Universitat Ramon Llull

# DOCTORAL THESIS

Title **OPEN MODELS OF DECISION SUPPORT TOWARDS A FRAMEWORK**

Presented by **STEPHEN DIASIO**

Centre **ESADE BUSINESS SCHOOL**

Department **ECONOMICS, SOCIAL SCIENCES AND METHODS**

Supervisors **DR. NÚRIA AGELL**

**ABSTRACT**

This thesis presents a framework for open models of decision support through a compendium of papers that links research on the inward and outward flows of knowledge to the organization and decision support technologies. The framework presents underlying factors driving new and more open models of decision support. A typology of decision support models is offered considering types of problems organizations and managers charged with decision-making face. Thesis essay #1 suggests a perspective of the changing landscape for decision support technology and the advancement of new technology for open models of decision support. This study provides insight into the role expertise has played in decision support technology application. The investigation sets out to reveal how expertise in supporting decision-making using technology has changed and sheds light on the new role that experts will play in organizational decision-making. It suggests that a significant change in how decision-making is being supported which challenge the traditional role of experts and non-experts. Finally, this paper explores opportunities for decision support technology integration and the added benefits artificial intelligence can bring to collective intelligence tools.

Thesis essay #2 investigates the ‘aggregate’ typology within the open model decision support framework. A forecasting problem is used to highlight the complexity of demand forecasting in supply-chain management within the film industry and how technology is leveraged for effective supply-chain management decisions. The investigation compares two decision support technologies: expert systems and collective intelligence tools and illustrates how the film industry uses each in forecasting box-office revenue. Finally, this essay explores the combined benefits in integrating each support technology for more accurate forecasting.

Thesis essay #3 is a longitudinal study over a 10 year period that uses IBM Innovation Jams as a context for large-scale collaboration within the ‘platform’

typology. This essay investigates the role of innovation jams on organizational change as IBM learned to engage with a new model of organizing innovation. It describes the role innovation jams have played in shaping the practice of open innovation at IBM. This essay uses the musical genre of a “jamband” as a metaphor to describe the emergent development and use of innovation jams as a way to understand organizational change. This longitudinal study brings innovation jam research up-to-date and presents innovation jams as they evolved from a concept, a management tool, and service. The essay concludes with a discussion on the implications of the findings for theorizing about new models of organizing innovation for organizational change.

Research conducted in this thesis offers a framework of open models of decision support that suggests that the use of internal and external sources of knowledge can be leveraged beyond product or service innovation, to include decision-making supported by emerging technology. Theoretical contributions of this thesis argues that organizations can no longer rely on decision support technology that solely focus on bridging the boundary between rational and non-rational aspects of human social behavior but instead, must consider the larger dynamic organizational network for decision support. Moreover, practical implications of this thesis encourages organizations to think strategically about how emerging technology can support decision making and the resulting decision support models to navigate the complex environment they work in and in turn, to forge stronger links with customers, suppliers, and the wider organizational network.

## TABLE OF CONTENTS

**CHAPTER 1: INTRODUCTION ........ 1**

1.1 INTRODUCTION ........ 1

**CHAPTER 2: OPEN MODELS OF DECISION SUPPORT CONCEPTUAL MAP ... 9**

2.1 STRUCTURAL CONCEPT: ORGANIZATIONS AS A SET OF DECISIONS ........ 10

*2.1.1 Utilization of Knowledge ........ 11*

*2.1.2 Decision Network Value Chain ........ 13*

*2.1.3 Types of Problems ........ 14*

2.2 RELATIONAL PERSPECTIVE: CO-CREATING (DECISIONS) ........ 15

*2.2.1 Tacit Knowledge of the Organizational Network ........ 15*

*2.2.2 Solution Creation through the Decision Network Value Chain ........ 16*

*2.2.3 Diversity of Perspectives and Heuristics ........ 18*

*2.2.4 Collective Intelligence ........ 21*

2.3 TRANSFORMATIVE PERSPECTIVE: OPEN DECISION-MAKING FOR TRANSFORMATION . 25

*2.3.1 Open Innovation ........ 25*

*2.3.2 Integration of knowledge ........ 27*

*2.3.3 Emerging technology ........ 29*

2.4 OPEN MODELS OF DECISION SUPPORT TYPOLOGIES ........ 32

*2.4.1 Aggregate: Summation of knowledge parts for probabilistic outcomes ........ 33*

*2.4.2 Broadcast: Requiring diversity of approaches ........ 35*

*2.4.3 Platform: Sharing a vision in a dynamic social context ........ 37*

*2.4.4 Relating Foundational Concepts and Typologies ........ 40*

**CHAPTER 3: THE EVOLUTION OF EXPERTISE IN DECISION SUPPORT TECHNOLOGIES: A CHALLENGE FOR ORGANIZATION ........ 41**

3.1 INTRODUCTION ........ 42

3.2 TERMS AND CONCEPTS ........ 43

*3.2.1 What is Expertise?* ........ *43*

*3.2.2 Introducing Expertise by means of Technology* ........ *44*

3.3 LEVERAGING EXPERTISE IN DECISION SUPPORT TECHNOLOGY ........ 45

*3.3.1 Expertise in Expert Systems* ........ *45*

*3.3.2 Expertise in Group Decision Support Systems (GDSSs)* ........ *47*

*3.3.3 Expertise in Collective Intelligence Tools* ........ *49*

3.4 ENHANCING DECISION-MAKING AND COLLECTIVE INTELLIGENCE TOOLS ........ 52

3.5 CONCLUSIONS ........ 53

**CHAPTER 4: A KNOWLEDGE REPRESENTATION APPROACH TO BOX-OFFICE FORECASTING: A COMPARISON OF EXPERT SYSTEMS AND COLLECTIVE INTELLIGENCE TOOLS ........ 57**

4.1 INTRODUCTION ........ 58

4.2 STATE OF THE ART: ROLE OF FORECASTING IN SUPPLY-CHAIN MANAGEMENT ........ 61

4.3 INTRODUCING KNOWLEDGE BY MEANS OF DECISION SUPPORT TECHNOLOGY ........ 64

*4.3.1 Leveraging knowledge through expert systems (ES)* ........ *67*

*4.3.2 Leveraging knowledge through collective intelligence tools* ........ *69*

4.4 ATTRIBUTE COMPARISON ........ 72

4.5 APPROACHES TO FORECASTING ........ 76

*4.5.1 Expert System Approach to Forecasting* ........ *76*

*4.5.2 Collective Intelligence Tool Approach to Forecasting* ........ *77*

4.6 REAL TIME DEMAND FORECASTS USING CI TOOLS ........ 79

4.7 DISCUSSION AND FUTURE WORK ........ 81

4.8 CONCLUSIONS AND FUTURE WORK ........ 83

**CHAPTER 5: ELEPHANTS CAN JAM: IBM INNOVATION JAMS FOR ORGANIZATIONAL CHANGE ........ 91**

5.1 INTRODUCTION ........ 92

5.2 MUSIC AS A METAPHOR FOR ORGANIZING ........ 94

5.3 OPEN INNOVATION AND TECHNOLOGY ........ 96

5.4 RELATIONSHIP OF TECHNOLOGY AND ORGANIZATIONAL CHANGE ........ 98

5.5 Method: A Longitudinal Approach .......... 101
*5.5.1 Data Sources* .......... *102*
*5.5.2 Data Analysis* .......... *107*
5.6 Orchestrating Openness .......... 111
*5.6.1 Background* .......... *111*
*5.6.2 IBM's Toolbox for Innovation Jams* .......... *113*
5.7 Innovation Jam Adoption and Mechanisms for Change .......... 114
*5.7.1 Structured approach to sharing* .......... *115*
*5.7.2 Broad management support for participation* .......... *117*
*5.7.3 Feedback for collaboration* .......... *117*
*5.7.4 Segmenting for toolbox development* .......... *119*
*5.7.5 Independent platforms for community building* .......... *120*
*5.7.6 Analytical tools for complexity management* .......... *121*
*5.7.7 Virtualization for cross-boundary engagement* .......... *122*
5.8 Evolution of Innovation Jams: Concept, Tool, and Service .......... 123
*5.8.1 Concept Phase:* .......... *126*
*5.8.2 Tool Phase:* .......... *128*
*5.8.3 Service Phase:* .......... *131*
5.9 Limitations and Future Research .......... 134
5.10 Implications and Conclusions .......... 136

**CHAPTER 6: CONCLUSIONS, IMPLICATIONS AND FUTURE RESEARCH ... 147**
6.1 Conclusions .......... 147
6.2 Organizational and Managerial Implications .......... 149
6.3 Future Research .......... 150

**APPENDIX 1: EXISTING LITERATURE RELEVANT TO THE 'BROADCAST' TYPOLOGY .......... 151**

**APPENDIX 2: BIBLIOGRAPHY FOR CHAPTERS 1, 2, AND 6 .......... 152**

**LIST OF FIGURES**

Figure 1.1: Thesis Structure ........................................................................ 6

Figure 2.1: Typology Ring of Open Models of Decision Support ...................... 33

Figure 3.1: Level of Expertise in Systems Design .............................................. 45

Figure 3.2: Evolving Decision Support Technologies Adapted from [26] .......... 51

Figure 4.1: Motion Picture Industry Supply Chain ............................................ 59

Figure 4.2: Poles of Decision Support Technology ........................................... 76

Figure 4.3: CI Tools for Real Time Forecasting in Film Industry Supply-Chain .. 80

Figure 5.1: Data structure ................................................................................ 110

Figure 5.2: IBM Mapping Innovation Jams Platform Integration, Complexity, and Sources of Knowledge ....................................... 124

Figure 5.3: Themecloud of jam forum discussions ......................................... 133

**LIST OF TABLES**

Table 1.1: Articles Prepared During Doctoral Period ....................................... 7

Table 2.1: Aggregate Typology Conditional Characteristics and Application . 34

Table 2.2: Broadcast Typology Conditional Characteristics and Application . 36

Table 2.3: Platform Typology Conditional Characteristics and Application ... 38

Table 2.4: Relating Foundational Concepts and Typologies ........................... 40

Table 4.1: Human and Technological Ways to Represent Knowledge ........... 65

Table 4.2: Types of Knowledge in Expert Systems and Collective Intelligence Tools ........................................................................................ 65

Table 4.3: Attribute Comparisons of Expert Systems and Collective Intelligence Tools ............................................................................ 73

Table 5.1: Chronology and Context of Data Collection ................................ 102

Table 5.2: Details on data collection ........................................................... 106

Table 5.3: Historical perspective of Innovation Jams implemented at IBM . 107

Table 5.4: Representative patterns in locus of innovation jam evolution.... 125

# Chapter 1: Introduction

## 1.1 Introduction

Scholars from many research areas have contributed to the understanding of decision-making; highlighting the complex environment in which policy makers, managers, and individuals face to enact solutions for their problems. This has drawn researchers to explore decision-making on national, organizational, and individual levels to help facilitate effective decision-making. It was Herbert Simon who introduced the organization as a set of decision-making processes in his 1947 book *Administrative Behavior*, which placed decision-making as the central point in administrative activity (Simon, 1976, pp. ix & xxv). Simon's (1976, pp. xxviii) main concern was at the boundary between rational and non-rational aspects of human social behavior. Simon’s contributions are of importance because it represented a shift from the dominant understanding of decision-making as a rational agents (Taylor, 1911) to what Simon and March (1958) describe as agents who are “bounded rationally”.

*“[I]f there were no limits to human rationality administrative theory would be barren. It would consist of the single precept: Always select that alternative, among those available, which will lead to the most complete achievement of your goals. The need for an administrative theory resides in the fact that there are practical limits to human rationality, and that these limits are not static, but depend upon the organizational environment in which the individuals decisions take place. The task of administration is so to design this environment that the individual will approach as close as practicable to rationality (judged in terms of the organization's goals) in his decisions” (Simon, 76, pp. 240).*

Research conducted to understand individual level decision-making has been made with “bounded rationality” in mind, but with deviations from what Simon had proposed. Gerd Gigerenzer (1999) and (2001) with Reinhard Selten have used the study of heuristics to understand rationally as an adopted tool for decision-making rather than the irrational cognitive biases that agents have as Kahneman and Tversky (1973: 1974) assert. These studies on the individual level of decision-making focused the attention of the research community on the importance of the environment in the form of time, information, and uncertainty around the decision maker in an organizational context.

Organizations have made efforts to aid rationally bounded individuals by designing an environment with the adoption of technology that addressed the limitations of individual rationality. Simon’s (1969) design perspective offered ways to relate information technology, a method for organizational design (Simon, 1973) to these limitations. The limitations of human rationality have spurred organizations to adopt a range of technologies to aid managers in the decision-making process. This group of information technologies supports the problem-solving and decision-making processes thus are referred to as decision support technologies and is used to contextualize information and for making information relevant to the task at hand.

Decision support technologies have been applied to a range of decision support processes from medical diagnosis, water treatment, to executive level strategy decisions. Support technologies have been developed to support decision making on the individual and group levels. Research into decision support technologies has emphasized value in supporting decision-making through increased employee productivity and more timely information (Power, 2002), improved decision making effectiveness (Hogue and Watson, 1983), improve communication, source of competitive advantage, and to promote learning. Even with technological advancements in information and communication technology (ICT), artificial intelligence, and inter-face software, decision support technologies limitations have been acknowledged emphasizing the rational perspective and overemphasize decision processes and decision making, while ignoring the social, political and emotional factors of decision making Klein and Methlie (1996: 172-181). The aspect of relevance brings limitations to a false belief in objectivity. According to Winograd and Flores (1986), *"Once a computer system has been installed it is difficult to avoid the assumption that the things it can deal with are the most relevant things for the manager's concern."* This lack of objectivity potentially transfers perceived decision authority from the manager to technology, obscuring responsibility with possible unanticipated effects as a result (Power, 2003).

Even with these limitations identified, research and industry continue to invest time and money into developing the next generation of decision support technology. According to the latest McKinsey Global Survey December 2011 (A rising role for IT) *"executives say their companies still rely upon a mix of data and experience in decision making, although they are increasingly looking to analytical tools for support."*

It is commonly accepted that organizational knowledge and technological approaches have importance in the development, implementation, and use of decision support technologies. Although organizations are already wired with layers of information-gathering technology suggesting technology is now a woven thread within the organization (Zamutto et al., 2007), organizations still find it difficult to deliver the right content to the right people for effective decision making.

The phenomenon of open source software development is an example of how dispersed knowledge has helped influence the democratization of innovation, where knowledge outside the organization has been utilized for development of internal organizational technology and support systems. This is leading to an expanding form of practice where organizations are tapping into a knowledge based previously underutilized. As organizations increase their willingness to experiment with new models to utilize knowledge in their organizational network, leading organizations may become more transparent to the problems they face and to those whom may be willing to provide solutions for these problems. Thus an open model paradigm of decision support assumes emerging technology is enabling organizations to find external sources of knowledge and internal hard to find sources of knowledge to be leveraged within their decision support processes. These sources of knowledge, not conventionally found in existing decision support models, expand an organizations scope of knowledge and problem-solving ability for more strategic ends. This moves decision support from an administrative passive function to a broader strategic role in minimizing risks associated with the decision support process. Success in linking the organizational resources of knowledge and technology lies in knowing where and when each best fits or can be integrated together to address the problems organizations and managers face. This requires the understanding of how decision support opportunities and challenges map to the resources and capabilities of the firm. New capabilities through the use of emerging technology that support new models of collaboration potentially can facilitate increase information sharing, delivering information in real-time, large-scale collaboration, and the growing ubiquity of technology for information and knowledge gathering from untapped areas. It is a challenging mission due to all the data flowing through organizations and important consequences for new models of decision support. This, in turn, requires a more detailed description of the decision models and decision making *'problems'* to which emerging technology are offered as a solution. For this purpose, this thesis presents a framework for categorizing types of open models of decision support and the type of problems faced by organizations that these models address. Research into areas that help understand new forms of decision support that consider the changing technological landscape and the limitations of existing decision support offer opportunities for researchers to contribute with important practical benefits for managers.

This thesis investigates the emerging phenomenon of new models of decision support and proposes a framework and typology of the underlying phenomena. First this thesis discusses the underlying factors that support the suggested framework, and then confers three typologies. The thesis is structured as follows: Essay #1- *'The Evolution of Expertise in Decision Support Technologies: A Challenge to Organizations'* suggests a perspective of the changing landscape for decision support technology and the advancement of new technology for open models of decision support, Essay #2 titled- *'A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence*

*Tools'*, investigates the 'aggregate' typology (the first typology) within the open model decision support framework. I use a forecasting problem within the film industry to illustrate how prediction markets aggregate dispersed knowledge of users for greater forecasting accuracy. For the second topology (broadcast), no systematic research has been conducted as part of this thesis however; research conducted during my doctoral studies has broadly covered aspects of this typology. Existing literature does explore phenomena under this typology, thus an extended reading list in Appendix 1 is offered that would support the 'broadcast' typology. Essay #3 titled- *'Elephants Can Jam: IBM Innovation Jams for Organizational Change'* investigates the context of large-scale collaboration within the 'platform' typology. Research conducted in this thesis has been presented and contributed to several academic communities illustrated in Table 1.1. Although three papers have been selected, all of the papers have contributed to various parts of this thesis. Figure 1.1 highlights the thesis structure.

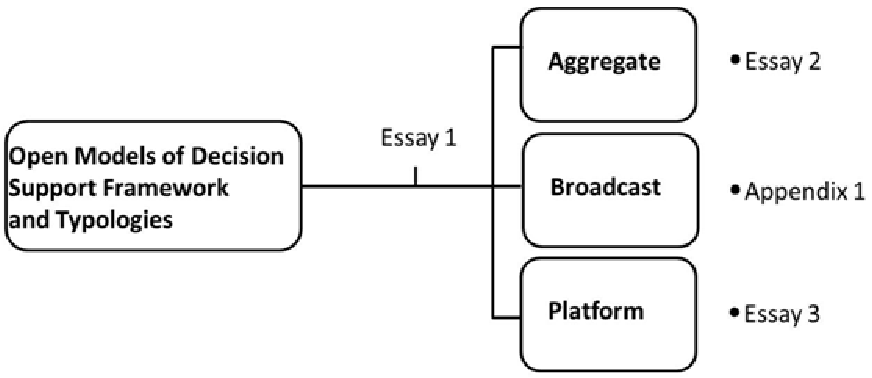


**Figure 1.1:** Thesis Structure

Essay 1 – The Evolution of Expertise in Decision Support Technologies: A Challenge to Organizations
Essay 2 – A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence Tools
Essay 3 – Elephants Can Jam: IBM Innovation Jams for Organizational Change

**Table 1.1:** Articles Prepared During Doctoral Period

| ARTICLES UNDER REVIEW & MANUSCRIPTS PREPARED | TARGETED JOURNAL & SUBMISSION DATE: |
|---|---|
| Diasio, S. and Agell, N. Expertise in Decision Support Technologies: Supporting Collective Decision-making. | *TBD. Under revision* |
| Diasio, S. and Agell, N. Demand Forecasting in the Motion Picture Industry: Expert Systems and Collective Intelligence Tools. | *Under review at journal* |
| Diasio, S. Elephants Can Jam: IBM Innovation Jams for Organizational Change. | *TBD. Under revision* |
| Diasio, S. and Soluki, A. Social Learning Cycle of Open IP management: The Case of CTMM. | *TBD. Under revision* |
| | |
| CONFERENCE PROCEEDINGS | |
| Diasio, S. and Agell, N. An Intermediary's Perspective on Co-creation: Mechanisms for Knowledge Management. | *Proceedings of the 16th Americas Conference on Information System (AMCIS) 2010. Lima, Peru. Track: End-user Information Systems and Knowledge Management.* |
| Diasio, S. and Agell, N. Replanting the Answer Garden: Cultivating Expertise through Decision Support Technology. | *Proceedings of 12th International Conference on Enterprise Information Systems (ICEIS) 2010. Funchal-Madeira, Portugal.* |
| Diasio, S. and Agell, N. IBM Innovation Jams A Mechanism for Change. | *Proceedings of the European Academy of Management (EURAM) 2010. Rome, Italy. Track: ICT enabling Collaboration, Innovation and Knowledge Sharing.* |
| Diasio, S. and Bakici, T. A Process View of Open Innovation. | *Proceedings of the DRUID-DIME (Danish Research Unit for Industrial Dynamics) Academy Winter Conference 2010. Aalborg, Denmark. Conference Theme: Innovation, Knowledge, and Entrepreneurship.* |
| Diasio, S. and Agell, N. Integrating Decision Support Systems: Expert, Group, and Collective Intelligence. | *Proceedings of the International Conference in Artificial Intelligence (IC'AI 09), 554-560, 2009. Las Vegas, Nevada. (27% acceptance rate) Track: Methodologies and Algorithms.* |
| Diasio, S. and Agell, N. The Evolution of Expertise in Decision Support Technologies: A Challenge to Organizations. | *Proceedings of the 13th Computer Supported Cooperative Work in Design Conference (CSCWD' 09), 692-697, 2009. Santiago de Chile. Track: Practice & Experience with Collaborative Systems.* |
| | |
| RESEARCH ONGOING | |
| Diasio, S., Sanchez, G, and Agell. N. A Consensus Approach to Social Networks: Analysis of Innovation Jams. | *Targeted Journal: Social Networks.* |
| Diasio. S. Rugby to Jazz to Jambands: A Metaphor for New Models of Organizing Innovation. | *Targeted Journal: Creativity and Innovation Management.* |
| | |
| TEACHING CASES AND MATERIALS | |
| Diasio, S. and Vanhaverbeke, W. An Open Innovation Approach to IP Management: A Case of Phillips. | *Working Paper.* |

# Chapter 2: Open Models of Decision Support Conceptual Map

In this chapter a general view from a research perspective will consider open models of decision support and its potential benefits in being a source for a competitive advantage for organizational and managerial decision-making. I draw upon existing areas of research to incorporate three foundational concepts that must be established in order drive the overarching framework of this thesis (Alavi and Leidner, 2001; Boisot 1995; 2004, Grant, 1996; Mitzberg and Waters, 1985). These three foundational concepts and the linking sub-concepts will be discussed in detail in this chapter. The three foundational concepts that drive the open models of decision support framework are the following:

- *Structural Concept*: Organizations as a set of decisions in order to create and influence solutions to the problems managers and organization will encounter.
- *Relational Concept*: To co-create decisions and solutions by aligning cognitive capabilities and tacit knowledge to problems for value creation within the organizational network.
- *Transformative Concept*: Leveraging open forms of decision support for transformation to become a more agile organization in the efficient allocation of resources.

The three foundational concepts that drive the open models of decision support framework are detailed in the next subsections. The final subsection will offer a typology of open models of decision support that is necessary to support the three underlying studies within this thesis.

## 2.1 Structural Concept: Organizations as a set of decisions

An abundant amount of organizational and managerial resources are placed into developing and enacting a strategy to meet organizations goals. Thinking of organizations as a set of decisions implies the constant use of knowledge to be able to compete in a specific environment in order to meet organizational goals. These goals are often laid out in mission statements, shareholder reports, and public statements then enacted through projects on the strategic, function, and tactical levels to meet them. Between the process of defining goals and reaching these goals is a series of future decisions or a ‘set of decisions’ to be made that are embedded within the ongoing support of enacting these projects for resource allocation. It is through these ‘set of decisions’ on the allocation of organizational resources that will determine the extent of meeting these goals and impacting the competitiveness of the organization. Since these actions are not taken in isolation, rather within a complex system made up of a variety of actors interacting internally and externally, we view the path for future decisions of allocation of resources to be subsets of knowledge within this system or value chain for the problems managers and organizations must deal with. Thus the ‘set of decisions’ are dependent upon an organizations ability to utilize knowledge found within the complex system, that is contributed by a series of actors that make up the organizational network. It is through the utilization of knowledge using the organizational network that a decision value chain is created for problem-solving of a constantly appearing type of problems. Thus explanations of these sub-concepts are needed.

### *2.1.1 Utilization of Knowledge*

The utilization of knowledge has been linked to the decision making process in research areas such as; organizational learning, management of technology, and managerial cognition (Grant, 1996). Characteristics of its value are tied to its transferability in developing a competitive advantage (Barney, 1986) or by placing ‘specific knowledge’ (Jensen and Meckling, 1992) or ‘knowledge of a particular circumstance’ (Hayak, 1945: 521) to the appropriate decision maker within the organization. This transfer of knowledge or ‘knowledge exchange has been acknowledged on several levels- individual, groups, researchers, organizations in a multi-directional way, with growing evidence that the successful uptake of knowledge requires more than one-way communication, instead requiring genuine interaction among decision makers and other stakeholders (Lavis et al. 2003). This supports Dobbins et al. (2002) argument that diffusion and utilization of knowledge is critical in influencing decision makers. Max Boisot (1995) I-Space framework explores the relationship between how knowledge is structured and how it flows within and between populations of actors. Here Boisot (1995) suggests the way useful knowledge is produced impacts the subsequent way knowledge is diffused and the way knowledge can be transferred. Like Boisot (1995; 2004) where the value of knowledge is on the action systems and can be considered associated to knowledge aligned for the disposition of action (Campbell, 1974).

The seminal work of Alavi and Leidner (2001: 124) connected knowledge and the role information technology can play in by "…actualizing, supporting, augmenting, and reinforcing knowledge processes at a deep level through enhancing their underlying dynamics, scope, timing, and overall synergy." Moreover, Alavi and Leidner (2001) argue for greater research to the widespread use of IT infrastructure that has brought changes to how knowledge is transferred and utilized in addition to its economic value in disseminating knowledge to an ever-broadening of knowledge creators. Paisley (1993) states "digital technologies bring the most significant new communication capabilities to knowledge utilization" (p. 222). Though Paisley (1993) refers to the role technologies were playing in the 1990s in building knowledge utilization capabilities for organizations, "… little is known about matching these media to the dissemination, coordination, technical assistance, and problem solving roles of knowledge utilization programs" (p. 227).

### *2.1.2 Decision Network Value Chain*

The value chain was proposed by Porter (1985) which suggested a series of process carried out by relational actors in the chain. The concept of value added was introduced to understand how a value chain can be utilized to develop an organization's sustainable competitive advantage. All organizations consist of activities that link together to develop the value of the business, and together these activities form the organization's value chain. They can consist of any of the processes and activities that an organization enacts for example, purchasing, logistics, distribution, and manufacturing. The introduction of a decision network value chain name implies the primary focus in decision network value chain is on the benefits that accrue to network members that share information and knowledge to generate value for each of the network members. Knowledge within the decision network value chain may be derived from knowledge spillovers from enacted processes or separate enacted decision or knowledge management processes.

Considering no decision is made in complete isolation, we can consider the decision value chain to be a set of links within a network. These links represent the potential of new information and knowledge on a decision. We can consider the decision network value chain to be a series of relational stakeholders that may have information and knowledge to a problem. Each stakeholder in the decision network value chain provides inputs into the understanding of the problem from their position in the value chain. As each stakeholder offers their insights to the problem with independent information and/or in combination to other stakeholders in the decision network greater insight into the problem emerges that has potential impact on each of decision stakeholder network.

### *2.1.3 Types of Problems*

Types of problems have been viewed from several perspectives linking classifications such as type, class, and order (Shavinina, 2003). Root-Bernstein (1982) has identified up to 10 different types of problems which overlap typologies of innovation problems by Terwiesch and Xu (2008). By classifying problems it becomes possible to link techniques, methods, or models in order to solve them. Although there is a classic model of problem solving that is widely accepted, limitations of its use stretch the boundary of human rationality embedded in the model for different problem types.

Problem types can differ along multiple dimensions, including (a) the amount of uncertainty in the overall pay-out function and hence the solver's ability to predict the outcome of an experiment and (b) the ability of the solver to learn from one experiment to another. For example, Loch et al. (2006) discuss different problem types and their implications for managing the associated risks common with product development problems within the innovation process. When linking problem types to models to facilitate innovation, an innovator choice of problem will impact the type of innovation that will be produced.

The open models of decision support framework focus on problem types from a problem structuring perspective. Viewing problem types from this angle allows for the identifications and matching of the emergent models of decision support in solution providing. We distinguish these problem types by using problem characteristics to help describe problems in which the different emergent models of decision support can support them. Problems considered must be hard or difficult problems where solutions or results may not be predicted. Such problems examples are designing products, curing diseases, and improving educational system.

## 2.2 Relational Perspective: Co-creating (decisions)

This section builds upon the notion of thinking of your organization as a set of decisions by incorporating the various organizational actors available within decision network value chain and relationship between the actors in co-creating decisions. It suggests the decision network value chain is an important source for external tacit knowledge that can bring value to an organization for building a competitive advantage. Next, it is through decision network value chain that co-creating decisions can occur for tacit knowledge to be integrated with the organizational network processes and enacted upon. The relational perspective proposes the value of diversity of perspectives and heuristics provide advantages in co-creating decisions. Finally, the thesis introduces the notion of collective intelligence and how a group can collectively organize for enhanced decision-making capabilities.

