15th ICCRTS

" The Evolution of C2 "

The Coordination and Collaboration Process within Committees in the Information Age

*****Student Paper*****

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Abstract

In today's information age teams reside in multi-participant problem solving processes that operate within both the physical and virtual environment (Gibson & Cohen, 2003). Teams in order to collaborate form their own "space of constraints" whether they act in the physical, the virtual environment or in both (Bordetsky, 1996). Scholars have examined teams that operate in the physical space (such as cliques by Poran & Sabastien, 1998; and teams in general by Salas et. al., 1992) or in the virtual space (Gibson & Cohen, 2003; Yoo, 2001) and examined coordination and collaboration within committees using the majority rule (Bordetsky, 1996; Miller & Page, 2007). In addition, teams' decomposition applies when complex problems arise (e.g. swarm groups as proposed by Arquilla, J. & Ronfeldt, D, 2000). Hence, a literature gap exists in addressing the dynamic, in terms of time, collaboration process that exists within committees with fluidic participation which operate in both the virtual and physical environment. In order to address this issue, the research design is presented which is divided into three mutual interdependent steps. As an initial step a theoretical System Dynamics model of collaboration is generated based on literature. The second step involves field experimentation which will be conducted within the Tactical Network Topology (TNT) experimentations to obtain the coordination process and the factors that affect coordination. Furthermore, the multivariate nature of this problem is examined with the Parameter Space Investigation (PSI) method of multi-criteria optimization (Statnikov, 2002) in order to identify the temporal equilibrium states of the coordination process using the data from the field experiments. The combination and repetition of these three steps can be used to examine the process of collaboration of a committee that operates both on the physical and virtual space on the basis of a time path.

Introduction

In today's information age teams reside in multi-participant problem solving processes that operate within both the physical and virtual environment (Gibson & Cohen, 2003). Simon (1996) suggests that goal seeking actors seek a satisfying solution limited by the existing endogenous and exogenous constraints. For each team member the endogenous are the members' self-interest constraints and the exogenous are the constraints that derive from the social rules between the members (descriptive, prescriptive, proscriptive, and evaluation constraints). At the aggregate level teams in order to collaborate form their own "space of constraints" whether they act in the physical, the virtual environment or in both (Bordetsky, 1996). Scholars have examined teams that operate in the physical space (such as cliques by Poran & Sabastien, 1998; and teams in general by Salas et. al., 1992) or in the virtual space (Gibson & Cohen, 2003; Yoo, 2001) and examined coordination and collaboration within committees using the majority rule (Bordetsky, 1996; Miller & Page, 2007). In addition, teams' decomposition applies when complex problems arise (e.g. swarm groups as proposed by Arquilla, J. & Ronfeldt, D, 2000). Hence, a literature gap exists in addressing the dynamic, in terms of time, collaboration process that exists within committees with fluidic participation which operate in both the virtual and physical environment.

The main focus of this conceptual paper is to set a research plan of the collaboration process that occurs inside a committee that operates both on the physical and virtual space on the basis of a time path. In order to derive this process certain questions have to be answered first. How committees maintain stability within and between the physical and virtual space and what factors drive its members to migrate from one space to another? How these factors affect the committee's members in both spaces (physical and virtual)? How the level of decomposition affects the performance of teams?

Stability in this study is perceived as a system property that tells you if the system will end at an attractor (or not) but it does not describe the exact time path to the attractor. The attractor types used are bounded and thus can be labeled as satisfying some unchanged characteristics (Flake,1998). So speaking of social stability, the idea of unchanging implies that the human actors involved do not change their decisions and the relationships between and among the actors does not change. The future is constructed by repetitively repeating the past and thus there is a physically situated social or team equilibrium. At any and time t, there exists a collection of social rules that have emerged from past actions. These rules classify objects, prescribe behavior, proscribe behavior, set social values etc. These social rules both constrain and facilitate decision-making by the actors. At equilibrium these do not change. So, all the human agents involved responding to their particular world do not change their decisions which include the creating and distraction of relationships between and among the agents. To summarize this study focuses on a dynamic system that changes over time according to a set of fixed rules and limitations and determines how one state of the system moves to another state.

