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**Modeling and Simulations Track**

# Decision Factors for the Operational Warfighter: Explicit Insights


**Authors**

*Paul Van Doren*
SAIC
7021 Harbor View Blvd, Suite 117
Suffolk VA 23435
757-203-5926
paul.vandoren@jfcom.mil

*Kevin L. Brandt*
MITRE Corporation
7025 Harbour View Blvd, Suite 107
Suffolk, VA 23435
757.673.5714
brandtk@mitre.org

*Frank Carr*
MITRE Corporation
7515 Colshire Drive
McLean, VA 22102-7508
703.883.6042
carr@mitre.org

**Abstract:**

*The Defense Modeling and Simulation Office (DMSO) and the United States Joint Forces Command Joint Futures Laboratory sponsored the initial phase of a cooperative study addressing the decision factors relevant to decision makers at the operational level of war. The combined study team completed an initial literature review and questioned and interviewed 26 operational level commanders, planners, and analysts involved in the use of M&S in support of real world operations from El Dorado Canyon to OIF and on as small a scale as Special Forces operations in Haiti to as large a scale as a Corps assault on Baghdad. The paper reviews the insights and decision factors collected.*

## Background

Future operational concepts envision the Regional Combatant Commander, the Joint Task Force Commander, and their component commanders executing accelerated decision-making.[1] While all are promised access to vast quantities of reliable information, transparent operations require that these decision makers rapidly weigh complex interactions of multiple forces and elements while considering a wide range of decision factors.[2]

Some of the future operational decision factors will be new. Most are traditional, but they will acquire more complexity. These factors encompass direct and indirect effects of interactions by all elements of national and international power – diplomatic, informational, military, and economic (DIME). Thus the decision-making process will be more complex, but decision makers will benefit from better decision support tools that augment their experience and assist their judgments.[3]

In recent years, the United States military has increased the use of and reliance on warfighting simulations as an effective decision-support tool. However, simulations must change to address critical decision factors in at least three aspects. First, the scope of operations has expanded past the scope designed into the current simulations. Today, we must embrace factors of human cooperation, competition, coercion, and conflict yet most current simulations only model combat. Second, the pace and diversity of operations has increased while the responsiveness of simulations has not kept pace. Third, most simulations are designed to model tactical operations and the few operational level simulations currently available are inadequate.[4] These shortfalls represent a challenge to the simulation community in supporting the decision making process of the operational commander.

## Vision

In the envisioned future, the operational warfighter will break the chains that confine the use and utility of modeling and simulation (M&S). M&S will still support training, material acquisition, and force structure development. Eventually the role of M&S will expand to dominate the mid-range to long-range deliberate planning process. One can expect M&S capabilities will grow to improve support for immediate tactical applications. However, the most striking change will be the extensions within operational decision-making processes.

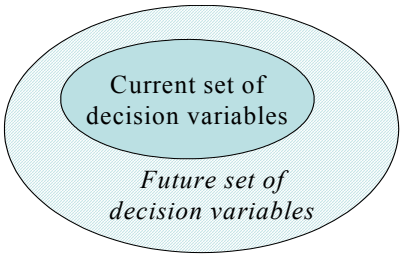
Operational warfighters will NOT use modeling and simulation tools to find the optimal solution or "perfect answer"; they will leverage the power of M&S to increase the breath and depth of understanding of possible actions. They will use M&S in concert with other decision support tools to explore millions of possible actions and interactions and their direct (discrete) and indirect (emergent) effects. They will use M&S to move beyond the development of fragile point solutions in two or three dimensions to more robust and adaptable regions of feasible solutions over multiple dimensions reflecting a multitude of (sometimes conflicting) decision variables. In short, operational warfighters will use M&S to populate feasible

decisionscapes, to continuously project actions and their impacts within those decisionscapes, and to shape the conflict space to compel operations in regions of the decisionscape that favor the achievement of the operational and strategic objectives.[5]

### Study Approach

The study team reviewed relevant literature, training reports, battlefield lessons learned, reports from operational activities, doctrinal publications, advanced concept papers, and prior studies. This review shaped the baseline set of questions for the interviews and questionnaires sent to a small group of flag officers, senior field grade officers, and analysts with operational experience. These study participants (see Appendix A) provided our primary source material. The study team captured and compiled this material in the interview and questionnaire results and incorporated these results into an extended list of decision factors intended for a subsequent survey. This approach documented the operational-level decision factors that have been critical in recent conflicts.

To reach beyond history, the team pulled in subject matter experts developing future Joint operational concepts. These inputs, combined with those documented in written concept drafts, helped derive future needs. The team added these future requirements to the baseline and extended lists to render a set of future operational decision factors.




The unanticipated diversity and depth of the composite set of operational decision factors forced the development of a broader structure to accommodate them. The conclusions reflect that structure.

### Explicit Insights

Several participants expressed strong opinions and provided explicit insights about the use of models and simulations as decision support tools in operational environments. Notably, these underscore five salient points:

- The commander is central to the decision making process.
- M&S must enable and encourage flexible use by diverse teams.
- M&S utility ties directly to speed of application.
- M&S tools need to reveal the unexpected.
- Decisions must focus on the endstate.

### Commander Centric

Retired Major General Scales, in a recent Parameters essay highlighted the central role of the commander in making decisions.

> We need to better understand what information is necessary for making decisions. Important in this effort is understanding how different commanders use information. Cognitive systems capable of customizing the decision-making process will emerge from that understanding. Perhaps soon commanders will be offered exercises and decision aids that will optimize their ability to make the right decisions in the midst of a mountain of information that invariably will descend on them in the heat of battle.[6]

The former Deputy Director of the Joint Staff J8 directorate for Wargaming, Simulations, and Analysis, Vince Roske, reinforced this perspective of commander-centric decision support.

> The way the Commander integrates the analysis and gaming with the staff and how he uses it day in and day out to shape their thinking is vitally important to how effective it may be. Look to the relationships between the commander, his staff and the analysts; and then to the methodology used; and last to the models and tools used in the methodology- in that order of importance for impact and value.[7]

**Flexible Uses**

Participants described M&S uses within the context of:

- Staff planning techniques,
- Brainstorming and wargaming problems, or
- Command and staff training and preparation.

Retired General Horner limited the air operations center (AOC) planning to two days to streamline the link between the air tasking order (ATO) and the real war (situation) versus an idealized plan. He warned that simulation results should not constrain a commander's thinking.

Retired General Dugan observed that commanders might have a small team use M&S to raise potential issues and consider a range of outcomes vice making "command observations" to the staff (as a whole) to avoid premature constraints (in thinking) and/or overreactions.

Lieutenant General Wallace emphasized V Corps use of simulations to explore options for attack up to and into Baghdad. Moreover, M&S provided a forum to rehearse the operation with his senior leaders.

**Responsive Application**

The value of M&S depends on how quickly these simulations can provide results to the commander. General Dugan observed that operational decision support tools must:

- Have current data,
- Convey a valid context,
- Produce timely results (*often immediate*),
- Allow flexible changes in parameters and entities, and
- Be highly transparent to the commander.

Transparency of the modeling process is paramount for commanders to have confidence in the tools and their results. It also enables commanders to be aware of M&S limitations. General Dugan concluded that command confidence in decision support tools requires a key culture shift that will occur as new generations with M&S experiences move to command.

