A quantum approach to knowledge fusion and organizational mergers

W.F. Lawless
Paine College
1235 15th Street
Augusta, GA 30901-3182
lawlessw@mail.paine.edu
lawless@itd.nrl.navy.mil

Abstract

Agent mediated knowledge management (AMKM) for multiple agent systems must address the generation of information, *I*, decision-making, the derivation of knowledge, *K*, and their relationship with agent organizations, requiring that trust, cooperation, and competition also be addressed. With the discovery of a group process rate equation, to satisfy these requirements an *ab initio* approach is used for organization formation based on first principles and then linked with *K* fusion and organizational mergers.

Introduction

Supposedly, trust is a function of the cooperation among agents, indicating that competition reduces social welfare, a presumption never validated. According to Wendt (1999), cooperation is inadequate to generate *I* about others to produce trust. Further, the downside of cooperation (e.g., corruption; reductions in computational power; in Lawless & Chandrasekara, 2002) places strict computational limits on the numbers of agents that can cooperate to solve ill-defined problems, *idp*'s (Hannebauer, 2000). In contrast to traditional models, the quantum social model (SQM) suggests that combining competition and cooperation with argumentation produces a robust model of decision-making that increases in computational power with *N* (Lawless, 2001). This is not a new perspective for AI. While cooperation reflects *K*, competition generates *I* by breaking symmetry (e.g., Robocup). What is new is that an analytical approach for decision-making and group formation can be extended to *K* fusion and organizational mergers.

The primary weakness in traditional rational theory, exemplified by game theory, is that uncertainty for action and observation in the interaction is treated independently (Von Neumann & Morgenstern, 1953, pp. 147-8). To overcome it requires bistable interdependence (Lawless et al., 2000) between uncertainty in action *I*, Δa (where $I = -\sum p(x) \log_2 p(x)$, and *I* flow $= a = \Delta I/\Delta t$), and *I* uncertainty, ΔI, to give

$$\Delta a \Delta I \geq c \qquad (1)$$

Since *c* is unknown, boundary conditions are necessary to solve (1). As $\Delta a \to 0$, $\Delta I \to \infty$, implying that observational *I* by self-observers becomes unbounded as skills are maximized. Alternatively, to process *I* and choose the optimal action for an *idp* requires orthogonal differences between entangled groups, like Republicans and Democrats after the last presidential election, to create tension sufficient for emotional responding in order to convert *I* into *K* yet insufficient to precipitate violence (Lawless, 2001). Our previous research indicates that, compared to consensus processes, emotions generated during decision-making if managed are associated with better decisions, more trust, and less conflict at local and national levels (Lawless & Schwartz, 2002). (For the inverse case, as $\Delta I \to 0$ to form ideology or strong beliefs, $\Delta a \to \infty$; see Lawless et al., 2000).

Conversely, maximum deception occurs when deceivers cooperate with opponents to reduce emotional responses to their politics. To maintain power with deception, dictators block *I* flow.

Once severed, however, entangled interactions render accounts into individual histories that cannot recreate the interaction (from Zeilinger, 1999), explaining the lack of validity with self-reports in social science (Eagly & Chaiken, 1993), making the intent of agents uncertain (e.g., Wendt, 1999, p. 360). One approach to detecting intent is to study a group's reactance to *I* change (Brehm, 1966), analogous to inertia, revising (1) to time, Δt, and energy uncertainty, ΔE (Lawless et al., 2000):

$$\Delta a \Delta I = \Delta (\Delta I/\Delta t) \bullet \Delta t/\Delta t \bullet \Delta I = j \bullet \Delta (\Delta I/\Delta t)^2 \bullet \Delta t = \Delta t \Delta E \geq c \qquad (2)$$

Equation (2) predicts that as time uncertainty goes to zero, *E* becomes unbounded (e.g., big courtroom cases or science); inversely, when ΔE goes to zero, time becomes unbounded (e.g., at resonance voice boxes operate a lifetime). Quantizing the interaction results in *E* wells localized around beliefs as set points, accounting for *j*. As increasing *E* levels approach set points, emotions increase, forcing a return to stability.

Axtell (2002) questions the validity of SQM. But his belief that application supervenes validation is a test that game theory has never passed (for strengths and weaknesses of game theory, see Lawless & Chandrasekara, 2002). Several reasons besides Bohr's exist to consider SQM. The brain acts as a quantum I processor, converting photons hitting the retina into usable I (French & Taylor, 1978). Unlike the continuous model of traditional signal detection theory (i.e., ROC curves), the Bèkèsy-Stevens quanta model is based on detecting discrete stimulus differences from background, producing a linear relationship between threshold and saturation (Luce, 1997). The dichotomous choices in decision making have been quantized (e.g., Eisert et al., 1999). And evidence for the validity of (2) comes from Penrose (Hagan et al., 2002): if the brain is one unit and c Planck's constant, h, then $\Delta E \Delta t = \Delta(h \square/2\pi)\Delta t \geq h/2\pi$ reduces to $\Delta \square \Delta t \geq 1$. Choosing $\square$ for brain gamma waves (≈40 Hz) associated with object awareness gives a reasonable minimum Δt of 25 ms (Crick & Koch, 1998).

