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Terrifying Landscapes:

A Study of Scientific Research Into Understanding Motivations of Non-State Actors to Acquire and/or Use Weapons of Mass Destruction

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A Study of Scientific Research into Understanding Motivations of Non-State Actors to Acquire and/or Use Weapons of Mass Destruction

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Albuquerque, NM

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One horrific September terrorist attack, in the United States, sent the stock market reeling and sparked anti-immigrant sentiment.

Another attack, in Madrid, plunged Spanish Politics into turmoil over issues of war and peace.

Politicians in the U.S. took to describing the war on terror as a struggle of good versus evil.

Religious leaders, quoting scripture, proclaimed that the end of the world was at hand…

…The Year: 1901

Laqueur, Walter, "*The World of Terror*"

Everything that can be counted does not necessarily count;

everything that counts cannot necessarily be counted.

Albert Einstein

Background

Concerns about non-state actor acquisition and use of weapons of mass destruction (WMD) against noncombatants have existed since the turn of the century, if not before. However, the level of concern has risen significantly since 9/11 for a number of reasons that include: the perception that a threshold was crossed on 9/11, concerns about more widespread availability of technology, greater attention given to the potential threat in the media, the growing and persistent military presence of the US in global affairs, increasing exploitation of the internet by non-state actors to create networks and disseminate information, and an increased awareness of vulnerability among the Western public. However, it is not clear that this heightened concern has been matched by scholarly research to better understand and characterize the real nature of the threat, the casual factors that are necessary to explain it, and the dynamic relationship between the evolution of threat and responses to it.

In 2002, Los Alamos National Laboratory held a conference to examine the motivations for terrorists to use weapons of mass destruction. At that conference, Dr. Brad Roberts noted the paucity of research that exists for understanding the relationship between motivations to acquire WMD on the part of non-state actors, the actual development/acquisition of capabilities, and how countermeasures on the part of states affected those motivations. As he accurately summarized, up until that time,

> "…experts interested in the terrorism subject had devoted only a tiny fraction of their time and effort to thinking about weapons of mass destruction. Similarly, experts on weapons of mass destruction had devoted little time and effort to thinking about terrorism." [1]

The Center for Nonproliferation Studies, in their 2002 literature review of open source work on modeling terrorist actions, came to a similar conclusion, stating that,

> "…with regards to the specific question of the terrorist decision to employ WMD, the project team could uncover no current research on modeling this aspect of terrorist behavior."[2]

[1] Roberts, Brad, "Motivation for Terrorists to Use Weapons of Mass Destruction", Confronting Terrorism, A Workshop Held at Los Alamos National Laboratory March 25-29, 2002. Proceedings edited by Rajan Gupta and Mario R. Perez.

[2] Center for Nonproliferation Studies, "Literature Review Of Existing Terrorist Behavior Modeling: Final Report to the Defense Threat Reduction Agency", Monterey Institute of International Studies, 2002.

Even more to the point, social scientist Dr. Jeff Goodwin from New York University recently made the following assessment with respect to scholarly contributions:

> "…Before 9/11, terrorism research was the exclusive preserve, with very few exceptions, of small networks of political scientists and non-academic 'security experts', relatively few of whom were interested in social science theory. Descriptive case studies abound, replete with ad hoc, case-specific explanations of terrorism. Curiously, most scholars of rebellion and revolutions have had virtually nothing of significance to say about terrorism. More generally, the *strategic choices* of social movements – of which terrorism is one – have received much less scholarly attention than the causes and consequences of such movements." [3]

The choice to acquire and/or use WMD could be considered a strategic choice for a terrorist movement.

Objectives

The purpose of this study was to explore and characterize the research base that exists, outside of these previous studies, for examining the motivations of non-state actors to acquire and/or use WMD, and what additional knowledge domains should be considered that have not yet been brought to bear on the problem. The primary (though not exclusive) target was open source, academic research in the past 5-10 years, accessible to Western scholars (though not exclusively Western in origin) and government personnel. In the process of conducting the study, it was furthermore desired to develop 1) a list of the researchers who are experts in fields important to the problem space, 2) a sense of what kind of data and research methods have been used to look at the problem, and by whom, and 3) a topology of the literature, 4) the common, congruent, and contradictory themes within the literature, and 5) research gaps and unanswered questions. In subsequent studies, these themes should be related to the Defense Threat Reduction Agency (DTRA) initiatives for modeling and analysis of WMD proliferation pathways.

The themes of what motivates nonstate actors - such as political, social, cultural, ideological, psychological, and economic factors - to acquire and/or use WMD are important to understand in developing the upstream dynamics of proliferation pathway models. These models assess the steps an actor might take to make a decision to acquire or not acquire and/or use/not use WMD. Historically, these decision process models have been primarily concerned with the assessment of technical and operational factors. However, motivations are key drivers for the initial decisions about WMD acquisition,

[3] Goodwin, Jeff, "A Theory of Categorical Terrorism", Social Forces, Volume 84, Number 4, University of North Carolina Press. June 2006.

choice of WMD technologies and delivery mechanisms which must be considered for robust, dynamic, systems-level models. As these motivations strongly influence the degree of effort that an actor may be willing to expend in overcoming obstacles to acquiring the WMD of choice, they must be considered in developing effective dissuasion and deterrence strategies along specific pathways, in addition to traditional technical and operational assessments.

In considering motivations for WMD proliferation pathway models, different contexts for different actors must be analyzed, as well as how the actions of the US shape those motivations, to create an ever-changing landscape of intentions and capabilities. The analysis of how the results of this study can be specifically applied in the decision process models is outside the scope of this report, and should be the subject of follow on work.

There were three major reasons to undertake the study at this time. The first was to characterize and begin to redress the gap that exists, as noted by Dr. Goodwin, between research in the social sciences and their application to questions about WMD. The second is that the global geopolitical situation has changed in the past five -six years (since last such studies were conducted for DTRA) in ways that have major implications for studying the motivations of non-state actors to acquire WMD. The third has to do with the nature of information availability and communication – both that available to analysts studying the motivations of nonstate actors and that which flows between nonstate actors themselves.

Primary geopolitical developments of the past five years to consider in analyzing motivations of nonstate actors to use WMD include: 1) the proliferation of a diversity of nonstate actors capable of mounting WMD attacks against the U.S. and its interests worldwide; 2) the emergence of Jihadism as a global ideology that shapes the context for debate among a growing number of extremist groups (not limited to jihadists) on the justified use of WMD; 3) the evolution of Al Qaeda into a surrogate figurehead for a diverse agglomeration of jihadist terrorist entities targeting the U.S. and its interests worldwide; 4) the attendant transformation of Al Qaeda from a relatively well-defined organization to something that continues to morph and evolve between a transnational movement, a civil insurgency, a terrorist organization, and a diffuse network of ideologically similar but organizationally and geopolitically dissimilar groups; and 5) Iraq and all of the implications –growing resentment towards the US for continued military presence as a foreign occupier; erosion of belief and training between disaffected groups and individuals. As a result of these developments, more emphasis was placed in this study on the geopolitical and ideological motivations of Islamic groups than other nonstate actor groups – such as social revolutionaries, right-wing extremists, etc. - which have been covered fairly extensively in previous studies.

Two key information drivers are 1) the increased availability in the past five years of strategic documents for ideological and rhetorical analysis of extremist and terrorist groups, and 2) the transparency into the world of extremist groups and other potential nonstate actors afforded by the increased use of the internet by to advocate their cause, communicate among members, and transmit technological expertise. Of particular interest are the debates among Islamists on the justifications for use of WMD and mass violence in general, and the degree to which these views are shared by, and/or shape the views of, the rest of the Muslim world.[4]

Scope

The study addressed the following questions:

1) What does recent literature tell us about:
    - Motivations of different non-state actors, including Islamists, and how they evolve?
        - Is the Role of WMD an end point of a "violence spectrum" that may be considered to achieve goals and/or express message?
        - What is the decision-making calculus of the particular group?
        - What are the influences of contextual factors?
    - What evidence exists that indicates alternatives to violence or WMD is being considered?
2) What are the different perspectives represented in the literature?
3) How robust is the knowledge domain?

This study built on previous work, attempting to augment the scientific foundations and

[4] These views are of concern, as surveys worldwide show increasing sympathy among diverse Muslim populations in the Arab world, Asia, and Europe for the goals and aspirations of violent jihadist groups while at the same time there is increasing antagonism towards the U.S. and its policies. Debates on the justification for killing indiscriminately abound within Islam. On the one hand, there are influential clerics, such as Saykh Nasir Bin Hamd Al-Fahd, who argue that the indiscriminate acts of violence by the US against innocent Muslims justifies the use of nuclear, biological and chemical weapons in return. A more moderate position is laid out in the fatwa issued by Nasir Al-Fahd in 2003, which specifies conditions under which the use of nuclear, biological, and chemical weapons would be justified under Islam. The equally influential (and controversial) Muslim cleric, Tariq Ramadan, has that "terror is a fact, not an ideology, and we must be very clear in condemning it"(McLean's Interview, 2005). Some of the arguments of clerics, who advocate against mass violence with their constituencies while maintaining the same ideological goals as more violent peers, were also referenced in this study as counterarguments and influencing factors in the perceptions of the broader community of support. Strategic analyses of these arguments are being conducted by the Harmony Project at the Combating Terrorism Center at West Point Academy, which has undertaken an initiative to translate, and make available in both English and the original Arabic strategic and tactical documents of Al Qaeda and its associates collected worldwide. See http://www.ctc.usma.edu. In addition, much of this literature is under study through the DTRA Strategic Cultures project, available at http://www.dtra.mil/ASCO/comparative strategiccultures.cfm .

fill in gaps. Studies by researchers at the Institute for Defense Analysis (IDA) in 1996 and again in 1999, reported on by Brad Roberts in 2002 at the aforementioned conference at Los Alamos National Laboratory, were primarily based on case studies of terrorist campaigns and strategic personalities examined through the lens of political science. Using arguments grounded in rational decision-making, the IDA study concluded that those least likely to seek mass casualties were leftists, national and ethnic separatists, state-sponsored groups and cyber criminals; most likely were right-wing, transnational and states pursuing asymmetric strategies in war against U.S. Those most likely to use were additionally motivated by religious ideologies. In summarizing this work, Roberts reported that, in 1999, literally no experts had written on transnational terrorist use of WMD.

Framing the Problem

Defining weapon of mass destruction

A definition for "weapon of mass destruction" was required as an initial step in formulating the nature of the problem to be studied. The term was first used in 1937 to describe the aerial bombardment of Guernica in Spain. Wikipedia provides the more recent vernacular definition, based on a synthesis from a number of reference sources that include encyclopedias, science dictionaries, etc[5]:

> *Weapon of Mass Destruction is a term used to describe a munition with the capacity to indiscriminately kill large numbers of living beings. The phrase broadly encompasses several areas of weapon synthesis, including nuclear, biological, chemical (NBC) and, increasingly, radiological weapons.*

However, in policy circles, the term often has a more narrow meaning that is limited to specific technologies. Based on terminology in many official US government documents, the Center for Nonproliferation Studies (CNS) at the Monterey Institute of International Studies defines weapons of mass destruction simply as "*nuclear, chemical, and biological weapons.*"[6] CNS notes, however, that those US laws and documents which are focused on responding to possible WMD incidents in the US often take a broader view of WMD, and include in their definition radiological weapons or conventional weapons causing mass casualties. In a statement to the Emerging Threats and Capabilities Subcommittee of Armed Services Committee of the United States Senate, Major General Robert P. Bongiovi, then acting director of the Defense Threat Reduction Agency, presents the latter view, testifying that,

[5] A number of other definitions of WMD can be found at http://www.answers.com/topic/weapons-of-mass-destruction#copyright

[6] See, http://nti.org/f_wmd411/f1a1.html for a list of documents that include Presidential directives, US State Dept policy, DOD doctrine, and Congressional legislation.

> *"The (WMD) definition encompasses nuclear, chemical, and biological weapons. However, it also radiological, electromagnetic pulse, and other advanced or unusual weapons capable of inflicting mass casualties or widespread destruction. In addition conventional high explosive devices, such as those used in the attacks on Khobar Towers and the USS COLE, are legally and operationally considered to be WMD."*[7]

The definitions for WMD which focus exclusively on the technology are problematic for the purpose of this study, which is not to characterize or assess specific WMD threats, but to explore the knowledge domain that describes the motivations that underlie potential WMD threats from non-state actors. Social psychology literature points out that, in terms of motivations, the important decision threshold to be crossed is whether or not to engage in mass destruction involving the killing of "innocent" noncombatants. (Note, the term "innocent" itself is a loaded term, which depends on ones perspective and world view). Once that decision has been made, the choice of technology – whether it be conventional explosives used on a massive scale, or something more "exotic" such as chemical, biological, or nuclear weapons -- is a much smaller step and often (although not always) is driven by factors involving opportunity and expertise rather than social and behavioral considerations.[8]

Therefore, the following definition for WMD that was adopted for this study does not depend on technology, but rather on the intended effects of the use of the technology its targets:

> ***A weapon of mass destruction is the means or capacity to intentionally and indiscriminately kill or put at risk the well being and livelihood of large numbers of living beings.***

This definition includes, but is not limited to, nuclear, chemical, and biological weapons; it also includes cases of destruction of critical infrastructures and other essential resources for life, as well as direct loss of human life.

