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Determining the Value of Future Information

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THESIS

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AFIT/OR-MS/ENS/11-20

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Abstract

Companies continuously struggle to quantify the value of their information in an attempt to gain a better understanding of the return on investment of their information technology (IT) architecture. One approach companies have taken to place a numeric value on information is to treat it as a traditional economic asset (e.g. equipment, buildings, and vehicles) that is governed by its own unique set of laws. Once an enterprise understands the behavior of information it can incorporate Skyrme's "10 value adding aspects of information" when developing IT architecture, thus maximizing the potential value of their information. Like most enterprises, the Intelligence Community (IC) is continuously trying to assess the value of their Intelligence Sharing Architecture. Currently, work is being done inside the Department of Defense (DoD) using Value Focused Thinking (VFT) to compare the value of different Intelligence, Surveillance and Reconnaissance (ISR) force mixtures. The current ISR force sizing study is very beneficial for evaluating today's ISR force mixtures, but little research has been done to evaluate the ISR force mixtures of the future. This research will present a generic methodology allowing any enterprise to determine the value of future IT architecture; specifically, it will be applied to the IC for determining the value of intelligence gathering capabilities for the year 2040.

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To my family

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James J. Springston

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I. Introduction

Background

"When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it your knowledge is of a meager and unsatisfactory kind."

- Lord Kelvin

To better understand its return on investment, most companies have methods for determining the value of their traditional economic goods (e.g. vehicles, real-estate, equipment, etc). However, trying to quantitatively express the value of these goods becomes more difficult the farther into the future they are projected. For example, an enterprise might know the fair market value of its office park today, but it is difficult for it to forecast what it may be worth in 30 years. Because the future holds so many unknowns, determining the value of assets decades into the future can be extremely difficult.

More difficult than determining the value of physical assets is determining the value of intangible assets (e.g. information). One way companies have tried to think about the value of information is by treating it as an asset. However, most companies still struggle to develop techniques for determining the value of information. For the same reasons it is difficult to

determine the value of physical assets years into the future, it can be even more difficult for an enterprise to determine the value of future information.

Problem Statement

This research presents a methodology that allows an enterprise to identify the high-value information gathering capabilities of the future. Since the information of the future is not yet available to collect, an enterprise is unable to assign value to a specific piece of data. However, with the methodology presented in this research, an enterprise is able to gain insight into which attributes of information can be exploited to maximize the potential value of information. When implemented properly, this methodology can help identify gaps between current capabilities and future requirements, thus guiding future system development.

Research Scope

"Information is increasingly being recognized as a key economic resource and as one of the firm's most important assets" (Moody and Walsh, 1994). As a result, many of today's enterprises view information as a strategic asset worth spending significant amounts of money collecting, storing, processing, and maintaining it. Not all information an enterprise manages is strategic, but when it is, decisions affecting it require a structured approach following a formal decision making process (Kirkwood, 1997).

In his book, *Making Strategic Decisions*, Kirkwood recommends the following five steps when making a strategic decision: 1) specify objectives and scales for measurement, 2) develop alternatives that achieve the objectives, 3) score alternatives, 4) consider trade-offs among objectives, and 5) select alternatives (1994). Since Value Focused Thinking (VFT) accomplishes

all five of these steps, plus a few more, this research uses VFT to evaluate information gathering capabilities.

The VFT method can be expressed as a 10-step process (Shoviak, 2001). However, the purpose of this research is to present a generic methodology allowing any enterprise to evaluate its information gathering capabilities. Therefore, it is not necessary to analyze all 10 steps of VFT to develop a methodology. For example, since this research is not evaluating alternatives, it did not generate alternatives. Instead, this research provides an in-depth analysis on the three steps needed to support a VFT methodology: problem identification, creating a value hierarchy, and weighting a value hierarchy. Future research will need to develop evaluation measures, create value functions, generate alternatives, score alternatives, perform deterministic analysis, and perform sensitivity analysis.

Thesis Organization

This research reviews the relevant literature, presents a generic methodology, provides a case-study employing the methodology, and presents recommendations for follow-on research.

Literature Review

In order to lay a solid foundation for the methodology being presented, Chapter 2 provides an extensive literature review. First, literature is presented showing that information is an asset capable of possessing value. Second, intelligence's role in the Intelligence Community (IC) and its support to military operations is examined to support the case study. Third, the 10-step VFT process is presented as a means of quantitatively evaluating alternatives. Fourth, two cases of how the Department of Defense (DoD) has employed VFT to support strategic decisions

is reviewed. Lastly, since the case study used throughout this research deals with future military intelligence, a synopsis of the Quadrennial Intelligence Community Review's (QICR) four future scenarios is presented.

Methodology

Although this research uses a DoD and IC focused case study, the methodology presented can be implemented by any enterprise. Chapter 3 presents the methodology in sequential steps. Each step is generic enough to be easily adapted to an enterprise's specific situation. However, after each step, an example of how that step was applied to the Defense Intelligence Agency's (DIA) problem is presented. The methodology presented in Chapter 3 walks an enterprise through defining its problem statement, building a qualitative hierarchy, transforming an "over-sized" hierarchy into a "small" hierarchy, and weighting the hierarchy using a new method.

Analysis

As Chapter 3 presents the generic steps for building, transforming, and weighting a qualitative hierarchy, the case study in Chapter 4 presents a step-by-step example for how the DIA's qualitative hierarchy is built.

Conclusion

This research primarily focuses on three of the 10 VFT process steps, but also provides recommendations for how two of the other steps should be carried out. Based on the insights gained from the literature review, Chapter 5 provides recommendations for developing

appropriate evaluation measures, and also identifies an obstacle future research will encounter when scoring alternatives.

II. Literature Review

Value of Information

Information as an Asset

The Federal Accounting Standards Advisory Board (FASAB) defines an asset as "a resource that embodies economic benefits or services that the federal government controls" (FASAB, 2007:1). There are two essential characteristics a federal government asset must possess in order to be considered an assett:

> To be an asset of the federal government, a resource must possess two characteristics. First, it embodies economic benefits or services that can be used in the future. Second, the government controls access to the economic benefits or services and, therefore, can obtain them and deny or regulate the access of other entities. (FASAB, 2007:10)

Although the FASAB's definition and essential characteristics of an asset refer to federal government resources, the terminology can also be applied to the resources of various enterprises. When determining the future value of information an enterprise needs to ensure the information of interest satisfies the enterprise's definition and "essential characteristics" of an asset. If the enterprise doesn't have its own definition and set of characteristics to define an asset, it should borrow them from a similar enterprise and modify if necessary.

The Seven Laws of Information

Once an enterprise identifies its information assets it must remind itself that information assets behave differently than traditional economic goods. "Information does not obey the same laws of economics that other assets do. It has its own unique properties which must be

understood in order to measure its value" (Moody and Walsh, 1999:4). A traditional economic good demonstrates properties like divisibility, appropriability, scarcity and decreasing returns to use. Moody and Walsh (1994:4) define the following seven laws of information "which govern its behavior as an economic good":

1. Information is (infinitely) sharable. Information has the ability to be shared simultaneously by several people, who may be geographically separated, without a loss in value.

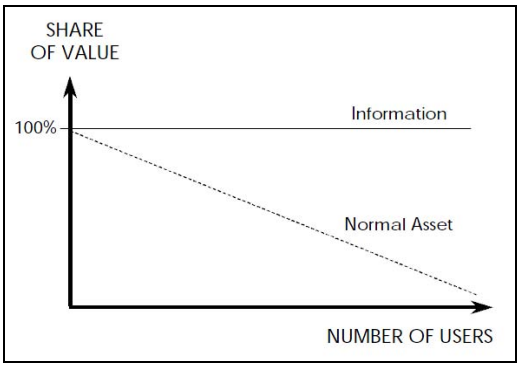


Figure 1. Shareability of Information (Moody and Walsh, 1994)

2. The value of information increases with use. Unlike traditional economic goods for which the value decreases with use (e.g. automobiles), information's value increases with use. The major cost of information is in its capture, analysis, storage and maintenance. However, information can be reused by analysts and decision makers (DM) over and over, providing the same measure of value each time. Economic goods, if never used,

can retain a vast majority of their value. On the contrary, unused information possesses zero value and is detrimental to the enterprise because it has already invested in collecting, analyzing, and storing the information.

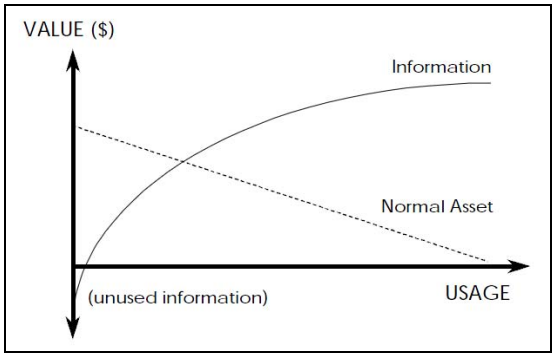


Figure 2. The Value of Information Increases with Use (Moody and Walsh, 1994)

3. Information is perishable. The value of information is time sensitive and decreases over time. The rate at which information loses value is dependent on the type of information. Information on an enterprise's yearly earnings may be valuable for years (e.g. forecasting). However, information about a particular stock may only be valuable for a few hours.

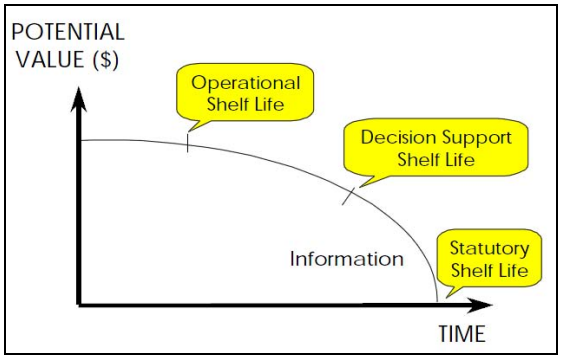


Figure 3 Depreciation of Value Over Time (Moody and Walsh, 1994)

4. The value of information increases with accuracy. The more accurate the information, the more confidence can be placed in a decision based on that information, thus increasing the value of the information. If information is not accurate and the DM is unaware of its inaccuracy, decisions can be made that damage the enterprise. Inaccurate information provides negative value to an enterprise.

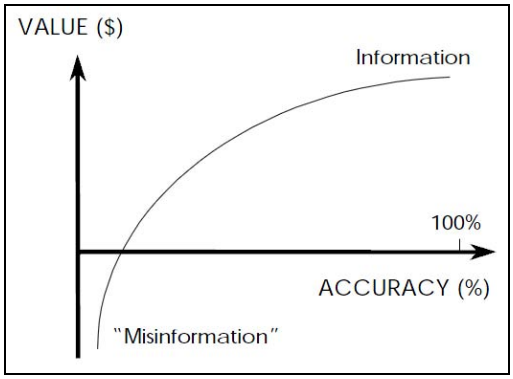


Figure 4. Value Increases with Accuracy (Moody and Walsh, 1994)

5. The value of information increases when combined with other information. Typically information becomes more valued when it is merged with other information. "For example, customer information and sales information are each valuable information on their own. However, being able to relate the two sets of information together is infinitely more valuable from a business viewpoint" (Moody and Walsh, 1999:8). Being able to combine different types of information to form a better representation of the decision context is very valuable to a DM. Following the Pareto Principle (or 80/20 rule), integrating 20% of the data generally leads to 80% of the benefits. Integrating beyond that point may have diminishing returns and be counterproductive.

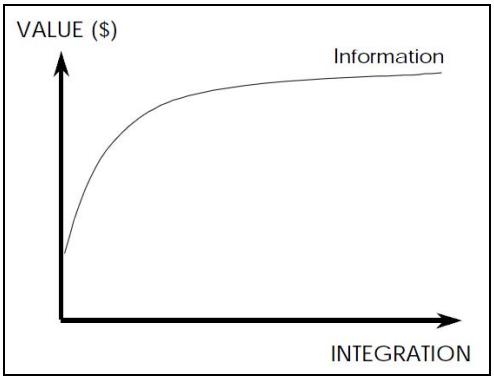


Figure 5. Value Increases with Integration (Moody and Walsh, 1994)

6. More information is not necessarily better. When referring to conventional economic goods, having more of a resource is generally considered better for the enterprise. On the contrary, information does not fall into this category, and many times organizations can

have too much information to digest. Psychological evidence has shown that humans have a finite amount of information they can process before reaching information overload.

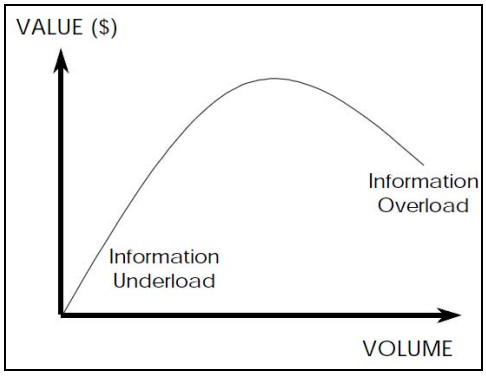


Figure 6. Volume vs. Value of Information (Moody and Walsh, 1994)

7. Information is not depletable. With traditional economic goods, the more the good is used, the less is left of that good. However, information does not follow this pattern; information is "self-regenerating or feeds on itself." The more information is analyzed and merged with other information the more it spawns new information (Glazer, 1993:101). This characteristic of information arises from the fact that information is infinitely sharable and that the value of information increases when combined with other information.

This research agrees that an enterprise can add value to their information by following Moody and Walsh's "7 Laws of Information." However, an enterprise must evaluate the value of their information within a specific context. For example, the Emergency Alert System (EAS) is a national warning system that allows information to be passed from government officials to U.S. citizens within a matter of minutes. The government wants as many citizens to receive the information as possible; therefore the value of the information communicated via EAS increases as the number of citizens it is shared with increases.

However, there are other enterprises (e.g. Department of Defense) that do not want certain types of information shared with people outside the organization. For example, the capabilities of certain U.S. satellites are kept classified, and only divulged with those people with the proper clearance and the need to know. If this classified information was shared with people for whom it was not intended, the value of the information could decrease.

With the EAS, the more the information is shared, the more value the information possesses. When it comes to the military's classified information, the more people information is shared with the greater the risk for decreasing the information's value. Basically, Moody and Walsh's "7 Laws" should be taken in the context of each individual enterprise.

Desirable Qualities of Information

Once an enterprise identifies its information assets and understand the laws that govern its behavior, the enterprise must determine if its information is providing value to the organization. If an enterprise invests money in its IT architecture, it does not necessarily follow that their information will provide value to the enterprise. When assessing the value of information desirable qualities include: relevance, timeliness, availability, comparability, objectivity,

sensitivity, conciseness, completeness, quantifiability, and quality. Relevance, timeliness, and availability are necessary for information to have value; the other attributes are useful but only need be present and are required in varying degrees (Nichols, 1969:3).

10 Value Adding Aspects of Information

If an enterprise successfully identifies information that is capable of providing value it can maximize the information's value by employing Skyrme's "10 value adding aspects of information" (1994). By using the "10 value adding aspects of information," an enterprise can "increase the user experience and usefulness of the information needed" (Engelsman, 2007:2).

1. **Timeliness**. As discussed earlier, all information is perishable, but different types of information have different shelf lives. An enterprise must determine what kind of decision the information is going to support and the timeframe of the decision. Once the timeframe of the decision has been determined an enterprise can determine how timely the information will need to be in order to support the decision.

2. **Accessibility**. How easy is the information to find and retrieve by those who need the information? The easier information is to find and retrieve, the quicker the information can be used to support a decision.

3. **Usability**. When information is relevant to the decision at hand and presented in a format that the DM can apply to the problem, the information becomes more valuable to the DM.

4. **Utility**. When one piece of information is capable of being used for several purposes it can support multiple decisions, making it more valuable than the same information used for a single purpose.

5. **Quality**. In order for information to add value, it must be of quality to the DM. The information's accuracy and credibility need to be of the highest standards. Accurate information from an unreliable source will most likely not be used to support the decision, and unused information provides zero value. On the other hand, inaccurate information from a trusted source may cause a DM to make a poor decision and provide negative value.

6. **Customized**. Information needs to be tailored to its user's specifications. The user needs to be able to receive the right information, at the right level, and in the correct format so that the information can be quickly applied to the decision at hand. Time wasted reformatting or reanalyzing the information is time lost, decreasing the information's value.

7. **Portability**. If information is to be accessible and used in a timely manner it must be maintained in a medium appropriate for portability and ongoing use. A single DM or multiple DMs may need the ability to travel with the information and access it at various locations or even on the move.

8. **Repackaging**. Once analyzed by one user, information may need to be tailored and passed to other users downstream for collaboration or new user-specific purposes. The capability to manipulate information to match downstream users' formats aids in customization, utility, and usability of the information, thus increasing its value.

9. **Flexibility**. The purpose of making information flexible is to make it easy to process, and it can be used in different ways.

10. **Reusability**: The more information is used, the more it will be refined whether it is the same user looking at the information later (possibly with new information in hand) or repackaged information accessed by a new user. Reusability increases information's value by building on information's ability to be shared infinitely and that information's value increases with use.

One enterprise that handles large amounts of information is the Intelligence Community (IC). The IC is constantly trying to determine which information is providing value and how they can increase the value of the information they collect.

The Intelligence Community

Intelligence as Information

According to Joint Publication 2 (JP 2), which "reflects the current guidance for conducting joint and multinational intelligence activities across the range of military operations," information that stands alone is just a truth or series of truths that may be of use to a DM.

However, when information is connected to other pieces of information about the operational environment, and takes into account the prior actions of an adversary, it takes the shape of a new type of fact called "intelligence." Information is turned into intelligence through a process of "relating one set of information to another or the comparing of information against a database of knowledge already held and the drawing of conclusions by an intelligence analyst." Once information has been turned into intelligence it can differentiate various courses of action (COA) by allowing DMs to "anticipate or predict future situations and circumstances" (JP 2, 2007:ix).

In order to acquire intelligence, intelligence operations need to be conducted by intelligence organizations with the purpose of providing DMs with "relevant, accurate, and timely intelligence." There are six categories of intelligence operations: planning and direction, collection, processing and exploitation, analysis and production, dissemination and integration, and evaluation and feedback (JP 2, 2007:I-6).

6 Categories of Intelligence Operations (JP 2, 2007:x-xi)

> **Planning and Direction**. Intelligence planning for rapid response to possible crises occurs well ahead of time as part of a command's overall joint operation planning process. The most likely threat scenarios are used as the core of this planning effort, which includes determining the personnel, equipment, and intelligence architecture essential for generic support to force deployments. When a particular crisis situation unfolds, planners develop an operation order (OPORD).
> **Collection**. Collection includes those activities related to the acquisition of data required to satisfy the requirements specified in the collection plan. Collection operations management involves the direction, scheduling, and control of specific collection platforms, sensors, and human intelligence sources and alignment processing, exploitation, and reporting resources with planned collection.
>
> **Processing and Exploitation**. During processing and exploitation, raw collected data is converted into forms that can be

readily used by commanders, decision makers at all levels, intelligence analysts and other consumers.

Analysis and Production. During analysis and production, intelligence is produced from the information gathered by the collection capabilities assigned or attached to the joint force and from the refinement and compilation of intelligence received from subordinate units and external organizations. All available processed information is integrated, evaluated, analyzed, and interpreted to create products that will satisfy the commander's priority intelligence requirements or request for information.

Dissemination and Integration. During dissemination and integration, intelligence is delivered to and used by the consumer. Dissemination is facilitated by a variety of means. The means must be determined by the needs of the user and the implications and criticality of the intelligence.

Evaluation and Feedback. During evaluation and feedback, intelligence personnel at all levels assess how well each of the various types of intelligence operations are being performed.

Seven Intelligence Disciplines

JP 2 defines a set of fundamental principles which are "intended to contribute to effective and successful joint intelligence operations (JP 2, 2007: II-1). One of these fundamental principles of Joint Intelligence is "fusion". "Fusion is the process of collecting and examining information from all available sources and intelligence disciplines to derive as complete an assessment as possible of detected activity" (JP 2, 2007:xiv). There are seven distinct intelligence disciplines that involve planning, collection, processing, exploitation, analysis and production, and dissemination, each using a specific type of technical or human resource. These seven disciplines are fused together to "complement and support analytic conclusions in an integrated, multidiscipline approach to intelligence analysis" for all military operations (JP 2, 2007:I-5).

Seven Intelligence Disciplines (JP 2, 2007:Appendix B)

Geospatial Intelligence (GEOINT). GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the earth. GEOINT consists of imagery, IMINT, and geospatial information.

Human Intelligence (HUMINT). HUMINT is a category of intelligence derived from information collected and provided by human sources. This includes all forms of information gathered by humans, from direct reconnaissance and observation to the use of recruited sources and other indirect means. This discipline also makes extensive use of biometric data (e.g., fingerprints, iris scans, voice prints, facial/physical features) collected on persons of interest.

Signals Intelligence (SIGINT). SIGINT is intelligence produced by exploiting foreign communications systems and noncommunications emitters. SIGINT provides unique intelligence information, complements intelligence derived from other sources and is often used for cueing other sensors to potential targets of interest. For example, SIGINT which identifies activity of interest may be used to cue GEOINT to confirm that activity. Conversely, changes detected by GEOINT can cue SIGINT collection against new targets.

Measurement and Signatures Intelligence (MASINT). MASINT is scientific and technical intelligence obtained by quantitative and qualitative analysis of data (metric, angle, spatial, wavelength, time dependence, modulation, plasma, and hydro-magnetic) derived from specific technical sensors for the purpose of identifying any distinctive features associated with the target, source, emitter, or sender. The measurement aspect of MASINT refers to actual measurements of parameters of an event or object such as the demonstrated flight profile and range of a cruise missile. Signatures are typically the products of multiple measurements collected over time and under varying circumstances. These signatures are used to develop target classification profiles and discrimination and reporting algorithms for operational surveillance and weapon systems.

Open-Source Intelligence (OSINT). OSINT is based on publicly available information (i.e., any member of the public could lawfully obtain the information by request or observation), as well as other unclassified information that has limited public distribution or access. Examples of OSINT include on-line official and draft documents, published and unpublished reference material, academic research, databases, commercial and noncommercial websites, "chat rooms," and web logs ("blogs"). OSINT complements the other intelligence disciplines and can be used to fill gaps and provide accuracy and fidelity in classified information databases.