The research is divided into three mutual interdependent steps. As an initial step a theoretical model of collaboration is generated based on literature. Building upon variables and their theoretical derived correlations a System Dynamics model is generated in order to examine the collaboration process in a time path. The detailed description of the model is described later on. The second step involves field experimentation which will be conducted within the Tactical Network Topology (TNT) experimentations to obtain the coordination process and the factors that affect coordination. Field research provides validity to the generated model as the variables are based on real world data. Furthermore, the multivariate nature of this problem is examined with the Parameter Space Investigation (PSI) method of multi-criteria optimization (Statnikov, 2002) in order to identify the temporal equilibrium states of the coordination process using the data from the field experiments. Using the Paretto Set of Criteria the temporal optimized collaboration is derived and in combination with the results of the System Dynamics model we can derive how the committee's space of constraints changes in a time path manner by "docking" the results of the two methods mentioned above (Burton & Obel,2003). In addition we can examine how the members of the committees migrate or should from the virtual to the physical space and vice versa in order to enhance collaboration in a time path manner.

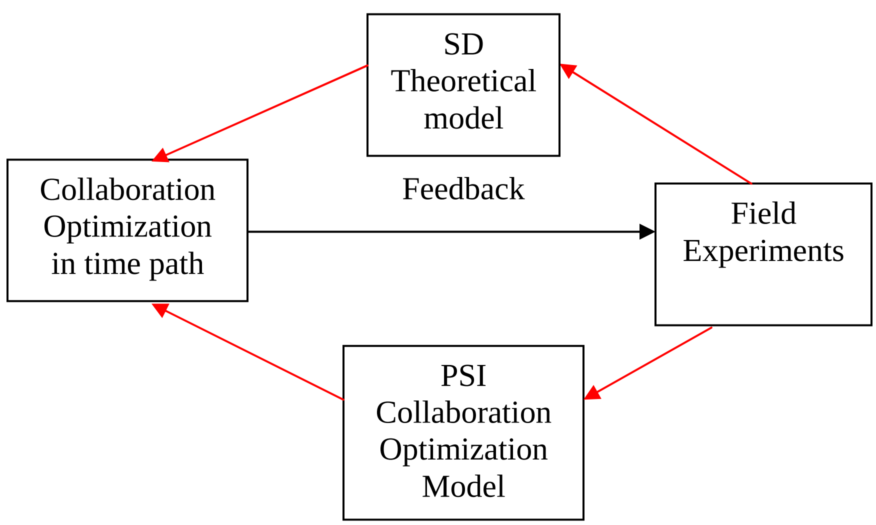


Figure 1. Research design

The level of analysis of the study is the committee level. Political scientists suggest that a committee system is a division of labor arrangement that distributes members to structural decision-making subunits of the organization (Shepsle, 1979). This research considers that committee members are not based on traditional pooled interdependent mechanisms but on reciprocal interdependent ones (Thompson, 1967) and are organizationally configured as “edge” (Alberts & Hayes, 2003).

Edge Committee (EC)

Wagner (2000) suggests that one of the most important elements of organizational structure is departmentation. Departmentation is divided in functional and regional. In functional departmentation people are divided in a way where each one or groups of people do different pieces of the project. In regional departmentation people tasks are divided geographically. Hence, committees can be described as a form of functional departmentation. Furthermore, Salas et.al. (1992) suggest that team is a disguisable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission and who has each been assigned specific roles or functions to perform. Political scientists suggest that a committee system is a division of labor arrangement that distributes members to structural decision-making subunits of the organization (Shepsle, 1979). Therefore committee can be described in terms of a team with specific roles or functions, who are not based on traditional pooled interdependent mechanisms but on reciprocal interdependent ones (Thompson, 1967).