[7] Statement of Major General Robert P. Bongiovi, USAF, Acting Director, Defense Threat Reduction Agency, Before the Emerging Threats and Capabilities Subcommittee, Committee on Armed Services United States Senate 12 July 2001.

[8] However, as will be pointed out in the results of the study, there are motivational factors for making the choices between technologies that have to do with perceptions of risk and propensity for risk-taking behaviors.

Defining motivation[9]

The second aspect to consider is the nature of motivation itself. Motivation has been studied from many perspectives - e.g., psychological, organizational, educational, biological, political, and spiritual. A cursory review of this research literature showed that there is no single definition of motivation, nor is there a grand canonical theory to explain it. However, a review of definitions across these different scientific domains showed consistency in concepts.

The following modified definition of motivation by Daft was chosen for this study (phrase in italics added):

> "**the forces either within or external to a person *or group* that arouse enthusiasm and persistence to pursue a certain course of action."**[10]

This definition was chosen for several reasons. First, it recognizes that the forces which activate behavior can be either internal or external. Second, it is neutral with respect to the nature and origin of those forces. Third, it highlights the importance of persistence. Lastly, it suggests both direction and goal-orientation in the pursuit of action without constraining the definition to rational actor approaches.

Fundamental to the study of motivation for acquisition of WMD are the universal premises derived from Maslow's hierarchy of needs, which bear directly on the correlations between motivation, deterrence, and evolution in shaping behaviors:

1. Human needs are either of an attraction/desire nature or of an avoidance nature.
2. Because humans are "wanting" beings, when one desire is satisfied, another desire will take its place.

Three additional principles important to this study are:

3. Behavior is always the result of a combination of drivers.
4. Cognitive beliefs about what will happen as a result of behavior are powerful motivators irrespective of their grounding in reality.

---

[9] Theories to explain motivation are derived primarily from behavioral, social, and cognitive psychology literature. The earliest and most basic are needs theories, pioneered by Maslow. These explain motivation according to the hierarchy of needs: physiological, security/safety, belongingness and love, esteem, self-actualization and transcendence. Expansions on Maslow's work bring in more complex ideas of the development of needs in relation to the environment and others, such as deprivation and attribution theories. Process theories explain how individuals select particular behaviors and how individuals determine if these behaviors meet their needs. The two primary drivers in these theories are expectancy and perceptions of equity. Theories of reinforcement, pioneered by Skinner, are based not on need but on the relationship between behavior and its consequences. According to this theory, reinforcements can be positive, negative, punishment, or extinction. An expanded discussion of some of these theories of motivation can be found in Appendix C.

[10] Daft, Richard L. (1997). Management, 4th ed. Orlando, Fl.: Harcourt Brace.

5. The persistence of motivation depends on feedback from the behavioral action taken.

With respect to religious ideologies and motivation, Bruce Hoffman wrote, in 1997,

> *Terrorism motivated by extreme interpretations of religious doctrine assumes a transcendental dimension, and its perpetrators are consequently unconstrained by the political, moral, or practical constraints that may affect other terrorists.*[11]

The question of what constrains non-state actors, and how those constraints are shaped by external factors as well as ideological beliefs is a key to understanding the motivation to acquire WMD, and the forces that do or do not come into play. What shapes the relationship between religiously motivated extremists and the broader pool of like-minded believers? Are there ideological constraint mechanisms? What role does ideological competition with other groups play? Figure 2 shows the multiple directions that these forces project within like-minded groups and between those groups and others in competition for the same resource base of popular support.

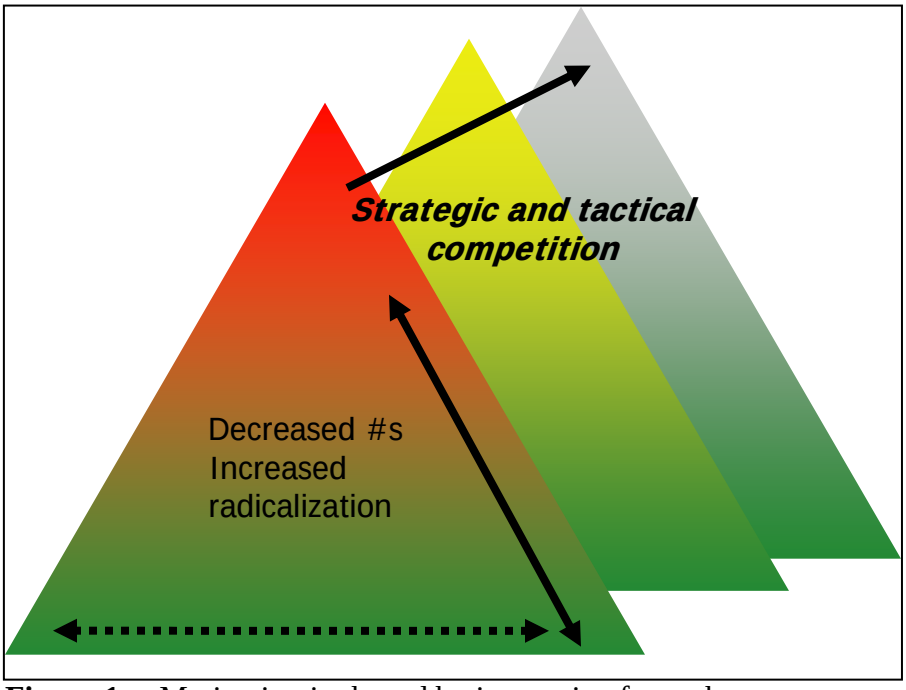

Figure 1. Motivation is shaped by interactive forces between extremists at the apex of ideological beliefs and their underlying base of support, those with whom the groups are in strategic and tactical competition, as well as the forces that shape the motivations of the underlying base of support themselves.

These concepts underscore the interactive, relational, and dynamic nature of motivations. Consider the context in which WMD motivations and capabilities evolve.

[11] Hoffman, Bruce, "Terrorism and WMD: Some Preliminary Hypotheses", Nonproliferation Review, V 104, N 43 (Spring-Summer 1997), p 45.

The motivations themselves can be viewed as emergent phenomenon of a complex system comprised of multiple actors – both human and technological. These interactions are continuously evolving, resulting in adaptive responses, behaviors, and beliefs. Figure 2 shows the multiple feedback paths between the technical capabilities acquired by actors, their motivations, the vulnerabilities of the systems they target, their perceptions of the consequences on the intended audiences, the ability of the intelligence community to detect and interdict the development and/or deployment of capabilities and the decisions of policy makers for intervention.[12]

Ideally, the required knowledge base must be able to inform the dynamics between all parts of this "system of systems", at the appropriate levels of granularity. In reality, the research fields and analysis methods don't tend to overlap, and even within domains, do not often span multiple levels of analytic consideration (i.e., individual, group, organizational, and institutional) with interdependent factors. As a result, analyses most often disaggregate the problem space into categorical actors, viewed through single

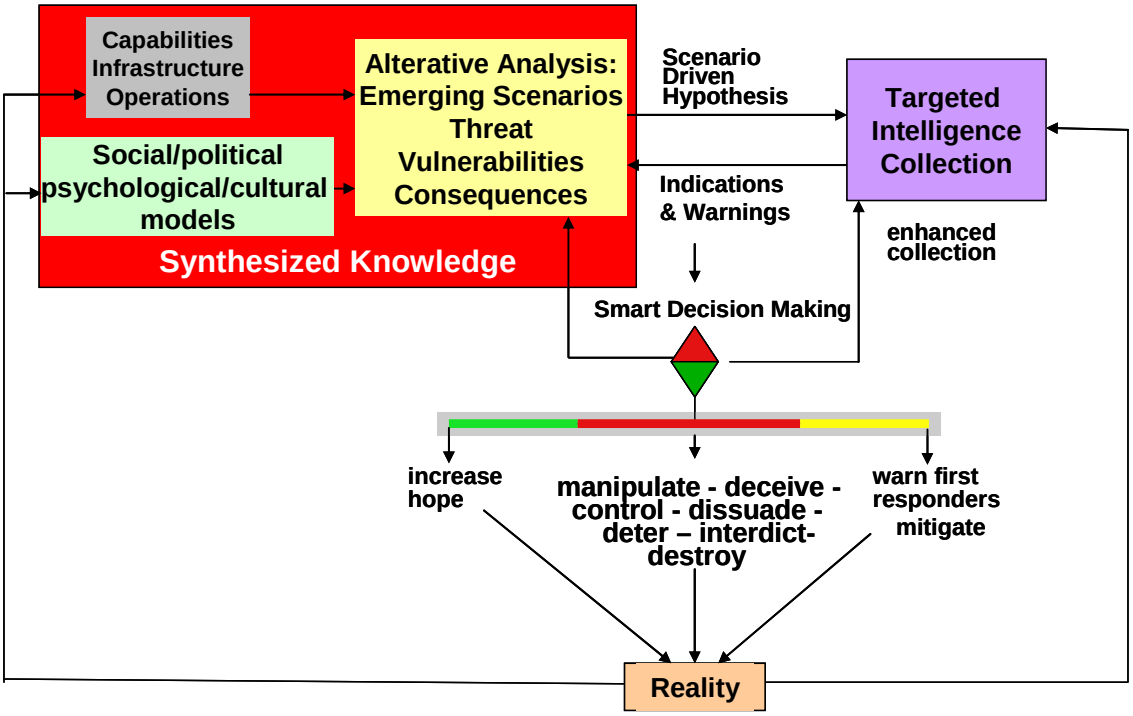

Figure 2. Motivations to acquire WMD emerge from complex interactions between multiple actors over time.

[12] Adapted from Hayden, Nancy K., "The Complexity of Terrorism: Social and Behavioral Understanding Trends for the Future", in Ranstorp, Magnus (editor), "Mapping Terrorism Research: State of the Art, Gaps, and Future Directions", Routledge, 2006. pp 292-315.

perspectives in a "once-through" mode, rather than considering the problem holistically, as an interacting and evolving "system of systems" seen through multiple perspectives. These multiple perspectives are extremely important when trying to explain the motivations of actors in diverse cultures.

This study undertook to identify research and analysis that support interdisciplinary models, diverse world views, and include domains not normally found together. A conceptual model of those domains and the types of inter-related behavioral factors that they represent, relative to motivations, is shown in Figure 3.

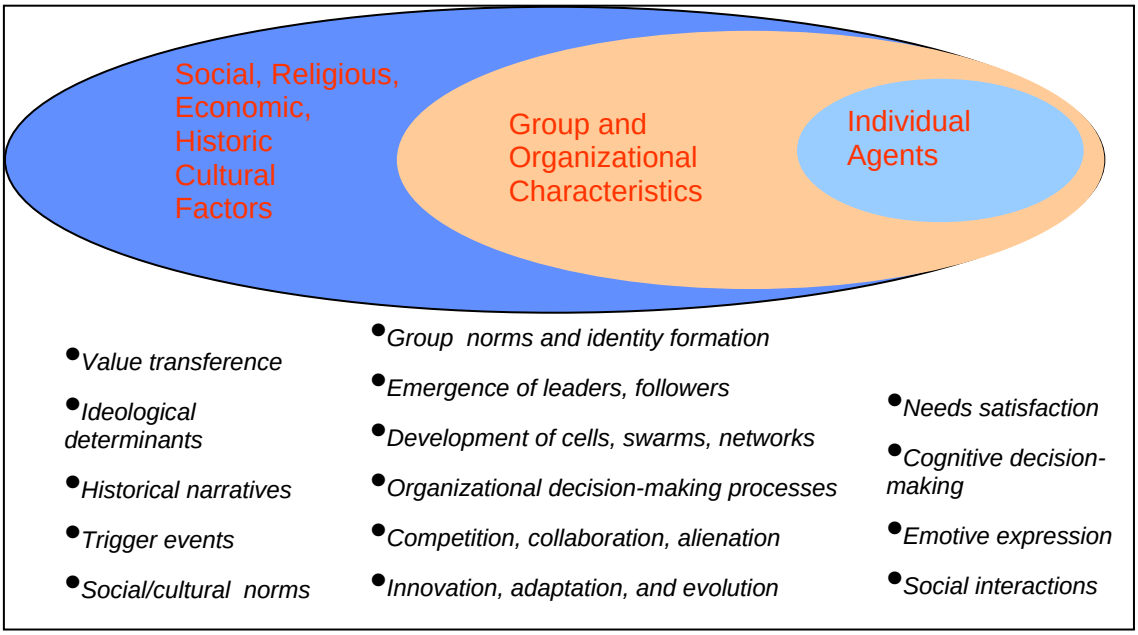

Figure 3. Multiples levels of analysis of contributing factors for motivations to acquire WMD.

