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Collective C2 in Multinational Civil-Military Operations

TOPICS: 6- Experimentation

"C2 Effectiveness and Operational Success: An Exploration"

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INTRODUCTION

Command and control is a primary function of military operations. The NATO definition is ""The organization, process, procedures and systems necessary to allow timely political and military decision-making and to enable military commanders to direct and control military forces."[1] The United States Department of Defense considers command and control to be "The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment."[2] With effective command and control, smaller and weaker forces can overcome seemingly insurmountable odds. Without effective command and control, even the most well trained and well equipped forces often fail. Or does it? Does effectiveness of C2 relate to success or failure in the real world?

This paper addresses the relationship of command and control with effectiveness. The paper compares the quality and importance of NATO's conceptualization of command and control effectiveness with the success or failure of a random sample of historical joint combat operations. The measurement instruments are a set of visual Likert-type scales subjected to assessment by a group of trained subject matter experts with respect to a pre-existing database of Likert scales measuring the success or failure of those operations. In effect, this test is a modified version of Thurston's Rules for Comparative Judgment (discussed below.)[3]

The findings indicate a statistically significant relationship between joint operational success and the NATO measures of command and control effectiveness, at least in terms of quality, importance and a combined quality and importance scale. Also, there appears to be a significant auto-correlation between Situational Awareness and Situational Understanding; this essay interprets this to mean that they seem to be measuring the same underlying concept. These findings should encourage the command and control research community because they reinforce the validity of major concepts used in C2 assessment *while using an independent database*. However, one may argue that this finding is premature for the sample is small; also, the actual measure of command and control effectiveness is quality and importance – *not* the direct measure of effectiveness.

The conclusion of this study is that the NATO C2 model seems to be valid for use in the field. However the C2 effectiveness measures do require more rigorous measurement conception and validity testing against critical dependent variables.

BACKGROUND AND METHOD

NATO has supported a robust research program into effective command and control approaches. The organization believes this is necessary in order to successfully conduct the complex civil-military operations it expects to experience in the 21st Century.[4] NATO believes that a new approach to command and control must be effected in order to succeed in these types of operations;[5] it has identified Network Enabled Capabilities (NEC) as the desired alternative approach. To hone the NEC alternative, the NATO C2 Research Program has developed a conceptual model, the C2 Approach Space, to examine the advantages and disadvantages of five types of command and control

systems: conflicted, de-conflicted, coordinated, collaborative, and edge. Each approach is determined by three variables: patterns of interactions among entities, distribution of information among entities, and allocation of decision rights to the collective.[6] The variables create a space in which the command and control systems can be populated. Operational leaders and planners can select the type of system depending on the effectiveness that they require.[7]

The NATO command and control concept also identifies three variables that describe command and control effectiveness: shared awareness, shared understanding, and adaptability of the collective C2 process.[8] Shared awareness is the ability of two or more entities (e.g. individuals, units, organizations) to develop a similar awareness of a situation; shared understanding refers to the available information that is accessible by two or more entities; adaptability of the collective C2 process refers to "the ability of C2 to cope with a variety of circumstances and stresses by altering structures and processes."[9] At this point, the authors of the Maturity Model make a curious statement: although the believe that C2 approaches are correlative of the operational C2 function, they hedge their advice on which C2 approach. They state that:" The appropriate approach to C2 depends on circumstances. Operational effectiveness, not C2 effectiveness needs to be the prime consideration when selecting a C2 approach.[10] This begs a question: taking this last statement as fact, why would anyone be interested in the NATO C2 Approach space if it related to operational (real-life) success? It is true that mathematical models, and models that aspire to mathematical rigor, are internally true if their conditions and equations of the model always hold. External truth (model relationship to real events) is not necessary for a mathematical model to be valid. Are the

authors advising their readers that the C2 Approach in an internally valid model not necessarily correlated with reality variables, and therefore limiting the C2 Approach model to abstract experimentation? Though these questions are highly important, even vital, to the continued utility of the entire NATO C2 Model, they are not the focus of this essay. This author simply assumes that C2 effectiveness is supposed to have *some* kind of correlation with operational success since the utilization of the C2 effectiveness measures *should* strongly relate with the choice of operational C2 functions and processes. From a different literature, C2 researchers on military operations know that C2 functions and processes are strongly related with operational success.[11] Thus, the research in this paper considers the C2 Effectiveness variables to have a least a hypothetically valid relationship with operational success.

