10th International Command and Control Research and Technology Symposium

A Computational Framework for Experimentation with Edge Organizations

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Abstract

Edge organizations emphasize moving knowledge and decision-making power to individuals and teams who directly interface with the environment. Traditional project modeling tools cannot adequately represent the critical impact of information and knowledge flows, nor the importance of developing trust between workers in Edge organizations. The Virtual Design Team (VDT) computational modeling platform evolved from ongoing research at Stanford University starting in the late 1980s. VDT has been used successfully to model activities, communications, and exception handling within traditional project organizations performing relatively routine, albeit highly concurrent, tasks. This paper discusses POW-ER, a new computational modeling platform based on the same "information processing" view of organizations as VDT. POW-ER is an extensible organization simulation platform, within which we have prototyped direct support for modeling several critical dynamic behaviors of workers in modern knowledge-based organizations: knowledge flows, trust effects, and cultural/institutional differences between team members from different backgrounds. POW-ER can also support demand-driven, dynamic allocation of resources to tasks as needed, to model work processes that cannot be represented by predefined tasks. Using POW-ER, researchers can now conduct emulation experiments on Edge organizations to validate and calibrate the computational model, ultimately aiding in the systematic design and optimization of these organizational forms.

Introduction

An *Edge organization* (Alberts and Hayes, 2003) is a new organizational form in which personnel in the field are given increased decision-making responsibility, allowing them to respond in a more agile and adaptive fashion to changes in their operational environment. The concept leverages advances in information and communication technologies, which permit real time, high bandwidth access to relevant information from any location in the world. In essence, the concept is to move from the traditional deeply hierarchical, headquarters-centric organization, towards a flatter hierarchy made up of small network-centric distributed units. As with any new conceptual model, however, a significant amount of research is required on how best to go about implementing this type of organization. Laboratory and analytical methods are helpful, but suffer from weaknesses that make it difficult to apply the results to real-world situations. Field methods can be time consuming, costly, and suffer from poor experimental control.

A complementary method which overcomes some of the limitations of both laboratory and field research is computational modeling. Agent-based computational modeling and simulation is a natural and intuitive method for developing predictive, multi-level social science theory. Mature, validated, micro-social science models of micro-behaviors can be embedded in computational organizational micro-agents (individuals or small groups) as sets of canonical micro-behaviors. Organizational researchers can then model the way in which these canonical agents behave and interact in their "virtual world"—which includes both other computational agents and relevant aspects of the task and/or environment—to generate predictive outcomes that can be validated against empirical data.

The Virtual Design Team (VDT) research group (Jin and Levitt, 1996) was initiated at Stanford University in the late 1980s to help managers design organizations and work processes for executing fast-track development of complex products without incurring the large cost overruns and catastrophic quality failures that had frequently plagued such efforts. VDT was developed as an agent-based computational model of project teams and the work processes they were attempting to execute in a highly concurrent manner. It has been successfully used to model work activities, communications, and exception handling within traditional organizations working on projects in areas such as construction, aerospace, consumer product development, and healthcare.

VDT models are intended to represent projects having a defined beginning and end, predefined sequences of tasks with estimable amounts of direct work, and predetermined actor task assignments. Initial attempts have been made to model Edge organizations using VDT (Nissen and Buettner, 2004), but VDT can not directly represent the knowledge-driven adaptive nature of these organizations. To address the needs of Edge organization researchers, aspects of the VDT model needed to be re-conceptualized and extended.

This paper discusses the design and use of POW-ER (Process, Organization, Work for Edge Research), a new modeling and simulation platform based on many of the same concepts in the VDT model. It extends the capabilities of VDT by adding direct support for modeling critical dynamic behaviors such as knowledge flows, trust effects, and cultural differences between team members within highly distributed organizations. POW-ER also provides for demand-driven, dynamic allocation of resources to tasks on an as-needed basis. These extensions allow researchers to conduct emulation experiments on Edge organizations to validate and calibrate the computational model, and ultimately, aid in the systematic design and optimization of these organizational forms.