### *2.2.1 Tacit Knowledge of the Organizational Network*

If an organization views its business as a set of decisions it can be viewed that the problems organizations face have an element of tacit knowledge or experience involved. This could be seen in the absence of knowledge about the future, or where an organization has yet to experience what the future will hold. We can consider though an organization has not experienced the future, others in the organizational network may provide a link to what the future does hold derived from their tacit knowledge and prior experience.

The ability to include and incorporate the tacit knowledge within the organizational network creates a competitive advantage and a strategic capability. As the tacit knowledge is shared and incorporated it becomes increasingly valuable. This provides a strategic capability that differentiates an organization and the organizational network in the market. When tacit knowledge is shared within the organizational network it provides an opportunity to learn from what others have experienced and becomes a input in the decision making process.

The importance of tacit knowledge has been compared to scarce recourses that are not easily transferable or replicated (Grant, 1996) but have importance to sustainability of an organizations competitive advantage through its application. Quinn (1992) has argued that knowledge- particularly tacit knowledge is the most strategically-important resource in which an organization can possess. By aggregating and collecting tacit knowledge from the decision network value chain, decisions can be made without an organization actually experiencing the context themselves. This allows organizations in the organizational network to utilize decision making as a source of strategic competitiveness and act upon this tacit knowledge found outside the organization.

### *2.2.2 Solution Creation through the Decision Network Value Chain*

Co-creating decisions goes beyond simply sharing knowledge. It is a different approach for an organization as it interacts with the external environment and views all internal sources of knowledge as potential contributors in formulating solutions. It can be seen as part decision-making and part solution building. It enables the opportunity for deeper relationship building within the organization and organizational network. Since the organizational network can be made up of various actors both internal and external to the boundaries of the organization it is important to distinguish which organizational network actors can contributor to co-creation process in creating value an in building a competitive advantage.

Several perspectives have been offered in showing how organizations can create value through co-creation with its organizational network. These have suggested that the consumer, for instance, is becoming the locus of value creation and value extraction (Prahalad and Ramaswamy, 2004), placing the customer at the same level of importance as the organization (Payne, Storbacka and Frow, 2008). These have emphasized a shift in logic from *service-to* customers to *service-with* customers. Here service is understood as an exchange of knowledge and skills between an organization with its customers and its customers with the organization (Vargo and Lusch, 2008a; 2008b).

Research into co-creation has linked customers as quasi-employees because of their potential role of becoming valuable organizational assets in the form of social capital in complementing or in substituting for employee tasks (Novicevic et al. 2011). Though the range of tasks were not defined, the customers contribution in complementing or in substituting existing employees within the organization can be seen as an important step in external knowledge sources application to wider organizational tasks. Extending these tasks, research has linked co-creation to building strategic capital in product development (Kristensson, Gustafsson, and Archer, 2004). For example, Nike used an online platform for idea sharing between the product development team and its future customers (Ramaswamy, 2008). Volvo used co-creation as a method to build a common understanding of its female customers before deciding to bring its XC90 model to the marketplace (Dahlsten, 2004). These studies are important because they illustrated how co-creation can influence decision-making in a strategic task. Even a large organization such as Proctor & Gamble has embraced co-creation by embedding it into its organizational strategy. P&G aims to drive new innovation through collaboration with external partners in at least 50% of cases (Dodgson, Gann, and Salter, 2006). P&G CEO A.G. Lafley has emphasized this by highlighting:

"*I want us to be the absolute best at spotting, developing and leveraging relationships with best-in-class partners in every part of our business.*" (P&G C&D Report, 2003, p. 2)

Having highlighted the value in co-creation in the strategic task of product development with the co-creators being customers, users, or organizational partners, it is realistic this model can be expanded to other problems organizations face. The potential benefits of co-creation should not be limited to customers or users of products and services but seen as a step to align organizational resources to organizational and managerial problems. Considering organizations have problems other than idea shortages for new products and services or market data on a particular targeted audience, but also must find solutions to their problems in operations, strategy, finance, internationally or locally. Co-creation of solutions to problems between an organization and its network provides broader potential benefits and a wider application to the co-creation phenomenon.

### *2.2.3 Diversity of Perspectives and Heuristics*

In section 2.2.2 I discussed how co-creation has been leveraged to link organizations and their organizational network of actors but what is it about these organizational actor that make them valuable to the organization in finding solutions to problems? I turn to consider the problem solver and the cognitive characteristics of the individuals. This is important because not only can the organizational network provide information and knowledge about their preferences about products and services, but also how they cognitively frame problems to solve them.

Research into decision making under uncertainty and limited information have focused on the biased reasoning of the individual- pioneered by Tversky and Kahneman (1974) and has primarily viewed decision making on an individual basis. This has left methods to rectify individual cognitive limitations understudied particularly in large-scale collaborative models. The value of diversity has been viewed in many different ways, thus I restrict looking at cognitive diversity or a set of perspectives and heuristics an individual holds, which we assume are different (Page, 2007). Perspectives are considered ways of seeing solutions or representations of a set of possible solutions (Hong and Page, 2001) and may include multiple mental models of viewing the related objects in an environment (Johnson-Laird, 1983), while heuristics are techniques or ways to construct solutions to a problem and when applied with perspectives clarify problems. Perspectives and heuristics can be seen set of competencies' an organization has available to them within their organization in their organizational network.

Each perspective has knowledge embedded in determining a set of solutions but may not be the exact knowledge needed to solve the difficult problem. When individuals are working together to provide a solution to a problem, these perspectives may complement each other at the limit to where one individual's perspective and embedded knowledge ends and another begins. This has been expressed by Peter Senge (1990) as shared mental models for learning and problem-solving. This has been expressed similarly in the knowledge management literature by Nahapiet & Ghoshal (1998) who suggest that the gradual creation of new knowledge results from the combination and exchange of previously unconnected pieces of existing knowledge. In addition to diverse perspectives complimenting (potentially) each other, diverse perspectives create many possible proposed solutions to any given problem. From here we can begin to see how solutions can be built upon further for a new solution from previous problem solvers.

Next, if we consider diversity of heuristics as sets of tools in the toolbox of a problem solver we can suggest that with more tools available to a problem solver or group of problem solvers multiple tools may be applied for a given problem. Though for any given problem there will be heuristics that perform well and others that will not, the additional heuristics available to problem solvers also add additional capabilities to their portfolio of tools. For example, a heuristic may be successful in solving a logistical problem, but not appropriate to apply to a personnel problem. Heuristics can be used to find optimal solutions but in the case of challenging problems, partial solutions maybe created and then combined with other partial solutions other problem solvers. Gerd Gigerenzer and the ABC research group at the Max Planck Institute for Human Development in Berlin, Germany (1999) suggest even simple heuristics make us smarter when considering the limits of human rationality and can be seen as a form of procedural knowledge. Heuristics can be applied to specific domains with great success or with trade-offs to its success in multiple domains (Gigerenzer et al. 1999). Though having multiple sets of heuristics from a diverse group of problem solvers may not guarantee successful problem solving, it does provide opportunities for new ideas.

The potential of the organizational network to provide diverse perspectives and heuristics offers organizations a large set of tools to manage the challenges they face and offer an alternative source of problem solving ability. According to Page (2007) the combination of diverse perspectives and heuristics stretches beyond being another source for problem solving but a source for better performance in solution building. Page (2007) suggests a group of problem solvers with diverse perspectives and heuristics is more important than individual excellence. Though greater empirical work is underway from diversity scholars to discover the boundaries of this premise, early evidence (*primarily through agent-based simulations*) provides an alternative to organizations relying on internal expertise for problem solving.

Moreover, the advancement of emerging technology is helping to create a common artifact in which organizations are using to utilize diversity of heuristics and perspectives in building a common perspective in viewing the same problem. Emerging technology as an artifact is helping to build a common perspective for communication especially when diverse perspectives and heuristics may not be located in one location.

This thesis has highlighted how heuristics and perspective diversity enhance problem solving ability but how does diversity improve problem solving performance. Now the thesis discusses the emerging phenomenon appropriately called collective intelligence.

Organizations and those enshrined with making decisions should seek out people of diverse experiences, backgrounds, training that could indicate diverse perspectives and a set of heuristics. Early adaptor organizations may consider thinking about implementation of diversity-enhancing policies to help build a stock of diversity within the organizational network. Having a pool of problem solvers with diverse perspectives and heuristics offers the possibility of improvement from any individual solution and suggests the value for iterative improvements in problem solving.

### *2.2.4 Collective Intelligence*

Theorizing about the differences between individual and collective behavior have been made throughout history. From Aristotle perspective on democracy, where individually observed parts of a whole collectively surpasses what can be described by any individual alone to Hayek (1945) utilization of knowledge which is and which remains widely dispersed among individuals in society to be aggregated or societal improvement. Though continuously up for debate, especially under the current economic and political turmoil, the success of democracies and markets provide a level of support that at least some collective action exists in the aggregate that has potential benefits.

More recently, anecdotal and empirical evidence also suggest benefits in collective action in forecasting (Suroweicki, 2004), problem solving (Page, 2007) and in the development of scientific knowledge (Woolley and Fuchs, 2011) leaving gaps understudied to when collective benefits emerge and into the boundaries to where collective action is appropriate in addressing problems.

Access to an organizational network of diverse perspectives and heuristics goes beyond having new ways to view problems and in solving problems, it has practical benefits in performance. Page (2007) outlines this in his diversity theorem:

***Diversity Trumps Ability Theorem-*** *conditions under which collections of diverse individuals outperform collections of more individually capable individuals*.

Instead of viewing two groups of problem solvers with equal ability, the diversity-trumps-ability-theorem assumes lower average ability for a collection of diverse problem solvers. Page (2007) formulates four conditions in which diversity trumps ability that include:

Condition 1: *The problem is difficult*.

This condition excludes problems that an expert would normally solve with very high levels of certainty. A difficult problem that would meet this condition would be previously unsolved problems, then asking a diverse group of problem solvers would have benefits in solving it. Other problem examples would be designing products, curing diseases, improving social health care.

Condition 2: *The problem solvers are smart*.

This condition suggests that problem solvers must have a reasonable level of understanding about the problem to meet this condition. It does not assume a diverse group of problem solvers can outperform a collection of experts when faced with a problem in the expert's domain (i.e. solving a calculus problem over mathematician).

<u>Condition 3</u>: *Some problem solver can find an improvement in the solution even if the improvement is small*.

This condition assumes that in the collection of diverse problem solvers, someone problem solver can always find and improvement in the collective decision. This highlights the contextual nature of collective intelligence which depends on the perspectives and heuristics of all others who work on the problem.

<u>Condition 4</u>: *The population of problem solvers must be large and the ones working together must be more than a handful of problem solvers*.

This condition suggests that problems a collection of problem solvers must be large and be from a large pool- firm, organizations, and universities. To identify an exact number would depend on the problems difficulty and the amount of diversity in the initial set of problem solvers. This is to ensure condition 3 would be met.

Now that we have discussed the conditions under which collective intelligence emerges, existing research has identified a number of contexts that have benefited from collective intelligence. Governments, organizations, universities all use some form of prediction to help allocate resources (i.e. capital and labor) to their future needs. Though not perfect, Futures Markets and the market traders are considered to be capable predictors of commodity prices. In fact, the economic theory of 'markets', has helped to propel growth in commodity trading and through the allocation of capital in the financial markets. The expanding importance on markets has ushered in more novel approaches to markets where collective intelligence has emerged. The Hollywood Stock Exchange (www.hsx.com) for instance has been a source for movie box office revenue prediction. Several studies outlined by Wolfers and Zitzewtz (2004; 2006) and Spann and Skiera (2003) have touched on the accuracy of forecasting through prediction markets like the Hollywood Stock Exchange. Existing research on the success of the Hollywood Stock Exchange will be outline in Essay #2- *A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence Tools*. Collective intelligence has in a similar fashion with the Iowa Electronic Markets (http://tippie.uiowa.edu/iem/index.cfm) have been used to predict winners of the US Presidential elections Berg, Forsythe, Nelson, and Rietz, 2001; Erikson and Wlezien, 2007) and foreign elections (Berg, Nelson, and Rietz, 2008). Organizations such as Google have used prediction markets to help facilitate information flows in determining product development (Cowgill, Wolfers, and Zitwewitz, 2008).

Reasons for the benefits of collective intelligence that support accuracy in prediction problems have been tied to incentives and isolated learning. Hong and Page (2009) suggest these types of incentives produces almost maximal diversity and for the best environment for collective accuracy to emerge. Though more research is needed it does potentially challenge some largely held assumptions in certain organizational learning paradigms and practices.

## 2.3 Transformative Perspective: Open decision-making for transformation

This subsection extends the notion that an organization is shaped by the stream of decisions its managers make and how they make those decision over time (Eisenhardt, 1989, Mitzberg and Waters, 1985) to include transformative mechanisms in enabling decision-making to play a strategic role in actively shaping the organization. For this reason, this thesis considers the inward and outward flows of knowledge within the open innovation literature. It proposes as a way to open up the decision support process, where integration of knowledge is a key enabler of knowledge flows benefits and it is through leveraging emerging technology that facilitates the transformation of decision support into a strategic function in shaping the organization.

### *2.3.1 Open Innovation*

The open innovation paradigm proposes a shift in the conventional thought of how research & development (R&D) for new products and services is carried out. Open innovation suggests how flows of knowledge are used to accelerate innovation and external markets uses for product (Chesbrough et al., 2006) and services (Chesbrough, 2011) and thus has two principle dimensions: (Chesbrough and Crowther, 2006) inbound and outbound flows of knowledge. Inbound knowledge is relevant when organizations incorporate external technical and scientific knowledge into its organizational processes, while outbound knowledge is transferred to external organizations which integrate it into their organizational process for commercialization. Researchers of open innovation have made strides in highlighting the benefits of open innovation (Dodgson, Gann, and Salter, 2006;

Dittrich and Duysters 2007) but these research streams primarily have focused on the flow of knowledge in and out of the organization to complement resource constrained R&D units and have left the applicability of these flows of knowledge underexplored to a broader context like decision support.

For example, Simard and West (2006) have considered a two by two dimension of network ties that are identified as deep versus wide ties and formal versus informal ties. This provides a starting point for organizations to access knowledge which Simard and West (2006) suggest are largely bound by geographic colocation. Though helpful in understanding network ties and their generalization on the types of ties that yield greater potential for benefits for innovation and the commercialization of products and services, it is insufficient in explaining the benefits these ties have for decision support. Moreover, the value created from these network ties may not be bound by the forms of collaboration ties (i.e. licensing, alliances, joint ventures, labor market movement, IP regimes, universities) in the network but, may in fact depend on the diversity of actors in the network which has not been considered. In this line, Powell et al. (1996) has suggested networks to be especially well suited for problem-solving and learning mechanism. Thus any organization looking to build a strategy may consider the diversity of actors instead of the formalities of the ties for knowledge flows. This means moving beyond suppliers, customers, and actors in a local proximity to include employees' embedded in the wider organizational network or knowledge sources that many not be intuitively linked to the local organization. Furthermore, this suggests that organizations need to worry less about redundant knowledge and more about capturing of diverse types of knowledge and problem solving ability and the potential of emerging technology in enabling and facilitating these new decision support capabilities. Here redundant knowledge may indicate a solution to a problem which may not be new to the organization, but also providing diversity in problem solving ability to for future decision support. The open innovation literature has also discussed various forms of open models impacting different organizational processes and activities. Open models have been linked to business models for utilizing intellectual property (IP) management (Chesbrough, 2006), in information technology development (Raymond, 1999), and in ways of organizing innovation (von Hippel and von Krogh, 2003). Each has offered insight into contexts flows of knowledge benefit organizational activities.

For instance, discussions of technology in the flows of knowledge have existed in the management of knowledge types for improving efficiencies in combining and disseminating existing information and explicit knowledge (Nonaka et al. 2001). Technology has been widely acknowledged as tools that *'do[es] not offer and integrated holistic way of dealing with tacit and explicit knowledge in the context of the knowledge economy'* (Nonaka et al. 2001:827). Alternatively, Antonelli and Geuna (2000) suggest enabling technology allows firms to systematically accumulate tacit knowledge. The value of emerging technology that supports the accumulation of tacit knowledge and dissemination offer opportunities for decision support capabilities for an organization.

### *2.3.2 Integration of knowledge*

Knowledge integration has been viewed from a long list of angles and has been identified as an important element for organizational competitive advantage through absorptive capacity (Cohen and Levinthal, 1989; 1990; Zahra and George, 2002), organizational capabilities (Grant, 1996), organizational learning (Pisano, 2006), and more recently- open innovation (Chesbrough, 2011). Knowledge integration has generally been viewed through how external knowledge can be captured and integrated with internal knowledge and organizational practices that offered room for previously disconnected silos of knowledge and capabilities

(Fleming, 2001; Hargadon and Sutton, 1997; Schumpeter, 1942) to be integrated with internal and external sources of knowledge. Alternatively, flows of knowledge and its integration to the external environment have been viewed as a method for commercialization of new technologies that were not able to be integrated with internal organizational knowledge and practices (Chesbrough, 2003; 2011).

The integration of knowledge for decision support can be seen as a form of absorptive capacity linking new knowledge to existing knowledge and does suggest additive properties to knowledge into where its efficiency in transferring is dependent upon a common language or through technologies in facilitating its transfer. For organizations to build a competitive advantage leveraging knowledge integration for decision support depends upon how productive firms are in utilizing the knowledge stored within and around organizational network, which is dependent upon the ability of the firm to access and harness the specialized knowledge of its employees and organizational network actors. Critical to the development of new models of decision support where large-scale knowledge integration is to occur is dependent on recent advancement of technology. Advances in technology have greatly facilitated knowledge integration through increasing the ease with which knowledge can be codified, communicated, assimilated, stored, and retrieved (Rockart and Short, 1989). Moreover the rapidly developing and changing technology enabling knowledge integration to occur will continue to evolve making these technologies easier to implement and use with little restrictions on organizational resources in terms of extensive capital requirements or deep technical knowledge and competencies. Instead organization will be more dependent on their ability and to integrate the extensive amount of knowledge these technologies facilitate.

### *2.3.3 Emerging technology*

The rise of new technology is enabling greater connectivity between the organization and its network. This new group of technology can be used independently or in combination with existing technology infrastructure and can be seen as a conduit between organizational processes and knowledge sources. This places the role of these new technologies as potential drivers in the facilitation of knowledge flows in the organization while adding an increasingly porous technology barrier.

Benefits from these new technologies include replacing informal knowledge flow channels within the organization and in extending the organization's reach to its customers, partners, suppliers, stakeholders or internally in access hard to find knowledge. Other benefits include:

- Increased information sharing
- Less hierarchical information flows
- Collaboration across organizational silos
- Tasks tackled in project-based way
- Decisions made lower in corporate hierarchy
- Work performed by mix of internal and external people

Since technology alone is rarely the key to unlocking economic value, organizations create real wealth when they combine technology with new ways of doing business. Thus, managers and executives enshrined with decision making must consider utilizing emerging technology within a well-defined context of tasks and deliverables. Managers and executives who understand the key differences among the emerging technologies will be better equipped in order to tailor solutions to the specific benefits these technologies allow for. This allows for managers and executives to integrate new knowledge into their own environments by taking steps to open their decision support processes and in encouraging a value network of knowledge sources in problem solving by using new tools to tap in the distributed knowledge of the organizational network.

The open innovation research stream has led researchers to explore how new technologies are shaping the support more open and collaborative models of practices- particularly in the context of innovation (Dodgson, Gann, and Salter, 2006; Christensen and Maskell, 2003; Pavitt, 2003), even arguing these technologies have the potential to reshape the way firms organize activities across the organization (Dodgson, Gann, and Salter, 2005). The reshaping of organizational processes, impact the structure of the internal process and the cognitive modeling of these processes. One group of technologies supporting this change- coined "innovation technologies (IvT)" are facilitating exploration across the boundaries of the organizations. "IvT influences the ways knowledge is constructed, shared and used. They affect the ways in which we think about and conceive innovations" (Dodgson, Gann, and Salter, 2006 pp. 335). IvT can be seen as placing people in creative tasks aimed at achieving economies of effort in a clear direction (Dodgson et al., 2002) that integrates internal and external inputs in to organizational process. In Essay #3- *Elephants Can Jam: IBM Innovation Jams for Organizational Change* details how IBM is using IvTs to support large-scale collaboration to develop solutions to challenging business and societal problems. From this, people in the organization are placed in a new environment for people to think about new options, share and engage with others and experiment with different ways of constructing solutions to a problem.

The potential for IvT has significance for how organizations can leverage IvT to organize their decision support processes. Additionally, IvT offer opportunities to shape the internal organization in ways to promote acceptance of external knowledge that has been acquired, while influencing the acceptance of internal knowledge on the external environment. Moreover, IvT has the ability to enable greater collaboration and sharing from contributors or ´knowledge activists´ (von Krogh, Nonaka, and Ichijo, 1997; von Krogh, Ichijo, and Nonaka, 2000) that are instrumental as part of a unified team across organizational silos, business units, and stakeholder networks. With these technologies, knowledge contributors may emerge from the organizational networks that were previously excluded from the decision support process. Technology such as IvT can be seen as a bridge in the process from external acquisition of knowledge to internal application and the delivery of internal knowledge to the external markets and wider environment. Moreover, Shirky (2010) suggests organizations have underused human potential or a "cognitive surplus" that could be tapped into as organizations utilize these emerging technologies.

Other emerging technologies such as ideagoras or marketplaces for ideas (Tapscott and Williams, 2006) and predictive markets technologies promote aggregation in open models of decision support based on the growing importance of rich exchanges for solutions building. The role of prediction markets will be explored in Essay #2- *A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence Tools*. Moreover, the rise of data-driven decision making and the emerging technologies that support big data strategies in generating insights through the analysis of information from multiple sources will continue to push the boundaries of how emerging technologies can be combined for decision support.

As organizations learn to use these technologies and engage with smarter and faster ways for the organizational network to create value through interactions, the development of decision support capabilities provides an alternative competitive advantage that will be difficult for competitors to replicate.

Considering technology alone will not build decision support capabilities and the resulting economic value, organizations can create real wealth when they combine new technologies with new ways of supporting organizational decision-making. Moreover, as organizations implement and remove constraints that limit the adoptions of emerging technologies that the boundaries among employees, vendors, and customers will blur ushering new ways for the organizational network to organize themselves driving new models of decision support.

## 2.4 Open Models of Decision Support Typologies

In this section a detailed presentation of typologies referred to open models of decision support are introduced. The typologies presented are linked to the theoretical framing of the foundational concepts and sub-concepts described in Section 2.3 in that each drive the phenomena under study and shown in the characteristics and application section of the proposed typologies. As can be show in Figure 2.1 the proposed typologies can be considered as a part of a ring that goes from those that are arranged from more to less problem structure as one moves along the typology ring left to right. Starting from the left, the aggregate typology and its supporting technology best address problems with more structure than the broadcast and platform typology. While, problems with least amount of structure are best supported by the platform typology and supporting technology than the broadcast and aggregate typologies. Each typology within the open models of decision support typology ring will be described in detail in the next sections.

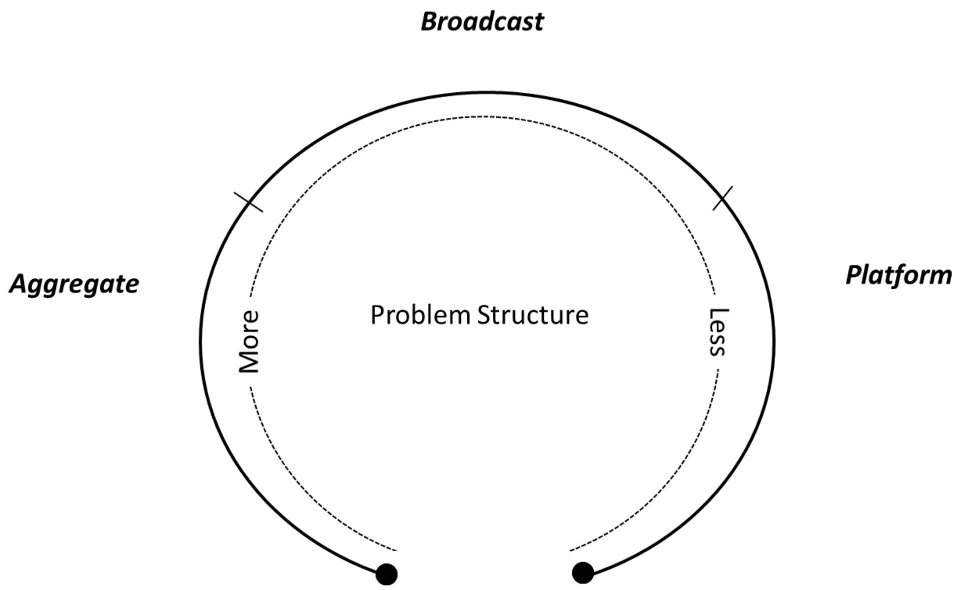


**Figure 2.1:** Typology Ring of Open Models of Decision Support

### *2.4.1 Aggregate: Summation of knowledge parts for probabilistic outcomes*

Within the Aggregate typology, problems are well known with broad consensus on objective criteria for a solution. These can be prediction, forecasting, search, and collaborative filtering problems to be solved. Techniques used through aggregation mechanisms that provide solutions through multiple actors, viewpoints, data sources. Solutions can be binary (yes/no) or ranges of finite options. Asymmetrically of dispersed knowledge exists between actors (Hayek, 1945; Smith, 1982). The heterogeneity of actor's knowledge exists where knowledge may be shared/ signaled directly or indirectly for the collecting, disseminating, and aggregating of knowledge from the widely dispersed group of actors (Sunder, 1995; Plott, 2000). Incentives may exist to reveal and share knowledge supporting feedback to participants for reevaluation through intrinsic or extrinsic motivational factors. Aggregate tasks include uncertainty in the form of probabilistic outcomes or a range of variables thus aggregation mechanisms are used to extract a forecast for a random variable or set of variables through aggregating knowledge and opinions about the likelihood of future actions.

Problems within the aggregate typology are not necessarily simple or straightforward. Forecasting box office revenue, recommending products and service preferences, and assumes a normal distribution curve requiring the outcome to be a random phenomenon. It is common for problems in the aggregate typology to have previously existing (and previously tested) methods for solutions. Problems or applications to apply the aggregate typology model includes: project management scheduling, demand forecasting for supply chain efficiency, risk evaluation, forecasting future revenue, sales, elections, and future events. Table 2.1 outlines the conditions and type of applications within the aggregate typology.

**Table 2.1:** Aggregate Typology Conditional Characteristics and Application

| **Underlying Logic:** |
| --- |
| • Knowledge is dispersed and difficult in collecting.<br>• Whole as sum of the parts logic.<br>• Independent feedback signals allowing for reevaluating prediction.<br>• Negative correlation of errors.<br>• Diverse attributes interpretations and perspectives from contributors.<br>• Knowledge-asymmetry exists between actors. |

- Assumes no knowledge of who is more expert on what topics is required.
- Limited range of future outcomes or possible outcomes.
- May rely on public and/or private available information.
- Decision support becomes more decentralized.

**What is Needed:**

- Interpreting an unknown event.
- Secure a diverse network of contributors.
- Independent information and indirect knowledge sharing.
- Contributors must at least know a part of the solution.
- Mechanism for aggregation.

**Problems/Application:**

- Predicting box office revenue, corporate sale, presidential election, product development, terrorist attacks, manufacturing capacity, health care, climate change, price of commodities.
- Application- market research, risk management, project management.

### *2.4.2 Broadcast: Requiring diversity of approaches*

Within the Broadcast typology problems are ill-defined and broadcasted to a large undefined network of actors with diverse approaches for solutions. Solutions are provided through submission process from the heterogeneous set of small groups or individual actors that offer unique solutions and not a combination of existing dispersed knowledge. The problem holder or (seeker) evaluates the actors' submissions. There may not be one solution to the problem or several that are viable solutions. It is critical to develop a robust network at the boundary of the problem space in order to transfer knowledge from one field to another. Autonomy through each actor makes their solution independent and all actors are assumed to be identical in problem solving ability, that is, all actors are equally capable for such a broad problem ex ante.

Examples of problems in the broadcast typology generally fall under the broad category of ideation problems that may include: new product and service design, scientific and technical problems in chemistry, design contests for the aesthetics of a new logo, new compound for chloride, fan video, a product concept for a child-proof container of medication, or design of the next generation binder. Table 2.2 outlines the conditions and type of applications within the broadcast typology.