The NATO C2 concept conceives of linear and directional relationships between the measures of effectiveness and the types of command and control systems. This proposed theoretical relationship is shown in Figure One:

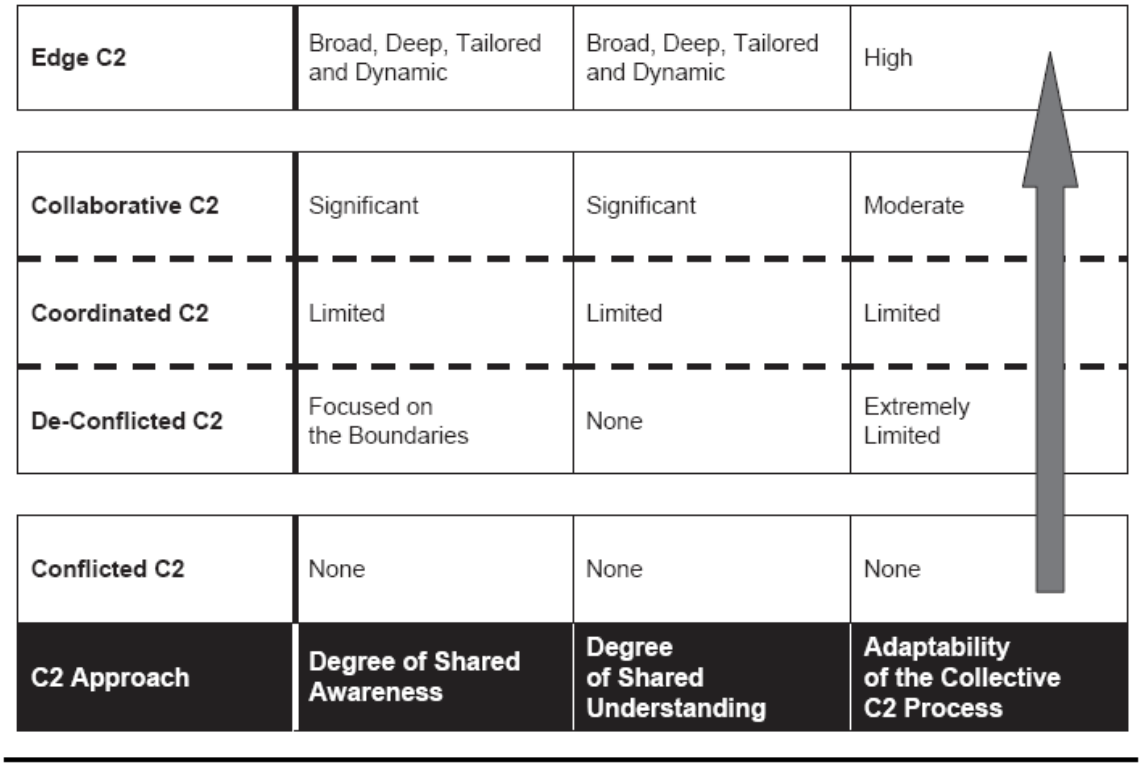

FIGURE ONE[12]
C2 Approach Compared with C2 Effectiveness Measures

The fact that the effectiveness measures assume a direct and linear relationship with C2 types implies that the effectiveness measures are at least ordinal (rank-ordered scores demonstrating mathematical transitivity) if not interval (equal intervals between scores) measures. Ordinality and intervality of measurement are necessary for research to use advanced statistical techniques in pursuit of concept exploration, description and causation.[13]

FIGURE 1 illustrates a hypothetical positive relationship of C2 effectiveness with C2 Approach Space type. The C2 Approach Space typology represents an attempt to map C2 maturity levels (edge organization C2 highest; conflicted organization C2 lowest) with NATO Network Enhanced Capability levels for operations.[14] The hypothesis for this investigation relates effectiveness to operations. It simply states as

follows: (H_1) C2 Effectiveness measures should correlate positively with the degree of operational success. That is, the more effective the C2 structure and function (Approach Space), the more likely the operation is to succeed.