The Virtual Design Team Model

VDT is a discrete event simulation system, which makes use of Monte Carlo techniques to statistically predict the performance of project models. VDT models represent work through inter-related tasks; actors communicate with one another while performing these tasks; and an organization structure defines roles and reporting relationships of the actors and constrains their behaviors. Figure 1 illustrates this view of tasks, actors and organization structure. As suggested by the figure, we model the organization structure as a network of reporting relations, which can capture micro-behaviors such as managerial attention, span of control, and empowerment. We represent the task structure as a separate network of tasks that can capture organizational attributes such as expected duration, complexity and required skills. Within the organization structure, we further model various roles (e.g., marketing analyst, design engineer, project manager), which can capture organizational attributes such as skills possessed, levels of experience, and task familiarity. Within the task structure, we further model various sequencing constraints, interdependencies, and quality/rework loops, which can capture considerable variety in terms of how work is organized and performed.

Each actor within the organization structure has a queue of activities to be performed (e.g., assigned work tasks, messages from other actors, meetings to attend) and a queue of information outputs (e.g., completed work products, communications to other actors, or requests for assistance). Each actor processes tasks at a rate and with an error frequency that depend upon a qualitative match between: the actor's skill types and levels vs. the skill required for a given task; the relative priority of the task; the actor's work backlog (i.e., queue length); and how many interruptions divert the actor's attention from the task at hand. Actors' collective task performance is constrained further by the number of individual sequential and parallel tasks assigned to each actor, the "work volume" of those tasks, and both scheduled (e.g., work breaks, ends of shifts, weekends and holidays) and unscheduled downtime (e.g., awaiting managerial decisions, awaiting work or information inputs from others, or performing rework).

Both primary work (e.g., planning, design, manufacturing) and coordination work (e.g., meetings, management, joint problem solving) are modeled in terms of work volume (measured in person-hours or person-days). Work volume is specified as Full-Time Equivalent (FTE) actors multiplied by time (FTE-Hours or FTE days) and represents the amount of information processing work associated with a task, a meeting, a communication, etc.

Thus, the VDT simulation engine employs both qualitative and quantitative reasoning. VDT alternates between qualitative pattern matching and numerical discrete event simulation. Results of the qualitative pattern matching adjust integer numerical variables such as numbers of missed meetings and real number variables such as error probabilities in the numerical Monte Carlo discrete event simulation part of the model.