Wicked problems

The dimensions of, and complexity inherent to, the study of motivation described above constitute characteristics of what has been termed a "wicked problem."[13] This is of particular importance to DTRA for incorporating motivation into models of pathways to proliferation, as it means that the solution space will have the same characteristics as those for wicked problems. These characteristics, discussed below, are fundamentally different from those inherent in solution spaces of technical and operational problems. One reason for this is that social complexity, not technical, drives the

[13] Rittel, Horst and Melvin Webber, "Dilemmas in a General Theory of Planning," Policy Sciences 4 (1973). Elsevier Scientific Publishing, Amsterdam, pp. 155-159. Also Reprint No. 86, The Institute of Urban and Regional Development, University of California, Berkeley, California.

nonlinearities in, and unpredictability of, wicked problems.[14] This in turn, has implications for the underlying knowledge base for motivations that must be incorporated into models for WMD proliferation pathways. In the end, it may need to be as diverse, dynamic, flexible, and adaptable (i.e., "wicked") as the potential solution space itself.

A generalization of wicked problem characteristics is given by Rittel and Webber:

1. You don't understand the problem until you have developed a solution.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not right or wrong.
4. Every wicked problem is essentially unique and novel.
5. Every solution to a wicked problem is a "one-shot operation".
6. Wicked problems have no given alternative solutions.

The upshot is that there is no well circumscribed boundary around the knowledge domains that must be considered for complete understanding of wicked problems. Each instantiation of a particular potential WMD proliferation pathway model must be able to draw upon a "dynamic" body of literature that is as flexible as the potential motivational responses to interactions between the potential proliferant and other actors in the system. With this caveat -- which implies that consideration of the questions posed in this study can never be complete or finished – an extensive knowledge base drawing on research from a broad (though still somewhat limited) spectrum of social sciences was developed and analyzed.

As mentioned previously, the point of departure for this study is the recognition that the terrorism research landscape has clearly changed since 2002. For one thing, the topic of terrorism and the potential use of weapons of mass destruction by non-state actors has became much more prevalent in academic institutions, as well as think tanks, policy forums, and public media. The rhetoric, literature and information that have come about as a result are of varying quality. Secondly, the context of the question has changed. Iraq has permanently changed the geopolitical environment. Internet use has permanently changed information, distribution, social, and communication networks among terrorists and their potential supporters. Al Qaeda has become a standard for a transnational movement that inspires local actions. Technologies continue to become more accessible. Global level of violence has been ratcheted up, and radical Islamic clerics openly debate legitimacy of WMD use. These factors opened up new avenues to consider for relevant research, beyond the political science lens that had been used previously. Of particular relevance is the literature on transnational groups, social movements, religious ideology and violence, and activist groups with extreme

[14] These nonlinearities, however, may be treated mathematically by similar nonlinear systems dynamics process models as those used for technical and operational. This is a current area of academic and scientific inquiry. Some of the DTRA Threat Anticipation Projects over the past several years have explored possible approaches, such as agent based modeling. See also, Hayden, 2006.

ideologies that choose not to resort to violence.

Approach

The author's own research, references from the previous studies already mentioned, and institutional resources, [15] were used as a starting point to identify key authors, topics, search terms and reference journals for structured data mining. In addition, use was made of bibliographic and data compilation developed on this topic and made publicly available, such as those maintained by the National Defense University, the US Military Academy, the Terrorism Research Center, and the Homeland Security Institute. Primary resources that were mined were peer reviewed academic journals, institutional publications, and special access and compilation services such as Jane's Intelligence Review, the Open Source Center, and the Congressional Research Service.[16]

Publications, primarily within the past five years, from both the US and non-US academic perspectives were sought. However, in accordance with DTRA guidance, priority was given to literature from the American academic community, supplemented by Western European and Islamic world views. Data-driven literature with clearly articulated research methodologies and/or unique data (such as statements by jihadists themselves) was preferentially considered over opinion pieces or political commentary. However, in some cases, allowance was made for citations that, while lacking substantial data, posed new lines of inquiry of interesting but as yet untested hypotheses. The search was expanded midway through the project to citations further back than five years, to include some important concepts from social sciences that had been overlooked in previous studies.

The literature from desired citations were compiled and analyzed according to content and context (See Figure 4). A data base was generated in Excel recording basic bibliographic information, the author's background and theoretical perspective, and the sponsoring institution where known. Overall themes were noted, and, within the limitations of time and resources, the content of each reference was summarized according to major premise, level of analysis, timeframe of analysis, evidence base, and issues raised. General research trends that were noted are summarized in the remainder of this report. A detailed critique is outside the scope of this work and requires more substantive exploration of the citations and the references they draw upon.

Preliminary exploration of the data base was conducted using semantically based, natural language processing, pattern recognition, and large graph analysis software tools as a pilot exercise in using these tools to discover visually analyze trends and correlations between concepts, authors, and institutions, and to aid in conducting web-based literature searches. Two Sandia developed software packages (TaMALE and STANLY) and one commercial text extraction middleware product available for federal

[15] Access to special collections and subject matter expertise through institutional resources at Sandia National Laboratories provided guidance for expanded search terms in the public domain.
[16] See Appendix D for list of institutional resources mined in structured search.

systems (InXIGHT) -- for which Sandia has a developers license -- were used.

One “lesson learned” early on is that the use of these tools entails a significant up-front investment of data manipulation and programming to get information into a common format that is “clean” with respect to the tool. As the project was not funded, nor intended, for an extensive analysis using these tools, only very cursory exercises were done with a limited subset of citations.

Results of those exercises, presented visually in Appendix A and B, showed potential value in identifying clusters within the citations (see results from TaMALE and InXIGHT in Appendix A); conducting time-series analyses of research trends, discovering latent connections between authors, institutions, and concept (TaMALE); and side-by side comparisons of concepts between different collections of writings (See Appendix B for STANLY analysis of extremists Islamic clerics was performed using semantic text analysis.).

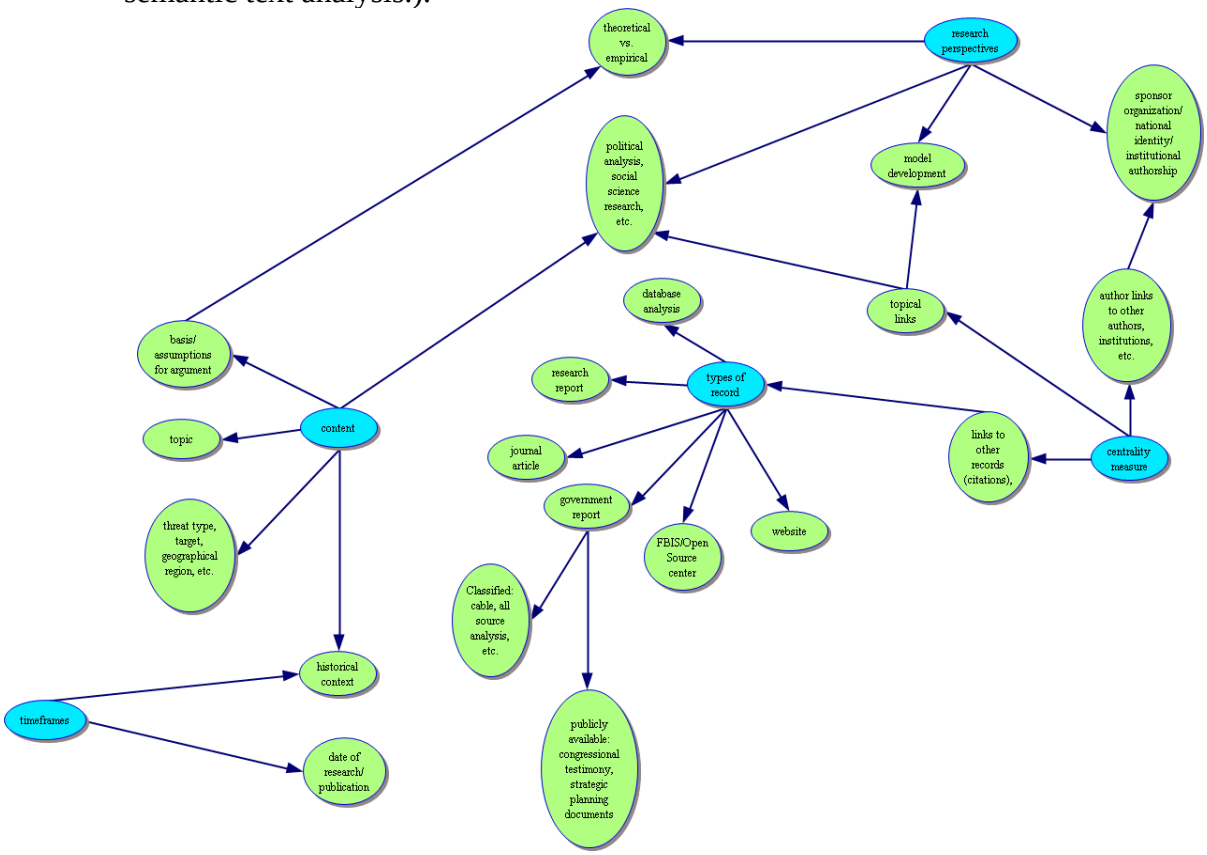

Figure 4. Conceptual map of literature analysis

Findings

Over 250 relevant citations were collected, with the majority being published within the past five years. These have been entered into a data base (Excel format) and analyzed

according to research perspective, basic content of arguments, linkage to other research, type of record, and timeframe of research, as shown in Figure 4. Of these, approximately 40 were peer-reviewed journal articles, with only a handful of these directly addressing WMD. One of the primary drivers for this study was to expand the base of research considered to include contributions from a broader spectrum of social science disciplines than has been included in previous studies for DTRA. Accordingly, although not necessarily mentioning WMD specifically, citations were also drawn from literature on group violence; Islamic views on social justice, violence, terrorism, and WMD; religion and violence; and apocalyptic world views, where they were deemed to have relevance to motivations that lead to the acquisition of WMD. Due to resource limitations, the breadth and depth of possible domains searched had to be limited. Future studies could continue to expand this base.

….historic precedence, combined with the difficulties in acquiring and using WMD, and the political and social/cultural constraints against indiscriminate mass casualties in general, form the basis of fairly uniform arguments about the primary "de-motivating" factors for WMD use.

The majority of citations that directly address the question of WMD came not from peer reviewed social science literature, but from reports of think tanks, security and policy research institutions, or thesis papers. The thesis papers are primarily from US military academies, and draw heavily upon political science traditions and historic analogues. For the most part, this body of WMD literature was based on case studies of the very limited instances where WMD has been, or has been attempted to be, used, with the definition of WMD being limited to chemical, nuclear, or biological weapons.

…these conclusions have come to be taken as conventional wisdom; there has been little ongoing re-evaluation of data to ascertain their validity in evolving contexts.

One of the most interesting areas of consensus in this literature is that, based on analyses of the limited case studies available, WMD use by non-state actors has proved to be relatively ***ineffective*** in causing mass casualties.[17] That historic precedence, combined with arguments about the difficulties in acquiring and using WMD, and the political and social/cultural constraints against indiscriminate mass casualties in general, form the basis of fairly uniform arguments about the primary "de-motivating" factors for WMD use. The political constraints draw on rational choice theory, strongly coupled to assumptions about the 1) role of social/cultural norms and their importance in maintaining a sympathetic base of support from the populace and/or 2) the state responses perceived to be likely. These assumptions have not been proved empirically, however, and are identified as being in need of further research.

[17] See, for example, Parachini, John V. "Comparing Motives and Outcomes of Mass Casualty Terrorism Involving Conventional and Unconventional Weapons", *Studies in Conflict and Terrorism*, 24: 389-406. 2001.

So what are the motivational factors that might entice actors to overcome these obstacles and pursue WMD? What does current literature -- especially that since 911 -- have to say, in comparison with the "conventional wisdom" generated prior to that time?

The question of which non-state actors are most likely to be motivated to acquire and/or use WMD has, for the most part, been analyzed according to some variation of the basic typology of terrorist groups originally proposed by Jerrold Post, in which groups are differentiated by their "raison-d'etre"; namely, social-revolutionary, nationalist-separatist, religious-fundamentalist, religious extremists (closed cults), right-wing extremists, and single-issue extremists.[18] The one notable addition to these categories in the literature since 2001, as noted previously by Roberts, is the **increasing attention being paid to transnational, criminal, and networked based groups, especially among Diaspora communities.[19]**

Many of the potential motives for WMD acquisition attributed to nonstate actors had been identified in previous research. These were: attract more attention to cause, create economic havoc, hasten the apocalypse, promote a worldwide race (culture) war to establish homogenous state, create an aura of divine retribution, impress target audiences with high technology, and copy-cat tactics.

