AN ANALYSIS OF THE ELEMENTS OF COLLABORATION ASSOCIATED WITH TOP COLLABORATIVE TOOLS

THESIS

Kristopher C. Nagy, Captain, USAF

AFIT/GIR/ENV/10-M01

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

The views expressed in this thesis are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States Government.

AFIT/GIR/ENV/10-M01

AN ANALYSIS OF THE ELEMENTS OF COLLABORATION ASSOCIATED WITH TOP COLLABORATIVE TOOLS

THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Information Resource Management

Kristopher C. Nagy, BS

Captain, USAF

March 2010

AFIT/GIR/ENV/10-M01

AN ANALYSIS OF THE ELEMENTS OF COLLABORATION ASSOCIATED WITH TOP COLLABORATIVE TOOLS

Kristopher C. Nagy, BS

Captain, USAF

Approved:

_____//Signed//_____	_22 Mar 2010_
Jason M. Turner, Lt Col, USAF (Chairman)	Date
_____//Signed//_____	_22 Mar 2010_
Todd A. Peachey, Lt Col, USAF (Member)	Date
_____//Signed//_____	_22 Mar 2010_
Dennis D. Strouble, PhD, USAF (Member)	Date

Abstract

United States government agencies have historically experienced problems with inter-agency information sharing and collaboration. In fact, the National Commission on Terrorist Attacks upon the United Stated recommended that the U.S. government "increase information sharing" and "improve collaboration across government agencies." To this day, no collaborative tools are being used to fully address that recommendation. In fact, there is little agreement as to what collaboration necessarily means and what characteristics or capabilities are best suited for the design and use of collaborative tools. Before we can improve collaboration across agencies, we need to better understand the nature of collaboration itself, and the hallmarks of better collaborative tools. As such, this research developed a comprehensive definition of collaboration grounded in relevant academic and scholarly research. With this definition in hand, the foundational elements of collaboration were documented and explicitly articulated in the form of a collaborative framework. This framework was then used to assess current trends and state-of-art in collaborative tools and specifically to identify the key elements of better collaborative tools. Six of the nine academic elements of collaboration were strongly supported throughout the assessments indicating which features, functionalities, or aspects of the "collaborative problem space" should be addressed or instantiated within collaborative technologies and tools.

Dedication

To my wife and daughters

Acknowledgments

I would like to express my sincere appreciation to my faculty advisor, Lt Col Jason Turner, for his guidance and support throughout the course of this thesis effort. His insight, wisdom, and experience were certainly appreciated. I would, also, like to thank my committee, Lt Col Todd Peachey and Dr. Dennis Strouble for their perspective and support throughout this research.

Kristopher C. Nagy

Table of Contents

Page

Page

List of Figures

Page

List of Tables

Page

Page

AN ANALYSIS OF THE ELEMENTS OF COLLABORATION ASSOCIATED WITH TOP COLLABORATIVE TOOLS

I. Introduction

"I've asked [the Director of National Intelligence] to improve information sharing within the intelligence community and with officials at all levels of our government, so everyone responsible for the security of our communities has the intelligence they need to do their jobs."

- PRESIDENT GEORGE W. BUSH

The System was Blinking Red

On the morning of September 11, 2001, the world witnessed the grand finale of a terrorist plot many years in the making. A series of events that started in the 1990s ultimately led 19 terrorists to freely and publically travel into and around the United States, plan their attacks, and obtain the flight training and skills necessary to hijack four commercial aircraft. In the end, nearly 3,000 people lost their lives, thousands of families and friends lost loved ones, three iconic American landmarks were damaged or destroyed, total estimated damage costs were nearly $2 trillion (How Much did the September 11 Terrorist Attack cost America?, 2004), and the U.S. was dragged into a global war on terror that is still ongoing nearly 10 years later.

In hindsight, most of the hijackers were either temporarily detained or at least questioned by a government criminal agency: Federal, state, or local, and then released them because no single organization had enough derogatory or criminal information to take action (National Commission on Terrorist Attacks Upon the United States, 2003). For example, in January 2000, the National Security Agency (NSA) had undistributed information that would have identified Nawaf al Hazmi as a member of a terrorist

organization called Al Qaeda (National Commission on Terrorist Attacks Upon the United States, 2003). Had the NSA shared this information with the Federal Bureau of Investigation (FBI) or the aviation industry, the outcome on that fateful September morning may have been different. As it was, Hazmi and four accomplices boarded American flight 77 at 7:15am on September 11, 2001, forcefully overtook the crew and passengers, and flew the plane into the west wall of the Pentagon (National Commission on Terrorist Attacks Upon the United States, 2003).

Some speculate that inter-agency information sharing was hindered by the lingering cold war culture of information protection (Information Sharing Environment, 2004), which could explain why no single organization had access to the information needed to thwart the terrorist operations (National Commission on Terrorist Attacks Upon the United States, 2003). Is it possible that the very nature of our "need to know" culture was an element in the success of the 9/11 attacks?

In order to better understand why our nation was unprepared for that day of unprecedented shock and suffering, the President and Congress created the 9/11 Commission, more formally known as the National Commission on Terrorist Attacks Upon the United States (Public Law 107-306, 2002). The 9/11 Commission was a bipartisan group of 10 commissioners chosen by elected leaders to "investigate the facts and circumstances relating to the terrorist attacks of September 11, 2001" (National Commission on Terrorist Attacks Upon the United States, 2003). The subsequent report produced by the commission highlighted several weaknesses that were considered contributing factors to the success of the attacks.

One area of concern addressed in the report was “collaboration across government agencies” (National Commission on Terrorist Attacks Upon the United States, 2003). The intelligence community was criticized for not being able to act as “a whole” on information collected by the different departments. For example, in July of 2001, the FBI had information indicating potential terrorist interests in aircraft training in Arizona. In August of 2001, Minnesota authorities arrested Zacarias Moussaoui, a 9/11 planner and a possible backup pilot, for suspicious activity at a local flight school. Unfortunately, none of this information was shared across agencies (National Commission on Terrorist Attacks Upon the United States, 2003, p. 347).

Interestingly, the commission's report did not define collaboration, so it is unclear what was actually meant by “collaboration across agencies.” The commission reviewed over 2.5 million pages of documents and interviewed more than 1,200 people, including every senior official from the Clinton and Bush administrations (National Commission on Terrorist Attacks Upon the United States, 2003, p. xv). George Tenent, Director of the Central Intelligence Agency (CIA), told the 9/11 Commission “the system was blinking red” in the summer of 2001 (National Commission on Terrorist Attacks Upon the United States, 2003, p. 277). He stated that terrorist threat reports during the first half of 2001 were frequent and fragmented, and because of the seemingly infinite and unconnected volume of information, only a fraction was passed to the President and senior leaders via the President’s Daily Briefing (PDB) (National Commission on Terrorist Attacks Upon the United States, 2003).

