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A Normative, Simulation-Based Approach to Evaluating the Contribution of Conflict-Management Mechanisms to Groupware Effectiveness

Richard Burkhard and Thomas Horan
School of Information Science, Claremont Graduate University, 130 E. Ninth St., Claremont, CA 91711, USA

ABSTRACT
This paper discusses the results of a simulation-based evaluation of an information system that implements mechanisms for conflict management. Three concept areas are addressed in the study. First, the study simulates a groupware information system that incorporates a functions based on research in organizational Emotional Intelligence (EI). Second, the simulation assesses performance and cost relationships of the enhanced groupware using a normative methodology for economic evaluation of information systems. Finally, differences in performance within and between two groupware-mediated teams, a standard project team and an integrated project team, are modeled. The results suggest that the groupware-based performance shift can bring about significant cost savings, if other conditions are held equal. Limitations and directions for further study are discussed.

INTRODUCTION
This paper presents results of a study that forms a component of research addressing a central question: Can Information Systems effectively incorporate conflict management tools such as Emotional Intelligence (EI)? In this study, we use simulation as an exploratory modeling, analytical and estimation tool, which in turn allows us to estimate the economic utility of adding EI to project management groupware. Groupware presents a special opportunity to introduce soft management functions because groupware increasingly serves as a focal point and channel of interaction between group members (Power 2003). The simulation follows the "computational experiment" model described by Bankes and Gillogly (1994) by conducting exploratory evaluation of a model of information system performance that uses groupware to introduce and reinforce an empirically validated performance shift. The results offer both a demonstration of concept and a normative valuation of an information system, which in turn has implications for the organizational aspects of the Productivity Paradox.

The questions addressed by this study are:

1. How will the introduction of conflict-management functions to groupware affect group efficiency?
2. How will such enhanced groupware affect the efficiency of alternative team configurations?
3. Can groupware-facilitated interactions be simulated in a way that sheds light on the group performance issues involved?
4. What are the results of applying the simulation as a normative model to estimate the economic value of conflict-reduction mechanisms in groupware?

To pursue these research questions, this study combines several elements. First, we use dynamic simulation to assess groupware-based group performance improvement and conflict-management functions, known as Emotional Intelligence (EI) competencies. An *a priori*, normative, simulation-based approach can provide a useful step in analyzing the potential of such systems prior to system development. We compare the simulated performance improvement effect within and between alternative team configurations – a standard configuration and an integrated project team (IPT). Finally, we use simulation to derive estimates of economic value for the groupware-based performance improvement functions.

This paper begins by presenting the rationale for this study in the context of prior research in three areas: Evolved views of the Productivity Paradox in terms of I.S. performance in organizational contexts, the group support system as a platform for introducing Emotional Intelligence, and simulation as a normative evaluation method for information systems. Next, the specifics of the simulation model and simulation cases are presented, followed by the results of the simulation runs. Finally, limitations and conclusions are offered, with directions for further research.

BACKGROUND

The Productivity Paradox in a Socio-Technical Context
The task of finding the true value of information systems has challenged researchers for a number of years. The Productivity Paradox, a concept first introduced in the late 1980s (Ives 1994), derives from a variety of studies that suggest that investments in information technology are associated with negligible increases, or even decreases, in productivity (Brynjolfsson 1993). Subsequent analyses suggest that the Paradox originates in part from the use of inappropriate productivity measures (Ives 1994) or from efforts to detect gains from fully realized improvements in operations (Banker, Kauffman et al. 1990).

However, recent insights into the role of IT in productivity have focused on the role of IT in innovation of business processes and practices, which in turn stem from IT's contribution to such important but difficult-to-measure factors as trust-building and knowledge sharing (Brown and McFarlan 2003). A key concept of our approach is that while simple introduction of information technologies alone may have little effect on productivity, information technology produces real results as "an essential component of a broader system of organizational changes (that) does increase productivity (Brynjolfsson and Hitt 1998)." Following this reasoning, we address the issues underlying the Paradox by examining, via simulation, the direct contribution of improved information technology to organizational interaction and productivity in a defined context. We simulate enhanced groupware that can improve organizational interaction in a new way, thus leveraging the deeper capabilities of IT.