**Table 2.2:** Broadcast Typology Conditional Characteristics and Application

| |
|---|
| **Underlying Logic:**<br>• Broadcast search of an ill-defined problem to a large audience.<br>• Looking for relevant knowledge that can help create a workable solution.<br>• Bridging knowledge fields – taking solutions and approaches from one area and applying it to other different areas.<br>• Applying specialized knowledge or instruments developed for another purpose. |
| **What is Needed:** |

| |
|---|
| • Diversity of potential scientific approaches to a problem was a significant predictor of problem solving.<br>• Intrinsic and extrinsic motivation factors.<br>• Problem solving requires the application of heuristics and perspectives.<br>• Application of a variety of “different” approaches to the problem. |
| **Problems/Application:**<br>• Compounds for flame retardant material, prevention of inactivation of actives resulting from enzyme activity, technologies, methods, processes, or coatings for the surface of steel which decrease the surface frictional.<br>• Scientific and technical problems- chemistry, engineering/ design, life science, food science, computer science, physical science. |

### *2.4.3 Platform: Sharing a vision in a dynamic social context*

Within the Platform typology problems are considered ‘wicked’ or ill-structured with an evolving set of connected issues and constraints. These are problems that do not have a definitive solution rather one or more solutions appear to be good enough or a Herbert Simon (1969) offered us- ‘satisficing.’ Complexity exists in that some variables are unknown, and will remain unknown until sometime in the future. The ‘problem’ and the ‘solution’ have a bidirectional relationship where the impact of one affects the other and underscores the social complexity of the diverse number of actors involved.

Knowledge may be chaotic and scattered and represent the perspectives and heuristics, understanding, and intentions of the actors. Knowledge may build upon or be incompatible with other actor's axiomatic assumptions about the problem or solution. Each actor believes that his or her understandings are complete but may not be shared by all. Solution building is not linear and is opportunity-driven by creating possible solutions and considering how they might work. Through a creative learning process the problem understanding continues to evolve.

Solution building in the 'platform' typology is a process of generating ideas in various fragments and through filtering through the reduction of ideas- socially and technologically maybe used to identify, refine, develop, and expand relevant ideas for broad consensus on objective criteria for a solution. Due to the social complexity and its uncertainty multiple futures rather than a single path must be considered. Solutions are assessed in a social context in that it puts human relationships and social interactions at the center. Solution quality is not objective and cannot be derived from following a formula.

Within the platform typology it is assumed there are external events beyond the control of the actors which will have a major impact on whether the problem can be solved, or whether it will stay solved. Actors accept the ambiguity, and stay involved with an emerging solution that may require midcourse corrections. Examples of problems in the platform typology may include: economic, political, environment issues that deal with a high level of social interrelated problems. Table 2.3 outlines the conditions and type of applications within the broadcast typology.

**Table 2.3:** Platform Typology Conditional Characteristics and Application

| |
|---|
| **Underlying Logic:**<br>• Wicked problems and ill-structured in nature. |

- Key variables are unknown, and will only become known at some future time.
- Problems are divergent with varying levels of uncertainty.
- Any present solution presumes a future that cannot be guaranteed and is irrevocable.
- Large group of participants with different levels of knowledge and opinions with strong and diverse views held.
- Problem and solution always emerging and changing.
- Feedback rich and unstructured.
- Actors are part of the reality of solution and not out of the problem.

**What is Needed:**

- Crafting solutions that are good enough or 'satisfice' a solution.
- Utilizing knowledge and cultivating interaction.
- Mechanism for capturing segmented knowledge and perspectives.
- Leverage technology to maximize interaction through extensive use of collaboration.
- Enhancing creativity for solution building.
- Solutions can be seen as combinatorial of shared knowledge.

**Problems/Application:**

- Initiatives to address climate change, developing a common mission (corporate or social), understanding social phenomena.

- How to integrate the developed world into the globalize economy, examining the future of business, how to improve the lives of socially and economically marginalized people, future of cities.

### *2.4.4 Relating Foundational Concepts and Typologies*

To contextualize the theoretical framing and proposed typologies Table 2.4 provides a relational perspective between the structural, relational, and transformative concepts presented and the aggregate, broadcast, and platform typologies. From this, knowledge, solutions, and decision support are identified for each of the foundational concepts and corresponding typologies highlighting relational differences and similarities.

**Table 2.4:** Relational Perspective of Foundational Concepts and Typologies

| | *Structural* | *Relational* | *Transformative* |
|---|---|---|---|
| Aggregate | Knowledge is partially utilized through embedded aggregation mechanisms | Solutions are indirectly shared with organizational network participating | Can be used to guide ongoing decision support over time or in isolation |
| Broadcast | Knowledge is utilized once it is found | Solutions are not shared within the organizational network and compared to each other in separate internal stages | Provides decisions support for a set period |
| Platform | Knowledge utilization is a ongoing process through several different mechanisms ongoing at once | Multiple solutions are partially shared through fragments and that may represent complementary or exclusive solutions | Decision support as an evolving solution process with no optimizing stop rule |

# Chapter 3: The Evolution of Expertise in Decision Support Technologies: A Challenge for Organization

**Abstract**

This study provides insight from an evolutionary perspective of expertise that has shaped the field of decision support technologies. The investigation sets out to reveal the changing landscape of expertise in supporting decision-making using technology and sheds light on the new role that experts will play in organizational decision-making. The results show significant changes in how decision-making is being made which challenge the traditional role of experts and non-experts. Finally, this paper explores opportunities for decision support technology integration and the added benefits artificial intelligence can bring to collective intelligence tools.

**Key Words:** Decision Support Systems, Collective Intelligence, Artificial Intelligence, Expert Knowledge.

## 3.1 Introduction

Decision-making has been an important area of study for researchers since the 1940's. Researchers from many areas have contributed to this important human and organizational activity to understand how decisions are made in society, the economy, management, engineering, etc. Faced with new research opportunities from emerging technology and the changing make-up of expertise, researchers and research disciplines must evolve in order to understand new methods organizations use in decision-making. The research area of Computer Supported Cooperative Work (CSCW) provides the backdrop for understanding cooperative work [1] that has used technology to harness expertise in supporting decision-making within organizations. The following paper presents an evolutionary view of three decision support technologies that support the use of expertise. Decision support technologies included are: expert systems (ES), group decision support systems (GDSS), and collective intelligence tools (CI tools). A review of the literature shows a changing landscape in expertise in supporting decision-making through technology. Findings show that as decision support technologies have changed over time so has the level of expertise and the number of people collaborating in contributing to decision-making.

The paper is outlined as follows: first a review of terms and concepts for understanding expertise in decision support technology is presented in Section 2. Section 3 describes three decision support technologies that organizations use supporting expertise, and Section 4 discusses opportunities for enhancing decision-making and collective intelligence tools through integration of existing methodologies. Conclusions and direction for further research appear in Section 5.

## 3.2 Terms and concepts

### *3.2.1 What is Expertise?*

Though no agreed upon definition exists within the literature for expertise, researchers would agree expertise is multidimensional [2], with expert knowledge as the essential part. Three main components make-up expert knowledge: (1) formal knowledge, (2) practical knowledge, and (3) self-regulative knowledge [3]. Formal knowledge is explicit where learning is the focus of factual information. Practical knowledge develops in the skill of "knowing-how" and is tacit, where intuition plays a role making expert knowledge difficult to explicitly express. The third component, self-regulative knowledge consists of the reflective skills that individuals use to evaluate their own actions.

As elusive as a definition is for expertise is, its short supply and difficulty to represent makes it extremely valuable for organizations because of its influence on decision-making. Nevertheless, expertise is thought of as a highly specialized or domain-specific [4] set of skills that have been honed through practice for a specific purpose [5] and perform consistently more accurate in relation to others [6].

### *3.2.2 Introducing Expertise by means of Technology*

Organizations have allocated significant amount resources to leverage expertise using technology to influence decision-making. Different technologies and systems have been developed each to better capture knowledge or represent expertise in the cognitive process of the decision-maker(s) for effective decision-making to occur [7][8][9]. Though managed differently, expertise used within expert systems, group decision support systems, and collective intelligence tools underline the foundational theories for use. A review of the literature shows how organizations have used decision support technology to expertise needs and how the level of expertise for decision-making can be augmented by increasing the amount of participants in the decision-making process. Figure 3.1 represents the three decision support technologies that will be discussed considering the evolving level of expertise in each system. Expertise selection is considered to be an artificial process rather than a natural process and where adaptation in organizational use is seen as a mechanism of evolution.

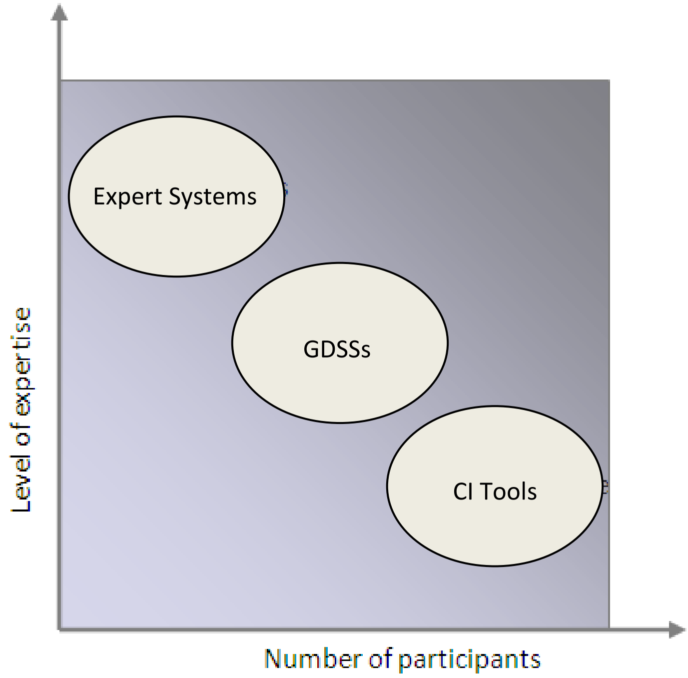


**Figure 3.1:** Level of Expertise in Systems Design

## 3.3 Leveraging expertise in decision support technology

### *3.3.1 Expertise in Expert Systems*

Expert systems are playing a critical role in being a source for a competitive advantage for many organizations [10]. Since organizations are employing expert systems to capture expertise, potential benefits exist in understanding the technical aspects of expert systems and the social needs they are providing to organization and their decision-makers who use them. Expert systems, a branch of artificial intelligence, are contributing to decision-making through their representation of knowledge and reasoning of human experts for its users [11]. By mimicking and replicating the cognitive process of a human expert, novice users can be supported to perform as well as experts [12] while expert users can have their expertise further refined. By emulating an expert's problem-solving ability, knowledge and reasoning are transferred to a user through the use of expert systems for faster learning and decision-making than would occur when developing these skills over time. The main function of an expert system is to represent expertise to its users for decision-making when a human expert cannot be found or is in short supply.

Legitimated as an alternative to human experts in the 1970's, the expert system MYCIN was found to perform better or equally as well at diagnosing meningitis in blood as human experts [13][14]. Expert systems are constructed with four main components: knowledge base component, heuristic engine component, user interface, and explanation module. The knowledge-based component consists of the factual knowledge a human expert would have of a specific and narrow domain, while the heuristic knowledge or expertise is based on intuition, experience, and judgment to apply rules efficiently under uncertainty or with incomplete information. The user interface component allows the user to interact with the system but it is the explanation module that queries the user for more information. As the user responds by answering the questions presented through the explanation module, the new information is then incorporated in the decision-making process of the mimicked expert and finally responds with a justification for solution, which is a critical factor for system intelligence. The end decision, resulting from the dialogue and collaboration between the user and mimicked human expert is valuable for organization. For example, researchers have [15] found that users' interaction with the expert system while verifying information may impact whether the user accepts the system's output for consideration in decision-making. The explaining and rationale why a decision is made, is possible through a knowledge acquisition process, which is generally from one specialized expert and one line of reasoning. Knowledge-acquisition is the diffusion of problem-solving expertise from some knowledge source to a program [16]. Pointed out by researchers [17], the power from expert systems derives from the knowledge it possesses.

Though many organizations have successfully implemented expert systems to address particular problems in a narrow domain, changing external factors impacting competitiveness and sustainability have forced organizations to approached critical decisions differently. Studies indicate [18], the more complex organizations become, and the fewer decisions are made by any single individual (or expert system). Rather than rely on expertise from one individual or system for an important decision, businesses turn to groups or teams of experts in the decision-making process. Furthermore, groups of experts may be necessary when diverse subsets of knowledge are required and no single expert has complete knowledge of the problem.

### *3.3.2 Expertise in Group Decision Support Systems (GDSSs)*

Interest grew in organizations in the 1980's to improve decision-making in group meetings as a result of the changing dynamics characterized by greater knowledge, complexity, and turbulence [19][20] that groups face. As organizations turned to communication technology to foster more effective and efficient group decision-making [21] changes in computing power and electronic communication supported new forms of CSCW. Organizational transformation occurred as a result of developments in new decision support systems impacting the organizational structure, project based teams, dispersed workforce, and greater emphasis on collaboration.

One technology supporting organizational change and group decision making is group decision support systems (GDSS). GDSSs use has shown to reduce time, costs [22], and foster collaboration, communication, deliberation, and negotiations [23]. Research in group decision support system theory suggests that through communication, collective knowledge, and interaction of participants enables better solutions to be reached over any single individual. When groups use a GDSS it facilitates aims to improve the process of group decision-making for opinion convergence, group consensus, and better outcomes in decision-making. Designed using the rational of decision-making, GDSSs optimize the decision-making process by following what is referred to as intelligence, design, and choice [24]. GDSS use enhances decision outcomes by leveraging the cognitive knowledge of participants by supporting the behavioral and social needs of the group to resolve uncertainty in the group decision making process. GDSSs possess expertise in the cognitive decision-making process as a result of techniques used within the support system. As a result of this process, GDSSs are able to capture the knowledge and contribution from the individual users collaborating to arrive at a better solution or create a greater sum than the individual parts. In addition to the cognitive expertise, GDSSs occupy the center point for the aggregation of information and expertise from each participant. GDSSs impact on the decision-process outcome will depend on the degree of change in communication of the users.

Though GDSSs have supported organizations by utilizing the expertise of the group and providing structure for effective decision-making [25], decision-makers are still constrained by the information they receive to make a decision. Since the quality of group discussion is greatly contingent upon the quality of information brought to the session by group members and having tools with capabilities to increase available information internally and externally to the organization would be beneficial [26]. In organizations, decision-makers do not have access to all the information they need when making a decision [27] and thus, effective decisions can be compromised. Three potential reasons why critical information is not accessed by decision-makers could be: conventional methods and technologies insulate information flow to only a select group of people, decision-makers do not ask for all the information accessible to them, or those who have it do not share because of political or social reasons. As a response, emerging collective intelligence tools such as prediction and decision markets are helping to alleviate these constraints.

### *3.3.3 Expertise in Collective Intelligence Tools*

Based on the premise that the collective judgment of a large group is better at predicting and forecasting future events than individual experts or small groups of experts [28][29][30], collective intelligence offers an alternative to the constraints of information flow in decision-making and increases forecasting accuracy of uncertain events. Investigation has also explored how collective intelligence tools can be used in the organization for decision-making [31]. Accordingly, the primary goal of collective intelligence tools is to facilitate the summative body of knowledge, information, and resources of its users.

Collective intelligence tools contrast sharply to traditional decision support tools because of their ability to democratize decision-making by including many people in and outside the organization into the information gathering and decision-making process. Decision-making that becomes democratized enables both firms and individuals to increasingly solve problems, deal with uncertainly, and in better forecasting. Diverging from traditional thought where high levels of expertise are seen as the best source of decision-making, collective intelligence tools have the ability to harness lower levels of expertise for peak solutions in decision-making.

Decision-makers and firms who use collective intelligence tools do not need to rely solely on their resources', but can benefit from resources freely shared by others outside the organization.

Prediction markets, a collective intelligence tool can be defined as markets that are designed for the purpose of collecting and aggregating information that is scattered among the traders (users) who participate by trading so information can be reflected in the market contracts in order to make predictions about specific future events [32][33]. Derived from the efficient markets hypothesis, markets are expected to be the best predictor of unknown future events and should be seen as a complement to executives and experts to aid in information flows to make decisions more quickly and accurately. Much like a real market, traders are rewarded monetarily or through visibility within the organization based on the accuracy of the information they provide by participating. When individuals buy or sell contracts based on the information they have they will be rewarded by being the first mover to reflect this new information into the market before others.

Seeking to push decision-making down the corporate ladder and information up toward the top, collective intelligence tools incubate the hidden information that is scattered around the organization or network to be discovered that allows non-experts to produce expert like results when collectively mobilized. By including a large number of people such as rank and file workers or the public into the decision-making process organizations can create opportunities to augment their expertise needs for a competitive advantage by using a large group of people even if individually they have low levels of expertise for a given problem. Companies that choose to use collective intelligence tools leverage resources of knowledge, information, and problem solving far beyond what they could afford to deploy internally.

Use of collective intelligence tools by companies has had some success; however, much is still unknown about these tools. Future challenges may include using collective intelligence tools not as a replacement for experts but as an additional tool in decision-making (Figure 3.2). Traditional roles of experts may change and represent a mindset shift from answer givers to inquiry mediators in effort to harness the knowledge of the masses in decision-making. Today the internet has made it easier and more cost effect for companies to implement such tools to guide information flow, however it's the organizations choice and ability to effectively manage the collective intelligence of its resources. Thus a discussion on how organizations can enhance decision-making using the existing support technologies they have and the potential for added benefits from artificial intelligence methodologies on collective intelligence tools is needed.

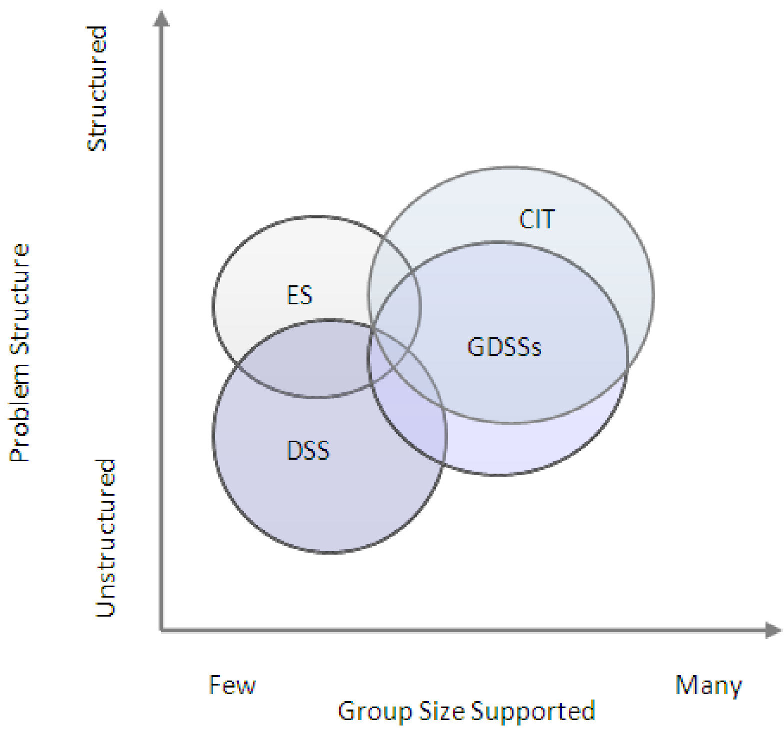


**Figure 3.2:** Evolving Decision Support Technologies Adapted from [26]

## 3.4 Enhancing Decision-Making and Collective Intelligence Tools

Past attempts to enhance the quality and efficiency of collaborative work through system integration and have shown compatibility among two of the support systems however, have not included emerging decision support technologies or analyzed based on today's environment landscape. Preliminary investigation shows opportunities exist to enhance decision-making and collective intelligence tools as usage matures and influence in demand grows. Foremost, strong synergies exist between the three decision support technologies which when combined have the flexibility to solve a wide spectrum of problems. Each system has a comparative advantage from each other that provides further basis for justification in fusing these three technologies. Further investigation is currently underway to provide a list of system benefits when amalgamating for decision-making.

In addition, techniques from the artificial intelligence (AI) field offer real possibilities to enhance collective intelligence tools use and benefits, much like AI can support current decision support technologies [34]. Design benefits may include: opportunities to simplify the use of collective intelligence tools by transforming these tools from passive agents that collect and aggregate information into active agents that enhance interaction and solicit information from its users based on reasoning and creditability. Evolution towards fusing emerging support technologies with long standing decision support systems provide real opportunities to capitalize on synergies for advancement managing companies expertise in and outside the organization.

## 3.5 Conclusions

A review of the literature has indicated organizational use of expertise in decision support technologies are changing which reflects the new roles of experts and non-experts in decision-making. Next, this paper has explored issues of design for integration with existing decision support technologies and the benefits artificial intelligence techniques can play to enhance collective intelligence tools. Each of the research areas described has played an important role for business in the past and present. By bridging each tradition's literature and in combining their successes, they can continue to support business decision-making in the future.

Finally, this paper lays a foundation contributing to the role decision support technologies play supporting expertise in organizations by: (i) showing an evolutionary perspective of expertise supporting decision support technologies that organizations currently use; (ii) operationalizes how organizational expertise in short supply can be augmented using collective intelligence tools (iii) and emphasizing fusion of existing methodologies, by considering benefits from each technology that enhances decision-making.

**References**


1. Bañón, L. & Schmidt, K. CSCW: Four characters in search of a context. *Proceedings of the First European Conference on Computer-Supported Cooperative Work - EC-CSCW* 1989 13-15 September, 1989, Gatwick, London, 1989. pp. 358-372.
2. Sternberg, R. J. Cognitive conceptions of expertise. In P.J. Feltovich. K. M. Ford & R. R. Hoffman. *Expertise in context. Human and Machine,.* 1997. pp. 149-162. Menlo Park, CA: AAAI Press/ The MIT Press.

3. Tynjala, P. Towards expert knowledge? A comparison between a constructivist and a traditional learning environment in the university. *International Journal of Education Research*. 31, 1999. pp 357-442.
4. Chi, M. T. H., R. Glaser, & M. J. Farr, eds., *The Nature of Expertise,* 1988. Hillsdale, NJ: Erlbaum.
5. Jackson, P. *Introduction to Expert Systems.*(3rd) ed, 1999. Pearson Addison Wesley.
6. Hartley, R. Expert System Methodology: A Conceptual Analysis. International Journal of Systems Research and Information Science. Vol. 1, 1985. pp. 11-22.
7. Barton, A. Experiences in Expert Systems. *The Journal of the Operational Research Society*, Vol. 38, No. 10, The Practice of OR in Central Government (Oct., 1987), 1987. pp. 965-974.
8. Liou, Y. & Nunamaker, J. Using a Group Decision Support System Environment for Knowledge Acquisition: A Field Study. *Proceedings of the ACM SIGBDP conference on Trends and directions in expert systems*. Orlando, Florida, United States, 1990. pp 212 – 236.
9. Smith, B. Collective Intelligence in Computer-Based Collaboration, 1994. Hillsdale, NJ: Lawrence Erlbaum.
10. Gill, T. Early Expert Systems: Where are they now? MIS Quarterly. March, 1995.
11. Weiss, S. & Kulikowski, C.A. A Practical Guide to Designing Expert Systems, 1984. Chapman and Hall Ltd.
12. Cascante, L., Plaisent, M., Bernard, P., & Maguiraga, L. The impact of expert decision support systems on the performance of new employee. Information Resource Management Journal; Oct-Dec 15, (4), 2002. pp. 67-78.

13. Shortliffe, E.H. Computer-based medical consultation MYCI, 1976. American Elsevier.
14. Shortliffe, E. & Buchanan, B. Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project, 1984.
15. Murphy, D.S., & Yetmar, S. A. Auditor evidence evaluation: Expert systems as credible sources. *Behavior & Information Technology,* 15, 1996. pp. 14-23.
16. Buchan, B.G., Barstow, D., Bechtel, R., Bennett, J., Clancey, W., Kulikowski, C., Mitchell, T. and Waterman, D.A. Constructing and Expert System, I *Building Expert Systems,* Hayes-Roth, F., Waterman, D.A. and Lenat, D.B. (eds), 1983. pp. 127-167, Addison-Wesley, Reading, MA.
17. Feigenbaum, E.A. The Art of Artificial Intelligence: Themes and Case Studies of Knowledge Engineering. *International Joint Conference on Artificial Intelligence,* 1977. pp. 1014-1029.
18. Gannon, M. J., Organizational Behavior: A Managerial and Organizational Perspective, 1979. Boston: Little, Brown.
19. Huber, G. P. Group decision support systems as aids in the use of structured group management techniques. *In DDS*-82 Conference Proceedings, 1982. pp. 96-108.
20. Huber, G.P. Issues in the Design of Group Decision Support Systems*, MIS Quarterly,* Vol.8, No. 3, Sept. 1984, pp. 195-204.
21. DeSantics, G. & Gallup, R. A Foundation for the Study of Group Decision Support Systems. Management Science. V 33. No. 5, 1987. pp. 589-609.
22. Gallup, B. The impact of task difficulty on the use of a group decision support system. Ph.D. dissertation, Dept. of Information and Decision Sciences, Univ. of Minnesota, 1985.
23. Kull, D. Group decisions: Can a computer help? *Computer Decisions, vol. 15(5),* 1982. *pp. 64-70.*

24. Simon, H. Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations, 4th ed. In 1997, The Free Press.
25. White, S.E., Dittrich, J.E. and Lang, J.R. The Effects of Group Decision Making Process and Problem Situation Complexity on Implementation Attempts. Administration Science Quarterly. Vol 25 (2), 1980. pp. 428-440.
26. Aiken, M., Liu Sheng, O., & Vogel, D. Integrating expert systems with group decision support systems, *ACM Transactions on Information Systems (TOIS)*, v.9 n.1, 1991. pp. 75-95, Jan.
27. Dye, R. The Promise of Prediction Markets: A Roundtable. *McKinsey Quarterly.* Number 2 2008.
28. Hanson, R. Decision Markets, *IEEE Intelligent Systems*, 14, 1999. pp. 16-19.
29. Berg, J., Nelson, F., Rietz, T. Accuracy and forecast standard error of prediction markets. Working Paper, The University of Iowa, 2001.
30. Surowiecki, J.. The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations, 2004. Little, Brown.
31. Ho, T. & Chen, K. (2007). New Product Blockbusters: The Magic and Science of Prediction Markets. *California Management Review*. Fall, Vol. 50 (1), 2007. Berkeley, California.
32. Berg, J., & Rietz, T. Prediction Markets as Decision Support Systems. *Information Systems Frontiers.* V5(1), 2003. pp. 79-93.
33. Wolfers, J. & Zitzewitz, E. Prediction Markets in Theory and Practice. In S. Durlauf and L. Blume (eds) *The Palgrave Dictionary of Economics,* 2006. (McMillan, 2nd ed).
34. Crowston, K., and Malone, T. W. Intelligent software agents, *Byte Magazine*, 1988. pp. 267-272, December.

# Chapter 4: A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence Tools

**Abstract**

Demand forecasting in supply-chain management has become increasingly more difficult and complex. As a result of the changing market, organizations are more proactively seeking out new methods of forecasting demand. Technological changes due to the rise and influence of the Web have driven organizations to refine how they forecast and approach managing demand that effect supply-chain management decision-making. This study compares two decision support technologies: expert systems and collective intelligence tools and illustrates how the film industry uses each in forecasting box-office revenue, which reveals the changing landscape of expertise in supporting decision-making using technology. The results show significant changes in how decision-making is being made which challenge the traditional role of experts and non-experts. Finally, this paper explores opportunities to increase the knowledge about the combined benefits in integrating each support technology for more accurate forecasting.

**Key Words:** Decision Support Technologies, Expert Systems, Collective Intelligence, Knowledge Representation, Artificial Intelligence.

## 4.1 Introduction

The motion picture industry generated approximately $10.46 billion in revenue in 2010 (www.mpaa.org) and represents an important industry for jobs, tax revenue, and wages for the U.S. economy. Box office revenue is highly concentrated with over 80% of the revenues controlled by six movie studios. New movies consisting of long production cycles and complicated logistics during development and distribution contribute to their high production costs. New movie average component costs have been grouped in production, marketing, and finally distribution costs. The distribution of motion pictures has shown to be an important link in the movie production supply-chain, making them a critical component in determining a movie financial success (Reardon, 1992; Thomas, 1998). Figure 4.1 represents the supply chain of a new motion picture release and the controlling actors at each phase.