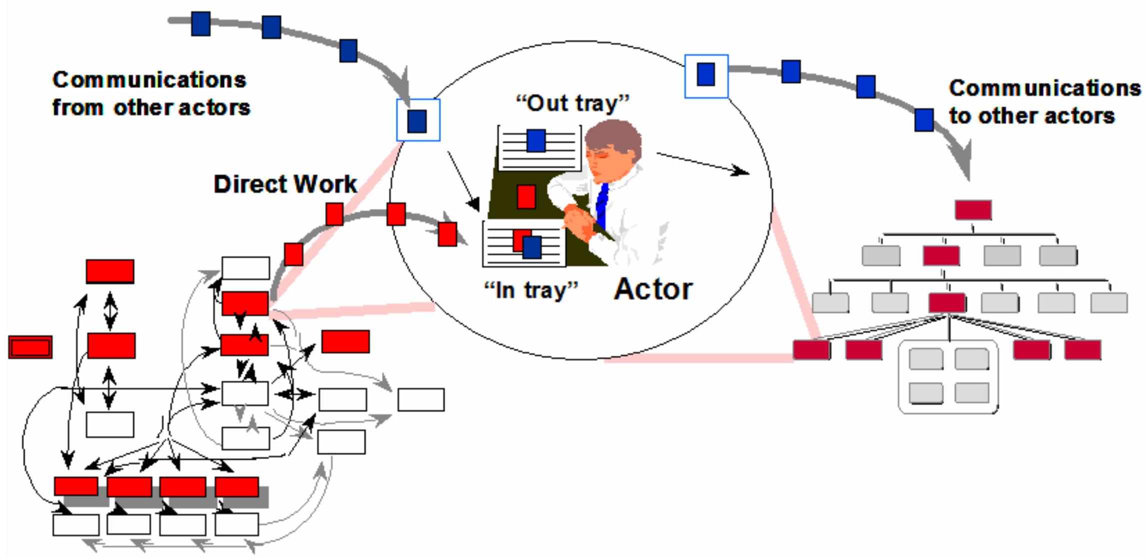

Figure 1 VDTs Information Processing View of Knowledge Work. VDT actors process both direct tasks and communications from other actors as "information-processing sub-tasks." Subtasks arrive constantly during the duration of the project and accumulate in actors' in-trays. When sub-tasks arrive faster than the actor can process them, the actor becomes backlogged, triggering delays and increased quality risks due to missed communications and meetings. Each sub-task is tagged with a specified work volume, required skill, arrival time and priority. Based on these tags, VDT actors stochastically select particular items from their in-trays to work on, experience exceptions in processing tasks, and determine which supervisory actors they will consult to help resolve exceptions that may arise. Unresolved exceptions, missed communications and missed meetings all increase the probability of exceptions in subsequent tasks.

VDT applies AI-style symbolic pattern matching—i.e., it reasons qualitatively, using pattern matching over nominal and ordinal variables, based on micro-behaviors derived from organization theory. In tandem, the discrete-event simulation engine steps a simulation clock forward in time using time steps as small as one minute to enable quantitative computation of work volume and elapsed time; and it tracks the number of missed communications, missed meetings, items of rework not completed, and other process quality metrics by task, actor and for the aggregate project team. Bridging between the qualitative and quantitative reasoning are a set of tables called "behavior files" which represent the results of our ethnographic studies of actor micro-behavior in project teams. Each behavior file is a small matrix with about three rows and three columns containing a set of numerical values in each cell of the matrix. The qualitative inference engine in VDT reasons about nominal and ordinal variables such as actor role (one of: Subteam, Subteam Leader or Project Manager) and level of centralization (one of: Low, Medium or High) to pick a row and column in the behavior file matrix; the VDT controller takes the numerical value from this row-column intersection in the behavior matrix and passes it to VDT's quantitative, discrete simulation engine where it is used to reset a task's exception probability, adjust an actor's processing speed, etc. An advantage of this representation is that many details of the actor micro-behaviors in VDT can be calibrated over time by simply using a spreadsheet or word processor to change the values of entries in the behavior files—enabling non-programmers to develop and extend the model. Readers interested in additional details of the VDT model's implementation should see (Jin and Levitt, 1996).

Quantitative simulation places a significant burden on the modeler in terms of validating the representation of a knowledge-work process. It requires hands-on fieldwork to study an organization in action, and to formalize and calibrate the information processing micro-behaviors of its participants. Our computational modeling environment benefits from extensive fieldwork in multiple domains—e.g., power plant construction and offshore drilling (Christiansen, 1993); aerospace (Thomsen, 1998); software development, (Nogueira 2000); healthcare (Cheng and Levitt, 2001); and other domains. VDT has been used since 1996 to teach classes on organization design at Stanford University and at more than 30 other universities worldwide. Through a process of "back-casting"—attempting to predict known performance outcomes of a past project using only information available at the beginning of a project—students in these classes have developed VDT models of real-world projects and demonstrated dozens of times that the outcomes predicted by VDT correspond well to actual performance outcomes for those projects (Kunz et al. 1998).

Limitations of VDT for Modeling Edge Organizations

Edge organizations differ significantly from the traditional project-oriented organizations that VDT was intended to model. Rather than incorporating a fixed reporting hierarchy, interactions that cross the boundaries of role and rank are encouraged when it aids in the successful completion of tasks. Leadership emerges from competence and circumstances, not from position. Information is shared with all who may find it relevant to their tasks, rather than being limited to specific domain experts. Edge organizations are not intended to accomplish a fixed and predefined series of tasks, instead they are intended to perform actions in response to continuous, rapid changes to the environment in which they are operating. This is inherently a knowledge-driven situation, in which the choice of action(s) is directly determined by the current demands of the environment, based on information available to the actors.