The PDB consisted of a broad array of six to eight topics, selected by CIA staff, that were considered to be important at the time. Between 20 January and 10 September 2001, there were 40 intelligence articles related to Usama bin Laden briefed at the PDB, but due to the sensitive nature of the PDB, the information only reached a small number of high-level officials (National Commission on Terrorist Attacks Upon the United States, 2003, p. 254). Senior leaders outside the PDB received a daily Senior Executive Intelligence Brief (SEIB), which is a watered-down version of the PDB with less information to protect sources and methods of intelligence collection. The Attorney General, FBI Director, and National Security Council (NSC) Counterterrorism Coordinator all received the SEIB, not the PDB, nor did they have access to internal, non-disseminated information from the NSA, CIA, or FBI (National Commission on Terrorist Attacks Upon the United States, 2003, p. 255).

By the end of 2003, it was clear that the U.S. government needed to overhaul its information sharing policies in order to better respond to new dynamic threats and respond to the 9/11 Commission report with improved "collaboration across agencies." Following several successful information sharing initiatives, the intelligence community developed a new information sharing strategy. In May 2008, the Director of National Intelligence released an information sharing strategy that emphasized the need to challenge the status quo in the information “need to know” culture and move to a “responsibility to provide and share” mindset (Office of the Director of National Intelligence, 2008). While the “need to know” culture may have been a necessity during the Cold War in order to protect information, this approach assumes it is possible to know

in advance who will need the information. One implication of a "need to know" culture suggests that the risks of inadvertent exposure outweigh the benefits of wider sharing; this conclusion was challenged on a particular September morning in 2001.

Information Sharing and Collaboration in the AOC

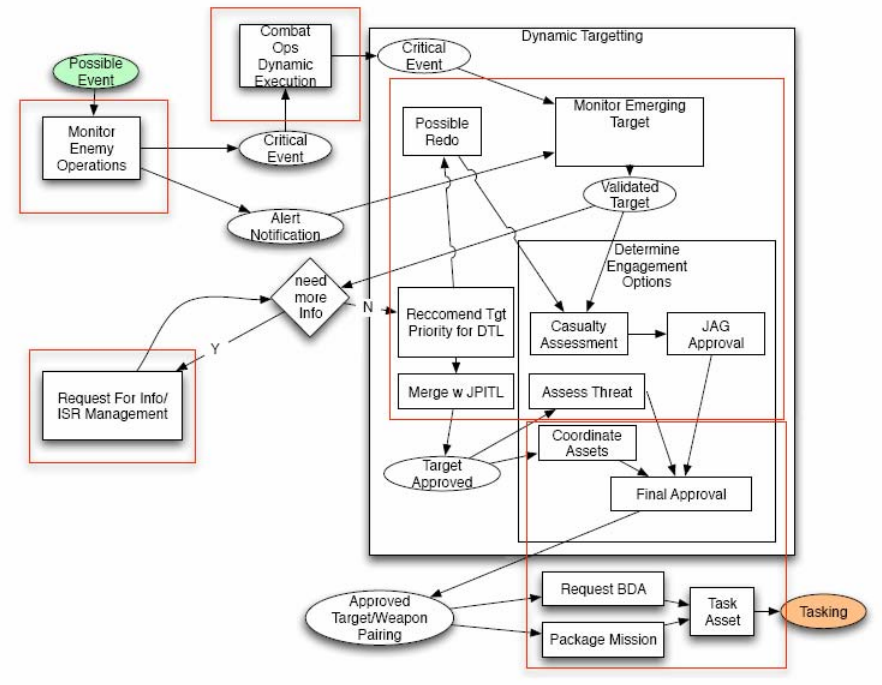
The 9/11 Commission Report also evaluated procedures for situations that required coordination between multiple agencies. For example, until 2003, hijackings required the attention of the Federal Aviation Administration (FAA), the Pentagon's National Military Command Center (NMCC), and North American Aerospace Defense Command (NORAD) (National Commission on Terrorist Attacks Upon the United States, 2003, pp. 17-18). I took a personal interest in the report's evaluation of coordination because NORAD hosts Air Operations Center (AOC) components in Colorado and Alaska, and as a newly commissioned officer, I was assigned to the Theater Battle Management Core Systems (TBMCS) Program Office. TBMCS is a primary component of the AOC that automates the planning and execution of the Air Battle Plan (ABP) and allows the air commander to plan, execute, and control all air theater operations in support of command objectives. TBMCS enables coordination between multiple agencies and addresses a concern of the 9/11 commission.

The AOC is comprised of over 48 major systems, but many are "stove-pipe" systems built by different Air Force major commands with limited inter-operational capabilities (Wathen, 2006). In fact, despite a $130 million dollar budget between fiscal years 2005 – 2010 (Theater Battle Management (TBM) C4I, 2006), many systems are not

interoperable and cannot perform theoretically important functions such as sharing databases, exchanging mission essential information, and allowing collaborative planning in order to manage complex operations in the AOC (Wathen, 2006).

As a result of the previously mentioned shortfalls, operators are forced to manage intricate work flows and disruptive events with little help from technology. For example, consider the emergence of a Time Sensitive Target (TST). TSTs can materialize at any time and require massive coordination efforts within the AOC (see Figure 1). Surprisingly, the entire process shown in Figure 1 below is managed with basic tools that were not designed specifically for the dynamic and interrelated processes that occur in the AOC environment.

Figure 1: Air and Space Operations Center (AOC) process model



Despite the demand for better technology to support coordination, sharing, and collaboration, a recent MITRE study (Mathieu, James, Mahoney, Boiney, Hubbard, & White, 2007) highlighted the rudimentary tools used by AOC operators to manage daily operations as well as to perform critical tasks like process TSTs. The tools (and their relative usages) include:

- Chat (75%)
  - Text chat (70%)
  - Audio chat (5%)
- E-mail (10%)
- Face-to-face meetings (10%)
- Telephone (5%)

A major drawback with the current tools used in the AOC is the disruptiveness they cause to the environment. For instance, operators typically scan 10 or more chat rooms and may be involved in any number of chat conversations (Mathieu, James, Mahoney, Boiney, Hubbard, & White, 2007). Face to face meetings and telephone calls also divert attention from the primary job of planning missions. In my experience working with members of the AOC, delays caused by the use of current communications tools and methods may result in missing the TST entirely and/or failure to incorporate lower priority targets into the ABP. As the first decade of the 21st century comes to a close, the lessons learned from the 9/11 commission report emphasize the importance of enhancing collaboration at all levels in order to allow seamless workflow and communications -- up, down, and across organizations.

What do Amazon, Boeing, and Google have in Common?

A quick glance into the dictionary reveals a suitable definition for collaboration, which will be expanded later. For now, collaboration is - *people working together for a common purpose or benefit* (The American Heritage Dictionary, 2009). Collaborative environments breed innovations and provide more assets to draw from including social contracts, capital, equipment, and ideas (Ariyur, Azpurua-Linares, Bekel, & Cleaver, 2007).

