation could come from a count of warheads missiles, both those negotiated away and those developed to counter SDI. This data can be used to measure the surrogate leverage measure mentioned in the previous section, of the success of arms control negotiations. Data generation for the stability MOPE could be a collection of stock market data, combined with data on the other leading economic indicators for both the U.S. and Soviet Union, or a comparison of expenditures in the areas of defense, social services,

etc. This data can then be used to measure the surrogate stability measure of the current economic status of each country. Each of these last three surrogate measures, and a means of quantifying each, will be discussed in Chapter 5.

For a system as complex as SDI, which evokes such extreme responses from all sectors of the world, data generation is an extremely complicated issue. Years could be spent accumulating data to support the MOPIs alone, not to mention the other aspects of SDI approached at the Workshop. To date, considerable effort has been put into identifying possible means for measuring the effectiveness of the SDI system. At this time, as the 1990 decision date rapidly approaches, efforts should proceed into the areas of quantification of those measures, with data generation to support the quantification.

H. MODULE 7: AGGREGATION OF MEASURES

Module 7 is the aggregation of measures data and interpretation model. While the task of generating data appears overwhelming, it can barely compare to the intricacies involved in aggregating and interpreting the data and measures. There are so many subtleties to be accounted for during the aggregation. For example, this author believes the following questions will seriously affect the final result of the leverage MOPE, and its surrogate measure of success in arms control negotiations:

- 1) Were the warheads/missiles negotiated away current technology or older generation weapons about to be disarmed anyway?
- 2) Were they aimed at the U.S. or Europe?
- 3) Have they been replaced with improved conventional missiles?
- 4) Can the status of these weapons really be verified?

Each of these questions should, somehow, be translated into a weighting factor and applied to the overall analysis of the leverage MOPE.

For each MOPE, a similar set of questions pertaining to the aggregation of data can be generated. A means of weighing the data must be established, enabling the measures to be quantified. Then, a means of equating the results of the measures must be determined in order to allow these results to be of assistance to the decision makers when they answer the question "is SDI effective?" With the 1990 decision date rapidly approaching, aggregation of measures, like data generation, can offer significant advantages to the decision maker.

I. SUMMARY

This chapter has applied the MCES to the overall policy issues of SDI. The SDI MCES MOE workshop results were presented, compared with the Soviet ideological differences, and the workshop results modified when necessary. The overall outcome of the application of the first five modules was the derivation of five general MOPEs. After considering the Soviet background information presented in Chapter 2, surrogate measures of effectiveness were generated for three of the MOPEs. While the application efforts stopped with Module 5, possibilities were discussed for Modules 6 and 7. The next chapter will address the possible quantification of the revised measures determined in this chapter.

V. DEVELOPMENT OF MEASURES

A. INTRODUCTION

In the last chapter, the results of the Working Group's application of the MCES to the overall policy issues of SDI were presented. The five derivative measures, defined and developed in the last chapter were:

- 1) Perception
- 2) Stability
- 3) Operational Effectiveness
- 4) Leverage
- 5) Affordable Risk.

After considering the Soviet ideological differences, as well as the current Soviet political and technological status, as described in Chapter 2, three more specific surrogate measures evolved at the end of Chapter 4, as shown in Table 3.

TABLE 3
SURROGATE MEASURES AND THEIR MOPE

MOPE	Surrogate Measure
Perception	success of propaganda/counter propaganda campaign
Leverage	success of arms control negotiations
Stability	current economic status of each country

The purpose of this chapter is to discuss the possible quantification of the surrogate measures. This chapter will not produce any values or numbers for these measures. However, it will present suggestions that, with further research, could be developed into actual quantitative measures of SDI political effectiveness. The aggregation of values are beyond the scope of this thesis.

B. PERCEPTION - THE PROPAGANDA CAMPAIGN

Chapter 2 discussed the ongoing Soviet propaganda campaign, aimed at fomenting dissent in both the U.S. and Europe. The campaign has two basic components. The Soviets first want to instill fear in the public that any or all of the following are true:

- 1) SDI violates the 1972 ABM Treaty
- 2) SDI is not technically feasible
- 3) SDI will not lead to a safer world, but will instead cause an unprecedented arms race
- 4) If SDI is successful, it will decouple the NATO alliance.

At the same time the Soviets are publicizing the evils of SDI, the second part of their propaganda campaign is to present Soviet General Secretary Gorbachev as a peace loving individual willing to work towards arms control, only to have his initiatives refused by President Reagan.

The United States is also conducting a propaganda counter propaganda campaign, in which SDI is depicted as the greatest peace initiative ever proposed. President Reagan has even offered to share SDI technology, after it is developed, with the world, in the hopes of eliminating the need for nuclear weapons. In fact, SDI is being compared to the Kennedy administration goal of putting a man on the moon - a *technological challenge that the U.S. should be proud to meet.*