**Unanticipated Revelations**

Simulations need to reveal the unexpected. General Mike Dugan observed, "Use of M&S could and should precede the real world operations so the staff can consider the range of outcomes."[8] Mr. Vince Roske wrote, "The real challenges today are to be found in helping commanders anticipate and deal with the **"Unforeseen"** problems. That means that our methods … must be able to surprise us – show us plausible worlds we hadn't yet thought of."[9] Major General Scales observed:

> Disruption – the need to create uncertainty – should be the aim of war gaming. As a matter of course, every exercise, game, and major Joint training event should add uncertainty and

unpredictability in the form of alien representation. Otherwise games become exercises scripted through the preconceptions and biases of Western culture.[10]

### Endstate Guidance

Participants repeatedly endorsed the strategic and military endstate guidance as the starting point for critical decision factors. Colonel Matthew Caffrey noted, "USAF War College teaches that before considering COAs [courses of action], one must settle on the decision criteria. And the first influence on the decision criteria is the theater guidance."[11]

### Questionnaires

Questionnaire responses were generally written; a few were oral. Eighteen questionnaires were completed reporting on one or more operations each for a total of 21 operations or groups of operations. Table 1 shows the operational context of each reported use. In a few cases two sources reported on the same operation.

| Context | Tactics | Planning | Operations | Training | Analysis | Force Structure | End-State | Force Application | Logistics | Homeland Defense |
|---|---|---|---|---|---|---|---|---|---|---|
| TTP: Defense against small boats | X | | | | | | X | | | |
| TTP: Post 9/11 Airport Re-Opening | | X | | | | | | | | X |
| OPLAN: logistics feasibility | | | | | | | | | X | |
| OPLAN: V Corps OIF | X | X | | X | | | | | | |
| OPLAN: JTF7 SASO | | X | | | X | | | | | |
| Campaign Plan: CJTF7 | | X | X | | | X | | | | |
| Engagement Plan: CENTCOM | | X | | | | X | X | | | |
| OPLAN: El Dorado Canyon | X | | | X | | | | X | | |
| OPLAN: Desert Shield | | X | | | | | | X | | |
| OPLAN: Desert Storm | | X | | | | | | | | |
| OPLAN: Balkans Campaign | | X | | | | | | | | |
| OPLAN: "JFACC" in El Dorado Canyon | X | X | | | | | | | | |
| OPLAN: JFACC in Desert Storm | X | X | X | | | | | | | |
| OPLAN: Central European | | X | | | | X | X | X | | |
| CONPLAN: Dual MRC | | X | | | | X | X | X | | |
| OPLAN: JSOTF in Haiti | X | X | X | X | | | | | | |
| OPLAN: Proven Force | | X | | | | | | | | |
| CONPLAN: EUCOM CAP | | X | | | | | | | | |
| OPLANS, CONPLANS, FUNCPLANS: CENTCOM | | X | | | | | | | | |
| OPLAN: OIF Abn Ops Risk Assessment -173 Abn Bde | X | X | | | | | | X | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OPLAN / CONPLAN: JFACC in OEF and OIF | | X | | X | | | | X | | |

OPLAN: Operational Plan; CONPLAN: Contingency Plan; TTP: Tactics, Techniques, & Procedures; FUNCPLAN: Functional Component Plan

**Table 1: Case Studies**

### Interviews

The interviews addressed three areas, but several participants went beyond these bounds and addressed other aspects of operational command and control and/or use of simulations. Inquiry focused on:

- Critical operational-level decision factors and associated measures of merit
- The importance of strategic and military endstate guidance
- The role of simulation in operational decision support

The interview stimulated responses by asking participants comment on six possible benefits of M&S.

- Sense Making: use M&S to aid the commander to understand information within the context of the mission.
- Risk Assessment: use M&S to explore potential threats and opportunities.
- Decision Options: use M&S to frame key decisions or develop and select options (e.g., courses of action).
- Decision Points: use M&S to identify operational decision points prior to execution.
- Training: use M&S to coach subordinates and enhance their understanding of the concept and command intent.
- Synchronization: use M&S to develop understanding of time and distance factors pertinent to key decisions.

Participants were also encouraged to add to this list.

### Collective Responses

Collectively responses reveal that despite the success made in training, experimentation, and analysis, M&S tools have not been well received by operational commanders for actual operations. All participants expressed a desire to use M&S while operations where underway, but only some did.

M&S use is limited by:

- Dynamic changes in plans and operations,
- Time constraint to develop and publish plans,
- Lead times to set up simulations and analyze results, and
- Lack of confidence in the results.

### Operational Decision Factors

Our compiled list of decision factors from multiple sources includes those presented in the interviews and questionaires (see below).

### Endstate Guidance

All those that addressed the question not only responded in the affirmative but emphasized that all the critical decision factors are driven by the guidance or that the guidance provides the first critical decision factors.

| | Perspective | Positive | Conditional | Negative | Neutral |
|---|---|---|---|---|---|
| **Endstate Guidance** | Seniors | 3 | 0 | 0 | 2 |
| | Field Grade | 9 | 0 | 0 | 8 |

**Table 2: Endstate Guidance**

### Operational Benefits of M&S

Responses to benefits were judged as positive, conditional, negative, or neutral.

| Potential Use | Perspective | Positive | Conditional | Negative | Neutral |
|---|---|---|---|---|---|
| **Sense Making** | Seniors | 4 | 1 | 0 | 0 |
| | Field Grade | 7 | 0 | 0 | 5 |
| **Risk Assessment** | Seniors | 5 | 0 | 0 | 0 |
| | Field Grade | 4 | 0 | 1 | 7 |
| **Decision Options** | Seniors | 3 | 1 | 0 | 1 |
| | Field Grade | 5 | 2 | 0 | 5 |
| **Decision Points** | Seniors | 0 | 1 | 2 | 2 |
| | Field Grade | 6 | 1 | 1 | 4 |
| **Training** | Seniors | 3 | 1 | 0 | 1 |
| | Field Grade | 7 | 0 | 0 | 5 |
| **Synchronization** | Seniors | 1 | 1 | 1 | 2 |
| | Field Grade | 3 | 0 | 0 | 9 |

**Table 3: Operational Benefits of M&S**

The interviews strongly endorsed three of the six: Sense Making, Risk Assessment, and Training. One other was favored: Decision Options. Two were not supported or controversial: Decision Points and Synchronization.

The primary objection to identifying decision points was the risk of fostering inflexible mindsets when executing the operation. However, it is interesting to note the wide disagreement between the senior officers and field grade commanders. The younger officers had some very strong affirmative statements and cited several examples that expressly identified this benefit. One participant noted that M&S has shown that the consequences of a late decision outweigh the desire for more data or time to make the decision.

V Corps exemplified the use of M&S to analyze decision options when they assessed the terrain in the Western corridor of Iraq. When planners observed operational (synchronization) constraints, they explored and adopted other routes. Concurrently on the training front, another team explored new tactics and

developed the techniques for rapid urban forays to seize Baghdad. However, both of these studies were conducted in Europe long before the operations started.

In preparation for V Corps combat operations, simulations played another critical training role – albeit invisible – by supporting large-scale exercises. These exercises forced senior commanders to think through their operation (sense making), develop creative ways to accomplish the mission (decision options), and – perhaps most important – learn the strengths other leaders and organizations in the fight (risk assessment and synchronization).

At the tactical level, M&S have depicted integrated air defenses (sense making) very well and allowed mission planners to develop routes and position electronic combat assets to reduce risk (risk assessment). In another area of traditional strength for M&S, logistics planners assessed mission requirements (sense making) and estimated deployment timelines (synchronization) for alternative force structures (decision options). Nevertheless, these limited successes fall far short of the objective vision for M&S support of the operational warfighter.

### Literature

The study team examined several documents (Appendix C) and identified a wealth of decision factors. Most of these sources are published documents. However, some are unpublished working papers and initial drafts of concept documents. In one notable case, the document cited is a Mission Needs Statement from the battlefield in Iraq.

In addition to identifying decision factors, at least three sources also addressed methods to establish or evaluate attainment of desired endstates.[12] These are addressed in more detail (Appendix C), but assessment of these techniques was beyond the scope of this initial effort. These deserve further investigation in follow-on studies, seminar wargames, and limited objective experiments.