Organizations like Apple, Amazon, Boeing, Goldcorp, Google, and Wikipedia have been very successful in finding new ways to collaborate with customers, partners, and people in general. They seem to have hit the jackpot with the idea of allowing anyone to access, modify, and use available company services and information.

Apple, for example invites developers to create interesting iPhone applications ("apps") while Apple focuses on selling, marketing, or securing the "apps"; thereby letting the market decide which "apps" are selected. This way, Apple does not have to expend its own resources to develop "apps."

Amazon allows everyone to be book sellers. After registering, interested sellers simply ship their books to an Amazon warehouse; Amazon takes care of the rest. This allows anyone to use the power of Amazon without having to deal with marketing, shipping, and sales.

Boeing's 787 Dream Liner was developed through a manufacturing process where contractors and sub-contractors designed, created, and digitally tested components in a virtual environment before physically producing them (Design News, 2007). This

process allowed contractors to make design changes while minimizing the impact on related parts.

Goldcorp, a gold mining company in financial trouble, made an unprecedented move and published its highly sensitive geological data on the web and challenged the world to find the next prospective gold mine. The company offered a half million dollar prize for information leading to a profitable mine.

Google, Wikipedia, and many others appear to have also built entire businesses on a foundation of collaboration. These examples suggest that the DoD may be able to improve information sharing, coordination, and collaboration efforts by looking to the commercial industry for answers.

The 9/11 Commission Report states that we need better collaboration across agencies. My experience in the AOC tells me that we need better collaborative technologies and procedures. But, before we can improve collaboration across agencies, we need to understand *what exactly is collaboration*, and what are the hallmarks of better collaborative tools?

A Look Forward

As this research progresses, Chapter 2 will develop a foundation for understanding the importance of collaboration and define necessary elements of collaboration based on academic literature. Chapter 3 will convert the academic ingredients of collaboration into a framework and test the framework against three sets of collaborative tools. Chapter 4 will discuss the results of the tests and show how the

academic elements of collaboration compare with industry standards of collaboration. And finally, Chapter 5 will draw on the conclusions of the tests to describe the contributions of the research, make future recommendations, and discuss limitations of the research.

II. Literature Review: The Three Pillars of Collaboration

"Processes don't do work, people do"
- JOHN SEELEY BROWN

Chapter Overview

The words "collaborative" and "collaboration" seem to be common labels used by many tools available today. For example, environments such as Google Documents, Microsoft SharePoint, StumbleUpon.com, and Wikipedia.org make "collaborative" claims in their respective documentations (Google Docs, 2009; Microsoft SharePoint, 2009; About StumbleUpon, 2009; Wikipedia: About, 2009). Further, organizations commonly talk about 'collaborative' environments to encourage people to work together; in fact, Google.com offers a suite of 'collaboration' applications for businesses for $50 per user, per year (Google Docs, 2009). But what makes a tool collaborative? Can any tool that connects people be called collaborative? It seems like there should be a way of evaluating the level of collaboration that a tool supports. In order to understand what collaboration means and what elements appear in better collaborative tools, further dissection is needed.

Ellis, Gibbs, and Rein (1991), Orilikowski (1992), and Kling (1991) all maintain that the collaborative problem space encompasses three fundamental aspects or subject areas: social, task, and technology. The social aspect of collaboration focuses on human interaction; the task concerns nature of the task to be completed through the course of that interaction; and the technology focuses on the design and use of tools to facilitate interaction and support the completion of the task. Interestingly, academic literature often focuses on only one or two of these collaborative dimensions without accounting for the complex interactions between all three. Throughout the following sections of this chapter, I will examine the research literature

directly addressing the notion of collaboration per se, as well as the three aspects of the collaborative problem space as described above, in an effort to better inform and enhance the totality of the "collaborative enterprise" between individuals.

What is Collaboration?

As indicated at the start of this chapter, the meaning of the word "collaboration" seems to have become diluted by its generic use over the past decade to describe virtually any situation where people interact to share information. Academic literature describes a wide range of definitions for collaboration. For example, a Harvard Business School professor (Kanter, 1994) discusses three fundamental aspects of collaboration as 1) a relationship that benefits all parties (i.e., two or more people); 2) a relationship where all parties (i.e., two or more people) must create new value together rather than a quid pro quo arrangement; and 3) where these relationships cannot be controlled by formal systems, but rather require a web of interpersonal relationships. A researcher at a National Research and Development center (Halverson, 2002) views successful collaboration as a set of clearly defined expectations by all parties (i.e., two or more people) and agreement on a shared goal that will direct the process to its mutual conclusion. According to experts at the Wilder Research Center (Mattessich, 2005), collaboration is a set of defined mutual relationships and goals; a jointly developed structure and shared responsibility; mutual authority and accountability; and the sharing of resources and rewards between two or more people.

Though there may not be a unanimously accepted definition of collaboration, there are several commonalities that seem to underlie these notions of collaboration per se; these commonalities have been collected to form a description of collaboration that will be the

foundation of this study. When the commonalities are extracted from the previously mentioned descriptions, nine major elements (labeled C1-C9 in Table 1) emerge as the foundation of collaboration. First, collaboration appears to occur between *two or more people* with clearly *recognized relationships*. Next, the interaction seems to be *based on common interests* and occurs in an *organized* manner. Additionally, the previously mentioned descriptions suggest that collaborative efforts are executed in pursuit of *common goals*. It is important to take a moment to emphasize the importance of goals, because without them, there is no clear direction, thus making it difficult achieve any level of collaboration.

Other major elements of collaboration as previously cited include *mutual benefits* and *mutual accountability* for all parties involved. Mutualism is achieved when all parties benefit from the association or transaction and mutual accountability denotes a responsibility for one's actions to the others in the group. Finally, for successful collaboration to occur, all parties *must bring something useful* to the relationship and the effort should *create value*. Collaboration is a concerted effort and lack of participation can stifle most efforts. Table 1 captures the nine major elements of collaboration based on relevant literature.

Table 1: Collaborative Elements

Commonalities of Collaboration Definitions
C1. Two or more people
C2. Recognized relationship
C3. Common interests
C4. Organized interaction
C5. Common goals
C6. Mutual benefits
C7. Mutual accountability
C8. Provide useful contribution
C9. Create value

Collaboration vs. Cooperation

Before more fully exploring the three dimensions of the collaborative problem space, it is important to distinguish between collaboration and cooperation as the terms are sometimes confused or even used interchangeably (Ellis, Gibbs, & Rein, 1991), (Kyng, 1991). Granted, collaboration and cooperation may share many of the same underlying traits, but cooperation does not require parties to achieve mutual benefits and does not necessarily progress towards common goals (Hord, 1981, p. 6). Lanier's (1979) family metaphor may further illustrate the differences between these concepts: In a family, a mother may 'cooperate' with her son by allowing his rock band to practice in their home. There is a relationship of *two or more people* where the parties have *common interests* and *organized interaction*, but there may not be *common goals*, *mutual benefits*, *mutual accountability*, *useful contribution*, or *value*. But, the family "collaborates" when working together to prepare dinner because the family has *common goals* (to eat dinner), *mutual benefits* will result (the well-being of the family will be enhanced), *mutual accountability* will exist (the family will be accountable for accomplishing the task of preparing dinner), the group will provide *useful contributions* and *create value* (family members will assume duties within their skill sets and create value in the form of a meal). Therefore, cooperation may be achieved in the absence of collaboration. Table 2 illustrates a comparison between the concepts of cooperation and collaboration.