In terms of measuring the effectiveness of the U.S. campaign, and subsequently the perception MOPE, the major media sources - newspaper magazine, television, and radio - need to be considered. A major element in any good propaganda campaign is deception. An underlying assumption in the measurement of the surrogate measure is that each country's campaign would successfully mask the origin of the information so that the average citizen would not recognize that the information is propaganda. Furthermore, the U.S. and Soviet propaganda efforts will not be individually identifiable. Therefore, one way to measure the success of the U.S. campaign over the Soviet campaign, is to consider pro - SDI information as originating from the U.S. and anti - SDI information as originating from the Soviet Union. Another option would be to consider the positive and negative effects of the information on the average citizen's opinion of SDI. For the written media, the number of column inches of positive and negative propaganda can be measured. For television and radio broadcasts, the number of minutes allocated can be measured. Weighting factors would need to be

applied, such as assigning greater value to major news broadcasts, cover stories, headline stories, as opposed to the value give the less visible articles broadcasts. Another weighting factor to be considered is the cost of the campaign to each country and whether or not the country can afford that cost. [Ref. 13] Once all factors have been considered, a number can be assigned to each side, say

$$X_{us} \text{ and } X_{su}$$

Using these factors, a possible measurement of the effectiveness of the U.S. program could be found from applying a straight ratio test, such that

$$\text{if } X_{us} / X_{su} > 1$$

then the U.S. propaganda counterpropaganda campaign is more effective than the Soviet, and therefore from the perception point of view, SDI is successful.

To give a numerical example of this concept, suppose after tabulating the value for the positive negative SDI press coverage, the pro - Gorbachev coverage, and applying the appropriate weighting factors, the values for X_{us} and X_{su} were 150 and 160, respectively. It must be emphasized that these are not representative values, but merely assumed values to more clearly demonstrate the concept under discussion. These values are not scientifically determined, and have no bearing on the actual topic. With this in mind, continuing the example then indicates:

$$X_{us} / X_{su} = 150 / 160 = 0.9375 < 1.$$

The results of this fabricated example would indicate the Soviet campaign has been more successful. However, accurate results would require significant research and more complicated calculations, to properly account for all weighting factors. A more scientific analysis would still result in a degree of uncertainty.

C. STABILITY - ECONOMIC SHIFTS

One of the national goals of SDI is to provide a growing and stable U.S. economy. As explained in Chapter 2, the opposite side of this goal is to further pressure the already strained Soviet economy to the point where the Soviets would be forced to make significant cuts in their defense budget. In the U.S., trends such as the stock market, leading economic indicators, and consumer price indices can be evaluated, and the state of the economy determined. However, in their closed society, the Soviets do not openly publicize such economic statistics, and what is publicized is often fabricated. One source of such information is the CIA Economic Analysis. A more reliable, commonly available, indicator is the Gross National Product (GNP) of

each country. A comparison can be made to determine whether or not the relative growth of the GNP can support and maintain the relative growth of the defense budget resulting from SDI. If the U.S. growth can support SDI technological demands, but the Soviet growth cannot, then SDI has been effective as an economic stability threatening tool.

More specifically, in terms of measuring the surrogate measure of the economic shifts of the two countries, the average percent increase of each GNP over the past five years should be determined. Then, the percent of GNP spent on SDI technology by the U.S. and counter SDI technology by the Soviets could be calculated and averaged over the five years since President Reagan announced the SDI research program. Since it might be difficult to determine exactly what Soviet programs have SDI applications, another more general average of the percentage of GNP spent on defense could be calculated for the five years before and after SDI, enabling an estimate of percent spending on SDI counter SDI technology to be made.

The values obtained for each country would be:

- 1) Average percent growth of GNP for last five years
- 2) Average percent of GNP spent on defense before SDI
- 3) Average percent of GNP spent on defense after SDI
- 4) Average percent of GNP spent on SDI counter SDI programs.

For the sake of an example, let's assume the following values, shown in Table 4. Again, as in the previous section, these values are by no means accurate or representative. They simply present a means of clarifying the current discussion.

Country	% GNP Growth	%GNP on defense	% GNP on SDI
U. S.	3%	6%	1%
S. U.	0.7%	12%	4%

In this fabricated example it appears that U.S. economic growth can support the cost of SDI technology, but the Soviet economy is not growing at a rate that would support

the long term maintenance of the cost. This example, then, indicates the U.S. economy is in a more stable position.

D. LEVERAGE - ARMS CONTROL NEGOTIATIONS

Possibly the greatest indicators of the effectiveness of SDI as a policy making tool, as well as of the intensity of Soviet paranoia about SDI, came out of the last arms control talks, held in Iceland. It is extremely significant that every arms control proposal put forth by the Soviets was contingent upon restrictions and limitations on the U.S. SDI program, even in the research phase. This shows that, carefully used, SDI can present itself as an effective negotiating chip. At this early stage, concessions might not affect the system's long run operational capabilities. Schedule delays, as offered by President Reagan, can work to U.S. advantage. If the program is already behind schedule, why not offer to delay deployment in return for Soviet offensive limitations?

The Soviets are, however, extremely clever negotiators, and if a proposal seems too good to be true, it probably is. In reality, the effectiveness of SDI as a bargaining tool must be carefully evaluated. The number of warheads missiles to be reduced in the Soviet arsenal is not as significant as the type, age, location and capability of those weapons. Therefore, the effort to quantify the leverage measure from the Soviet side should not deal with specific numbers of weapons disarmed, but with more effectiveness oriented measures like the decline of force effectiveness. An example of this could be a measure of the total megatonnage of the Soviet versus U.S. ICBM forces after negotiations and concessions relating to SDI have been made. Likewise, measurement of U.S. SDI limitations should not deal with the number of platforms weapons conceded, but rather with the decrease of the efficiency of the SDI system itself.