Groupware as a Mechanism for Conflict Management

Information system applications for group support have traditionally been described as decision support systems (DSS), group support systems (GSS), executive information systems (EIS), collaboration information systems (CIS) and related project management systems (Nunamaker, Romero et al. 2001; Power 2003). These systems have benefited from over two decades of research and development and have been deployed and evaluated in a wide variety of management contexts. In spite of the extensive research and development support for group support systems, they have met with mixed experimental success and limited adoption (Nunamaker, Romero et al. 2001). Some group management functions are included in Microsoft's NetMeeting technology (Microsoft 2002), and many other vendors and open-source developers offer similar products.

Conflict management functions are promising candidates for improving the effectiveness of group support systems. The past decade has seen significant management research in organizational Emotional Intelligence, which can be defined as a specific set of competencies in the areas of self-awareness, social awareness, and the skills for managing relationships based on such awareness (Goleman 2000; Cherniss and Goleman 2001). Many studies show a positive relationship between EI and improved managerial effectiveness, and a number of graduate business schools formally incorporate EI training into their management programs (Cherniss and Goleman 2001; Cherniss 2003; Shinn 2003). Such approaches are traditionally considered to be "soft" management techniques.

A number of methods can be employed to raise the EI of groupware users, and this has special implications for group conflict. Because conflict is pervasive and potentially destructive, one of the most important tasks of management should be the minimization of conflict and its harmful effects (Baron 1990). Therefore, a systematic groupware method that addresses the sources of conflict, leverages the positive effects of conflict, and reduces the harmful effects of conflict can make a clear contribution to the satisfaction of team participants, as well as the productivity and effectiveness of team efforts. Such productivity has been measured and economically evaluated in non-groupware environments (Spencer 2001).

Groupware presents a special opportunity to actively introduce and maintain conflict management mechanisms because it serves as a principal channel of interaction between group members. Integration of EI into groupware can lead to diligent application of conflict management techniques in ways that take advantage of groupware's capability to serve as an intelligent buffer. Ordinary training alone has a fade effect (Cherniss, Goleman et al. 1998; Sikstrom 2002), but EI reinforcement mechanisms can be incorporated into the groupware feature set, thus providing the reinforcement that is requisite to EI effectiveness (Cherniss, Goleman et al. 1998).

Simulation as an Evaluation Platform

Simulation allows detailed research into the performance of proposed or existing systems such as the groupware enhanced with EI by modeling the behavior of key processes and entities of those systems (Kelton, Sadowski et al. 2004). In theory, this simulation can be performed with considerable precision, depending on validity of the assumptions and statistical patterns that are incorporated into the simulation models. Computer simulation is particularly useful in modeling complex interactions that include both behavioral and technological components such as those in the Groupware/EI. The tool used in this study is Rockwell Arena, which is based on the SIMAN simulation programming language.[1]

This approach allows us to perform detailed sensitivity analyses of various scenarios relevant to our research, such as the potential response of the Groupware/EI to activation of the EI functions that can be designed into groupware applications. In addition, the dynamic behavior of the Groupware/EI can be modeled and predicted based on the random, or stochastic inputs that are seen in processes that include human behavior and other natural phenomena as inputs. Animated, visual displays of the system in action provide compelling ways to view the performance of the system and are useful in training managers and users in the overall function of the system (Repenning, Ioannidou et al. 2000). Detailed reports are generated about most aspects of system performance, which in turn can be subjected to statistical analysis.

In this case, we use simulation as an exploratory modeling and estimation tool, according the approach described by Bankes and Gillogly (Bankes and Gillogly 1994):

In the process of constructing a computer model of such a system, some number of "guesses" must be made. Running such a model is a computational experiment that reveals how the system would behave if those guesses were correct. Such computational experiments, whose outputs cannot be regarded as predictions, can be used to examine ranges of possible outcomes, to suggest hypotheses to explain puzzling data, to discover significant phases, classes, or thresholds among the ensemble of plausible models, or to support reasoning based on an analysis of risks, opportunities, or scenarios.

Our approach implements these recommendations by examining the thresholds and trends of increased productivity in teams using groupware that is enhanced with EI functions.