### Decision Factors

The study compiled a list of decision factors from multiple sources, surveys, and interviews. This list intends to structure rather than reduce the scope of these factors. Like all such lists, it is NOT exhaustive or complete, but can serve as a reasonable starting point for a more comprehensive ontology for the development of requisite capabilities.

The operational warfighter must embrace diverse facets of human cooperation, competition, coercion, and conflict. Decision factors relevant to these decision makers represent this diversity and this complexity. The composite structure developed by this study classifies decision factors into five main categories:

1. Force Capability (include Diplomatic, Informational, Military, and Economic)
2. Physical States and Impacts (States of Nature)
3. Intent for Cooperation, Competition, & Conflict
4. Infrastructure, Informational, Social, Economic, Military, and Political States and Effects
5. Transition States

### Force (DIME) Capability

Force capability factors span diplomatic, informational, military, and economic (DIME) assets. These factors address the inherent capabilities of these forces in situ and in concert with other forces, but not the

force on force dynamics of state transitions resulting from conflict. These factors apply to all actors in the conflict space: friendly, enemy, supporting, impeding, competing, nonaligned, and non-belligerent.

Force capability derives from many factors that may each be complex or compound factors in their own right, but they are interdependent in their contributions to overall force capability.

- Force (DIME) Structure
- Force (DIME) Readiness
- Component Capabilities:

  These factors center on unique capabilities within each component and synergistic capabilities across DIME forces.
- Cross-Domain (DIME) Capabilities:

  These factors address the capabilities DIME forces have in other domains (for example, diplomatic capability to support or execute military or economic activities).
- Vulnerabilities:

  These factors assess known or potential vulnerabilities to include asymmetric vulnerabilities.
- Asymmetric Capabilities:

  These factors identify asymmetric capabilities of DIME forces for any actors in the conflict space.
- Critical Capabilities:

  Factors highlight critical capabilities for specific action (situational dependent).

**Physical States and Impacts**

Physical factors cover those states of nature beyond the immediate control or influence of the operational commander while impacts address their potential influence on possible actions and activities.

- Weather & Climate
- Geography & Terrain
- Science & Technology
- National & International Infrastructure
- Weapons Capabilities
- Asymmetric Capabilities

**Intent and Impacts**

Intent (desired result) applies to all actors in the conflict space across all types of cooperation, competition, conflict, and combat. It differs from force capability (feasible actions) and political will (feasible extent). It addresses the extent of the intent, the objectives, the impact, and the implications across the board for:

- Cooperation
- Competition
- Conflict
- Combat (Mission and/or Objectives)

- Asymmetric Relations

  These factors also capture the nature of any asymmetry between actors.

**Domain States and Effects**

Factors address both initial Political, Military, Economic, Social, Information, and Infrastructure (PMESII) domain states and subsequent effects of actions on those states in transition. Category may be expanded to include states and effects for other domains (beyond PMESII) and to add other factors relevant to the decision maker.

Each domain subdivides into structure, effectiveness, influence, and both asymmetric and critical capabilities:

- Political States & Effects
- Military States & Effects
- Economic States & Effects

  Factors focus on non-material issues and on the impacts and effects of actions on materiel damages, infrastructure damages, environmental damages, resources damage or loss, diversion of resources, opportunity costs, stability and risk costs, intangible (market) costs, black market impacts, economic recovery, international trade, foreign investments, regional investments, international banking …
- Social States & Effects

  Factors include population demographics, human losses and impacts, leadership (community, business, religious, and educational leaders), interaction with economic states, Judicial systems and social values, educational institutions, subsistence levels and distribution of subsistence resources, medical services …
- Information States & Effects

  Factors include reliability and credibility of data, criticality and production of information, broad capabilities and effects of information operations, and the effects of information on other domains.
- Infrastructure States & Effects

  Factors focus on changes wrought by actions related to the conflict space by any and all actors. These include destruction, degradation, loading, and repairs of the infrastructure components and systems as well as environmental impacts.
- Technology States & Effects

  Factors focus on changes by all actors. These include destruction, degradation, loading, and acceleration of the technology infusion into DIME components.

**Transition States**

Operations seek change. Transition states record, track, and project changing states. As such, critical decision factors arise from the dynamic nature of conflict.

- Initial States**:**

  Factors address indications & warning, warning time, and response time.

- Mission States:

  Factors include: warning time, response time, decision points & time, execution time, intermediate mission states, transition states (intermediate objectives), and accomplishment parameters. This dynamic also tracks force capability versus mission states and risk versus mission states (force exchange ratios, cost-benefit ratios, risk of failure, etc.).

- Coherency / Friction:

  Factors address coherency of strategic and operational objectives, mission objectives, and intent. They include harmonization and synchronization of actions.

- End States:

  Factors identify criteria for establishing the objective end state, intermediate states, and transition strategies to include an exit strategy or return to normal engagement strategy.

- Transition Points:

  Factors address the identification of flash points, tipping points, and operational discontinuities.

- Limitations, Constraints, & Prohibitions:

  Factors include the identification of limitations, constraints, and prohibitions of operational significance and their impact on operations.

## Conclusion and Recommendations

### Conclusions

This interim report identifies decision factors considered by operational-level commanders and develops an overarching structure for these variables. These decision factors are key to development of M&S tools, command & control tools, and decision support systems that will be relevant to commanders at the operational level of war. However, the task is not finished.

Subsequent efforts must validate these results, develop mathematical models for the future simulations and decision support tools, and develop the conceptual model for their use (i.e., tactics, techniques, and procedures).

### Recommendations

Future endeavors are needed to test and validate the resultant set of operational decision factors. The number of initial participants was limited by time and availability. Subsequent surveys conduced in conjunction with Joint seminar war games, concept briefings to war colleges, Joint training exercises, and other Joint venues are needed to confirm and validate the reported results. The study results provide a reasonable basis for this follow-on survey.

Subsequent study efforts need to expand the examination of decision factors to identify:

- Measures of merit,
- Contributing decision variables,
- Mathematical foundations (e.g., formulae) or
- Decision models (e.g., subject matter experts or polls),
- Information needs,
- Information sources, and

- Priority of (development) effort.

The final development phase must address network centric operations (NCO) / global information grid (GIG) enabled concept architectures, infrastructure, and technology approaches that will enable the flexibility and responsiveness needed by the operational warfighter exercising Joint command and control in the Joint Operational Environment (JOE). The ending application phase must develop and test the practical uses of these tools to support the missions of the operational warfighter.