Table 2: Cooperation versus Collaboration

Commonalities of Collaboration Definitions	Cooperation	Collaboration
Two or more people	Yes	Yes
Recognized relationship	Yes	Yes
Common interests	Yes	Yes
Organized interaction	Yes	Yes
Common goals	No	Yes
Mutual benefits	No	Yes
Mutual accountability	No	Yes
Provide useful contribution	No	Yes
Create value	No	Yes

As previously cited, Ellis, Gibbs, and Rein (1991), Orilikowski (1992), and Kling (1991) all claim that collaboration has three major pillars: social, task, and technology. The next section will identify the sub-elements of each pillar in order to determine what comprises collaboration at the foundational level. After the foundation has been constructed, it may be possible to evaluate the level of collaboration that a tool is capable of providing.

The Social Pillar

Social behavior, by definition, involves behavior in the context of more than one person. Thus, In order to appreciate collaboration as it occurs within aggregates of people, it is important to first distinguish between the different types of aggregates. According to Poole (1998), there are four major types of aggregates that are commonly used in the study of human interaction and communication. There are those who believe individuals are the key to understanding communications in social situations (Coleman, 1986), and may even feel that groups are a hindrance to human activities such as decision making (Poole, 1998). Others are proponents of dyadic research and claim the dyad is the appropriate level of aggregation for communications

research (Shaw M. , 1959). Still others consider groups as the locus of social reality (Poole, 1998; Mooreland, Hogg, & Hains, 1994). Finally, organizational researchers advocate for studying organizations and societies as a whole (Poole, 1998; Katz & Kahn, 2003).

According to Poole (1998), communication theories focusing on individuals fail to capture the reality of human socialization encountered in everyday life. For example, it is common for people to be assigned to groups in the workplace to address projects. Our personal lives often revolve around groups such as sports groups, church groups, family groups, school groups, and online social networking groups. Dyads may similarly be interesting for laboratory research, but Poole suggests they do not reflect the reality of social interaction because most groups have more than two members. Finally, Poole maintains that organizational theory is complex and often treats organizations or societies as 'giant individuals' and fails to consider the influence of other 'giant individuals' on the organization in question (Poole, 1998). Based upon these observations, I have elected to focus on collaboration occurring amongst groups of three or more parties (as opposed to dyads, individuals, or organizational/societal collectives) as the basic unit of consideration for the remainder of this study.

Groups

Groups are all around us. We are born into family groups. As we grow, we join school, work, and social groups. When we die, we are mourned by family and friend groups. But what does it take to make up a group?

According to the lite rature, not all aggregates of two or more people can be considered groups. In order for a collection of individuals to be considered a group, it must remain *relatively small* (ie., two or more people) so its members are *mutually aware of one another* and *can interact with each other* (McGrath, 1984). A mutual awareness simply implies that any

group member has a clear understanding of who all of the other members in the group are. Further, any member must have the ability to interact with any other member; therefore, families, work crews, and social aggregates of friends can be considered groups whereas societies, cultures, and general 'publics' that lack potential awareness and interaction are not considered groups (McGrath, 1984).

Another definitive element of a group is that members are connected in some way by *common interests* (DeVito, 1991, p. 269; McGrath, 1993). Common interests are a set of beliefs people share that bring them together and are a foundational element of a group (Merriam-Webster, 2009). As an important note, human interaction in itself does not necessarily require parties to have common interests, so interaction can occur without common interests. For example, consider a scenario where an employee is instructed to send a file to another employee, that transaction may occur between two parties with no common interests. It is also important to point out that a group with 'common interests' does not necessarily mean that the group will have common goals; rather a 'common interest' simply brings people together. Common goals will be discussed in the next section, but the literature does not suggest that they are necessarily a requirement for a group.

According to McGrath (1993) groups also *engage in purposeful activities*. Purposeful activities typically result in the production of something useful through a series of projects, tasks, and steps. Projects are the missions or the set of objectives needed to achieve a goal; tasks are a series of items needed to complete projects; and steps are a series of activities needed to complete tasks (McGrath, 1993). In order to alleviate the subjectivity of determining what is and is not subjective, one can logically assume that an activity can be considered purposeful as long as all of the members agree and engage in the activity.

Finally, group members must have a *recognized relationship* in the past, present, or future (McGrath, 1984). Relationships involve some level of interdependence. People in a relationship tend to influence each other, share their thoughts and feelings, and engage in activities together. Because of this interdependence, most things that change or impact one member of the relationship will have some level of impact on the other member.

Teams

Like collaboration and cooperation, groups and teams are often used interchangeably in everyday language, but there are notable differences between the two concepts that bear closer investigation. For example, teams are purported to have all of the previously mentioned properties of groups, but they are also more specialized and have three additional qualities (Gibson, Ivancevich, Donnelly, & Konopaske, 2003). First, teams typically include members with *complementary skills* to ensure maximal breadth. Team members are commonly hand-selected based upon a set of skills they possess and the hand selection typically results in a group or team with overall complementary skills.

Next, teams are typically formed around the pursuit of mutually agreed upon, *common goals*, which generally lead to higher levels of performance and efficiency because members are all moving in the same direction (Gibson et al, 2003). Common goals are the end to which effort is directed. Also, common goals are group level goals rather than individual goals. Individual tasks such as sending emails are typically not counted as common goals, but group accomplishments such as completing a project are considered common goals.

Third, team members hold themselves hold themselves *mutually accountable* for their actions (Gibson et al, 2003). The notion of accountability is important because people tend to put more effort into their roles when they are held responsible for the outcome (Dykstra, 1939).

The added element of accountability also suggests that teams may make better decisions due to the fact that they may be scrutinized in the future (Dykstra, 1939). In fact, relevant literature (Gibson et al, 2003) suggests that teams achieve the ultimate level of 'groupness' and produce the highest levels of performance and efficiency.

Table 3 below shows a comparison of groups to teams; the table does not to identify the "magical moment" when a group becomes a team. Instead, it illustrates how the formal definitions of these concepts have been treated in the literature. It is interesting to note that the elements of teams seem to be very similar to the elements of collaboration, and the elements of groups coincide with the elements of cooperation. This alignment is not to suggest that members of a group are *incapable* of collaborating, only that the formal conceptualization of a group may be typified more by actions associated with cooperation, while teams, by their very nature, seem to be more closely associated with collaboration.