To examine the relationship between command and control effectiveness and operational success, this researcher turned to a validated model of the prerequisites for operational success, the Major Combat Operations Statistical Model or MCOSM. MCOSM uses a sample of historical joint operations from 1939 forward to examine the explanatory variables for operational success. First developed in 2004, the model has proven quite reliable and valid (criterion and prima facie); it can explain operational success over 70 percent of the time (adjusted R^2 with significance (s) > .001.) The model contains values for joint operational success.[15] Operational Success is measured on a Likert Scale with values ranging from 1 (Completely Unsuccessful) to 7 (Completely Successful.) The definition with the visual scale used in assessments can be found at Appendix B.

There may be a concern that using major combat operations as a stand-in for the complex joint, interagency and combined operations that typify 21st Century military activity is a leap of faith, and not truly indicative of the operations described in NATO C2 research documents. In response, this author makes the claim that *all* military operations have common characteristics that distinguish them from *other* operations. First and most obvious, the operations have the participation of professional military organizations. Second, the operations, however structurally designed, have common behavioral characteristics, as in planning and execution. Third, military operations all maintain significantly more information connectivity both vertically and horizontally

than any other operations.[16] This level of commonality should overcome most concerns about the comparativeness of the operations.

To investigate the relationship in question, one takes the existing MCOSM joint operational success measure and has judges (subject matter experts) populate the three effectiveness measures for each of the campaigns and operations recorded in the model. A straightforward statistical examination of the variables then should reveal the extent of the relationships, if any. This ex post facto, quasi-experimental application[17] is an application of Thurstone's theory of comparative judgment. The theory – also referred to a Law or Rule – requires judges to conduct pairwise comparisons of subjective variables; however, the theory has been considerably extended by researchers over the years to the point where the pairwise comparison requirement has been dropped.[18] In the present analysis the variables of interest are each of the three NATO C2 effectiveness variables and the MCOSM joint operational success measure.[19]

The judges doing the actual scoring were professional mid-grade (U.S. grades O-3 thru O-5) military officers, each of whom received the task to become expert on a randomly selected MCOSM operation/campaign. Their next task was to assess the quality and importance of the NATO C2 effectiveness measures to the specific operation to which they were assigned. This study selected at random 34 campaigns and operations from the MCOSM database, allowing one to generalize findings at least to 99 percent confidence.[20] As a criterion validity check, the judges also provided an independent assessment of the operational success or failure.

The judges used quality and importance scales because those are the measures designed to be used with MCOSM (See Appendix A for a visual description of the actual

scales given to judges.) The Quality measurement scale ranges from 1 (Extremely Low Quality) to 7 (Extremely High Quality); the Importance measurement scale ranges from 1 (Extremely Unimportant) to 7 (Extremely Unimportant.) This presents a methodological problem for the analysis for the judges were assessing the quality and importance of each effectiveness measure, not the effectiveness itself. The reason why effectiveness was not used is because it appears to have multi-dimensional characteristics; simply put this means that effectiveness means different things to different judges. Indeed, this was the case of an early trial of this quasi-experiment; further, some judges in the early trial found themselves hard-pressed to distinguish some of the effectiveness measures when directly measured. This problem has been noted above in that the shared awareness and shared information effectiveness measures are highly similarly defined using self-referential terms. As a result of the feedback from the early trial judges, this author, the main researcher on this project, made the decision to use the MCOSM quality and importance scales (both tested and found highly uni-dimensional with singular meaning) to be associated with the three C2 effectiveness definitions. Thus, one can argue that whatever the results, C2 effectiveness was not measured, only the quality and importance thereof was. The view of this analysis is that, lacking a common uni-dimensional understanding of what constitutes effectiveness, quality and effectiveness are sufficiently inter-correlated that the two concepts may be considered interchangeable.[21]

ANALYSIS

The analysis of the data scores from the judges proceeded in a straightforward manner. After examining each variable's characteristics for evidence of bias, dimensionality and measurement error, analysis then considered each variable's

correlations and cross-tabulations with each other variable. In all cases, the relationships appeared linear. Table One summarizes the analytical findings of this study through use of Pearson Product-Momentum correlation coefficients (r).

	OS-M	*OS-C*	*SA*	*SU*	*CA*
OS-M	1.000				
OS-C	0.743	1.000			
SA	0.312	0.373	1.000		
SU	0.319	0.420	0.673	1.000	
CA	0.259	0.439	0.226	0.282	1.000

TABLE ONE
CORRELATION MATRIX AMONG VARIABLE OF INTEREST

OS-M is the MCOSM Operational Success variable; OS-C is the Check Operational Success variable; SA is Situational Awareness; SU is Situational Understanding; and CA is Collective Adaptability. All correlations are significant at least to the .01 level. There is no reason to reject the idea that the variables do measure what they appear to measure on an interval scale.[22] As for the substantive findings, three stand out as worth reporting.