Technical Intelligence (TECHINT). TECHINT is derived from the exploitation of foreign materiel and scientific information. TECHINT begins with the acquisition of a foreign piece of equipment or foreign scientific/technological information. The item or information is then exploited by specialized, multi-service collection and analysis teams. These TECHINT teams assess the capabilities and vulnerabilities of captured military materiel and provide detailed assessments of foreign technological threat capabilities, limitations, and vulnerabilities.

Counterintelligence (CI). CI is similar to, and often confused with HUMINT, as CI uses many of the same techniques for the information collection. CI obtains information by or through the functions of CI operations, investigations, collection and reporting, analysis, production, dissemination, and functional services. CI is not solely a collection discipline, however, and also acts upon information for both offensive and defensive purposes, in coordination with other intelligence disciplines, law enforcement and/or security elements.

Range of Military Operations

The Department of Defense (DoD) utilizes a variety of military capabilities to support national security interests, both at home and abroad, throughout a wide range of military operations (Figure 7) (JP 3, 2010:I-6). "Military operations vary in size, purpose, and combat intensity," and can be grouped into three categories: (1) military engagement, security cooperation, and deterrence, (2) crisis response and limited contingency operations, and (3)

major operations and campaigns (JP 3, 2010:I-7). "The nature of the security environment may require US military forces to engage in several types of joint operations simultaneously across the range of military operations" (JP 3, 2010:I-8).

Although JP 3 breaks down the various types of military operations into three distinct categories, "a particular type of operation is not doctrinally fixed and could shift within that range (e.g., counterinsurgency operations that escalate from a security cooperation activity into a major operation or campaign)" (JP 3, 2010:I-8).

Figure 7. Types of Military Operations (JP 3, 2010)

Military Engagement, Security Cooperation, and Deterrence

Military engagement, security cooperation, and deterrence operations "establish, shape, maintain, and refine relations with other nations and domestic civil authorities" (JP 3, 2010:I-8). Military engagements are characterized by "routine contact and interaction between individuals or elements of the Armed Forces of the United States and those of another nation's armed forces,

or foreign and domestic civilian authorities or agencies to build trust and confidence, share information, coordinate mutual activities, and maintain influence" (JP 3, 2010:I-8). Security cooperation involves establishing relationships with foreign nations in order to "build defense relationships that promote specific US security interests, develop allied and friendly military capabilities for self-defense and multinational operations, and provide US forces with peacetime and contingency access to a host nation (HN)" (JP 3, 2010:I-8). "Deterrence helps prevent adversary action through the presentation of a credible threat of counteraction" (JP 3, 2010:I-9).

Military engagement, security cooperation, and deterrence activities cover a wide range of military operations. Joint forces may be called to support other government agencies (OGA) and intergovernmental organizations (IGO) (e.g., United Nations (UN), North Atlantic Treaty Organization (NATO)) in order defend national security interests and deter potential conflicts. Below is a list of the different types of military engagement, security cooperation, and deterrence operations defined by Joint Publication 3 (JP 3) (2010:VII 2-9).

> **Emergency Preparedness (EP).** EP encompasses those planning activities undertaken to ensure DoD processes, procedures, and resources are in place to support the President and SecDef in a designated national security emergency.
>
> **Arms control and disarmament** means the identification, verification, inspection, limitation, control, reduction, or elimination of armed forces and armaments of all kinds under international agreement including the necessary steps taken under such an agreement to establish an effective system of international control or to create and strengthen international organizations for the maintenance of peace.
>
> **Combating Terrorism.** This effort involves actions taken to oppose terrorism from wherever the threat exists. It includes antiterrorism - defensive measures taken to reduce vulnerability to terrorist acts - and counterterrorism - offensive measures taken to

prevent, deter, preempt, and respond to terrorism. **Antiterrorism** involves defensive measures used to reduce the vulnerability of individuals and property to terrorist acts, to include limited response and containment by local military forces and civilians. **Counterterrorism** involves measures that include operations to prevent, deter, preempt, and respond to terrorism.

DoD Support to Counterdrug Operations. DoD supports federal, state, and local law enforcement agencies in their effort to disrupt the transport and/or transfer of illegal drugs into the United States.

Enforcement of Sanctions are operations that employ coercive measures to interdict the movement of certain types of designated items into or out of a nation or specified area.

Enforcing Exclusion Zones. An exclusion zone is established by a sanctioning body to prohibit specified activities in a specific geographic area. Exclusion zones can be established in the air (i.e., no-fly zones), sea (i.e., maritime), or on land (i.e., no-drive zones).

Ensuring Freedom of Navigation and Overflight. These operations are conducted to demonstrate US or international rights to navigate sea or air routes.

Nation Assistance is civil or military assistance (other than Foreign Humanitarian Assistance (FHA)) rendered to a nation by US forces within that nation's territory during peacetime, crises or emergencies, or war, based on agreements mutually concluded between the United States and that nation.

Protection of Shipping. When necessary, US forces provide protection of US flag vessels, US citizens (whether embarked in US or foreign vessels), and US property against unlawful violence in and over international waters

Show of Force Operations are designed to demonstrate US resolve. They involve the appearance of a credible military force in an attempt to defuse a specific situation that if allowed to continue may be detrimental to US interests or national strategic objectives or to underscore US commitment to an alliance or coalition.

Support to Insurgency. An insurgency is defined as an organized movement aimed at the overthrow of a government through the use

> of subversion and armed action. It uses a mixture of political, economic, informational, and combat actions to achieve its political aims. It is a protracted politico-military struggle designed to weaken the control and legitimacy of an established government, an interim governing body, or a peace process while increasing insurgent control and legitimacy - the central issues in an insurgency.
>
> **Counterinsurgency Operations** include support provided to a government in the military, paramilitary, political, economic, psychological, and civic actions it undertakes to defeat insurgency.

Crisis Response or Limited Contingency Operation

Crisis response or limited contingency operations can be stand-alone, "limited-duration" operations on a "small-scale," or can be a "significant part of a major operation of extended duration involving combat." The overall objective is to "protect US interests and/or prevent surprise attack or further conflict" (JP 3, 2010:I-9). Below is a list of the different types of crisis response and contingency operations defined by JP 3 (2010, VI 2-13).

> **Noncombatant Evacuation Operations (NEO)** are operations directed by the Department of State (DOS) or other appropriate authority, in conjunction with the DoD, whereby noncombatants are evacuated from foreign countries when their lives are endangered by war, civil unrest, or natural disaster to safe havens or to the United States.
>
> **Peace Operations (PO)** are multiagency and multinational operations involving all instruments of national power; including international humanitarian and reconstruction efforts and military missions; to contain conflict, redress the peace, and shape the environment to support reconciliation and rebuilding and facilitate the transition to legitimate governance.

Foreign Humanitarian Assistance (FHA) operations relieve or reduce the impact of natural or man-made disasters or other endemic conditions such as human pain, disease, hunger, or privation in countries or regions outside the United States.

Recovery Operations may be conducted to search for, locate, identify, recover, and return isolated personnel, sensitive equipment, items critical to national security, or human remains.

Consequence Management (CM). CM are actions taken to maintain or restore essential services and manage and mitigate problems resulting from disasters and catastrophes, including natural, man-made, or terrorist incidents. CM may be planned and executed for locations within US-owned territory at home and abroad and in foreign countries as directed by the President and SecDef.

Strikes and Raids. Strikes are attacks conducted to damage or destroy an objective or a capability. **Raids** are operations to temporarily seize an area, usually through forcible entry, in order to secure information, confuse an adversary, capture personnel or equipment, or destroy an objective or capability.

Homeland Defense (HD) and Civil Support (CS) Operations. Security and defense of the US homeland is the Federal Government's top responsibility and is conducted as a cooperative effort among all federal agencies as well as state, tribal, and local security and law enforcement entities. Military operations inside the United States and its territories, though limited in many respects, are conducted to accomplish two missions - HD and CS. HD is the protection of US sovereignty, territory, domestic population, and critical defense infrastructure against external threats and aggression or other threats as directed by the President. CS consists of DoD support to US civil authorities for domestic emergencies and for designated law enforcement and other activities.

Major Operation or Campaign

From time to time the U.S. must conduct major operations or campaigns in order to achieve national strategic objectives or protect national interests. "Major operations and campaigns are the most complex and require the greatest diligence in planning and execution due

to the time, effort, and national resources committed" (JP 3, 2010:xxi). The fundamental objectives of these large-scale operations are to "conclude hostilities and establish conditions favorable to the HN and the United States and its multinational partners" as quickly as possible (JP 3, 2010:xii).

Large-scale major operations and campaigns are broken down into smaller, more manageable pieces. This helps Joint Force Commanders (JFC) and their staffs to think sequentially about the campaign, organizing plans by combining and synchronizing subordinate operations. "The primary benefit of phasing is that it assists commanders in systematically achieving military objectives that cannot be attained all at once by arranging smaller, related operations in a logical sequence" (JP 3, 2006: IV-25).

"Each phase should represent a natural subdivision of the campaign/operation's intermediate objectives." Although phases are designed to transpire sequentially, a number of activities from one phase may continue into the following phase or initiate during a previous phase. Often the JFC will "adjust the phases to exploit opportunities presented by the adversary or operational situation or to react to unforeseen conditions" (JP 3, 2006: IV-26).

The phasing model is designed so that advancing from one phase to the next brings about distinct shifts in focus for the joint forces. Advancing to the subsequent phase is necessary when all objectives of a phase have been accomplished or when an adversary's actions require a shift in focus. Transitioning to a new phase may require "changing priorities, command relationships, force allocation, or even the design of the operational area." These changes "demand an agile shift in joint force skill sets, actions, organizational behaviors, and mental outlooks." Joint forces must be able to effectively coordinate "with a wider range of other organizations to provide those capabilities necessary to address the mission-specific factors" (JP 3, 2006:IV-27).

> Intelligence support is crucial to all aspects of execution. Immediate, precise, and persistent intelligence support to force employment is a particularly important prerequisite for military success throughout all phases of a joint operation (i.e., shaping, deterrence, seizing the initiative, dominance, stabilization, and enabling civil authority) regardless of how the battle evolves. Joint intelligence operations centers (JIOC) must be familiar with specific phasing arrangements of each command operations plan (OPLAN) because the phasing may differ for specific types of operations. During execution, intelligence must stay at least one step ahead of operations and not only support the current phase of the operation, but also simultaneously lay the informational groundwork required for subsequent phases. Execution of joint operations requires optimizing the use of limited ISR assets and maximizing the efficiency of intelligence production resources. (JP 2, 2007: xvii)

The Joint Force Commander (JFC) decides which phases are used during a campaign and when the transitioning between phases should take place. The phasing model, represented in Figure 8, can be applied to various military operations.

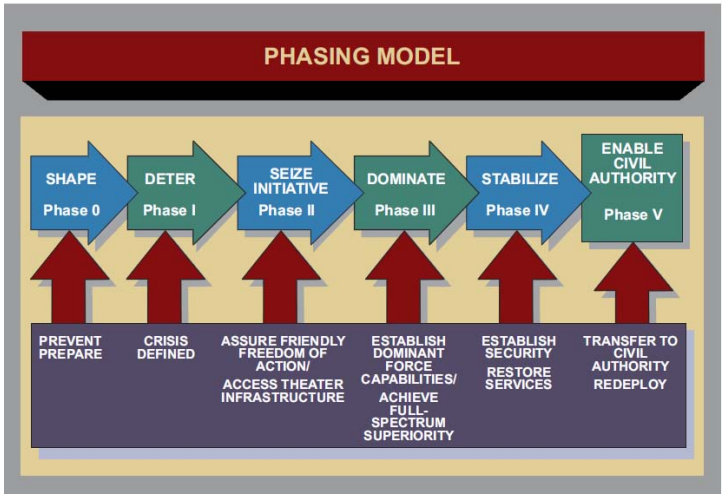


Figure 8. Phasing Model (JP 2, 2007)

Shaping

JP 2 describes the "Shaping" phase as:

> The actions undertaken before committing forces to assist in determining the shape and character of potential future operations. In many cases, these actions enhance bonds between future coalition partners, increase understanding of the region, help ensure access when required, strengthen future multinational operations, and prevent crises from developing. Intelligence activities conducted during the shaping phase lay the groundwork for intelligence operations in all subsequent phases of the operation (2007: IV-12).

Information operations (IO) help identify an adversary's vulnerabilities, centers of gravity, potential COAs and critical key nodes. This information is crucial to joint forces when developing initial targets lists and no-strike lists during the shaping phase. An optimized portfolio of intelligence gathering platforms should be identified, allowing information requirements to be satisfied without wasting assets resources. Due to long lead times, it is important to initiate HUMINT operations as soon as possible.

The enemy's chain-of-command and their decision-making process must be studied as early as possible in order to better understand the enemy and what actions will serve to deter hostilities. Similarly, psychological operations (PSYOP) units must assess the target population to determine which PSYOP initiatives will provide the most desirable effects. "An analysis and assessment of the civil dimension in targeted countries, that identifies civil society key influences, individuals, organizations, structures, and areas must be performed as early as possible to determine what civil engagement actions may serve as effective points of influence" (JP 2, 2007: IV-12).

Deterrence

JP 2 describes the "Deterrence" phase as:

> Before the initiation of hostilities, the JFC must gain a clear understanding of the national and military strategic objectives; desired and undesired effects; actions likely to create those effects; COGs and decisive points; and required joint, multinational, and nonmilitary capabilities matched to available forces. The joint force J-2 assists the JFC in visualizing and integrating relevant considerations regarding the operational environment into a plan that will lead to achievement of the objectives and accomplishment of the mission. It is therefore imperative that the JIPOE effort (initiated during the shaping phase) provide the JFC with an understanding of the operational environment at the outset of the deterrence phase (2007: IV-13).

Information operations can be used to study the enemy's command structure and decision-making process, helping determine what actions can be taken to serve as effective deterrents. Target populations should be closely monitored to determine the effectiveness of PSYOP initiatives. Intelligence operations support indications and warning (I&W) efforts by monitoring target areas for key signs of impending enemy actions. Analysts continuously fine-tune assessments of the enemy's current situation, capabilities, objectives, and most likely COA (JP 2, 2007: IV-13).

Information operations, also, support targeteers in generation of target lists and help identify protected objects to place on the no-strike list. GEOINT is critical to developing maps, charts, imagery products, and support data for joint operations. Certain intelligence operations are tailored to serve as their own form of deterrence. "For example, the deployment of additional ISR resources in the operational area not only increases intelligence collection capabilities and provides early warning, but may also demonstrate US resolve without precipitating an armed response from the adversary." Similarly, intelligence sharing arrangements, conferences, training and exercises with host nations may emphasize US resolve, thus discouraging hostile

enemy actions. Intelligence operations may also be used to support interdiction efforts intended to isolate an enemy from other nations, safe havens, and international sympathizers by identifying vulnerabilities in an enemy's support network (JP 2, 2007: IV-14).

Seizing Initiative

JP 2 summarizes the "Seizing Initiative" phase as:

> As operations commence, the JFC needs to exploit friendly asymmetric advantages and capabilities to shock, demoralize, and disrupt the enemy immediately. The JFC seeks decisive advantage through the use of all available elements of combat power to seize and maintain the initiative, deny the enemy the opportunity to achieve its objectives, and generate in the enemy a sense of inevitable failure and defeat. Additionally, the JFC coordinates with the appropriate interagency representatives through a joint interagency task force, joint interagency coordination group, or individually to facilitate coherent use of all instruments of national power in achieving national strategic objectives. JFCs and their J-2s should be on continuous guard against any enemy capability which may impede friendly force deployment from bases to ports of embarkation to lodgment areas (2007: IV-14).

Information operations are critical during the seizing phase. It can be used to identify and examine potential targets and match targets "with appropriate agents (weaponeering)" based on a target's vulnerabilities. Intelligence analysts will then work with operations personnel to develop prioritized target lists. HUMINT, SIGINT, and OSINT are used to provide valuable information on enemy morale, allowing joint forces to evaluate the effectiveness of PSYOP initiatives. Information operations can be used to analyze friendly force actions from the adversary's point of view, providing insight into the enemy's intelligence collection plan. Counterintelligence operations can then be developed to deceive enemy analysts (JP 2, 2007: IV-15).

"Real-time, persistent surveillance and dynamic ISR collection management are important throughout the execution of joint operations, but are particularly critical during the seizing the initiative and dominance phases." Joint forces need the capability to continuously and accurately monitor enemy operations in order to support retargeting and precision engagement. "An ISR strategy that fully integrates and optimizes the use of all available US, coalition, and host-nation ISR assets is essential to persistent surveillance" (JP 2, 2007: IV-15).

Dominance

> During the dominance phase, JFCs conduct sustained combat operations by simultaneously employing conventional, Special Operations Forces (SOF), and IO capabilities throughout the breadth and depth of the operational area. Civil Military Operations (CMO) is executed to preclude civilian interference in attainment of operational objectives or to remove civilians from operational areas. Operations may be linear (i.e., combat power is directed toward the enemy in concert with adjacent units) or nonlinear (i.e., forces orient on objectives without geographic reference to adjacent forces). Some missions and operations (i.e., strategic attack, interdiction, and IO) are executed concurrently with other combat operations to deny the enemy sanctuary, freedom of action, or informational advantage. JFCs may design operations to cause the enemy to concentrate their forces, thereby facilitating their attack by friendly forces, or operations may be designed to prevent the enemy from concentrating their forces, thereby facilitating their isolation and defeat in detail" (JP 2, 2007: IV-15).

Information operations must be ready to support both linear and nonlinear operations. The complexity of nonlinear operations, "due to their emphasis on simultaneous operations along multiple lines of operations, places a premium on a continuous flow of accurate and timely intelligence," helping protect friendly forces. This continuous stream of intelligence enables

"precise targeting, mobility advantages, and freedom of action and is enabled by persistent surveillance, dynamic ISR management, and a common intelligence picture" (JP 2, 2007: IV-15).

Intelligence operations must be able to "identify known and suspected locations of enemy WMD stockpiles and delivery systems, anticipate the conditions under which the enemy is most likely to use WMD, and analyze the effects on the operational environment of WMD use" (JP 2, 2007: IV-16).

Information operations must also be capable of anticipating and addressing information requirements necessary to plan for the stabilization phase. After combat operations have concluded, intelligence must be ready to support actions to fill a power vacuum. "In order to set the groundwork for stability, security, transition, and reconstruction operations, the JFC will require detailed intelligence regarding the status of key infrastructure, enemy government organizations and personnel, and anticipated humanitarian needs" (JP 2, 2007: IV-16).

Stabilization

> Stabilization typically begins with significant military involvement to include some combat, then moves increasingly toward enabling civil authority as the threat wanes and civil infrastructures are reestablished. As progress is made, military forces increase their focus on supporting the efforts of host nation authorities, OGAs, IGOs, and/or Non-Governmental Organizations (NGO) (JP 2, 2007: IV-17).

Information operations must transition from supporting combat operations to identifying leaders of groups who have the potential to threaten civil authority and reconstruction efforts. In order to minimize disruptions to stabilizing efforts, intelligence operations must be used to identify and evaluate critical infrastructure vulnerabilities. Intelligence can also be utilized to

assess PSYOP initiatives and their effectiveness of increasing the local population's support of civil authorities and reconstruction efforts (JP 2, 2007: IV-17).

Enabling Civil Authority

> This phase is characterized by the establishment of a legitimate civil authority that is enabled to manage the situation without further outside military assistance. In many cases, the United States will transfer responsibility for the political and military affairs of the host nation to another authority. The joint operation normally is terminated when the stated military strategic and/or operational objectives have been met and redeployment of the joint force is accomplished (JP 2, 2007: IV-17).

Categories of Intelligence Products

A variety of intelligence products are produced to support the entire range of military operations. These intelligence products are usually assigned to one of seven production categories: I&W, current, general military, target, scientific and technical, counterintelligence (CI), and estimative intelligence. These seven intelligence production categories are defined by the reason for which the intelligence was produced. The same intelligence can, and often does, fall into more than one category (JP 2, 2006: I-16). Below is a list of the different types of intelligence product categories, defined by JP 2 (2006,I-16):

> **Indications and Warning (I&W)** intelligence concerns foreign developments that could involve a threat to the United States, US or allied military forces, US political or economic interests, or to US citizens abroad. I&W is very time-sensitive. It includes forewarning of adversary actions or intentions; the imminence of nuclear or nonnuclear attack on the United States, its overseas

forces, or allied nations; hostile reactions to US activities; terrorist attacks; and other similar events.

Current Intelligence provides updated support for ongoing operations across the full range of military operations. It involves the integration of time-sensitive, all-source intelligence and information into concise, objective reporting on the current situation in a particular area.

General Military Intelligence (GMI) focuses on the military capabilities of foreign countries and organizations and other topics that could affect potential US or multinational military operations.

Target Intelligence. Targeting is the process of selecting and prioritizing targets to satisfy stated objectives and matching the appropriate response to them, considering operational requirements and capabilities.

Scientific and Technical (S&T) Intelligence encompasses foreign developments in basic and applied sciences and technologies with warfare potential, particularly enhancements to weapon systems. It includes S&T characteristics, capabilities, vulnerabilities, and limitations of all weapon systems, subsystems, and associated materiel, as well as related research and development. S&T also addresses overall weapon systems and equipment effectiveness.

Counterintelligence analyzes the threats posed by foreign intelligence and security services and the intelligence activities of non-state actors such as organized crime, terrorist groups, and drug traffickers. CI analysis incorporates all-source information and the results of CI investigations and operations to support a multidiscipline analysis of the force protection threat.

Estimative Intelligence provides forecasts on how a situation may develop and the implications for planning and executing military operations. Estimative intelligence goes beyond descriptions of adversary capabilities or reporting of enemy activity. It tries to forecast the unknown based on an analysis of known facts using techniques such as pattern analysis, inference, and statistical probability.

Attributes of Intelligence Product Quality

The quality of intelligence products is of great concern to the IC, therefore the authors of JP 2 combined intelligence theory and operator knowledge to develop 10 fundamental principles of joint intelligence. These principles are "intended to contribute to effective and successful joint intelligence operations." The 10 fundamental principles of joint intelligence support joint intelligence activities and are suitable for use across the entire range of military operations (JP 2, 2006: II-1).