Table 3: Groups versus Teams

Social Elements	Group	Team
Two or more people	Yes	Yes
- Members are aware of other members		
- Members can potentially interact		
Common interests	Yes	Yes
Engage in purposeful activities	Yes	Yes
Recognized relationships	Yes	Yes
Complementary skills	No	Yes
Common goals	No	Yes
Mutual accountability	No	Yes

Communication as a Vehicle for Groups

Imagine life without communication. No speaking. No writing. No gestures. No expressions. We cannot even look at someone's face or into their eyes without some form of communication. To not communicate would be to live alone, away from society. Without

communication, Groups would not exist and social interaction would not be possible. Therefore, the notion of communication, as it relates to the social component of collaboration, must also be examined.

Communication is an observable phenomenon that binds people and groups together as social systems (Buckley, 1967). According to DeVito (1991, p. 5), communication is the act of sending and receiving messages that are distorted by noise, occur within a context, have some purpose, and provide opportunity for feedback. All messages are distorted by some aspect or property of the physical world, in our minds through biases and prejudices, and through semantics on the part of the sender and receiver.

According to Devito (1991) *socio-psychological factors* in communication are extremely important. Socio-psychological factors include *rewards*, *roles*, *status*, and *rules* should be considered in communicative efforts because they impact or shape communication positively or negatively. *Rewards* are a type of compensation given in return for a service, attainment, or achievement and do not necessarily have to be economic. Examples of non economic rewards are seen in the form of points, stars, friends, followers, or twits. *Roles* are important because they enhance socially expected behavior patterns determined by status and require little explanation. For example, the roles of "administrator," "presenter," or "owner" all call for specific behaviors. *Status* denotes position relative to others. Status can influence behavior and communication positively or negatively between members of different statuses (Pepinsky, Hemphill, & Shevitz, 1958). *Rules* are a set of clear guidelines that guide members in their conduct and describe how they might, or should, take actions.

Finally, *feedback* is arguably the most important facilitator of communication according to several experts (Dittes & Kelley, 1956; McGrath, 1984; Schachter, 1951; Shaw, 1959).

Groups that receive more positive feedback have higher satisfaction rates (McGrath, 1984, p. 151), while groups that receive negative feedback communicate less (Dittes & Kelley, 1956). Communication is essential to collaboration, because without it, people cannot interact and collaboration cannot occur (Schachter, 1951). Table 4 below summarizes the various social and communicative elements defined in the previous section and matches each element with a corresponding essential element of collaboration (from Table 1).

Table 4: Social Elements

Social Elements	Collaborative Essentials
S1. Two or more people S1a. Members are aware of other members S1b. Members can potentially interact	C1. Two or more people
S2. Common interests	C3. Common interests
S3. Engage in purposeful activities	C9. Create value
S4. Recognized relationships	C2. Recognized relationship
S5. Complementary skills	C8. Provide useful contribution
S6. Common goals	C5. Common goals
S7. Mutual accountability	C7. Mutual accountability
S8. Socio-psychological factors S8a. Rewards S8b. Roles S8c. Status S8d. Rules	 C4. Organized interaction C2. Recognized relationship C2. Recognized relationship C4. Organized interaction
S9. Feedback	C7. Mutual accountability

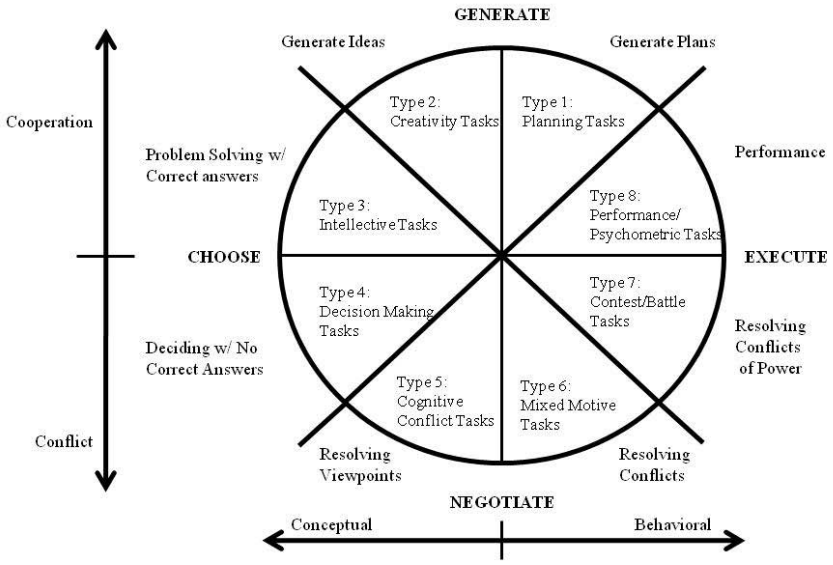
The following rationale was used to link the sub-elements to the major elements in the table above. First, *two or more people* (S1) and *common interests* (S2) were directly linked to *two or more people* (C1) and *common interests* (C3) respectively. Next, *purposeful activities* (S3) was linked to *create value* (C9), because as stated by McGrath (1993), purposeful activities usually result in the production of something of value. Third, *complementary skills* (S5) supports *useful contribution* (C8) because selecting members based on their skill sets allows members to maximize contributions. Fourth, *common goals* (S6) and *mutual accountability* (S7) are directly

linked to *common goals* (C5) and *mutual accountability* (C7) respectively. Next, the socio-psychological factors *rewards* (S8a) and *rules* (S8d) support *organized interaction* (C4) in that they both guide and describe how members interact (DeVito, 1991). *Roles* (S8b) and *status* (S8c) support *recognized relationships* (C2) because they affect the behavior patterns of groups interacting. Finally, *feedback* (S9) is associated with *mutual accountability* (C7) because feedback is a means of holding people accountable for their actions.

The Task Pillar

The nature of the *task* can actually influence how people work together, and ultimately, their relative success at collaboration. There are several different schools of thought on tasks including Shaw's Classifications (Shaw, 1973), Hackman's Task Types (Hackman, 1968), Steiner's Task Types (Steiner, 1966), and Laughlin's Group Task Classification (Laughlin, 1980) that are useful in describing group task performance. Although the classification schemes are all different, they do have fundamental similarities; for example, many classify tasks based on issues such as performance processes (Hackman, 1968), task interdependencies among members (Steiner, 1966), or group cognitive processes (Shaw, 1973; Laughlin, 1980). Because none provide a collectively exhaustive and mutually exclusive classification scheme for all tasks, McGrath integrated several of the aforementioned frameworks into a scheme he called the Group Task Circumplex (GTC) shown in the figure below (McGrath, 1984).