Many of the potential motives for WMD acquisition attributed to nonstate actors in this survey had been identified within the existing literature base. Examples are: attract more attention to cause, create economic havoc, hasten the apocalypse, promote a worldwide race (culture) war to establish homogenous state, create an aura of divine retribution, impress target audiences with high technology, and copy-cat tactics.[20] Regarding the question of who is most likely to act on these motives, a fairly consistent causal story has begun to emerge around three key hypotheses: 1) motivations of non-state actors are different than state actors with corresponding differences on constraints; 2) non-state actors most likely to use WMD have apocalyptic/millennial beliefs with sense of global mission; and 3) the "new" terrorism (characterized by a transnational and networked nature and epitomized by the World Trade Center attack in 2001), has increased the threat while simultaneously reducing constraints.

[18] Post, Jerrold, "Psychological and Motivational factors in Terrorist Decision Making: Implications for CBW Terrorism" in Toxic Terror Tucker, J. (ed.) M.I.T. Press, 2000.
[19] Roberts, Brad, "Motivation for Terrorists to Use Weapons of Mass Destruction", Confronting Terrorism, A Workshop Held at Los Alamos National Laboratory March 25-29, 2002. Proceedings edited by Rajan Gupta and Mario R. Perez.
[20] See, for example, Jessica Stern, "Prospect of Domestic Bioterrorism", Infectious Diseases, V 5, N 4 (July-August 1999), P 517; or Brad Roberts (Ed), "New Terrorism": Does it Exist? How Real Are the Risks of Mass Casualty Attacks?, CBACI Conference Report, April, 1999.

These three premises taken together support a tightly linked argument prevalent in the literature for assessing WMD motivations that has become "conventional wisdom". Namely, that the primary threat of WMD by non-state actors, both in terms of use as well as acquisition, is from transnational, apocalyptic and religious groups. As noted by Gary Ackerman in 2004 commenting on his own survey of books, journal articles, monographs, and government reports on WMD terrorism, "the scholarly and policy-related literature has increasingly begun to recycle the same interpretations and staid shibboleths. This is not meant to denigrate several excellent works that have emerged, merely to point out that truly novel insights into WMD terrorism are becoming few and far between."[21]

There are several explanations for this convergence of ideas about WMD motivations. One is that, in as much as these conclusions have come to be taken as conventional wisdom; there has been little ongoing re-evaluation of data to ascertain their validity in evolving contexts. As a result, there have been relatively few new hypotheses being put forward to test these ideas. Another is the relatively small domain of subject matter expertise that has been tapped in coming to these ideas – as noted by Dr. Goodwin's remarks cited earlier. Yet another is the limited empirical base that has been used to develop and test hypotheses; to date this has rested primarily on the few case studies of WMD use that exist, alongside trend analyses of past terrorist events. This, in effect, tests only on the behavior of interest (use of threat of mass destruction by non-state actors to achieve end goals), and does not provide adequate control groups for developing robust causal models for decisions to use or not use WMD by the entire spectrum of potential non-state actors. Finally, as noted in several recent papers, the causal factors for motivations to acquire and/or use WMD by non-state actors has been treated as a deterministic, first order problem when in reality, it is a "wicked problem", driven by second order, nonlinear affects that are only just beginning to be studied.

> …***the willingness of traditional terrorist groups to engage in mass casualty terror indicates that they may be more likely to acquire and use WMD than has been assumed by the majority of analysts***.

Re-evaluation of Data

Comprehensive structured data sets with internal consistency that can be used to deduce the behavioral motivations underlying terrorist incidents has suffered from a multitude of problems, as has been noted by several researchers.[22,23,24]

[21] Ackerman, Gary, "WMD Terrorism Research: Whereto From Here?" in "Nonstate Actors, Terrorism and Weapons of Mass Destruction"; Blum, Asal and Wilkenfeld, eds., *International Studies Review* (2005) 7, p. 140.

[22] Atran, Scott, "Failure of Imagination", *Studies in Conflict and Terrorism*, Volume 29, Number 3, April-May 2006.

[23] LaFree, Gary, Laura Dugan and Derrick Francke, "The Interplay Between Terrorism, NonState Actors, and Weapons of Mass Destruction: An Exploration of the Pinkerton Database", in "NonState Actors, Terrorism, and Weapons of Mass Destruction", Blum, Asal and Wilkenfeld, eds., *International Studies Review* (2005) 7, p. 156.

One of the primary criticisms is that these data sets have focused narrowly on details of the events (i.e., methods used, casualties, fatalities, targets, perpetrating organization), in isolation from information about the context of the event, responses to the event and subsequent activities of terrorists, and behavioral characteristics of the perpetrators of the event. Other limitations to developing globally relevant causal behavior models are the lack of consistency across different data sets gathered at different times and covering different geographic regions, and the attribution of significantly different definitions to the events characterized, resulting in different event counting methods.

With the increased interest in the behavioral drivers behind terrorism in general, and questions about potential WMD use specifically, there has very recently been an increase in the amount and types of data gathered on terrorists and their networks of support, and terrorist incidents in general that is just starting to become available for the broad research community. One such database is the Global Terrorism Database (GTD), which covers over 69,000 incidents since 1970 -- including religious, economic, and social acts of terrorism as well as political.[25] Sponsored by the Department of Homeland Security and maintained by the National Center for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland, the GTD combines global terrorist incident data collected by Pinkerton since the early 1970's with data compiled by RAND Corporation. Further work on the GTD has been done to redress problems encountered in other databases around issues of consistency in counting methods, comprehensiveness of geopolitical coverage, and breadth of characteristics captured.

1) Contrary to the conventional wisdom, groups engaging in mass casualty attacks to date have achieved symbolic impact through their choice of targets, not their choice of weapons
2) While a clear plurality of mass casualty terrorist events have been perpetrated by terrorists from the Islamic world targeting the non-Islamic world, these attack have run the gamut of religious and ethno-nationalist motivations.

Analysis of the GTD in its beta phase has shown trends counter to the conventional wisdom. Namely, that "the willingness of traditional terrorist groups to engage in mass casualty terror indicates that they may be more likely to acquire and use WMD than has been assumed by the majority of analysts."[26] Future studies of this data might allow more detailed analysis around questions such as, "Under what conditions have groups who have shown a willingness to use mass violence been deterred from doing so again?", and "Under what conditions have groups who have shown a reluctance to use mass violence changed their strategies?".

[24] Sageman, Marc, Understanding Terror Networks, University of Pennsylvania Press, 2004.
[25] LaFree et all, 2005.
[26] Ibid.

A handful of other researchers have recently posed similar questions about motivations for WMD use in the expanded context of overall propensity to engage in mass casualty terror report similar conclusions. Such is the previously mentioned work of Parachini,[27] and that of Asal and Blum.[28] Using the Incidents of Mass Casualty Terrorism database, created by Robert Johnston,[29] Asal and Blum argue that, 1) contrary to the conventional wisdom, groups engaging in mass casualty attacks to date have achieved symbolic impact through their choice of targets, not their choice of weapons; and that 2) while a clear plurality of mass casualty terrorist events have been perpetrated by terrorists from the Islamic world targeting the non-Islamic world, these attack have run the gamut of religious and ethno-nationalist motivations.

These analyses show a recent research trend towards using data to explore the broader question of motivations for mass casualty terror in general as a precursor to understanding WMD motivations in particular.

New Ideas

Some new concepts were introduced in the surveyed literature, addressing nuances of high-stakes decision-making and WMD, with distinct differences between points of view based on rational choice models, most often found in political science literature, and those based on sacred values.[30] In the case of the former, Stohl evokes expected utility theory to develop a framework for assessing the strategic value of WMD based on six questions around capabilities, motivations, and resources. Lichbach demonstrates the contradictory positions reached through rational choice theory, depending on whether one takes the view of the bargaining theory of war or the view of the rebel's dilemma theory of dissent to support acquisition and perhaps even limited use of WMD. He uses this to demonstrate the potential impact of conflict histories on motivations to acquire WMD – depending on whether those histories encourage or discourage the involved parties' abilities to forge credible commitments. These examples show creative uses of rational choice theory being employed to account for more factors than previous game theoretic approaches to the problem.

With respect to sacred values, new literature from the field of anthropology reinforces their motivational power for extreme behaviors. However, the paper put forward by Asal and Blum presents a more complex picture with respect to potential WMD acquisition and/or use, by demonstrating that the data on mass casualty attacks does **not** support the conclusion that apocalyptic, religious groups are the most likely to engage in mass casualty attacks. On the basis of data from 1970 – 2002, they argue that

[27] Parachini, 2001.
[28] Asal, Victor and Andrew Blum, "Holy Terror and Mass Killings" Reexamining the Motivations and Methods of Mass Casualty Attacks", in "Nonstate Actors, Terrorism and Weapons of Mass Destruction"; Blum, Asal and Wilkenfeld, eds., *International Studies Review* (2005) 7, p. 154.
[29] Available online at http://www.johnstonearchive.net/terrorism/wrjp394.html.
[30] See for example, Stohl's work on expected utility theory, or Lichbach's arguments on the bargaining theory of war and the rebel's dilemma as decision-making models, compared to work by Atran and by Sosis on the motivational role of sacred values.

groups with strictly religious motivations account for less (23%) of the attacks than do those with ethno-nationalist causes (32%); while a substantial number (14%) are ethno-nationalist based framed within a religious context.[31] To deconstruct the complexities of the motivations in these cases requires comparative studies of the confluent roles of religion, ethnic identity, and social grievance in the WMD context. Such studies could not be found in the WMD literature.

Other new ideas that were introduced into the WMD literature since 2001 are the "socio-autoimmune" effect proposed by Steinbruner (in which over-reactive responses by the attacked society are strategically exploited)[32] ; the role of Diaspora communities[33]; the risk from minority communities[34]; the role of transnational organizations and international criminal networks[35]; the impact of specific cultural geopolitics[36]; generational effects[37]; and global conditions, such as climate and environmental degradation.[38] These dynamical arguments have not been extensively studied to date, and bear implications for potential strategic use of WMD by some of the "more pragmatic-minded" non-state actors than in the past.[39]

A new research development during the past five years is the increased access to the ideas of terrorists and other extremist nonstate actors themselves for analysis of strategic intentions. The internet increasingly provides an unprecedented accessibility to, and transparency of, internal and external debates among these actors. This is particularly true with respect to Islamic and right-wing militia groups using the web for dialogue and communication among supporters and for recruiting. The internet resources are supplemented by an unmediated "publicity campaigns" for extremist causes that show more and more sophistication, exploiting the broadcasting industry, print, and digital formats. These are accompanied by self-promotion in the forms of interviews and video productions.

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[29]Asal and Blum (2005).

[32] Steinbruner, John, "Terrorism: Practical Distinctions and Research Priorities", International Studies Review Volume 7, Number 1, March 2005, pp. 137-140.

[33] See for example, Sheffer, Gabriel. "Diasporas, Terrorism, and WMD" International Studies Review Volume 7. Number 1, March 2005, pp. 160–162.

[34] Gurr, Tedd, "Which Minorities Might Use WMD?," International Studies Review Volume 7, Number 1, March 2005, pp. 143-146.

[35] See, for example, Dishman, Chris, "Terrorism, Crime, and Transformation", US Commission on National Security, 2001; and Auerswald, David, "Deterring NonState WMD Attacks", Political Science Quarterly, Volume 121, Number 4, Winter 2006.

[36] See for example, the analysis of complex new geopolitical relations between Saudi Arabia and various Islamic groups by Lacroix, "Between Islamists and Liberals: Saudi Arabia's New 'Islamo-Liberal'Reformists", Middle East Journal Vol 28 No 3 Summer 2004; and the studies on trends in SE Asia reported by Andrew Tan, "The New Terrorism: Anatomy, Trends, and Counter-Strategies", Singapore Times Academic Universities Press, 2003.

[37] See for example, Drennan, Shane, "Fourth Generation Warfare and The International Jihad", Jane's Intelligence Review, 2006.

[38] See, for example, Leven, Mark, "The Changing Face of Mass Murder: Massacre, Genocide, and Post-genocide", International Social Science Journal 2002, V 54; Part 4; Issue 174, pages 443-452.

[39] These ideas may be supported by further exploration of the GTD analyses mentioned previously.

While providing potentially valuable resources for analyzing intent, these must be considered carefully before being taken at face value in academic studies. There are several considerations, some of which are particular to Western scholars. With respect to jihadist literature, there is the context of Islamic culture itself, and the limited ability of Western scholars to have a complete understanding of cultural nuances implied by certain images and phrases. Another issue is the inherent difficulty in distinguishing what the ultimate intent of some writings are - can they be taken at face value or can there be extraneous issues and contexts that instigated the writings that have become obscured? The writings might be geared towards influencing a specific audience, and the knowledge of who that audience is might be required to understand the document. There is also a question of the degree of persistent influence that is wielded by these writings upon the intended audiences. Finally, with respect to prison interviews and "confessions", there are well documented issues in research literature regarding the caveats that must be placed on such data, due to the tendency of some individuals in these circumstances to say what they believe they are expected to say, or what is to their best advantage to say.