It is obvious that of the three derivative measures presented this is the most difficult to quantify, because of the difficulties in verification of arms control, complicated by the closed nature of the Soviet society. However, based on the numbers and specifications generated by future arms control discussions, it could be possible, albeit difficult, to quantify the leverage MOPE in the near future.

E. SUMMARY

This chapter has presented several possibilities for the quantification of three surrogate measures developed from the derived MOPEs of perception, stability, and

leverage, which resulted from the application of the MCES in the previous chapter. While some surrogate measures were more easily quantified than others, and only the perception MOPE is clearly quantifiable at this time, the leverage and stability MOPEs have the potential to be quantified in the near future. Continued reasearch in this area should provide a useful product to the decision makers prior to their 1990 development decision.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This thesis has shown that the Soviet responses, to date, to the SDI research and development program are significant enough to indicate some level of political effectiveness of SDI. The MCES was chosen as the methodology to evaluate this level of effectiveness, and has proven to be a robust tool leading to the development of measures of effectiveness. At the 1986 SDI MCES/MOE workshop, the overall political SDI working group applied the MCES to the policy issues of SDI, with respect to the national goals, and derived a set of MOPEs. This thesis has incorporated Soviet ideological and conceptual differences into the working group application, modifying the workshop results accordingly. Finally, this thesis has shown that not only can MOPEs be derived for SDI at this point, but that they can also potentially be quantified.

Of the five MOPEs derived at the workshop, Perception, Stability, and Leverage demonstrated the greatest potential for quantification at this time. A surrogate measure of effectiveness for each MOPE was defined in order to produce a measurable quantity. The success of the propaganda campaigns measure was developed to assist in the quantification of the perception MOPE. The success of arms control negotiations measure was used to begin quantifying the leverage MOPE. The comparison of the current economic status of the U.S., Soviet Union was used to assist in the quantification of the stability MOPE. The determination of actual values for the measures exceeded the scope of this thesis. However, specialists in this field, with a considerable amount of effort, could produce actual values.

B. RECOMMENDATIONS

Future work with the MCES on this issue should to concentrate on the application of Modules 6 and 7, data generation and aggregation of measures, respectively. SDIO faces the difficult task, in 1990, of convincing Congress that funding development of the SDI research program should continue and expand. Attempting to secure funding from Congress for any purpose is hard; securing funding for a controversial program like SDI will be even more difficult. Therefore, if the MCES can be exploited to its fullest potential, and Modules 6 and 7 used to produce

actual values relating to the effectiveness of SDI, the SDIO staff can present some concrete evidence to Congress, furthering their case for the continuation of SDI.

APPENDIX MCES FIGURES

This appendix contains the most current MCES figures available at the time of this research. However, the MCES is an evolving methodology. As such, the figures are subject to constant modification.