One of the 10 fundamental principles, "Excellence," calls for manufacturers of intelligence to "strive to achieve the highest standards of quality" in their products. The ability to deliver quality products to intelligence consumers is vital to intelligence professionals and their "ability to attain and maintain credibility." JP 2 defines eight attributes of intelligence product for "which the quality of intelligence products should be continuously evaluated" (JP 2, 2006: II-6). Below is a list of the "attributes of intelligence product quality," defined by JP 2 (2006, II 6-19).

> **Anticipatory.** Intelligence must anticipate the informational needs of the commander and joint force staff in order to provide a solid foundation for operational planning and decision making. Anticipating the joint force's intelligence needs requires the intelligence staff to identify and fully understand the command's current and potential missions, the commander's intent, all relevant aspects of the operational environment, and all possible friendly and adversary COAs. Most important, anticipation requires the aggressive involvement of intelligence in operation planning at the earliest time possible
>
> **Timely.** Intelligence must be available when the commander requires it. Timely intelligence enables the commander to anticipate events in the operational area. This, in turn, enables the commander to time operations for maximum effectiveness and to avoid being surprised.

Accurate. Intelligence must be factually correct, convey an appreciation for facts and the situation as it actually exists, and provide the best possible estimate of the enemy situation and COAs based on sound judgment of all information available. The accuracy of intelligence products may be enhanced by placing proportionally greater emphasis on information reported by the most reliable sources. Source reliability should be evaluated through a feedback process in which past information received from a source is compared with the actual "ground truth" (e.g., when subsequent events, reports, or knowledge confirm the source's accuracy).

Usable. Intelligence must be tailored to the specific needs of the commander and must be provided in forms suitable for immediate comprehension. The commander must be able to quickly apply intelligence to the task at hand. Providing useful intelligence requires the producers to understand the circumstances under which their products are used. Commanders operate under mission, operational, and time constraints that will shape their intelligence requirements and determine how much time they will have to study the intelligence that they are provided. Commanders may not have sufficient time to analyze intelligence reports that are excessively complex and difficult to comprehend. The "bottom line" must be up front and easily understandable. Oral presentations should be simple and to the point. The use of approved joint terms and straightforward presentation methods will facilitate rapid and effective application of intelligence to support joint operations.

Complete. Complete intelligence answers the commander's questions about the adversary to the fullest degree possible. It also tells the commander what remains unknown. To be complete, intelligence must identify all adversary capabilities that may impact mission accomplishment or execution of the joint operation. Complete intelligence informs the commander of all major COAs that are available to the adversary commander and identifies those assessed as most likely or most dangerous. The effort to produce complete intelligence never ceases. While providing available intelligence to those who need it when they need it, the intelligence staff must give priority to the commander's unsatisfied critical requirements. Intelligence organizations must anticipate and be ready to respond to the existing and contingent intelligence requirements of commanders and forces at all levels of command.

> **Relevant.** Intelligence must be relevant to the planning and execution of the operation at hand. It must aid the commander in the accomplishment of the command's mission. Intelligence must contribute to the commander's understanding of the adversary, but not burden the commander with intelligence that is of minimal or no importance to the current mission. It must help the commander decide how to accomplish the assigned mission without being unduly hindered by the adversary. Commanders must communicate their intent and their operational concept to the intelligence staff if relevant intelligence is to be produced. Requirements must be updated and refined as the friendly mission or the adversary situation changes.
>
> **Objective.** For intelligence to be objective, it should be unbiased, undistorted, and free of prejudicial judgments. The objective analyst must remain open-minded to all hypotheses and should never attempt to make the facts fit preconceptions of a situation or an adversary. In particular, intelligence should recognize each adversary as unique and should avoid mirror imaging. Red teams should be used to check analytical judgments by ensuring assumptions about the adversary are valid and intelligence assessments are free from mirror imaging and cultural bias.
> **Available.** Intelligence must be readily accessible to the commander. Availability is a function of not only timeliness and usability, but also appropriate security classification, interoperability, and connectivity. Intelligence producers must strive to provide data at the lowest level of classification and least restrictive releasability caveats, thereby maximizing the consumers' access, while ensuring that sources of information and methods of collection are fully protected.

Minus "anticipatory," which has more to do with the analyst than the information, the "attributes of intelligence product quality" agree with Nichol's "desirable qualities of information." JP 2's eight attributes include relevance, timeliness, and availability; the necessary qualities intelligence must have to qualify as information and possess value are satisfied.

An enterprise's raw data, by itself, has little to no value to a DM. However, raw data that is "processed for a purpose" and "presented in a form that is meaningful to the recipient" can be extremely valuable when making decisions (Engelsman, 2007:2). But how valuable is the

information? Or, if you're the IC, "how valuable is your intelligence?" Value Focused Thinking (VFT) has the ability to quantify the value of information, allowing DMs to evaluate competing IT architectures.

Decision Analysis

According to Kirkwood, "one essential element of a decision is the existence of alternatives." Without alternatives there may be a problem; however, there is no decision to make. If each alternative leads to the same conclusion then one does not have to conduct much analysis. However, when different alternatives lead to different outcomes, various alternatives and their outcomes need to be compared to one another to help determine which alternative provides the most desirable outcome (Kirkwood, 1997:2).

There have been many methodologies developed in the past to aid DMs in decision situations. Keeney states that, most of the "existing methodologies" are used to aid in decisions where objectives and alternatives are already determined (Keeney, 1992:8). Keeney classifies approaches that look first at the available alternatives as "alternative-focused thinking." "Alternative-focused thinking is starting with what is readily available and taking the best of the lot" (Keeney, 1992:6). Keeney refers to this act of selecting from a predetermined set of alternatives as "constrained-thinking," which may leave more desirable solutions out of consideration (Keeney, 1992:7).

Keeney recommends a "constraint-free thinking" approach to problem solving. When a DM takes a "constraint-free thinking" approach to solving a problem they do not focus on selecting an alternative from a given set but on what they want to achieve or what a desirable alternative might look like (Keeney, 1992:7). One approach is to use VFT which "involves

starting at the best and working to make it reality" (Keeney, 1992:8). Because VFT is constraint-free thinking, it leads a DM to a larger, more appealing set of alternatives from which to choose.

VFT Terminology

In order to assist the reader we have provided a list of VFT terminology defined by Kirkwood (1997:12):

> Evaluation Consideration: Any matter that is significant enough to be taken into account while evaluating alternatives.
>
> Objective: The preferred direction of movement with respect to an evaluation consideration.
>
> Goal: A threshold of achievement with respect to an evaluation consideration which is either attained or not by any alternative.
>
> Evaluation Measure: A measuring scale for the degree of attainment of an objective.
>
> Value Structure: Encompasses the entire set of evaluation considerations, objectives, and evaluation measures for a particular decision analysis.
>
> Value Hierarchy: A value structure with a hierarchical or "treelike" structure.
>
> Tier: Evaluation considerations at the same distance from the top of a value hierarchy.

Benefits of VFT

VFT's benefits go beyond its ability to repeatedly, objectively, and quantitatively evaluate competing alternatives. Below is a list of less obvious advantages an enterprise can gain by using VFT (Keeney, 1992:24-28):

Uncovering Hidden Objectives: As a DM initially thinks about their values they will generate a list of obvious values almost immediately. However, as the DM continues to analyze their values they will begin to identify values that hide in their subconscious thus adding values to their initial list.

Guiding Information Collection: Once a DM understands what is important in the decision context, they will be able to direct information collection to the important areas.

Improving Communication: The act of developing a hierarchy creates an opportunity for stakeholders to exchange thoughts on what is important to each of them.

Facilitating Involvement in Multiple-Stakeholder Decisions: VFT can take multiple stakeholders and encourage them to work together to produce a decision.

Interconnecting Decisions: Usually a DM makes more than one decision. Many objectives for a particular decision problem will carry over to other decision problems within the enterprise.

Creating Alternatives: When using VFT a DM is applying constraint-free thinking and has no predetermined alternatives. VFT provides a foundation for generating quality alternatives. When the desired end-state is known, it is easier to identify alternatives that satisfy the DM's objectives.

Identifying Decision Opportunities: If an enterprise is having a difficult time identifying decision problems, VFT can be employed to identify shortfalls. An enterprise

can "identify decision opportunities, that is, opportunities to better achieve their overall values by formulating a decision situation" (Keeney, 1992:27).

Guiding Strategic Thinking: An enterprise's strategic objectives are clearly stated and provide direction for future decisions.

Desirable Properties of Value Hierarchies

Kirkwood states the desirable properties of a value hierarchy are completeness, nonredundancy, decomposability, operability, and small in size (Kirkwood, 1997:16).

Completeness: There are two aspects of completeness. First, when looking at a collection of evaluation considerations in the same tier, all considerations needed to evaluate the overall objective must be captured. Second, each evaluation measure in the lowest tier should sufficiently measure how well the associated objective is accomplished.

Nonredundancy: No two evaluation considerations in the same tier should overlap.

Decomposable or Independent: The analysis must allow for the "separate treatment of different objectives" (Keeney, 1992:82).

Operability: Operability ensures that the person who is intended to operate the value hierarchy understands how to use it.

Small in Size: A smaller hierarchy is easier to communicate to stakeholders and requires fewer resources to evaluate resources.

Many times the properties of completeness and nonredundancy are referred to as mutually exclusive and collectively exhaustive (MECE). "The evaluation considerations in each tier, taken as a whole, must include everything needed to evaluate the decision alternatives (collectively exhaustive), and nothing necessary to do the evaluation can be included in more than one evaluation consideration (mutually exhaustive)" (Kirkwood, 1997:17).

VFT 10-Step Process

The VFT process can be expressed as a 10-step process (Shoviak, 2001). Due to time constraints this research will focus on steps one and two, problem identification and creating a value hierarchy.

1. Identify Problem
2. Create Value Hierarchy
3. Develop Evaluation Measures
4. Create Value Functions
5. Weight Value Hierarchy
6. Generate Alternatives
7. Score Alternative
8. Deterministic Analysis
9. Sensitivity Analysis
10. Conclusions and Recommendations

Problem Identification

First, a team consisting of the DM and key stakeholders (including subject matter experts (SME)) should be formed. The team must work together to clearly define the problem statement and decision context, or the setting in which the decision takes place (Clemen and Reilly, 2001:23). When the team has agreed on the problem statement, decision context, and identified a desirable future state, the team can begin to create the value hierarchy.

Create Value Hierarchy

Once step 1 is complete, the team should begin to frame the decision situation. A decision situation is framed by the values and alternatives considered when making the decision (Keeney, 1992:30). When using VFT it is important for the team to state explicitly what they value and not focus on the alternatives in front of them. The team must determine what they want to achieve with respect to their values given the current decision context. By answering this question the team can generate a list of objectives they would like to accomplish. Keeney recommends the team ask why each objective on the list is important, leading the team to realize less obvious objectives (Keeney, 1992:22). A team's objectives, when considered together, make up their values and identify what is considered important when making a decision (Clemen and Reilly, 2001:22).

An objective is defined as "a statement of something that one desires to achieve" (Keeney, 1992:34). Keeney distinguishes between two different types of objectives: fundamental objectives and means objectives. A fundamental objective describes a basic reason for being interested in the decision situation. While a means objective helps achieve a more fundamental objective.

Not all of a DM's objectives translate to every decision situation. Different decision situations call for different objectives. A DM may have an overarching set of objectives of which he selects a subset that pertain to a particular decision. Understanding the setting in which the decision situation occurs is vital to choosing the correct objectives to place in the value model. Clemen and Reilly refer to this as a requisite model, or a model that "includes all of the objectives that matter, and only those that matter, to the decision context" (Clemen and Reilly, 2001:24).

There are two different ways to approach building a value hierarchy. When there is a predetermined set of alternatives a bottom-up approach should be used. When a set of alternatives is not apparent, a top-down approach is appropriate. A top-down approach can be successful in generating potential alternatives (Kirkwood, 1997:20).

When developing the value hierarchy with a top-down approach, there are three important steps to accomplish: (1) identify the overall objective, (2) link objectives on different tiers, and (3) stop the hierarchy building process (Keeney, 1992:77).

The objectives identified by the team represent their values; therefore, the task of accurately identifying all necessary objectives is a crucial step in VFT. When identifying objectives, it is very important to distinguish between fundamental objectives and means objectives (Keeney, 1992:55).

A preliminary list of objectives will contain both fundamental and means objectives (Keeney, 1992:78). When trying to determine if an objective is fundamental, the team should answer the question, "Why is this objective important in the decision context?" (Keeney, 1992:66). There are two different answers to this question. One, "the objective is one of the essential reasons for interest in the situation." This type of objective has potential to be considered a fundamental objective. The second response is "the objective is important because of its implications for some other objective." This response implies the objective is a means objective which is used to support a more fundamental objective. The same "Why is it important?" question must then be asked about the more fundamental objective. This process is repeated until all fundamental objectives and their corresponding means objectives are identified (Keeney, 1992:66).

Figure 9 depicts four techniques for identifying and moving between fundamental and means objectives (Clemen and Reilly, 2001:49).

	Fundamental Objectives	Means Objectives
To Move:	*Downward in the Hierarchy*:	*Away from Fundamental Objectives:*
Ask:	"What do you mean by that?"	"How could you achieve this?"
To Move:	*Upward in the Hierarchy:*	*Toward Fundamental Objectives:*
Ask:	"Of what more general objective is this an aspect?"	"Why is that important?"

Figure 9. Techniques for Organizing Means and Fundamental Objectives (Clemen and Reilly, 2001)

When an overall objective is difficult to define, the set of fundamental objectives should be analyzed until the overall objective appears. The overall objective, or first tier of the hierarchy, should describe the rationale for being interested in the decision situation and capture the overall concern of the decision situation (Keeney, 1992:77).

When working from top to bottom in building the value hierarchy, the team must remember to push down past the qualitative value hierarchy and identify specific evaluation measures (Keeney, 1992:80). The final tier of evaluation measures will be used to quantitatively

measure the attainment of objectives. Identifying the evaluation measures becomes easier as the lower tiers of the hierarchy take shape. Evaluation measures, or metrics, "allow an unambiguous rating of how well an alternative does with respect to each objective" (Kirkwood, 1997:24). When the overall objective, evaluation measures, and the relationship among all objectives have been built into the hierarchy, the building process is complete.

VFT has been used to support various DoD decision problems. VFT has been used by the National Reconnaissance Office (NRO) to help improve their resource allocation process. Also, in Air University's study, Operational Analysis 2025, the Air Force used VFT to help evaluate how well competing systems would perform in future environments.

VFT Research

NRO Resource Allocation

The National Reconnaissance Office's (NRO) mission is to design, build, and operate the nation's reconnaissance satellites. The NRO provides their growing list of customers, including the Central Intelligence Agency (CIA) and the DoD, with products that can identify potential trouble spots around the world, help plan military operations, and monitor the environment. The NRO's Operational Support Office (OSO) "orchestrates and delivers tailored support to DoD, National and other approved users of NRO products and services in concert with appropriate agencies and offices" (Parnell, Bennet, Engelbrecht, Szafranski, 2002:77).

Parnell's team's research was intended "to help the OSO to identify and develop high-value tasks that directly support OSO and NRO strategic objectives and to select the best portfolio of tasks to meet resource and programmatic constraints." The team wanted to help OSO develop a methodology that allowed OSO to repeatedly and objectively identify the

customer support portfolio that provided the most value to their customers, while staying within organization constraints (Parnell et al, 2002:78).

To begin their research, the team interviewed OSO leadership to determine their current method for decision-making and resource allocation. The overall conclusion from the eleven interviews the team conducted was that OSO did not have a repeatable, objective method in place to help allocate resources. One OSO leader put it best when he said “they wing it” (Parnell et al, 2002:78).

The team decided to use “future value analysis (FVA) to help allocate resources” (Parnell et al, 2002:78). A three step approach was implemented to develop and analyze future opportunities: “(1) a strategic assessment of future opportunities and challenges, (2) a multi-objective decision analysis using value-focused thinking, and (3) a portfolio analysis using optimization” (Parnell et al, 2002:77).

First, the research team used NRO and OSO documentation to determine the organizations’ mission, vision, and strategy. Once the team had a firm understanding of these concepts, structured interviews were conducted with OSO leadership. Twenty-three interviews were conducted with internal and external managers, assessing how the OSO provides value to the NRO and their customers. The interviews were used to identify “past problems, new opportunities, strategic objectives, goals, evaluation measures, resource constraints and programmatic constraints” (Parnell et al, 2002:80). To gain a better understanding of the situation, the team asked questions like:

- "What are the major future uncertainties facing OSO and NRO?"
- "What are the OSO and NRO strategic objectives?"

- "What evaluation measures should be used to assess achievement of these objectives?"
- "What new opportunities exist for OSO that they are not currently pursuing?"
- "What is the most valuable future OSO product or service? Why?"
- "Describe the current OSO resource-allocation process?" (Internal only)
- "What types of resource and programmatic constraints must be considered?" (Internal only)
- "How effective has OSO been in justifying the need for additional budget requirements?"

The second step in the FVA process was for the team to perform Multi-Objective Decision Analysis (MODA). The team decided to use a VFT approach to evaluate competing alternatives and to "identify value opportunities, provide value feedback and to identify value gaps" (Parnell et al, 2002:79). Team members used *gold standard* and *combined standard* methods to help build the value model. The gold-standard method uses approved vision, policy, strategy, planning, or doctrine as the primary source of objectives. The combined standard method is used when documentation alone is not enough to build a complete value model and interviews are conducted to gain insight into an organization's objectives (Parnell, 2007:8).

In their study, Parnell's team interviewed DMs and stakeholders in groups to ensure the accuracy of the decision context. With information gained from the group interviews, the team used affinity diagrams to help structure the qualitative value model (Parnell et al, 2002:81). Due to the lack of time DMs and stakeholders were able to commit to interview sessions, the team used the combined standard in order to collect all the information needed for the qualitative model (Parnell et al, 2002:82).

To solicit weights for the value model the team surveyed 23 OSO personnel, including senior leadership, with a bottom-up approach. All final weights were rounded to the nearest 5% to show a lack of preciseness in the weighting (Parnell et al, 2002:85). With the help of the OSO task managers, the team proceeded to score each task, determining each task's overall value to the NRO and customer (Parnell et al, 2002:84).

The third, and last, step of FVA was for the team to determine an optimized portfolio. To accomplish this task, the team "developed a binary linear-programming model using the task values and the resource and programmatic constraints." The final product was "an optimization model that maximized task value subject to resource and programmatic constraints" (Parnell et al, 2002:86).

Operational Analysis 2025

In 1995, the Chief of Staff of the Air Force directed Air University to conduct a study on what capabilities the United States Air Force will need to possess in order to dominate air and space in the future. The tasker specifically tasked Air University to "generate ideas and concepts on the capabilities the United States will require to possess the dominant air and space forces in the future [, to] detail…new or high-leverage concepts for employing air and space power [and to] detail…the technologies required to enable the capabilities envisioned." The research team's goal was to identify "high-value system concepts and their enabling technologies in a way that was objective, traceable, and robust" (Jackson, Jones, Lemkuhl, 1996:vii).

In order to accomplish their goal, the team developed *Foundation 2025*, a VFT model, which captured the values of the study's participants. "The purpose of the model was to quantify and compare different system concepts' contributions to future air and space capabilities."

Foundation 2025 is characterized by: its ability to analyze a large number of system concepts, a 30-year focus into the future, and it was developed with a bottoms-up technique (Jackson et al, 1996:vii).

In order to "stimulate creativity, generate ideas, and evaluate concepts," the team from Air University developed a four-phase approach. In the preparation phase, team members were subjected to an assortment of creative thinking and problem-solving techniques. Phase one paved the way for the idea generation phase by having participants generate reasonable future scenarios as well as future capabilities and technologies. The team also received help as contributions rolled in from all over the world, collecting over 1,000 inputs worldwide. During the assimilation phase, phase three, team members were divided into sub- teams based on operational experience, each team having a specific focus area. Once a set of potential future capabilities was decided on, teams developed system concepts and technologies that could satisfy those future capabilities. This phase generated a large number of system concepts but not all of them could be pursued. In order to determine which concepts and technologies should be pursued, the team needed to prioritize the future system concepts and their enabling technologies. Lastly, an operational analysis phase was conducted to help prioritize the list of ideas that was generated in phase three. The operational analysis phase had three objectives: assess the potential operational utility of future air and space systems, identify the high-leverage technologies required by those system concepts, and provide an objective, traceable, and robust analysis (Jackson et al, 1996:1).

In order to meet their objectives, the 2025 team developed a methodology to evaluate the future systems and technologies against a diverse set of criteria. Since the study was looking almost 30 years into the future, many of the system descriptions did not have engineering

specifics but relied on the subject matter experts' opinion on future operational capabilities and associated enabling technologies (Jackson et al, 1996:6).

After comparing various analysis tools, the team chose to use a value focused thinking approach. The main advantages of VFT for this study were that "it was particularly suited for structuring the subjective judgments required to evaluate the systems," "it allowed the operational analysis to be completed in the limited time available," and "because VFT was used in the SPACECAST 2020 study, it was well understood and accepted by the Air University senior leadership" (Jackson et al, 1996:6). A VFT model also satisfied the team's desire to have an "objective, traceable, and robust" process to evaluate competing alternatives (Jackson et al, 1996:7).

The team's first step in creating a value model was determining a clear and concise objective. The overall objective of 2025 would be "Achieve Air and Space Dominance." Once the top tier of Foundation 2025 was established, the team worked on developing the rest of the hierarchy. In an effort to avoid "preconditions" and "priori assumptions," the team built their hierarchy from the bottom-up, attempting to introduce "less institutional bias." The second tier of Foundation 2025 was broken into three functions (awareness, reach, and power) that "are the only operational activities that contribute to the overarching objective of air and space dominance" (Jackson et al, 1996:12). Foundation 2025's "awareness" branch is of particular interest to this research because it falls in line with the IC's mission. The team defined awareness as "knowledge, understanding, or cognizance of some thing or situation through alertness in observing, detecting, and identifying, so as to enable, direct, and communicate an informed decision" (Jackson et al, 1996:13).

The team's last step in building the hierarchy was developing appropriate metrics. The team's first step in metric development was to have each sub-team identify "force qualities" based on their operational expertise. "Force qualities are generally adjectives, since they characterize a system's ability to accomplish a task or subtask." The team found that most of the future force qualities were the same as force qualities they would expect to see in present day Air Force. The list of force qualities was refined several times to its final number of 134. Each force quality had a metric associated with it to quantify system performance (Jackson et al, 1996:15).