With these caveats in mind, recently compiled writings from the jihadists have been included in the data base for informing analyses of WMD motivations. The most complete translated compendiums are those recently published by McCants and Brachman at the US Military Academy.[40] What is interesting to note in their massive compilation of documents is the relative minor role that WMD plays in these strategic documents in the overall scheme of militant ideology and strategy. This is consistent with observations of scholars that, in spite of some rhetoric to the contrary, the weapons of choice for mass casualties by jihadists to date have been conventional, as opposed to WMD, technologies. When WMD is mentioned, it is usually endorsed on the basis of the principles of jihad. This obscures what the real motivations might be, which, as pointed out by Parachini in 2001, can be range from fascination with technology to victimization narratives to act of cosmic war, and many in between.

New Contributions from Expanded Domains of Expertise

The recent WMD literature points out the need for better understanding of the causes of extremism and mass violence; the complex, multi-actor dynamics of collective action in contentious politics; and the role of culture, historical narratives, social institutions, and identity formation in shaping those dynamics. Literature from the fields of social psychology, history, religious studies, organizational and group dynamics, communications, and anthropology contain rich material for addressing these issues which as yet are underutilized in exploring the question of WMD.

A full review of the literature on collective action and violence and what it has to say about potential motivations for WMD acquisition and/or use by non-state actors was outside the scope of this study. However, some initial scoping was done of research from that field that can contribute to understanding what motivates groups to actively

[40] McCants, William and Jarrett M. Brachman,"The Militant Ideology Atlas", CTCHarmony Report, US Military Academy, 2006. .

move along trajectories towards mass violence to advance extreme ideologies, as well as choices of non-violent means to advance those ideologies, and is catalogued in the data base as a starting point for further exploration. The research on collective action and violence can be organized around questions of causal mechanisms that move individuals and groups from belief to action, from emotion to action, and combinations of the two.

Communications theory, social networks, and influence dynamics were found to provide perspectives for studying the spread of ideas; psychological and cognitive decision making theories provide contributions to the understanding of movement from belief to action. Religious violence, especially with respect to political Islam, emerged in this study as a category in itself that warrants deeper comparative analysis than has been done to date for looking at conditions under which mass violence has been motivated by sacred values, and under which the same sacred values have channeled behavior away from indiscriminant mass violence. A final research category emerged around the framing of the problem – dealing with parameterization of concepts, formation of modeling and simulation tools, and risk assessment methodologies.

Non-linear and Second Order Affects

As noted at the beginning of the paper, the motivation to acquire WMD by non-state actors is complex, and occurs in a dynamic and evolving context. This research perspective is beginning to be noted in the most recent literature, where the need to study non-linear and second order affects has been specifically being called out, especially when making judgments about trajectories of future developments.[41]

The debate in the jihadist strategic literature over the use of WMD illustrates one aspect of this. In 2003, the Saudi cleric Nasir Bin Hamd Al-Fahd, citing the damage of American bombs in Muslim lands, used the pronouncements of historic Islamic jurists to legitimize the use of WMDs. On the other hand, Tariq Ramadan, who purportedly shares similar ideological visions, publicly exhorts Muslims against terrorism and violence to achieve them. Who holds more sway among audiences, which audiences are most likely to take action, and what is the impact of the contradictory views of these two leaders? These dynamics, arising out of ideological competition among leaders for followers, are not well understood, especially by Western scholars, within the Islamic context.

Other unresolved questions that surface repeatedly in the literature that bring in to play second order affects revolve around the interaction between motivations and technical capabilities, perceived vulnerabilities, and impact of state actions. How do repressive versus facilitative state responses impact the motivations of followers? What is the impact of surveillance on the crystallization of extremist beliefs within groups? How do transnational trends in terrorism organizations – such as connection to criminal

[41] See, for example, Ackerman, Gary, "WMD Research: Whereto From Here?", International Studies Review Volume 7, Number 1, March 2005.

networks – change the motivational factors and constraints?

Future Directions

As discussed above, recent literature directly and indirectly related to WMD sheds new light on questions of motivation. Of primary interest to the DTRA is the degree to which these motivations can be influenced and, ideally, constrained. Perusal of the recent WMD literature, as well as the past, shows a consistency at a meta-level with respect to the **types** of factors that shape motivations that may provide insight into this question.

In particular, the WMD literature is consistent with virtually all other literature on human behavior in as much as (at the meta-level) drivers are some combination of internal and external factors. One can begin to build a two-dimensional decision space to map the intersection of the most important of these factors, where internal factors forms one axis and external drivers form another. The preliminary analysis of literature for this study suggests that of the internal drivers, one that may be dominant is the degree of internal group cohesion that is present and necessary to sustain the non-state actor in accordance with the group's goals and operational modes; while a dominant external factor may be the strength and direction of relationships of the actor to external institutions (political, social, or religious) necessary for its power base.

Summary

An extensive (though not exhaustive) collection of scientific publications was generated and analyzed to a first order, drawing on primarily Western-based academic publications over the past five years which purport to examine the motivations of nonstate actors to acquire and/or use of WMD. A review of the literature collection showed the following trends, gaps, and outliers:

1. Capabilities versus motivations: With respect to WMD research, the majority of Western-based work continues to focus on capabilities of nonstate actors, rather than on motivations.

2. Old Ideas/New Questions: Much (though not all) of the research that *does* focus on motivations of nonstate actors to acquire WMD is generated from the political science discipline (not behavioral sciences), and draws heavily on relatively static ideas of rational actor theory, bargaining theory of war, or the rebel's dilemma with its asymmetric power relationship. The second most dominant discipline to contribute to the research literature on motivations to acquire WMD by nonstate actors is the field of psychology.

These ideas have not changed much in the past five years, and many of the "old questions" around the interfaces between states and nonstate actors that existed in 2000 remain largely unaddressed by data based research. Some of these are: With respect to acquisition of WMD, how do state and nonstate actors influence and/or constrain

each other (outside of capacity building or denying), and if so, how? That is, what are the channels of influence – e.g., power relationships, economic factors, ability to shape social conditions, and/or cultural ties -- and how important are they? How do these co-evolve? Under which conditions have states found it in their favor to intentionally encourage and/or facilitate nonstate actor acquisition of WMD? Have state actions in the past unintentionally created motivation for nonstate actors to acquire WMD? What is the evidence base for state actions to have a deterrent affect (motivationally) on nonstate actors to acquire of WMD? How do the relationships of primary state actors and secondary state actors to each other and to the cause of the nonstate actor affect the choices made by nonstate actors with respect to acquisition of WMD?

Some new questions were present in the literature, however, that highlight the importance of second order effects, the larger set of actors that shape motivational factors, and the impact of unmediated communication channels (i.e., the Internet, cell phones, electronic media distribution). Some of the important actors being considered are transnational entities such as NGOs, criminal networks, and Diaspora communities.

3. New ideas: Research contributions from other disciplines provides a valuable knowledge base for examining strategic decisions to engage in mass violence writ large and how these shape motivations to acquire (or not) WMD. Some new ideas that appeared from this broadened perspective suggest "barely-tapped" resources that can contribute meaningfully to an understanding of motivations for WMD acquisition by nonstate actors:

- consideration of more extensive data on mass violence and new methods of analysis of existing data
- transdisciplinary fields that integrate considerations of sacred values, culture, social psychology, and group dynamics.
- the trade-off between nonviolent actions and violent actions, and use of these in negotiation strategies, to compensate for asymmetric power relationships between actors engaged in struggle
- strategies for motivating mass support for movements, and creating perception of legitimacy and authority for challengers to state authorities
- de-escalation of spirals of mass violence

4. Outliers: Rigorous analyses of historic data on mass casualties may challenge conventional wisdom regarding most likely actors to employ WMD, as they show in the long view the relative ineffectiveness of this tactic to achieve objectives of nonstate actors.

5. To understand the evolutionary dynamics of motivations, the interplay between competing motivations of actors and how trajectories towards or away from WMD proliferation are influenced by state actions, there needs to be more extensive research into second order effects, with better exploitation of confluence of ideas from social science literature on religion and violence; radicalization; social movements; communications theory; anthropology; and history. Even with such understanding,

however, the ability to incorporate into operational models of proliferation pathways with current analysis tools is questionable. Some means of analysis and new data bases have appeared that allow dynamic, nonlinear analysis of these second-order affects, but inclusion of complex models of motivation within these are at preliminary stages and are the exception, rather than the rule.

6. The potential for analysis of first hand sources provided by extremists and potential terrorists themselves is only just beginning to be tapped for understanding the motivations and the debates that are incurred in developing intent to action. However, the methodologies for analysis need to incorporate controls for a number of factors such as intentional disinformation, framing of messages to adjust for intended audiences, sensationalism, and credibility of sources.

A recurrent proposition which appears in the literature is that "if Al Qaeda could get their hands on WMD, they would use it". This assertion is cited by the national security community without consideration of caveats, context, or critical examination of the data on which the statement is made. In fact, there was no evidence in the survey to refute or confirm this statement. The study did reveal contradictory arguments that the evidence of history suggests political ju-jitsu is far more effective than mass violence for achieving goals of nonstate actors. Strategic analysis of Al Qaeda documents themselves are ambiguous – revealing an ultimate emphasis on mass **effect** – such as winning hearts and minds of Muslim world, re-establishment of the Umma, and a risk-averse, conservative approach to choice of means and tactics. Mass **destruction** is called for as one of the means (out of many others – such as bringing down the US economy) called upon as acceptable (but not necessarily preferable) to achieve this.

The motivations for WMD acquisition are increasingly recognized to be complex. For those who study the problem from the perspective of "Who is likely to acquire WMD?", the literature survey highlighted the need for understanding how the means and ends are inter-related and may constrain each other. This is true not only for Al Qaeda, but for all nonstate actors who depend upon maintaining legitimacy in the eyes of a base of support in whose name they act.

For those in the social sciences who consider the question, "How do nonstate actors engage in struggles to achieve their goals, and how are decisions regarding violence and nonviolence considered?", there is a growing trend to consider the possible use of WMD. This in turn is beginning to expand (albeit by marginal increments) the social science community actively engaged in the question of WMD proliferation.

Those who study motivation and how it shapes behaviors differentiate between drivers at the individual, group, and societal levels for when and how action is chosen. Within each level, the motivations are fairly well understood. However, the inter-relationship of drivers across these levels is not well understood. These inter-dependencies need to be accounted for in examining motivations for WMD acquisition. Cultural differences, especially between Western and Islamic contexts, also need to be

accounted for.

Information extraction and visualization analysis tools were employed for preliminary assessment of how they may be used for building and analyzing research bases of this type. These proved useful for mapping the collection into clusters around research themes, authorship, and key concepts. In addition, cognitive models built on partitioned subsets of the collection can be useful in highlighting key differences.

Implications for DTRA

Analysis of the literature showed additional questions that might be addressed by future DTRA studies. Some of these are:

1. What are the relationships between deterrence methods and motivations? How do they shape each other in a dynamic sense, and what types of influencing feedback loops are created by different policy strategies?
2. What evidence exists for understanding the relationship between the base of sympathetic support for groups and the moderating or amplifying affect on motivations to acquire and/or use WMD?
3. What are the different models for understanding how external motivational drivers (i.e., resource mobilization, political opportunity structures, repression) and internal drivers (i.e., inter-group competition, leadership challenges, alienation) interact to shape decisions regarding acquisition and/or use of WMD? How are these contextually and culturally dependent? Socially and psychologically specific?
4. Under what conditions have nonviolent repertoires of contention been employed by nonstate actors as alternatives to same motivational factors that exist for WMD acquisition and/or use?
5. Under what conditions have nonstate actors desisted in the pursuit of WMD to achieve goals?
6. What are additional research perspectives that can be brought to bear on the question of motivation of acquisition and/or use of WMD from experts in trans-nationalism, globalization, and world systems?

When incorporating motivation into systems levels models of proliferation pathways, mechanisms should be provided for exploring alternatives to WMD available to nonstate actors that include not only conventional means of violence, but also nonviolent actions that have historically been brought to bear to address socio-political grievances and power struggles against oppressive forces.[42] By doing so, the models can better accommodate not only behaviors that may directly deter terrorists and extremists groups, but also allow the consideration of second

[42] For example, nonviolent action was key in the overthrow of communist regimes in Poland, Ukraine, Georgia, and Hungary; as well as challenges to dictatorships in Chile, Argentina. In the run-up to the Oslo Agreement, and lasting until the second Intifada action was also the preferred tactic by Palestinian organizations.

order effects that include the populations in whose name the nonstate actors act, who hold these grievances. This understanding is critical for present and future US national security policy initiatives that emphasize strategic communication.[43] The growing disenchantment with US policies among Muslim communities and the increasing numbers of peripheralized populations worldwide make it imperative that explore these issues continue to be explored.

An integrative framework for accommodating and analyzing the multiplicity of themes across the domains represented in the literature collection might be developed by looking at the space may be created internal and external drivers of cohesion and power structures, respectively. As pointed out in the literature on nonviolent campaigns, internal debates about violence and nonviolence and the degrees of acceptable violence have been a key factor in the disintegration of opposition groups. Further work to explore such an integrative framework would be valuable to help organize input from this collection of literature for DTRAs WMD proliferation pathways models.