A frequent approach to modeling complex systems involves building the simulation model from simple, known subsystems or processes (Richardson 2003). Several additional studies illustrate methods that help illustrate the applicability of such model-building to normative economic analysis. For example, simulation requires construction of one or more models that represent the system of interest using process nodes and various functions defined to reflect key factors in the "real" system. In this sense, dynamic simulation is based on model adequacy, and a great number of models have been employed in normative evaluation. One example of such model construction is a static model (not dynamic as in the model constructed in this study) based on judgmental assignment of several coefficients: Relative "importance" of business functions, asset interrelation (dependency) identification, threat and vulnerability assessment (Suh and Han 2003). Dynamic simulations have the added benefit of capture and estimation of nonlinear behaviors of the kind that may be expected in the Groupware/EI under study (Bankes and Gillogly 1994).

The Economic Value of EI

A central question for this study concerns the evaluation of the added economic value of including EI functions in Groupware applications. The variable for EI that is implemented in this study is based on extensive empirical work in measurement of the productivity increases that occur as a result of EI training. This stream of research produced a number of studies of a wide range of work environments, that demonstrate a 44-67% increase in productivity from EI training of the type recommended in non-GSS environment (Spencer 2001). This confirmed increase in productivity is the primary empirical link for this otherwise exploratory normative simulation.

METHOD: THE NORMATIVE SIMULATION MODEL

The simulated system is based on a typical groupware application environment: A technology development and production cycle environment that includes project management, design management and production management. These functional elements are a generalized form of the structure that might be found in a large, program-based development and production environment such as might be found in a variety of high-tech industries. The hypothetical environment includes Program or Project managers (4 processes), Design Engineers or Engineering Management (4), Production Managers (4), Random distribution modules, Loopback functions, Project Information Item generators, and various counters and performance measuring modules. This arrangement allows alternative combinations of behavioral and technological components to be simulated in detail, and permits random interprocess interaction effects to take place. These interactions cannot be easily simulated by other methods.

Normative evaluations of information systems should be "based on quantitative analysis of situations in which the IS can be rigorously modeled and the impact of various traits of information on the decision maker's performance can be calculated (Ahituv 1989)." The approach used in this study conforms to this definition in the following ways. First, it is a quantitative analysis in terms of its specification of performance parameters of individual elements, processes, and performance shifts. It is modeled in an exploratory, but reasonable way, and therefore does not seek to be a rigorous reflection of a true environment, but rather to allow rigor in manipulation of the variables of interest. These include the specific traits of decision-maker (or information-user) performance that can be calculated, resulting in a variety of measures of throughput, value added, and the ranges of these values. In addition, this study does not limit the performance measure to the decision maker (or information user), but assumes the reasonableness of extending the performance measure to the overall organization's performance.

The key elements, processes and variables for the simulation are presented below.

1. Design Engineers / Engineering Management processes: These four modules are assigned a processing sequence with an initial triangular continuous distribution: Mode - 1 hour, minimum - 0.5 hour, maximum, 1.5 hours.
2. Program / Project Management processes: Four modules, performance parameters as in 1, above.
3. Production management processes: Four modules, performance parameters as in 1, above.
4. Integrated Project Team process: A single module is assigned a processing sequence with an initial triangular continuous distribution that reflects the arithmetic sum of the three separate processes it replaces: Mode - 3 hours, minimum - 1.5 hour, maximum, 4.5 hours.
5. Project Information Item generators: 100 project information items are generated according to an exponential distribution typical of arrival times: Mean of 2 hours.
6. Loopback functions: Three loopback mechanisms send a randomly chosen 20-25% of project information items.
7. Randomizers: Project information items are randomly assigned to individual members within the project groups.

Relationship to Four Key Attributes of Information Valuation

The methodology of this study also addresses several key characteristics of information valuation adequacy as defined by Ahituv (Ahituv 1989). These include the appropriate timing of the measures, the contents of the system being measures, the format of the interface, and the cost assignment to the measures. The implementation of these concepts in this study is presented.

EI Performance Shift Variables

In keeping with the 44-67% performance improvement seen in prior studies (Spencer 2001), this study uses a midrange figure of 50% as a working variable for the groupware-based simulation, implemented as a corresponding reduction in modes and extremes of processing times. In order to study the effects of this shift, the performance increase was applied in three stages: First, to the Program Management Team, then to the Program Management and Development Teams, and finally to all three teams.