To best determine the value of a system, one must first understand the type environment the system will be operating in. Since 2025 was looking into the future 30 years, an "Alternative Futures" team generated 6 alternative futures. Four of the futures were considered extreme in order "to provide a diverse set of future conditions against which to evaluate the proposed air and space systems" (Jackson et al, 1996:19).

Once the team's hierarchy was built and the appropriate metrics were developed, weights were assigned to the various functions representing each function's level of importance to achieving the overall objective. Because different future environments need different capabilities, the model's weights were not held constant for the various futures. To account for the different futures, the team solicited a set of weights from participants for each of the six alternate futures. For each future, the team solicited two sets of weights. The first set of weights was an average of all weights generated by interviewing each member of the sub-teams. The second set of weights was solicited from the team that generated the alternative futures (Jackson et al, 1996:21).

Next, the team used an iterative process to develop scoring functions. Sub-teams were interviewed and the shape of each function was refined several times until all sub-team members

came to an agreement (Jackson et al, 1996:22). Then, a "system-versus-technology" matrix was developed by identifying 43 unique systems and 43 key technologies (the number was a coincidence) from the sub-teams' research (Jackson et al, 1996:23).

The team then developed a procedure for scoring individual technologies.

> For each technology, its contribution to each system is multiplied by the system value, and the resulting products are summed across all systems. The result is a set of technology scores that takes into account both the technologies' degree of contribution to future air and space systems and the importance of those systems to air and space operations. (Jackson et al, 1996:23)

Finally, a team of technical and operational experts took a "consensus-seeking" approach to score all 43 systems against the metrics in the model. The scoring team was not allowed to know the shape of the function curve. The team repeated this scoring process for each alternative future, where each future had a unique weight set, until all systems were evaluated (Jackson et al, 1996:23).

Future Scenarios

Just as *Operational Analysis 2025* generated alternate futures to support their value model, this research requires a decision situation to exist inside some future environment. This research will use the *Quadrennial Intelligence Community Review's* (QICR) alternate futures, per the direction of the Office of the Director of National Intelligence (ODNI), to support value model development. The ODNI urged that others (e.g. IC elements, U.S. Government departments and agencies, foreign intelligence services) use the below scenarios "to make their planning and decision making more robust" (QICR, 2009:6). The Joint Chiefs of Staff have also provided a concept paper, *Functional Concept for Battlespace Awareness* (FCBA), which

"describes how the joint force is envisioned to operate in the next 15-20 years," and "the attributes and capabilities that tomorrow's force requires" (2003:1).

Quadrennial Intelligence Community Review

The 2009 QICR is a "scenario-based" strategic look at what the world could look like in the year 2025. The 2009 QICR has two primary purposes: (1) "QICR helps the Intelligence Community (IC) minimize surprise by identifying the range of future of future settings in which the IC might have to operate, and (2) QICR enables the IC, as an enterprise, to manage strategic risk against these possible futures" (QICR, 2009:1). The 2009 QICR generated four extreme scenarios that can be used to develop future National Intelligence Strategies and identify future capabilities that will be needed for the IC to effectively operate within these various future environments. The QICR states that the real future will be somewhere in between these four extreme futures. Identifying capabilities that overlap the four futures provides insight into which capabilities provide the most potential value in the real future.

The QICR team relied heavily on the National Intelligence Council (NIC) Global Trends 2025 study to aid in scenario development. The *Global Trends 2025* study was developed for all audiences, not just the IC. By combining the information in *Global Trends 2025* with other industry and government efforts concerning future environments, the QICR team was able to develop scenarios that could directly support IC planning efforts. The QICR team used a four phase approach to develop the four future scenarios (QICR, 2009:6).

Phase one consisted of two one-day sessions where IC stakeholders discussed the value of scenario analysis for strategic planning (QICR, 2009:1). Phase two brought participants together for a two-day workshop where stakeholders reviewed the four "geostrategic" scenarios

from *Global Trends 2025* and tailored the scenarios based on recent government and industry literature. Scenarios were developed "to serve QICR's long-range strategic planning purposes" by being "divergent, plausible, challenging (compared to the official future), and relevant to the IC." The team's goal was to create "substantively different" scenarios that challenged current assumptions about the future, well beyond the scope of what our Government and IC are planning for today (QICR, 2009:3). Phase three commenced once an agreed upon set of scenarios were developed. Four working groups were created to analyze the types of missions and capabilities the IC would require to operate in the given scenarios. Each team's findings were then briefed and refined until a set of common missions and capabilities were identified (QICR, 2009:1-2). Phase four incorporated the results from phase three into a draft report for stakeholder feedback (QICR, 2009:2).

The QICR defines four different futures the IC could find itself operating within: (1) World Without the West, (2) Brazil, Russia, India, and China's (BRIC) Bust-up, (3) October Surprise and (4) Politics Is Not Always Local (Figure 10).

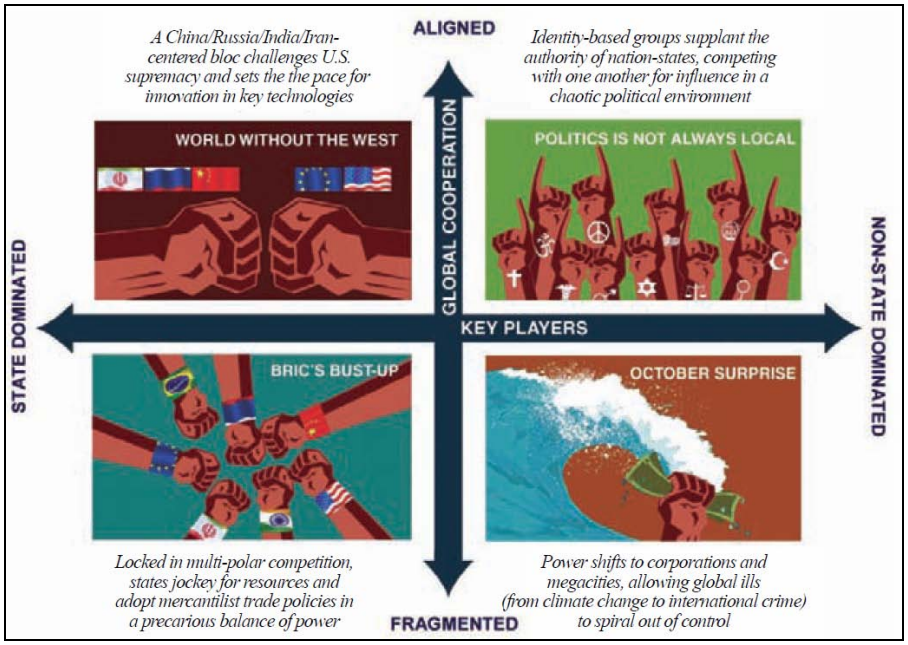


Figure 10. QICR Scenario Overview (QICR, 2009)

World Without the West

In this scenario, key players are state dominated and global cooperation is high. A new counter-balance to the "Washington Consensus" has emerged by Russia, China, India and Iran forming a new coalition referred to as the Shanghai Cooperation Organization (SCO). Taking advantage of their large energy reserves, huge population, and high level of technological advancement, the SCO will challenge the U.S.'s economic, military, and technological dominance (QICR, 2009:7).

Both the West and the SCO look to form regional and Middle Eastern alliances that can provide strategic advantages. The SCO, in order to increase global influence, will "develop global military reach through capabilities such as blue water navies and robust airlift support." Old alliances will reconsider their strategic partnerships due to a decline in U.S. influence. Both the West and SCO look to militarize non-traditional battlegrounds (e.g. space, cyberspace and the Arctic) leveraging new innovations in science and technology. Western nations will still

remain democratic, while the SCO will push their alternative model of authoritarian capitalism on their coalition. Americans will struggle as their supremacy is challenged and will prioritize national security over individual privacy. The defense industry will have no shortage of funding and will be one of the first places college graduates seek employment. An influx of homegrown scientists will cause a technology and innovation boom in the SCO, diminishing the U.S. position as the world's technology leader. Due to SCO's "growth-first" mentality natural resources will be consumed at a high rate with little regard for environmental impacts. Environmental movements will take place all over the SCO landscape but will gain little traction due to authoritarian regimes. Slow economic growth in the West and steady growth inside the SCO will cause centers of international finance to switch from New York and London to China and the Persian Gulf. Growth rates will differ across the globe and small scale confrontations will break out sporadically over energy sources leading to increased energy prices worldwide (QICR, 2009:7-8).

As the SCO rises up to challenge the West's military, there will be an increased potential for major conflicts which could involve the use of Weapons of Mass Destruction (WMD). The development of innovative defense capabilities will be necessary due to an increasing number of conflicts with state actors on non-traditional battlefields. Russia will increase their stockpile of WMD and conventional weapons. China will see a growth in both their Army and blue water navy and will become a world leader in biotechnology. The U.S. will also be threatened by the continued development of WMD by an Iran supported SCO coalition (QICR, 2009:8).

The West will maintain a policy of diplomacy before military action in order to maintain fragile relationships with existing partnerships. America will attempt to strengthen alliances with European and Western Hemisphere partners while countering the SCO's growing influence

by tapping into traditional alliances in the SCO's "backyard" (e.g. Japan, Thailand, Saudi Arabia), strengthening the U.S.'s foothold in the region. Slow economic growth and an aging labor pool will limit the U.S.'s homeland security and defense spending (QICR, 2009:9).

BRIC's Bust-up

In 2025, worldwide energy and resource shortages halt growth by BRIC (Brazil, Russia, India, and China) countries. Countries all over the world withdraw from free trade agreements and implement national protectionism. Economic growth slows due to the lack of flowing goods, ideas, and currencies across borders. Alliances frequently change, and competition for energy resources increases leading to local and interstate clashes. A shortage of international unity allows for the spread of WMD across Asia and the Middle East (QICR, 2009:10).

Military conflicts breakout in African and Asian sea lanes as countries fight for control of energy transit routes. Old alliances and treaties are stressed or broken due to the proliferation of WMD. States adopt a nationalistic point of view and enforce strict immigration policies. Border security is beefed up with an increased fear of terrorism and international crime. Historic tensions re-emerge between Japan, China, and India. Healthcare systems suffer from a lack of free flowing ideas and goods. Immigration restrictions curb the influx of workers and the U.S.'s aging workforce will strain the nation's budget. Personal privacy dwindles as citizens support the state's control of information to bolster security. The U.S. adopts national identification cards trusting that the government will guard personal information from foreign governments and individuals. Countries that don't have the financial and technological means to acquire WMD invest their resources in hacking capabilities (QICR, 2009:10-11).

The number of conflicts related to energy concerns increases in the Middle East and Asia and cause a global military buildup. Assured access to foreign energy and natural resources becomes a top U.S. priority as possible disturbances could cripple the U.S. economy. An increase in WMD proliferation with rival states and a shortage of multinational organizations could lead to abrupt conflicts with smaller states that potentially have WMD (QICR, 2009:11).

Assured access to energy supplies and other natural resources will be a top priority for the U.S. leaders. The spread of nationalism will drastically reduce the number of U.S. foreword operating bases, leading to the military's increased reliance on the Navy and global strike packages. "Mobile military assets and short-term partnerships with strategically located countries are integral to both securing energy resources and the associated energy transportation infrastructure." The U.S. will need to identify and work with countries with similar beliefs about ending the spread of WMD. The ongoing energy shortage and strict immigration laws will slow economic growth thus hindering the U.S.'s ability to properly manage all priorities (QICR, 2009:11).

October Surprise

In this scenario, key players are non-state dominated, and global cooperation is highly fragmented. Governments and corporations are more interested in immediate gratification economic strategies than long-term strategies. Focus shifts to fast growth in efficient markets and away from global health, climate change, and international issues. The gap between rich and poor expands while health and environmental crisis overwhelm domestic agencies. "A hurricane striking Manhattan with little warning (the "October Surprise") during a major world conference demonstrates the danger posed by this world" (QICR, 2009:13).

The governments' economic growth and domestic affairs fixation leads to "a vacuum of international political authority" influencing the political and military environments. Governments unwilling to address the variety of humanitarian and environmental concerns are considered illegitimate. "Some NGOs and super-powered individuals step in and attempt to fill governmental leadership void." The unimpeded flood of workers to centralized areas of economic growth leads to large demographic swings creating powerful mega-cities, supplanting national authority. Governments concern themselves with local (city and community) intelligence gathering capabilities. Mega-cities start to provide their own private security, leaving minimal roles for state and local law enforcement. In the developing world, "ambiguous spaces" like refugee camps, slums, and "no-go" areas become more ubiquitous. The expanding divide between classes arises from discrepancies in the quality of education, healthcare, and other social services. A strong exodus of talent to the private sector leaves government offices understaffed and at a disadvantage. Populations become wary of big government and request more privacy, while mega-city corporations call for more taxes to be directed from waning rural areas to budding urban economic hubs. The un-checked private sector ravages all natural resources in its pursuit of growth leaving behind famine, floods, pandemics and other disasters. Multinational corporations gain political and economic clout and limit the influence of global trade organizations by conducting private trade agreements. Criminals and terrorist organizations take advantage of the enormous, unchecked, cross-border flows and increase their influence through illegal weapon, drug, and human trafficking (QICR, 2009:13-14).

Governments and international institutions are frequently challenged by health crises and environmental threats caused by climate change. Permeable borders further complicate health crises and facilitate the spread of international crime and terrorism. Key U.S. infrastructure (e.g.

power grid, financial systems and water containment systems) are constantly threatened by natural disasters. Pandemics will become more prevalent, threatening the public's safety, increasing public anxiety, and over-extending resources. The "have-nots" will rise up to test government authority and result in an increase in local violence. A decrease in the number of geopolitical threats combined with a lack of government resources will lead to an underfunded defense department. This underfunded defense department will be slower to react to international health and environmental crises (QICR, 2009:14).

The U.S. government will rely heavily on partnerships with the private sector to combat the growing threat of climate change, health crises, and environmental emergencies. Ensuring the "have-nots" have access to education and health services will become a top priority to curb social instabilities. Intelligence sharing between mega-cities will become vital in order to respond to dispersed terror and criminal cells. Several key challenges governments must be ready to overcomes are: (1) the shift of human capital from the public to the private sector, (2) state-level diplomacy erodes as corporations increase their economic and political influence over mega-cities, and (3) the government's ability to access critical data will be limited by citizens and corporations who control the information environment (QICR, 2009:14-15).

Politics Is Not Always Local

In this 2025 scenario, key global players will be non-state actors and global cooperation will be high. The expansion of communication has allowed the world's population to become more connected forming identity-centered networks that have moved beyond traditional borders. Traditional governments see their authority replaced by identity-centric groups who flock to

megacities creating their own policies and partnerships. Conflicts between identity-centered groups grow in number and severity (QICR, 2009:16).

The erosion of national governments define the landscape of this highly decentralized world. Non-state actors gain high profile seats at international organizations but are unable to provide global response to health and environmental crises, shifting more attention to state services. Regional and international institutions struggle to remain relevant despite efforts to integrate state and non-state actors. Support for traditional state militaries wane as national patriotism is replaced by loyalty to identity-centric groups. As the authority of traditional state's decline, border security and export control deteriorate, leading to widespread proliferation of weapons and technology. Most groups will operate their own security forces and will demand independence from state governments. Jurisdictionally ambiguous space and fragmented societies with fewer shared norms lead to the degradation of public services such as: water delivery, roads, schools, and parks. Although medical discoveries are shared rapidly across porous borders, healthcare will "operate within silos" based on opposing healthcare systems. Non-state actors and powerful individuals will accept the burden of healthcare costs. The inability of the government to safeguard personal information will lead to technologies making it difficult to infiltrate community networks. Dispersed networks of identity-centered groups will rely heavily on advanced communication and information sharing technologies. The failure of opposing groups to negotiate will limit the global response capabilities. Declining governments will find it difficult to impose strict tax laws, reducing state spending (QICR, 2009:16-17).

Rival affinity groups confront each other on both traditional and non-traditional battlegrounds. Recurring conflicts on U.S. soil erode stability and threaten the national security environment. Rural, under-governed areas will be a safe haven for illegal trade, financing

affinity groups, and other criminal activity. Bombings with inexpensive unmanned aerial vehicles, cyber-attacks, and disturbances of key infrastructure will be preferred targets for hostile groups. Groups will grow larger, wealthier, and increase their reach, transcending outdated asymmetric strategies developing into heavily armed militias (QICR, 2009:17).

The U.S. will need to be able to swiftly identify hostile groups and quickly protect against key communication and infrastructure attacks. The ability to monitor growing tensions between opposing affinity groups will be essential to thwart conflicts that directly affect the U.S. population and national interests. U.S. leaders will need to work closely with NGOs to encourage global law to fight corruption and illegal trade. Diplomacy will become complicated due to the short-term nature of alliances between state actors, non-state actors, and NGOs. "Conflict over the appropriate role of government erupts between powerful interest groups, each representing large segments of the population, resulting in a more libertarian-style small government with a narrow definition of national security." Less skilled labor will find its way to civil and government jobs as loyalty to nation shifts to loyalty to affinity group, thus leaving the public sector unequipped to properly react to the threats of a fragmented world (QICR, 2009:17-18).

Functional Concept for Battle Space Awareness

"The future joint force will operate in a complex and uncertain security environment that is global in nature and is characterized by asymmetric threats. International organizations, nation states, rogue states, and terrorist organizations all contend within this environment." In order to prepare for this unknown future environment, the Joint Requirements Oversight Council (JROC) has approved the range of military operations (ROMO), which has identified 43 "activities" our

joint forces need to be prepared to face. These 43 activities represent a change in the future security environment and provide a framework for the *Joint Operations Concepts (JOpsC).* The *JOpsC* is "a strategic guidance document that operationalizes the Chairman's vision of achieving Full Spectrum Dominance in the joint force." The *JOpsC* has two roles: (1) "an overarching concept paper that describes how the joint force is envisioned to operate in the next 15-20 years" (2) "a family of joint concepts that describes the attributes and capabilities that tomorrow's force requires" (FCBA, 2003:1).

JOpsC defines *Battlespace Awareness* (BA) as "the situational knowledge whereby the Joint Force Commander plans operations and exercised command and control." BA takes friendly, adversary, non-aligned actors, physical environment, culture, social, political, and economic factors into consideration when providing "actionable intelligence" to decision makers and warfighters. (FCBA, 2003:2)

In order to quantitatively evaluate BA systems and compare them to one another, JOpsC recommends there be an analytical process and set of metrics available to measure competing BA systems and architectures. *FCBA* categorizes attributes into two categories: attributes for information (precision, quality, security, timeliness, and sharing) and attributes for qualities associated with the conduct of operations (reach, persistence, agility, and spectrum). (2003:41)

The attributes of information are enablers for the four attributes associated with conducting operations. *FCBA* defines information attributes as (FCBA, 2003:41):

> **Precision** – the degree that the DM is able to receive information that is relevant, appropriate and in an understandable form
>
> **Quality** – measures the level of accuracy and confidence associated with the information

Security – the level to which the information has been safeguarded from falling into adversary hands

Timeliness – measures the time between the desire for the information and the receipt of the information by the DM

Sharing – the extent the information can be shared both in terms of the exportability of its content and form as well as the existence of shared policy, procedures, protocols, and infrastructure to move information within the network

The attributes for qualities associated with the conduct of operations are: (1) reach (2) persistence (3) agility (4) spectrum. Reach is "a measure of where and when effects can be applied within the desired influence area." Reach includes not only a distance measurement but also encompasses the ability to be effective in urban environments and outer space, during day and night, and during peace and war (FCBA, 2003:41). The persistence of a system is comprised of its staying power and its ability to survive. Survival simply refers to the system's ability to survive in the environment in which it operates. A system's staying power has more to do with the system's endurance with respect to time (FCBA, 2003:42). Agility is described by the capability to re-direct. There are three characteristics of agility: speed of effect, speed of redirection, discrimination of effect. Speed of effect refers to "how quickly a system's effect can be brought to bear". Speed of redirection "describes the ability to retarget a particular effect". Discrimination describes "the ability to narrow the operation or application of effects to only influence precisely defined targets" (FCBA, 2003:42). Spectrum refers to the ability of using multiple systems to achieve a single objective. Spectrum is achieved when individual services bring their own capabilities to the fight and work in unison to accomplish results that could not have been achieved independently (FCBA, 2003:43).

FCBA recommends replacing the old bottom-up "threat-based method of determining the requirements for the Joint forces," with a capabilities-based analysis methodology (Figure 11). In order to achieve "maximum flexibility in the application of military resources," *FCBA* recommends taking a top-down approach to perform portfolio analysis "to determine if the future needs of the force are being met" (FCBA, 2003:81).

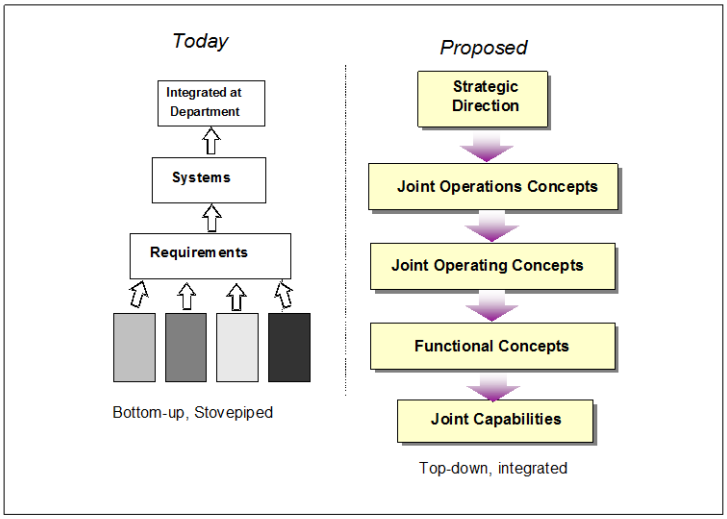


Figure 11. Capabilities-based Methodology (FCBA, 2003)

FCBA recommends the BA Joint Capabilities Board (JCB) Working Group and underlying Functional Capabilities Board for Intelligence (FCB-I) perform "assessments of the Service and Joint programs to determine if there are gaps, duplication, or overlaps in the desired capabilities." In order to perform this assessment *JOpsC* necessitates an analytic methodology be developed that takes into account "national level guidance, emerging technology, lessons

learned from current operations and joint experimentation, and the acknowledged drivers of the intelligence arena." These elements will then be used to evaluate systems and services to see how they satisfy the capability requirements of joint forces (FCBA, 2003:82).