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• Tom Utsunomiya, MITRE

• Robert Wright, IITRI

• Chuck Bradbury, JPSD

# Appendix A: Participants – Questionnaire and Interviews

| Relevant Position(s) | Historical Example | Interview | Service |
|---|---|---|---|
| Army Technology LNO to USJFCOM, J9<br>OSD T&E MC02 Range Integration<br>USJFCOM, J9 ONA Technology Lead | | X | |
| Director of Operations, Warrior Preparation Center, 98-02<br>Director, US Army Battle Command Training Program 95-98 | X | | A |
| Research Scientist: Military Decision Making Process | | X | |
| Deputy Chairman, Department of M&S and Wargaming, Air Command and Staff College 97–01<br>Advisor, US AFRL, Information Dir, 02-04<br>Chief, Wargaming Strategy Development, HQ USAF/XOOC - CHECKMATE, 95-02 | | X | AF |
| Chairman, Concepts Department, Naval Warfare Development Center, Naval War College | X | X | N |
| Chief of Plans, V Corps, 02-03.<br>V Corps OPLAN (Iraqi Freedom) | X | | A |
| Plans Officer, Joint Staff, J-3, CENTCOM Branch, 90-92 (Desert Storm & post) | X | X | AF |
| Chief of Staff, US Air Force | | X | AF |
| Plans Officer, CJTF-7 (Baghdad, Iraq) | X | | A |
| Commander, North American Aerospace Defense Command<br>Commander, CENTAF (Desert Storm) | | X | AF |
| Plans Officer, CJTF7 (Baghdad, Iraq 03-04) | X | | A |
| Department of State, Support Team 99-2001 African Crisis Response Initiative<br>USA Battle Command Training Program | | X | A |
| Staff Officer, Joint Electronic Warfare Center & CENTCOM (Proven Force and Desert Shield)<br>Vice-President, Fraunhofer Center for Research in Computer Graphics, Inc. | X | X | A |
| National Military Command Center; US Army Concepts Analysis Agency;<br>MITRE Corporation (JWARS development) | X | X | A |
| Director of Operations, 48th Tactical Fighter Wing (El Dorado Canyon) April 1986 | X | | AF |
| Vice Commander, Warrior Preparation Center, USEUCOM<br>Plans, J5, USCENTCOM (Desert Storm) | X | | A |
| Chief Engineer, NWDC/M&S | X | | N |
| Asst Director, Joint Staff, J8 M&S | | X | JS |
| Analyst, Joint Staff, J8, Warfighting Analysis Division | | | JS |
| Chief, Analysis and Simulation (ECCS-AS), USEUCOM 91-94,<br>Chief, Combat Analysis Group, USCENTCOM 94-97<br>Chief. Modeling, Simulation and Analysis USJFCOM J7, 97-99 | X | X | A |

| Relevant Position(s) | Historical Example | Interview | Service |
|---|---|---|---|
| Commander, Company B, 1st Bn, 3d Special Forces Group (stability operations in Haiti - Uphold Democracy 94-95) | X | X | A |
| Chief, Weapons and Tactics, 48th Fighter Wing (El Dorado Canyon)<br>Chief, War Operations, CHECKMATE (Desert Shield / Desert Storm) | X | | AF |
| Analyst, US Army Concept Analyst Agency (modeling for Illustrative Planning Annex of the Defense Planning Guidance - DPG)<br>Analyst, OSD (modeled Illustrative Scenarios for the DPG) | X | | |
| Commander, V Corps (Iraqi Freedom)<br>Director, Joint Training, USJFCOM J-7 | X | X | A |
| Chief, Concept Development, JFMCC Ops; SSG concept development & wargaming | | X | N |
| Director, HQ USAF, Checkmate<br>Recalled to serve as assistant to the Director, Checkmate (Iraqi Freedom) | X | | AF |

# Appendix B: Baseline Questionnaire

The questionnaire and interview process reached people with a wide-range of experience. The questionnaire attempted to extract operational-level decision variables that have been used. It also identified simulation tools and their usefulness. On the other hand, the interviews looked to the future.

## Baseline Questions:

From your perspective and experience in each operational-level operation or contingency planning event indicate:

1. Your position or role,
2. The period (or term) at issue, and
3. The operation being addressed for each of the following questions:

| Line | Question |
|---|---|
| a. | Describe the operation or plan you supported. |
| b. | Was a simulation (M&S) product used? If so, what simulation? |
| c. | What decision criteria (factors) were critical in this operation? |
| d. | What objectives were critical in this operation? |
| e. | What measures of merit were critical in this operation? |
| f. | What performance factors were critical in this operation? |
| g. | What did the use of the simulation actually accomplish? |
| h. | Did its use clarify any decision variables? |
| i. | Was operation executed? If so, what was the role of the simulation during the operation? |
| j. | How much preparation time and how intensive was the overhead relative to the usefulness of the simulation? |
| k. | Were the results timely? Where they relevant? |
| l. | How easy was it to prepare the results for presentation? Were the results understood? How easily? |
| m. | What decision-support tasks would you like the simulation to perform that it could not? |
| n. | What tasks were attempted or accomplished with another tool that might be better accomplished with a simulation? |

# Appendix C: Literature Review (Annotated Bibliography)

The brief descriptions here are combinations of self-descriptions included in the document and the descriptions written by study members.

**UJTL**

The Universal Joint Task List identifies the joint tasks that a joint force could perform. Each of these requires decisions that will be driven by a variety of factors. The UJTL does not describe these factors. An examination of applicable doctrine or subject matter experts could produce valid lists.

**Automated Behavior-Based Interaction Customization for Military Command and Control**

By Scott D. Wood

This paper outlines a proposed architecture for behavior-based customization of user inter-action with an adjustably autonomous system. The architecture could be used to experiment with use of robotic forces and to help define the level of control that humans should exert in operating such forces. The paper identifies the intelligent control framework in terms of task automation, information delivery, and common needs. The paper then briefly describes two potential models that could be used to develop the architecture. Finally, the paper lists issues that must still be resolved to include the following:

- How does behavior based customization fit within a larger control hierarchy/system?
- How well can it deal with multi-tasking?
- How will the task models need to be augmented?
- What sort of reasoning will be required?
- How will the autonomous systems need to be re defined to work with adjustable autonomy?
- How ill users interact with the system for maximal benefit?

The paper concludes that there are many complex issues yet to be resolved. This paper did not have anything related to decision factors.

**Concept Primer Collaborative Information Environment (CIE)**

Final CIE Concept Primer Draft.pdf

The collaborative information environment trans-forms joint collaborative planning from the traditionally hierarchical, sequential process to a more parallel method that allows supporting staffs and other resources, separated by geography, time, and organizational boundaries, to interact and coordinate the plans development. Virtual collaboration allows a reduced command-and-control "footprint" in forward areas of operation. Each level of command—from the joint force commander to the components—will be involved simultaneously in planning, resulting in a better understanding of the commander's intent, in a better unity of effort, and in shorter planning cycles. This paper is a reference used in the background section of the study.

**Concept Primer Joint Operations Concepts (JOpsC)**

FinalJOpsC Concept Primer Draft.pdf

The Joint Operations Concepts is a family of documents that forms a framework to describe how the joint force intends to operate 15 to 20 years from now. It provides the operational context for the transformation of the armed forces of the United States by linking strategic guidance with the integrated application of joint

force capabilities. JOpsC describes the conduct of joint military operations in the context of interagency and multinational coordination across the full range of military operations. It focuses on joint military operations at the operational and strategic level of war and describes the integration of emerging capabilities across the domains of air, land, sea, space, and information, as well as the development of subordinate operating, functional, and enabling concepts.

The JOpsC *capabilities-based approach* focuses on how the United States can defeat a broad array of capabilities that any adversary may employ, rather than on the identities of the adversaries and on where they may engage joint forces or U.S. interests. This approach shifts from threat-based force development to force planning, based on the desired capabilities for any given military operation. This paper is a reference used in the background section of the study.

**Concept Primer Operational Net Assessment,**

FinalONAConceptPrimerDraft.pdf

Operational net assessment integrates people, processes, and tools that use multiple information sources and collaborative analysis to generate products that improve command decision-making. The ONA concept also works hand in hand with the effects-based operations concept, which aims to change or direct the behavior of a complex adaptive target. ONA is the tool that identifies the correct targets, links, and nodes that will create the desired effect.

ONA enables effects-based operations by providing an expanded view of the combatant commander's battlespace. This further allows insight into complex relationships, dependencies, and vulnerabilities within and throughout an adversary's political structure, military capabilities, economic system, social structure, and information and infrastructure networks. Such analysis provides unparalleled insights into their basic fabric. Viewing the adversary as an adaptive system-of-systems allows us to understand how we may use the full force of our national and coalition diplomatic, information, military, and economic power to achieve far-reaching effects. ONA aims to provide a thorough understanding of the total effect and of how to achieve it.

This paper is a reference used in the background section of the study.