Table 1. Critical Attributes of Information Valuation

Attribute (Ahituv 1989)	Approach in This Study
Timeliness	Measure total throughput of project deliverables over time.
Contents	Accuracy of contents modeled via loopback function – i.e., inaccuracies lead to repeated review and modification.
Format of Interface	Beyond the scope of this model
Cost	Assume employee time as true variable cost; Measure calculates employee time x employee rate.

Alternative IPT Project Team Variables

An alternative project configuration was constructed and tested for comparison purposes. The popular Integrated Project Team method was simulated as a parallel group with identical task inputs and the identical number of employees as the first configuration. However, the assumption is that the IPT members can flexibly interoperate on all project tasks and the inter-team queuing times are eliminated. The modal activity durations for the IPT are the arithmetic sum of the three separate processes they replace.

Conceptual Views of the Simulated System

Figure 1 (below) shows the role of the Groupware (GSS) within the closed system.

Figure 2 depicts the IPT (Integrated Project Team) alternative organizational structure.

Figure 3 shows the simulation configuration (screenshot).

RESULTS

The results shown below represent an average of five runs for each of the case conditions, which are the base cases for the separate team configuration and integrated project team configuration, followed by the addition of the groupware-based EI productivity shift to each separate team in additive sequence, and finally the productivity shift added to the IPT. Specifically:

Figure 1.

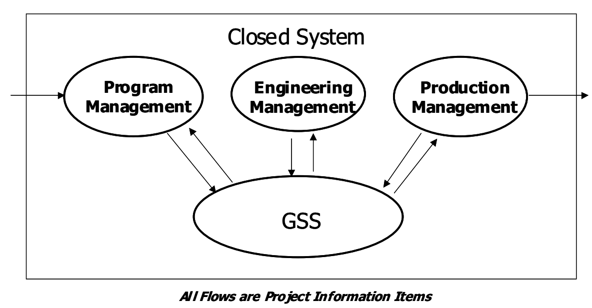


Figure 2.

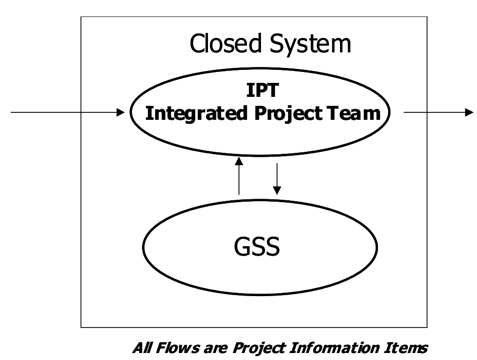
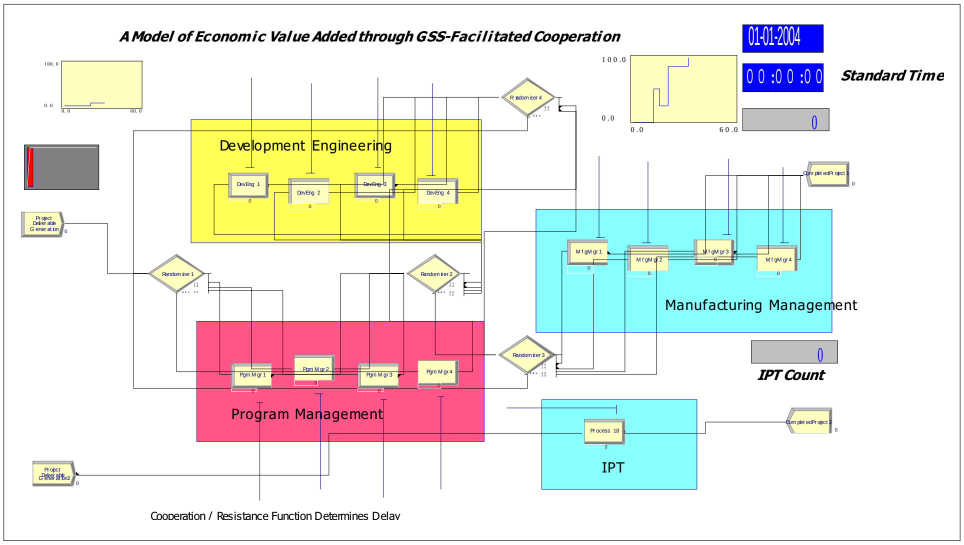


Figure 3.



of information systems presents a number of "severe research and technical problems" as defined by Ahituv (Ahituv 1989). Our approach to these limitations is presented in the Table 3.