Figure 2: The Group Task Circumplex



The GTC is divided into four quadrants: Generating, Choosing, Negotiating, and Executing. Each quadrant hosts two task types for a total of eight task type classifications, and all tasks can be accommodated by the model (McGrath, 1984). According to McGrath (1984), each quadrant and task type is significant to group task performance because groups react differently to different types of tasks. For example, Quadrant 1, Generate, is comprised of planning and creativity tasks. Planning tasks focus on generating plans and creativity tasks generate new ideas. In Quadrant 2, Choose, there are intellective tasks and decision making tasks. Intellective tasks are tasks that have a specific correct answer which has to be computed or solved by logical problem solving skills and expert consensus. Decision making tasks require answers that are not necessarily correct but require the group to agree on a preferred answer. Quadrant 3, Negotiate, includes cognitive conflict and mixed motive tasks. Cognitive-conflict tasks revolve around conflicting viewpoints are often seen in jury-related decision-type tasks. Mixed-motive tasks include mixed motive conflicts and are performed by negotiating and

bargaining processes. Finally, Quadrant 4, Execute, includes contests and performances. Contests include wars or other competitive activities where parties are competing for victory; performances are achieved through objectives or standards of excellence and can be physical or mental.

From a collaboration perspective, it is important to understand that the *task* dimension (TE1) is directly tied to collaborative elements *organized interaction* (C4), and *create value* (C9). As previously mentioned human interaction is associated with organization, and since the task dimension facilitates organization, it seems natural to that tasks support organized interaction. Furthermore, tasks also help to create value, because tasks by their very nature, are a set of actions used to complete something.

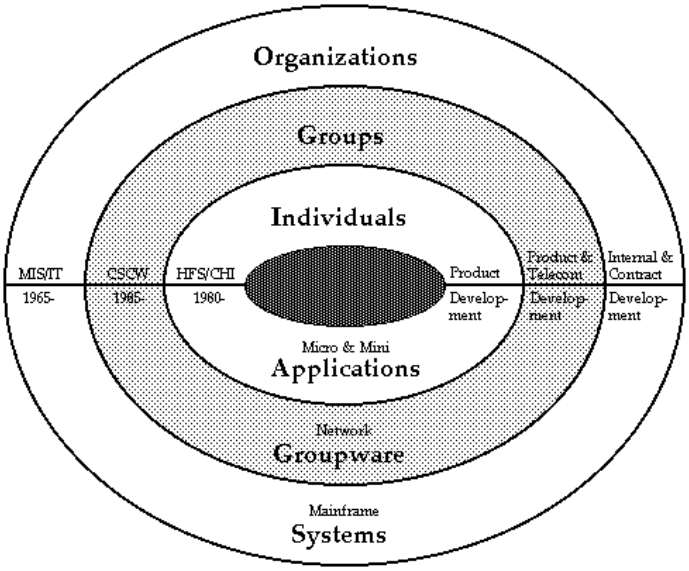
The Technology Pillar

In the Information Technology (IT) world, technology can be described as tools or capabilities created by the practical application of knowledge (Franklin, 1999). According to Grudin (1994), technology is designed to support human behavior and interaction in one of three distinct areas: 1) systems to support organizations, 2) groupware to support groups, 3) and applications to support individuals; each area emerged independently and produced corresponding literature as indicated in Figure 3 below. Based upon the primacy of group interaction as discussed in this analysis, much of the relevant literature concerning collaborative technologies was culled from the Computer Supported Cooperative Work (CSCW) field due to its focus on groups and groupware.

The fact that the CSCW field focuses on "cooperative" work does not diminish the implications of the research since cooperation and collaboration share many of the same

foundational elements as previously cited. Another reason the CSCW field is a great candidate for research is because of its focus on groupware or groups support systems. In general, group support systems are interactive computer based environments that support coordinated team effort toward completion of joint tasks (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1997), (DeSanctis & Gallupe, 1987). This type of software is in line with many of the elements of the social pillar of collaboration as previously discussed in this chapter.

Figure 3: Development and research contexts (Gruden, 1994)



The CSCW field originated in the mid 1980s as an effort by technologists to learn from economists, social psychologists, anthropologists, organizational theorists, educators, and anyone who would shed light on group activity (Gruden, 1994) (Lyytinen & Ngwenyama, 1992). Authors from the field describe several important implications regarding technology design that are directly related to the essential collaborative elements. First, several authors (Feld & Stoddard, 2004; Ross, Weill, & Robertson, 2006) claim that *technology should be linked to*

strategy and *implemented horizontally*. Linking technology to strategy (not vice versa) helps to ensure that the technology compliments and supports the overarching goals of the group; thereby enhancing the desired benefits of the technology (Feld & Stoddard, 2004). Next, technology should be implemented horizontally through applications designed to provide seamless integration, rather than vertically to automate specific business processes (Ross et al., 2006). Horizontal integration thus helps eliminate silos and promotes interoperability.

Other studies identify elements such as *work versus benefits* and *degree of synchronicity* as important aspects of technology design. For example, Grudin (1994) discusses the concept of work versus benefits, where, essentially, the benefits of the technology must outweigh the work associated with using the technology. DeSanctis and Gallupe (1987), Moran and Anderson (1990), and Ellis et al. (1991) identify the degree of synchronicity as an important concept in technology design. For example, interactions take place both synchronously, in real time (i.e., meetings), and asynchronously, over extended time (i.e., e-mail).

Benford et al. (2001) further claim that *scalability* is important to the design of technologies used to support potentially collaborative activity. Scalability can be a concern for tools that support real-time interaction between groups distributed across wide areas and can be impacted by issues such as delays caused by bottlenecks in other systems or networks. Table 5 matches key technology considerations to the essential collaborative elements.

Table 5: Technology Elements

Technology Elements	Collaborative Essentials
T1. Technology linked to strategy	C6. Mutual benefits
T2. Horizontal implementation	C5. Common goals C6. Mutual benefits
T3. Work versus benefits	C9. Create value
T4. Degree of synchronicity	C8. Provide useful contribution
T5. Scalability	C1. Two or more people

The following rationale was used to link the sub-elements to the major elements in the table above. First, *technology linked to strategy* (T1) was *associated with mutual benefits* (C6) because according to Feld and Stoddard (2004), when technology is linked to strategy the desired benefits of the technology are enhanced. Next, *horizontal implementation* (T2) was linked to two major elements of collaboration. *Horizontal implementation* (T2) supports *common goals* (C5) because, as discussed in Chapter 2, goals lead processes to conclusions. Horizontal implementation can affect how processes lead to conclusions through efficiency and transfer of information. Horizontal implementation is also associated with *mutual benefits* (C6), because, as discussed in Chapter 2, mutualism is achieved when all parties benefit from an association or transaction, and horizontal implementation by its very nature benefits all parties using the integrated systems. Third, *work versus benefits* (T3) was linked to *create value* (C9) because, as stated by Grudin (1994), when the benefits of the technology outweigh the work associated with using the technology, value is created. Fourth, *degree of synchronicity* (T4) was associated with *provide useful contribution* (C8) because the degree of synchronicity used (synchronous or asynchronous) may affect whether the contribution is useful. For example, consider tool that supports online meetings. In meetings, it is important for people to communicate synchronously and share their thoughts and comments. The value of the communication would be degraded if

synchronous communications were not available. Finally, *scalability* (T5) was linked to *two or more people* (C1) because scalability is related to the interaction of groups and can affect the number of people that may participate in the groups.

