A Quantum Real-Time Metric for NVOs

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INTRODUCTION

Networked and virtual organizations (NVO's) represent a new organizational paradigm, but no effective management solution exists. NVOs are supposed to be dynamically reconfigurable and more effective to manage than traditional organizations, even though the roles embedded within their structures disappear when a project is done. No matter how short-lived, a key opportunity afforded by an NVO is to extract its performance data for better control and also to measure its cultural and technological integration. To capture the essence of such a metric, we review traditional organizations. Whether a real or virtual organization, the central problem remains the lack of a theory of dynamic interdependence generated by social situations as when forming a dyad between two humans alters the cognitions and actions of both. Introduced to solve this central problem, the quantum mathematical model of dynamic social interdependence has recently gained credibility in the field and from a pilot study in the laboratory. Our ultimate aim is to develop a real-time metric to control and optimize NVO performance.

BACKGROUND

A hard problem common to artificial intelligence (AI) and cognitive science is the integration of statics and dynamics in a rational theory that predicts valid outcomes for change and nonchange in real world problems. Game theory was developed by Von Neumann and Morgenstern (1953) with static interdependence to model real problems. However, Bohr's criticism of its lack of dynamic interdependence led them to fret that if Bohr was correct, a rational theory of behavior was "inconceivable" (p. 148). It remains a hard problem to simulate dynamic interdependence in organizational processes such as decision making. So far, the lack of model validation leaves much to be desired (Putnik, Cunha, Sousa, & Avila, 2005), leaving current agent-based models (ABMs) in danger of being considered as "toys" (Macy, 2004).

Our model of computational organizational decision making derives from Bohr's (1955) belief that quantum interdependence models dynamic social interdependence. We developed and tested our model with field research on the decisions of citizen advisory boards (CABs), addressing legacy nuclear waste cleanup programs for the U.S. Department of Energy (DOE). Our first investigations centered on CABs at DOE's consensus-ruled Hanford facility (Richland, Washington) and majority-ruled Savannah River Site (Aiken, South Carolina). The assumption in traditional studies of consensus that self-reports of behavior are sufficient allows DOE operations in the field to be ignored (e.g., Bradbury, Branch, & Malone, 2003). Counterintuitively, we proposed that CAB decisions affect operations at DOE facilities (Lawless, Bergman, & Feltovich, 2005). Using Bohr's ideas, we found trade-offs in uncertainties between cooperation from consensus seeking and competition from majority rule. Consensus rule dampens conflict but strengthens risk perceptions, making concrete decisions problematic, producing the gridlock found at Hanford (Lawless & Whitton, 2006). Majority rule enhances conflict within the group but, if moderated, lessens risk perceptions by promoting information processing (Dietz, Ostrom,

& Stern, 2003), accelerating cleanup at the Savannah River Site. Modeling the trade-offs we have discovered in the field has suggested the metric to control NVOs reported here.

Applying Bohr's ideas to artificial models of organizations is a challenge because the uncertainty principle means that a model should be precluded from gathering information about two conjugate state variables simultaneously (e.g., at the atomic level, position and velocity, or energy and time; at the organizational level, planning and execution, or resource effectiveness and time). The uncertainty principle for dynamic interdependent variables means that as the status of one variable is measured, information on the other variable is lost, what we have termed the "measurement problem" (Lawless, Bergman, & Feltovich, 2006a).

Traditional Cognitive Models of Organizations: Extensions to NVOs

The bi-stable nature of interaction among agents may be the best reason for adopting a quantum model of social interaction (the semiotic signs interdependent between actors and observers as they attempt to interpret social reality inside of physical reality; in Putnik et al., 2005, p. 21). Agents can be explained in terms of three interdependent couples—agents are either in an action or observation state, in a normal or excited state, or in a state of influence from one or another culture. Significant information is lost as agents shift between states to produce static cognitive representations (e.g., memory of a sign's meanings). Similarly, measurement in social systems distorts the information gathered. Shafir and LeBoeuf (2002) review evidence that self-reports do not merely reveal experience but construct it. Modern research on self-esteem (Baumeister, 2005) exemplifies information loss. Analyzing over 30 years of research, Baumeister concluded that there is only a weak link between self-esteem and academic or occupational performance, implying that self-reports of behavior do not capture actual behavior (Lawless, Bergman, Louçã, Kriegel, Nicole, & Feltovich, 2006b). Thus, self-esteem can be reconceived as static observations (collected through self-report) that cannot predict agent performance.

Partners generally tend to synchronize language choices (Clark, 1996). But when decisions are linked to survival, disagreements can crystallize into multiple cultures (Ehrlich, 2001). This separation is important to NVOs because insufficient integration among subsystems can become a cultural fracture line under stress. It would be helpful to management and NVO agents if potential and actual cultural divergences could be monitored and controlled in real-time. Since all observations of agents are taken at fixed positions and times, it becomes easy to generate action-observation information couples of disagreement when interdependence is a factor, no matter how fast an NVO reconfigures. For example, in solving a problem in virtual space, a speaker and listeners are differently located in knowledge and structural space, producing different interpretations of ostensibly the same information (Carley, 2002).

The inability of agent reports to fully capture social behavior reflects a fundamental indeterminacy (Glimcher, 2005). Scientists now know that indeterminacy exists not only between atoms but also between neurons. Baumeister's results indicate indeterminacy also occurs in social interactions. Hagoort, Hald, Bastiaansen, and Petersson (2004) reported data to suggest that delays in cognition and action form a lower bound that follows the Heisenberg uncertainty principle as brain waves shift between gamma (e.g., information corresponding to physical reality) and theta waves (grammatical information), 25 ms to 200 ms, respectively. These bounds should be a factor as information and knowledge interact with human agents and as an NVO transitions between problems.

The problem at the individual cognitive-behavioral level can be generalized to organizations. Not only for NVOs (Putnik et al., 2005, p. 9), theory for organizations is very poor. Pfeffer and Fong (2005) argue for a new approach by adopting the principle of the "illusion of well-being" (Taylor & Brown, 1988) to establish the illusion of control. We agree that illusions such as risk perceptions are elemental in organizations, and illusions indirectly support Bohr by assuming that agents select from among multiple interpretations of reality to maintain illusions. But their model cannot explain business restructurings (e.g., Unilever in 2005), why some organizations perform better than others (e.g., GE has outperformed the market vs. the reentry of U.S. Airways into bankruptcy), why mergers and spin-offs occur (Exelon and PSE&G merged, Liberty Mutual is breaking apart), and when illusions like risk perceptions play a part (e.g., GM's flirtation with bankruptcy in 2005 undercut its denials of ineffectiveness). To illustrate the interaction between illusion and reality, in the 2004 presidential election, pretend futures incorrectly predicted a landslide for Kerry while real futures correctly

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