First, the two Operational Success variables, one rated in the MCOSM Model and the other rated by the judges in the NATO C2 effectiveness experiment, are extremely highly correlated. This is a good indication that the variables of interest are addressing a common underlying concept. Reinforcing this observation is the fact that with only one exception (concerning Operation FREQUENT WIND) the direction of the two operational variables are the same; they only differ in strength of success. The strong relationship enables the researcher to extend the analysis to include the NATO C2 Effectiveness variables.

Second, the three NATO C2 Effectiveness variables are significantly correlated with the MCOSM generated Operational Success measure. This finding provides an

independent confirmation of the validity and utility of the Effectiveness measures, always assuming that quality and effectiveness are sufficiently interchangeable. Further, all three measures are significantly correlated with each other, thus indicating that the variables are related to a common construct (command and control effectiveness.) Finally, the Situational Awareness and Situational Understanding variables are far less correlated with Collective Adaptability than with each other. This relationship is as one should expect: the situational variables seem to measure C2 effectiveness of individuals while the Collective Adaptability variable clearly addresses the collective or collaborative whole of the organization(s).

Third and finally, the two Situational effectiveness measures, being highly inter-correlated ($r = .673$), indicate that the judges may have considered the two to measure the same concept; anecdotal evidence from the judges in their scoring reports support this assessment. If NATO researchers believe that there is a significant difference between awareness and understanding, they must develop more distinctive and rigorous differential measures of each. Alternatively, if these researchers are unsure or are willing to consider a common concept for awareness and understanding, then they can form a composite scale that captures that common concept. Although it is highly speculative without the historical context of the NATO research, this author nominates the concept of Situational Information Processes as that underlying, implicit concept.

CONCLUSIONS

This brief analytic paper has investigated the relationship of the NATO C2 Effectiveness measures with operational success as measured in an independent database, in this case the Major Combat Operations Statistical Model (MCOSM.) That the

Effectiveness measures should correlate with actual operations' success or failure is the working hypothesis; the analysis found that it is the working hypothesis is sustained; thus one can reject the null hypothesis in all three cases on statistical grounds. This is an important finding because it takes the NATO C2 Concept, assessed by the Effectiveness measures, from abstract theory to statistical reality.

There clearly is more work to be done; the current research has been limited by sample size, the use of a single operations database, and the use of quality and importance as surrogates for effectiveness. Also, there is a conceptual issue concerning awareness and understanding that needs to be resolved, and the earlier in a research program that is accomplished, the better.

Nonetheless, there is reason for NATO C2 research to find great encouragement in this independent validation of its Effectiveness measures. If the NATO C2 Approach Space Concept, for which the C2 Effectiveness measures appear to have been developed, is to be used for implementation as well as experimentation, then its component and associated measures and variables, must prove themselves in the real world, not just the conceptual one.

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[1] U.S. Department of Defense Command and Control Research Program reprint, NATO Code for Best Practice C2 Assessment; Washington, D.C.: CCRP, October 2002, page 2.
[2] Joint Publication 1-02, DOD Dictionary of Military and Associated Terms; Washington, D.C.: Joint Chiefs of Staff, 18 November 2010, page 64.
[3] Jum C. Nunnally, Psychometric Theory; New York: Mcgraw-Hill, 1978, pages 57-65.
[4] David S. Alberts, Reiner Huber, James Moffat, NATO NEC C2 Maturity Model; Washington, D.C.: CCRP, 2010, Chapter One provides a detailed background on the NATO research program. Chapter Two describes the literature and concept review of existing approaches and their inabilities to address the complex civil-military environment expected.
[5] Types of operations refers to Bosnia and Kosovo types of operations per Chapter Two, ibid.
[6] Ibid., Chapter Three describes this model and applies it to the five types of command and control systems.
[7] Ibid. Page 69.
[8] Ibid. Pages 69-70.
[9] Ibid. Page 283 contains the definitions of shared awareness and understanding; page 71 contains the definition of adaptability. All three definitions appear tightly tautological; this is a conceptual problem for

the overall model. For the purposes of this essay, criticism is passed in the pursuit of a more specific goal: relating effectiveness to operational success.