In order to perform BA analysis, a set of metrics needs to be developed that are "reflective of the broad overarching guidance that summarizes the desired national capabilities." The Joint C4ISR Decision Support Center's Program Synchronization Initiative proposed "a set of ISR-related capstone metrics that capture the necessary functionality of the BA community." These capstone metrics were broken down into a set of specific metrics that can be used to evaluate BA systems and services (FCBA, 2003:83). Below is a list of proposed metrics that could be useful for evaluating BA systems (FCBA, 2003:86):

Command and Control of BA Assets:

- Error rate on orders given to BA assets [Quality]
- Latency from issue of order to receipt by BA asset [Timely]
- Latency from issue of order to action by the BA asset [Agility]
- Number of alternative means of communicating C2 to BA asset [Spectrum]

Observe & Collect

- What fraction of the Hardened Deeply Buried Targets can be identified? [Precision]
- Percent of targets identified within time frame to target [Timely]
- Number of BA assets (by type & location) mission ready [Persistence]
- Number of alternative phenomenologies that can be used to obtain a desired piece of information [Spectrum]
- Minimum radiation level to detect nuclear source [Precision]
- Alpha and beta error rates for sensor [Quality]
- Hardening measure for sensor to EMP [Persistent]
- Number of sensor systems w/security patches applied [Secure]

Analysis of Intel

- Fraction of correct conclusions [Quality]
- Time from tasking to delivery of intelligence product [Timely]
- Time to set-up new analysis cell [Agility]
- Number of disciplines represented by analysts [Spectrum]
- Number of analysts with the same discipline (by location) [Persistence]

M&S, Forecast

- Number of data elements filled in training database [Precision]
- Fraction of correct forecasts [Accuracy]
- DTED level of terrain data in simulation [Precision]
- Time from model start to results [Timely]
- Time to set-up simulation [Agility]
- Number of different scenario types available to run [Spectrum]

Manage Knowledge

- Number of formats that information (by type) can be transmitted in [Spectrum]
- Information storage capability [Spectrum]
- Time to retrieve data query [Timely]
- Fraction of systems using point to point encryption [Secure]
- Error rates for information [Quality]
- Number of systems able to exchange information in a particular format [Share]
- Geographic distribution of systems in the BA network [Reach]

Integrate BA network

- What fraction of BA nodes on are on the network [Share]
- Geographic distribution of BA nodes on the network [Reach]
- Fraction of BA nodes using point to point encryption [Secure]

Infuse Emergent Technology

- Length of time from initial exploration of technology to inclusion in operational capacity [Timely]
- Percentage of new technologies used in (specified) operational setting bench-tested for security [Secure]
- Level of Information System Interoperability rating for technology [Share]

Recruit, Retain, Train

- Skill levels of linguists (by language) [Quality]
- Number of languages with qualified linguists [Spectrum]
- Number of linguists with up to date polygraph [Security]
- Number of ethnicities covered by field operatives [Spectrum]
- Average time to retire demographics for BA personnel (by specialty and grade) [Persistence]

III. Methodology

Defense Intelligence Agency

The Defense Intelligence Agency (DIA) exists as a key member of the United States Intelligence Community (IC). This Department of Defense (DoD) combat support agency provides military intelligence to warfighters, defense policymakers, and force planners to inform planning and operations, and weapon systems acquisition. The DIA's mission is to "satisfy the military and military-related intelligence requirements of the Secretary and Deputy Secretary of Defense, the Chairman of the Joint Chiefs of Staff, and the Director of National Intelligence, and provide the military intelligence contribution to national foreign intelligence and counterintelligence." Serving as the DoD lead for coordinating intelligence support, the DIA "leads efforts to align analysis, collection, and Intelligence, Surveillance, and Reconnaissance (ISR) actions with all operations" (DIA Website, 2010).

Current Force Sizing Efforts

By request of the Office of the Chairman of the Joint Chiefs of Staff (OCJCS), the DIA is conducting a series of ISR force sizing studies to determine the correct allocation of ISR platforms necessary to support Combatant Commanders. These force sizing studies typically support near term operations, and they only take current ISR capabilities into consideration. However, others in the DoD and IC are researching the ISR capabilities of the future.

Future Capabilities Studies

The DoD and IC are continuously researching new ways to employ old technologies while simultaneously developing new technologies to support future operations. In many cases these studies are stove-piped, only looking at one capability per study. Often times, results from a stove-piped study only provide a recommendation on the best way to implement a specific capability, not taking into account how each capability fits into an ISR architecture.

DIA's Dilemma

Because these studies are conducted independently of other studies, team members have little knowledge of what other studies recommend. Often times these studies suggest that the DoD and/or IC invest in the best method for employing a certain type of capability. However, the best method of employing a capability is often the most expensive. With multiple simultaneous studies examining various future capabilities, it can get expensive trying to fund the best of each capability. It is the DIA's job to recommend the right mixture of capabilities so that individual systems and overall architectures are developed to provide the highest overall value for the DoD and IC while staying within budget.

In order to provide sound recommendations, the DIA requires a repeatable, objective, and traceable methodology for determining the value of future intelligence. By understanding how intelligence is going to be valued in the future, the DIA can recommend the proper allocation of ISR capabilities, thus satisfying the DoD and IC intelligence needs of the future without excessive spending.

Value of Information

Before attempting to determine the value of future information, an enterprise must make sure its information of interest is capable of possessing value. Most enterprises have established methods for assigning value to traditional economic goods and physical assets (e.g. equipment, real-estate, merchandise, etc). However, information is not a traditional economic good, and conventional methods for assigning value to physical assets are not appropriate for determining the value of future information. Therefore, this research presents a methodology allowing an enterprise to determine the potential value of future information.

Definition of an Asset

First, an enterprise must ensure its information of interest is, in fact, an asset of the enterprise. According to the Federal Accounting Standards Advisory Board (FASAB), to be an asset of the government the asset must possess economic benefits (or services) that can be used in the future. The government must also be able to control access to these benefits (2007:10).

For this research, intelligence is the DoD and IC's information of interest. Since intelligence is used to support operations that benefit national security and because the DoD and IC control access to such intelligence, this research considers intelligence to be an asset of the DoD and IC.

Information Can Possess Value

An enterprise cannot assume that all information of interest provides value. In order to determine if the information is capable of possessing value, an enterprise must ensure the information of interest is: 1) relevant to the decision at hand, 2) able to support decision making

in a timely manner, 3) made available for the decision maker to utilize, and 4) of a certain level of quality (Nichols, 1969:3).

The DoD and IC make a conscious effort to ensure their intelligence satisfies these four necessary qualities of information by incorporating them into doctrine. Joint Publication (JP) 2's "attributes of intelligence product quality" fully capture the qualities of information that allow intelligence to possess value (2007:II-7). Therefore, intelligence that is gathered in accordance with JP 2 is capable of possessing value.

Determining the Value of Intelligence

Once an enterprise has ensured their information of interest is capable of possessing value, it can begin the process of determining the value of future information. Because the future contains many unknowns, an enterprise may struggle with determining the future value of traditional economic goods. Similarly, because future information has not been collected yet, determining the value of future information can be just as, if not more, difficult. For example, an IC analyst can determine the value of a photograph based off what objects are present, or are not present, in a specific image. However, how can an analyst determine the value of an image that has not yet been taken?

This research proposes a methodology utilizing Value Focused Thinking (VFT) which allows an enterprise to evaluate information gathering capabilities years into the future. When implemented correctly, the results of this process will provide insight into which types of capabilities maximize the potential value of information.

Value Focused Thinking

While there are many ways for an enterprise to evaluate competing alternatives, this research uses VFT for several reasons. First, when an enterprise is dealing with a limited budget, trade-offs between competing objectives must be made. VFT allows an enterprise to show preference of competing objectives by allowing decision makers (DM) to assign weights to these objectives. Second, VFT allows an enterprise with numerous alternatives a repeatable, objective, and traceable methodology for evaluating each alternative. Lastly, VFT is an intuitive approach that most stakeholders can grasp with little or no technical background.

Because the strengths of VFT suit the needs of the DIA, this research uses a VFT approach to evaluate competing ISR capabilities. First, the DIA provides recommendations to national DMs with limited budgets and competing objectives. VFT will allow DMs to express preferences and make trade-offs between competing objectives. Second, the DIA would like the problem to be solved objectively and in a manner which allows senior DMs to follow the process. There can be no magic black boxes that spit out answers; everyone involved in the decision needs to understand how each alternative is scored. Finally, the DIA is familiar with the VFT process from its use in current force sizing initiatives, and is comfortable with its ability to stand-up to the scrutiny of senior DMs.

The task of determining the value of future information is strategic in nature and a large undertaking for any enterprise. Therefore, this research takes the first step of developing a methodology that any enterprise can employ to determine the value of future information. The following sections describe how an enterprise should: 1) identify the problem, 2) develop future scenarios 3) build a qualitative value hierarchy, and 4) weigh the value hierarchy.

Methodology

Problem Identification

The first step of the 10-step VFT process is to identify the problem (Shoviak, 2001). In order to identify the "right problem" Clemen and Reilly recommend that an enterprise assemble a team consisting of the DM, key stakeholders, and subject matter experts (SME). The team must work together to clearly define the problem statement and the setting in which the decision takes place, also called the decision context. Once the team has agreed on the problem statement, decision context, and the desired future state, the team can begin to create the value hierarchy (Clemen and Reilly, 2001:23).

For most enterprises, the initial problem statement of "determine the value of future intelligence" is ambiguous and needs to be more specific. In order to clearly define the DIA's problem statement, this research employs both Parnell's gold and combined standards to gather the information necessary to define the problem and build the value hierarchy (Parnell, 2007:8).

Decide What to Model

This research uses SME interviews and DoD publications in order to identify how an alternative should look. Three potential alternatives emerge: 1) ISR architectures, 2) ISR platforms, and 3) ISR capabilities. Consulting with DIA SMEs reveals, ISR architectures are extremely difficult to model given the unknowns about the future capabilities of ground stations, platforms, bandwidth, sensor technology, and so on. Airborne, satellite, and cyber platforms are ruled out because, again, there are too many unknowns regarding future technologies. This research decides to model future ISR phenomenologies (e.g. infrared radar, synthetic aperture radar, electro-optical, etc), which fall under the Technical Intelligence (TECHINT) disciplines of

Measures Intelligence (MASINT), Signals Intelligence (SIGNINT), and Geospatial Intelligence (GEOINT), a subset of JP 2's "Seven Intelligence Disciplines" (2007:I-5).

Identify the Overall Objective

The next step of defining the problem statement is for an enterprise to ask itself, "If I had no limitations at all, what would my overall objective be?" (Keeney, 1992:57) The OCJS's publication *Functional Concepts of Battlespace Awareness* (FCBA) states that the overall objective of joint forces is to achieve "full spectrum dominance" (2003:1). Similarly, JP 3 states "full spectrum superiority" is the primary goal of joint forces (2010: V-13). Since the DIA's problem pertains to ISR's support of joint forces, this research defines the overall objective of intelligence as providing *full spectrum awareness* in support of joint operations.

Defining the Future

The last step an enterprise must take when defining the problem statement is to decide which year in the future to refer to. An enterprise must be sure to select a year that places their pending decision outside of the current acquisition cycle. This ensures all recommendations have a chance to provide insight to the DM. For example, the DoD acquisition cycle can be a tedious process that can take up to 15 years. Because the DIA wants their recommendations to support future system designs, this research will look at evaluating ISR capabilities 30 years into the future.

Problem Statement

When an enterprise puts all these steps together it will have a clearly defined problem statement. This research defines the DIA's problem statement as: "Which ISR capabilities will the DoD and IC need to achieve full spectrum awareness in the year 2040?"

Develop Future Scenarios

Not knowing what future environments might be like makes it difficult for an enterprise to determine how effective a particular capability will be at achieving desired objectives. In order to determine how well an alternative performs, an enterprise needs to generate future scenarios for the alternatives to operate in.

This research uses five future scenarios to represent the possible environments the DoD might have to operate within throughout the years surrounding 2040. As directed by the Office of the Director of National Intelligence, four of the future scenarios come from the Quadrennial Intelligence Community Review (QICR). The fifth future scenario, known inside the DoD as Major Combat Operations (MCO), uses the current global environment as a future scenario. These five scenarios take into consideration the four extreme environments laid out by the QICR, and a fifth more realistic "middle scenario" to provide balance. This approach is similar to the approach Parnell et al take in *Operational Analysis 2025,* with their six alternate futures.

Create Qualitative Value Hierarchy

Top-Down Approach

The enterprise's next step is to build a qualitative value hierarchy. Because it is unlikely that an enterprise will already have a predetermined set of alternatives, this research recommends

building the value hierarchy with a top-down approach, starting with the overall objective and working downward until evaluation measures are developed (Kirkwood, 1997:20).

The OCJCS authored paper *Functional Concepts for Battlespace Awareness* supports a top-down approach when evaluating a capability's capacity to meet the needs of emerging uncertainties in the world (2003:82). Therefore, this research uses a top-down approach for building a value hierarchy.

Define the Overall Objective

When creating a value hierarchy with a top-down approach, an enterprise must first identify its overall objective. Luckily, the overall objective was identified when the problem statement was defined. The overall objective of "full spectrum awareness" is all-encompassing and can be a candidate overall objective for any enterprise. However, the phrase "full spectrum awareness" contains the word "spectrum" which could have different meanings to different people. Therefore, an enterprise must make sure to clearly define all ambiguous terms.

Identify Fundamental Objectives

To help move downward when building a hierarchy, Clemen and Reilly recommend asking, "What do you mean by that?" (2001:49) In order to clarify the meaning of the word "spectrum", an enterprise should ask itself, "What do I mean by that?" Thus, when an enterprise defines their spectrum they are essentially identifying their fundamental objectives.

When JP 3 states that the overall objective of joint forces is to achieve full spectrum superiority, the authors define their "spectrum" as land, air, maritime, space, and information environment (2010:GL-15). The authors of FCBA provide two definitions for "spectrum." The

first definition of "spectrum" consists of leadership, facilities, proliferation mechanisms, and high-value forces (2003:18). This research, consulting with DIA SMEs, accepts FCBA's second definition of "spectrum" as the "full spectrum of military operations" (2003:38), also referred to as the "full range of military operations (ROMO)" (JP 3, 2010:I-1). "Military operations vary in size, purpose, and combat intensity," and are grouped into three categories: (1) military engagement, security cooperation, and deterrence, (2) crisis response and limited contingency operations, and (3) major operations and campaigns (JP 3, 2010:I-7).

An enterprise should continue asking itself "What do I mean by that?" until all fundamental objectives have been identified. This research decomposes each of the three categories of military operations into the specific types of military operations, as defined by JP 3 (2010:I-8), that make up each category. This research identifies the fundamental objectives as the three categories of military operations and the operations that make up the three categories. A value hierarchy using these fundamental objectives is shown in Figure 12.

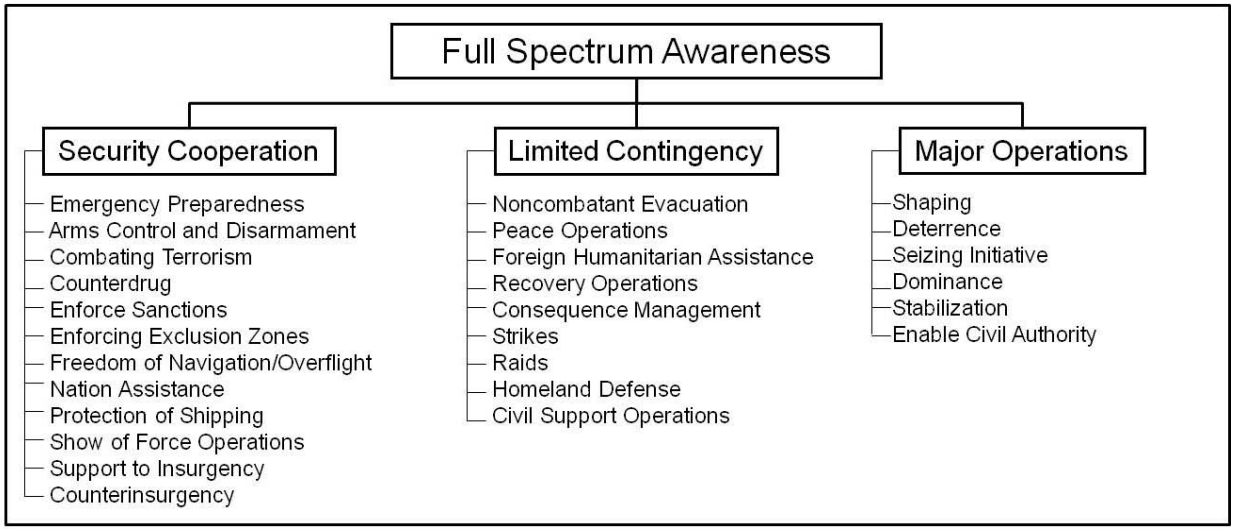


Figure 12. ROMO Hierarchy (Fundamental Objectives)

Identify Means Objectives

Once the overall objective and fundamental objectives have been identified, an enterprise should identify the means objectives. By looking at each fundamental objective and asking, "How could I achieve this?" an enterprise can identify its means objectives. First, SMEs knowledgeable of an enterprise's operations should identify the action+noun combinations that support each operation. The actions identified will make up the next tier of the value hierarchy, while the nouns identified create the tier below the "action" tier. Figure 13 depicts a notional qualitative value hierarchy for a generic enterprise.

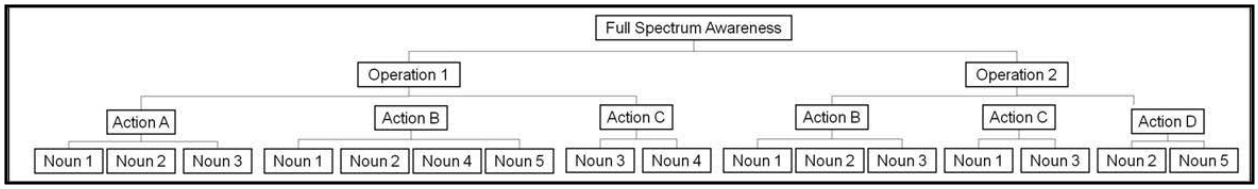


Figure 13. Notional Qualitative Value Hierarchy

Joint targeting is essential to the joint operation planning process (JOPP), and "supports all of the planning horizons of the JOPP ensuring that the targeting process adaptively supports achievement of the commander's objectives." The six phases of the joint targeting cycle, "describe the steps that must be satisfied to successfully conduct joint targeting" (JP 3-60, 2007:ix). Phase 5, mission planning and force execution, of the joint targeting cycle consists of 6 steps: 1) find, 2) fix, 3) track, 4) target, 5) engage, and 6) assess (F2T2EA) (JP 3-60, 2007:II-12).

Dynamic Targeting Cycle (JP 3-60, 2007:ix-x)

Find - During this step, possible targets are detected and classified for further prosecution.

Fix - The fix step of dynamic targeting includes actions to determine the location (fix) of the potential target.

Track - During this step, the target is observed and its activity and movement are monitored.

Target - During this step the decision is made to engage the target in some manner to create desired effects and the means to do so are selected and coordinated.

Engage - In this step, action is taken against the target.

Assess - The assessment phase is common to both deliberate and dynamic targeting of the joint targeting cycle and examines the results of the target engagement.

Intelligence is used to find a target, fix its location, track the target if it is moving, and assess the damage inflicted after the target has been engaged. Since intelligence does not target or engage, this research breaks down the F2T2EA model into the following list of actions intelligence is responsible for: detecting, locating, identifying, tracking, and assessing. These actions are considered means objectives and make up the fourth tier of the ROMO hierarchy. The fifth tier, also consisting of means objectives, consists of nouns that are of interest to the DoD and IC when supporting operations. Figure 14 illustrates one branch of a notional ROMO hierarchy, consisting of an overall objective, fundamental objectives, and means objectives.

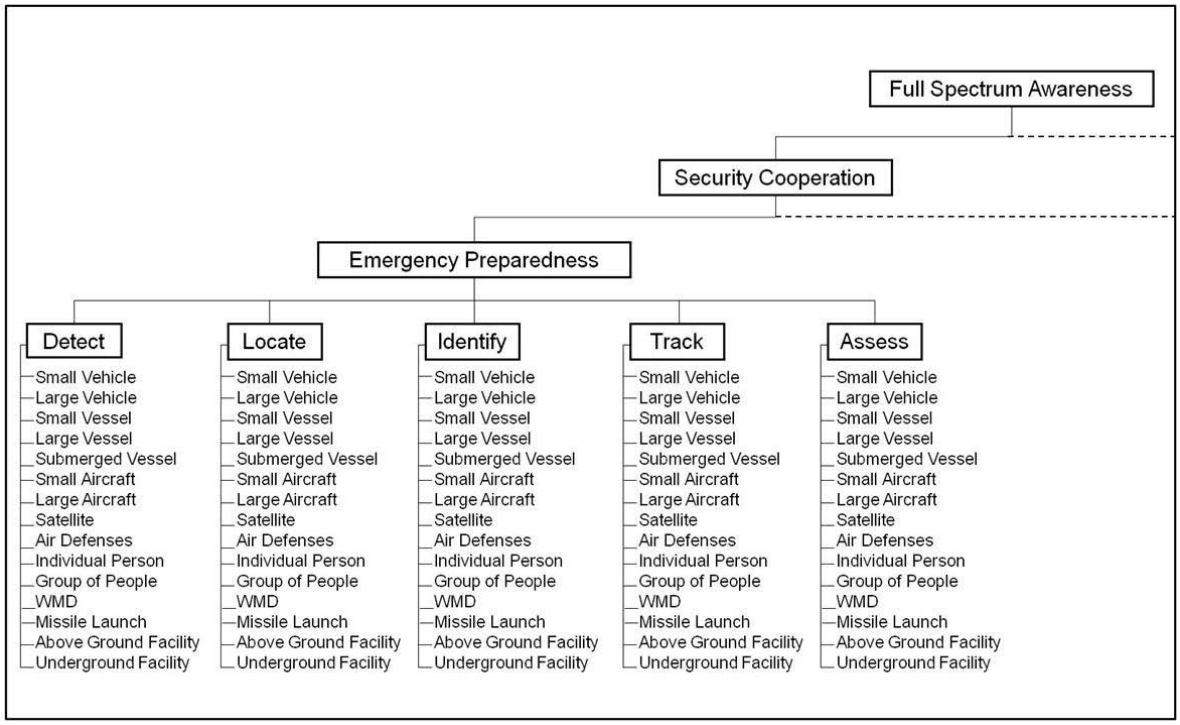


Figure 14. Single Branch of Notional ROMO Hierarchy

In an attempt to only identify the necessary action+noun combinations, this research uses a survey (Appendix A) to solicit information from military analysts to help build the ROMO hierarchy. Responses to the survey provide information about which action+noun combinations support each military operation. If a specific action+noun combination is used to support an operation, it is included in the ROMO hierarchy. Each action+noun combination can appear multiple times in the ROMO hierarchy, once for each operation it supports. For example, the DoD may need to detect air defenses when conducting strikes and also when performing recovery operations.