VDT is intended to model projects with a fixed set of tasks, by pre-assigned actors with known sets of static skills. VDT does not allow simulated actors to take on assignments dynamically based on availability, proximity, and applicable skills. It does not model non-human resources such as equipment and information systems. It also can not model the movement of resources, including travel time and other delays.

VDT can be extended to model concepts applicable to Edge organizations more directly, but this must be done with care to maintain the integrity of previously validated micro-behaviors. Existing project models should continue to behave in a fashion consistent with the traditional VDT model. This may be accomplished by re-conceptualizing some of the existing simulation mechanisms such that they become flexible enough to represent the more dynamic Edge concepts. It can also be accomplished by layering new facilities on top of the existing mechanisms.

POW-ER: A New Organization Simulation Platform

To address the limitations of VDT in representing Edge and other similar organizational forms, we have created a new computational modeling and simulation platform called POW-ER. It represents organizations and activities using a flexible abstract object model, which can support shared and disjoint sets of properties for several independent semantic models simultaneously. It is implemented using the Python dynamic programming language, which allows for easy extension of the object model to support future research needs. The platform consists of a graphical model editor, simulation engine, and a charting and reporting module. These components can be used in a stand-alone fashion, or combined together into a complete desktop modeling and simulation application.

The model editor provides the primary user interface to POW-ER. It allows for the construction of complex project models by dragging, dropping and connecting simple graphical objects representing actors, tasks, meetings, etc., along with the relationships between these objects. A property editor supports direct manipulation of the numeric and symbolic properties specific to each type of object. The model editor also supports automatic derivation of alternate versions of a model, supporting comparative analysis of related scenarios.