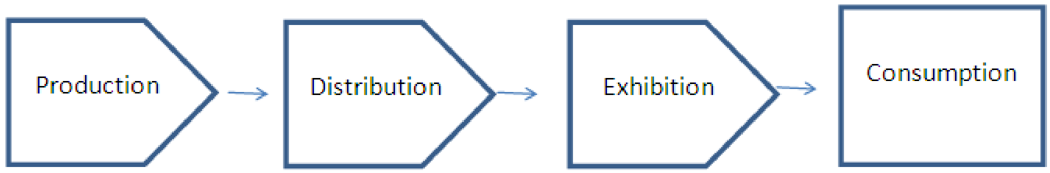


**Figure 4.1:** Motion Picture Industry Supply Chain

In addition to its economic influence, the motion picture industry offers a challenging domain for research scholars in demand forecast modeling. Demand forecasts are important in the motion picture industry to measure effective demand in the market for a new motion picture release. It can be seen as a proxy to the markets product needs or purchasing power that will result in box office revenues. While the artistic and creative aspects can be debated within the humanities, the motion picture industry's products and uncertainty qualities from an economic perspective has been marked as inherently different from other industries making common methods for improving performance irrelevant (Eliashberg, Weinber, Hui, 2008). The struggle between artistic production and a motion picture studio's desire to maximize profits potentially creates differences in the production of a movie. Moreover, movies with long production cycles, high production costs, and a network of actors in the production and distribution of the final product reinforce the need for correct and accurate forecasts of box office revenue. Not only do decision making styles differ from the network of actors in the production and distribution but it is the information and knowledge that each one holds that has the potential to improve performance in demand forecasting of box office revenues.

Box office success prior to movie production and release are associated with high levels of uncertainty for customer demand (Sawhney & Eliashberg 1996, Eliashberg et al. 2000), which has led to a high percentage of films failing; further emphasizing that film forecasting is largely nonscientific. Such a view can be seen in long-time president and CEO of the Motion Picture Association of America Jack Valenti's statement *"…No one can tell you how a movie is going to do in the marketplace… not until the film opens in darkened theatre and sparks fly up between the screen and the audience"* (Valenti, 1978). Others have expressed predicting demand for Hollywood movies to be more of a "*wild guess*" (Litman and Ahn 1998). Lack of accurate forecasting in the film industry could be due to lack of historical data for traditional forecasting methods or because few movies are being made at each studio making demand predictions difficult if not impossible using traditional support models of forecasting. A new movie launch entails coordination tasks from studio companies, production houses, distributors, marketing companies, and retailers (Sawhney & Eliashberg 1996, Eliashberg et al. 2000) creating a complex environment in motion picture production. These actors, which interact directly or indirectly throughout the supply-chain, offer insight in a new motion picture production that potentially positions their information and knowledge as important components in forecasting demand to this challenging problem in the motion picture industry.

With high financial stakes involved and significant failure rates it is understandable that movie studios and production houses are willing to invest in new methods to accurately predict box office success (Davenport & Harris, 2009). To accurately capture the information and knowledge in each of the production and distribution network provides a unique setting for comparing different forecasting methods using expertise/ knowledge supported by decision support technologies. With this in mind, motion picture studios have recently begun to implement decision support technologies into their decision making process but have taken different approaches to demand forecasting of box office revenues. The objective of this study is to analyze of the polarity of decision support technology being implemented in the motion picture industry. Focus will be given to the underlying locus of knowledge and an attribute comparison within. It is argued that, salient assumptions to the locus of knowledge are embedded attributes in the polarity of decision support technologies being implemented and address different problem frameworks.

The paper is outlined as follows: first a review of the role of forecasting in supply-chain management in Section 2. Section 3 we introduce the management of knowledge in decision support technology and then describe the role of knowledge representation in expert systems (ESs) and collective intelligence tools (CI tools), and Section 4 compares the two decision support technologies. In Section 5 we offer two different approaches to forecasting in the motion picture industry. In Section 6 an example of how future uses of CI tools can be made for real time demand forecasting. Section 7 provides a discussion and future work that has emerged from this study. Conclusions from this research appear in Section 8.

## 4.2 State of the Art: Role of Forecasting in Supply-Chain Management

The demand forecast forms the foundation for strategic and tactical planning decisions within the supply chain management process. Often these forecasts are inaccurate resulting in increased production costs and missed opportunities (Erhun, Goncalves, & Hopman, 2007). A forecast of future demand is essential to an organizations planning process which consists of the management and coordination of the flow of materials, information, and funds across the entire supply-chain, from suppliers, producers, manufactures, distributors, and consumers (Silver, Pyke, & Peterson, 1998). The first step for supply-chain managers and organizations is anticipating customer demand, which impacts decisions in each phase or step within the supply-chain network such as the level of production needed and the capacity to fill it. Other functional areas that decisions based on demand forecasts are: production including the scheduling, inventory control, and aggregate planning, marketing made up of the sales-force allocation, promotions, and new product introduction, finance for equipment availability, budgetary planning, and workforce planning. A number of models have been used to try and support demand forecasting but have marginal effects on accuracy of initial box office revenue forecasting (Eliashberg and Shugan, 1997; Jedidi et al. 1998; Ravid, 1999; Swami et al. 1999; Basuroy et al. 2003). These studies have primarily focused on linear regression modeling or diffusion models in demand forecasting of box office revenues using varying distribution models. Alternatively, various explanatory variables have been linked to the study of demand forecasting literature such as: star power (De Vany and Wallsm 1999; Ravid, 1999), movie release time (Krider and Weinberg, 1996), movie competition (Ainslie, Dreze and Zufryden, 2003), word-of-mouth (Dellarocas, Zhang and Awad, 2008), message board posts (Liu, 2006; Duan et al. 2005), and expert critic reviews (Eliashberg and Shugan, 1997; Basuroy, Chaterjee and Ravid, 2003; Reinstein and Snyder 2005). Though several of these studies have been able to show explanatory power in several of these variables many focused on post-release of the motion picture undermining the production investment problem prior a motion picture has been made.

Since it is not uncommon for demand forecast to be wrong or inaccurate due to the complexity of predicting, members in the supply-chain responsible for any portion to deliver a product or service often make different independent decisions based on their information within the same supply-chain. This mutuality among the supply chain members within coordination and logistics research argues for creating a creating a collective knowledge base (Senge, 1990). This includes an overall picture shared among the supply chain members from end-to-end in the supply chain process (Goldratt, 1994). This collective knowledge base has been linked to concepts of integration that consists of information, logistics coordination and organizational relationship linkage (Lee, 2000). This has been extended in the form of coherency by Lissack and Roos (2001) for supply chain members to make sense of the turbulent environment in building a common viewpoint, purpose and action and shared goals through information sharing and collective learning. The collective learning capacity from the organizations knowledge is thought to be a main source of competitive advantage (Kogut and Zander, 1992; Barney, 1991) and if combined with appropriate technology to be a strategic capability impacting decision making (Zack, 1999). If organizations are to move to a common viewpoint through collective learning by leveraging organizational knowledge to produce common demand forecasts, the capabilities of an organization to produce demand forecasts must also be considered. These capabilities can be viewed from a knowledge perspective held by individuals within the supply chain members and in the technologies organizations' employ. From this perspective technology can be seen as a facilitator for knowledge management due to the dynamic nature of the supply chain (Sher and Lee, 2004). This point suggests space for a human-computer system that captures the knowledge from individuals and from knowledge management systems organizations utilize for a collective knowledge base. To this end, collective learning is potential through an emergent for of knowledge. To continue this scope, accommodations must be made for emerging technology that offers new methods for forecasting demand further aligning knowledge as a strategic resource for decision making. It is argued that, if the supply chain members want to maintain their competitive edge within the supply chain network and each member's knowledge impacts the creation of a shared vision, then the creation of shared decision support technology for improvement of demand forecasting potentially is beneficial. We move to a relational framework to highlight knowledge representations through human and technological levels.

## 4.3 Introducing Knowledge by means of Decision Support Technology

Considering knowledge is not only restricted to human beings- rather technology's capacity to increase an organizations knowledge processing and decision making capacity ability, organizations have allocated significant resources to leverage knowledge using technology. Though managed differently, knowledge used within these support systems underline the foundational theories for use. To help understand the role technology is playing in decision-making, a relational framework illustrating the human counterpart to the decision support technologies that organizations use and are emerging in popularity due to ubiquity of available technology. Each technology or system has been built to better capture knowledge or represent knowledge in the cognitive process of the decision-maker(s) for effective decision-making to occur (Barton, 1987; Liou & Nunamaker, 1990; Smith, 1994).

Organizations may choose to use technology to represent knowledge within their organization for decision support instead of relying on human experts. Table 4.1 is suggested that shows a relational framework with a comparison of the prevailing human and decision support technologies use for forecasting and the centralized and decentralized nature of knowledge. On human level organizations can turn to a centralized human expert for decision-making for forecasting or through the collection of the availing opinions, feelings, and needs using a decentralized method of surveying, polling, or voting. These methods are used in organizations however, have limitations extensively addressed in decision theory research (Simon, 1947; March & Simon, 1958).

**Table 4.1:** Human and Technological Ways to Represent Knowledge

| | ***Centralized Knowledge*** | ***Decentralized Knowledge*** |
|---|---|---|
| ***Human*** | ■ Human Expert | ■ Survey/ Polling/ Voting |
| ***Technology*** | ■ Expert Systems | ■ Collective Intelligence Tools |

On the technology level, organizations have used ESs to replicate human experts for various problem-solving and knowledge in narrow domains of decision-making or domain specific learning. Recently, organizations are turning to capture distributed knowledge when expertise may not be available or in ill-structured problems from employees and customers through CI tools. Using knowledge types as a dimension identified by Nonaka & Takeuchi (1995), Table 4.2 shows the relationship between the types of knowledge within ESs and CI tools in a two-by-two matrix considering implicit and explicit knowledge. This reflects the dynamism between the different types of knowledge that decision support technologies support. Conceptual categories and examples are offered for understanding of knowledge types within ESs and CI tools.

**Table 4.2:** Types of Knowledge in Expert Systems and Collective Intelligence Tools

| | **Expert Systems** | **Collective Intelligence Tools** |
|---|---|---|
| **Explicit** | • Cognizant (Codified knowledge and rule-based information) | • Aggregate (Product from collaborative work, Linux operating system, Wikipedia, collective prediction, multi-player games) |
| **Implicit** | • Automatic (Heuristics and AI Techniques used to determine decision making methods) | • Collective (raw Web content and human interaction in the Web- links, blogs) |

The expert system category considers a single frame of knowledge, generally from an individual expert or knowledge that is agreed upon from a group of experts and is made up of formal knowledge, practical knowledge, and self-regulative knowledge (Sternberg, 1997). Collective intelligence tools assume a group or mass amounts of people, distributed or not in coherence to a single frame of knowledge. In Table 4.2 the interaction within each column conducts different models of knowledge. For instance, cognizant indicates a high level of formal knowledge. The field of artificial intelligence (AI) has significantly excelled at solving problems in this caste using formal logic such as if-then programming. In the automatic quadrant practical knowledge is prevalent. Here different heuristic or AI techniques can be implemented to try and find the right practical method for problem-solving for decision-making. Knowledge that is self-regulative or learned through experientially would be represented and would fall in this quadrant. This quadrant's knowledge would be the knowledge gained through apprenticeships and knowledge that cannot be codified.

The CI tools category contains knowledge that has been aggregate or subject to the public domain. This is a product from the collective quadrant and the actions of many to produce explicit knowledge such as Wikipedia entries, open sourced operating systems, or forecasts using prediction markets is found here. Here knowledge can be linked to the formal and practical knowledge of expertise. The collective quadrant knowledge, which holds new knowledge to the self-regulative interplay of practical and formal knowledge, forms from many individuals' cognizant and automatic knowledge. This is a social process that creates the collective, which will bring to bear the aggregated category of knowledge through the use of CI tools.

### *4.3.1 Leveraging knowledge through expert systems (ES)*

Expert systems are one decision support technology used by organizations to represent knowledge for learning and decision making. ESs, a branch of artificial intelligence, are contributing to decision-making through their representation of knowledge and reasoning of human experts for its users (Weiss & Kulikowski, 1984) and have been a source for competitive advantage (Gill, 1995) in the banking, insurance, and credit card industries. By mimicking and replicating the cognitive process of a human expert, novice users can be supported to perform as well as experts (Cascante, Plaisent, & Bernard, 2002) while expert users can have their expertise further refined. By emulating an expert's problem-solving ability, knowledge and reasoning are transferred to a user through the use of ESs for faster learning and decision-making than would occur when developing these skills over time. The main function of an expert system is to represent expertise to its users for decision-making when a human expert cannot be found or is in short supply.

ESs have gained some legitimacy as an alternative to human experts since the 1970's, when the expert system- MYCIN was found to perform better or equally as well at diagnosing meningitis in blood as human experts (Shortliffe, 1976; Shortliffe & Buchanan, 1984). ESs are constructed with four main components- knowledge base component, heuristic engine component, user interface, and explanation module. The knowledge-based component consists of the factual knowledge a human expert would have of a specific and narrow domain, while the heuristic knowledge or expertise is based on intuition, experience, and judgment to apply rules efficiently under uncertainty or with incomplete information. The user interface component allows the user to interact with the system but it is the explanation module that queries the user for more information. As the user responds by answering the questions presented through the explanation module, the new information is then incorporated in the decision-making process of the mimicked expert and finally responds with a justification for solution, which is a critical factor for system intelligence (Woodridge & Jennings, 1995). The end decision, resulting from the dialogue and collaboration between the user and mimicked human expert is valuable for organization. For example, researchers have (Murphy & Yetmar, 1996) found that users' interaction with the expert system while verifying information may impact whether the user accepts the system's output for consideration in decision-making. The explaining and rationale why a decision is made, is possible through a knowledge acquisition process, which is generally from one specialized expert and one line of reasoning. Knowledge-acquisition is the diffusion of problem-solving expertise from some knowledge source to a program (Buchanan, Barstow, & Bechtel, 1983). Pointed out by researchers (Feigenbaum, 1977), the power from ESs derives from the knowledge it possesses.

Though many organizations have successfully implemented ESs to address particular problems in a narrow domain, changing external factors impacting competitiveness and sustainability have forced organizations to approached critical decisions differently. Studies indicate (Gannon, 1979), the more complex organizations become the fewer decisions are made by any single individual (or expert system). Rather than rely on knowledge from one individual or system for an important decision, businesses turn to groups of people and the support technology to support them in the decision-making process (Shim, Warkentin, & Courteny, 2002). Furthermore, groups of people may be necessary when diverse subsets of knowledge are required and no single expert or ES has complete knowledge of the problem.

In addition to no one single person or system having complete knowledge of a problem, a new organizational paradigm (Tapscott & Williams, 2008) has emerged transforming away from a half century of support system development and research that centralized decision-making for experts, to a decentralized model of managing external capabilities, resources, and information of the organization. In organizations, decision-makers do not have access to all the information they need when making a decision (Dye, 2008) and thus, effective decisions can be compromised.

Three potential reasons why critical information is not accessed by decision-makers could be: conventional methods and technologies insulate information flow to only a select group of people, decision-makers do not ask for all the information accessible to them, or those who have it do not share because of political or social reasons (Mauboussin, 2008). As a response, emerging CI tools are alleviating these constraints providing a method for building a collective knowledge base.

Clay Shirky (Shirky, 2008), calls for the tapping of the underused human potential that organizations have access to. One way to utilize what Shirky call "cognitive surplus" is by using the CI tools that harness the power of cognitive diversity or groups of people for reasoning, perspectives, and problem-solving abilities. Scott Page (2007) expressed within his "Diversity Prediction Theorem" that being different cognitively is as important as ability. In addition for cognitive diversities ability to increase accuracy, diversity helps to avoid groupthink or flawed reasoning on solution convergence.

### *4.3.2 Leveraging knowledge through collective intelligence tools*

Based on the premise that the collective judgment of a large group is better at predicting and forecasting future events than individual experts or small groups of experts (Hanson, 1999; Berg, Nelson, & Rietz, 2001b; Surowiecki, 2004; Wolfers &

Ztzewitz, 2006), collective intelligence offers an alternative to the constraints of information flow in decision-making and increases forecasting accuracy of uncertain events.

Researchers have focused on the benefits of collective intelligence tools such as increased organizational information processing, quick aggregation of knowledge, and forecasting ability (Berg, Forsythe, Nelson, 2001a; Berg & Rietz, 2003, Cowgil, Wolfers, & Zitzewitz, 2008). Investigation has also explored how collective intelligence tools can be used in the organization for decision-making (Ho & Chen, 2007). Accordingly, the primary goal of CI tools is to facilitate the summative body of knowledge, information, and resources of its users.

CI tools contrast sharply to traditional decision support tools because of their ability to democratize decision-making by including many people in and outside the organization into the information gathering and decision-making process. Diverging from traditional thought where high levels of expertise are seen as the best source for decision-making, CI tools have the ability to harness lower levels of expertise and fragmented knowledge for decision-making (Page, 2007). Decision-makers and organizations that use CI tools do not need to rely solely on their resources', but can benefit from resources freely shared by others outside the organization.

Prediction markets, a CI tool can be defined as markets that are designed for the purpose of collecting and aggregating information that is scattered among the traders (users) who participate so information can be reflected in the market (Berg & Rietz, 2003; Wolfers & Zitzewitz, 2006). Instead of independently-derived individual predictions, predictions markets enable a collaborative evaluation process. Derived from the efficient markets hypothesis, markets are expected to be the best predictor of unknown future events and should be seen as a complement to executives and experts to aid in information flows to make decisions more quickly and accurately.

Much like a real market, traders (users) purchase contracts or "futures" to some expected outcome at the going market rate and if corrected are rewarded monetarily or through visibility within the organization based on the accuracy of the information they provide by participating. When individuals buy or sell contracts based on the information they have, individuals will be rewarded as the contract rises in value based on the increased likeliness of that outcome occurring.

Seeking to push decision-making down the corporate ladder, external information into the organization, and information up toward the top, CI tools incubate the hidden information that is scattered around the organization or network to be discovered that allows non-experts to produce expert like results when collectively mobilized (Scott, 2007). By including a wide spectrum of stakeholders from employees inside the company, suppliers and customer outside the company into the decision-making process, organizations can create opportunities to augment their knowledge needs for a competitive advantage by using a large group of people even if individually they have only a partial view of a given problem. Famous economist F. A. Hayek emphasized *"Each member of society can have only a small fraction of the knowledge possessed by all, and… to over come that limitation… utilization of knowledge… but by the utilization of knowledge which is and which remains widely dispersed among individuals."* Companies that choose to use CI tools leverage resources of knowledge, information, and problem solving far beyond what they could afford to deploy internally.

Use of CI tools by companies has had some success; however, much is still unknown about these tools and their impact. Future challenges may include using collective intelligence tools not as a replacement for experts but as an additional tool in decision-making. Traditional roles of experts may change and represent a mindset shift from answer givers to inquiry mediators in effort to harness the knowledge of the masses in decision-making. Today the Internet has made it easier and more cost effective for companies to implement such tools to guide information flow and in decision-making (Howe, 2008). However it is the organizations choice and ability to effectively manage the collective intelligence of its resources. One way organizations can manage information flow is to build CI tools into the supply-chain network for real time demand forecasts.

## 4.4 Attribute comparison

A review from the different decision-support technology literature, one can cite site important attributes between an ES and CI tools. Using established dimensional attributes (Aiken et al. 1991; Turban and Aronson, 1998; Turban and Watkins, 1986), Table 4.3 summarizes what is evident as the major attributes between ESs and CI tools. In comparison to the *objectives* of the support technologies, an ES is to advise a decision-maker by replicating the expertise of a human expert, where CI tools support the aggregation of information and knowledge from many people. Though both support technologies are used to support individuals or groups and in making recommendation, *the problem area characteristics* and *problem type* are different. An ES focuses on narrow domain or structured problems and is used to treat repetitive problem types, while CI tools are used to address forecasting/ prediction, probabilistic and dispersed collaborator problems, making the problem area best addressed when there is limited variability.

**Table 4.3:** Attribute Comparisons of Expert Systems and Collective Intelligence Tools

| Attribute | ES | CI TOOLS |
|---|---|---|
| Objective | Replicate or mimic human experts/ or replace human | To sum the knowledge and information of many people |
| Who makes the recommendation (decision)? | The system or heavily weighted if human is involved | The System/ Tool |
| Major orientation (characteristic) | Transfer of expertise (human-machine-human) | Transfer of hard to find information or qualitative to quantitative data from dispersed agents to decision-maker |
| Operating costs | Expensive retooling if external environment assumptions change | Minimal operating costs |
| Nature of support | Individual or group | Individual or group |
| Problem area characteristic | Narrow domain | Limited variability |
| Type of problem treated | Repetitive | Forecasting/ dispersed collaborators/ Probabilistic |
| Valuation or assessment | Based on expert opinions/ user friendliness of interface | Price and volume of contributions (trades) |
| Reasoning capability | Yes (induction & deduction) | Yes (induction & deduction iterative process) |
| Assumptions | Closed-world | Changing |
| Expertise Level or In-depth knowledge of problem | Specific/ Expert Level | All levels including learning capacity with use |

Both support technologies are used to transfer knowledge while the *major orientations are* different. An ES is to transfer knowledge from human to machine in the development stage and back to the human decision-maker once implemented. CI tools are to transfer hard to find information from dispersed agents to the decision-maker. CI tools play a role in transforming qualitative variables into quantitative data. The decision-maker can use assessments based on the expert recommendation on who built the ES and the friendliness of the interface, while assessments of the recommendation is based on users experience and interaction with CI tools. ESs can use deductively or inductively *reasoning* because of its factual procedural and knowledge based content, while CI tools use an iterative back and forth, inductive and deductive reasoning based on the knowledge from its users.

Additionally, an ES creates recommendation on closed-world *assumptions*, oppose to recommendations based on the open-world or continuous changing assumptions with CI tools. Once the different support technology is implemented into an organization they differ in the operating costs. An ES operating costs could be significant and expensive to retool or reengineer the embedded knowledge that makes an ES valuable; in contrast CI tools have minimal operating costs due to the decreasing cost of web technologies. It is important to suggest that though operational costs in implementing CI tools are a fraction of ESs, the extent of developing and maintaining a network or community of users is understudied. By definition, ESs have a high *level of knowledge* on a specific problem, while CI tools support a variable level of knowledge which is dependent on the users involved.

Figure 4.2 illustrates several characteristics that define the poles of decision-support technology. At one end of the pole you have ESs, which uses systematic analysis based on rules and clearly defined variables for *assessment*. CI tools assessments are built from users' individual experiences that maybe not be precise, but are reconfirmed or connected by other users' individual experiences. *Interaction* is limited with an ES; usually limited to one user to transfer knowledge, while interaction using CI tools encourage highly interactive exchanges of information and knowledge between its users. Accordingly, an ES acts as the centralized point in the *hierarchy* where information is funneled to from different areas to make a make a decision. Accordingly, an ES acts as the centralized point where information is funneled to and from different areas to make a make a decision. CI tools facilitate a distributed structure where information from large groups can be harnessed for decentralized decision-making to occur. Finally, the *users* on the poles of decision-support differ. ES users are internal employees of the company, while CI tools can encompass the complete spectrum of any stakeholder network. As a result and further differentiating the poles is the spectrum of knowledge. At one end, ESs focuses on a narrow dominion of knowledge and as the decision support technology moves to the opposite pole a gradual broader domain of knowledge is represented.

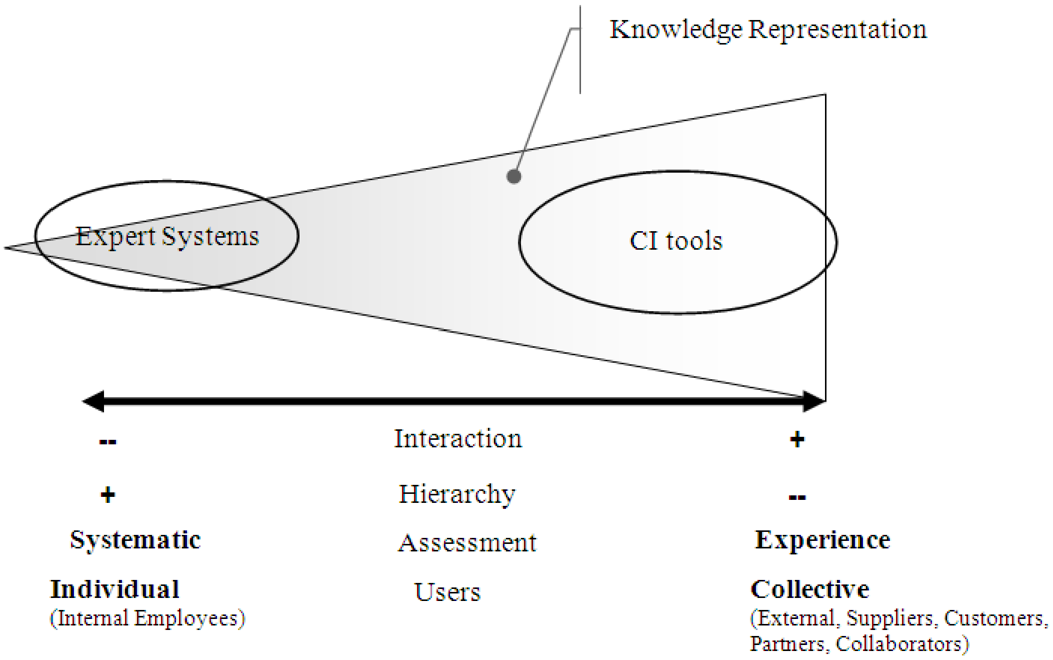


**Figure 4.2:** Poles of Decision Support Technology

## 4.5 Approaches to Forecasting

To demonstrate the application of the different forecasting methods a review from the film industry will be used. An introduction of how movie studios are using ESs and CI tools to help make better box-office revenue predictions to manage demand and supply-chain network follows.

### *4.5.1 Expert System Approach to Forecasting*

Epagogix Ltd. a UK-based company has developed an expert system to predict box office revenue prior to movie production (www.epagogix.com/). Epagogix's proprietary expert system, based on a neural network (algorithms) analysis, uses movie script attributes to correlate future success or failures on past movies produced. Using neural network algorithms, Espagogix is "training" and modeling how the human brain may operate using data and rules to determine customer interest for a movie. The expert system uses variables such as genre, star actors, technical effects, and release time to find statistical patterns to forecast financial success. Success designated by box office revenue helps to ensure whether a movie will recover its costs and likely hood to be made and is extremely valuable to movie studios.

In addition, to being able to forecast, Epagogix's expert system is also able to make recommendations either to reduce costs based on production or increased opportunities for greater box off revenue success (Davenport & Harris, 2009). Since the actors involved in making a film are key members in the supply-chain network, knowledge on possible future revenue may provide a key factor in recruiting actors who are paid as percentage of box office revenue possibly helping to optimizing another step in the value chain.

### *4.5.2 Collective Intelligence Tool Approach to Forecasting*

Started in 1996, the Hollywood Stock Exchange (HSX) (www.HSX.com) is an internet based stock exchange where participants trade shares of virtual stocks that bet on the future box office revenue of movies. Participants who join are given two million "Hollywood Dollars (H$)" to buy and sell shares of movie stocks. Each trader individually bets on movie stocks based on their believed future market demand for that movie stock, which is then aggregated based on the efficient market hypothesis to best represent market expectations for box office receipts. Open 24 hours a day, 7 days a week, the 25,000 daily users (www.hsx.com/) are able to start trading on a movie from its IPO or the date a movie deal has been announced to exchange news, gossip, or thoughts about the future film.

Once the future event occurs or the known box office revenue is recorded, shares in the movie stocks are exchanged for cash dividend or payoff equal to $1 for each share owned. Dividend payoff and community recognition are incentives for participants to participate and invest time and information in the HSX. Because of the availability to trade via the Web, traders are able to make new predictions as they acquire new information, making trades reflect in real-time stock prices and predictions of the future market demand for the movie.

HSX popularity with its users and with corporate stakeholders has grown. M. Singer a corporate forecast analyst states *"We use the Hollywood Stock Exchange to assess what market expectations are for a film"* (*International Hearld Tribune*). Spann and Skiera (2003) found that HSX performance compared to only two human film column writer experts forecasting accuracy was encouraging. Not only is HSX being used to forecast box-office revenue, its impact continues to grow. HSX has aided both academic and market research to determine impact of advertisement on market expectations prior to release (Elberse & Anand 2007) and star power influence on movie success (Elberse, 2006).

It is clear from the effort and expense that organizations are making that great importance is made on forecasting future box office revenue. Traditional methods of forecasting will continue to used, but alternatives to statistical modeling and pattern recognition have emerged, both challenging other methods and possibly enhancing them. The Web for combined with the collective knowledge of many has transformed the ambiguities and uncertainties of movie forecasting into a consumer interactive predictive market.