Conclusion

This chapter identified the elements of collaboration and associated collaboration with three supporting pillars: Social, task, and technology. According to the academic understanding of a "collaborative tool" presented thus far, a truly or exhaustively collaborative tool may do more than connect people or facilitate interaction. Furthermore, it seems clear that the collaborative problem space includes social, task, and technology dimensions. Table 6 below combines the elements of the three pillars into a single table.

Table 6: The Three Pillars of Collaboration

Social	**Collaborative Element Supported**
S1. Relatively small size	C1. Two or more people
S1a. Members are mutually aware of other members	
S1b. Members can potentially interact with one another	
S2. Common interests	C3. Common interests
S3. Engage in purposeful activities	C9. Create value
S4. Have a recognized relationship	C2. Recognized relationship
S5. Complementary Skills/Useful contribution	C8. Provide useful contribution
S6. Common goals	C5. Common goals
S7. Hold themselves mutually accountable	C7. Mutual accountability
S8. Socio-Psychological aspects	
S8a. Rewards	C4. Organized interaction
S8b. Roles	C2. Recognized relationship
S8c. Status	C2. Recognized relationship
S8d. Rules	C4. Organized interaction
S9. Feedback	C7. Mutual accountability
Task	**Collaborative Element Supported**
TE1. Task type	C4. Organized interaction
	C9. Create value
Technology	**Collaborative Element Supported**
T1. Technology linked to overarching strategies	C6. Mutual benefits
T2. Horizontal implementation	C5. Common goals
	C6. Mutual benefits
T3. Work versus benefits	C9. Create value
T4. Degree of synchronicity	C8. Provide useful contribution
T5. Scalability	C1. Two or more people

According to the literature, truly collaborative tools should take into account as many of these elements as possible. The efficacy of the elements and sub-elements developed in this chapter must now be tested against tools that claim to be collaborative in order to determine if the academic understanding of collaboration coincides with reality, and if certain elements of the framework consistently appear in the top rated collaborative tools.

III. Methodology: Creating the Collaborative Framework

"Reality is merely an illusion, albeit a very persistent one"
-ALBERT EINSTEIN

In this chapter, a collaborative framework is developed and used to assess three sets of tools. The selection method of the tools is described where the tools are divided into three groups based on popularity. Finally, the procedures used for the assessments are discussed.

Instrument Development

The discussion in Chapter 2 provided an academically oriented perspective and understanding of the concept and nature of collaboration, and it identified nine major elements of collaboration that could be incorporated into collaborative tools to improve their "collaborative potential" or support for collaborative work. Specifically, Table 6 summarized the required elements of each of the three pillars of collaboration and was used to create a checklist of essential collaborative elements that could help identify gaps between collaboration as described academic literature and collaboration as executed in commercial tools and technologies. Table 7 below shows how each element of the social, task, and technology pillars of the collaborative problem space were operationalized into concrete exemplars that could then be used for independent assessment of collaborative technologies; where ever possible, explicit translations, or direct invocation of the collaborative elements as defined in the literature, were used to limit the degree of capricious or potentially idiosyncratic generation of these exemplars.

Table 7: Collaboration Framework

C1. Two or more people	Evaluation Criteria
S1a. Members are mutually aware of other members	Any member can potentially see all other members of the group. Availability of a directory or listing with all members of the group is required to meet this criterion.
S1b. Members can potentially interact with one another	Any member must have the ability to interact with any other member. The tool should provide a way to facilitate the interaction such as an e-mail interface, chat, message board, or other communication method (including integration with existing communication tools) between any two or more members to meet this criterion.
T5. Scalability	The tool can be scaled up or down to support the appropriate number of members. Evidence of scalability can be seen in tools with multiple packages/plans where services and number of users can be increased or decreased.
C2. Recognized relationship	
S4. Have a recognized relationship (past, present, or future)	Relationships involve some level of interdependence. People in a relationship tend to influence each other, share their thoughts and feelings, and engage in activities together. Because of this interdependence, most things that change or impact one member of the relationship will have some level of impact on the other member. The tool must provide for visibility that some sort of relationships exist to meet this criterion. Roles and status indications may be used as evidence of relationship support.
S8b. Roles	The tool prescribes or embodies the use of clear, explicit roles beyond implied member/non-member roles. Examples include admin, leader, presenter, owner, etc. Tool must indicate roles to meet this criterion.
S8c. Status	The tool denotes status in some way; rank, position, and title are examples of status indicators. Tool must show status to meet this criterion.
C3. Common interests	
S2. Common interests	Common interests are a set of beliefs people share that bring them together and are a foundational element of a group. Human interaction in itself does not necessarily require parties to have common interests, so interaction can occur without common interests. Tool must provide visibility of, or means of tracking, elements of common interest beyond those directly involved in the completion of a task itself. Evidence of communities of practice or means/allowances for off-topic conversations (e.g., bulletin boards, chat rooms, etc.) may provide some indications that interaction based on common interests is supported.
C4. Organized interaction	
S8a. Rewards	Rewards are a type of compensation given in return for a service, attainment, or achievement. Rewards may be economic or non economic and can be distributed in numerous ways such as in the form of points, stars, followers, twits, etc… The tool must have an explicit reward system to meet this criterion.
S8d. Rules	Clear guidelines exist to inform users how the tool is used. Guides in the form of

	text, video, or audio must exist to meet this criterion.
TE1. Task Type (Generate, Choose, Negotiate, Execute)	Tools should be clearly designed to support a task type(s). The task type can be determined through tool overviews and compared to actual system features and operation. As long as the overview and the operations appear to match, the tool meets this criterion.
C5. Common goals	
S6. Common goals	Tools should support common goals among members. Goals are the end to which effort is directed. Also, common goals are group level goals rather than individual goals. Individual accomplishments such as transferring files or sending emails are typically not counted as common goals; group accomplishments such as completing a project are considered common goals. Evidence of common goals may be seen in tracked milestones, task management/summaries, goal boards, etc. Tools that support overall group level goals meet this criterion.
T2. Horizontal implementation	Technology should be implemented horizontally through applications designed to provide seamless integration rather than vertically to automate specific business processes. Interoperability is key to horizontal implementation; a tool that is interoperable and works with other tools has the potential to meet a greater number of common goals as articulated or expressed across multiple platforms/tools and therefore meets this criterion.
C6. Mutual benefits	
T1. Technology linked to overarching strategies	Tools should show evidence of linking technology to strategy (not vice versa). This helps ensure that the tool compliments and supports the strategy of a group of users; thereby enhancing the desired benefits of the technology. Without greater insight into the rationale and motivations of the tools' users, it is assumed that any tool used was selected and employed as such for a particular reason(s) relevant to the users' needs and is therefore likely to be congruent with an overarching strategy. Therefore, if the tool seems to accomplish the stated objectives as described in its overviews, then technology may very likely be linked to strategy and this criterion is met.
T2. Horizontal implementation	Technology should be implemented horizontally through applications designed to provide seamless integration rather than vertically to automate specific business processes. Interoperability is key to horizontal implementation; a tool that is interoperable and works with other tools has the potential to create a situation in which a greater number of mutual benefits are met, supported, or realized and therefore meets this criterion.
C7. Mutual accountability	
S7. Hold themselves mutually accountable	Accountability is important because people tend to put more effort into their roles when they are held responsible for the outcome. Evidence of accountability will include features that link people to their inputs/projects/actions
S9. Feedback	Feedback facilitates group communication and collaborative tools should allow individual/group feedback to be given to member in order to meet this criterion. Feedback can be directed to a single or all group members including direct feedback of meaning/message, as well as evaluative feedback such as rating systems or other means of providing visible assessment measures.
C8. Provide useful	