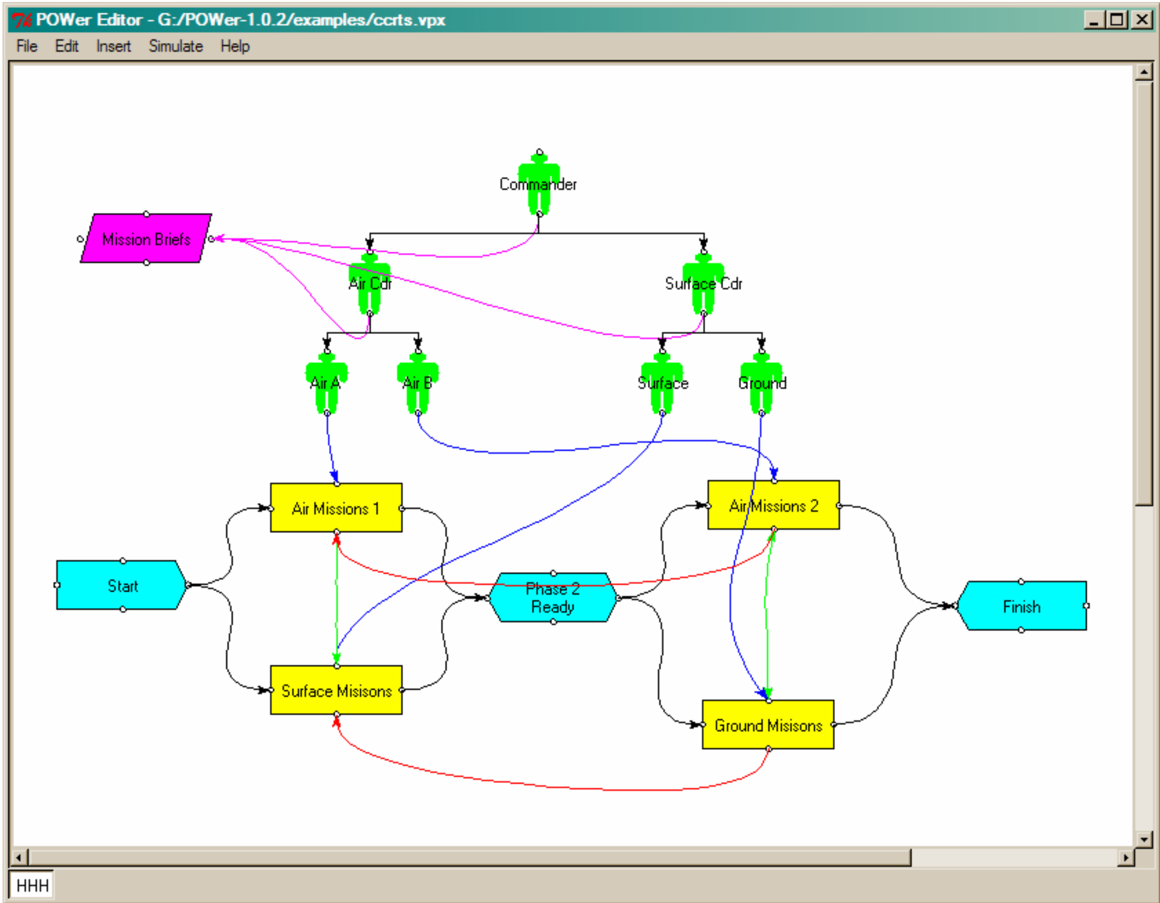

Figure 2 POW-ER Model Editor. A graphical model editor is the primary means of entering models into POW-ER. Shown above is a simple command and control (C2) model, which is described in the article (Nissen and Buettner, 2004). The diagram represents actors, tasks, milestones, and meetings, along with the relationships between them.

POW-ER incorporates a discrete event simulation engine, which is conceptually similar to the VDT implementation, but significantly extends its capabilities. The simulation algorithm is now completely time-scale independent, allowing for consistent results from tasks ranging in time duration from minutes to years. Certain model properties, such as skill and experience levels, have been switched from course-grained discrete values, to continuous numeric ranges, allowing for support of gradual learning processes.

Today, we have implemented several conceptual extensions required to model Edge organizations in prototype form, and conducted some early testing of their reasoning. We discuss these extensions in the following section.

Proof-of-Concept Extensions for Modeling Edge Organizations

Prior to, and concurrently with, developing POW-ER, we have prototyped a number of modeling extensions to the VDT framework to model distributed, knowledge-intensive organizations more accurately. These experiments were all encouraging, and confirmed the feasibility of extending our VDT framework to model key micro-behaviors that are uniquely important for the success of Edge organizations. We describe each of these extensions briefly in this section before elaborating on the design of POW-ER.

Cross-Cultural Effects

There is a huge literature on cross-cultural effects in organizations. In particular Hofstede (1991) has demonstrated that persons from different national backgrounds have significant differences in several dimensions of their beliefs and values that can lead to misunderstandings, conflict and reduced organizational performance. Members of our research group are currently conducting ethnographies, case studies and computational modeling experiments to explore the feasibility of modeling cross-cultural effects in organizations with sufficient fidelity to help support the design of multi-cultural organizations such as international joint ventures.

The first proof of concept prototype that our group developed to explore computational modeling of the impact of cultural differences in project teams was performed by Tamaki Horii (2004). This extension had its origins in research to explore the effect on participant behavior and project outcomes of cultural differences between Japanese and American firms in International Joint Ventures (Horii et al, 2004). Horii proposed representing and reasoning about practice and value differences—specifically, the adoption of culturally-specific project organization structures (practices) and decision-making behaviors (values) by US versus Japanese workers. The initial proof of concept extension was developed using VDT. Horii modified the behavior files that describe participant micro-behaviors in VDT to reflect idealized US versus Japanese decision-making behaviors for computational agents, and by creating organization structures with more or less centralization of decision-making, and flatter or steeper hierarchies (Horii 2005). This VDT extension was able to demonstrate convincingly the effects of cultural differences on team performance through theorem-proving simulation experiments using idealized tasks and organization structures.