Small in Size

Per Kirkwood's desirable properties of value hierarchies, an enterprise should ensure its value hierarchy is small in size. A small hierarchy "can be communicated more easily to interested parties and requires fewer resources to estimate the performance of alternatives" (1997:17). For example, the qualitative ROMO hierarchy includes 27 operations, 5 actions, and 15 nouns. This means that even if each means objective had only one evaluation measure associated with it, the completed ROMO hierarchy would have over 2,000 evaluation measures. A value hierarchy with over 2,000 evaluation measures could not be easily communicated to the DM, and it would require a tremendous amount o f man hours to not just build, but to input data.

This research looks at instances when an enterprise's value hierarchy is too large to effectively implement, and presents a methodology for transforming an over-sized hierarchy into a condensed, more manageable hierarchy.

Transforming a Value Hierarchy

Although the notional value hierarchy in Figure 13 would not be considered "too large" for an enterprise to use, this research uses it below to detail how to transform an over-sized hierarchy into a condensed hierarchy. When transforming a large value model into a smaller value model, an enterprise must use the action+noun combinations solicited from the SMEs to help construct a new hierarchy. First, like actions are grouped together and become the second tier of a new condensed value hierarchy. The nouns identified become the third tier of the new hierarchy, each falling under its corresponding action. The over-sized hierarchy (Figure 13) contains 16 means objectives, while the new, condensed hierarchy (Figure 15) contains only 13 means objectives. The new hierarchy consists of mutually exclusive objectives, which allows an

enterprise to use an *additive value model* (Clemen and Reilly, 2001:605) to evaluate competing alternatives.

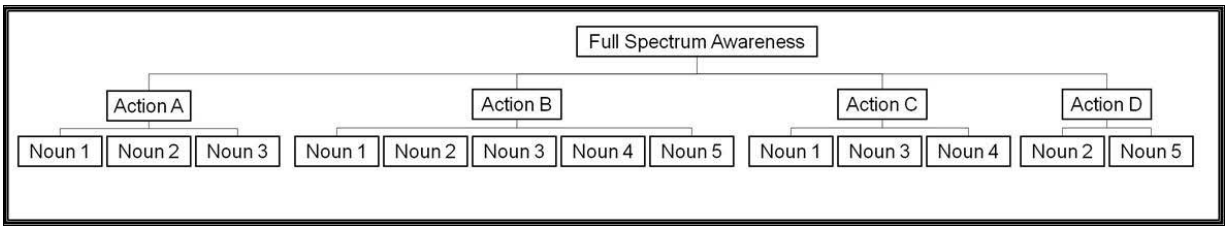


Figure 15. Notional Condensed Hierarchy

This research uses the action+noun information solicited from the military analyst surveys (Appendix A) to build a smaller, more manageable hierarchy for the DIA. With the DIA's new condensed hierarchy (Figure 16) the number of means objectives has been drastically reduced from 2,025 to only 75, a reduction of 96%.

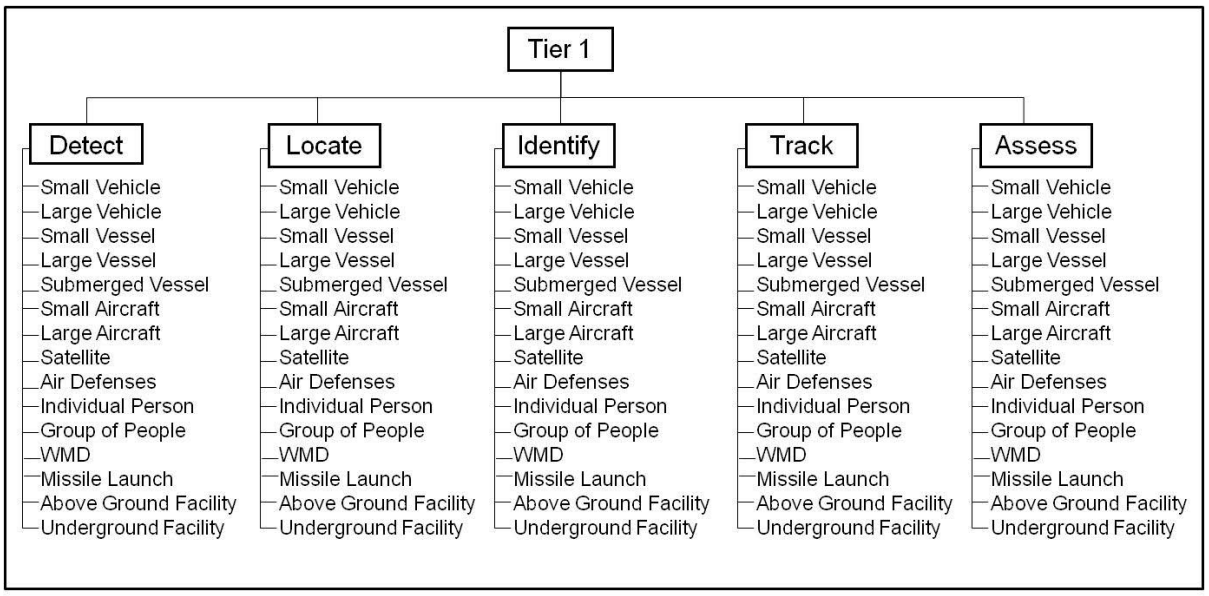


Figure 16. DIA's New Condensed Hierarchy

Weighting the Hierarchy

Because it could take a lot of time for one individual to weight an over-sized hierarchy, an enterprise should solicit information from two different groups of SMEs. The first group of SMEs should have knowledge of how important each operation will be given a specific future scenario. Looking at only the fundamental objectives of the over-sized hierarchy, SMEs should generate a unique set of local weights for each future scenario. Each unique set of local weights represents an operation's degree of importance for a specific future scenario. The second group of SMEs should have knowledge of the enterprise's operations and which action+noun combinations support each operation. These SMEs determine the local weights for the means objectives. Figure 17 illustrates an enterprise's notional over-sized hierarchy with local weights. Once all local weights have been determined, an enterprise can calculate global weights (Figure 18).

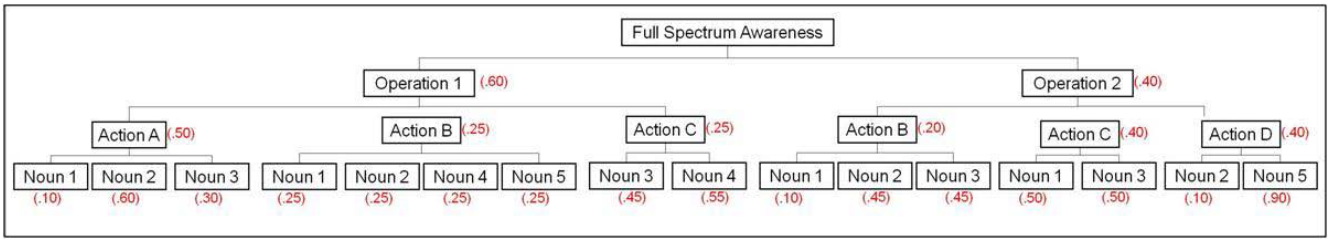


Figure 17. Notional Over-sized Hierarchy with Local Weights

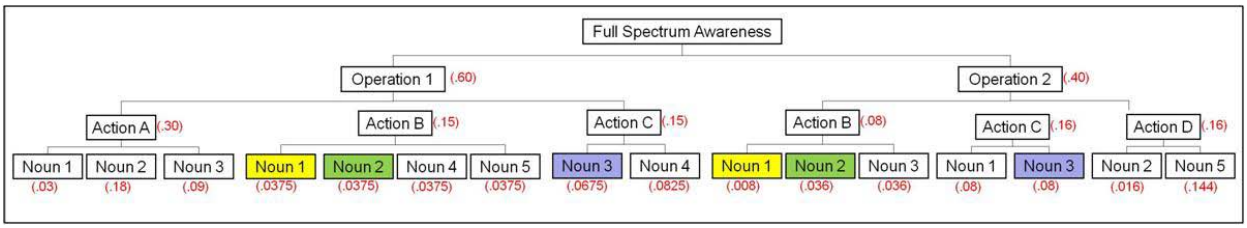


Figure 18. Notional Over-sized Hierarchy with Global Weights

The global weights for the over-sized hierarchy represent an action+noun's degree of importance for a given operation during a specific future scenario. For the DIA's problem, future research will solicit tier 2 and tier 3 local weights from experts knowledgeable about which operations will be most important given a specific future scenario. Tier 4 and tier 5 local weights will be solicited from SMEs who can quantitatively articulate how important each action+noun combination is for each operation.

Once an enterprise has calculated the global weights for the over-sized hierarchy, it can determine the weights for the condensed hierarchy. First, an enterprise should ensure only the action+noun combinations present in the over-sized hierarchy are present in the condensed hierarchy. Next, each action+noun combination in the condensed hierarchy should accumulate the global weight associated with the same action+noun combination found in the over-sized hierarchy. For example, in Figure 18, the global weight of "Action B+Noun 1" during

"Operation 1" is 0.0375 and the global weight of "Action B+Noun 1" during "Operation 2" is 0.008. Therefore, the global weight for "Action B+Noun 1" in the condensed hierarchy (Figure 19) is their sum, 0.0455.

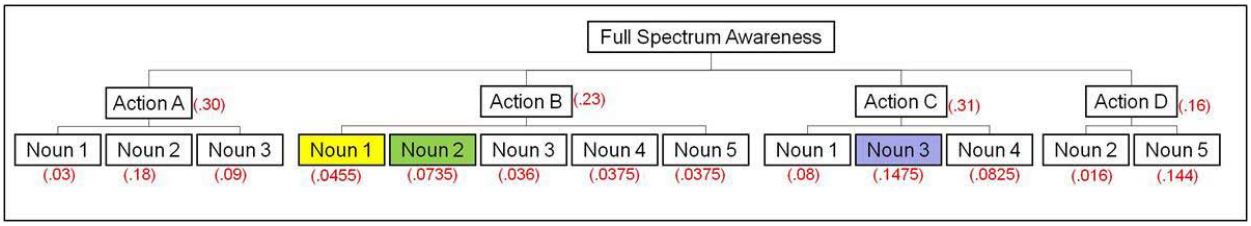


Figure 19. Notional Condensed Hierarchy with Global Weights

Scoring Alternatives

Once an enterprise has developed their qualitative condensed hierarchy, developed evaluation measures, weighted its hierarchy, and created value functions, it can begin to score alternatives. This research recommends that an enterprise have personnel with expertise in the enterprise's various information gathering capabilities participate in scoring alternatives. For the DoD and IC this means, collection managers with detailed knowledge on each ISR phenomenology's collection capabilities help score alternatives.

IV. Analysis

Overview

This section of the research uses the methodology presented in Chapter 3 to create and weight a notional qualitative hierarchy for the Defense Intelligence Agency's (DIA) problem. The problem statement identified by the DIA, "Which ISR capabilities will the Department of Defense (DoD) and Intelligence Community (IC) need to achieve full spectrum awareness in the year 2040?" will be used to support the notional hierarchy. However, the real-world information solicited from DIA subject matter experts (SME), via the *military analyst survey* (Appendix A), is classified and is not presented in this research. Therefore, this research uses information from a hypothetical military analyst survey to help build a notional hierarchy. Although the DIA's problem includes five future scenarios, each requiring a uniquely weighted hierarchy, this section creates and weighs one notional hierarchy.

Methodology

The problem statement and future scenarios identified by the DIA in chapter 3 are not classified and will be used to support building the notional hierarchy in this section. Therefore, this section of the research will begin with creating a qualitative value hierarchy.

Define the Overall Objective

Using Joint Publications (JP) authored by the Office of the Chairman of the Joint Chiefs of Staff (OCJCS) and with concurrence from DIA SMEs, this research identifies the overall

objective of the DoD, with respect to Intelligence, Surveillance, and Reconnaissance (ISR), as achieving "full spectrum awareness." Because the DoD's overall objective captures the overall concern of the decision situation, this research uses "full spectrum awareness" as the first tier of the value hierarchy.

Identify Fundamental Objectives

Referencing *Functional Concepts of Battlespace Awareness* (2003:38) and consulting with DIA SMEs, this research defines the DoD and IC's "spectrum" as the full range of military operations (ROMO). The ROMO consists of: (1) military engagement, security cooperation, and deterrence, (2) crisis response and limited contingency operations, and (3) major operations and campaigns. This research uses these three categories as the fundamental objectives that create the second tier of the DIA's notional hierarchy (Figure 20).

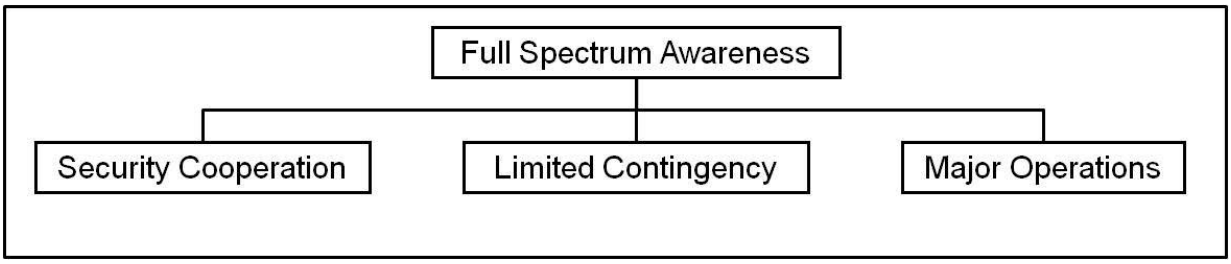


Figure 20. Tier 1 and Tier 2 of Notional Hierarchy

Next, this research breaks down each of the three categories of military operations into the specific military operations that make up each category. This research uses these specific operations to make up the third tier of the DIA's notional hierarchy (Figure 21).

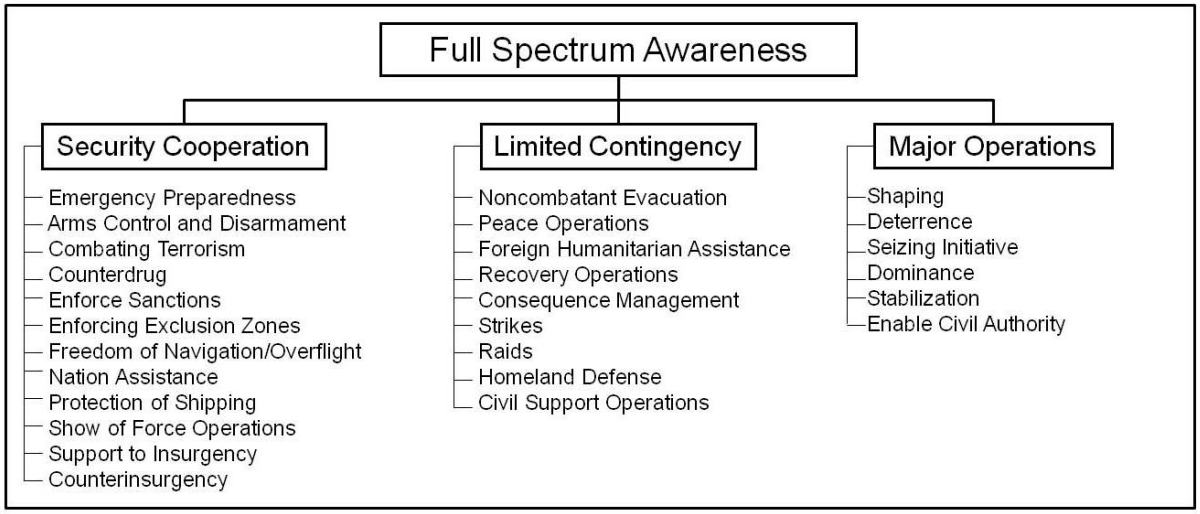


Figure 21. Notional Hierarchy with Fundamental Objectives

Identify Means Objectives

According to JP 3-60, when conducting an operation, joint forces find, fix, track, target, engage, and assess (F2T2EA) various targets (2007:I-6). Intelligence is used to find a target, fix the target's location, track a moving target, and assess the damage inflicted after the target has been engaged. Since intelligence does not target or engage, this research breaks down the F2T2EA model into the following list of actions intelligence is responsible for: detecting, locating, identifying, tracking, and assessing. These actions are considered means objectives and make up the fourth tier of the notional hierarchy. The fifth tier, also consisting of means objectives, consists of nouns that are of interest to the DoD and IC when supporting operations.

In order to identify the action+noun combinations that should be included in the DIA's hierarchy, follow-on research will have military analysts fill out the *military analyst survey* (Appendix A). This research uses a notional military analyst survey to identify the action+noun combinations to include in the DIA's notional hierarchy (Figure 22).

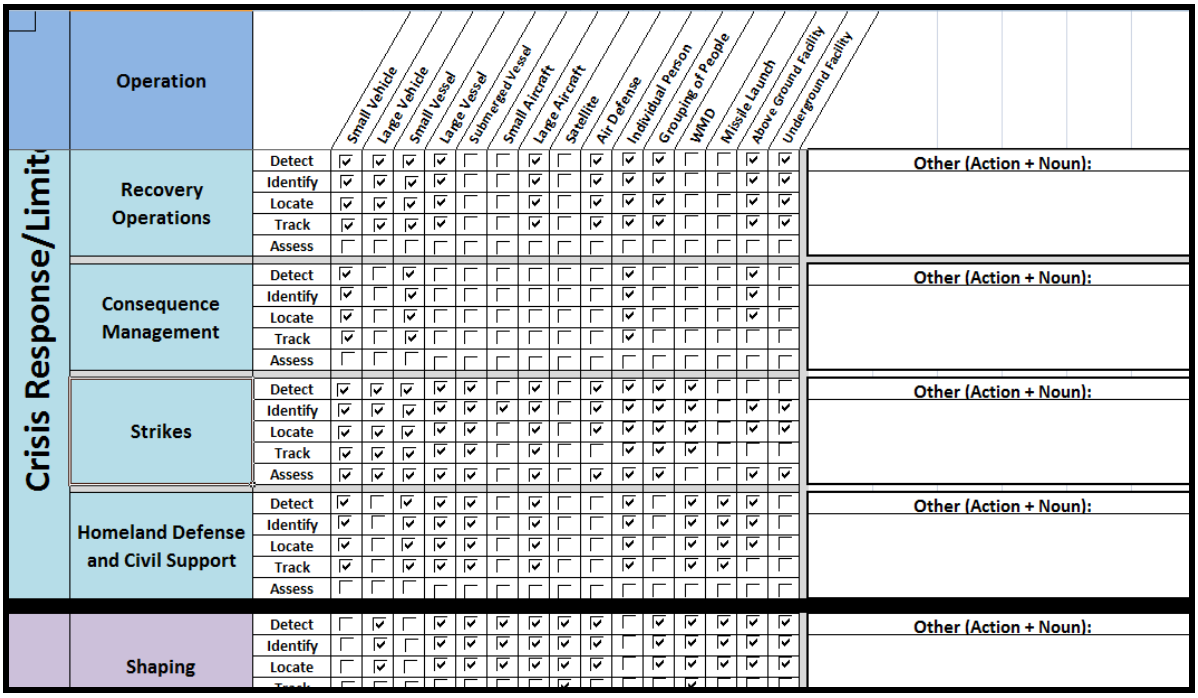


Figure 22. Notional Military Analyst Survey

Figures 23 and 24 illustrate two of the 27 branches of the notional hierarchy. Each branch contains the overall objective, one fundamental objective, and the corresponding means objectives. The action+noun combinations depicted in Figures 23 and 24 correspond to the action+noun combinations selected in the notional military analyst survey (Figure 22).