[10] Ibid, page 70.

[11] The concept of C2 is leader-centric (in U.S. Joint Forces Command jargon.) And it is leadership quality, measured in several different ways, that is one critical variable promotes or retards operational success in war. Read Jonathan E. Czarnecki, "Military Organizations and Operations as Models of Change: A Statistical Explanation of Who Succeeds and Fails On the Battlefield," Paper presented at the Midwest Political Science Association Conference, April, 2010, that includes a summary critique of the two other major models explaining success and failure in military operations.

[12] This chart can be found on Page 70, Ibid.

[13] Full discussions of measurement scale considerations and typologies are found in most social statistical texts. In the present case, the paper uses Fred N. Kerlinger, Foundations of Behavioral Research; New York: Holt, Rinehart and Winston, 1973, pages 433-438.

[14] Alberts, Huber, and Moffat, NATO NEC C2 Maturity Model…, pages xviii-xxi.

[15] Several articles between 2003 and the present describe the progress and maturation of the Major Combat Operations Statistical Model. The most up-to-date is found in Jonathan E. Czarnecki, "Military Organizations and Operations as Models of Change…"

[16] A thorough discussion of command and control in military organizations and operations can be found in David S. Alberts and Richard E. Hayes, Understanding Command and Control; Washington, D.C.: CCRP, 2006, especially Chapter 4. There is an implied assumption in much C2 research and that concerns the nature, structure, and behavior of the organizations practicing C2. Alberts and Hayes provide illumination on this assumption, but far deeper and more thorough research is necessary.

[17] Referring to an instance of social science experimentation in the real world illustrated in Campbell, D. T., and Stanley, J. C.; Experimental and Quasi-experimental Designs for Research; Chicago: Rand McNally, 1966.

[18] Thurston Scaling Method found in The Research Methods Knowledge Base, http://www.socialresearchmethods.net/kb/scalthur.php, accessed on 1 May 2011.

[19] See Nunnally, Psychometric Theory, same pages.

[20] The officers were students of a Joint Military Operations graduate course at the Naval Postgraduate School, Monterey, California. The officers evaluated their particular campaigns and operations from September to November, 2010. The MCOSM database currently has an N = 94.

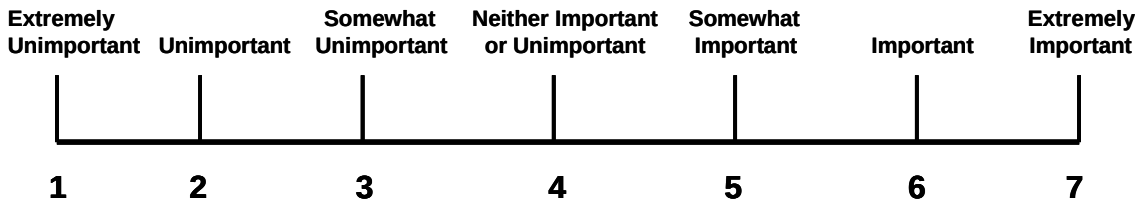
[21] In an initial effort to examine the relationship, the author attempted to directly measure effectiveness with success, just letting the measures vary themselves, as it were, across a seven point Likert scale of "effectiveness." The results indicated that effectiveness is not a term of concordance or even consensus; what is more, the NATO documents do not define effectiveness *per se*. So, the subsequent examination by judges relied on the validated quality and importance scales of the MCOSM.

[22] Social science research requires careful attention to the quality and type of data it uses because of the lack of transparency between measure and phenomenon. It accomplishes this through definition of Levels of Measurement, ranging from Nominal and Ordinal scales that only name and count, to Interval scales that count with exact distances between scalar numbers, and Ratio scales that have a true zero point. See, for example, Dennis J. Palumbo, Statistics in Political and Behavioral Science; New York: Appleton-Century-Crofts, 1969, pages 6-12.

APPENDIX A

Visual Quality and Importance Scales for Measuring C2 Effectiveness

QUALITY SCALE



IMPORTANCE SCALE

APPENDIX B

Operational Success Measurement Scale

Joint Operational Success means the degree to which the specific major combat operation succeeded in achieving its objectives and/or effects.