A second area of limitation stems from our use of an externally-derived base coefficient of improvement for the groupware-implemented EI functions. Although this study applies this coefficient in new and complex simulated models that offer useful insights, it is clear that improved calibration of the model should be based on empirical investigation of the performance of a variety of actual EI functions implemented in groupware. These issues will be addressed in future research planned by the authors.

Table 2.Table of Results

Case	Condition	Total Time, H	Cost at $2.4K*H^{-1}$, $
Case 1	No EI	543.43	1304232
Case 2	EI All Program Mgt	487.87	1170888
Case 3	EI Pgm + Eng	384.38	922512
Case 4	EI All Groups	344.76	827424

Case	Condition	Total Time, H	Cost at $2.4K*H^{-1}$, $
Case 6	IPT No EI	312.12	749088
Case 7	IPT EI	266.41	639384

- Case 1 simulates the standard team without EI functions
- Case 2 simulates the standard team with EI functions added to Program Management
- Case 3 simulates the standard team with EI functions added to Program Management and Engineering
- Case 4 simulates the standard team with EI functions added to all groups
- Case 6 simulates the Integrated Project Team without EI functions
- Case 7 simulates the IPT with EI functions

The costs are calculated on a $200 per hour basis for each individual on all teams. The IPT contains the identical number of staff members as the standard configuration — only the team structure and loopbacks are changed.

As shown in the table of results, the groupware-based EI productivity shift decreases throughput time significantly within the standard configuration, although not in a purely linear relationship. These findings confirm the expected result that the introduction of EI-based productivity will decrease total time and costs in the EI-groupware facilitated teams. An additional finding is that the IPT configuration is more efficient at the outset than the standard configuration, but the EI productivity shift has far less of an impact in the IPT configuration than in the standard configuration. Future research will examine the differential in EI-based efficiency gains between the standard and IPT cases.

LIMITATIONS

Although simulation can be highly useful in exploration of value relationships between information systems and their users, it is also clear that the use of simulation as a normative tool for economic evaluation

CONCLUSION

This paper discussed the results of a simulation-based evaluation of an information system that implements mechanisms for conflict management. The simulation modeled groupware that implements functions based on research in organizational Emotional Intelligence.

This study was unique in several ways: It employed dynamic simulation to assess performance and cost relationships within and between a standard project team and an integrated project team, and it applied the groupware-based EI functions in a stepwise manner within the team configurations. The model was constructed using estimates that serve as a useful basis for exploring various thresholds (Bankes and Gillogly 1994). The results suggest that the groupware-based EI performance shift will bring about significant time and cost savings, if all other conditions are held equal. Future research will address the observed increase in efficiency of the integrated project team relative to the standard configurations, and the decreased EI performance benefit in the integrated project team.

Table 3. Limitations and Recommendations for Simulation in Economic Analysis of IS

Limitation (Ahituv 1989)	Approach used in This Study
All components and machine-user interactions should be modeled in detail.	The model is simplified and considered as a closed system. Many specified components are modeled in detail, but machine-user interactions are beyond the intended resolution of this exploratory simulation.
Simulations are difficult to calibrate.	Three factors allow reasonable calibration of the model: Reasonable, face-valid estimates are used for all functions (per Bankes et al, 1994). Performance (throughput) increases are based on empirical studies (per Spencer, 2001). Further calibration could only be possible through modeling a real system using real performance data.
Model complexity leads to difficulty in analysis.	A particular strength of the approach of dynamic simulation is the ability to capture and model complex, dynamic behaviors and interactions with statistical distributions defined at submodule levels.

This study has implications for both research and practice in information systems. First, the study provides a unique demonstration of simulation as a normative evaluation technique for groupware-based interactions. In addition, the study extends prior research in group support systems, organizational conflict, and emotional intelligence, and combines these elements in a new way, providing additional evidence to support the case for applied research in which EI elements are designed into groupware applications. In addition, the research forms an initial look into the practical potential of enhancing groupware applications with soft management tools.