The Edge is an organizational configuration, introduced by Alberts & Hayes (2003), which shares similarities with the Adhocracy (e.g., coordination by mutual adjustment, small unit size, many liaison links throughout, selective decentralization), Professional Bureaucracy (e.g., low vertical specialization, high training and indoctrination, market and functional grouping), and Simple Structure (e.g., low horizontal specialization, low formalization), but it also demonstrates several key differences, and does not correspond cleanly with any single archetype (e.g., it is characterized as an hybrid *Professional Adhocracy*—a combination of archetypes). Key to Edge characterization is decentralization, empowerment, shared awareness and freely flowing knowledge required to push power for informed decision making and competent action to the “edges” of organizations (Alberts and Hayes 2003), where they interact directly with their environments and other players in the corresponding organizational field (Scott 2001). In contrast, the Edge organization shares almost no similarities with the Machine Bureaucracy (cf. high training and indoctrination).

Burton & Obel (2004) suggest that if environmental complexity is simple, and environmental change is static, then the organizational structure should be functional. Research on teams that operate in uncertain environments (such as Leweling, 2007; Koons et.al. 2008) suggests that the Edge organizational configuration outperforms compared to others.

This research focuses in uncertain environments; participating members form an Edge Committee (EC) that mutually adjusts depending on the endogenous and exogenous conditions.

Computational Modeling

Albert and Hayes (2005) suggest campaigns of experimentation have four phases: formulation, concept definition, refinement and demonstration. The formulation phase establishes, based on an initial idea, the experiment's research question and establishes the focus of the experiment. In the concept definition phase scientists develop a conceptual model in order to make a first point of departure which consists "relatively simple elements (ideally primitives) that are linked together to form relationships." Therefore a simple but rich in implications conceptual model is the first step of this research.

According to Simon (1996) and Epstein (1999), computer-based computational models generate virtual environments that imitate actions and behaviors of social life based on real world observations. The model's simplicity is vital in every simulation. Every model must be complex up to the point where no critical attribute or element is excluded from the model. Unnecessary complexity may require statistical analysis that limits our ability to address the research question (Burton & Obel, 1995). Some details from the real world can be ignored as soon as the main building blocks have been captured by the model (Miller & Page 2007). Simon (1996) suggests that "we do not have to know, or guess at, all the internal structure of the system but only that of it that is crucial to the abstraction".

There are mainly two approaches in computational modeling. The bottom up approach focuses on the interactions at the lowest level of the system (the individual level) which, by simulation, generates the emerging system behavior (Burton & Obel 1995).The top down approach is the approach where general properties are abstracted from the real world and with the use of feedback loops examines the system's behavior (Epstein & Axtell 1996). System Dynamics models trace the patterns of behavior of a dynamic system to its feedback structure. This computational tool can be used to study "what is", "what might be" and "what should be" questions. In this research it would be used to answer all of the three kind of questions mentioned above.

In the conceptual model formulation phase, the modeler constructs a mental model followed by "a verbal description of the feedback loops that are assumed to have caused the reference mode" (Randers, 1980).