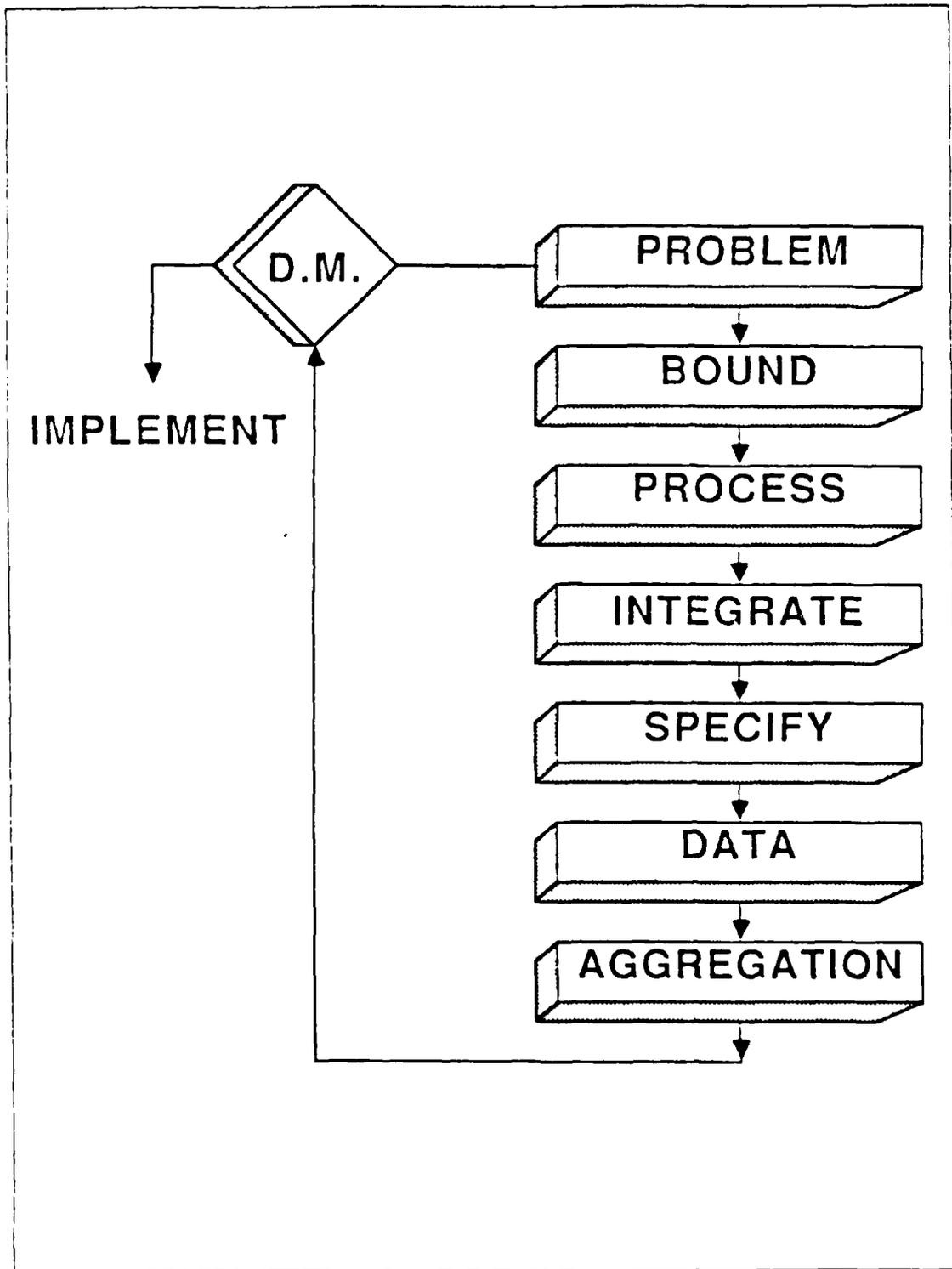


Figure A.1 The MCES Methodology.

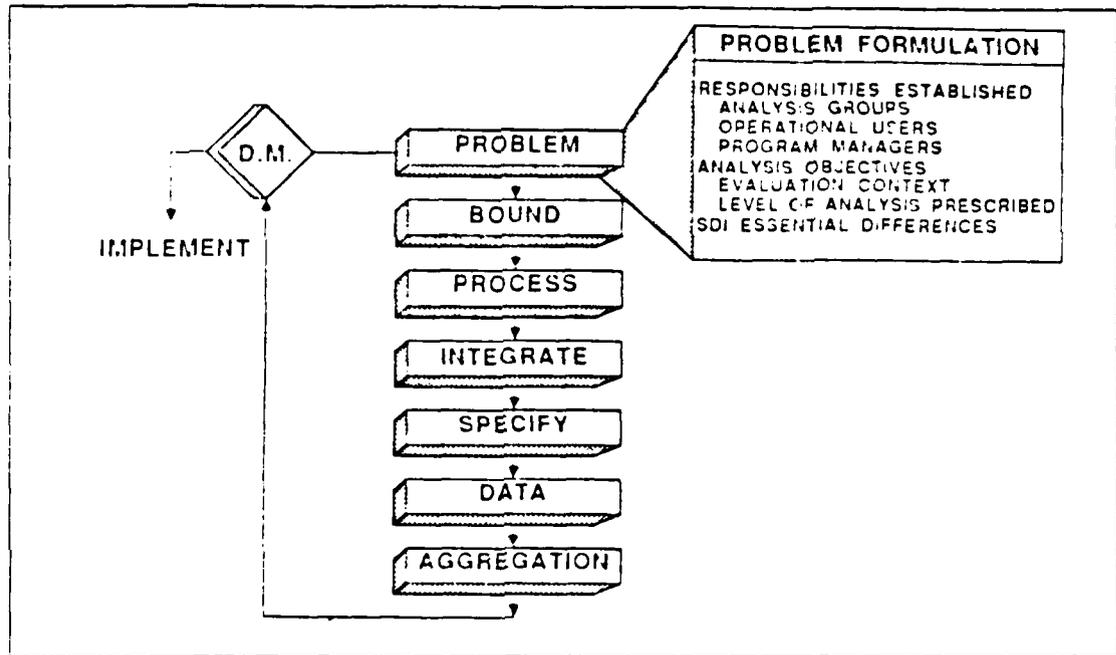


Figure A.2 Module 1: Problem Formulation.