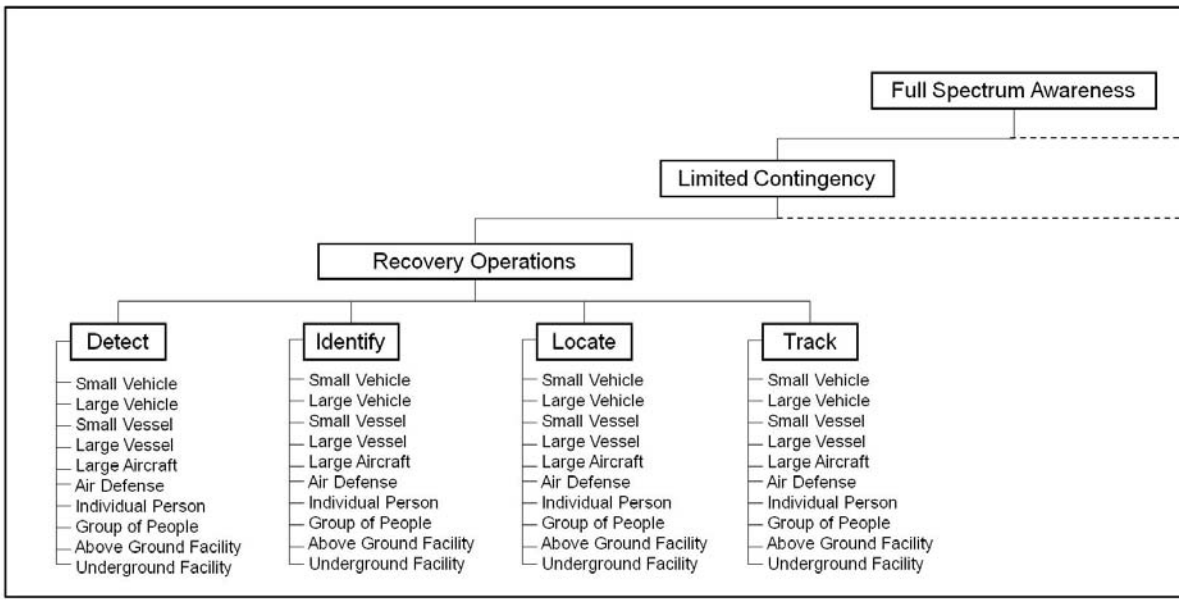


Figure 23. Recovery Operations Branch of ROMO Hierarchy

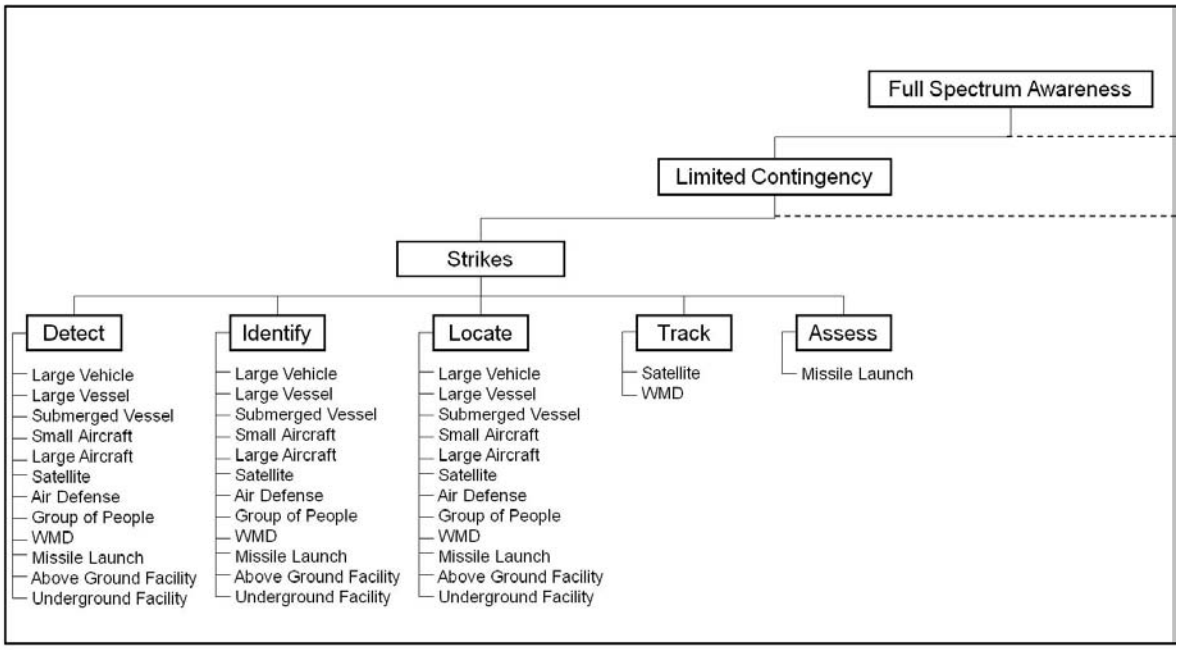


Figure 24. Strike Operations Branch of ROMO Hierarchy

Figures 23 and 24 represent only a fraction of the notional hierarchy. The entire hierarchy consists of 27 branches and over 780 means objectives. This hierarchy is too large to use and must be condensed into a more manageable hierarchy.

Transforming the Notional Hierarchy

Using the transformation technique described in Chapter 3, the "over-sized" notional hierarchy is transformed into a condensed hierarchy. Except for tracking air defenses, tracking above ground facilities, and tracking underground facilities, every action+noun combination in the notional military analyst survey was checked at least once. Therefore, the condensed hierarchy (Figure 25) contains only the action+noun combinations found in the "over-sized" hierarchy. The condensed hierarchy contains only 72 mean objectives, down from the 783 found in the "over-sized" hierarchy. Transforming the "over-sized" hierarchy into the "condensed" hierarchy reduces the number of means objectives by over 90%. Evaluating alternatives requires fewer resources when the hierarchy is smaller.

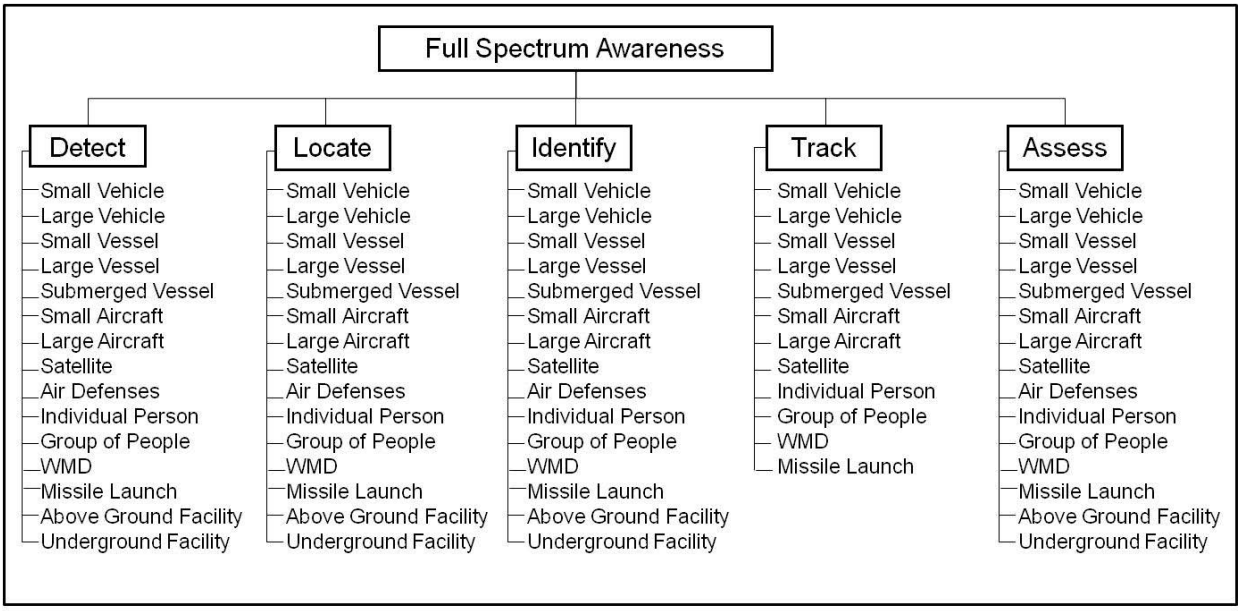


Figure 25. Condensed Notional Hierarchy

Weighting the Notional Hierarchy

Although future research will solicit weights from SMEs, this research uses a hypothetical set of weights for one generic future scenario (Figure 26). In this hypothetical future scenario "Security Cooperation" is the most important category of military operations, and "Combating Terrorism" is the most important operation making up "Security Cooperation."

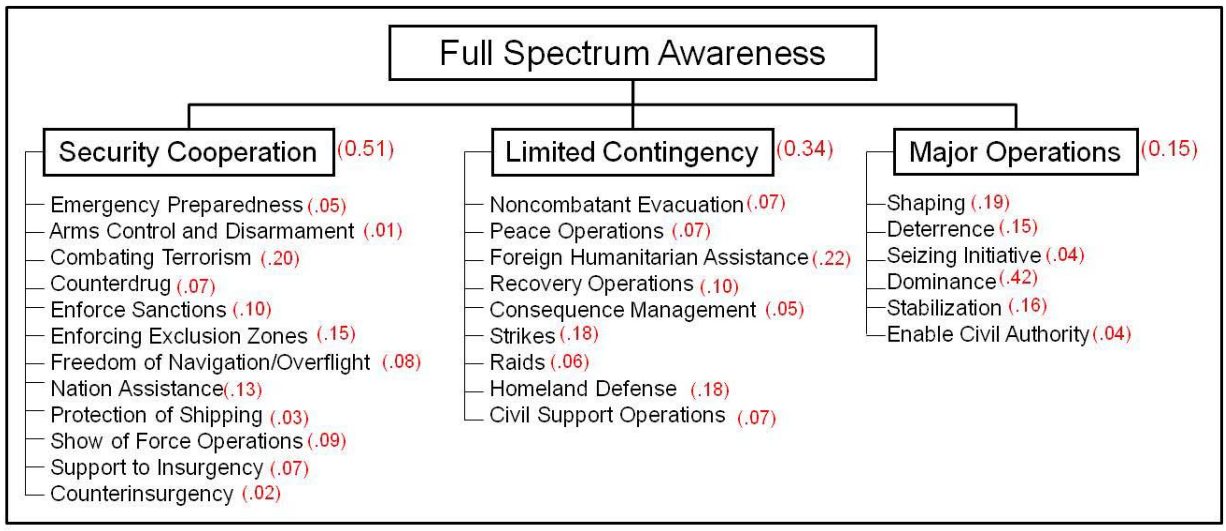


Figure 26. Fundamental Objectives with Hypothetical Local Weights

The local weights for each action+noun combination should be solicited from SMEs with knowledge of what information is important for each operation. However, this research uses hypothetical local weights to show how important each action+noun combination is to an operation for the generic future scenario. Figures 27 and 28 illustrate hypothetical local weights for “Recovery Operations” and “Strikes.”

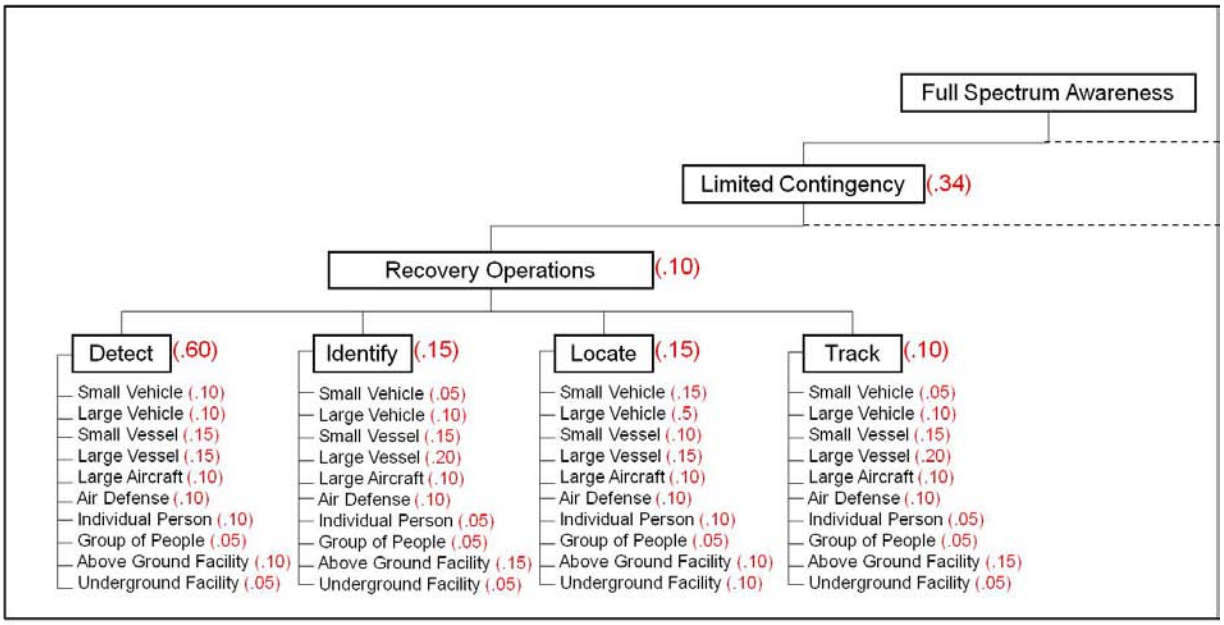


Figure 27. Recovery Operations with Hypothetical Local Weights

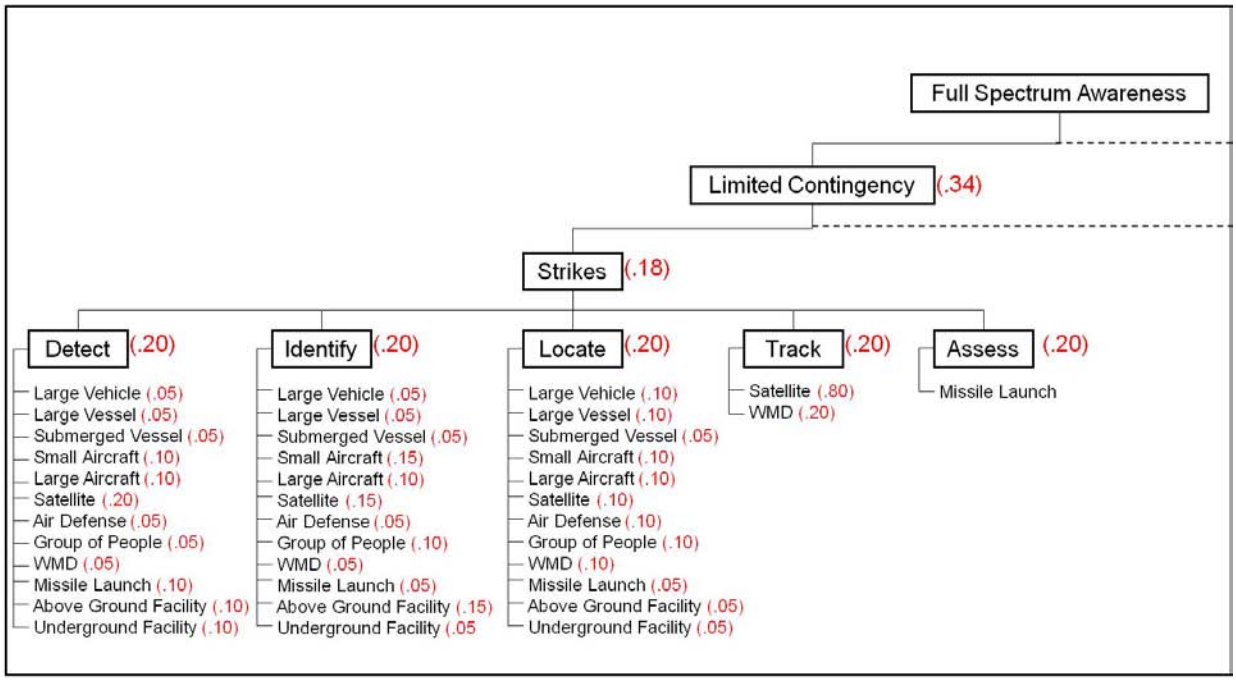


Figure 28. Strike Operations with Hypothetical Local Weights

Once all local weights have been determined, global weights are calculated. Figures 29 and 30 illustrate the global weights for the "Recovery Operations" and "Strike" branches.

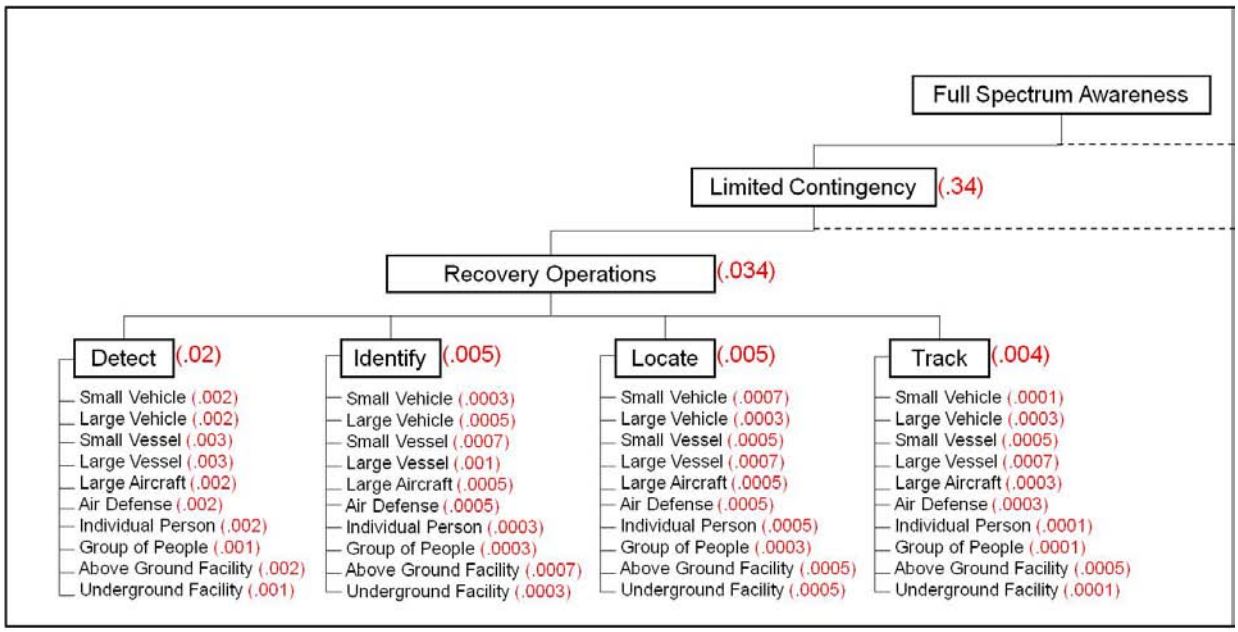


Figure 29. Recovery Operations with Hypothetical Global Weights

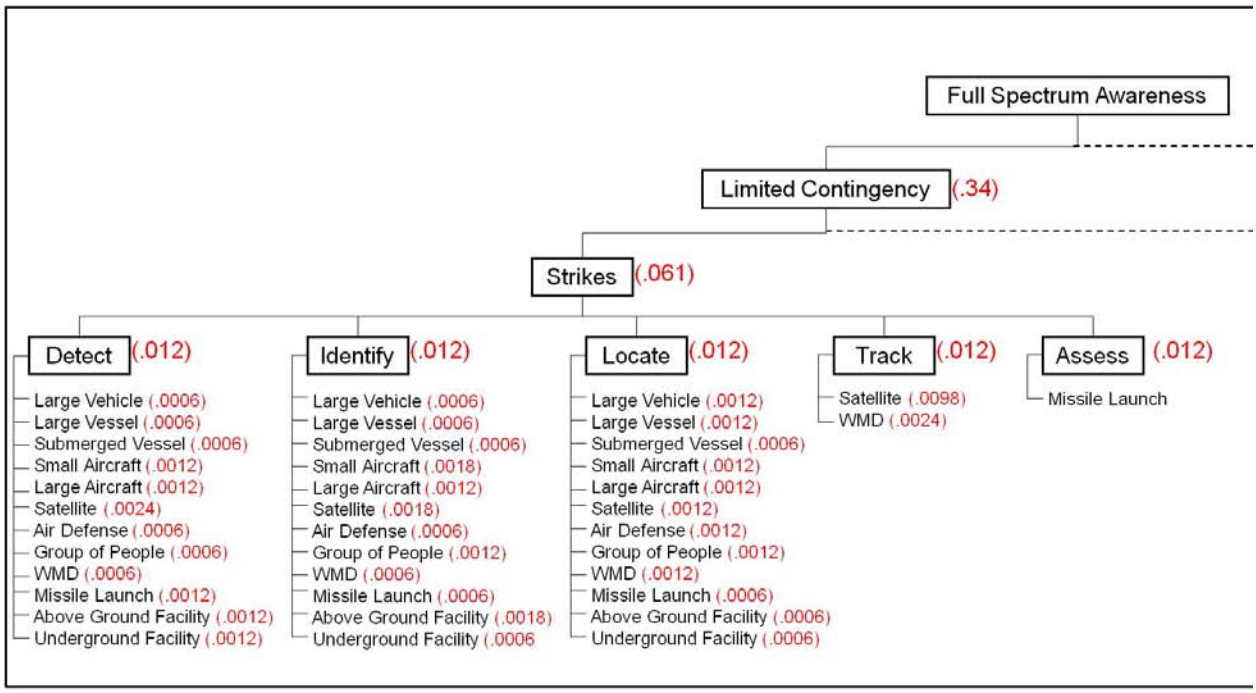


Figure 30. Strike Operations with Hypothetical Global Weights

Due to the magnitude of the "over-sized" hierarchy, this research only calculates the global weights for two branches. Once the global weights for the "over-sized" hierarchy have been calculated, the global weights for the "condensed" hierarchy are computed. Although the same action+noun combinations are found in multiple branches of the "over-sized" hierarchy, each action+noun combination used will appear only once in the "condensed" hierarchy.

The global weights for each action+noun combination in the "condensed" hierarchy (Figure 31) are accumulated from the global weights of the "over-sized" hierarchy. For example, the global weight for "Detecting Large Vehicles" during "Recovery Operation" is 0.002, and the global weight for "Detecting Large Vehicles" during "Strikes" is 0.0006. When these two action+noun combinations are combined in the "condensed" hierarchy, they make up 0.0026 of "Detecting Large Vehicle's" global weight of 0.01.

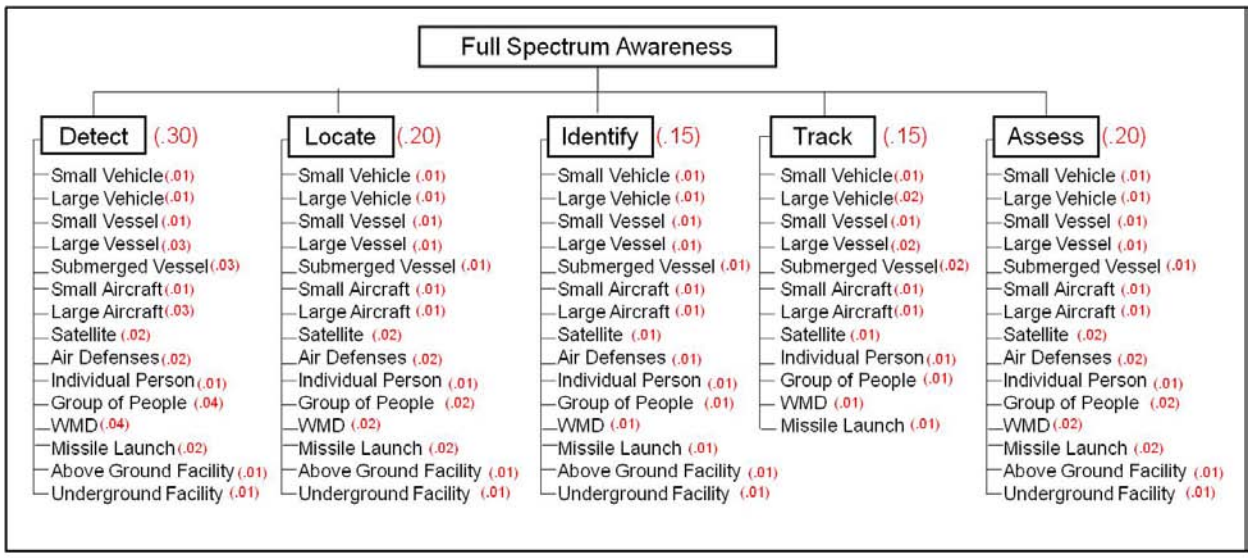


Figure 31. Condensed Hierarchy with Hypothetical Global Weights

This chapter has explained how to build and weigh one qualitative hierarchy for the DIA's problem. The "condensed" hierarchy in Figure 31 is incomplete, and follow-on research is needed to develop appropriate evaluation measures. Once all evaluation measures have been developed, SMEs with knowledge of ISR capabilities will be able to evaluate how well various ISR capabilities perform in future scenarios.