SD Theoretical Model

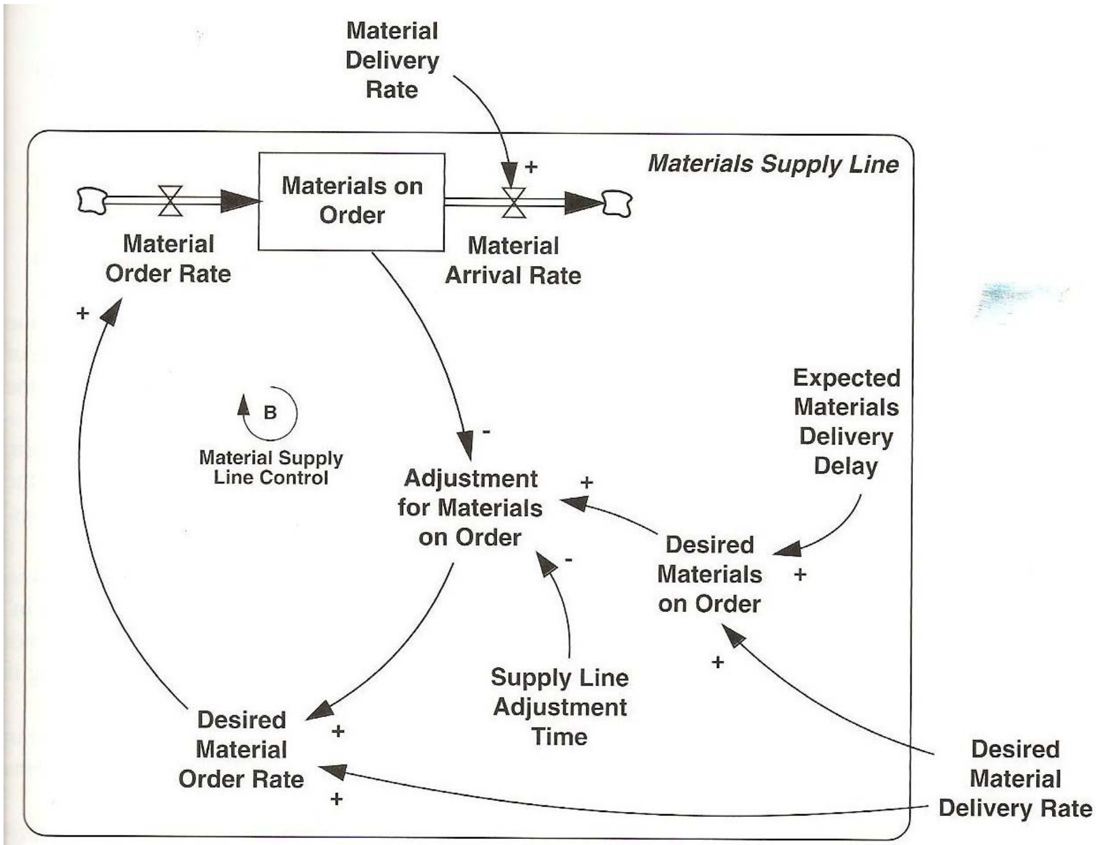


Figure 2. Interactions Among Supply Chain Partners (After: Sterman,2000)

Having as a basis an already validated model from literature, gives to the researcher the privilege to start from a “solid base”. Sterman(2000) in order to describe a industry’s supply chain “consisting of two firms (or sectors, such as the automobile industry and its principal suppliers) suggested the supply line model of Figure 2.

Two firms or sectors that cooperate in order to produce a material can be easily translated into a committee with members that operate both in the virtual and physical domain and try to accomplish specific tasks collaborating. Of course the model above illustrates the material supply process only in the physical domain. The initial System Dynamics conceptual model that serves as a point of departure for this research is shown in Figure 3.