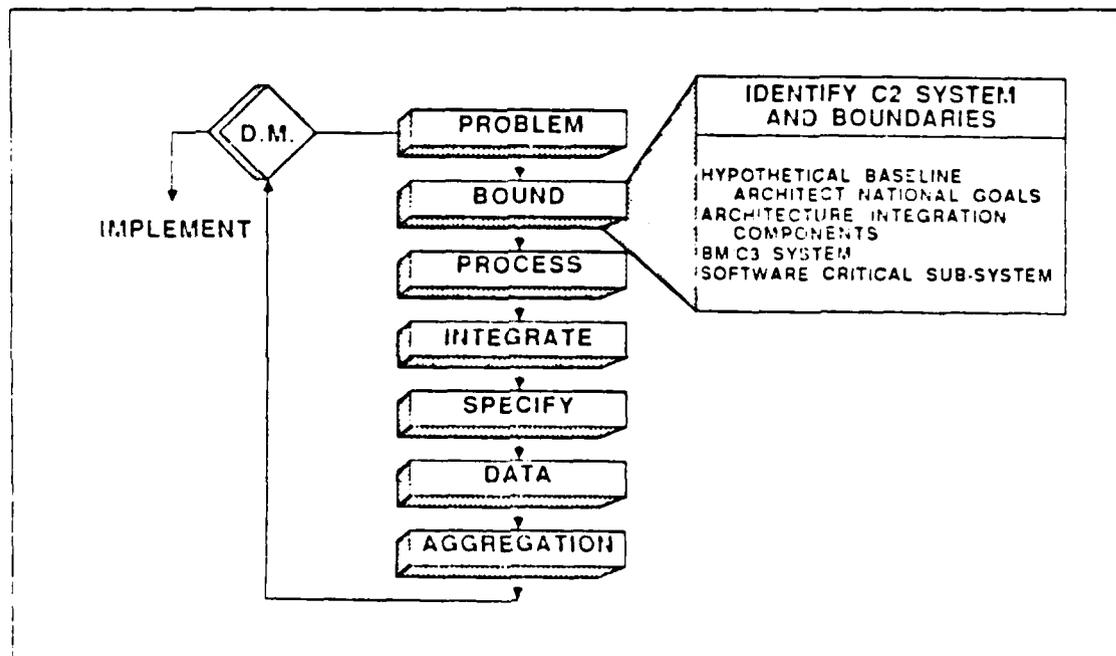
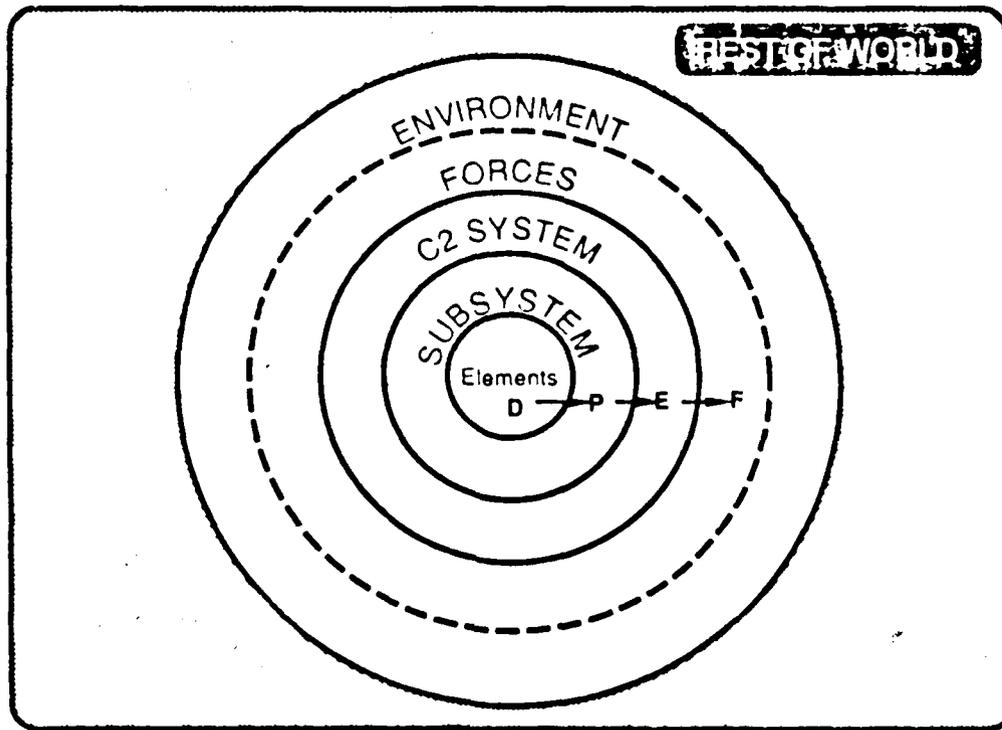


Figure A.3 Module 2: System Bounding.



D = DIMENSION
 P = PERFORMANCE

E = EFFECTIVENESS
 F = FORCE OUTCOME

Figure A.4 The Onion Skin.