[43] The 2006 Quadrennial Defense Review establishes strategic communication as a cornerstone of national security policy.

Appendix A. Preliminary Cluster Analyses using TaMALE and InXIGHT

Overview of TaMALE

TaMALE is a semantic graph creation, visualization, and analysis tool developed at Sandia National Laboratories under internally directed laboratory research and development funds. A semantic graph has multiple types of nodes, such as people and organizations, and different types of edges between them such as people connected to one another by "related" or "business partner" links and people connected to organizations connected by "member of" links. Moreover, these nodes and edges can have attributes, such as names for people nodes and date ranges for the period of time that a person is connected with an organization.

Creating these graphs is typically labor intensive, but in TaMALE, the process is automated process so that these can be created directly from Excel workbooks or text files via a graphical user interface (GUI). Once the graph is created, it can be color coded and filtered as specified by the user. For instance, a user may only be interested in seeing users and hide all nodes and connections related to organizations. The nodes can be moved around manually or automatically grouped using one of several graph layout algorithms. TaMALE also has algorithms to derive new links such as linking two organizations if they have one or more members in common. Moreover, TaMALE can import and export additional analysis results on the fly as they are created by external computation such as tensor analysis, including multi-way versions of latent semantic analysis that were used for this project.

TaMALE is written in Java and can run on Linux, Mac OS, and Windows. It can and has been used on many different types of data from bibliometric to network traffic. SNL has successfully tested TaMALE for up to 100,000 nodes and 500,000 links. Other projects include: network traffic analysis, bibliometric analysis, WWW analysis. Tensor analysis was used in this project to simultaneously link terms, documents, authors, and years.

Citations to related tensor work (but not TaMALE work) are:

- Peter A. Chew, Brett W. Bader, Tamara G. Kolda, and Ahmed Abdelali. Cross-language information retrieval using PARAFAC2. Technical Report SAND2007-2706, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, May 2007. Accepted to KDD2007.
- Brett W. Bader, Richard Harshman, and Tamara G. Kolda. Pattern analysis of directed graphs using DEDICOM: An application to Enron email. Technical Report SAND2006-7744, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, December 2006.

- Daniel M. Dunlavy, Tamara G. Kolda, and W. Philip Kegelmeyer. Multilinear algebra for analyzing data with multiple linkages. Technical Report SAND2006-2079, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, April 2006.
- Tamara Kolda and Brett Bader. The TOPHITS model for higher-order web link analysis. In *Workshop on Link Analysis, Counterterrorism and Security*, 2006.
- Tamara G. Kolda, Brett W. Bader, and Joseph P. Kenny. Higher-order web link analysis using multilinear algebra. In *ICDM 2005: Proceedings of the 5th IEEE International Conference on Data Mining*, pages 242–249, November 2005.

Exemplary Analysis of WMD Literature Data Base with TaMALE

A representative sample of documents from the WMD literature data base were analyzed using the fields title, author, abstract, and year groupings/clusters from the data base, organized as document x term x author x year.

A tensor analysis of the collection revealed ten clusters in the data, based on relationships between document titles, the terms, the authors, and the years. Graphs were constructed to visually represent these relationships, where documents, authors, editors, terms, and year are the nodes, as shown in Figure A.1

In Figure A.1, authors are shown as blue dots, documents as red dots, terms as pink, and years as green. The green links are between documents and year. The yellow lines are latent connections (from the tensor analysis) between documents and terms. The blue links are between authors and documents.

Zooming in on these clusters shows further insights about commonalities and differences between documents that can be furthered explored to develop a detailed sense of the topology of this knowledge base from a number of perspectives. These closer views are useful to develop a sense of the types of connections and second-order correlations between documents, ideas, authors, and time trends. For example, Figure A.2 is a zoomed view of one of the clusters in the first image that appear to have their density around term relationships. In Figure A.2, purple links between a term and a document indicates that the term is actually in the document, and yellow links indicate latent connections. The red links between authors and documents indicate authorship. Interesting characteristics of document relationships can be gleaned, such as the fact that several documents are latently linked (yellow line) to certain terms but do not directly use them (red links) in the title or abstract. The idea is that these articles are closely related to other articles that use that term and so there is a reasonable chance that the term is relevant to these closely related articles.

Figure A. 3 shows another cluster, where the density of the cluster appears to be primarily around authorship.

These results could have been further exploited to build web search engines and more detailed graph analysis, with additional funding and time.

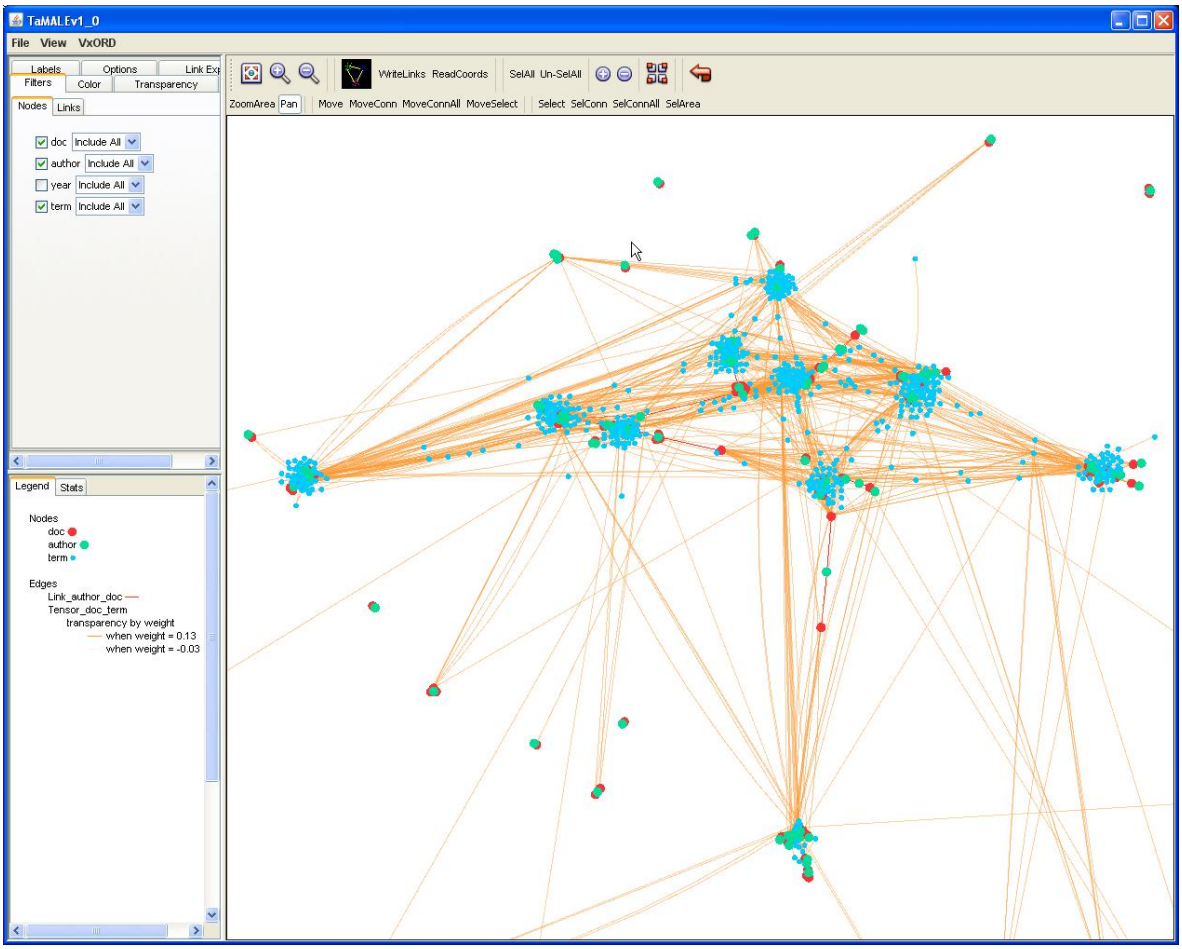

Figure A.1 TaMALE Graphical Representation of WMD Motivations Literature Data Base.