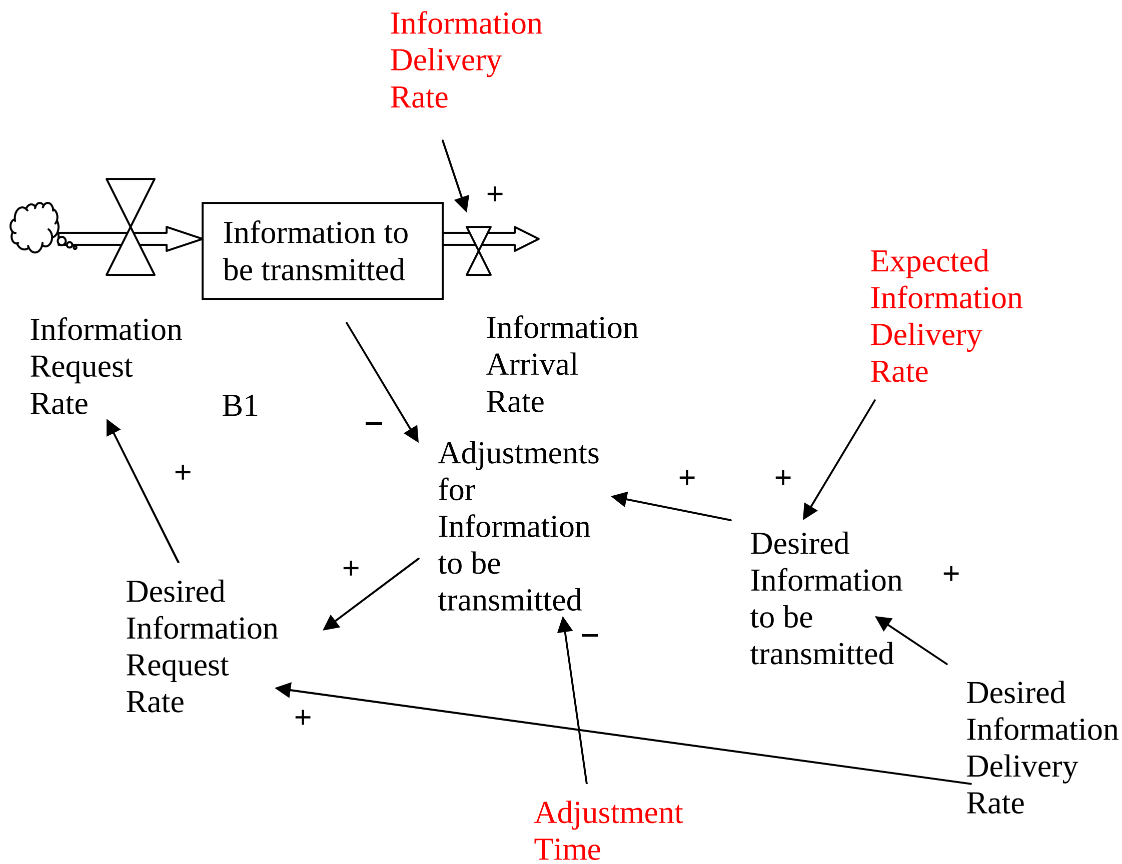


Figure 3. SD Information Exchange Model

This model is similar with the model of Figure 3 but with one basic difference. The model of Figure 2 represents a flow between two firms in the physical domain. On the other hand the model in Figure 3 represents the information flow of committee members that work both in the virtual and physical domain. The variables in red represent the variables that are affected by the interchangeability of the committee's members between the virtual and physical domain. So the "expected information delivery", the" information delivery rate" and the "adjustment time" are different if a member operates from either the physical or virtual domain.

Of course the model of Figure 3 is only one part of the puzzle of the final System Dynamic model. Trust is another important factor of team collaboration. Gibson and Cohen (2003) suggest that trust flourishes easier at the physical domain rather that the virtual. Trust affects behaviors and performance within organizational and team settings (Coleman, 1990; Castelfranchi & Tan, 2002; Dirks & Ferrin, 2001). Coleman (1990) argues that the decision of an actor to trust or not is a function of the expected gain and loss involved. So members that want to pass information and strengthen their trust bonds would choose the physical domain for this action despite the fact that this would cost them in terms of time. Moreover, strong trust ties increases the information exchange rate among members. Vangen and Huxham (2003) suggest that trust is a continuous process interconnected with collaboration and described it as a “continuous process of nurturing”(Figure 4).