**Culture-Centric Warfare**

Major General Robert H. Scales Jr., US Army (Retired), **Proceedings**, September 2004, http://www.usni.org/Proceedings/Articles04/PRO10scales.htm

General Scales presents in this paper changes required to master the later phases of conflict where the fundamentals of human relationships is dominant. Our recent experiences have been plagued with misjudgments in this regard. He believes that finding collective solutions to address human failures during this "cultural phase (*Stability Operations)* is essential and long overdue."

Success in this phase rests with the ability of leaders to think and adapt faster than the enemy and of soldiers to thrive in an environment of uncertainty, ambiguity, and unfamiliar cultural circumstances. Intimate knowledge of the enemy's motivation, intent, will, tactical method, and cultural environment has proved to be far more important for success than the deployment of smart bombs, unmanned aircraft, and expansive bandwidth..

Reflective senior officers returning from Iraq and Afghanistan have concluded that great advantage can be achieved by outthinking rather than out equipping the enemy. We should start improving how our military thinks and studies and start an additional transformation based on cognition and cultural awareness.

These are the Initiatives he calls for,

- **Because of a significant failure of lower level intelligence the Intelligence Services must be transformed.**

Soldiers and Marines have been immersed in an alien culture unable to differentiate friend from foe or to identify those within the population they could trust to provide useful and timely tactical intelligence.

The enemy's motives often remain a mystery and the cost in casualties due to this inability to understand the enemy and predict his actions has been too great.

- **Reform the Military Learning Systems**

This new era requires soldiers equipped with exceptional cultural awareness and an intuitive sense of the nature and character of war. The schools should teach the central elements of the nature and character of war via—military history, along with war games and military psychology and leadership—.

- **Responsibility for learning must be shifted to those most responsible for success—unit commanders.**
- **Leverage Learning Science**

Exploit learning science by conducting research in cognition, problem solving, and rapid decision making in uncertain, stressful environments.

Attention should be given to understanding how culture-centric systems interpret and use data.

We need to better understand what information is necessary for making decisions and how different commanders use information

Cognitive systems capable of customizing the decision-making process will emerge from that understanding. Perhaps soon commanders will be offered exercises and decision aids that will optimize their ability to make the right decisions in the midst of a mountain of information that invariably will descend on them in the heat of battle.

As a matter of course, every exercise, game, and major joint training event should add uncertainty and unpredictability in the form of alien representation.

- **Acculturate Every Soldier: the cultural wall must be torn down. Lives depend on it.**

**He concludes noting that cognitive reform is hard.**

A process of cognitive and cultural transformation requires a revolution in learning throughout the Department of Defense. Reform of this magnitude is essential, long overdue, and undoable without the commitment of the entire military intellectual community.

This paper was used for background and reinforces in a summary manner some of the decision factors.

**Effects Based Operations: A Guide for Practitioners**

by Dr. Guy Duczynski Paper

The subject paper was part of the published works of the 2004 Command and Control Research and Technology Symposium, held 15-17 June in San Diego, CA. It provides a systematic method for

examination of how different "factors" interact (in our study, decision factors), a process for organizing these into a problem space, a solution space, and a design space, as well as a means of analysis that allows for showing progression towards an "Effects" based operation, rather then a "Means" based operation. There are many elements of this work that are appropriate to the study.

This paper provides a means for integrating the analysis of decision factors as well as using real world decision factors for illustration purposes.

**Homeland Security Joint Operating Concept, Version 1.0**

HLS JOC draft v1.0 (OSD Version) 02 Feb 04.doc;

This DOD HLS Joint Operating Concept (JOC) describes how DOD intends to perform its responsibilities associated with securing the Homeland, to include HLD, CS, and EP. This JOC describes how the Joint Force will plan, prepare, deploy, employ, and sustain the force in the 2015 timeframe to detect, deter, prevent, and defeat attacks against the Homeland, provide military forces in support of civilian authority, and plan for emergencies. This concept serves to guide the development of desired future capabilities within a specific segment of the Range of Military Operations that includes HLD and CS missions, and EP planning activities.

This paper is a reference used in the background section of the study.

**Joint Operational Environment Version 16 August, 2004**

The Joint Operational Environment (JOE) White Paper represents an ongoing dialogue whose purpose is to inform USJFCOM joint concept development and experimentation strategy, as well as its training strategy. It is intended to be an enduring investigation that will assist with the identification and refinement of future capabilities. Updated annually, this security environment blueprint will help foster strategically, operationally, and tactically responsive forces that are able to provide tomorrow's commanders decisive, coercive operations within a complex, integrated, interagency and multinational environment. This document put forward 11 critical factors as existing in all operational environments and as having the greatest impact on "military forces and the attainment of political goals." The 11 are presented in the Decision Factors appendix.

**JCDE TPG M&S Assessment Report**

This report focused on JFCOM J9 M&S accomplishments and needs from an experimentation perspective. It addressed in general the various models and federations that were being used, and what needed to be developed. There was nothing on decision factors in this document.

**Joint Experimentation M&S Requirements Working Group, standing, prioritized M&S future requirements list v1.6**

The Joint Experimentation M&S Requirements Working Group is chaired by members of the JFCOM Experimentation Directorate, J9 and includes RCC and Service representatives. The requirements are oriented towards experimentation. Currently this list has 43 items. Thirteen correlate to a decision factor and are included in the decision factor appendix.

**Joint Command and Control Functional Concept, v1.0, DRAFT**

jroc_c2_jfc.doc;

The Joint Command and Control Functional Concept describes a vision of how Joint Command and Control (C2) will be executed in 2015 in support of the Joint Force Commander. It integrates the required C2

capabilities from the Joint Operations Concepts, the Joint Operating Concepts and the other functional concepts and provides an approach for transforming C2 capabilities primarily at the operational level.

As the environment is becoming more challenging, the need for being more precise and discriminating in the application of force is further raising the bar for the effective performance of command and control. Command and control needs to become more agile while maintaining decision quality and speed that are superior to those of the adversary. It needs to give commanders the option to employ a wide range of command approaches and control mechanisms so that they can readily address any new situation in which they find themselves. It needs to tie together the numerous decision-making processes taking place across the range of participants in the diverse coalitions of the future.

This concept provides the measurement framework for evaluating the command and control investment options needed to implement Joint C2, and for supporting those investment decisions. This Joint C2 Functional Concept also serves to:

- Generate thought and discussion about new methods for performing command and control across the range of military operations;
- Provide the conceptual framework for developing integrated architectures used for analyzing Joint Command and Control capabilities; and
- Provide the basis for military experiments and exercises.

The concept is expected to lead to force development guidance that would require changes in joint force doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF).

This paper is a reference used in the background section of the study.

**Joint Forcible Entry Operations, Joint Enabling Concept, Version 0.85, 2 January 2004,**

JFEO

The focus is on joint forcible entry operations against a high-end regional competitor with significant military capabilities. No set blueprint for joint forcible entry operations exists. Each joint forcible entry operation is unique, driven by discrete variables and specific situations. Each joint forcible entry operation will be conducted against different opponents, in different geo-political environments, with different coalitions, and for different purposes. Regardless, this joint forcible entry concept presents a set of principles that future joint force commanders can apply to the specific case at hand. The paper also identifies the joint operational capabilities essential to execute joint forcible entry operations.

This paper is a reference used in the background section of the study.

**Joint Urban Operations Concept, version 0.95, 4 June 2004,**

JUO concept 0 95 (DRAFT 04 June 04)-4.doc;

This paper outlines the central concept and the principles by which the joint force will operate in complex urban terrain, across the range of military operations. The paper serves as a means for generating and capturing thought and discussion on the methods for conducting joint urban operations in the next decade. The paper also serves to influence Joint and Service transformation. It departs from current doctrine where it no longer serves. It describes methods for employing specific military attributes and capabilities to achieve desired end states in the urban environment. After development, experimentation, assessment and refinement, the concept may lead to doctrinal changes.