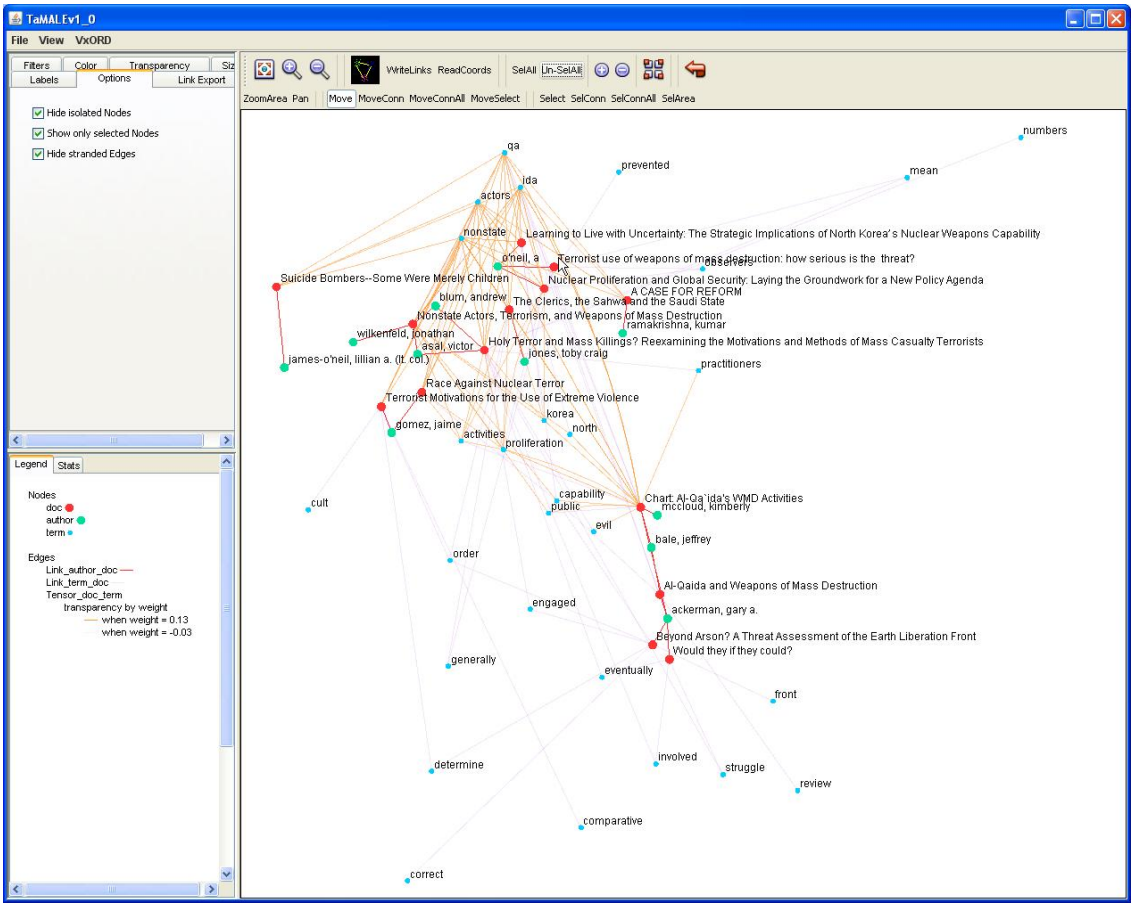

Figure A.2 Zoom view of cluster with density around terms

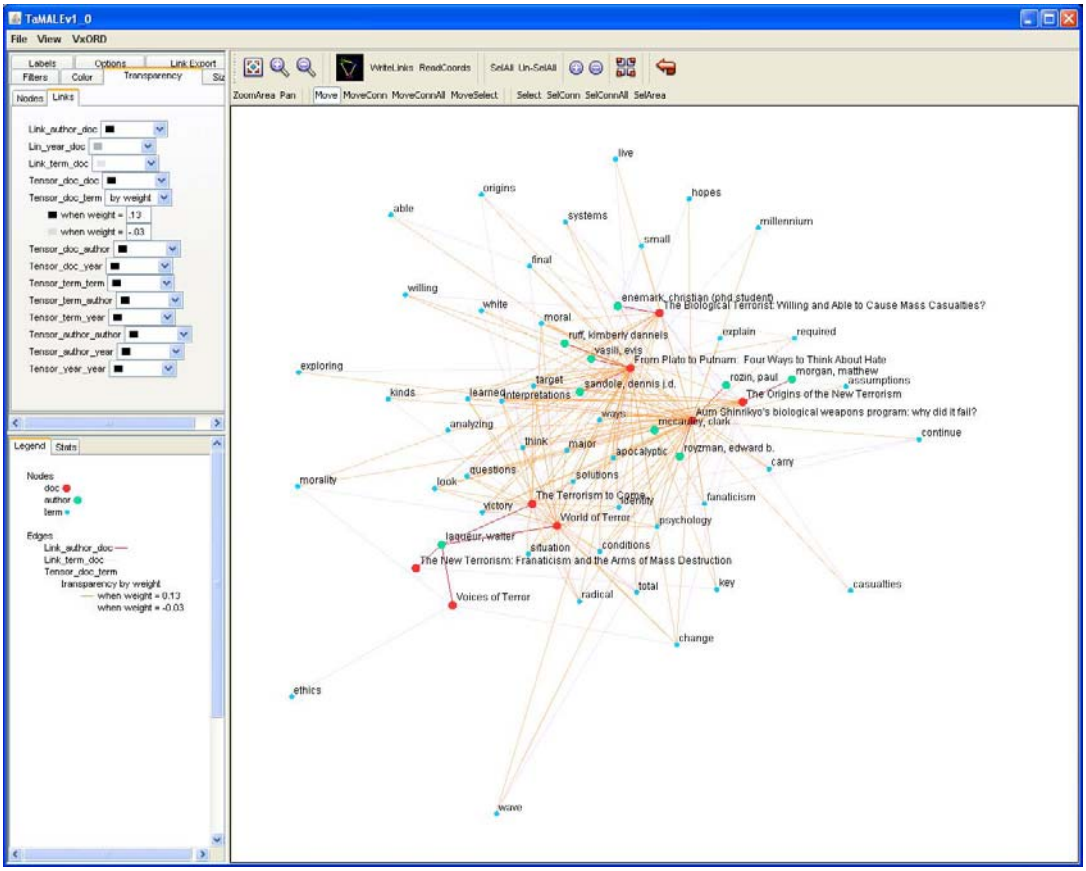

Figure A.3 Zoom view of cluster with density around authorship

Overview of InXIGHT

InXIGHT is a suite of commercially available middleware packages for federated searches, information extraction and visualization to discover, organize, and understand information in unstructured text in all major languages.[44] Two packages were used, for which Sandia National Laboratories has development licenses with InXIGHT: Smart Discovery Extraction Server (with Thing Finder), and Awareness Server. The results of Awareness Server are not presented, as analysis with this product was determined to require more effort than could be expended, due to its basic nature as a middleware product, rather than end-user software product. However, we did conclude that its potential analysis power on this type of problem is significant, where the upfront programming efforts are warranted.

Smart Discovery Extraction Server (along with ThingFinder) is a tool for reading electronic documents with unstructured text, and, based on tagging techniques and NLP, discovering connections between entities that fall into the categories of "who, what, when, and where" (or others as may be custom defined) in those documents. Some user input is required to steer the search for discovering relationships, however. (Note: this made it unattractive as an initial discovery tool for discovering dominant themes in the data base, although it could have significant analysis power once the main themes and patterns to explore in more depth are known. For example, changes over time, and secondary relationships can be discovered). The types of connections between certain themes can also be explored.

Cluster	Name	Descriptive Terms	#	%
1	Effect	terrorism, + nuclear terrorism, proliferation, + actor, nuclear, + provide, + inflict, + involve, + weapon, + study, + understand, radiological, + develop, mass, destruction, + mass destruction, + acquire, + nuclear weapons, + examine, + organization	66	28 %
2	Operation	+ terrorist, + terrorist groups, + capability, + attack, + use, chemical, + weapon, + group, wmd, + pose, biological, + material, + seek, + mass destruction, destruction, + article, + casualty, + acquire, + nuclear weapons, nuclear	82	35 %
3	Islamism	+ osama, + islam, muslim world, + wide, + interpretation, + life, bin, + religion, + success, + shift, muslim, world, + begin, + time, islamic, + muslim, + islamist, europe, + enemy, + find	30	13 %
4	Arabism	saudi, violence, + shaykh, + people, + situation, + suicide, little, + bombing, + century, + religion, + day, domestic, + analysis, + event, + understand, important, recent, + trend, + regime, past	45	19 %
5	European Muslims	+ tariq, + critic, integration, + interview, + revoke, visa, swiss, theologian, notre dame, french, double, language, + teach, + muslim, + islam, europe, muslim, + say, + west, controversial	13	6%

Table A. 1 InXIGHT Clustering Results

[44] Information on the capabilities of InXight and types of licenses available can be found at: http://www.inxight.com.

Like most other such tools currently available, a significant amount of time was required to get data into a form that was “clean” as input for InXIGHT. The data entries, while containing unstructured text, needed to be entered as structured records into an input file. The
preliminary results revealed five primary clusters based on key concepts in the documents in the data base, as shown in Table A.1. These clusters make some intuitive sense, as they seem to be differentiated based on concepts of consequences, operations and tactics, violent Islamism, Arabism, and nonviolent Islamism.

These clusters are difficult to compare with TaMALE as the underlying techniques and logical structures are different. However, the results between the two do not seem to be inconsistent. More data mining with both would be useful, especially using full texts of papers, and not just abstracts.

Appendix B. Terminology Comparisons Between Western Journal Articles and Jihadist Strategic Literature Generated Using Sandia Text Analysis Tool (STANLY)

Sandia's Analyst Aide (STANLY) is a software tool using natural language processing (NLP) to build a "model" of an entity – person, set of files, group of people, etc. – based on the key concepts expressed by that entity and the relationships between the key concepts. These models can then be used to provide insights into trends in these key concepts- such as dynamic time series analysis that track changes in key concepts over time, and comparative analyses between entities. The tool is part of a larger suite of augmented cognition tools built at Sandia to provide a dynamic, flexible, comprehensive desktop analysis framework. For example the models can be used to create web spiders for automatic searches of similar entities based on key concept relationships, and to generate automatic reports on key concepts in large collections of files that define a particular entity.

A particularly attractive feature of STANLY is that it can read in whole documents through "drag and drop" techniques on the desktop without having to input them as structured records. STANLY's underlying NLP engine supports non-English languages, including Arabic and Chinese. Basic NLP tools are augmented with statistical information retrieval tools to provide capabilities that extend beyond mere information retrieval or nearness analysis by attributing meaning and context to occurrences of concepts and the linkages between them.

STANLY was used to compare a model of key concepts built on exploration of a subset of the primarily Western literature based collected for this study with a collection of FBIS articles written suitable for demonstrating the potential value of STANLY in comparative analysis of concepts in the Western-based literature with those of Al Qaeda statements, but not to conduct a definitive analysis of the content of either.

Two cognitive entity models were built – one derived from the western based literature on motivations to use WMD, and one from Al Qaeda statements as reported by FBIS. The term to term comparison of these two models shown in Table B.1 reveals an interesting distinction in the two models. Top terms in the Western literature closely related to the occurrence of the term WMD tend to focus on means of delivery of WMD and their physical effects (e.g. mass destruction, attack, nuclear, materials), whereas the top terms in the jihadist literature focus on the potential socio-psychological impact of WMD (e.g. panic, fear, risk). With respect to jihadists, at least, this illustrates the underlying premise of this study – namely that whereas jihadists may be primarily concerned with the effect of WMD use on a populace, Western scholars tend to focus more on the methods of delivery, and are relatively silent on the motivational factors.

Cluster maps can also be built with STANLY, which could be compared to those of TaMALE and InXIGHT. However, this was not done due to limitations of funds and time.

Western Literature

	Relationship Measure
WMD	1
weapons	0.286
mass	0.2619
destruction	0.2593
terrorism	0.2585
terrorist	0.2486
threat	0.2259
terrorists	0.222
attack	0.2196
nuclear	0.2137
attacks	0.1879
groups	0.1864
materials	0.1835
deterring	0.1829
incidents	0.1804
radiological	0.1776
biological	0.1747
chemical	0.171
conventional	0.169
whiteneck	0.1686
united	0.1663
rogue	0.164
casualties	0.1619
qaeda	0.1575
capability	0.1561
global	0.1559
proliferation	0.1544
possibility	0.1508
cbrn	0.1489
weapon	0.1451
facilitators	0.1448
deterrence	0.1405

FBIS Results (AQ statements)

	Relationship Measure
WMD	1
weapons	0.5641
resulted	0.5219
panic	0.5089
feared	0.5089
limited	0.5059
factor	0.5059
rogue	0.5057
terrorist	0.4609
proven	0.4597
destruction	0.4512
shibh	0.4327
risk	0.4327
psychological	0.4327
unforeseen	0.4278
uncontrollable	0.4278
severely	0.4278
results	0.4278
propaganda	0.4278
prefer	0.4278
plant	0.4278
moment	0.4278
maximum	0.4278
handy	0.4278
devastation	0.4278
dent	0.4278
compare	0.4278
causing	0.4278
cancelled	0.4278
boundaries	0.4278
mass	0.4271
nuclear	0.4213

putting	0.1404	motivation	0.4156
idea	0.1399	clandestine	0.4129
support	0.1399	extent	0.4087
involving	0.139	example	0.3987
religious	0.1386	capability	0.3972
threaten	0.138	network	0.3936
actors	0.1369	especially	0.3841
Ackerman	0.1359	scientists	0.3704
threats	0.1351	nature	0.3634
example	0.1349	technical	0.36
entail	0.1345	employment	0.3561
diverted	0.1344	information	0.3537
motivation	0.1331	respect	0.3533
potential	0.1324	fear	0.3533
quarterly	0.1324	Pakistan	0.3493
response	0.1315	Qaeda	0.3381
Bale	0.131	provided	0.3372
shipment	0.131	programs	0.3372

Table B.1 STANLY Analysis of Cognitive Models: Terms Closely-Related to the Phrase "Weapons of Mass Destruction"

Appendix C. Theories of Motivation

There are many sources for definitions of motivation related to behaviors. Three in particular were noted in conducting this study. First are the popular science references, due to the broad perspectives they present, which are in general representative of the types of perspectives of decision makers in the US government, who will be ultimate consumers of the conclusions from this research. A second perspective is that of the scientific community. The third is from the perspective of organizational and business, as this may be more closely related to the context in which decisions (at least from rational actor perspective) about WMD are made. All three of these are represented in the material below, extracted from the online Encyclopedia of Business.[45]

A simple definition of *motivation* is the ability to change behavior. It is a drive that compels one to act because human behavior is directed toward some goal. Motivation is intrinsic (internal); it comes from within based on personal interests, desires, and need for fulfillment. However, extrinsic (external) factors such as rewards, praise, and promotions also influence motivation. As defined by Daft (1997), motivation refers to "the forces either within or external to a person that arouse enthusiasm and persistence to pursue a certain course of action" (p. 526).

People who are committed to achieving organizational objectives generally outperform those who are not committed. Those who are intrinsically rewarded by accomplishments in the workplace are satisfied with their jobs and are individuals with high self-esteem. Therefore, an important part of management is to help make work more satisfying and rewarding for employees and to keep employee motivation consistent with organizational objectives. With the diversity of contemporary workplaces, this is a complex task. Many factors, including the influences of different cultures, affect what people value and what is rewarding to them.

From a manager's perspective, it is important to understand what prompts people, what influences them, and why they persist in particular actions. Quick (1985) presented these four underlying principles that are important to understanding motivation:

1. People have reasons for everything they do.
2. Whatever people choose as a goal is something they believe is good for them.
3. The goal people choose must be seen as attainable.
4. The conditions under which the work is done can affect its value to the employee and his or her perceptions of attainability or success.

When management was first studied in a scientific way at the turn of the twentieth century, Frederick Winslow Taylor worked to improve productivity in labor situations so important in those days of the developing Industrial Revolution. Taylor developed efficiency measures and incentive systems. When workers were paid more for meeting a standard higher than their normal production, productivity increased dramatically.

[45] See: http://business.enotes.com/business-finance-encyclopedia/motivation

Therefore, workers seemed to be economically motivated. At this time in history, social issues involved in human behavior were not yet considered. Amore humanistic approach soon developed that has been influencing management ever since.

During the late 1920s and early 1930s, Elton Mayo and other researchers from Harvard University conducted studies at a Western Electric plant in Hawthorne, Illinois, to measure productivity. They studied the effects of fatigue, layout, heating, and lighting on productivity. As might be expected when studying lighting, employee productivity levels increased as the illumination level was increased; however, the same effect was noted when the illumination level was decreased. The researchers concluded that the attention paid to the employees was more of a contributing factor to their productivity level than the environmental conditions. The fact that paying attention to workers could improve their behavior was called the *Hawthorne effect*. As a result of this research, it was evident that employees should be treated in a humane way. These findings started the human relations movement—a change in management thinking and practice that viewed increased worker productivity as grounded in satisfaction of employees' basic needs. [Many years later, it was discovered that the workers in the Hawthorne experimental group had received an increase in income; therefore, money was probably a motivating factor, although it was not recognized as such at the time. (Daft, 1997)].

Motivation theories have continued to evolve and have their roots in behavioral psychology. They provide a way to examine and understand human behavior in a variety of situations. A simple model of motivation is shown in Figure 1.