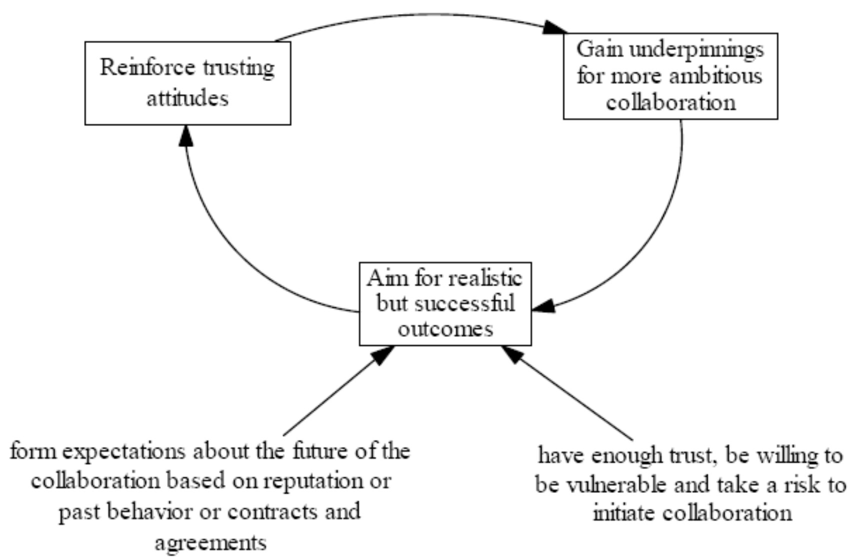


Figure 4. The Trust Building Cycle(Adapted from: Vangen & Huxham (2003))

This loop derived from literature can be connected with the Information Exchange model by putting in the place of “Aim for realistic but Successful outcomes” the “Expected Information Delivery Rate” variable.

Theoretically the outcome of the model is not predictable since it is impossible to figure out how the members of the committee would migrate from the physical to the virtual domain in order to collaborate and of course examine the collaboration process that occurs inside a committee that operates both on the physical and virtual space on the basis of a time path. Moreover, putting values in a model that are not derived from real world data has no meaning at all and does not promote computational research (Carley & Prietula, 1994). This is why the experimentation phase is so important for this research.

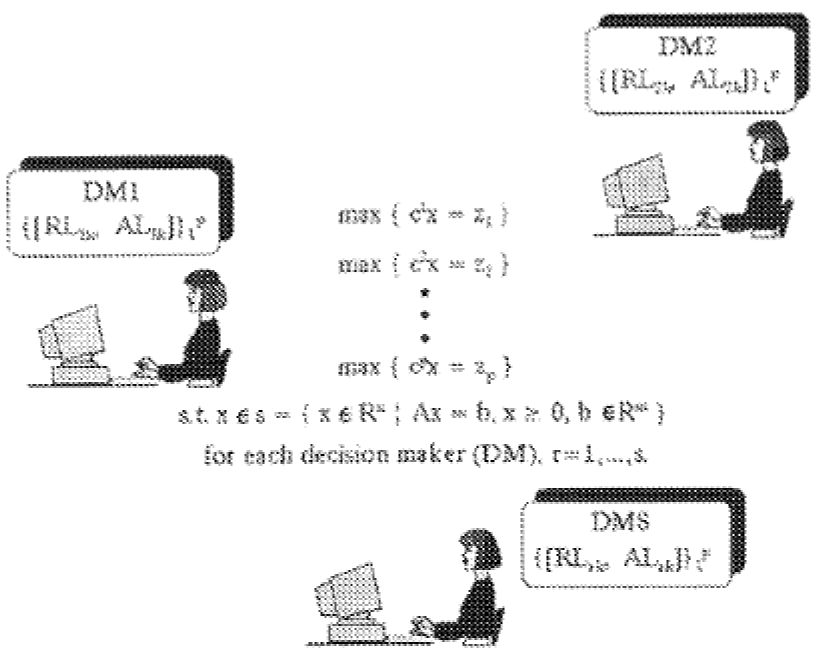
The Field Experiment

The experimental phase starts with the pre-experimentation phase where the researcher determines the variables that will be measured in the experiment along with the scenario of the experiment.