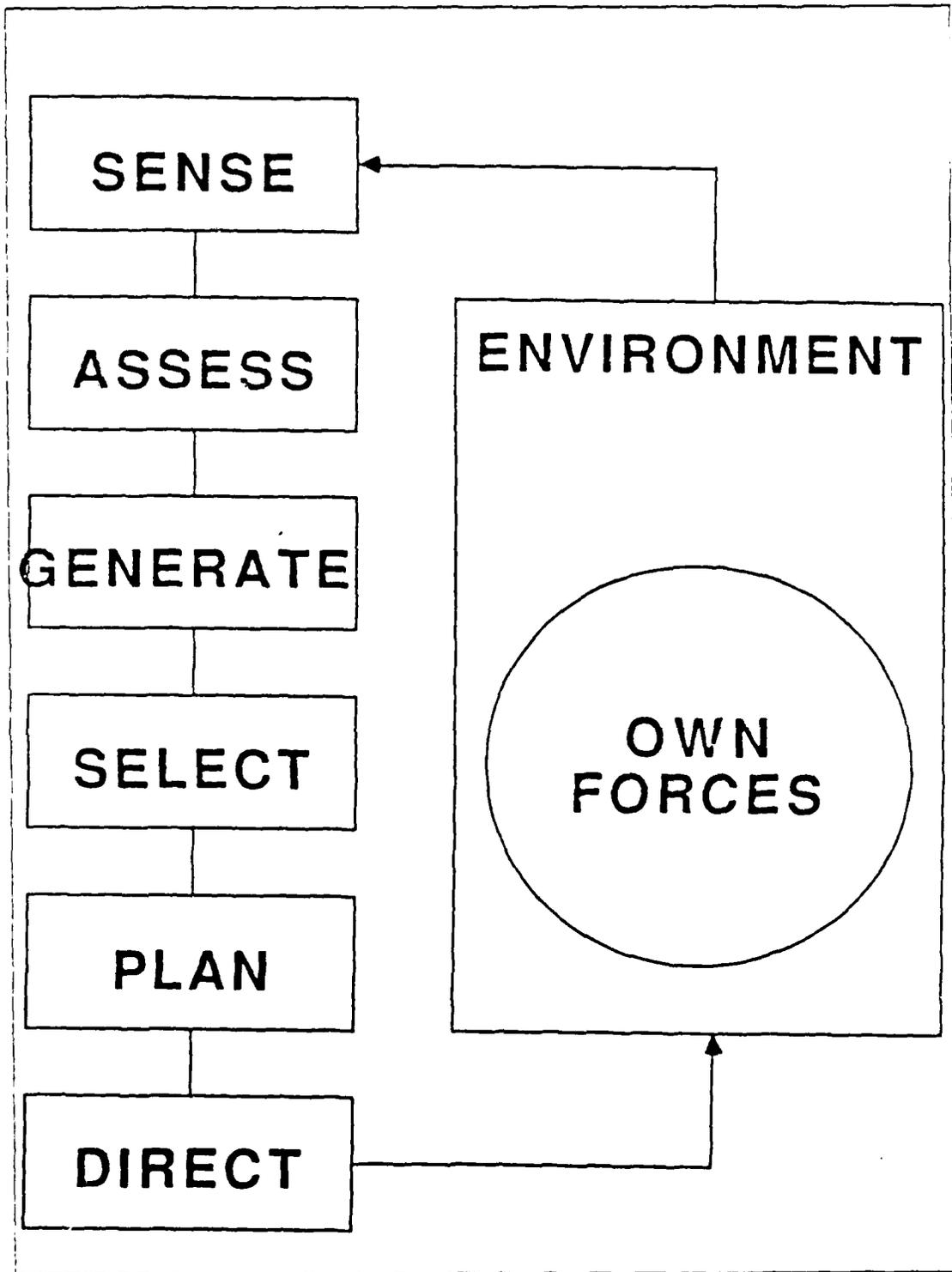


Figure A.5 Generic C2 Process.

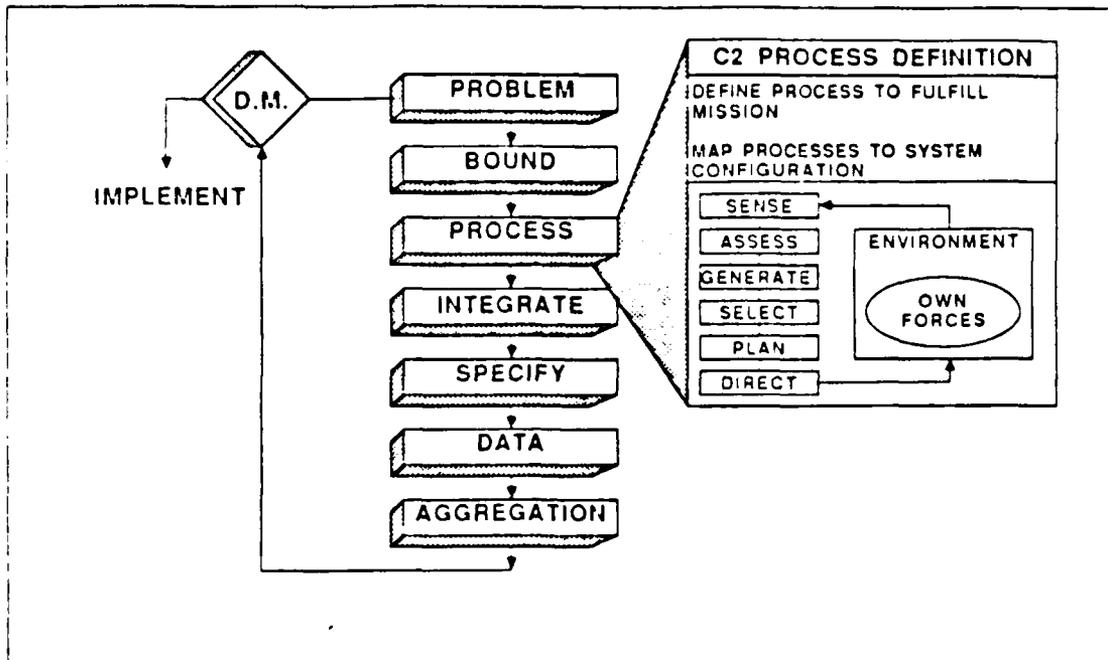


Figure A.6 Module 3: Process Definition.