Ongoing changes in the workplace require that managers give continuous attention to those factors that influence worker behavior and align them with organizational goals. No one theory is appropriate for all people and for all situations. Each individual has his or her own values and differing abilities. In business settings, managers apply motivation theories to influence employees, improve morale, and implement incentive and compensation plans.

The following discussion of motivation theories is grouped according to need, process, and reinforcement theories.

Need Theories

Need theories are based on some of the earliest research in the field of human relations. The premise behind need theories is that if managers can understand the needs that motivate people, then reward systems can be implemented that fulfill those needs and reinforce the appropriate behavior.

Hierarchy of Needs Abraham Maslow, a professor at Brandeis University and a practicing psychologist, developed the *hierarchy of needs* theory. He identified a set of needs that he prioritized into a hierarchy based on two conclusions (Daft, 1997; McCoy, 1992; Quick, 1985):

6. Human needs are either of an attraction/desire nature or of an avoidance nature.
7. Because humans are "wanting" beings, when one desire is satisfied, another desire will take its place.

The five levels of needs are the following (see Table 1):

- *Physiological*: These are basic physical comfort or bodily needs: food, sex, drink, and sleep. In the workplace, these needs translate into a safe, ergonomically designed work environment with appropriate base salary compensation.
- *Security/safety*: People want to feel safe, secure, and free from fear. They need stability, structure, and order. In the workplace, job security and fringe benefits, along with an environment free of violence, fills these needs.
- *Belongingness and love*: This is a need for friends, family, and intimacy—for social acceptance and affection from one's peers. In the workplace, this need is satisfied by participation in work groups with good relationships among co-workers and between workers and managers.
- *Esteem*: People want the esteem of others and they want to be regarded as useful, competent, and important. People also desire self-esteem and need a good self image. In the workplace, increased responsibility, high status, and recognition for contributions satisfy these needs.
- *Self-actualization*: This highest motivation level involves people striving to actualize their full potential, to become more of what they are capable of being. They seek to attain self-fulfillment. In the workplace, people satisfy this need by being creative, receiving training, or accepting challenging assignments.

Focusing on the needs of retraining for growth and challenge as well as rewards and recognition is important to the quality of work life. Managers can affect the physical, social, and psychological environment in the workplace, and they have a responsibility to help employees fulfill their needs.

ERG Theory In his work, Clayton Alderfer expanded on Maslow's hierarchical theory. He proposed three need categories and suggested that movement between the need levels is not necessarily straightforward. Failure to meet a higher-order need could cause an individual to regress to a lower-order need. These *ERG theory* categories are:

- *Existence needs*: Needs for physical well-being
- *Relatedness needs*: Needs for satisfactory relationships with others
- *Growth needs*: The development of human potential and the desire for personal growth and increased competence (Daft, 1997)

Motivation-Hygiene Theory Frederick Herzberg, a professor of psychology at Case Western Reserve University, studied the attitudes of workers toward their jobs. Herzberg proposed that an individual will be moved to action based on the desire to avoid deprivation. However, this motivation does not provide positive satisfaction because it does not provide a sense of growth. Herzberg's research found that positive

job attitudes were associated with a feeling of psychological growth. He thought that people work for two reasons: for financial reasons to avoid physical deprivation and for achievement because of the happiness and meaning it provides. Herzberg also identified the concept of job enrichment, whereby the responsibilities of a job are changed to provide greater growth and challenge (McCoy, 1992; Quick, 1985 p. 10-12)] 1985. His *motivation-hygiene* theory includes two types of factors:

1. *Motivation* is based on the positive satisfaction that psychological growth provides. The presence of factors such as responsibility, achievement, recognition, and possibility for growth or advancement will motivate and satisfy people. The absence of these factors will not necessarily demotivate or cause dissatisfaction.
2. *Hygiene* is based on an individual's desire to avoid deprivation and the resulting physical and emotional discomfort. Hygiene factors include willingness to supervise; positive working conditions; interpersonal relations with peers, subordinates, and superiors; status; job security; and salary. These factors do not motivate, nor will their presence cause job satisfaction. Their absence, however, will cause dissatisfaction.

Although salary is considered a hygiene factor, it plays an indirect part in motivation as a measure of growth and advancement or as a symbol of recognition of achievement.

Theory X and Theory Y Douglas McGregor, a professor at the Massachusetts Institute of Technology and a social psychologist, was greatly influenced by the work of Maslow. McGregor recognized that people have needs and that those needs are satisfied at work. He described two sets of assumptions about people that he labeled *Theory X* and *Theory Y* (Bruce and Pepitone, 1999; Quick, 1985):

- The assumptions of *Theory X* are that most people will avoid work because they don't like it and must be threatened or persuaded to put forth adequate effort. People have little ambition and don't want responsibility. They want to be directed and are most interested in job security.
- The assumptions of *Theory Y* are that work is very natural to people and that most people are self-directed to achieve objectives to which they are committed. People are ambitious and creative. They desire responsibility and derive a sense of satisfaction from the work itself.

These assumptions were, at one time, applied to management styles, with autocratic managers labeled as adhering to Theory X and democratic managers to Theory Y. Unfortunately; this fostered a tendency to see people as members of a group rather than as individuals. The important contribution of McGregor's theory was to recognize these two perspectives and to recognize that people can achieve personal objectives through helping organizations achieve their objectives. Their work can be a motivator.

Acquired Needs Theory David McClelland developed the *acquired needs theory* because he felt that different needs are acquired throughout an individual's lifetime. He proposed three needs:

1. *Need for achievement*: The desire to accomplish something difficult, attain a high standard of success, master complex tasks, and surpass others
2. *Need for affiliation*: The desire to form close personal relationships, avoid conflict, and establish warm friendships
3. *Need for power*: The desire to influence or control others, be responsible for others, and have authority over others.

McClelland found through his research that early life experiences determine whether people acquire these needs. The need to achieve as an adult is influenced by the reinforcement of behavior received as a child when a child is encouraged to do things independently. If a child is reinforced for warm, human relationships, then the need for affiliation as an adult develops. If a child gains satisfaction from controlling others, then the need for power will be evident as an adult (Daft, 1997).

Process Theories

Process theories help to explain how individuals select particular behaviors and how individuals determine if these behaviors meet their needs. Because these theories involve rational selection, concepts of cognition are employed. Cognition, according to Petri (1996), "is generally used to describe those intellectual or perceptual processes occurring within us when we analyze and interpret both the world around us and our own thoughts and actions (p. 236).

Expectancy Theory Victor Vroom developed the *expectancy theory*, which suggests that individuals' expectations about their ability to accomplish something will affect their success in accomplishing it. Therefore, this theory is based on cognition—on thought processes that individuals use.

The expectancy theory is based on an individual's effort and performance, as well as the desirability of outcomes associated with high performance. The value of or preference for a particular outcome is called valence. To determine valence, people will ask themselves whether or not they can accomplish a goal, how important is the goal to them (in the immediate as well as the long term), and what course of action will provide the greatest reward. An individual's expectation of actually achieving the outcome is crucial to success, and many factors influence this (Daft, 1997; Quick, 1985).

The expectancy theory can be applied through incentive systems that identify desired outcomes and give all workers the same opportunities to achieve rewards, such as stock ownership or other recognition for achievement.

Equity Theory The *equity theory* focuses on individuals' perceptions of how fairly they are treated in comparison to others. It was developed by J. Stacy Adams, who found

that equity exists when people consider their compensation equal to the compensation of others who perform similar work. People judge equity by comparing inputs (such as education, experience, effort, and ability) to outputs (such as pay, recognition, benefits, and promotion).

When the ratio is out of balance, inequity occurs. And inequitable pay can create an impossible situation when implementing salary and incentive systems. According to Daft (1997), Individuals will work to reduce perceived inequity by doing the following:

- *Change inputs*: Examples include increasing or reducing effort.
- *Change outcomes*: Examples include requesting a salary increase or improved working conditions.
- *Distort perceptions*: This occurs when individuals cannot change their inputs or outcomes; one example is artificially increasing the importance of awards.
- *Leave the job*: Individuals might do this rather than experience what they perceive to be continued inequity.

When administering compensation and incentive programs, managers must be careful to assure that the rewards are equitable; if programs are not perceived as equitable, then they will not contribute to employee motivation.

Reinforcement Theories

Theories of reinforcement are based not on need but on the relationship between behavior and its consequences. In the workplace, these theories can be applied to change or modify on-the-job behavior through rewards and punishments.

B. F. Skinner, a professor at Harvard, was a highly controversial behavioral psychologist known for his work in operant conditioning and behavior modification. His *reinforcement theories* take into consideration both motivation and the environment, focusing on stimulus and response relationships. Through his research, Skinner noted that a stimulus will initiate behavior; thus, the stimulus is an antecedent to behavior. The behavior will generate a result; therefore, results are consequences of behavior.

According to McCoy (1992), "The quality of the results will be directly related to the quality and timeliness of the antecedent. The more specific the antecedent is and the closer in time it is to the behavior, the greater will be its effect on the behavior.…The consequences provide feedback to the individual" (p. 34).

If the results are considered positive, then the behavior is positively reinforced. When the behavior is positively reinforced, the individual is more likely to repeat the behavior. People tend to have an intrinsic (internal) need for positive reinforcement. And when a behavior is ignored, the behavior tends to go away or become extinct. The four types of reinforcement are the following (Daft, 1997):

- *Positive reinforcement*: The application of a pleasant and rewarding consequence following a desired behavior, such as giving praise.
- *Negative reinforcement*: The removal of an unpleasant consequence following a desired behavior, such as a manager no longer reminding a worker about a weekly deadline when the worker meets the deadline. This reinforcement is also called avoidance.
- *Punishment*: The application of an unpleasant outcome when an undesirable behavior occurs to reduce the likelihood of that behavior happening again. This form of reinforcement does not indicate a correct behavior, so its use in business is not usually appropriate.
- *Extinction*: The withdrawal of a positive reward. If the behavior is no longer positively reinforced, then it is less likely to occur in the future and it will gradually disappear.

Continuous reinforcement can be effective in the early stages of behavior modification, but partial reinforcement is more commonly used. Reinforcement is most powerful when it is administered immediately.

The appropriateness of a reward depends on the situation. But for managers to apply rewards appropriate for work performance, it is necessary to understand what constitutes a reward. And no single reward will be perceived as positive by all employees. Rewards, however, are important in behavior-based incentive plans because they reward employee behavior that is desirable for the company. According to McCoy (1992), both incentives and recognition provide a reward; however, incentives drive performance while recognition is an after-the-fact display of appreciation for a contribution.

Financial rewards are certainly important in compensation programs. Social recognition provides employees with a sense of self-worth by acknowledging the contributions they have made. This recognition could be given in the form of a ceremony that helps to validate and is an important compensation—and one that probably costs a company very little in relationship to the benefit to employees (McCoy, 1992).

Summary

The application of motivation theories can help managers to create work situations and employee recognition systems that help workers fulfill their needs. As Maslow wrote, "man has a higher nature…and…this higher nature includes the needs for meaningful work, for responsibility, for creativeness, for being fair and just, for doing what is worthwhile and for preferring to do it well" (pp. 244-245).

Some aspects of all jobs may be routine or mundane, but other aspects can be developed to promote job satisfaction and increased productivity. The sharing of responsibility can provide opportunities for growth, renewal, and achievement. This empowerment of workers can heighten employee motivation and improve morale. Both long-term and short-term incentive programs are needed for the employee commitment

and effectiveness necessary to achieve organizational objectives. And in all instances, workers must be treated fairly and equitably.

Bibliography

Bruce, Anne, and Pepitone, James S. (1999) *Motivating Employees*. New York: McGraw-Hill.

Daft, Richard L. (1997). *Management*, 4th ed. Orlando, Fl.: Harcourt Brace.

Maslow, Abraham H. (1998). *Toward a Psychology of Being*, 3d ed. New York: Wiley.

McCoy, Thomas J. (1992). *Compensation and Motivation: Maximizing Employee Performance with Behavior-Based Incentive Plans*. New York: AMACOM, a division of American Management Association.

Petri, Herbert L. (1996). *Motivation: Theory, Research, and Applications*, 4th ed. Pacific Grove, CA: Brooks/Cole.

Quick, Thomas L. (1985). *The Manager's Motivation Desk Book*. New York: Wiley.

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Appendix D.
List of Sandia National Laboratories Technical Library Resources Mined in Structured Literature Searches

1. JSTOR (Journal Storage) General Sciences Collection
2. American Sociological Review
3. American Psychological Review
4. CNS Nonproliferation Database
5. CNS WMD Database
6. GrayLit Network
7. International Security and Counter Terrorism Reference Center
8. Studies in Conflict and Terrorism
9. Journal of Terrorism and Political Violence
10. Jane's Terrorism and Insurgency Center
11. Journal Citation Reports (JCR) Science Edition
12. PyscINFO
13. Science Citation Index Expanded (ISI)
14. Science Research Connection
15. Social Science Citation Index (ISI)
16. Social SciSearch (LANL)
17. Terrorism Research Center (TRC)
18. ISI Web of Knowledge
19. ISI Web of Science