Variables:	
Task	Qualitatively
Number of nodes	#
Cost	Dollars
Delays	Time
Information	Tokens
Trust	Qualitatively
Functions	
Bandwidth per link	Hz / # of nodes
Information Exchange Rate	Tokens/minute
# of layers	#
Size	# of total links needed
Links	# of links per node
Collaboration	Nodes / task / time
Limitations:	
Environmental carrying capacity	nodes per square meter per time
Transmission carrying capacity	Transmissions per square meter
Node failure	Percentage of failed nodes per time
Data termination	bad data from data source / times permitted

Links available	Max # of links per node
Bandwidth available	Max bandwidth per node
Committee’s social rules	Qualitatively

The Collaborative process with Multicriteria tool was initially introduced by Bordetsky(1996). The multivariate nature of this problem will be examined with the Parameter Space Investigation (PSI) method of multi-criteria optimization (Statnikov, 2002) in order to identify the temporal equilibrium states of the coordination process.Therefore, using the Pareto set of criteria this study will monitor the “optimum” values for each dependent variable under study and examine how the process of collaboration should be made in order to reach the higher levels of collaboration. This would lead in another of experiment where the new data in addition to new variables (that were not included in the first experiment) would feed the study until data saturation.



Collaborative Process with Multi Criteria tool (Adapted from Bordetsky (1996))

The scenario of the initial experiment is based on TNT's current experiments on San Francisco Bay and other places around the world (Germany, Greece). The recent experiment of TNT in Souda bay Greece (September, 2009) showed that MIO experimentation around the world benefits military research since new ideas and opportunities emerge.

The scenario involves MIO operations where the participating members are officers from different NATO countries. This allows the researcher to examine the collaboration process among members without team experience that build trust while they are immigrating from the virtual to the physical domain and vice versa. The members of the experiment should be interviewed before the experiment in order to determine the trust bonds among them. This experiment can be repeated with members of the same nation and be compared with the first experiment with the NATO participants. Once these experiments are repeated in order to exclude as much as possible randomness interesting results will be reached for both the process of collaboration among members that migrate from the physical to the virtual domain and vice versa and the collaboration in general among NATO officers. So this design will highlight the difficulties NATO faces and spread light to NATO's collaboration problems.

The hypotheses to be tested in this experiment are:

Hypothesis 1: If trust among members of a committee increases, then the members migrate from the physical to the virtual environment more often.

Hypothesis 2: Information exchanges faster when members migrate from the physical to the virtual environment.

Hypothesis 3: The need for information increases among members that communicate in the virtual environment.

Conclusion

The main focus of this conceptual paper is to set a research plan of the collaboration process that occurs inside a committee that operates both on the physical and virtual space on the basis of a time path. In order to achieve this, the research plan is divided into three mutual interdependent steps. As an initial step a theoretical model of collaboration is generated based on literature. Building upon variables and their theoretical derived correlations a System Dynamics model is generated in order to examine the collaboration process in a time path. The second step involves field experimentation which will be conducted within the Tactical Network Topology (TNT) experimentations to obtain the coordination process and the factors that affect coordination. The experiment will examine the collaboration process of committees that have members from the same and from different NATO countries. Furthermore, the multivariate nature of this problem is examined with the Parameter Space

Investigation (PSI) method of multi-criteria optimization (Statnikov, 2002) in order to identify the temporal equilibrium states of the coordination process using the data from the field experiments. Using the Paretto Set of Criteria the temporal optimized collaboration is derived and in combination with the results of the System Dynamics model we can derive how the committee's space of constraints changes in a time path manner by "docking" the results of the two methods mentioned above (Burton & Obel,2003). In addition this research plan sets the basis to examine how the members of the committees migrate or should from the virtual to the physical space and vice versa in order to enhance collaboration in a time path manner.

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