V. Conclusion

Research Contribution

This research presents a methodology which allows an enterprise to evaluate its information gathering capabilities of the future. By identifying the attributes of information that increase its value, an enterprise can develop systems that exploit these attributes, thus maximizing the potential value of future information. Also, the insights an enterprise gains from implementing this methodology can identify gaps between current capabilities and future requirements, helping guide today's research and development efforts.

The Department of Defense (DoD) and intelligence community (IC) have conducted numerous studies looking at the intelligence, surveillance, and reconnaissance (ISR) capabilities of the future. These studies are typically stove-piped, only looking at the best way to employ capability "X." But, what if the best employment of capability "X" is useless in the future? The DoD and IC can use this methodology before starting a study, identifying the ISR capabilities worth studying.

Great insight can be gained by building and weighting the qualitative hierarchy presented in Chapter 3. For example, when the DIA builds and weights a qualitative hierarchy, a decision maker (DM) will be able to identify which action+noun combinations are the most important in the future. For example, the DoD and IC might say, "No matter what future scenario happens we will always need to be able to detect air defenses!" Armed with this knowledge, the DoD and IC can ensure that they properly invest in capabilities that can detect air defenses in the future.

By identifying the information that will be important in the future, an enterprise can focus its research on the technologies that are good at collecting those types of information. However, an enterprise will not be able to quantitatively evaluate how well an information gathering capability achieves an enterprise's overall objective until evaluation measures are developed and alternatives are scored.

Research Limitations

This methodology provides a strategic level of insight to senior DMs. It is meant to identify high-value information gathering capabilities, not to support tactical decisions about how to employ a capability or how many information gathering assets to procure.

The DoD and IC should employ this methodology before funding a study or beginning research on a future ISR capability. This methodology can also support decisions about continuing or canceling on-going research. However, this methodology does not tell DoD and IC DMs whether the capability should fly on a remotely piloted aircraft (RPA) or a satellite. It also does not tell a DM how many RPAs or satellites to acquire.

Future Research

Since this research focuses on just three of the 10 value focused thinking (VFT) steps, providing a recommendation for how the other steps should be carried out is very important. Based on the insights gained from the literature review, this section provides recommendations for developing appropriate evaluation measures and discusses some issues that may occur when scoring alternatives.

Developing Evaluation Measures

If an enterprise only intends to use the hierarchy building process to gain qualitative insights into their decision problem then there is no need to develop evaluations measures. However, evaluation measures should be created if an enterprise hopes to quantitatively evaluate how well an alternative achieves an enterprise's objectives. "The measurement of objectives clarifies their meaning, and this may lead to the creation of desirable alternatives-perhaps even an obvious solution to the problem" (Keeney, 1992:99).

Since each enterprise is unique and has different objectives, this research does not recommend a generic set of evaluation measures. This research recommends an enterprise interested in developing metrics refer to Nichols' article which identifies the "desirable qualities necessary to possess value," (1969) and Skyrme's article regarding the "10 value adding aspects of information" (1994). The information provided by Nichols and Skyrme can help an enterprise identify the capabilities that maximize information's value by evaluating alternatives in the areas that add value to information.

When developing metrics for the Defense Intelligence Agency's (DIA) problem, future research should compare JP 2's "attributes of intelligence product quality," (2006:II-1) with Nichols' (1969) and Skyrme's (1994) articles and the with metrics proposed by *Functional Concepts of Battlespace Awareness* (2003:86). When each alternative is evaluated with the appropriate metrics, the DoD and IC can identify the ISR capabilities that increase the value of future intelligence.

Scoring Alternatives

Normally when an enterprise uses VFT to evaluate alternatives it builds one value hierarchy, weights the hierarchy one time, and runs each alternative through the model one time. However, when an enterprise employs this research's methodology, it will have one uniquely weighted hierarchy for each future scenario being considered. This means that each alternative will receive multiple scores, one for each future scenario. For example, the DIA will have five uniquely weighted hierarchies, one for each of the four future scenarios in the Quadrennial Intelligence Community Review (QICR) and one for Major Combat Operations (MCO). Each alternative the DIA considers will receive five different scores, one from each of uniquely weighted hierarchy.

Some very important insights can be gained from examining the scores of each alternative. For example, if ISR capability "X" scores well in all future scenarios, the DoD and IC know that no matter what future scenario happens, capability "X" will always be useful. However, if capability "Y" doesn't score well in any future scenario, then the DoD and IC know not to invest money further researching that capability. But what should the DoD and IC do when a capability scores well in only two future scenarios? Future research needs to examine ways of comparing/combining scores from multiple value models.

Conclusion

Many of today's enterprises rely heavily on information and view it as a strategic asset. Enterprises spend a significant amount of money collecting, storing, processing, and maintaining information. Not all information an enterprise manages is strategic, but when it is, decisions affecting it require a structured approach following a formal decision making process

(Kirkwood, 1997:3). This research provides a methodology which allows DMs to repeatedly, objectively, and quantitatively evaluate one of their most important assets, information. By identifying the information gathering capabilities that maximize the potential value of future information, DMs can invest wisely today. This ensures that their enterprise is ready to compete tomorrow, no matter what the future holds.

Appendix A. Military Analyst Survey

	Operation	Description (JP-3, 2010), (JP-2, 2007)		Small Vehicle	Large Vehicle	Small Vessel	Large Vessel	Submerged Vessel	Small Aircraft	Large Aircraft	Satellite	Air Defense	Individual Person	Grouping of People	WMD	Missile Launch	Above Ground Facility	Underground Facility	
Military Engagement/Security Cooperation/Deterrence	Emergency Preparedness	encompasses those planning activities undertaken to ensure DOD processes, procedures, and resources are in place to support the President and SecDef in a designated national security emergency	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Arms Control and Disarmament	the identification, verification, inspection, limitation, control, reduction, or elimination of armed forces and armaments of all kinds under international agreement	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Combating Terrorism	Antiterrorism involves defensive measures used to reduce the vulnerability of individuals and property to terrorist acts, to include limited response and containment by local military forces and civilians. Counterterrorism involves measures that include operations to prevent, deter, preempt, and respond to terrorism.	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Counterdrug	supports federal, state, and local law enforcement agencies in their effort to disrupt the transport and/or transfer of illegal drugs into the United States	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Enforcement of Sanctions	operations that employ coercive measures to interdict the movement of certain types of designated items into or out of a nation or specified area	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Enforcing Exclusion Zones	An exclusion zone is established by a sanctioning body to prohibit specified activities in a specific geographic area. Exclusion zones can be established in the air (i.e., no-fly zones), sea (i.e., maritime), or on land (i.e., no-drive zones).	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Ensuring Freedom of Navigation and Overflight	operations are conducted to demonstrate US or international rights to navigate sea or air routes	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Nation Assistance	civil or military assistance (other than Foreign Humanitarian Assistance (FHA)) rendered to a nation by US forces within that nation's territory during peacetime, crises or emergencies, or war	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Protection of Shipping	US forces provide protection of US flag vessels, US citizens (whether embarked in US or foreign vessels), and US property against unlawful violence in and over international waters	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Show of Force Operations	demonstrate US resolve. They involve the appearance of a credible military force in an attempt to defuse a specific situation that if allowed to continue may be detrimental to US interests or national strategic objectives or to underscore US commitment to an alliance or coalition.	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Support to Insurgency	an organized movement aimed at the overthrow of a government through the use of subversion and armed action. It uses a mixture of political, economic, informational, and combat actions to achieve its political aims. It is a protracted politico-military struggle designed to weaken the control and legitimacy of an established government, an interim governing body, or a peace process while increasing insurgent control and legitimacy	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Military Engagement/Security Cooperation/Deterrence	Counterinsurgency	support provided to a government in the military, paramilitary, political, economic, psychological, and civic actions it undertakes to defeat insurgency	Detect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Other (Action + Noun):
			Identify	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Locate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Track	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
			Assess	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

					Other (Action + Noun):
Crisis Response/Limited Contingency	Noncombatant Evacuation	operations directed by the Department of State (DOS) or other appropriate authority, in conjunction with the DOD, whereby noncombatants are evacuated from foreign countries when their lives are endangered by war, civil unrest, or natural disaster to safe havens or to the United States	Detect Identify Locate Track Assess		
	Peace Operations	multiagency and multinational operations involving all instruments of national power; including international humanitarian and reconstruction efforts and military missions; to contain conflict, redress the peace, and shape the environment to support reconciliation and rebuilding and facilitate the transition to legitimate governance	Detect Identify Locate Track Assess		Other (Action + Noun):
	Foreign Humanitarian Assistance	relieve or reduce the impact of natural or man-made disasters or other endemic conditions such as human pain, disease, hunger, or privation in countries or regions outside the United States	Detect Identify Locate Track Assess		Other (Action + Noun):
	Recovery Operations	search for, locate, identify, recover, and return isolated personnel, sensitive equipment, items critical to national security, or human remains	Detect Identify Locate Track Assess		Other (Action + Noun):
	Consequence Management	actions taken to maintain or restore essential services and manage and mitigate problems resulting from disasters and catastrophes, including natural, man-made, or terrorist incidents. CM may be planned and executed for locations within US-owned territory at home and abroad and in foreign countries as directed by the President and SecDef	Detect Identify Locate Track Assess		Other (Action + Noun):
	Strikes and Raids	Strikes are attacks conducted to damage or destroy an objective or a capability. Raids are operations to temporarily seize an area, usually through forcible entry, in order to secure information, confuse an adversary, capture personnel or equipment, or destroy an objective or capability	Detect Identify Locate Track Assess		Other (Action + Noun):
	Homeland Defense and Civil Support	a cooperative effort among all federal agencies as well as state, tribal, and local security and law enforcement entities. Military operations inside the United States and its territories, though limited in many respects, are conducted to accomplish two missions - HD and CS. HD is the protection of US sovereignty, territory, domestic population, and critical defense infrastructure against external threats and aggression or other threats as directed by the President. CS consists of DOD support to US civil authorities for domestic emergencies and for designated law enforcement and other activities	Detect Identify Locate Track Assess		Other (Action + Noun):
Major Operations/Campaigns	Shaping	JFCs are able to take actions before committing forces to assist in determining the shape and character of potential future operations. In many cases, these actions enhance bonds between future coalition partners, increase understanding of the region, help ensure access when required, strengthen future multinational operations, and prevent crises from developing. Intelligence activities conducted during the shaping phase lay the groundwork for intelligence operations in all subsequent phases of the operation.	Detect Identify Locate Track Assess		Other (Action + Noun):
	Deterrence	Before the initiation of hostilities, the adversary leadership structure and decision-making process must be continuously monitored and reassessed. Focus is placed on monitoring the current situation and assessing adversary capabilities. JIPOE analysts support I&W by looking for specific indications of imminent adversary activity. It is essential that any maps, charts, imagery products, and support data — to include datum and coordinate systems — to be used in a joint operation be fully coordinated. Intelligence may be used to identify an adversary's potential allies and sanctuaries, and identify and assess the vulnerability to interdiction of the adversary's sources of support, to include intelligence	Detect Identify Locate Track Assess		Other (Action + Noun):
	Seizing Initiative	The JFC's target intelligence element is active in this phase. It is responsible for gathering target nominations; vetting targets; matching target vulnerabilities with appropriate agents (weaponeering); monitoring ongoing operations; conducting assessment. SIGINT sources may detect indications of enemy demoralization and providing insight into the PSYOP success or failure. Real-time, persistent surveillance and dynamic ISR collection management are critical are also critical. Adversary force deployments must be tracked with a level of persistence and accuracy sufficient to support retargeting and precision engagement. ISR visualization provides real-time cross cueing and provides a basis for re-tasking	Detect Identify Locate Track Assess		Other (Action + Noun):
	Dominance	The complexity of nonlinear operations requires a continuous flow of accurate and timely intelligence to help protect individual forces. This intelligence supports precise targeting, mobility advantages, and freedom of action and is enabled by persistent surveillance, dynamic ISR management, and a common intelligence picture. JFCs require assessments of an enemy's capability, willingness and intent to employ WMD. These assessments should identify known and suspected locations of enemy WMD stockpiles and delivery systems, and analyze the effects on the operational environment of WMD use. JFC will require detailed intelligence regarding the status of key infrastructure, enemy government	Detect Identify Locate Track Assess		Other (Action + Noun):
	Stabilization	During the stabilization phase, intelligence collection and analysis should transition from supporting combat operations to focus on actual or potential threats to the joint force (e.g., insurgent groups, criminal elements, terrorist cells). Particular attention should be paid to identifying and assessing the leaders of groups posing potential threats to civil authority and reconstruction efforts. Intelligence should also identify critical infrastructure and analyze its vulnerability to disruption by elements hostile to stabilization efforts.	Detect Identify Locate Track Assess		Other (Action + Noun):
	Enabling Civil Authority	Intelligence support may remain in place after termination of the joint operation in order to support the civil authority and/or to continue to monitor the situation.	Detect Identify Locate Track Assess		Other (Action + Noun):

Appendix B. Blue Dart

DETERMINING THE VALUE OF FUTURE INTELLIGENCE

The year is 2030. By leveraging their vast energy reserves, huge populations, and high level of technological development the Shanghai Cooperation Organization (China, Russia, India, and Iran) has become a "new counterbalance to Washington economics and American military preeminence" (Quadrennial Intelligence Community Review, 2009). Unfortunately, the Department of Defense (DoD) and intelligence community (IC) are ill prepared for the emergence of this new adversary. The U.S. suffers from large gaps in military intelligence due to the previous decades' overinvestment in the intelligence, surveillance, and reconnaissance (ISR) capabilities best suited for counterinsurgency operations.

In the present year, the DoD and IC are thinking about the ISR assets of the future. They are trying to determine which ISR assets the U.S. will need 15 to 30 years from now, but this is a difficult task in a field where technology and information can be fleeting. The studies typically select a specific capability (e.g. Radar) and determine the best way to implement it. However, there is always a risk that the capability will not be beneficial in the future, rendering the capability and the research useless.

Because different ISR capabilities are better at different things, the DoD and IC need a methodology for determining the value of future intelligence. For example, in future scenario "A", the U.S. faces a certain type of threat for which ISR capability "X" is useful. Meanwhile, in future scenario "B", the U.S. faces a very different threat, for which ISR capability "Y" is useful. We don't know which future threat the U.S. will face. Therefore, the DoD and IC need a

methodology for identifying the ISR capabilities that maximize the potential value of future intelligence.

By combining military doctrine with commercial industry research, the Air Force Institute of Technology (AFIT) has developed a methodology allowing an enterprise to evaluate information gathering capabilities for the future. This methodology provides insight about which qualities of a system maximize the potential value of information. The proposed model also helps identify gaps between current capabilities and future requirements, guiding future system development.

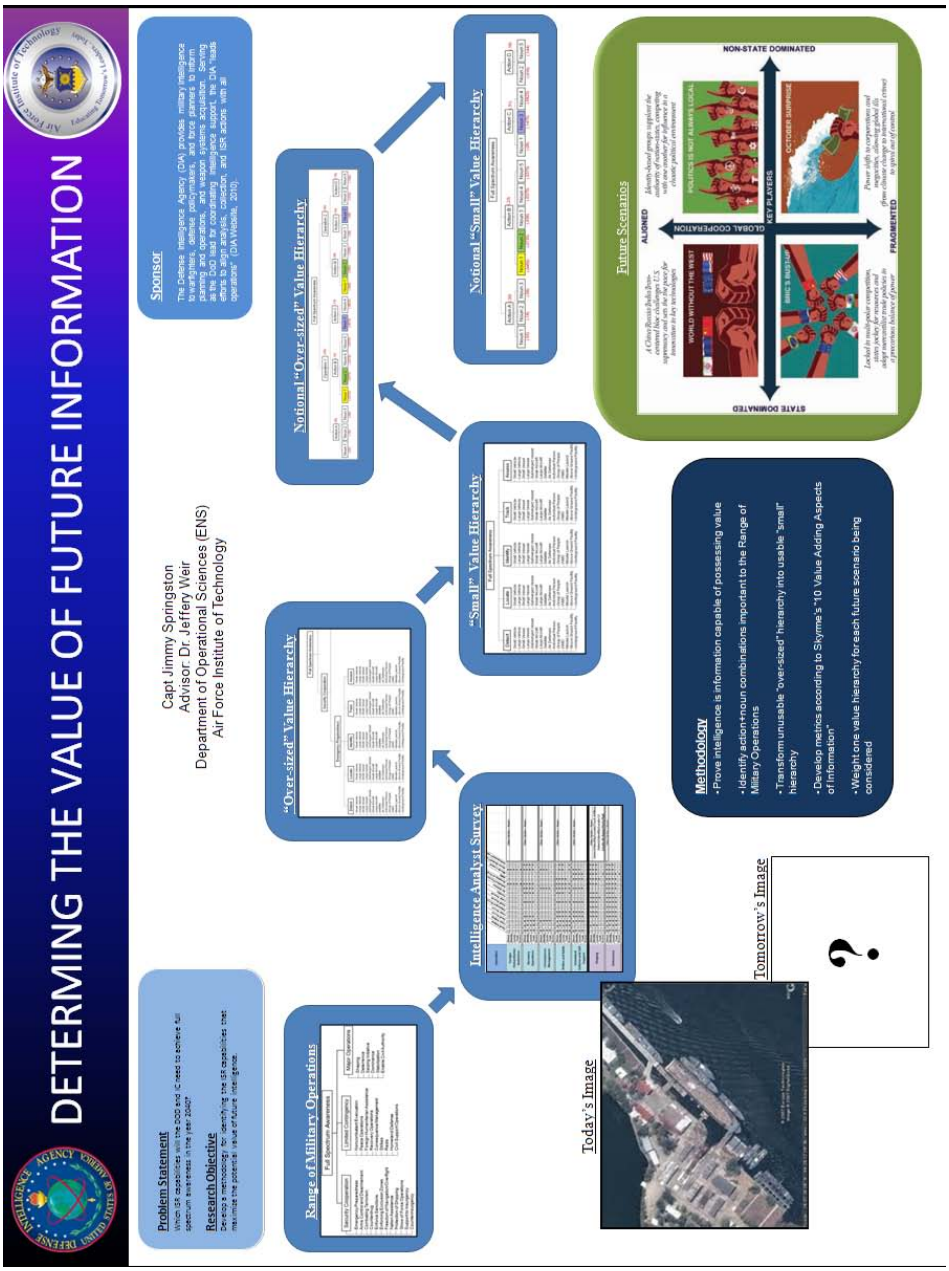
Most commercial companies can easily determine the value of traditional economic goods (e.g. vehicle, real estate, etc). However, determining the value of their intangibles (e.g. information) can be difficult. The commercial world responded by treating information as an asset that behaves differently than traditional economic goods. By ensuring their information is available, high quality, relevant to the decision it supports, and collected in a timely manner, an enterprise's information is capable of possessing value. Similarly, AFIT has shown that military intelligence is an asset of the U.S. Government capable of possessing value.

By treating intelligence as an asset capable of possessing value, AFIT was able to employ value focused thinking (VFT) in order to calculate the value of various ISR capabilities. VFT provided a robust, repeatable, and objective approach for evaluating alternatives. Also, by allowing a decision maker to specify an operation's degree of importance for each future scenario, AFIT was able to identify robust ISR capabilities that scored well no matter what the future holds.

Since tomorrow's intelligence hasn't been collected yet, it is impossible to assign it a value. However, AFIT's methodology allows the DoD and IC to identify the ISR capabilities

that maximize the potential value of future intelligence. By using this methodology today, military planners can gain insight into which ISR capabilities are going to be most useful tomorrow.

Appendix C. Poster



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Vita

Captain Jimmy Springston graduated from Our Lady of Providence High School in Clarksville, IN. He entered undergraduate studies at Indiana University where he graduated with a Bachelor of Science degree in Mathematics in May 2006. He was commissioned through the Detachment 215 AFROTC at Indiana University.

Captain Springston was first assigned to the 4th Space Launch Squadron (4SLS) at Vandenberg AFB, CA, to serve as an Atlas V launch vehicle engineer. While in the 4SLS, Capt Springston was lead launch vehicle engineer for the Atlas V's maiden west coast launch. In June 2008, he became the Executive Officer of the 30th Launch Group, supporting Missile Defense Agency (MDA) and Evolved Expendable Launch Vehicle (EELV) operations. While at Vandenberg he also earned a certificate in Space Systems Operations from the Naval Postgraduate School. In Aug 2009, he entered the Graduate School of Engineering and Management's Operational Research program, Air Force Institute of Technology. Upon graduation, he will be assigned to the Air Force Personnel Center's (AFPC) analyst shop.

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14. ABSTRACT

Companies continuously struggle to quantify the value of their information in an attempt to gain a better understanding of the return on investment of their information technology (IT) architecture. One approach companies have taken to place a numeric value on information is to treat it as a traditional economic asset (e.g. equipment, buildings, and vehicles) that is governed by its own unique set of laws. Once an enterprise understands the behavior of information it can incorporate Skyrme's "10 value adding aspects of information" when developing IT architecture, thus maximizing the potential value of their information. Like most enterprises, the Intelligence Community (IC) is continuously trying to assess the value of their Intelligence Sharing Architecture. Currently, work is being done inside the Department of Defense (DoD) using Value Focused Thinking (VFT) to compare the value of different Intelligence, Surveillance and Reconnaissance (ISR) force mixtures. The current ISR force sizing study is very beneficial for evaluating today's ISR force mixtures, but little research has been done to evaluate the ISR force mixtures of the future. This research will present a generic methodology allowing any enterprise to determine the value of future IT architecture; specifically, it will be applied to the IC for determining the value of intelligence gathering capabilities for the year 2040.

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