Given the complexity and challenges of operating in an urban environment, the central theme for joint urban operations is: **achieving our desired end state by understanding, controlling, and exploiting the unique elements of the urban environment (e.g., terrain, infrastructure, population, and information); sensing, locating, isolating, and destroying the adversary; controlling the pace and tempo of operations; and applying power precisely and discriminately**. Power includes the coherent application of sequential and simultaneous, military and nonmilitary, kinetic and non-kinetic means to achieve lethal and non-lethal effects.

This paper is a reference used in the background section of the study.

***Joint Task Force Standard Operating Procedures Review***

A review of the JTF SOP suggests many decision factors. First, from Chapter 16 of the SOP, information requirements are listed in the form of standing reports. Of the 51 reports listed, 5 are submitted directly to the Combatant Commander by the JTF commander. They are:

- The intelligence summary
- The collection emphasis (often referred to as the Commander's Intelligence Requirements) submitted by the JTF
- The JTF Commander's situation report
- The logistics situation report
- The Joint communications control center report

**Joint Pub 3.0 Doctrine for Joint Operations**

This publication discusses

- The Strategic Environment within Which Joint Operations Take Place
- The Fundamental Principles of Joint Operations
- Planning Guidance for War and Military Operations Other Than War
- Considerations for the Conduct of Joint Operations
- Principles for Military Operations Other Than War
- Considerations for Multinational Operations

Several decision factors were identified in this publication.

**Major Combat Operations Joint Operating Concept, Version 1.11, 9 Sept 2004**

,MCO JOC Draft v1 11 9 Sept 04.doc

"The Major Combat Operations Joint Operating Concept (MCO JOC) is a pillar of the Joint Chiefs of Staff's new family of Joint Operations Concepts. It recognizes the complexity and uncertainty of tomorrow's combat environment and the adaptive nature of our potential adversaries. It establishes a framework for the armed forces to transition from the industrial age to the information age in order to better harness our human and organizational capabilities, better target our adversaries' critical nodes, and to place us in greater harmony with the realities of the modern battlespace. It addresses the challenges of conducting large-scale military actions in a distributed, collaborative environment against a militarily capable regional nation state with significant anti-access capabilities and weapons of mass destruction. The central theme of the MCO JOC is to **achieve decisive conclusions to combat and set the conditions for decisive**

**conclusion of the confrontation; use a joint, interdependent force that swiftly applies overmatching power simultaneously and sequentially, in a set of contiguous and noncontiguous operations; employ joint power at all points of action necessary; and create in the mind of our enemy an asynchronous[13] perception of our actions—all to compel the enemy to accede to our will.** Joint power in the context of this paper includes the integration and appropriate balance of conventional and special operations forces."

This paper is a reference used in the background section of the study.

**Network Centric Operations Conceptual Framework version 2.0**

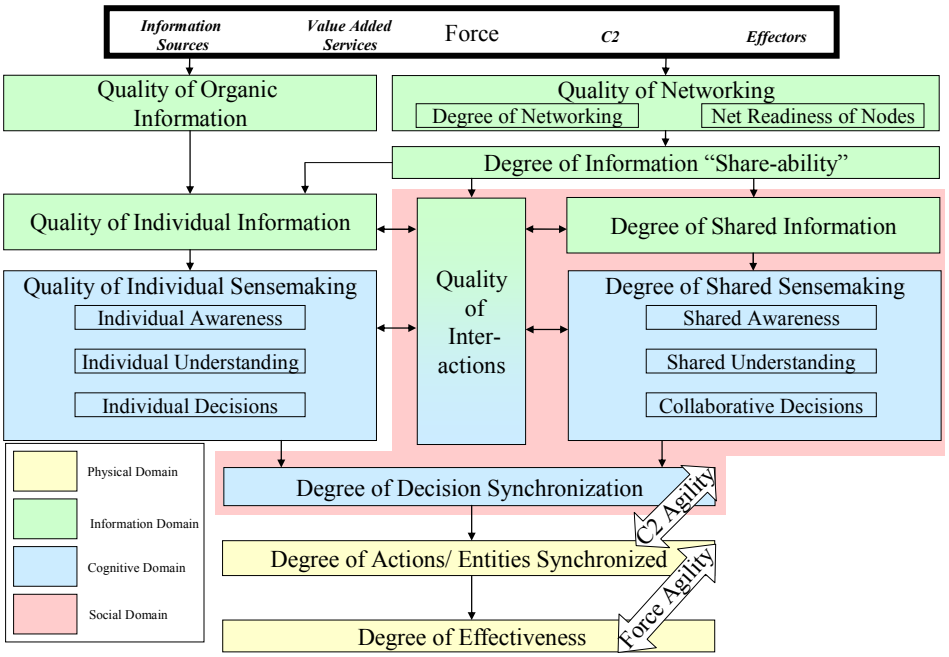
Version 2.0 describes the results of the Network Centric Operations Conceptual Framework Initiative Phase I (June 2003–June 2004). It first discusses Transformation in the context of the changing strategic environment. Next it describes the theory of Network Centric Operations and explains the social, cognitive, physical and information domains in the context of NCO. It then explicates the NCO Conceptual Framework in detail, followed by a summary and synopsis of the case study research conducted in Phase I.

The NCO Conceptual Framework:

- Builds on the tenets of NCW
- Is best understood as a generic "process model"
- Explicitly recognizes the key role of the "social domain"
- Incorporates important research on "sense making"
- Identifies key concepts important in most workflow processes
- Identifies potential dependencies among concepts
- Identifies and defines *Attributes* and *Metrics* for each concept
- Is scalable across different levels of aggregation
- Provides a basis for quantitative exploration and/or assessment of
    - NCW hypotheses
    - Investment strategies and other DOTML-PF related issues

While anecdotal evidence existed to support the NCO claims,[14] no systematic effort to collect and analyze NCW related data had been undertaken to date. As a consequence the Office of Force Transformation (OFT) and the Office of the Assistant Secretary of Defense, Networks and Information Integration (OASD/NII) began collaborating on an effort to develop metrics to test hypotheses in the NCW value chain. The primary objective was to develop a rich and comprehensive set of NCW related metrics that could be used in experimentation and other research endeavors to gather evidence. This evidence then could be used to inform investment decisions across the DOTML-PF. The result of this effort is the development of a Conceptual Framework for Network Centric Operations and a variety of other NCO related research, outreach, and publications. The Network Centric Operations Conceptual Framework (NCO CF) for Assessment identifies key concepts and linkages to output measures in the Network Centric Operations value chain in the context of the physical, information, cognitive, and social domains.

A primary objective of the OFT and the OASD/NII is to develop a comprehensive set of metrics that can be used to evaluate NCO hypotheses. In order to facilitate this goal, an additional extension of the original tenets was necessary. Each concept in the NCO value chain was further extended so that metrics could be developed. The result is the NCO Conceptual Framework represented at the 'concept level' in the figure below. The complexity of this view reflects the fact that it is a guide for experimentation and research.




**Network Centric Operations Conceptual Framework**

Decision factors were found in version 1.0 of this paper. Version 2.0 has a significant amount of changes and should be reviewed for additions.