Horii's high-level findings were:

1. Agents with Japanese micro-behaviors performed better when they were placed in Japanese-style organizations with steep hierarchies and centralized decision making.
2. Similarly agents with US micro-behaviors performed better when they were placed in US style organizations with flatter hierarchies and decentralized decision-making.
3. Japanese-style organizations were more effective, with either US or Japanese agents, at performing tasks with high interdependence when the team experience of members was low.

These findings not only confirm Hofstede's (1991) "cultural contingency" theory, but also match the predictions of organizational contingency theory that suggest centralized decision making in a functional hierarchy will produce better quality outcomes for complex, highly interdependent tasks. (Burton and Obel, 2004).

Knowledge Networks

POW-ER implements a simple form of *knowledge network* (Ibrahim et al. 2005), which is represented by peer-to-peer knowledge relationships between actors. This work is based on ethnographic studies into *discontinuous organizations.* Such organizations involve situations where one or more functional roles are added to or eliminated from a project while it is ongoing, due to the differing skill requirements needed to complete successive parts of the process.

In VDT, actors who encounter exceptions—situations in which they do not have all the information required to complete a task—seek advice from more knowledgeable managers one or more levels above them in the hierarchy. This hierarchical exception handling was at the core of Jay Galbraith's (1974) information-processing view of organizations, which has been so influential in the analysis and design of project and matrix organizations. However, in modern, knowledge-based organizations, the relevant knowledge bases can change extremely rapidly, so that the knowledge possessed by managers who completed their formal training some time in the past can rapidly become obsolete, greatly reducing their value as "exception handlers" for younger workers. So how can workers get their exceptions resolved in such organizations?

Fields like biotechnology, computer science, or microprocessor design are based on fast-changing technologies. In such organizations, employees frequently find that they prefer to refer exceptions to knowledgeable persons at their own level, or even below their level, outside of their project organization. Actors possess "meta-knowledge" about the perceived levels of knowledge on different topics of dozens or even hundreds of persons within their social and professional networks. We call this meta-knowledge about others' knowledge an actor's "knowledge network." To model Edge organizations more accurately, we implemented a mechanism by which actors could attempt to get exceptions resolved through their knowledge networks, rather than just relying on persons above them in the project hierarchy.

Like VDT, POW-ER can model two kinds of exceptions: *functional exceptions* that relate to the technical area or discipline of the task being worked on, and *project exceptions* that relate to interface issues between project subsystems and knowledge areas. In our prototype knowledge network extension to POW-ER, project-related exceptions continue to be sent up the project organization hierarchy for resolution. However, when confronted by an exception related to a particular functional area, an actor will attempt to pass the exception to the most highly skilled peer in its knowledge network for resolution.

Each actor's knowledge network encapsulates that actor's perception of the skills of its peers, which may or may not reflect each peer's actual capabilities. The higher the skill level of the actor to whom the exception is referred, the better the quality outcome of the task will be. The outcome of a task is thus directly related to the accuracy of the responsible actor's perception of peers' skills, since actors with more accurate knowledge networks will more frequently route their exceptions to actors who actually have high skills. Based on the quality of the response received to the exception request, an actor will update its knowledge network over time. Hence, the longer an actor works in an organization, the more accurate its knowledge network becomes. Workers new to the project team will have limited and potentially quite inaccurate knowledge networks. This is the reason that discontinuous participation in organizations can incur substantial costs in terms of reduced quality and schedule delay due to misrouting of exceptions.

Our knowledge network proof of concept prototype was able to demonstrate this kind of performance penalty for organizations that had significant discontinuity of participants across project phases. We plan to extend and refine this initial knowledge network prototype in our ongoing research.