SQM has been extended to approximate the function of I density and discrete E effects in an organization from adding or removing members. A group forms or reforms by entangling I from an aggregation of individuals to solve an *idp*, like designing a complex weapon (Ambrose, 2001). The chief characteristic of an *idp* is that K concepts do not correspond to objects or actions in reality, R. Once solved, however, an *idp* becomes a well-defined problem, *wdp*, characterized by a correspondence between K, skills and R (Sallach, 2002), and by cooperation and low I density. In the solution of *wdp*'s, individuals function in roles bonded into a stable network oriented by a shared emotional potential E field, E^{PES}, representing function, hierarchy and geo-cultural differences across an organization:

$$E^{PES}(x,y) = min_{z,R\text{-}org} E^{TOT}(x,y,z,R_{org}) \qquad (3)$$

A recruit moves across the E surface, R_{org}, where E^{TOT} is the ground state and PES the minimum total E along the z coordinate of the organizational configuration (hierarchy) until reaching a minima. Its growth rate for different processes, P, like diffusing or adsorbing recruits, gives

$$\square_P = n_A n_B \, a \, \square_{AB} \, exp(-\Delta A/k_B T) \qquad (4)$$

where n_A and n_B are the numbers of recruits and leaders; $a = \Delta I/\Delta t$; $\square_{AB}$ is the cross-sectional area, $\square_{\square}$, times the vocal frequency of leaders, $\square_0$, and recruits, $\square$, increasing as language "matches" resonate, giving $\square_{\square} (\square^4/(\square^2 - \square_0^2)^2))$; and with k_B as Boltzman's constant and T emotional temperature ($T = \partial E/\partial I$), $exp(\bullet)$ becomes the probability for interaction, decreasing with the increasing free E required, ΔA, increasing for rising T.

Once a bond forms between two members, A and B, the ground E state of the group is less than the aggregate of its members, the difference being the binding E, W, calculated from the configuration of barriers and nearest and next-nearest neighbors. The E required to reverse the process and break apart the group becomes $\Delta A + W$. Assuming that two recruits (A) bind to one another and to one leader (B), the Hamiltonian consists of a site contribution, H_0, plus an interaction term, H_{int} (for details, see Lawless & Chandrasekara, 2002).

As an aggregate of individuals with independent sets of beliefs begins to interact, arousal first increases then reduces over time to a joint E ground state as interactions serve the group and stabilize, forming interdependent emotional fields that orient shared K and skills to correspond with R, the amount of effort (training) determining E well-depth. Effort expended to convert I into K, and to recruit, indoctrinate, and train new members departs from resonance.

While physical T has no analog in social systems, assuming that T is the average activation experienced in a social I field (emotion), T affects the strength, $f(E)$, of an interaction structure, becoming $f(E) = 1/(1 + exp(-2E/k_B T))$; as T drops, interaction structures become more reactant to I change. Baseline T or minimum E occurs at resonance, the point of greatest cooperation between agents (see Lawless, 2001). Conversely, as emotion T increases, I becomes random (increases), causing organizational bonds to dissipate, illustrating creative destruction (Schumpeter, 1989).

The USS Vincennes engaged in battle with Iranian gunboats in 1988 inadvertently shot down an Iranian Airbus (www.crashdatabase.com), but also illustrating that the danger of central decision-making is the belief that there always exists a single rational decision superior to a democratic solution (Benardete, 2002). That is why democratic decision-making minimizes operational mistakes when orthogonal arguments are used to generate I (alternatives) by strengthening opposing arguments until neutral decision-makers reach an optimum decision or K (Lawless & Schwartz, 2002). But to fuse data into K requires a T sufficient for neutrals to process the argument, but not so high as to impair the interaction. The speculation is that the acquisition by neutrals of the concept being forwarded by one of the discussants followed by the reverse perception from the second discussant helps to capture the essence of a problem, and that a certain number of concept reversals are required to decide on the solution path, measuring the degree of the problem and the E required to achieve K fusion.

Andrade and Stafford (1999) noted that mergers from an excess of profit can reduce social welfare (e.g., gaining price control across a market) and promote organizational fragmentation. Senator R. Shelby, Republican, recently criticized the fragmentation between intelligence agencies: "We've made some adjustments, but the cultures have not changed between all the intelligence agencies making up the community. I don't believe they're sharing information. There's no fusion, central place yet to do it" (www.cbsnews.com/sections/ftn). Similar to optimum decision-making or K fusion, reducing fragmentation in an organization requires a rise in T to break barriers between groups.

In contrast, mergers for survival occur in a consolidating market (e.g., the loss of purchasing power across a market sector); they are highly threatening, spontaneously causing a rise in *T*, but also reducing the likelihood of cultural clashes; e.g., in past merger plans between AOL Time Warner's CNN and Walt Disney's ABC News (www.latimes.com), internal conflicts over star anchors and content control derailed merger talks meant to help both compete against Fox News; however, as the plunge in advertising revenue exacerbated, merger talks resumed. Mergers based on survival are strikingly similar to slime molds and ants when their environments are threatened (Nicolis & Prigogine, 1989, pp. 33 and 236).

Conclusion

SQM offers the possibility that an analytical model that simulates the conjugate aspects of decision-making, *I* generation, and organizational growth may also simulate *K* fusion and organizational mergers. The major discovery with SQM is the existence of interaction cross-sections, suggesting new areas for future research. But SQM also accounts for differences between an aggregation and a group constituted of the same individuals, succeeding where game theory has failed (Luce & Raiffa, 1967); it explains why traditional models based on the individual perspective of rationality fail (Levine & Moreland, 1998), why ABM's cannot be validated (Bankes, 2002), and why traditional perspectives of cooperation are normative (Gmytrasiewicz, 2002), rather than scientific. Finally, with SQM it becomes possible to speculate that during negotiations as foreseen by Nash (1950) and others but only when driven by competition, cooperation harnesses competition to solve *idp*'s by precluding convergence (unlike machine intelliqence) until after orthogonal arguments have been sufficient to promote optimal mergers of organizations or the production and fusion of *K*.

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