## 4.6 Real Time Demand Forecasts Using CI Tools

Expensive and complicated solutions such as supply-chain or demand management software have been used in the past to aid organizations in managing their supply-chain process. However, today CI tools allow a multichannel, multilevel approach to information collection from each member in the supply-chain network that portrays the full spectrum of value chain constituents from beginning-to-end and in real time. By using CI tools and centralizing the coordination of demand forecasting, collaborators across the supply-chains are brought closer to respond to changing industry trends while continuing to add value to the supply-chain network. In addition to integrating the supply-chain networks information and eliminating uncertainty as a result of demand forecast that are static, CI tools are helping to understand the customer's needs by bringing the customer into the supply chain network.

Real time demand forecasts using CI tools makes information highly visible across the entire supply-chain, while providing real time information that can be viewed from the CEO level to the warehouse floor. Implementing CI tools takes supply-chain management to the next level by enabling the network to map demand against each partner's ability to meet the forecast, which provides synergies across the different collaborators. For example, if any member in the supply-chain network has information and insights that can aid in planning and forecasting decisions, methods must be introduced to collect, aggregate that information, and transform it into intelligence. This intelligence supports "feedback loops" for coordinating the supplies for a product or service on a continuous basis, making it possible for each partner in the supply-chain network to strengthen profitability, gain market share, keep inventory lean, and continue to meet market expectations.

Though there are different types of supply chains each with different characteristics in regards to decision-making, having access to the same information to monitor demand is crucial all supply chains. Different entities on the supply chain operate under different sets of constraints and objectives; however are highly depend on meeting the expectations based on the supply chain. Added information to help meet these constraints provides recourse to meeting the demands. Figure 4.3 is a representation of how CI tools can facilitate information flow for demand forecasting across the motion picture industry supply chain network.

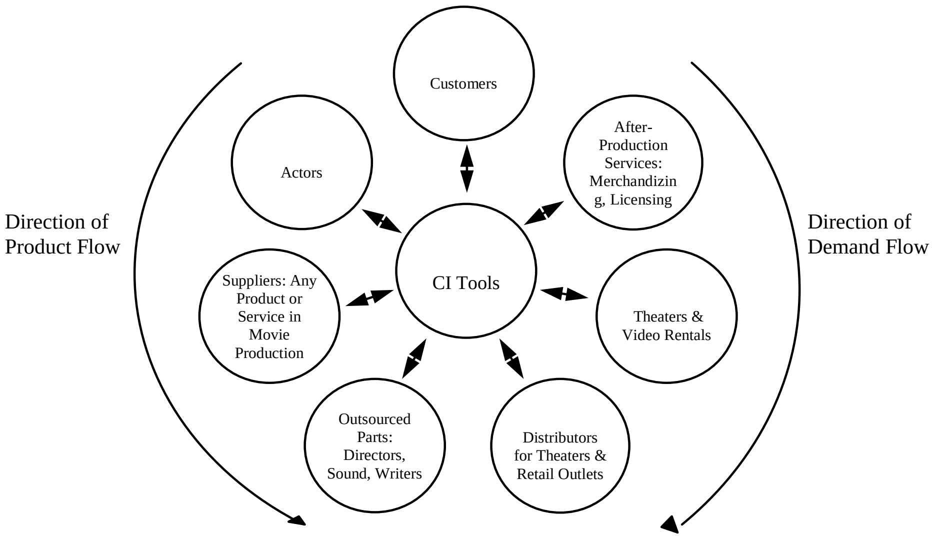


**Figure 4.3:** CI Tools for Real Time Forecasting in Film Industry Supply-Chain

In a recent survey published (Constantine, Ruwadi, & Wine, 2009), organizations who took a multilevel and cross-functional approach to decision-making were twice as likely as other companies to use information from the different members in the supply chain network resulting in being leaders of the companies in low levels of inventory, cost leaders, while maintaining customer service. In addition, the study highlighted that formal IT systems did not improve the supply chain performance as expected. Finally, the study (Constantine et al. 2009) showed that an integrated sales and planning process made-up of different supply chain members was more effective in producing organizations as leaders in inventory management and cost, oppose to have strong individuals with supply-chain or functional expertise within the supply-chain network. This is evident in one executives comment, *"Our (IT) systems cannot be smarter than our colleagues (network), or we will have problems. (p. 4)"*

CI tools represent a radical shift in how many industries will operate based on real-time data allowing for new logistical solutions. This can guide supply chain management decisions. The earlier in the production cycle accurate demand is forecasted the more time and effective execution can be made within the supply chain network to maximize profit and efficiencies. Information gathered through CI tools in information flow that encourages supply chain partners to capitalize on opportunities and rectify inefficiencies and in remaining agile. The firm's ability to respond to the changing demand forecast requires managing the critical constraints making the difference between success and failure. The more prepared a company in decision-making for the allocation of resources the more successful it will be.

## 4.7 Discussion and future work

Past attempts to enhance the quality and efficiency of collaborative work through system integration has shown compatibilities between ESs other decision support technologies such as, group decision support systems (GDSSs) (Aiken et al. 1991) and decision support systems (DSS) (Turban and Watkins 1986). This paper provides a foundation comparing the emerging CI tools and ESs and should be seen as first step for further investigation into this area. Given that research and use into CI tools are in a formative stage, exploration into how different the artificial intelligence (AI) techniques can enhance CI tools use. Such examples would be to introduce improve CI tools interface with query options that draw full reasoning out of the users for transparency and reduced heuristic biases. Additional research may attempt draw on users who are not likely to participate in CI tools. This has the potential to incorporate even more hard to find information or hidden knowledge where existing incentives do not motivate participants. Much like the CI tool- Digg, which monitors users recommendations on web postings, research opportunities exist for AI techniques to manage trading patterns of users in CI tools such as, prediction markets or information markets to identify possible market manipulation or trading biases.

Other areas of research may include benefits to simplify the use of CI tools by transforming these tools from passive agents that collect and aggregate information and knowledge into active agents that enhance interaction and solicit information from its users based on trust and creditability. Since participation is critical for the benefits of collective intelligence to be realized, opportunities exist to add intelligent components to CI tools.

The framework provided can be used for future studies how ESs and CI tools can be integrated taking advantage of each and achieving greater synergies for overall decision making. The possibility of a hybrid system would differ from the approach either of the considered methods and would combine different knowledge domains, aggregating results using the different forecasting techniques (Blattberg & Hoch, 1990; Armstrong, 2001). If a hybrid system was considered the combining of analytical approaches where one may provide an input to the other and vise a versa, may yield interesting results concerning the interaction between the two forecasting techniques and new information to be examined. Finally, we have seen through the literature a research gap comparing forecasting accuracy between available ESs and CI tools, in which this study hopes to provide the foundation for.

## 4.8 Conclusions and future work

Decision support technologies are supporting supply chain management by aiding organizations in the managing of this complex environment. ESs and CI tools are two decision support technologies organizations are implementing to forecast demand. These decision support technologies, which support the management of knowledge, represent the polarity of decision support technologies that organizations have at their disposal in dealing with the complex supply chain process. Using a relational framework in how technology can represent knowledge we compared ESs and CI tools attributes. By highlighting various characteristics on the poles of decision-support technology, ESs and CI tools differences and future synergies emerged. In summary, organizations have a wide spectrum of choices to help in knowledge management using decision-support technologies. As organizations and technology evolves, we propose that decision-support technology is not moving toward or away from narrow domain knowledge for forecasting, but instead are taking more of a broad perspective on how knowledge within the organizational network can be utilized for forecasting creating a shared perspective of the future. We suggest that organizations that incorporate a wide variety of tools in the decision-making process can build a strategic capacity to harness knowledge in the organizational network to build a competitive advantage.

## References


Ainslie, A., Dreze, X. and Zufryden, F. (2003). Modeling Movie Lifecycles and Market Share. *Marketing Science,* 24(3): 508-517.

Aiken, M., Liu Sheng, O., and Vogel, D. (1991). Integrating expert systems with group decision support systems, *ACM Transactions on Information Systems* (TOIS), 9(1): 75-95.

Barton, A. (1987). Experiences in Expert Systems. *The Journal of the Operational Research Societ*y, 38(10): 965-974.

Basuroy, S., Chatterjee, S., and Ravid, S.A. (2003). How Critical are Critical Reviews? The Box Office Effects of Film Critics, Star Power and Budgets. *Journal of Marketing.* 67(3): 103-117.

Berg, J., and Rietz, T. (2003). Prediction Markets as Decision Support Systems. *Information Systems Frontiers*. 5(1): 79-93.

Berg, J., Nelson, F., and Rietz, T. Accuracy and forecast standard error of prediction markets. (*Working Paper)* The University of Iowa, 2001.

Buchanan, B.G., Barstow, D., Bechtel, R., Bennett, J., Clancey, W., Kulikowski, C., Mitchell, T. and Waterman, D.A. (1983). *Constructing and Expert System, I Building Expert Systems*, Hayes-Roth, F., Waterman, D.A. and Lenat, D.B. (eds), pp. 127-167, Addison-Wesley, Reading, MA.

Cascante, L., Plaisent, M., Bernard, P., and Maguiraga, L. (2002). The impact of expert decision support systems on the performance of new employee. *Information Resource Management Journal*, 15(4): 67-78.

Chi, M. T. H., R. Glaser, and M. J. Farr. *The Nature of Expertise.* Hillsdale, NJ: Erlbaum, 1988.

Constantine, B., Ruwadi, B, and Wine, J. (2009). Management Practices that Drive Supply Chain Success. *The McKinsey Quarterly*, 4: 46-59.

Davenport, T. and Harris, J. (2009). What People Want (and How to Predict It). *Sloan Management Review*. 50(2): 23-31.

De Vany, A. and Walls, D. (1999). Uncertainty in the movie industry: Does star power reduce the terror of the box office? *Journal of Cultural Economy,* 23(4): 285-318.

DeSantics, G. and Gallup, R. (1987). A Foundation for the Study of Group Decision Support Systems*.* *Management Science*, 33(5): 589-609.

Dye, R. (2008). The Promise of Prediction Markets: A Roundtable. *McKinsey Quarterly*, 2: 83-93.

Elberse, A., and Anand, B. (2007). The effectiveness of pre-release advertising for motion pictures: An empirical investigation using a simulated market. *Information Economics and Policy*, 19(3-4): 319–343

Elberse, A. The Power of Stars: Do Star Actors Drive the Success of Movies. (*Working Paper)*. Harvard Business School, 2006.

Eliashberg, J., Jonker J.-J., Sawhney, M.S., and Wierenga, B. (2000). Moviemod: An implementable decision-support system for pre-release market evaluation of motion pictures. *Marketing Science*, 19(3): 226–243.

Eliashberg, J., and Shugan, S.M. (1997). Film critics: Influencers or predictors? *Journal of Marketing*, 61(2): 68-78.

Erhun, F., Goncalves, P. and Hopman, J. (2007). Managing New Product Transitions, *Sloan Management Review*, 48(3): 73-80.

Epagogix's Web site, www.epagogix.com/. Accessed February 18th 2008.

Feigenbaum, E.A. (1977). The Art of Artificial Intelligence: Themes and Case Studies of Knowledge Engineering. *International Joint Conference on Artificial Intelligence,* 5: 1014-1029.

Gallup, B. (1985). The impact of task difficulty on the use of a group decision support system. *Ph.D. dissertation*, Dept. of Information and Decision Sciences, Univ. of Minnesota.

Gannon, M. *Organizational Behaviour: A Managerial and Organizational Perspective*. Boston: Little, Brown, 1979.

Gill, T. (1995). Early Expert Systems: Where are they now*? MIS Quarterly*, 19(1): 51-81.

Goldratt, E. *It's Not Luck,* North River Press, Great Barrington, MA, 1994.

Hanson, R. (1999). Decision Markets*, IEEE Intelligent Systems*, 14(3): 16-19.

Hartley, R. (1985). Expert System Methodology: A Conceptual Analysis. *International Journal of Systems Research and Information Science,* 1(1): 11-22.

Hollywood Stock Exchange, www.hsx.com/. Accessed February 18th 2008.

Ho, T. and Chen, K. (2007). New Product Blockbusters: The Magic and Science of Prediction Markets. *California Management Review*, 50 (1): 144-158.

Howe, J. *Crowdsourcing: Why the Power of the Crowd is Driving the Future of Business.* Crown Business, 2008.

Huber, G. P. (1982). Group decision support systems as aids in the use of structured group management techniques. *In DDS-82 Conference Proceedings*, 96-108.

Huber, G.P. (1984). Issues in the Design of Group Decision Support Systems, *MIS Quarterly*, 8(3): 195-204.

Jackson, P. *Introduction to Expert Systems*.(3rd) ed. Pearson Addison Wesley, 1999.

Jedidi, K., Krider, R.E., and Weinberg, C.B. (1999). Clustering at the movies. *Marketing Letters,* 9: 393-405.

Johnson, E. M. & Whang, S. (2002). E-Business and Supply Chain Management: An Overview and Framework. *Production and Operations Management*. 11(4): 413-423.

Krider, R. and Weinberg, C. (1998). Competitive Dynamics and the Introduction of New Products: The Motion Picture Timing Game. *Journal of Marketing Research,* 35: 1-15.

Lee, H. (2000). Creating value through supply chain integration. *Supply Chain Management Review,* 4(4): 30-36.

Lee, H., Padmanabhan, V. and Whang, S. (1997). The bullwhip effect in supply chains*. Sloan Management Review,* 38(3): 93-102.

Liou, Y. and Nunamaker, J. (1990). Using a Group Decision Support System Environment for Knowledge Acquisition: A Field Study. *Proceedings of the ACM SIGBDP conference on Trends and directions in expert systems*. Orlando, Florida, United States, 212 – 236.

Lissack, M. and Roos, J. (2001). Be coherent, not visionary, *Long Range Planning,* 34(1): 53-70.

Litman, B., and Ahn, H. *Predicting financial success of motion pictures*. In: Litman, B.R. (Ed.), The Motion, 1998.

Litman, B.R., Kohl, L.S., 1989. Predicting financial success of motion pictures: The ’80s experience. *Journal of Media Economics* 2: 35–50.

Malone, T. *The Future of Work*. Harvard Business School Publishing, 2004.

March, J. and Simon, H. (1958). *Organizations*. Wiley, 1958.

Mauboussin, M. (2008). What Good Are Experts? *Harvard Business Review.* 1: 43-44.

Mills, S. Computer Supported Cooperative Work Kevin Mills *Encyclopedia of Library and Information science*, Marcel Dekker, Inc. New York, 2003.

Nonaka, I. and Takeuchi, H. *The knowledge creating company: how Japanese companies create the dynamics of innovation.* New York: Oxford University Press, 1995.

Page, S. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton University Press, 2007.

Ravid, S.A. (1999) Information, Blockbusters, and Stars: A Study of the Film Industry. *Journal of Business* 72(4): 463-492.

Reinstein, D. and Snyder, C. (2005) The Influence of Expert Reviews on Consumer Demand for Experience Goods: A Case Study of Movie Critics. *Journal of Industrial Economics,* 53(1): 27-51.

Sawhney, M., and Eliashberg, J. (1996). A parsimonious model for forecasting gross box-office revenues of motion pictures. *Marketing Science* 15(2): 113–131.

Sawhney, Mohanbir S., and Eliashberg, J. (1996). A Parsimonious Model for Forecasting" Gross Box-Office Revenues of Motion Pictures, *Marketing Science*, 15: 113-131.

Senge, P. *The Fifth Discipline.* Doubleday, New York, NY, 1990.

Sher, P. and Lee, V. (2004). Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & Management*, 41(8): 933-945.

Shim, J., Warkentin, M., Courteny, J., Power, D., Sharda, D., and Carlsson, C. Past, Present, and Future of Decision Support Technology, *Decision Support Systems*, 33: 111-126.

Shortliffe, E. and Buchanan, B. *Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project*. Report, 1984.

Shortliffe, E. *Computer-based medical consultation MYCIN*. American Elsevier, 1976.

Simon, H. (1947). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations*, 4th ed. In 1997, The Free Press.

Silver, E., Pyke, D., and Peterson, R. (1998). *Inventory Management and Production Planning and Scheduling.* (3 ed.). New York: John Wiley & Sons

Smith, B. *Collective Intelligence in Computer-Based Collaboration.* Hillsdale, NJ: Lawrence Erlbaum, 1994.

Spann, M. and Skiera, B. (2003). Internet Base Virtual Stock Market for Business Forecasting, *Management Science,* 49(10): 1310-1326.

Sternberg, R. (1997). Cognitive conceptions of expertise. In P.J. Feltovich. K. M. Ford & R. R. Hoffman*. Expertise in contxt. Human and Machine.* pp. 149-162. Menlo Park, CA: AAAI Press/ The MIT Press.

Surowiecki, J. *The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations* Little, Brown, 2004.

Swami, S., Eliashberg, J. and Weinberg, C. (1999). SilverScreener: A modeling approach to movie screens management. *Marketing Science,* 18: 352-372.

Tapscott, D. and Williams, A. *Wikinomics: How Mass Collaboration Changes Everything.* New York, Portfolio, 2008.

Turban, E., and Aronson, J *Decision Support Systems and Intelligent Systems*. 5th ed., Prentice - Hall, 1998.

Turban, E. and Watkins, P. (1986). Integrating Expert Systems and Decision Support Systems. *MIS Quarterly*, 10(2): 121-136.

Tynjala, P. (1999). Towards expert knowledge? A comparison between a constructivist and a traditional learning environment in the university. *International Journal of Education Research*. 31: 357-442.

Weiss, S. and Kulikowski, C. *A Practical Guide to Designing Expert Systems.* Chapman and Hall Ltd, 1984.

White, S., Dittrich, J., and Lang, J. (1980). The Effects of Group Decision Making Process and Problem Situation Complexity on Implementation Attempts. *Administration Science Quarterly*, 25(2): 428-440.

Wolfers, J. and Zitzewitz, E. (2006) *Prediction Markets in Theory and Practice*. In S. Durlauf and L. Blume (eds) The Palgrave Dictionary of Economics. (McMillan, 2nd ed).

Woodridge, M. and Jennings, N. (1995). Intelligent agents: Theory and practice. *The Knowledge Engineering Review*, 10(2): 115-152.

Zack, M. (1999). Developing a Knowledge Strategy, *California Management Review.* 41(3): 125-145.

Zufryden, F. (1996) Linking advertising to box office performance of new film releases - A marketing planning model. *Journal of Advertising Research.* 36(4): 29-41.

# Chapter 5: Elephants Can Jam: IBM Innovation Jams for Organizational Change


### Abstract

This study investigates the role of innovation jams on organizational change as IBM learned to engage with a new model of organizing innovation. It describes the role innovation jams have played in shaping the practice of open innovation at IBM. We use the musical genre of a "jamband" as a metaphor to describe the emergent development and use of innovation jams as a way to understand organizational change. This longitudinal study brings innovation jam research up-to-date and presents innovation jams as they evolved from a concept, a

management tool, and service. We conclude with a discussion on the implications of the findings for theorizing about new models of organizing innovation for organizational change.

**Key words**: open innovation; organization communication and information systems; IBM; innovation; innovation jams; technology and innovation management; organizational change; technology-induced organizational change.

## 5.1 Introduction

The study of organizing of innovation has been of considerable interest to management science scholars. Researchers have considered an organization's ability to innovate as a source for achieving and sustaining a competitive advantage. Competing models of organizing innovation have offered several perspectives into how organizations can learn and adapt to the changing environment, but have left out the elements of how organizations change to incorporate this innovative ability. This study investigates the role of innovation jams on organizational change, as IBM learned to engage with a new model of organizing innovation. This new model of organizing innovation is a result of IBM's development and use of innovation jams overtime as IBM leveraged internally developed technology and its organizational networks' knowledge to develop a platform for innovation. As this platform for innovation evolved, methodological and technological mechanism emerged where organizational actors and technology supported a large-scale collaborative approach to organizing innovation that situates internal and external sources knowledge together for collective problem solving. From this engagement, organizational change occurred less as a result of predefined management plans, or top-down directives but rather from the organizational networks participation in and practice of open innovation. IBM's engagement with innovation jams has created structural mechanisms for the recombination of innovative knowledge collaboration that is rarely found in more traditional forms of organizing innovation. We use IBM innovation jams and the music metaphor of a "jamband" that it invokes as the context of this study to help illuminate and provide insight into a way of organizing innovation for organizational change. Moreover, the study of innovation jams provides the prospect for enrichment into the techno-social nature of work and organizing by investigating the interaction between technological systems and organizations (Orlikowski and Barley 2001) through the organizing of innovation.

To date, there is a lack of systematic inquiry into innovation jams and there influence on organizational changes. Much of the literature on innovation jams tends to focus on the value of using such systems such as managing large-scale collaboration through a practitioner based descriptive analysis (Bjelland and Wood 2008; Dorsett, Fontaine, and O'Driscoll 2002) or through illustrations using social network analysis (Helander, Lawrence, Liu, Perlich, Reddy, and Rosset 2007). In addition, these studies to a large extent have been outdated in their description, due to the rapidly changing technology involved. Though it is important to acknowledge their importance in providing early insight into innovation jams, the shortcomings of such an approach have neglected the mechanisms by which such technologies are adopted, leaving them under theorized and treated as if they are just technologies, receiving no special attention in facilitating the practice of open innovation. Since current research has stressed the need for more research linked to other management areas (Van de Vrande, Vanhaverbeke and Gassmann 2010) using longitudinal perspectives qualitatively focusing on the mechanisms for the adoption of open innovation practices (Lichtenthaler 2011), this study examines the role innovation jams have played in shaping organizational change at IBM.

## 5.2 Music as a Metaphor for Organizing

Using music and more specifically, jazz, as a metaphor for organizing in management science research is not new. We only have to turn to Organization Science special issue on Jazz Improvisation and Organizing (Vol. 9, No.5, 1998) and its citations count (1,300+ according to goggleschola r) to understand the influence of the jazz metaphor in the research of organizational analysis, theorizing, improvisation and learning (Weick 1998; Lewin 1998; Crossan 1998; Peplowski 1998; Hatch 1998: 1999). Researchers have extended the use of jazz as a mechanism to understand the organization of innovation processes by suggesting that sub-genres of jazz may better represent the spirit of innovation (Zack 2000). The relationship of jazz and innovation has been of continuous interest to researchers in product innovation (Kamoche and Cunha 2001), the management of organizational innovation (Bastien and Hostager 1988), and the organizational structure and managerial control (Pasmore 1998). However, the adoption of jazz as a form of theorizing about organizing has received "considerable resistance" due to "limits of its application" that has highlighted its historical roots as (of) being potentially insular or exclusive, and thus limiting sources of (limits on) diversity (Hatch and Weick 1998 pp. 600). Though the interest in jazz and innovation has been explored, it is the new developments in the advancement of technology that potentially push the boundaries of the jazz genre to understand emerging innovation practices. New modes of organizing innovation and the technology that supports them give researchers the opportunity to use other or more recent genres in aiding the explanation of designing new models for innovation practices.

IBM has leveraged the musical genre of a jamband as a way of organizing innovation. The use of the jamband metaphor will serve two purposes: (1) act as a tool to understand new objects and situations and (2) allow us to refer to these new objects consistently through analogies as we relate them to known objects (Lakoff 1990). Moreover, the jamband metaphor will aid us in describing the emergent development and use of innovation jams as IBM learned to engage with a new model of organizing innovation. The jamband metaphor will also provide a foundation to understand how innovation jams have evolved into a large-scale collaborative platform consisting of innovation technologies (IvTs) for rapid improvised ideation and initiative development to solve challenging business and societal problems.

A jam band utilizes similar aspects found within the jazz genre such as improvisation, experimentation, and experience to “speed up the pace of innovation” (Pasmore 1998 pp. 562), but has the propensity to cross genre boundaries, drawing from a wide-spectrum of musical traditions. A jam band combines and recombines aspects of several genres in various forms to create a new genre that is not bound by the constraints of any single genre and allows for variation in the creation of music.

Beyond incorporating aspects of jazz, a jam band employs a toolbox of genres from blues, bluegrass, funk, rock, psychedelia, and even techno to make and change the harmonic structure, melody, and rhythm of a song as it is being created (Budnick 2003). By using this toolbox of genres, the characteristics of a jam band would allow for song crafting with both individual and “group-minded” improvisation that may last for lengthy periods, far from the predefined notes, cords, and scales with little resemblance of the original song (Tuedio and Spector 2010). Each genre offers its own history, tradition, and repertoire to manage the complexity of making music. Since organizations employ a variety of strategies to manage the complexity of the innovation process, using the jamband genre metaphor potentially provides a vehicle to improve the way we talk about and understand new methods of organizing innovation. In addition, the jamband genre which is associated with influencing change emphasizes a sense of community, collaboration, and sharing among the participants may help to invoke understanding of the latent elements in contextualizing new models of organizing innovation.

## 5.3 Open Innovation and Technology

Research into the practices of open innovation at IBM has been widely cited, and has offered insight into IBM's transformation from a closed system of research and development (R&D) to an open form of innovation. In fact, IBM is one of the keystone cases that the open innovation research stream is founded upon (Chesbrough 2003; 2006). Outlined in at that time IBM's CEO-Lou Gerstner's book, Who Says Elephants Can't Dance? Inside IBM's Historic Turnaround, the need for change due to IBM's declining revenue, earnings and stock price that placed sever financial constraints on IBM's existence. Gerstener (2002) acknowledged that IBM could no longer rely on its reputation and legacy of being a hardware and technology to revitalize IBM. Gerstner (2002) believed change would be driven from tapping into IBM's unique and unequaled capability to "apply complex technologies to solve business challenges" (Gerstner 2002 pp 125) in order to focus on bringing their customers closer and in challenging the assumptions of its existing innovation and R&D practices that IBM had previously held. The open innovation paradigm proposes inflows and outflows of knowledge to accelerate innovation and external markets uses for product innovation (Chesbrough et al. 2006) and service innovation (Chesbrough 2011). For innovation jams it is the internal and external flows of knowledge that enable problem-solving of these business challenges.

Like a jam band that uses different genre tools to induce change within a song, organizations use technological tools to influence its practices. The open innovation research stream[1] has led researchers to explore how technologies shape and support more open models of innovation practices (Dodgson, Gann, and Salter 2006; Christensen and Maskell 2003; Pavitt 2003), even arguing these technologies have the potential to reshape the way firms organize their innovative activities across the organization (Dodgson, Gann, and Salter 2005). This reshaping of the organizational innovation process impacts both the structure of the internal innovation process but also the cognitive modeling of innovation.

Focusing on practices of open innovation, researchers have offered understanding on the role technology can play (Dodgson et al. 2006; Kohler, Matzler, and Fuller 2009; Dogdson and Gann unpublished paper). However, understanding the role of emerging technology such as innovation jams as a driver in shaping and facilitating organizational change has been largely overlooked. Given that these emerging technology have be harnessed in a variety of capacities (Dodgson et al. 2005), individually or in combination, we consider these technologies as being arranged and embedded in a larger technological system such as innovation jams and can be observed at work at IBM.  Since these emerging technology can be used individually or a variety of arranged technological systems, aspects of the jamband metaphor would also apply to these situations and wider organizational contexts.

---

[1] See Dahlander and Gann (2010) for a review of openness in open innovation research

## 5.4 Relationship of Technology and Organizational Change

Since our focus is on innovation jams- a technology-supported platform, it is imperative to discuss the relationship of technology to organizations. Technologies and organizations are undergoing dramatic change in form and function creating new and unprecedented ways of organizing whole structures and processes. Technology and its relationship to organizational structure, processes, and outcomes have been viewed from many perspectives (Woodward 1958: 1965; Aldrich 1972; Gerwin 1981). Researchers have presented several perspectives in examining the role of social context shaping the use of technology (George and King 1991) or how key actants influence technology (Orlikowski and Robey 1991) while implicitly implying that technology impacts the organization. This has led researchers of technology to place technology as a discrete entity within an organization (Aiman-Smith and Green 2002), that posit technology as an independent or moderating variable, or one piece of a mutually dependent ensemble of co-evolving interactions with actors (Majchrzak, Rice, Malhotra, King and Ba 2000; Edmondson, Bohmer and Pisano 2001; Vaast and Walsham 2005). More recently, researchers of technology have shifted towards a focus on agency and a more self-influencing fusion between actors (Boudreau and Robey 2005) and technology (Leonardi 2010) that better represents the ubiquity and materiality technology plays intrinsically in our everyday activities (Zamutto et al. 2007; Orlikowski and Scott 2008). This leaves executives and managers keen to understand the organizational changes that might result from technology's growing influence within their organizations.