Trust Effects

There is a large volume of social science literature in fields ranging from social psychology through economics and organization theory on trust and its importance to the performance of organizations of all kinds. Trust is central to our understanding of coordination within organizations. Economic, organizational, and sociological theory have long recognized trust as the most efficient mechanism for governing transactions (e.g., Arrow, 1974), and as essential for the stability of social relationships (Blau, 1964). Trust significantly improves cooperation and coordination within organizations, as well as overall effectiveness (e.g., Fukuyama, 1995). Not all social systems, however, require the same amount of trust (Zucker, 1986). Organizations that rely on a high level of interdependence and that involve a high number of exchanges among constituents require higher levels of trust. Organizations that are as multi-disciplinary and multi-cultural as Edge organizations tend to be, rely heavily on frequent, real-time interactions, and thus require high levels of trust. Consequently, trust is more important than it is in other, less interdependent organizations (Gavrieli and Scott, 2005).

Together with Dr. Roxanne Zolin of the Naval Postgraduate School, we have developed a simple proof of concept prototype in POW-ER to explore the feasibility of beginning to model trust in a computational simulation framework based on information-processing approaches. In this model, the level of trust between two actors is based on their similarities in culture, and organization, role within the project team and overlapping skill sets. Based on the level of trust between two actors, a communication from one actor to the other will be assigned a higher or lower priority in the in-basket of the receiving actor. With just this one simple extension, we can already begin to see the impact on organizational performance of higher or lower levels of trust between the actors on the team. If we integrate this with the knowledge network extensions described above, the effect is amplified. When a request for exception handling is sent by an actor to a perceived expert in its knowledge network, if the receiving actor has low trust for the sender, the request will be assigned a relatively low priority. This makes the communication less likely to be answered before it "times out" in that actor's in-basket and is discarded. The sending actor will thus have no chance to update its knowledge network to better reflect the receiving actor's skill set, increasing the likelihood of misrouted exceptions in the future.

These extensions have not yet been extensively validated either against theory or empirical data. Ongoing research by Dr. Zolin will attempt to calibrate and validate this set of extensions. In our ongoing POW-ER research, we will be attempting to model and simulate several other micro-behaviors specified by Scott and

Gavrieli that can affect the level of trust between actors, to predict the consequences of higher or lower levels of trust between team members on the performance outcomes of Edge organizations.

Knowledge-Driven Simulation in POW-ER

The extensions described in the previous section are able to represent many of the static aspects of Edge organizations. This section discusses our ongoing research into the dynamic flow of information and knowledge between actors within these organizations. Conceptually, we view knowledge as information combined with experience that enables action. Based on *transactive memory* theory (Wegner, 1987), we will define new micro-behaviors that will allow the simulated actors to act upon their accumulated knowledge of the operational environment, gaining skill and experience in the process.

This enhanced version of the POW-ER simulation engine is intended to support models representing tens to hundreds of individuals and/or teams, located in one or more geographic areas, and potentially engaged in several missions simultaneously. It will be able to model a variety of communications technologies and information systems, such as radio communication, text-based messaging, email, video conferencing, databases, etc.

Modeling Information

We need to represent a variety of different types of information, covering concepts as simple as a notification that a particular task has been performed, or as complex as a detailed plan of action. No attempt is made to represent the semantic content of the information, instead information is viewed as abstract concepts, which have some level of certainty, and may or may not be relevant to the interests of a given actor.

Each abstract piece of information can be thought of as a *fact* that can be stored, retrieved, and/or communicated. A fact is associated with one or more skill categories that determine the domains to which it will be relevant. Facts can be stored and retrieved through simulated interaction with abstract *information resources* that are used to model databases and other forms of information systems. Actors also act as information resources, facts are passed between actors through use of simulated communication tools.

A set of micro-behaviors is used to determine how an actor handles incoming facts. If the fact is not relevant to one or more of the skills possessed by the actor, it is simply ignored. If it is relevant, and the actor is not already aware of the fact, the actor determines a certainty that the fact is correct based upon the source's supplied certainty, and an assessment of the reliability of the source. The actor then forms a *belief* about the fact. If the actor has previously formed a belief about the fact, it will be adjusted to be more or less certain based upon the reliability of the newly received information. An actor can only retain a limited number of beliefs at a given time, and will retain those beliefs that belong to its high skill areas longer than those beliefs that do not. Additional micro-behaviors determine whether an actor will communicate newly formed beliefs to other actors in its knowledge network, and/or store it in an information system.