**Recognition Primed Decision (RPD) Agent Decision Model**

by John Sokolowski, PhD

The purpose for the RPD Agent Decision Model is to develop a computational model of Joint Task Force Commander (CJTF) decision-making. The model assumptions and purpose are:

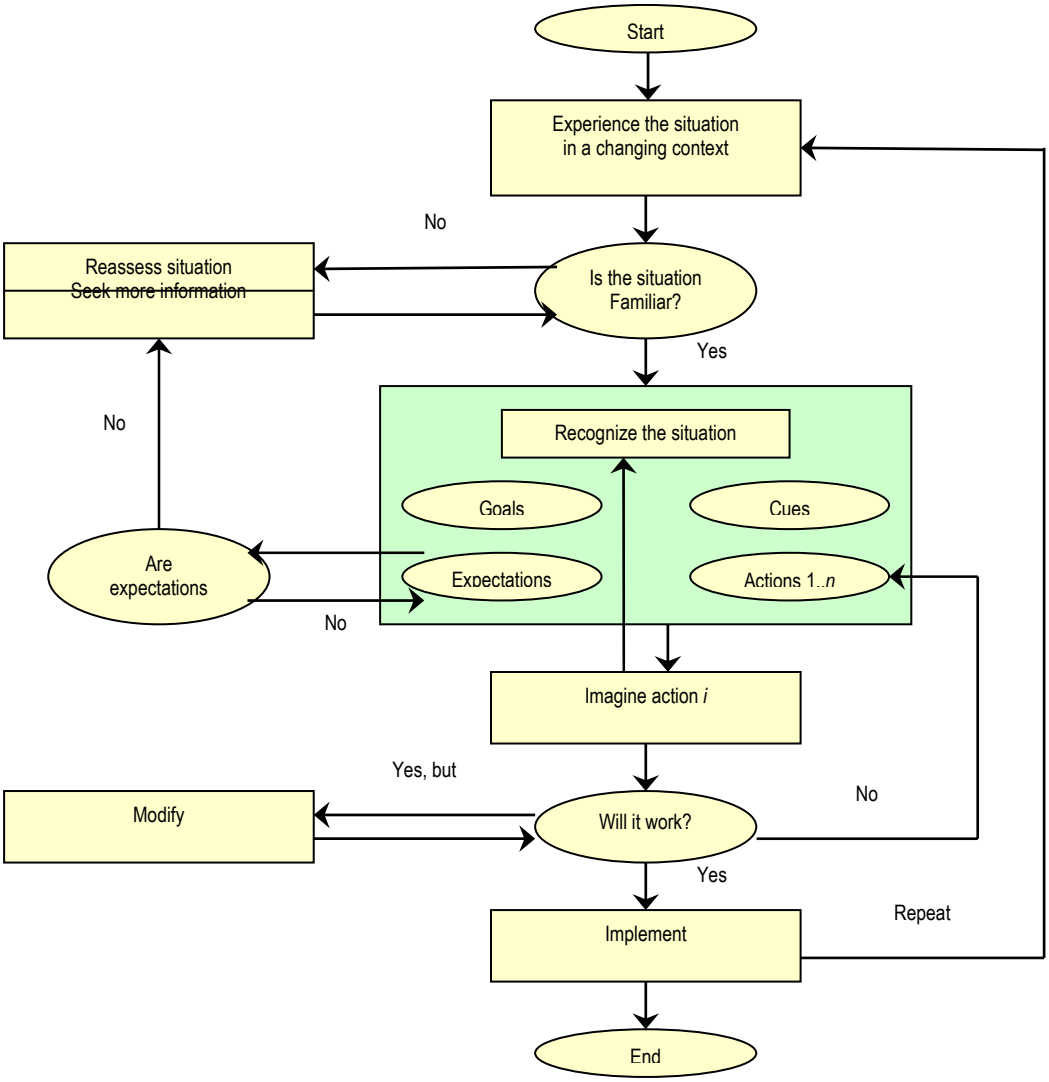
- Operational level of warfare.
- Model based on RPD.
- Model implemented in Java using Multiagent System Simulation (MAS).
- Meant to mimic human decisions, not compute the "optimum decision."

These assumptions were based on the official military decision model which is described as an observe, orient, decide, act (OODA) loop. The decision process focuses on the physical process of gathering information for a decision but not on the individual cognitive process of making a decision.

The RPD model is based on the concept of naturalistic decision making. Naturalistic Decision Making (NDM) emerged in the late 1980s. It is formally defined as how people use their experience to make

decisions in a field setting. It describes how experienced decision makers act in situations characterized by time constraints, incomplete or inaccurate information, and conflicting goals.

The Recognition-Primed Decision (RPD) Making concept is a cognitive model that formalizes NDM. The RPD describes the cognitive process experienced decision makers use when making decisions. The key is the decision maker's past experience in the decision domain. The figure below depicts the process.




In order to experiment with the RPD concept it was necessary to develop a simulation that would permit subjects to use the process and researchers to collect the data to prove that the model accurately represented the real world. Research into possible modeling tools resulted in selection of the Multiagent system (MAS) simulation. The MAS is a system in which several interacting, intelligent agents pursue some set of goals or perform some set of tasks. An agent is defined as an autonomous, computational entity that perceives its environment through sensors and acts upon that environment through effectors to achieve goals. There are two types of agents in MAS:

- Symbolic agents—an agent that possesses a symbolic representation of its environment and its behavior and syntactically manipulates them to achieve its goals. This manipulation corresponds to deductive reasoning via a set of rules.
- Reactive agents—an agent that responds directly to stimuli from its environment without reasoning about it.

The MAS simulation was chosen to implement RPD because:

- A MAS embodies many of the elements of the RPD model.
  - Goal oriented.
  - Action oriented.
  - Senses and interacts with its environment and can produce an internal representation of that environment.
- A MAS can react in many different ways that were not necessarily preprogrammed thus it can closely mimic realistic human behavior.

The key to RPDAgent functionality is the knowledge and experience representation approach. The knowledge and experience are described by a set of frames and an agent negotiation function.

The results of the experiment showed that the MAS model accurately portrayed the actions associated with the decision making process. Analysis of the data proved the null hypothesis, thus indicating that the mental decision making model accurately represents the steps in decision making. This conclusion was further supported by surveys of experienced military decision makers who participated in the experiment. Hence, the RPD process appears to be an accurate representation of the decision making process.

This paper did not provide any decision factors but will be useful for the subsequent steps in the overall project.

**Stability Operations Joint Operating Concept, Version 1.04**

Stability Operations Version 1 04 20 Apr 04.doc;

This initial version of the Stability Operations Joint Operating Concept articulates how a future joint force commander plans, prepares, deploys, employs, and sustains a joint force conducting stability operations that precede, occur during, and follow conventional combat operations.

This concept describes the challenges the United States and its coalition partners will face and proposes solutions to these challenges while identifying the capabilities required to implement the proposed solutions. Additionally, this concept explicates 10 principles to guide a joint force commander's thought process in developing a coherent strategy for conducting stability operations associated with major conventional combat.

The iterative process of developing the joint operating concept provides a product reflective of historical analysis, operational lessons learned, and past experimental findings as well as forming the foundation for future experimentation. Finally, this concept contributes to further development of subordinate joint functional and enabling concepts that feed Joint and Service transformation plans.

This paper is a reference used in the background section of the study.

**Strategic Deterrence Joint Operating Concept, Version 1.11, 11 Feb 2004**

SD JOC V1.0_11Feb04.DOC;

The ultimate purpose of the Strategic Deterrence Joint Operating Concept (SD JOC) is to help guide the transformation of the joint force. This concept will generate thought and discussion about new methods for waging strategic deterrence in response to current and emerging military threats. This concept will also provide the basis for military experiments and exercises. If validated, this joint operating concept will influence subsequent concept development and will lead to capability development efforts that could result in doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) changes. There are a number of capabilities and attributes derived from this joint operating concept unique to strategic deterrence.