Implications of technology can be seen as being technologically grounded within an organization, where an organization's culture can be intertwined with technology, "… not simply a culture that uses a technology; instead, it is a culture whose image, identity, and relationship to its environment are strongly associated…" (Leonardi and Jackson 2009, pp 397). This binding between technology and an organizational culture can be seen as a continuum which can change overtime, where an organizational culture develops a self-image around the material, social, and symbolic characteristic of that technology (Leonardi 2007; Leonardi and Jackson 2009).

Technology-based changes have traditionally been viewed as a planned or deliberate orchestration of key actors with substantial technological resources that occur gradually. However, researchers have continued to push the boundaries of technology's influence on organizations by challenging this conventional thought (Tyre and Orlikowski 1994; Leonardi and Barley 2008). Similar views have been expressed before, highlighting that explanations for organizational change may be less dramatic than the changes themselves and that change takes place as people do their jobs while being intelligently attentive to their environments (March 1981), invoking social innovation (Barley 1988).

A growing body of literature expands this thought, arguing that organizational change and organizational-wide transformation is grounded in ongoing practices (Orlikowski 1996; Cook and Brown 1999; Orlikowski 2007)- norms and routines (Suchman 2007) and the agentic forces within the environment for legitimizing transformation (Scott 1995). In IBM's case it is through the ongoing practices of opening up its innovation process through technology that influenced change. This type of organizational transformation emerges out of the deep-rooted experiences actors encounter over time when interacting in practice, in the world, and in their environment through their ongoing interaction with these organizational processes and the technologies that support them (Ciborra 1996).

With this in mind, transformation is less a deliberate shift of predefined plans, technological inevitability, or prearranged directives from top executives and management that invoke new innovative ability, than something that occurs through the active agency of the organizational members in which change occurs (Giddens 1984, Tsoukas and Chia 2002). By taking this view it suggests a struggle between users' contextualized situation and a manager's decontextualized perspective (Leonardi 2008a) making room for the trial and error experimenting of technology implementation (Thomke 1998). From this we begin to see change that is situated, not as a static capacity or stable disposition of technology and organizational actors, but an ongoing social accomplishment, constituted and reconstituted within an organization (Orlikowski 2002) between "the mental spheres to the concrete material world" (Tuomi 2002, pp 20).

Similarly, researchers of technology have begun to investigate organizational implications in the acute context of new and emerging technologies that are increasingly becoming more prevalent in organizations today (Constantinides and Barrett 2006; Leonardi 2008b). This has led to a perspective that shows the changing interaction of actors and their collective capability with these newly introduced technologies as a series of ongoing and situational accommodations, adoptions, and alterations for change to be achieved. With no clear beginning or endpoint available to map organizational change, mechanisms supporting change-enacted overtime are offered and created. These mechanisms, which are insufficiently identified particularly within the limits of new and emerging technology, rest on the assumption of action, not stability, to spur organizational change.

As innovation is associated with organizational change within and across organizational boundaries (Tushman, Anderson, and O'Reilly 1997), several approaches from the open innovation literature have supported organizational change processes, particularly in aiding organizations to move from closed to open innovators. These have provided insights into various frameworks to support managerial decision-making (Huizingh 2010) within the innovation process. However, they have left managers with a lack of knowledge about how to do it. This has left executives and managers engaged in producing organizational growth with little more than a trial and error process, rather than a professionally-managed method in leveraging the benefits of open innovation (Gassmann, Enkel, and Chesbrough 2010) and the technology that supports it. Attention has been given to the anatomy of the organizational change process (Chiaroni, Chiesa, and Frattini 2010), which has stressed the importance of organizational and cultural issues in the adoption of open innovation practices (van de Vrande, de Jong, Vanhaverbeke, and Rochemont 2009; Ili, Albers, and Miller 2010), but more research into new management styles and systems to exploit the benefits of open innovation is needed (West and Gallager 2006). Thus a research approach that includes elements of process and change is especially relevant here in providing a rich context for research that provides insight into technology's growing influence in organizations as a result of their engagement in implementing open innovation strategies.

## 5.5 Method: A Longitudinal Approach

Our research was based on a longitudinal study of the IBM innovation jam platform (Table 5.1) as a context to understand technology-driven organizational change. It was carried out as one case out of 15 of a larger project, which focused on innovation as an accelerator for competitiveness and growth. IBM can be seen as a "rare or unique" case, in that it is a revelatory case that presents the opportunity for researchers' to observe and analyze a phenomenon that is understudied or novel, as well as to answer "how" and "why" questions (Yin 1984; Eisenhardt 1989). Since the constitutive relationship between innovation jams and organizational change has not been adequately examined in studies of a large organizational innovation process, we used an embedded design for this study. Embedded case designs use multiple levels of analysis to create a rich and reliable account of organizational processes (Yin 1984). This study focuses on IBM from three levels of analysis (1) the technology level (2) organizational level (3) processual level.

**Table 5.1:** Chronology and Context of Data Collection

| Source of Data | World Jam 2001 | Value Jam 2003 | World Jam 2004 | Habitat Jam 2005 | Global Jam 2006 | Innov. Jam 2008 | SmWrk Jam 2009 | GlPulse Jam 2010 | SocBus Jam 2011 |
|---|---|---|---|---|---|---|---|---|---|
| IBM Innovation Jam reports | * | * | * | * | * | * | * | * | *n/a* |
| News & trade publications | * | * | * | * | * | * | * | * | * |
| Participant observations & field notes | | | | | | | * | * | * |
| Interviews & correspondence† | * | * | * | * | * | * | * | * | * |
| Jam forums | | | | | | | * | * | * |

*† Interviews and correspondence were about Innovation Jams at IBM and conducted between 2009-10.*

## *5.5.1 Data Sources*

To effectively triangulate important technological and methodological elements represented in the organizational change process at IBM, we combined data collection methods such as archives, textual analysis, participant observation, and interviews (Eisenhardt 1989). We used three primary and two secondary data sources (Table 5.2) that include: (1) internal and public reports about IBM innovation jam events, (2) published materials about IBM organizational change and its innovation jam platform, (3) participant observation in innovation jams, (4) interviews and correspondence with the Program Director and the founder of the Jam Program Office and Collaborative Innovation and the Chief Strategist, and (5) jam forum data from three innovation jams. From the collected data found below, reconstruction of past contexts, processes, and decisions were possible in order to discover patterns and find underlying mechanisms over time (Pettigrew 1990) and provided varying distances between the researcher and the phenomenon understudy.

*Innovation Jam Reports.* As IBM was a focal company and pillar case study for a larger project, deep engagement with the company ensued from early 2009 to 2011, culminating with the sharing of internal and public reports about each of the IBM Innovation Jam events from 2001-2010. In each of the innovation jam reports collected, we paid close attention to the changes in description of each innovation jam, the technology use, and processes around the implementation, facilitation, and hosting of the innovation jam. Following Cheney and Christensen (2001), these communication reports of internal organizational processes bring to light ideologies about intended change.

*Published materials.* As a result of the novelty of innovation jams and large-scale collaboration, news reports in both daily and trade press publications have been widely circulated. Using archival databases (list), we collected articles about IBM innovation jams that were reported in daily local and international newspapers from February 2001 to February 2011, three months prior to the first innovation jam at IBM and up to the latest innovation jam held. Newspapers included all major national US newspapers from across the country and two major trade newspapers internationally. Articles contained either (1) public discourse about the company and the nature of the innovation jam being held, or (2) reflections on the innovation jam from participants after the innovation jam. In total, we collected nearly 145 news articles about innovation jams. Criteria for including an article were its timeframe of being published and its specifically mentioning the influence of innovation jams at IBM on its innovation process.

Since innovation jams have recently gained a significant amount of attention outside of academia- particularly in practitioner journals (Bjelland and Wood 2008) and books (Surowiecki 2004; Howe 2008), we considered these to provide further background knowledge that led to better understanding of innovation jams.

*Participant Observation.* Next, invitations to participate in IBM hosted Innovation Jams were extended. The researchers participated in SmartWork Jam 2009, GlobalPulse Jam 2010, and SocialBusiness Jam 2011. From this, over 70 hours of participant observation were recorded and provided real-time insight into the most recent developments of innovation jams. Observations were documented resulting in a total of 100+ pages of field notes. This provided experiential access to the local environment of participating in innovation jams using the technology, posts within the jam forums, and observing other participants. In addition, participation included pre and post innovation jam events.

*Interviews and Correspondence.* Over the two year-project a lengthy dialogue with IBM was maintained. This dialogue, facilitated by the IBM Program Director and the founder of the Jam Program Office and Collaborative Innovation and Chief Strategist, was documented. Before interviewing, background information was gathered by the authors. This helped in identifying detailed questions to how innovation jams have aided IBM in its innovation strategy and how innovation jams have evolved over time. A semi-structured approach to interviewing allowed for opportunities to explore the technical and social aspects of innovation jams, particularly the history, present use, and vision of innovation jams at IBM. Transcripts were made and confirmed for authenticity.

*Jam Forum Data.* Forum data on three innovation jams from 2009-2011 including: posts, participant information (ex. location, age, gender, affiliation, job role, language) and content were collected.

**Table 5.2:** Details on data collection

| Source of data | Type of source | Type of data | Use in the analysis |
|---|---|---|---|
| **IBM Innovation Jam Reports** | Primary | 8 IBM Innovation Jam reports*. Innovation Jam reports consist of internal and public reports about each IBM innovation jam events. These reports are produced by IBM and detail information on the innovation jam platform, statistics about the jam and forums, participants' information, processes around the implementing, facilitating, and hosting of the innovation jam, and the results of the jam. | Familiarize with each innovation jam over the 10 year period since inception. Provide a longitudinal perspective of IBM's view on innovation jams providing rich description and statistics of each innovation jam. Detailed the technology and event from a company perspective, providing key findings and outcomes. Grounded the understanding of innovation jams as they occurred in time. |
| **Local, International News & Trade Publications** | Primary | 145 news and trade articles about innovation jams were collected published from February 2001 to February 2011. This time period covered three months prior to the first innovation jam at IBM and up to the latest innovation jam held. Articles contained either (1) public discourse about the company and the nature of the innovation jam being held, or (2) reflections on the innovation jam from participants after the innovation jam event. | Enrich our understanding through jam participants and external perspectives overtime on the jam experience, technology use, issues and limitations experienced and overall feeling that participants expressed. |
| **Participant Observations & Field Notes** | Primary | Participation in 3 IBM Innovation Jams (SmartWork Jam, GlobalPulse Jam, SocialBusiness Jam) held in 2009, 2010, and 2011. Over 70 hours of participant observation was documented resulting in a total of 100+ pages of field notes, double-spaced. Participation in pre and post jam events made for each of the 3 innovation jams. | Capture direct experience and understanding of the actual process and practices participants use when interacting with the technology and social event to corroborate the emerging framework. |
| **Interviews & Correspondence** | Secondary | In-depth semi-structured interviews where made with the IBM Program Director and the founder of the Jam Program Office and Collaborative Innovation and Chief Strategist at IBM. Interviews and correspondence were made over a 1.5 year period. These were recorded, transcribed and confirmed for authenticity by interviewees. | Familiarize with the history, the content, the structure, and the management of the technology from an "insider" perspective to improve our understanding of innovation jams and jam event implementation in triangulating evidence derived from innovation jam reports and participant observations. |
| **Jam Forums** | Secondary | Forum data on 3 innovation jams including: posts, participant information (ex. location, age, gender, affiliation, job role, language) and content. | Expanded our understanding with the jam data providing a look into forum, thread, and reply structure to triangulate and integrate the evidence deriving from innovation jam reports and participant observations. |

**The internal SocialBusiness Jam Report was not available at the time of this study.*

### 5.5.2 *Data Analysis*

Since our framework suggests innovation jams have facilitated organizational change in shaping IBM's innovation process, we constructed a historical perspective (Table 5.3). This helped to explain relationships between historical factors pertaining to innovation jams transitional periods of development and IBM's move towards leveraging technology for more open forms of innovation.

**Table 5.3:** Historical perspective of Innovation Jams implemented at IBM

| | World Jam 2001 | Values Jam 2003 | World Jam 2004 |
|---|---|---|---|
| Dates | May 21-24 | July 29- Aug 1 | Oct 26-28 |
| Time | 72 hrs. | 72 hrs. | 54 hrs. + 7 days of rating ideas |
| Number of Forums | 10 | 4 | 6 |
| Number of People | 52,595 participants | 22,007 participants | 56,870 participants |
| Number of Posts | 268000 posts | 9,337 posts | 32,622 posts |
| Purpose | New medium for bring people and ideas together, mass parallel conference (MPC) | Values and beliefs defining | To identify actionable ideas to accelerate profitable growth, unleash productivity, innovation consistent with IBM Values |
| Knowledge location | Internal employees | Internal employees | Internal employees |
| Investment/ Motivation | Cost estimated to be in the millions of dollars | Intrinsic motivation to define organizational values | Intrinsic and extrinsic, Committed $100 million to implement 35 ideas |
| Focus | Large scale communication | Aligning employees in a common purpose | Productivity of workers and practices |
| Fit | 1 component in larger collaboration strategy taking 10 months of planning | Exploration | Linked values to practices |
| Technology/ Change | Intranet, Database of existing knowledge available to all | Independent Platform (1st form of independent Platform) | First for pre and post jam events, Enlisted first-line managers to hold pre-jam discussion , moderated by 3 senior leaders that suggest hot topics, Ratings site translated into 11 languages for 7 days |
| Issues | Software not fully implemented, conversations only in English, use of site was difficult, few people used synchronous breakout technology or extra tools | Implementing platforms to IBM and newly acquired business unit | Rudimentary ability to post and analyze forums mostly directed at searching posts, 65% participation from Americas |

| | Habitat Jam 2005 | Global Innovation Jam 2006 | Innovation Jam 2008 |
|---|---|---|---|
| Dates | December 1-4 | July and Sept. 12-15 | October 5-9 |
| Time | 72 hrs. | Two 72-hour sessions | 90 hrs. |
| Number of Forums | 7 | 10 | 4 |
| Number of People | 39,000 participants from 158 countries | 150,000 participants from 104 countries and 67 participating companies | 60,200 participants from 80 countries |
| Number of Posts | 4,000 pages of posts | 29,499 posts | 32,000 posts |
| Purpose | Solving some of the world's most critical urban issues | Combine new technologies and & real world insights to create market opportunities | Building the "Enterprise of the Future" |
| Knowledge location | External Event (leaders of government, business and academia to youth, women's groups, citizens from impoverished communities around the world) | IBMers and their family members and IBM's customers and business partners | >1000 companies, personal commitment from CEO |
| Investment/ Motivation | Intrinsic and for a greater good | Tightening of relationships with external networks, $100 Million to bring 10 ideas to reality (Ideas as currency) | Follow-up to CEO study conducted earlier |
| Focus | Critical issues related to urban sustainability | Immediacy in outcomes from ideas | Developing approaches to monitor, measure, manage, and transform enterprise |
| Fit | Sponsored by the Government of Canada, UN-HABITAT & IBM. Taking 3 months to market | Integral part of IBM's global management strategy | Leadership and commitment with direct conversations between senior management and the employee population |
| Technology/ Change | Eclassifier text mining used, kiosks for participating in developing world | 3D virtual world meeting, Town hall meeting in China and in Second Life of the Virtual Forbidden City, 2 part process of jamming- 1. generate ideas 2 evaluate them | Using Jams as an iterative process for outcomes |
| Issues | Language barriers and technology divide limited impoverished communities | Lengthy break between jam event and idea generation and rating and reviewing phase | Greater measures for IP protection using real-time data analysis |

| | SmartWork Jam 2009 | Global Pulse Jam 2010 | Social Business Jam 2011 |
|---|---|---|---|
| Dates | September 16-18 | March 29-31 | February 8-11 |
| Time | 72 hrs. | 72 hrs. | 72 hrs. |
| Number of Forums | 4 | 10 | 5 |
| Number of People | 2,000 participants from 68 countries | 6700 participants from 150 countries | 2,700 participants from 80 countries |
| Number of Posts | 5,000 posts | 9,600 posts | 2666 posts +600 tweets |
| Purpose | How business and people can work smarter together | Social issues facing the global community within the fields of science and technology, entrepreneurship, and human development | Exploring the value of social technology in business |
| Knowledge location | Engaging industry and university thought leaders, clients, Business Partners and IBMers | Development professionals, NGOs, government leaders, Diaspora community members, students, academic leaders, think tanks | corporations, academic institutions, nonprofit organizations, government agencies and 45 external invited guests |
| Investment/ Motivation | Exploratory to empower people for change | Intrinsic | Exploring new approaches for the next era of business |
| Focus | Creating a collaborative and connected business environment | To improve the ways in which global citizens work to solve our most pressing development needs | How to mitigate potential risks and management system required to drive organizational transformation |
| Fit | Learning how to influence change | Sponsored by USAID with guidance from National Security Council, Offices of Social Innovation and Science and Technology Policy at the White House | explore the key issues and challenges of becoming a social business |
| Technology/ Change | Mini jam was used, IMPACT 2010 Conference held as follow-up to creative solutions developed in jam, Quick polls that were used to quantify participant's views on questions related to the forum topics. (low tech form of collaborative decision making) 10 tips for jamming included | Mini jam was used over 100 facilitators, continued discussion through Facebook after jam closed, Real-time demographic monitoring, Social media channels such as Facebook and Twitter for in promoting jam, multiple roles in facilitating- facilitator, host, featured guests | Mini jam was used, concurrent discussion via Twitter |
| Issues | Outcomes limited to ideas and sentiment | English dominant language, Arabic was next with 9% , lack of translation capability- participants could post in any language but not possible to carry on a multi-lingual conversation, | n/a |

In the preliminary stage we organized our data chronologically based on the order in which each innovation jam was held. This was done by ordering each innovation jam event from the collected data- IBM innovation jam reports, news and trade publications, participant observation field notes, and interview and correspondence transcripts in order to corroborate each innovation jam account over multiple sources. This provided a historical perspective of innovation jams as well as exploring the social context within IBM that innovation jams operate in (Klein and Myers 1999). For this study an iterative approach to coding and analysis was adopted. Thus, to identify the ways in which innovation jams influenced the innovation process, we followed three stages of coding practices outlined by Strauss and Corbin (1998) within and across each innovation jam. We engaged in an open coding strategy within (and across) each innovation jam to categorize the data collected (innovation jam reports, observations field notes, interview transcriptions, and news & trade publications) in order to group like concepts that described what transpired and how it occurred. An inductive approach allowed for insights to emerge from each innovation jam independently.

Next, through our analysis, we grouped these first-order themes by constructing subcategories, and regrouped the data into clusters of similar activities allowing conceptual links to emerge. From this, we combined these provisional first-order categories into fewer, broader and theoretically relevant groupings that addressed more directly the overarching questions driving the investigation (Locke 2001).

After all of the data had been analyzed in this fashion within each innovation jam, we applied a similar process across each innovation jam. Finally, we integrated our analyses from each category into a set of core findings, building on relationships between first order- second order categories and theoretical dimensions (Figure 5.1). This iteration between data, concepts, and emerging patterns ended when we reached theoretical saturation. Definitions were developed at the different stages for the first and second order codes to help guide our analysis.

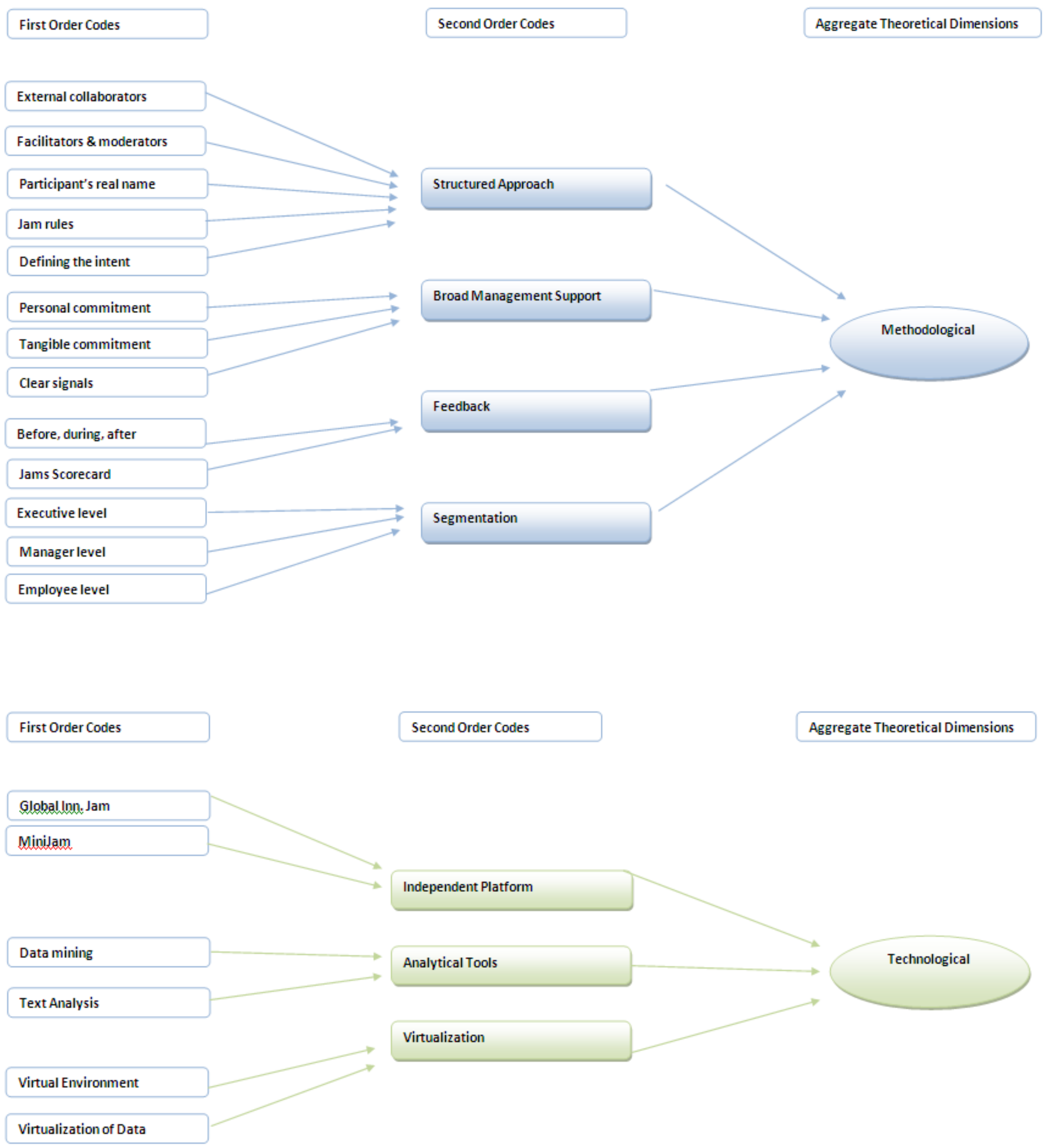


**Figure 5.1:** Data structure

To add context to these findings, we constructed a chronological outline of the relationship between innovation jams and the organizational innovation process over the 10-year time frame. This allowed us to concentrate our attention on expounding the important similarities and differences in regards to changes in technology, process, and use across the innovation jams. No prior hypotheses were made as to what took place across the innovation jams. Relationship refinement was made through revisiting the data in an attempt to find patterns between the innovation jams that could indicate changes.

From this analysis naturally occurring phase changes began to emerge. To avoid arbitrary partitions and to develop a systematic way to identify phase changes, we included circumstances recognized as significant by the organizational actants, changes that differed in innovation jam practices, and the strategic organizational perspective to leverage innovation jams. Partitions signal the end of one phase and the start of another- what I later call critical phase change events. In this step, triangulation of sources (innovation jam reports, interviews, field notes, and news and trade publications) helped us refine and strengthen our analysis in demarcating the phase changes that occurred over time. In the following section we present the interpretative framework that has emerged.

## 5.6 Orchestrating Openness

### *5.6.1 Background*

It is important to recognize that early foundations for the support of innovation jams began during a company-wide reorganization after reporting at that time

(1993) the single largest quarterly loss in US business history. Under its new CEO Lou Gerstner and facing one of the most difficult times in its company history, IBM initiated a shift from its conventional inwardly- focused innovation model to a more ‘open’ approach (Chesbrough 2003). Aspects of IBM’s R&D transformation from a ‘closed’ model to a more ‘open’ model of innovation has been well documented (Chesbrough 2003) and has offered insight to the antecedents for strategic change in its R&D process where the boundaries of the organization are redefined. IBM’s corporate reengineering focused on its culture and deep knowledge and experience with technology to move from a product to service-based organization (Gerstner 2002). Part of the reengineering and execution approach taken by Gerstner (2002) was to get the insular IBM to focus its corporate mindset on bringing value to the customer in the marketplace. Gerstner (2002) wanted IBM’s culture to continue to be a source for growth as it had done in the past, but in the changing competitive environment this meant viewing its entire workforce as a source for collective creation to innovation. As a result, IBM implemented its innovator’s innovator strategy which emphasized the need to foster a company-wide culture of collaboration. As IBM Chairman and current CEO Sam Palmisano (2006) later stressed “If you are going to build a business based on continual innovation and on the creation of new intellectual capital, you are signing up for total dependence on the creativity and adaptive skills of your workforce.” IBM initiated a movement beyond just the ‘opening up’ of processes, business units, and IP management, and towards leveraging its workforce and model of how innovation can be organized.

The recognition that its R&D unit could not continuously produce enough new products and services needed to meet its strategy to become an “innovator’s innovator” led IBM to choose to connect important members of its organizational network that signaled the importance of sharing across divisions and openness. Having relied successfully on its vertical model of innovation for several decades, the transition in opening up its innovation process was a result of a series of fragmented steps over time that facilitated a more distributed model of innovation. Innovation Jams have played a role in this transformation that combines culture and technology at IBM.

### *5.6.2 IBM's Toolbox for Innovation Jams*

Having established the context of IBM's relationship to exploring new ways of organizing innovation we examined our data to understand the processes through which innovation jams emerged using the jamband metaphor to guide us. Characteristics of the jamband genre can be viewed from several levels in facilitating new models of organizing innovation. First we explore this on the organizational level at IBM. In much the same way a jamband would use multiple genres in creating its music, IBM has leveraged emerging technologies and platforms IBM had been developing fragmentally in separate business units to help craft innovation jams. Transformative mechanism such as innovation technology (IvT) (Dodgson, Gann, and Salter 2005) offered opportunities in bridging IBM's internal innovation process, promising internally developed technology, and benefits of open innovation that were being implemented with success in other parts of the organization. Instead of relying on the knowledge of different musical genres in which jam band musicians would need to know, IBM extracted its deep technological knowledge from parts of its organization. This transformation was to move beyond independent implementing of new processes, technology, or models but was focused on spreading innovative activity outward in the organization enabling its workforce regardless of business unit or job boundaries to be involved in the organization of innovation. By pushing the innovation process outward within IBM, it was in turn bringing knowledge and expertise of its existing workforce inward to be utilized. In utilizing technology and knowledge across the organization IBM began signaling the value and importance it placed on innovation that made innovation a priority to all at IBM that would later be expanded as IBM's innovation jam platform emerged and influenced change.

## 5.7 Innovation Jam Adoption and Mechanisms for Change

Through our analysis several mechanisms for change occurred as a result of IBM's continued use of innovation jams. These mechanisms, which were initiated in an effort to help implement successful innovation jams, provided a series of supporting mechanisms in cultivating organizational change. According to the Director of Innovation Jams:

"It [InnovationJams] really helped us. Jam served as a changing factor in IBMs culture and how we collaborate across our businesses" (Int. 1).

Each mechanism occurred over time as IBM continued to experiment with innovation jams and resonate with the characteristics of the jamband genre in that the underlying codes have similar attributes between them. These mechanisms for change, broadly categorized into methodological and technological categories, illustrate how the emergent development of innovation jams have influenced IBM's culture by aligning its workforce behind IBM´s goal to build a communal sense of creating innovation to provide innovation as a service. Six themes emerged through our analysis.

### *5.7.1 Structured approach to sharing*

Though management continued to play a lead role in change, cultivating organizational change for a culture of innovation required change to occur from the top-down and the bottom-up at IBM. In a very ***structured approach to sharing***, management first began by setting up the appropriate environment to build a constructive conversation. This was done by defining the intent of a proposed innovation jam or the overarching question to be addressed with focused forums embedded. Since each innovation jam is unique, in that the intent, time and composition of the participants will be different, it is reminiscent of a jam bands performance, which is expected to vary with each performance, and song that creates a shared relationship between the band and audience. When management decides what the intent of the Jam is, it is knowingly seeking the passionate people on the topic to come forward. By tapping into what IBM calls the "passion of the workforce" well-meaning intent from its participants emerge. IBM believes passionate people on a topic want to jam with other passionate people to create meaningful dialogue for future outcomes in addressing challenging business problems or in shaping the future direction of IBM. The Enterprise Transformation Unit (ETU) under the CIO was formed to provide support for innovation jams. The ETU's role expanded to support beyond identifying and communicating the jam's intent to include, development, implementation, and use of innovation jams as they evolved. For example, to accelerate innovation jam infrastructure, ETU strategically explored and integrated existing technological components found within other business units creating an underlying structure necessary for innovation jams. Since innovation jams were to address challenging business problems IBM and its clients faced, ETU helped to identify early foundations and a technological structure that provided medleys or the linking of linear discussions together and simultaneously.