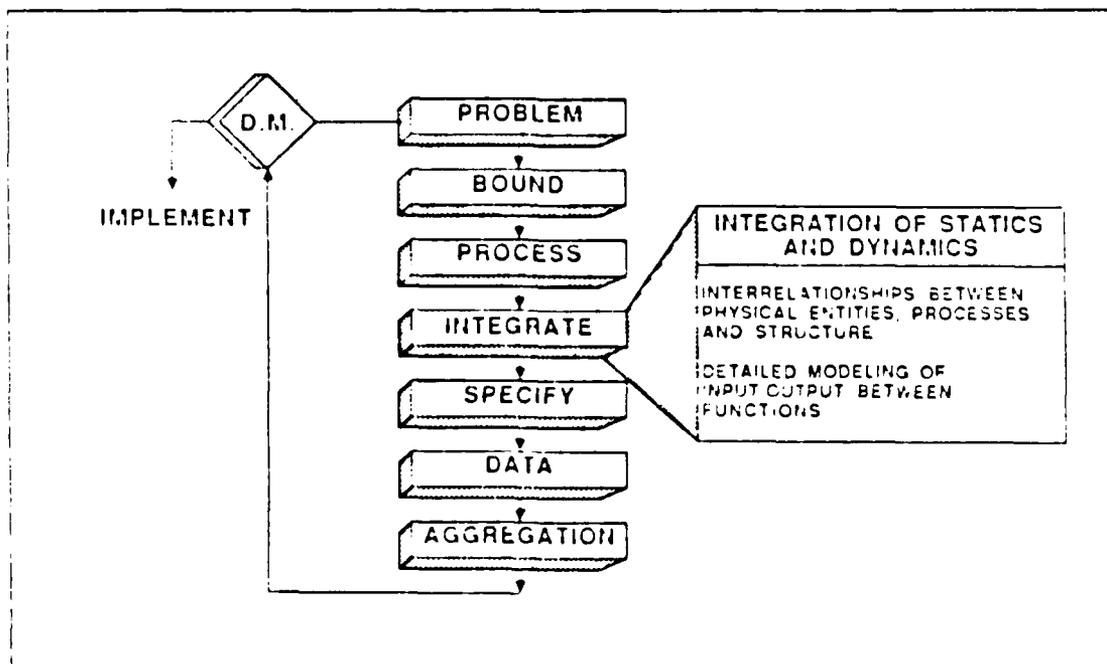


Figure A.7 Module 4: Integration of Statics Dynamics.

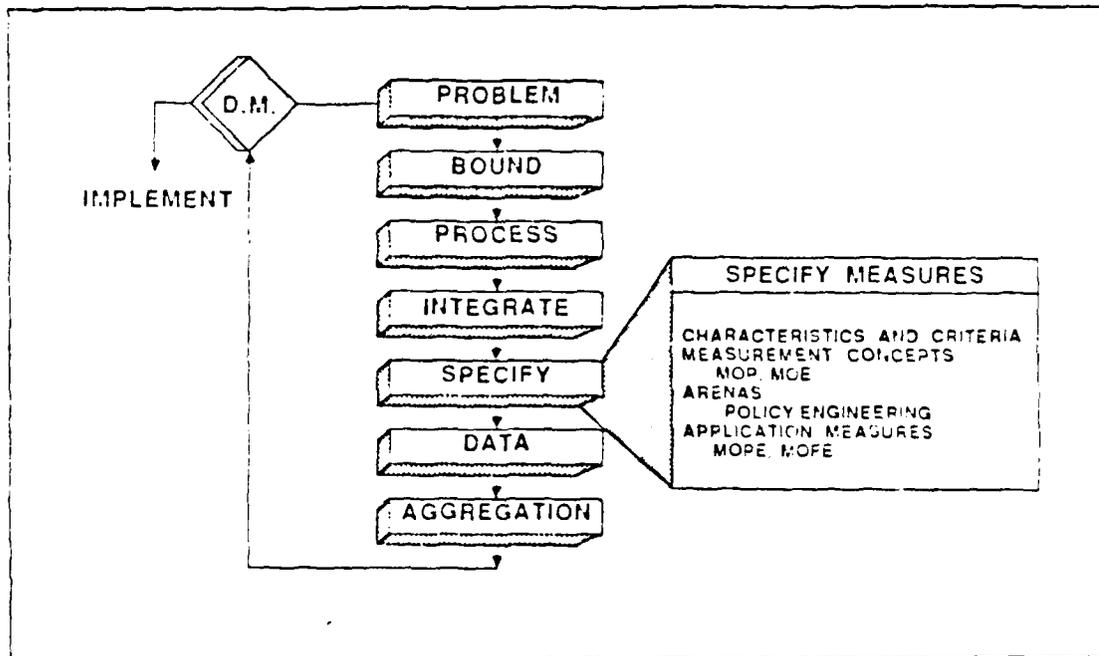


Figure A.8 Module 5: Specification of Measures.