In addition, because successful strategic deterrence requires many of the same credible capabilities needed to conduct military operations in accordance with other joint operating concepts—(Major Combat Operations, Stability Operations, Homeland Security, and eventually others) there is considerable overlap of capabilities and attributes with all of them.[15] This joint operating concept highlights those overlaps that are critical to strategic deterrence, and illustrates how they are relevant to influencing an adversary's decision-making regarding possible attacks that would threaten U.S. vital interests. This concept also highlights functional capabilities and attributes that are uniquely required for strategic deterrence to conduct operations in support of defense policy goals and national objectives.

This paper is a reference used in the background section of the study.

**Warfighter M&S Needs Assessment of the Unified Commands and Selected Supporting Commands**

Defense Modeling and Simulations Office, 17 November 2000

The purpose of this report is to provide the Director of the Defense Modeling and Simulation Office (DMSO) with an assessment of a modeling and simulation (M&S) survey of organizational elements in the Unified Commands and selected Supporting Commands. The report is supported by three annexes. The first is a Warfighter M&S Needs Matrix that identifies M&S-related needs in functional and technical areas. The second annex consists of appendices that provide more detailed results of the surveys at each visited command. The third annex lists acronyms used in the report. Many decision factors were found in this report.

**Warfighter and Their M&S Requirements**

Dynamics Research Corporation, 19 February 2003

This report was prepared in support of Defense Modeling and Simulation Office research on developing and fielding an M&S toolbox to support operations other than war (OOTW). The report describes candidate users and their modeling and simulation requirements when conducting OOTW. Former commanders, staff officers, and OR analyst who participated in the planning, training, or execution pf relevant operations provided the information included in the report. The report addressed the following questions:

- Who are the warfighters that would be supported by the OOTW toolbox?
- What types of analyses are conducted to support the warfighters?
- Who are the likely users of the tools in the OOTW toolbox?
- What kinds of tools are currently being used and what other types of tools might be useful?

Many decision factors were found in this report.

**Effects Based Operations: A Guide for Practitioners**

By Guy Duczynski

This paper provides a systematic method for examination of how different "factors" interact (in our study decision factors). It also provided a process for organizing these into a problem space, a solution space, and a design space. Further, it described a means of analysis that allows for showing progression towards an "Effects" based operation, rather then a "Means" based operation. There are many elements of this work that are appropriate to the study, and should be included within the study report. This is not to say that the entire method and associated processes are being endorsed, but that the parallels and possibilities are important to note.

The paper repeatedly re-enforces a focus on the end state of an operation, and promotes an examination and explicit definition of what the 'conditions' of the end-state are desirable. It states that "In seeking to reset the conditions, possibly back to pre-concern/action levels, planners [should] be guided by the need to impose effects that are anchored to the movement of specific conditions in specific directions." It walks through a systems approach to designing a solution space (graphically) that reflects all possible states from the current situation to all possible solutions or end states. Duczynski also promotes levels for each factor, similar to developing measures of effectiveness, as a way of assessing whether you are moving away from or toward the end state.

The value here begins in the generalization of the factors, and the establishment of specific levels which identify progress in a desired direction. One example, drawn from the example from the paper, would be the "unification" of a nation state (Korea) in a particular desired political form (democratic). The example suggests several conditions through which the nation state might progress to get from the current condition (Unified-Communist) to desired end condition (Unified-democratic). In developing the example, the paper also describes similar transitions for relevant factors such as Societal Latitudes, Political Orientation, International Relations, Economic Performance, and Military Emphasis. The result of the methodology is a systemic network of states (figure 1, next page), each of which represents a unique combination of values applied to the relevant factors, that show a progression based on transitions that represent the changing of a single condition of each factor. Note that the diagram (and method) does not represent every possible state because as described and illustrated in the paper, substantial pruning of the tree can occur from its potential extreme size and consequent unwieldiness.

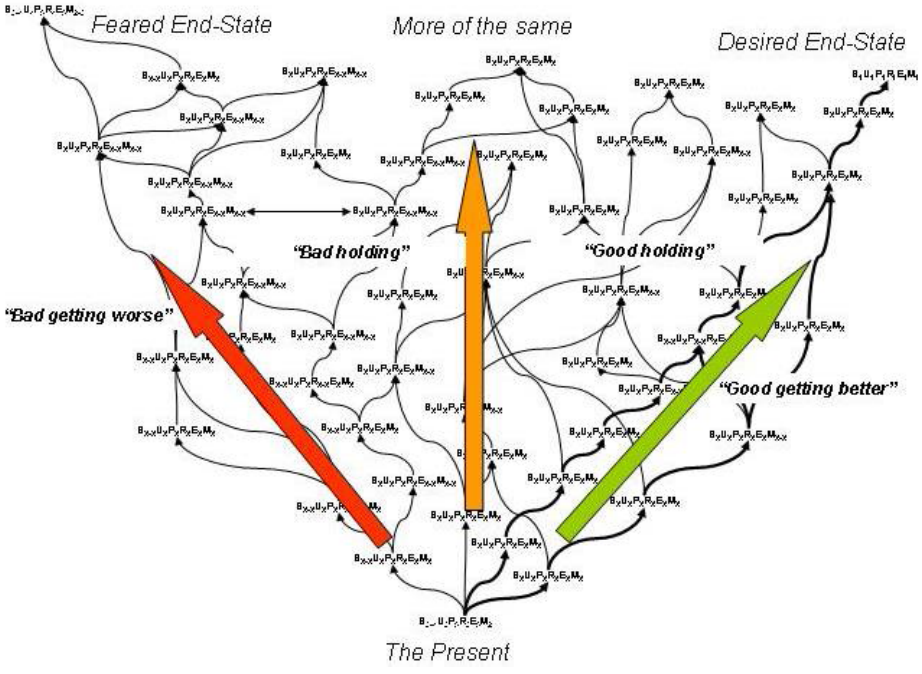


**Figure 1: Duczynski's End State Analysis**

The appeal of this methodology is the framework, which could be coded into an automated planning system with several potential applications. Clearly, the discussion the paper puts forth about conditions that apply to a particular state would be relevant to an automated planning system, which could assess pre-, current, and post-conditions and determine which of the multitudes of potential states represented the current situation. A further premise to consider is that although any given simulation system may be inadequate for evaluating a wide variety of decision factors each generally has a significant capability in one or more areas/domains. Since this method breaks down the effects based transitions to a state diagram that includes single transitions from the current to some desired end state, the possibility exists to use simulations to evaluate the smaller transitions in isolation or small groups. Alternately, the network could be used to monitor a current situation, provide warnings, or suggest courses of actions based on whether a situation was improving or deteriorating.

By focusing a single (or small set) of evaluation factors the potential paths of a situation might be explored by the trading off of effects against each other in a more focused fashion. It may be possible that a previously unconsidered (or ill-considered) path through the network might be discovered and provide an automated explanation of the cause and effect of applying unconventional means. Finally, the breakdown of the analysis provides the opportunity to distribute, process, and store the results in a “net-centric” fashion, by applying multiple analysis engines, each looking at a piece of the problem and comparing the results as a whole or within the subset.

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USSTRATCOM, Strategic Deterrence Joint Operating Concept, n 2
USNORTHCOM, Homeland Security Joint Operating Concept, p 25
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[11] Caffery, oral interview

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[13] Asynchronous, in this context, refers to our desire to create an indiscernible pattern in time and space in the mind of our enemy. Our operations, however, must retain unity of purpose and coherency of action.

[14] Alberts, David S., John Garstka, Richard E. Hayes, and David T. Signori. *Understanding Information Age Warfare.* Washington, DC: CCRP Publication Series. 2002. (Chapter 10)

[15] Not all activities and functions conducted by the Joint Force support strategic deterrence. Some Joint Force capabilities exist that benefit the security of the U.S. through their warfighting application but may conflict with the strategic deterrence methods outlined herein. Additionally, some capabilities have complementary characteristics that support both deterrence and warfighting aims.