In order to build a foundation under a common set of principles for everyone to share “rules of engagement” where developed. These rules are a form of building a highly organized structure for free and open dialogue similar to the musical structures needed for the jamband genre. By requiring all participants to accept and abide by jam rules, IBM took the first step in protecting intellectual property (IP) rights to ensure that large-scale collaboration did not infringe on trade secrets, anti-trust agreements and other sensitive material. Jam rules developed in accordance to IBM’s business policy and were an essential component in protecting intangible assets and particularly valuable when working with highly regulated industries. We can view these types of IP rights as preexisting before the hosted innovation jam event and demarcates between what is open to be shared similar to the tapping policy found in the jamband genre that allowed sharing and distribution of live performances but not studio recorded albums. As part of creating a structured approach to sharing, innovation jam participants used their real names as an incentive to build reputation and credibility but also to deter bad behavior common in anonymity.

From this, a bottom-up approach was further established where trained facilitators and moderators were used to support the flow of discussions and to contribute constructively to issues rose. This was done by steering the dialogue, encouraging participation and deeper thinking, offering insight into the topic, or identifying topics that had the potential for immediate implementation. Having facilitators and moderators allowed for a more coherent discussion to develop from the contributions’ made, regardless who or where the contribution came from. Outside influences are incorporated in the jamband genre when other musicians are invited to perform on stage with the jam band. These outside influences often push the creation process even further.

### 5.7.2 Broad management support for participation

Next, **broad management support** was critical in initiating innovation jams, but also in building support for participation. Clear signals were sent by management to show support for the up-coming Jam and to encourage participation from all levels of the organization. Broad management support included personal commitment from all levels of management to ensure the depth and breathe of participation, as well as the quality and focus of the content. By challenging its employees and placing tangible commitments in the form of money and commitment in idea development, IBM helped to create transparency about future outcomes and in turn a step in authenticating this new model of organizing innovation. By engaging the workforce in this manner, it offered encouragement for participants to perform, while generating excitement, enthusiasm, and expectations of the innovation jam. Effort to involve all levels of the organization contributed to building the understanding that innovation jams were being taken seriously and that open and collaborative work was to be supported.

Authenticity is a common element in the jamband genre because it offered a sense of realness in jam bands particularly in their live performances in which identities, commitment, and shared values where developed between the audience, music, and musicians. Authenticity in the jam band genre helped build a commitment from its audience that followed their tours from city-to-city and innovation jam participants from innovation jam-to-innovation jam.

### 5.7.3 Feedback for collaboration

To reinforce the importance of innovation jams to its workforce, IBM began implementing ***feedback*** mechanisms for collaboration. On-going feedback before, during, and after the innovation jam created an iteration of communication between the company and employees. Much like in the jamband genre and in response to spontaneous suggestions of band members and/or feedback from audience members, jam bands alter their songs and play list as a way to respond to the jamband community. Jam bands audiences are known to have contributed to naming and monitoring of songs by voting and record keeping of the songs that have and have not been played as part of their followings and commitment to the band. It is here the relationship between jambands and their audience, which is acted out in its life performance, is adjusted as feedback is given through their performance and tour.

In effort to monitor and provide feedback the innovation jam community IBM created a quarterly report through a Jams Scorecard. The purpose of a Jams Scorecard was to link ideas generated in each jam and the outcomes from these ideas. The Jams Scorecard was presented with IBM's quarterly earnings report, which was published internally and reflected important quantitative and qualitative metrics on the project. Metrics included a broad summary where the project stood, identified the executives in charge of the idea, idea number, and the status of the project. This showed accountability, visibility, control, and commitment to the ideas and solutions that were derived from the innovation jams. This was important because it not only showed the status of an idea but strengthened the notion that employee contributions and ideas were being implemented and valued by top management. The feedback through the Jams Scorecard showed the depth of how important innovation jams had become and how ingrained innovation jams evolved within IBM's innovation strategy.

Feedback mechanisms continued to evolve as innovation jams developed that allowed participants to rate and review ideas and comments until the innovation jam ended. This allowed for further refinement of ideas and gave executives and managers greater focus on where promising ideas were. These mechanism built support for future ideas from the bottom-up, which gave greater transparency to this new model of organizing innovation at IBM. Executives and managers saw this support as critical because it gave clear indication to which ideas, products, services, and initiatives that would likely succeed since they were being supported from those who would be implementing them.

### *5.7.4 Segmenting for toolbox development*

In order to fully tap its workforce, IBM ***segmented*** its organizational community for toolbox development. By segmenting the community, IBM was in turn tapping into the ethos of the organization at its different levels. IBM envisioned its organization as three large groups: employees, management, and executive levels. At the employee level IBM viewed people as those who want to feel like they were making a meaningful contribution to where they work. IBM believed if employees were provided with the right tools, incentives, and permission to act in a collaborative fashion, they would make meaningful contributions and help drive its innovation strategy.

At the managerial level, managers were expected to provide guidance for those employees, take directions from their executives, and in prioritizing the work that needed to be done. Managers play a dual role and were being squeezed from both sides. A manager takes organizational objectives and strategy from above to provide clearer directions in order to funnel it downward, so as to aid their employees to be as efficient as possible in their work.

Finally, the executive level was seen to be about understanding how collaborative innovation and the use of tools like innovation jams facilitate an enterprise-wide mind shift or a culture-change in the company. Orchestrating change is difficult, but by segmenting the organizational community, IBM found a practical way to garner top-down and bottom-up support in fostering change in order to build a culture for innovation.

The jamband culture thrived because of the inherent sense of community that was shared among the community members. Many members would travel from show-to-show and the across country to facilitate this bond at each performance by setting up illicit towns and markets that provided the necessary goods for travelers on the road. Having a common goal to follow a band, its members were motivated in different ways to contribute to the jamband culture.

### *5.7.5 Independent platforms for community building*

The success in participation in the form of idea generation and excitement for large-scale collaboration gave IBM incentives to develop ***independent platforms*** for specific audiences and purposes instead of relying on existing infrastructure that was less adaptable to the company's changing innovation process. Different platforms were arranged in a way to align the audience to the problem to be addressed. IBM learned that engaging a large global workforce had its challenges, thus IBM developed a GlobalInnovation Jam that provided support for a global discussion across the organizational segments and was typically sponsored from the CEO level. For a more focused jam, IBM developed a separate platform called a MiniJam that targeted a narrower audience for a more specific intent. The MiniJam was typically supported by heads of business units. For instance, the use of a MiniJam provided IBM with the option to direct problems to a more focused crowd across the functional levels of the organization, creating a different user experience that helped to connect people into the discussion more quickly. The

MiniJam was tailored to target smaller more specific audiences for faster solution providing and even greater in-depth discussion.

Early developments of the jamband genre also faced similar constraints. Due to the physicality of the jamband musical experience so ingrained in its culture, jam bands moved from small musical venues to giant stadiums and festivals. These platforms did alter the experience of the community that is continuously debate today, but few would argue the progression into large venues made sound boarding or tuning of the equipment more complex in addition to the complexity of organizing crowds of over 600,000 and their communal sense towards each other.

### *5.7.6 Analytical tools for complexity management*

IBM realized capturing and evaluating ideas from a vast amount of people was a difficult task using either no analytical tools or simplistic ones. To help analyze the contribution from jam participants, IBM utilized proprietary ***analytical tools for complexity management***. Real-time data analysis played a "scaffolding" role for analyzing participants' contributions and for governance since it provided the ability to monitor IP concerns. IBM's COBRA data mining tool provided focus and meaning to the on-going conversations within the innovation jam. For example, COBRA was used as a risk mitigating tool to extract words to determine if participants are or may violate innovation jam rules. This was used to monitor unconstructive language or highly sensitive information particularly as innovation jams grew to incorporate more companies in the discussion. COBRA´s use was invaluable because it ensured the protection of IP by monitoring discussions so anti-trust laws were not breached in real-time.

Even after the Jam, data mining played a critical role by segmenting participation so contributions could be divided. IBM's post-jam consisted of multiple levels of mining and re-mining data to extract as much as IBM could from multiple perspectives, locations, and areas of contribution. Data mining combined with the movement toward abstracting data and virtualizing it, allowed IBM to experiment further with the complexity of diverse inputs from multiple sources.

Though the use of analytical tools for complexity management was not supported, other forms of complexity management can be found in the music and lyrics of a jam band. It is here the music and lyrics of the song acted as a signpost for its audience as they journeyed through uncertainty on their hallucinogenic experiences.

### *5.7.7 Virtualization for cross-boundary engagement*

***Virtualization for cross-boundary engagement*** creates a common format and standard for data, information, and new ideas from internal and external participants in the innovation jam to explore and share common or divergent ideas. IBM's data mining tool- COBRA provides virtualization through Themeclouds*.* Themeclouds allowed for real-time conversation structure to be created allowing the innovation jam discussion forums to be analyzed using IBM´s text software to filter through discussions threads, filter out noise, organize, that broke down contributions into a digestible form for action. Participants could readily link to similar conversations through themeclouds most similar to their contributions. Themeclouds allowed innovation jam participants to join in the on-going discussion thread faster without the need to read all the past posts, while virtualization supported facilitators in directing the forum conversation for relevant outcomes. Themeclouds aided executive actions by highlighting about what was being discussed so ideas could be evaluated.

Virtualization expanded as innovation jams evolved at IBM to incorporated virtual worlds or a 'virtual meeting'. Virtual worlds allowed for participants all around the world to be 'co-present' in a virtual environment. Virtual worlds created an immersive environment where people interacted through avatars that facilitated the engagement across time, space, and culture. This allowed for enhanced engagement for collaboration in bring different innovation jam participants together regardless of background, job role, or expertise to share ideas.

Jam bands have embraced visualization in the form of rich expressive colors, animated textures, and pulsing lights to create a visual experience for the audience. Visualization offered a 'visual music' in real-time as the jam band played, improvised and created its music. The audience not only connected to the music that was being played but with the combination of lights, music, and the live performance giving a multi-dimensional experience to the audience.

## 5.8 Evolution of Innovation Jams: Concept, Tool, and Service

IBM learned to engage with innovation jams through a series of phases that we turn to illustrate the evolution of this new model of organizing innovation. Each phase built from the previous phase successes, which appear as a process, evolved in each attempt less from planned precisions and more out of continuously challenging the limits from were innovation can come from and the basic assumptions of innovation that IBM had previously held. These phases describe innovation jam evolution from an early conceptual phase that had rudimentary resemblance to today's existing innovation jam platform, to a tool phase- that helped management facilitate IBM's innovation process, and finally to a service phase, where innovation jams success in harnessing innovative activity from the periphery and untapped workforces of the organization. Figure 5.2 maps IBM's innovation jam evolution phases of concept, tool, and service to their degree of platform integration in IBM's innovation strategy, phase complexity, and source of knowledge. It emphasizes how innovation jams have been adopted into IBM's innovation strategy as complexity has grown with the technological advancements and by incorporating new sources of knowledge from external participants.

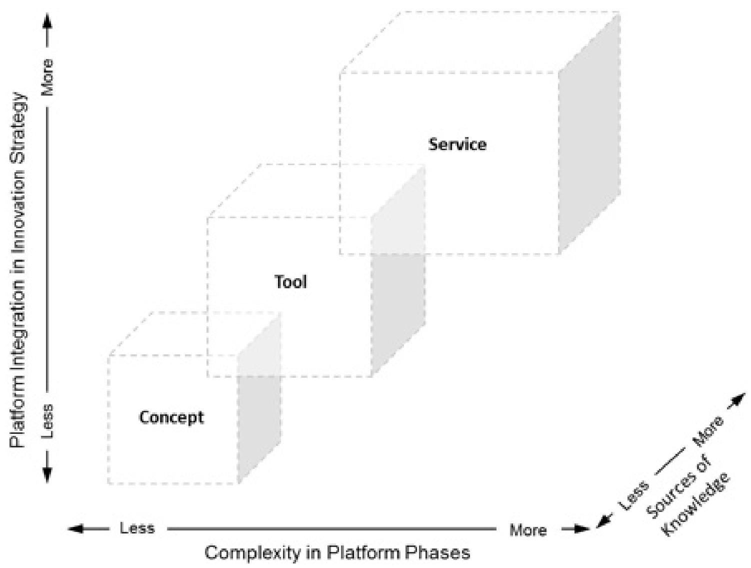


**Figure 5.2:** IBM Mapping Innovation Jams Platform Integration, Complexity, and Sources of Knowledge

While the different phases of evolution for innovation jams have overlapping attributes for innovation, they differ significantly in their enabling assumptions about innovation (Table 5.4). Here we contrast how the different phases in terms of the locus of innovation evolution, knowledge flows, actants, definition of, technological changes, and the enabling assumptions of the domain boundaries under which they occurred.

**Table 5.4:** Representative patterns in locus of innovation jam evolution

| Attribute | Concept | Tool | Service |
|---|---|---|---|
| **Actants & Interests** | IBM employees, intranet team | IBM employees, executives, managers, internal subject matter experts | IBM employees, trained facilitators, academics, stakeholders, |
| **Definition of Jams** | New medium to bring people and ideas together | Tool to align employees for a common purpose and structure for large scale discussion | A virtual round table to stimulate ideas, drive innovation around specific topics and collaborative solutions |
| **Goals of the Phase** | Capturing and exploration of new medium | Generation and evaluation | Influencing complex systems for accelerated decision making and action |
| **Knowledge Location** | Internal | Broad and internal | Internal and external with predetermined targeted audience |
| **Critical Phase Change** | Independent platform needed (scaling), inclusion of external knowledge and participants, | Event, Pragmatic outlook, not anonymous, 2 part process of jamming- 1. generate ideas 2 evaluate them | Transformational intervention, extensive pre and post preparation needed |
| **Requirements** | Intranet | Independent Platform | Pre and Post Jam events, multiple platforms |
| **Technological Changes** | N/A | Data analysis tools, | Robust real-time metrics and reporting, multiple platforms |
| **Methodology** | Top-down approach, information is pre-filtered determining what is available | Early stages to building a an egalitarian approach | Bottom-up approach supported with parallel forces from external knowledge |
| **Intellectual Property Risk Management** | Knowledge shared only with internal employees and maintained internally | Pre rule agreement needed, maintained internally | Pre rule agreement from all parties needed, text mining software and reporting for risk management |
| **Characteristics** | Building a sense of community | New medium for sharing and rating | Non-competitive active discussion, broad participation and legitimacy, Enabling culture change |

### *5.8.1 Concept Phase:*

An early form of innovation jams at IBM commenced in 2001 as a result of a company-wide self-reflection initiative to drive innovation internally. IBM believed by tapping into its extensive workforce and by bridging people and departments, greater cross-fertilization of ideas and solutions could accelerate R&D. Initially devised to be a new medium to bring people and ideas together it was considered to be a first in large-scale communication referred as a "massively parallel conference" (MPC) (Bjelland and Wood, 2008). World Jam 2001 was implemented through IBM's existing intranet, as an attempt to capture and explore internal knowledge and information exchanged through this new method of organizing. Focus was on experimenting with a new medium in facilitating cross-functional dialogues throughout IBM.

Though the MPC was seen as an open space where participants can move from topic to topic and cross-pollinate ideas, it was seen as a way which individuals of all ranks could talk to each other, where communication was through forum posts and the organizational intranet primarily played the role as a knowledge repository of these posts. IBM realized early on the impact of this new collaborative work and its ability to build a sense of community with IBM. This early form of innovation jams was a first in providing a platform for communication across physical boundaries and hierarchy, while bridging time and space across (*Redefining Manager Interaction at IBM Report*, 2002) the company and world.

With almost 53,000 participants all IBM employees creating more than 268,000 posts (see for details), internal user support included a light technical cast maintaining a database for knowledge and information retention. Consequently, all intellectual property (IP) concerns were managed under standard business policies and maintained internally. Moreover, the concept phase of innovation jams played one component of a larger innovation strategy for IBM and were still considered an experimental top-down approach to innovation because of the pre-filtering of information determining what information and knowledge was made available before and after an event. IBM would later cede more control over the information that circulated around and who would interact with one another as a result of IBM's willingness to continue to experiment with larger-scale collaboration platforms and advancements in technology that were occurring internally.

The overwhelming response to World Jam 2001 provided a foundation for future innovation jams to be held. Though World Jam 2001 participation and evolvement was encouraging it came with significant challenges. Limitations included software not being fully implemented for participants, language support was only in English, and limited use of synchronous breakout technology and extra tools. For innovation jams to move into the next process phase; several critical technological and phase changes where required. First, the existing technology and infrastructure was seen as an inhibitor to innovation jams use and a new independent platform was needed for scaling, enabling better computer-mediated support. Scaling allowed for future inclusion of external participants and subject matter experts who did not have access to IBM's existing intranet. Greater attention to user friendliness was considered to encourage even greater participation. Lastly, to manage a large-scale conversation with more effectiveness, data analysis tools were needed in order to sift through the large number of ideas and information that participants contributed. The overwhelming participation from World Jam 2001 encouraged IBM to explore new ways to virtually organize. Other spillovers occurred as a result of World Jam 2001 success. For instance, changes ensued with the adoption of company-wide technologies such as blogs, wikis, and other online tools, along with cross-functional collaboration, creating interaction with unprecedented levels of richness not seen at IBM before.

### *5.8.2 Tool Phase:*

Innovation Jam 2006 was a milestone in IBM's innovation process. It marked a turn in innovation jams from a concept to a management tool within IBM. It was within the tool phase that innovation jams are considered a key component in a larger management strategy for innovation. The tool phase for innovation jams invoked a new genre of corporate interaction that, by its very nature can only take place in computer-mediated environment. Having already been established as an independent platform facilitating its transition from the concept phase, the tool phase embedded innovation jams in the organization as a management tool. This new computer-mediated environment provided greater structure for large-scale discussion through the extension of technology in the form of data analysis and metric tools and pre and post-jam user support that allowed for greater idea generation and idea evaluation.

The transition into the tool phased also marked a first in allowing external collaborators to participate with innovation jams. Though participation was limited to family members of IBM employees it did offer a step to include external collaborators that were not employees of IBM. By giving external collaborates access to IBM's innovation jams, IBM could tap into an even broader range of contributors for idea generation and idea evaluation. It also marked a first for leveraging subject matter experts as facilitators and moderators in supporting the flow of discussion and in constructively developing issues raised within the innovation jam. Facilitators and moderators steered the dialogue, encouraged participation and deeper thinking, offering insight into the topic, or by identifying contributions that have the potential for immediate implementation.

The tool phase ushered in a more pragmatic outlook on how innovation could be organized, where innovation jams were seen as event and a catalyst for innovation that extended participation before and after an innovation jam was held. This helped create a buzz within IBM about innovation jams, where the term *"jamming"* was coined that referred to action of participating and contributing in an innovation jam.

Instead of a finite period of 48-90 hours to participate, Global Innovation Jam 2006 participation evolved in two separate parts. Steps included first breaking innovation jams into a two stage jamming process. Stage one was used for idea generation and for discussing promising ideas. After several weeks then stage two was launched where executive and management reviewed the plethora of ideas by opening the innovation process further by creating a focused session for idea refinement. This gave management areas to hone in on, saving management time in preparing the next steps to connect top ideas with the needed financial commitment and the key actants to produce these ideas into real outcomes.

As the complexity of implementation and hosting innovation jams increased, challenges also surfaced forcing IBM to commit greater resources to large-scale collaboration. Unlike previous IBM innovation jams where preparation was not viewed as necessary, Innovation Jam 2006 and future jams required familiarization with emerging technologies, which were described in on-line materials made available to all internal and external participants prior to the event. Greater preparation was needed to support the jam facilitators and moderators, who prior to the innovation jam would be expected to review the innovation jam objectives and sit for training on the new independent platform.

Since Innovation Jam 2006 expanded participants to include family members of IBM employees, IBM added pre-innovation jam rules. By making agreement to the jam rules a requirement to participate, IBM was able to establish a protocol to protect closely held IP. It was within the tool phase that IBM adopts early forms of advanced mediated technology to build links between participants' contributions and analysis and its geographically dispersed workforce. Technological changes such as data analysis and metric tools where incorporated within innovation jams for measuring participation, contribution, and collaboration, while the use of virtual worlds provided an additional dimension and environment for interacting. The use of Second Life in Global Innovation Jam 2006 offered its 150,000 participants the unique 3D avatar experience of having a town hall meeting in Beijing's 'Forbidden City'. This virtual world[2] experience was not limited to visualization, but also emphasized the importance and sense of "togetherness." IBM took this virtual world experience to corral the sense of being together in the innovation process with other valued colleagues from around the world. These early stage visualization techniques gave innovation jam participants' access to a standardized level of representation of information at a more intuitive level.

Next, a second series of critical phase changes ensued that would help transition innovation jams from the tool phase to the service phase. First, changes how innovation jams were implemented and delivered were made. This included the adoption of more extensive pre and post preparation planning, allowing for webcasts, interests groups, and greater opportunities in connecting IBM employees and external stakeholders. IBM chose to strategically expanded innovation jams offering to two separate platforms for large and more focused

---

[2] See Dogdson and Gann *(forthcoming)* for details on the evolution of virtual worlds at IBM

groups. This included the development of a scaled down platform called a MiniJam for a more focused discussion. Second, IBM began viewing innovation jams as a transformational intervention rather than a tool to be applied periodically. As innovation jams were gaining legitimacy as an integral part of IBM's global management strategy, they provided a platform for engagement, where technology and organizational relationships internally and externally could intertwine. Finally, the addition of jam rules and robust real-time data analysis would help facilitate the transition of innovation jams from an internal management tool at IBM to a service of innovation to its clients by securing legal boundaries for large-scale collaboration.

### *5.8.3 Service Phase:*

In the service phase IBM took advancements that were made in the tool phase to a step further by incorporating new knowledge sources and the latest technological advancements for accelerated decision-making and action. Participation moved from IBM employees and family members to an even broader spectrum of stakeholders. The intent was to build tighter relationships internally within IBM across business units and externally with business units and stakeholders. External knowledge sources flowed from trained facilitators and moderators outside IBM, academics, subject matter experts, suppliers, customers, governing bodies, politicians, and legal advisors each playing a role in the orchestration of innovation jams. This change drew on the collective knowledge of these stakeholders in the innovation process to gain new perspectives on problems and challenges IBM and its clients faced. In turn it helped delegate roles to an audience of people in search of innovation across this wide network that was made within IBM prior to the service phase.

With the search for innovation being pushed outward, IBM concentrated on segments of their network of innovation jam participants. IBM focused more attention on the audience it was targeting in order to direct specific topics and questions to those who may provide answers. With the development of the MiniJam platform, specific audiences could be targeted for a tailored discussion around the problem to be addressed. For example, this allowed IBM to target managerial problems to its management workforce or engineering problems to its globally dispersed engineers.

To complement IBM's wide and focused source of knowledge network, IBM incorporated more sophisticated technological tools in innovation jams to bridge participants' creativity and insight to the innovation process. IvT's played a critical role in manipulating data for visualization and understanding that underpins the innovation process within innovation jams. IvT's brought new ways for participants to organize innovation and in understanding the on-going dialogue. One-way IvT supported innovation jams was through the priority to deliver real-time analysis allowing the pulse of the different conversations to be monitored. Advancements in technology moved from collecting and storing to transforming and visualizing information in real-time and overtime. Past phases limited information to static intranet pages or to basic analysis, while it was through the implementation of IvT's in the service phase that enabled information to become more dynamic. As information became more fluid through its visualization from data analysis tools it allowed dynamic themes to be followed as it happened- moving the innovation jam service stage into one iterative stage of insight. Analytical tools adopted from an IBM Research groups provided the needed technology for robust analysis through the use of COBRA- Corporate Brand and Reputation Analysis. Topics were able to be refined using theme clouds that visually represented emerging trends and frequent words use that were commonly associated together. This allowed participants to add to the dialogue they were interested in faster and without the arduous task of reading from the forum posts that could number in the thousands.

Figure 5.3 is a themecloud of how analysis of jam forum discussions can be visualized using COBRA. It shows how the frequencies of words and word associations have changed overtime within the innovation jam. Figure 5.3 shows a sample of how the themecloud changes from the start of the jam and as it progression throughout the innovation jam.


**Figure 5.3:** Themecloud of jam forum discussions

Finally, it appears that innovation jams are moving into a fourth phase of development where innovation jam events are being linked to other social networking tools and sites to continue the dialogue. Groups are forming on independent social networking sites that give individuals an opportunity to continue the dialogue in other virtual environments beyond the hosted innovation jam event. Connections that were made within the innovation jam appear to be spreading across the web, keeping collaborating in tacked regardless of geography, businesses, industry, and time possible but more importantly keeping the passion for and discussion on a topic alive.

## 5.9 Limitations and Future Research

Our study has several limitations associated with case study research in its attempt to exchange generality for richness, accuracy, and insight into the observed innovation process (Langley, 1999; Yin, 1984). Moreover, our investigation was conducted in a company where specific organizational traits within the research setting may have affected how the observed changes unfolded. As IBM has gone through well documented changes (Gerstner, 2002) after being faced with near bankruptcy and revival, it would not be unreasonable to argue that this experience has created a heightened sense of adapting organizational change. We do believe this experience may have helped increase the emergent influence of innovation jams influence on the organization that would occur less apparently elsewhere.

It is also possible due to innovation jams novelty and the evolving technology that supports it, innovation jams of the future may only partially resemble innovation jams of the present where opportunities to compare how current and future technology may place boundaries on innovation jams. This has important consequences on innovation jam adoption, use, and diffusion across environments, in which theories of organizational change must be included to explain the possible outcomes. Though the authors acknowledge that more empirical work is necessary to expand and verify the framework, it is believed that a useful starting point has been made

Innovation jams offer many rich research opportunities in understanding large scale collaboration. Since innovation jams are now a service provided by IBM, investigation into organizations that have leveraged this service may further indicate the potential for innovation jams in influencing change in organizations of different size, industry, and nature. Next, surveys of innovation jam participants may be an area of research to investigate individuals' perceived views on innovation jams before and after or how organizations can exploit diverse sources of knowledge. This may lead insight if participants view innovation jams as a form of a gift economy or culture (Mauss, 1990) where ideas are given in return for future reciprocity through the development of social bonds over time.

Future research might investigate more systematically whether innovation jam practice within in the innovation process has spurred change or adoption of innovation in other areas of practice. Alternatively, investigation in the understanding of innovation jams influence on identity, learning, and culture particularly around organization and emerging technology provide future research with opportunities.

## 5.10 Implications and Conclusions

This study aimed to understand, using a longitudinal framework the relationship between innovation jams and organizational change. Using the metaphor of a jamband this paper describes the emergent development and use of innovation jams at IBM. It is through this engagement, which was reminiscent of jamband experimentation that has led to unexpected results in forming a new model to organize innovation. The use of grounded theory approach in this study was particularly fitting, offering new concepts and mechanisms that address the important organizational elements IBM has used to develop and adopt, that to date have largely been overlooked in the innovation jam literature. Albeit each research methodology has its own drawbacks in generalizability our research does provide value in stimulating new insights, while the papers contribution and approach are indicative of how organizations learn to engage with innovation jams through their development and practice.

This study contributes to elements of theory and practice particularly as organizations choose to leverage new technology to implement open innovation practices. Constituted through the continuous development and use of innovation jams at IBM, reciprocal influences of social and technical practices emerge. Moreover, by identifying the organizational and technological mechanisms, we have highlighted how bidirectional influences in IBM's use of innovation jams have facilitated organizational change in its innovation process.

Next, this study contributes to the open innovation literature by suggesting an evolutionary perspective of innovation jams as the object of analysis. Using the locus of innovation this study identified several attributes that contributed to the changing patterns of evolution. The evolution of innovation jams as a viable platform to service its clients has led to an internally developed experience with innovation jams that allow in the facilitation of internal knowledge and expertise of its workforce to be an external problem-solving engine outside of IBM.

Analysis within this study suggests technological and methodological changes occurred at different phases of IBM's use of innovation jams. The technical and methodological changes represented offer insight into how through the implementation of such technology can support both outside-in and inside-out modes of open innovation. From this we see how technology and organizational methods coexist and work in tandem to support the practice of open innovation. Next, emerging technology that allows users to play multiple roles in the practice of open innovation allow for greater flexibility in contributing to organizational change. IBM's approach to innovation and change sits on the assumption of action- not stability in providing innovation as a service that has emphasized greater fusion between humans and technology that assist them in the innovation process.