Adding Knowledge-Based Concepts to the VDT Simulation Model

An actor develops a set of beliefs as the simulation progresses. This set of beliefs, combined with the actor's skills and experience, form its *knowledge* of the operational environment. This model of knowledge is combined with the existing VDT simulation model, to create a new knowledge-driven simulation model.

The "missing piece" in the VDT simulation model is the implicit propagation of task completion information through the successor links that establish the task network. By making this task completion information explicit, an actor may only take action on implementing a task when notified through explicit communication that each of the prerequisite tasks has been completed. Once this task completion information is made explicit, it is also possible to introduce other forms of information which are not directly related to tasks. This allows tasks to be triggered by both the existing successor relations, and by the introduction of new information into the simulation environment.

Each task has an associated set of prerequisite facts, which must be known by the assigned actor with designated levels of certainty before work can be initiated on the task. Prerequisite facts can be defined implicitly using task successor relationships; they can also be defined as explicit task properties. When work begins on a task, the assigned actor will communicate a task *start* fact to the actors assigned to any successor tasks. After completion of the necessary work volume or duration, the actor will communicate a task *finish* fact to the actors assigned to its successor tasks. A task may also establish one or more explicit facts while being processed, these have a certainty that is a function of the assigned actor's skill and its certainty of the prerequisite facts. Several tasks may establish the same fact, allowing for simulated redundant and/or request-driven information processing activities.

Analysis of Simulation Results

The VDT model allows for direct tracking of task start and finish times, direct and indirect work volumes, and various quality metrics based on the rate of exceptions and associated decisions. The enhanced POW-ER simulation engine will add the capability to track the flow of information within the organization. By tracking the uncertainty of facts as they pass between actors, it can provide metrics that measure the ability of the organization to reject uncertain or irrelevant information, and act quickly on confirmed information when it becomes available.

Conclusion and Next Steps

The POW-ER platform has proven to be a robust, easily extensible follow-on to VDT. The Python programming language has also proven to be a good choice for developing this type of modeling and simulation platform. We have implemented a number of static and dynamic proof-of-concept extensions that show the ease with which significant changes can be made by subclassing a few key components of the system.

The proof-of-concept extensions require further validation and refinement. Part of this effort will involve case studies of command and control scenarios, including ethnographic research. We be making further enhancements to the actor trust model, based on the work of Gavrieli and Scott (2005). Development will continue on the knowledge-driven simulation engine, which will provide the critical capabilities needed to model and analyze the full range of Edge organization capabilities.

Additionally, we expect to implement the exploratory research by MacKinnon (MacKinnon et al. 2005) which applies proven inventory methods to modeling knowledge. This research attempts to describe knowledge as a set of discrete yet perishable skills, and considers how these perishable skills flow through organizations in response to demand triggered by environmental changes. He hypothesizes that analyzing the stocks and flows of perishable "knowledge inventory" in organizations, analogously to analyzing the flows of perishable physical goods inventory in a supply chain, uncovering useful insights to clarify current understanding and permitting initial quantification of knowledge management impacts on organizational performance.

The resulting system will be used by other researchers affiliated with the Naval Postgraduate School's Center for Edge Power, to further their efforts in examining Edge organizations and related organizational structures. We ultimately seek to supply a robust organization design and planning tool that can be used by the wider C2 community to engage in sophisticated "what-if" analysis of real world situations.

Acknowledgements

This research was primarily funded by the Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD/NII), through its Command & Control Research Program (CCRP), and coordinated by the Naval Postgraduate School's Center for Edge Power. Additional parts of this research were conducted under the auspices of the Stanford University Collaboratory for Research on Global Projects (CRGP).

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