In spite of the known limitations of this approach, this study confirms that simulation of this type can provide useful insights in evaluation of groupware in organizational environments. The results have both quantitative and illustrative value. Further study is planned by the authors to refine the information system groupware interaction model and to evaluate a greater variety of possible interactions in the enhanced groupware environment.

REFERENCES

Ahituv, N. (1989). Assessing the Value of Information: Problems and Approaches. Tenth International Conference on Information Systems, ICIS 89, Boston, MA, Association for Computing Machinery.

Banker, R., R. Kauffman, et al. (1990). “Measuring Gains in Operational Efficiency from Information Technology: A Study of the Positran Deployment at Hardee’s Inc.” Journal of Management Information Systems 7(2): 29-54.

Bankes, S. and J. Gillogly (1994). Validation of Exploratory Modeling. Conference on High Performance Computing, Society for Computer Simulation.

Baron, R. A. (1990). Organizational Conflict - Introduction. Theory and Research in Conflict Management. M. A. Rahim. New York, Praeger Publishers: 1-4.

Brown, J. and F. McFarlan (2003). “Does IT Matter? An HBR Debate (Letter).” Harvard Business Review: 1-17.

Brynjolfsson, E. (1993). “The Productivity Paradox of Information Technology.” Communications of the ACM 36(12): 67-77.

Brynjolfsson, E. and L. Hitt (1998). “Beyond the Productivity Paradox: Computers are the Catalyst for Bigger Changes.” Communications of the ACM 41(8): 49-55.

Cherniss, C. (2003). The Business Case for Emotional Intelligence, The Consortium for Research on Emotional Intelligence in Organizations. 2004.

Cherniss, C. and D. Goleman (2001). The Emotionally Intelligent Workplace: How to select for, measure, and improve emotional intelligence in individuals, groups and organizations. San Francisco, Jossey-Bass.

Cherniss, C., D. Goleman, et al. (1998). Bringing Emotional Intelligence to the Workplace: A Technical Report Issued by the Consortium for Research on Emotional Intelligence in Organizations. Piscataway, NJ, Rutgers University.

Goleman, D. (2000). “Leadership that gets results.” Harvard Business Review(March-April).

Ives, B. (1994). “Editor’s Comments: Probing the Productivity Paradox.” MIS Quarterly 18(2): xxi-xxiv.

Kelton, W. D., R. P. Sadowski, et al. (2004). Simulation with Arena. New York, McGraw Hill.

Microsoft (2002). Microsoft Windows NetMeeting, Microsoft Corporation. 2004.

Nunamaker, J., R. Romero, et al. (2001). “A Framework for Collaboration and Knowledge Management.” Proceedings of the Hawaii International Conference on System Sciences, HICSS34, IEEE.

Power, D. (2003). A Brief History of Decision Support Systems, DSSResources.com.

Repenning, A., A. Ioannidou, et al. (2000). “AgentSheets: End-User Programmable Simulations.” Journal of Artificial Societies and Social Stimulation 3(3).

Richardson, K. A. (2003). On the Limits of Bottom-Up Computer Simulation: Towards a Nonlinear Modeling Culture. 36th Annual Hawaii International Conference on System Sciences (HICSS’03), IEEE Computer Society.

Shinn, S. (2003). “Intelligence at Work: Daniel Goleman looks beyond IQs to determine the emotional qualities that distinguish corporate leaders.” BizEd - Journal of the AACSB International(September/October 2003).

Sikstrom, S. (2002). “Forgetting Curves: implications for connectionist models.” Cognitive Psychology 45(1): 95-152.

Spencer, L. (2001). The Economic Value of Emotional Intelligence Competencies and EIC-Based HR Programs. The Emotionally Intelligent Workplace: How to Select for, Measure, and Improve Emotional Intelligence in Individuals, Groups and Organizations. C. Cherniss, and D. Goleman. San Francisco, Jossey-Bass/Wiley.

Suh, B. and I. Han (2003). “The IS Risk Analysis Based on a Business Model.” Information and Management 41(2): 149-158.

ENDNOTES

[1] Rockwell Automation Software Arena Simulation Program, Milwaukee, WI

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