Findings have implications for managers, organizations, and governments who look to influence change to create a collaborative environment to address challenging problems. Findings suggest strategic benefits from emerging technology to influence change and innovation dynamics for increased knowledge sharing within the organization, creating a shared community and in developing a shared identity with organizational stakeholders. Implications for business suggest managers may shift efforts to illicit knowledge from untapped areas internally, to harness external sources of knowledge and in integrating this knowledge for innovative activities. Findings have implications on governments suggesting emerging technology may enable greater participation of its citizens in policy and societal decisions in providing workable solutions to complex problems for all stakeholders.

Finally, this study suggests that the engineering approach led by Gerstner (2002) in IBM's turnaround has continued today through the micro practices of experimenting with the application of innovation jams to drive innovation as a service. This is interesting because it suggests that IBM's development of innovation as a service that was previously thought (Chesbrough 2011, p. 144-145) to be to be occupied by only small niche firms with small markets opportunities may face competitive pressures not only from other small niche firms or intermediaries, but from large firms experimenting to control innovation services of markets in technologies or ideas. This may indicate the adaptive business models that innovation service firms have- which have been a source of their competitive advantage (Chesbrough 2011), maybe adaptable within large organizations.

**References**

Aiman-Smith, L., S. Green. 2002. Implementing New Manufacturing Technology: The Related Effects of Technology Characteristics and User Learning Activities. *Acad. of Manag. J.* 45(2) 421-430.

Aldrich, H. 1972. Technology and organizational structure: A reexamination of the findings of the Aston group. *Admin. Sci. Quart.* 17(1) 26–44.

Barley, S. 1988. "Technology, Power, and the Social Organization of Work," in N. Tomaso (Ed.), *Res. In the Sociology of Organizations,* JAI Press, Greenwich, CT, 6, 33-80.

Bastien, B., T. Hostager. 1988. Jazz as a Process of Organizational Innovation. *Comm. Research.* 15(5) 582-602.

Bjelland, O., R. Chapman Wood. 2008. An Inside View of IBM's Innovation Jams. *MIT Sloan Manag. Rev.* 50(1).

Boudreau, M., D. Robey. 2005. Enacting Integrated Information Technology: A Human Agency Perspective. *Organ. Sci.* 16(1) 3-18.

Budnick, D. 2003. Jambands: The Complete Guide to the Players, Music & Scene. San Francisco: Backbeat Books.

Cheney, G., L. Christensen. 2001. Organisational identity. “Linkages between ‘internal’ and ‘external’ organisational communication.” In F.M. Jablin & L.L. Putnam (Eds.), The New Handbook of Organisational Communication. (pp.231-269). Newbury Park, CA: Sage.

Chesbrough, H. 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology. Boston: Harvard Business School Press.

Chesbrough, H. 2006. “Open Innovation: A New Paradigm for Understanding Industrial Innovation,” in Henry Chesbrough, Wim Vanhaverbeke, and Joel West, eds., *Open Innovation: Researching a New Paradigm.* Oxford: Oxford University Press. 1-12.

Chesbrough, H. 2011. Open Services Innovation: Rethinking your Business to Grow and Compete in a New Era. San Francisco: Jossey-Bass.

Chiaroni, D., V. Chiesa, F. Frattini. 2010. Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. *R&D Manag.* 40(3) 222-245.

Christensen, J., P. Maskell. (eds). 2003. *The Industrial Dynamics of the New Digital Economy*. Cheltenham: Edward Elgar.

Ciborra, C. 1996. "Improvisation and Information Technology in Organizations", *Proceedings of the International Conference on Information Systems*. 369-380.

Constantinides, P., M. Barrett. 2006. Negotiating ICT development and use: The case of telemedicine system in the healthcare region of Crete. *Inform. and Organ.* 16(1) 27-55.

Cook, S., J. Brown. 1999. Bridging Epistemologies; The generative dance between organizational knowledge and knowing. *Organ. Sci.* 10(4) 381-400.

Crossan, M. 1998. Improvisation in Action. *Organ. Sci.* 9(5) 593-599.

Dahlander, L., D. Gann. 2010. How open is innovation? *Res. Policy.* 39(1) 699-709.

Dodgson, M., D. Gann, A. Salter. 2005. *Think, Play, Do: Technology and the New Innovation Process.* Oxford: Oxford University Press.

Dodgson, M., D. Gann, A. Salter. 2006. The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Manag.* 36(3) 333-346.

Dodgson, M., D. Gann, A. Salter. 2008. *The Management of Technological Innovation: Strategy and Practice,* Oxford, Oxford University Press.

Dodgson, M., D. Gann. working paper. Organizational Learning and the Technology of Foolishness: The Case of Virtual Worlds at IBM. Under submission at Organ. Sci.

Dorsett, L., M. Fontaine, T. O'Driscoll. 2002. Redefining Manager Interaction at

IBM. Knowledge Management Review. September/ October. Melcrum Publishing.

Edmondson, A., R. Bohmer, G. Pisano. 2001. Disrupted routines: Team learning and new technology implementation in hospitals. *Admin. Sci. Quart.* 46(4) 685–716.

Eisenhardt, K. 1989. Building theories from case study research. *Acad. of Manag. Rev.* 14(1) 532–550.

Gassmann, O., E. Enkel, H. Chesbrough. 2010. The future of open innovation. *R&D Mang.* 40(3) 213-221.

George, J., J. King. 1991. Examining the Computing and Centralization Debate. *Communications of the ACM.* 34(7) 63-72.

Gerstner, L. 2002. Who Says Elephants Can't Dance? Inside IBM's Historic Turnaround, Collins.

Gerwin, D. 1981. Relationships between structure and technology. P.C. Nystrom, W.H. Starbuck, eds. *Handbook of organizational design*. Oxford University Press, New York, 3-38.

Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structure,* University of California Press, Berkeley, CA.

Glaser, B., A. L. Strauss. 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine de Gruyter, New York.

Hatch, M. 1998. Jazz as a metaphor for organizing in the 21st Century. Special Issue on Jazz Improvisation and Organizing, *Orga. Sci.* 9(5), 556-568.

Hatch, M., K., Weick. 1998. Critical Resistance to the Jazz Metaphor. *Organ. Sci*. 9(5) 600-604.

Hatch, M. 1999. Exploring the empty spaces of organizing: How improvisational jazz helps redescribe organizational structure. *Organ. Stud.* 20 75-100.

Helander, M., R. Lawrence, Y. Liu, C. Perlich, C. Reddy, S. Rosset. Looking for great ideas: analyzing the innovation jam. Proceedings of the 9th WebKDD and 1st SNA-KDD Workshop on Web Mining and Social Network Analysis, in conjunction with the 13th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD 2007), pages 66–74, August 2007.

Howe, J. 2009. CrowdSourcing: Why the power of the crowd is driving the future of Business. Three Rivers Press, New York.

Huizingh, E. 2010. Open innovation: State of the art and future perspectives. *Technovation*. 30(1) 555.

Illi, S., A. Albers, S. Miller. 2010. Open innovation in the automotive industry. *R&D Manag.* 40(3) 246-255.

Lakoff, G. (1990) *Women, Fire, and Dangerous Things*. University of Chicago Press.

Langley, A. 1999. Strategies for theorizing from process data. *Acad. of Manag. Rev.* 24(1) 691-710.

Leonardi, P. 2007. Activating the informational capabilities of information technology for organizational change. *Organ. Sci.* 18(5) 813-31.

Leonard, P. 2008a. Indeterminacy and the Discourse of Inevitability in International Technology Management. *Acad. of Manag. Rev.* 33(4) 975-984.

Leonardi, P. 2008b. "Reclaiming Materiality: Explaining Interpretations of Technology and Resistance to Organizational Change" *Paper presented at the annual meeting of the International Communication Association, Montreal, Quebec, Canada*.

Leonardi, P. 2010. When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. *MIS Quart.* Forthcoming.

Leonardi, P., S. Barley. 2008. Materiality and Change: Challenges to Building Better Theory about Technology and Organizing. *Inform. and Organ.* 18(1) 159-176.

Leonardi, P., M. Jackson. 2009. Technological Grounding: Enrolling Technology as a Discursive Resource to Justify Cultural Change in Organizations. *Sci, Techn. & Hum. Values,* 34(3) 393-418.

Lewin, A. 1998. Jazz Improvisation as a Metaphor for Organizational Theory. *Organ. Sci.* 9(5) 553.

Lichtenthaler, U. 2011. Open Innovation: Past Research, Current Debates, and Future Directions. *Acad. of Manag. Persp.* 25(1) 75-93.

Locke, K. 2001. *Grounded Theory in Management Research*, Sage Publications, London, Thousand Oaks.

Kamoche, K., M. P. e. Cunha, J. V. d. Cunha. 2003., Towards a Theory of Organizational Improvisation: Looking Beyond the Jazz Metaphor. *J of Manag. Studies.* 40(1) 2023–2051.

Kamoche, K., M. P. e. Cunha. (2001) Minimal Structures: From Jazz Improvisation to Product Innovation. *Organ. Stud.* 22(5) 733-764.

Klein, H., M. Myers. 1999. A Set of Principles for Conducting and Evalutating Interpretive Field Studies in Information Systems. *MIS Quart.* 23(1) 1087-1099.

Kohler, T., K. Matzler, J. Fuller. 2009. Avatar-based innovation: Using virtual worlds for real-world innovation. *Technovation.* 29(1) 395-407.

Majchrzak, A., R. Rice. A. Malhotra, N. King, S. Ba. 2000. Technology adaptation: The case of a computer-supported inter-organizational virtual team. *MIS Quart.* 24(4) 569–600.

March, J. 1981. Footnotes to Organizational Change. *Admin. Sci. Quart*. 26(1) 563-577.

Orlikowski, W. 1993. CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development. *MIS Quart.* 17(3) 568-587.

Orlikowski, W. 1996. Improvising Organizational Transformation Over Time: A Situated Change Perspective. *Inform. Syst. Res.* 7(1) 63-92.

Orlikowski, W. 2002. Knowing in practice: enacting a collective capability in distributed organizing. *Organ. Sci.* 13(3) 249-273.

Orlikowski, W. 2007. Sociomaterial practices: Exploring technology at work. *Organ. Studies* 28(9) 1435–1448

Orlikowski, W., S. Barley. 2001. Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other? *MIS Quart*. 25(2) 145-165.

Orlikowski, W., J. Baroudi. 1991. Studying Information Technology in Organizations: Research Approaches and Assumptions. *Inform. Syst. Res.* 2(1) 1-28.

Orlikowski, W., D. Robey. 1991. Information Technology and the Structuring of Organizations. *Inform. Syst. Res.* 2(2) 143-169.

Orlikowski, W., S. Scott. 2008. Sociomateriality: challenging the separation of technology, work and organization. *Acad. of Manag. annals*. 2(1) 433-474.

Palmisano, S. 2006. The globally integrated enterprise. *Foreign Affairs.* 85(3) 127-136.

Pasmore, W. 1998. Organizing for Jazz. *Organ. Sci.* 9(5) 562-568.

Pavitt, K. 2003. Specialization and systems integration. In Hobday, M. (ed.), The Business of Systems Integration. Oxford: Oxford University Press.

Peplowski, K. 1998. The Process of Improvisation. *Organ. Sci.* 9(5) 560-561.

Pettigrew, A. 1990. Longitudinal Field Research on Change: Theory and Practice. *Organ. Sci*. 1(3) 267-292.

Scott, W. 1995. *Institutions and Organizations.* Thousand Oaks, CA: Sage.

Strauss, A. L., and J. Corbin. 1998. Basics of qualitative research: Techniques and procedures for developing grounded theory. 2nd ed. London: Sage.

Suchman, L. 2007. *Human-Machine Reconfigurations: Plans and situated actions* (2nd edition). Cambridge, MA: Cambridge University Press.

Surowiecki, J. 2004. The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations. Little, Brown.

Thomke, S. 1998. Managing experimentation in the design of new products. *Manag. Sci*. 44 6(1) 743-762.

Tuedio, J., S. Spector. 2010. *The Grateful Dead in Concert: Essays on Live Improvisation.* North Carolona: McFarland & Company, Inc., Publishers.

Tuomi, I. 2002. Networks of Innovation: Change and Meaning in the Age of the Internet. New York: Oxford University Press.

Tushman, M., P. Anderson, C. O'Reilly. 1997. "Technology Cycles, Innovation Streams, and Ambidextrous Organizations: Organization Renewal Through Innovation Streams and Strategic Change," Managing Strategic Innovation and Change, Michael Tushman and Philip Anderson (eds.), Oxford University Press: New York.

Tsoukas, H., C. Chia. 2002. On Organizational Becoming: Rethinking Organizational Change. *Organ. Sci.* 13(5) 567-582.

Tyre, M., W. Orlikowsk. 1994. Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations. *Organ. Sci*. 5(1) 98-118.

Vaast, E., G. Walsham. 2005. Representations and actions: The transformation of work practices with IT use. *Inform. and Organ.* 15(1) 65–89.

van de Vrande, V., J. de Jong, W. Vanhaverbeke, M. de Rochemont. 2009. Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29(1) 423-437.

van de Vrande, V., W. Vanhaverbeke, O. Gassmann. 2010. Broadening the scope of open innovation: Past research, current state and future directions. *Intern. J of Tech. Manag.* 52(3) 221-235.

Weick, K. 1998. Improvisation as a Mindset. *Organ. Sci.* 9(5) 543-555.

West, J., S. Gallagher. 2006. Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Manag.* 36(3) 319–331.

Woodward, J. 1958. *Management and Technology*. London: Her Majesty's Stationary Office.

Woodward, J. 1965. *Industrial organization: Theory and practice*. New York, NY: Oxford University Press.

Yin, R. 1984. Case Study Research – Design and Methods. Sage Publications, CA, USA

Zamutto, R., T. Griffith, A. Majchrzak, D. Dougherty, S. Faraj. 2007. Information technology and the changing fabric of organization. *Organ. Sci.* 18(5) 749–762.

Zack, M. 2000. Jazz Improvisation and Organizing: Once More from the Top. *Organ. Sci.* 11(2) 227-234.

# Chapter 6: Conclusions, Implications and Future Research

## 6.1 Conclusions

There has been no shortage of development in support technology to aid policy makers, managers, and individuals in decision-making. An array of support technology has been discussed in this thesis that has covered decision support on the individual and group level that have conventionally been designed to address the limitations of individual rationality. Organizations no longer can rely on decision support technology that solely focus on bridging the boundary between rational and non-rational aspects of human social behavior but instead, must consider the larger dynamic organizational network for decision support. Organizations today need to think strategically about how emerging technology can support decision making and the resulting decision support models to navigate the external environment and in turn, to forge stronger links with customers, suppliers, and the wider organizational network. Since no systematic framework or exhaustive review has been made in connecting the flows of knowledge in the open innovation literature to the decision support community, this thesis contributes to the linking of these research streams by presenting a framework of open models of decision support and the underlying phenomena driving these models. Considering potential synergies, research in this thesis has contextualized a framework in the intersection of decision support technologies and open models of collaboration.

The study presented in this thesis considers the structural, relational, and transformative foundational concepts within the open models of decision support framework. Three typologies have been suggested to categorize these new forms of decision support. Essay #1, *The Evolution of Expertise in Decision Support Technologies: A Challenge for Organization*- provided an evolutionary view of how decision support technologies are facilitating knowledge flows that has shown a shift in where knowledge can be harnessed for decision support. Essay #2, *A Knowledge Representation Approach to Box-Office Forecasting: A Comparison of Expert Systems and Collective Intelligence Tools*- covers the ´aggregate´ typology and uses a common forecasting problem in the motion picture industry to illustrate how prediction markets harness dispersed knowledge for box-office forecasting. Essay #3, *Elephants Can Jam: IBM Innovation Jams for Organizational Change*- uses empirical work on the evolution of IBM Innovation Jams within the ´platform´ typology. General conclusion can be made from this thesis that suggests the following:

Dispersed knowledge found internally and externally to the organization is being utilized for decision support.
Collective approaches to problem solving supported by emerging technology are circumventing limitations of human rationality.
Emerging technology has evolved enabling large-scale decision support that has not been possible in the past.

## 6.2 Organizational and Managerial Implications

Findings from this thesis have several organizational and managerial implications. Organizations that choose to be more open in organizational processes (i.e. product and service innovation) may realize competitive gains and performance improvements by utilizing open models of decision support. Managers who look to achieve the potential benefits from open models of decision support may be advised to integrate the supporting emerging technologies into the organizational workflows and processes to foster adoption by its employees. To enable the adoption of emerging models of decision support is by placing the emerging technologies into the existing IT infrastructure and processes of the organization, making use of these decision support models evident instead of an extra task for employees. Moreover, by designing systems those coordinate the output of the group, as a bye product of the operating of the system will help to facilitate adoption with greater results from emerging models of decision support and the technology that supports them.

Implications from this thesis suggest that organizations have incentives to expand their organization network to incorporate these external knowledge sources for their own decision support process.  This may lead to organizations leveraging untapped areas in its organizational network or through industry-university collaboration.

Moreover, implications for organizations from this thesis suggest benefits of integration within the organizational network may not be limited to processes that reduce costs, improve speed to market, or create economies of scale but also to decision support for problem-solving complex organizational problems.

## 6.3 Future Research

The continuous evolution of technology may create greater synergies between the different typologies for blends of new open models of decision support.

Opportunities in testing within the open models of decision support framework. This includes use of quantitative and qualitative methodologies to compare typologies, technologies, and use of the emerging technologies that support them.

Opportunities for research into these models have on managerial decision making and the possible consequences they may have on legal, marketing, communications, and public policy.

Research into the motivation aspects of actors in each of the open model of decision support and not to assume one incentive is appropriate for each of the typologies or underlying technology in use. This leaves open to what incentives are appropriate for the different typologies and technologies within.

Investigation into the diversity, group size, and cognitive ability within each typology would be fruitful for understanding the boundary, limitations, and circumstances and technology could be applied.

# Appendix 1: Existing Literature Relevant to the 'Broadcast' Typology

Though no systematic research has been conducted as part of this thesis under the 'broadcast' typology, existing literature does explore phenomena under this typology. A list of extended reading that would support the 'broadcast' typology is offered.

**References**


Brabham, D. (2008). Crowdsourcing as a model for problem solving: An introduction and cases. *Convergence: The International Journal of Research into New Media Technologies*, 14(1), 75-90.

Boudreau, K., Lacetera, N., and K. Lakhani. (2011). Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis. *Management Science* 57(5), 843-863.

Håkanson, L., Caessens, P., S. MacAulay. (2011). InnovationXchange: A case study in innovation intermediation. *Innovation: Management, Policy & Practice* 13(2), 261-274.

Jeppesen, L., and K. Lakhani. (2010). Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science* 21, 1016-1033.

Lakhani, K., and L. Jeppesen. (2007). Getting Unusual Suspects to Solve R&D Puzzles." Forethought. *Harvard Business Review* 85(5).

Lakhani, K., Jeppesen, L., Lohse, P., and J. Panetta. "The Value of Openness in Scientific Problem Solving. " Harvard Business School Working Paper, No. 07-050, 2007.

## Appendix 2: Bibliography for Chapters 1, 2, and 6


Alavi, M. and Leidner, D. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly* 25 (1): 107–136.

Antonelli, C. and Geuna, A. (2000). Information and Communication Technologies and the Production, Distribution and Use of Knowledge, *International Journal of Technology Management,* 20(1-2): 72-105.

Berg, J., Nelson, F. & Rietz, T. (2008). Prediction Market Accuracy in the Long Run, *International Journal of Forecasting*, 24(3): 283-298.

Berg, J., Forsythe, R., Nelson, R., and Rietz, T. Results from a Dozen Years of Election Futures Markets Research, *In The Handbook of Experimental Economics Results*. 2001.

Boisot, M. *Information Space- A Framework for Learning in Organisations, Institutions and Culture*. Rutledge: London and New York, 1995.

Boisot, M. (2004). Exploring the information space: a strategic perspective on information systems information. [Online working paper]: IN3-UOC (Working Paper Series; WP04-004). (URL: http://www.uoc.edu/dt/20415/index.html).

Campbell, D. (1987). Blind Variation and Selective Retention in Creative Thought as in Other Knowledge Process, in: Radnitzky G, Bartley WW II (eds). *Evolutionary epistemology, rationality, and the sociology of Knowledge*. 1987. Open Court: Illinois.

Christensen, J. and Maskell, P. *The Industrial Dynamics of the New Digital Economy*. Cheltenham: Edward Elgar, 2003.

Cohen, W., and Levinthal, D. (1989). Innovation and learning: The two faces of R&D, *The Economic Journal*, 99: 569-596.

Cohen, W., and Levinthal, D. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35: 128-152.

Cowgill, B., Wolfers, J., and Zitwewitz, E. (2008). Using Prediction Markets to Track Information Flows: Evidence from Google. *(working paper).*

Dahlsten, F. (2004). Hollywood wives revisited: a study of customer involvement in the XC90 project at Volvo Cars. *European Journal of Innovation Management*, 7(2): 141-149.

Davenport, T., and Harris, J. *Competing on Analytics: The New Science of Winning,* Boston: Harvard Business School Press, 2007.

Dittrich, K. and Duysters, G. (2007). Networking as a Means to Strategy Change: The Case of Open Innovation in Mobile Telephony. *Journal of Product Innovation Management*, 24: 510–521.

Dodgson, M., Gann, D., and Salter, A., (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management*, 36(3): 333-346.

Erikson R. S. & Wlezien C. (2007). Are Political Markets Really Superior to Polls as Election Predictors? *Public Opinion Quarterly*.

Fleming, L. (2001). Recombinant uncertainty in technological search. *Management Science*, 47: 117–132.

Florida, R. *The rise of the creative class: And how it's transforming work, leisure, community and everyday life.* New York, NY: Basic Books, 2002.

Gigerenzer, G., and Todd, P. *Simple Heuristics that Make Us Smart.* Oxford University Press: Oxford, 1996.

Golub, B. and Jackson, M. (2010). Naive Learning in Social Networks: Convergence, Influence and the Wisdom of Crowds, *American Economic Journal: Microeconomics* 2(1): 11249.

Grant, R. (1996). Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration, *Organization Science,* 7(4): 375–387.

Hargadon, A., and Sutton, R. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly,* 42: 716–749.

Hogue, J. and Watson, H. (1983). Management's role in the approval and administration of decision support systems, *MIS Quarterly*, 7(2): 15-26.

Hong, L. and Page, S. (2001). Problem Solving by Heterogeneous Agents. *Journal of Economic Theory*, 97(1): 123–63.

Hong, L. and Page, S. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences,* 16385-16389.

Johnson-Laird, P. *Mental models.* Cambridge, MA: Harvard University Press, 1983.

Klein, M. and Methlie L. *Knowledge-based Decision Support Systems with Applications in Business.* Chichester, UK: John Wiley & Sons, 1995.

Kristensson, P., Gustafsson, A., & Archer, T. (2004). Harnessing the Creative Potential among Users. *Journal of Product Innovation Management*, 21(1): 4-14.

Mitton, C., Adair, C., McKenzie, E., Patten, S. and Perry, B. (2007), Knowledge Transfer and Exchange: Review and Synthesis of the Literature. *Milbank Quarterly*, 85: 729–768.

Nahapiet, J., and Ghoshal, S. (1998). Social Capital, Intellectual Capital and the Organizational Advantage. *Academy of Management Review*, 23(2): 242-266.

Nonaka, I. and Teece, D. *Managing Industrial Knowledge Creation, Transfer and Utilization.* London: Sage, 2001.

Novicevic, M., Duke, A., Holmes, E., Breland, J., Buckley, M., and Bing, M. (2011). Customers co-creating value with the firm: Implications for IHRM. *International Journal of Human Resource Management.* 22(3): 746-761.

P & G Report. (2003). *Connect & Develop Report: Creating a Global Innovation Network to Better Serve Consumers.* 1:1-8

Page, S. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies,* Princeton University Press, 2007.

Paisley, W. (1993). Knowledge utilization: The role of new communications technologies. *Journal of the American Society for Information Science*, 44(4): 222-234.

Pavitt, K. Specialization and systems integration. In Hobday, M. (ed.), The Business of Systems Integration. Oxford: Oxford University Press, 2003.

Payne, A. F., Storbacka, K., and Frow, P. (2007). Managing the co-creation of value. *Journal of the Academy of Marketing Science*, 36(1): 83-96.

Pisano, G. P. (1994). Knowledge, Integration, and the Locus of Learning: An Empirical Analysis of Process Development. *Strategic Management Journal*, 15: 85–100.

Powell, W., Koput, K., and Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Control of Innovation: Networks of Learning in Biotechnology, *Administrative Science Quarterly,* 41(1): 116-45.

Power, D. (2000). What are the advantages and disadvantages of Data Warehouses? *DSS News*, 1(7).

Power, D. (2003). Can using a DSS have unintended negative consequences? *DSS News*, 4(8).

Porter, M. *Competitive Advantage*. The Free Press: New York, 1995.

Prahalad, C. K. and Ramaswamy, V. (2004). Co-creation experiences: The next practice in value creation. *Journal of Interactive Marketing*, 18(1): 5–14.

Quinn, J. *The intelligent enterprise: a knowledge and service-based paradigm for industry*. The Free Press: New York, 1992.

Ramaswamy, V. (2008). Co-creating value through customers' experiences: the Nike case. *Strategy Leadership*, 36(5): 9-14.

Riedl, J., Konstan, J., and Vrooman, E. *Word of Mouse: The Marketing Power of Collaborative Filtering*, New York: Warner Books, 2002.

Rockart, J., and Short, J. (1989). IT in the 1990s: Managing Organizational Interdependence, *Sloan Management Review*, 30(2): 7-17.

Root-Bernstein, R. (1982). The problem of problems. *Journal of Theoretical Biology*, 99(1): 193-201.

Schumpeter, J. *Capitalism, Socialism and Democracy*. Harper & Row: New York, 1942.

Senge, P. *The Fifth Discipline: The Art & Practice of The Learning Organization*. New York: Currency Doubleday, 1990.

Shavinina , L. *The International Handbook on Innovation*. New York: Elsevier, 2003.

Shirky, C. *Cognitive Surplus: Creativity and Generosity in a Connected Age*. Penguin Press, 2010.

Simard, C. and West, J. (2006). "Knowledge networks and the geographic locus of innovation," in Henry Chesbrough, Wim Vanhaverbeke and Joel West, eds., *Open Innovation: Researching a New Paradigm*, Oxford: Oxford University Press, pp. 220-240.

Spann, M. & Skiera, B. (2003). Internet-based Virtual Stock Markets for Business Forecasting, *Management Science,* 49(4): 1310-1326.

Surowiecki, J. *The Wisdom of Crowds: Why The Many Are Smarter than The Few and how Collective Wisdom Shapes Business, Economies, Societies, and Nations*. New York, NY: Doubleday, 2004.

Tapscott, D. and Williams, A. *Wikinomics: How Mass Collaboration Changes Everything*, Portfolio, New York, NY 2006.

Terwiesch, C. and Xu, Y. (2008). Innovation Contests, Open Innovation, and Multiagent Problem Solving. *Management Science,* 54(9): 1529-1543.

Thomke, S. *Experimentation Matters: Unlocking the Potential of New Technologies for Innovation*, Boston: Harvard Business School Press, 2003.

Tversky, A. and Kahneman, D. (1974). *Judgment Under Uncertainty: Heuristics and Biases Science. New Series,* 185(4157): 1124-1131.

Vargo, S. L., & Lusch, R. (2008a). Service-dominant logic: continuing the evolution. *Journal of the Academy of Marketing Science*, 36(1): 1-10.

Vargo, S. L., & Lusch, R. (2008b). Why "service"? *Journal of the Academy of Marketing Science,* 36(1): 25-38.

von Krogh, G., Nonaka, I. and Ichijo, K. (1997). Develop knowledge activists! *European Management Journal,* 15(5): 475-483.

von Krogh, G., Ichijo, K. and Nokaka, I. *Enabling Knowledge Creation. How to Unlock the Mystery of Tacit Knowledge and Release the Power of Information*. New York: Oxford University Press, 2000.

Weinberger, D. *Everything Is Miscellaneous: The Power of the New Digital Disorder*, New York: Times Books, 2007.

Winograd, T. and Flores, F. *Understanding Computers and Cognition.* Reading, MA: Addison-Wesley, 1986.

Wolfers, J. & Zitzewitz, E. (2004). Prediction Markets, *Journal of Economic Perspectives*, 18: 107-126.

Wolfers, J. & Zitzewitz, E. (2006). Prediction Markets in Theory and Practice, *New Palgrave Dictionary of Economics and the Law.*

Zahra, S., and George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension, *Academy of Management Review*, 27: 185-203.