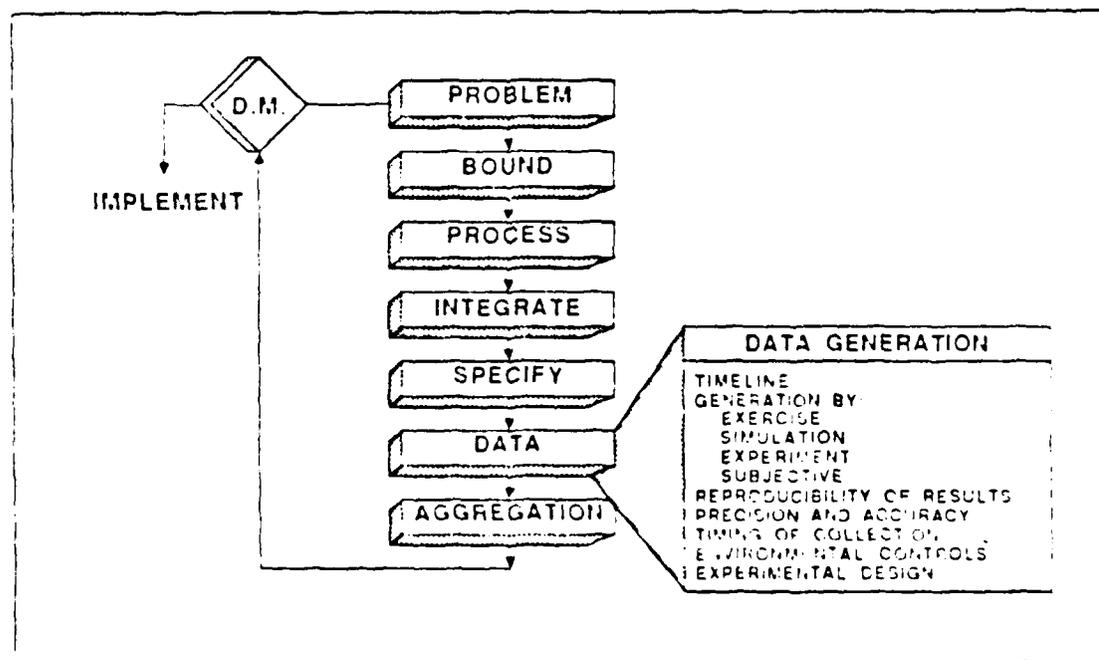


Figure A.9 Module 6: Data Generation.

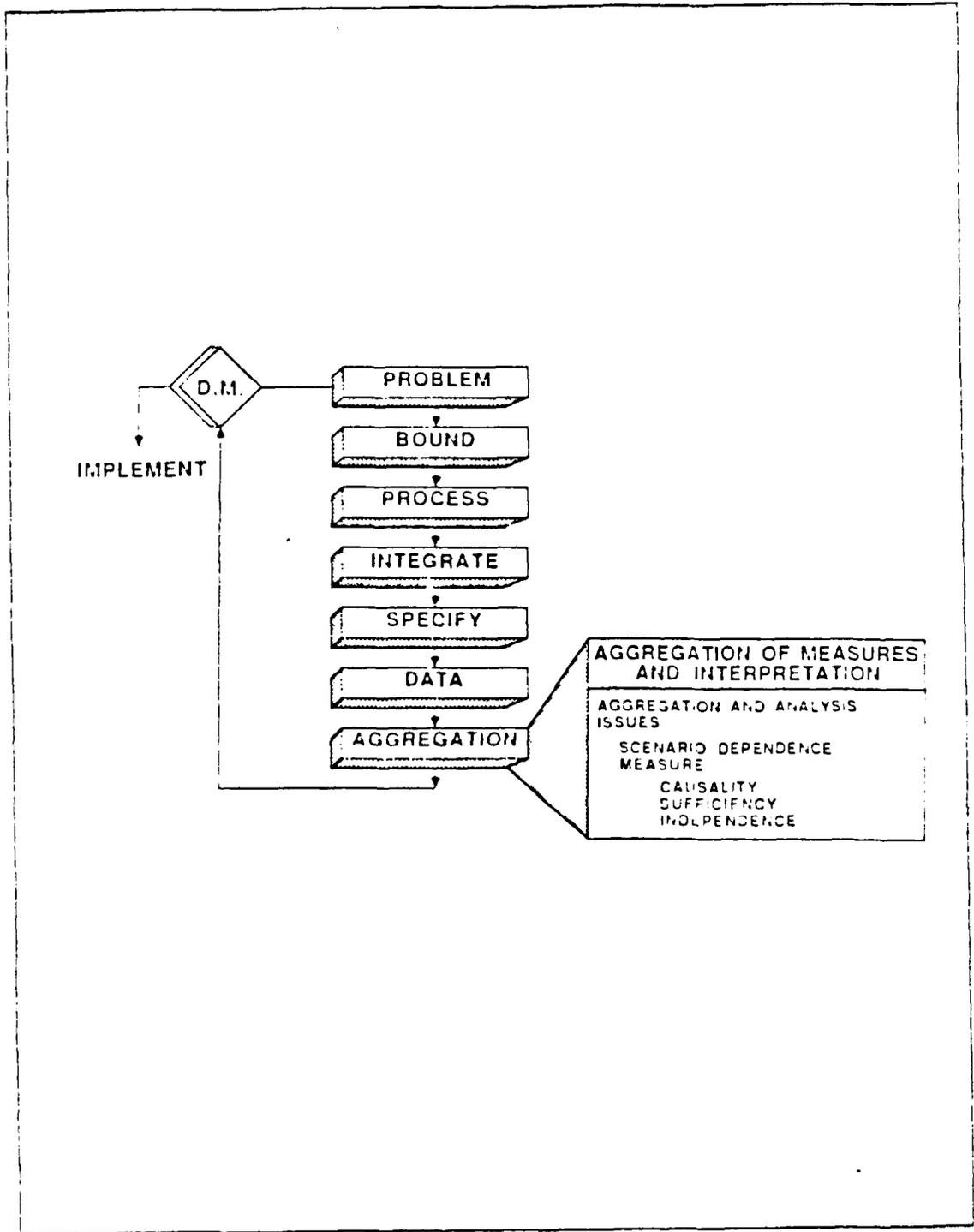


Figure A.10 Module 7: Aggregation of Measures.

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