contribution	
S5. Complementary Skills	Complementary skills ensure maximum efficiency is achieved when working towards goals because people tend to work more efficiently when their skills match the task they are performing. Complementary skills are typically associated with teams that are assigned members but may not be apparent in groups that associate based upon common interests alone. Evidence of support for, or recognition of, complementary skills may be identified through role (S8b) visibility.
T4. Degree of synchronicity	The tool should accommodate an appropriate but potentially varying degree of synchronicity. Tools can support asynchronous, synchronous, or both types of communication. A tool with greater collaborative potential should provide evidence of flexibility in its support for varying communicative synchronicity needs and capabilities.
C9. Create value	
S3. Engage in purposeful activities	Purposeful activities typically result in the production of something useful through a series of projects, tasks, and steps. Criteria indicating how the tool itself might enable activities in which group members engage did not exist in the tool itself. Therefore, assuming a rational group selects a tool because of the purpose it serves, assessing the tool based on how well its extant capabilities matched its purported capabilities seemed logical. Therefore, if the tool seems to accomplish the stated objectives as described in its overviews, then the tool may likely support purposeful activities and this criterion is met.
TE1. Task type (Generate, Choose, Negotiate, Execute)	Tools should be clearly designed to support a task type(s). The task type can be determined through tool overviews and compared to actual system features and operation. As long as the overview and the operations appear to match, the tool meets this criterion.
T3. Work versus benefits	The benefits of the technology must outweigh the work associated with using the technology. Therefore, the tool should be easier than alternative methods of completing the task. In the absence of direct knowledge about the relative benefits and costs associated with the work of each tool's users, such competitive assessments cannot be readily made against each potential alternative. However, evidence of work versus benefits may be observed through horizontal implementation (T2) (as less effort is required to translate, move, or apply the inputs and outputs of this tool to any other tools that may be in use).

During the construction of the framework above, five collaborative sub elements were found not to lend themselves well to direct translations or observables within the tools; therefore, the following concessions were made. First, due primarily to variability of the user groups employing such tools and lack of knowledge about the composition of those groups, it was not feasible to develop a solid confirmatory framework that indicated

whether a tool necessarily supported *complementary skills* (S5). However, it was reasonable to assume that a positive response in the *roles* sub-element (S8b) would demonstrate complementary skills because roles are typically assigned or assumed according to individual strengths and weaknesses, for example, tool administration roles are generally assigned to more technically savvy personnel. Additionally, roles may "bundle" tacit expectations about different types of skills that are used in one role but not another. Therefore, it is assumed that a tool accommodating *roles* differentiation could support the *complementary skills* criterion.

Second, without knowledge regarding the relative benefits and costs associated with using one tool over another, a single tool will necessarily demonstrate little evidence by itself of *work versus benefits* (T3). However, *horizontal implementation* (T2) implies that less effort will ultimately be required to translate, move, or apply the inputs and outputs of one tool to any other tools that may be in use; therefore, *horizontal implementation* was used as a proxy source of evidence for *work versus benefits*.

Finally, without insight in to the development of the tools themselves, or the inner workings of the groups using the tools, the sub-elements *technology linked to overarching strategies* (T1), *purposeful activities* (S3), and *task* (TE1) were especially problematic to operationalize in concrete exemplars. A concession was therefore made to evaluate the tools by comparing the purported capabilities and functions to the actual capabilities and functions of each tool to determine whether the tool accomplishes what it claims.

For instance, *linking technology to strategy* (T1) helps to ensure that the technology compliments and supports the overarching strategies of the group. However,

due to the fact that such group-specific information was not readily available for all of the tool's potential users, an assumption was made that rational groups of users would be most likely select tools that were congruent with the group's strategy; therefore, comparing the tool's documentation to its capabilities seemed a logical alternative exemplar for this sub-element.

Purposeful activities (S3) were defined as activities that all members are engaged in; therefore, unless a tool does not support any activity at all amongst members, it would necessarily serve *some* purpose. However, criteria indicating how the tool itself might enable enforcement of the kinds of activities in which group members would engage—i.e. only purposive activities—was ultimately infeasible to operationalize as such enforcement would likely be endemic within the group dynamics or communicative patterns of the individuals in the group, rather than anything explicit within the tool itself. Therefore, assuming a rational group selects a tool because of the purpose it serves, assessing the tool based on how well its extant capabilities matched its purported capabilities also seemed logical.

Similarly, tools are, by nature, developed to *do* something, some type of task or set of tasks (TE1) and therefore can be associated with at least one task type. However, it is also not feasible to know a priori what specific tasks are required by any one user or user group over another—(i.e., will the tool be used for generate tasks such as planning, or will it be used for choose tasks such as make a decision?). Again, it was therefore assumed that rational groups would be drawn towards tools that supported the type of work necessary to be performed by the group. Therefore, gauging the tool based on how well its extant capabilities matched its purported capabilities also seemed to be a logical

way of assessing evidence of support for this sub-element. These concessions will be further discussed in the limitations section of chapter 5.

Generation and Selection of Collaborative Tools for Analysis

In order to test the efficacy of the collaborative framework as described above, a candidate pool of collaborative tools was generated and selected through queries of popular search engine queries returned from: Google.com, Google Scholar, Bing.com, Yahoo.com, and Ask.com. The queries included the following strings "collaboration tools," "top collaboration tools," and "best collaboration tools"; queries were also re-run using the variant terms "collaborate" and "collaborative" in the place of "collaboration." These searches produced a massive result set and therefore required further refinement.

For example Google.com yielded more than 21 million results and Bing.com found over 8 million results. The first criterion of exclusion was therefore based on a subjective assessment of diminishing returns and relevance of search hits beyond the first 150 search returns; ultimately, only the first 150 results from each search string were reviewed. Second, search results dated prior to 2006 were also excluded because many of the tools appearing on such search return lists were extinct or had already been incorporated into other tools. Average list length of the search returns was 31 tools, typically organized either alphabetically or by collaboration category (i.e., project management, collaborative writing, web conferencing, etc.).

After eliminating duplicates, broken links, and irrelevant search hits, 26 lists of "top," "best," or "useful" collaboration tools were found. Collectively, the 26 lists accounted for 617 tools that were potentially relevant for study as collaborative tools

assuming reasonable accuracy and efficacy of the search engine returns. Unfortunately, none of these initial searches produced any scholarly or peer reviewed lists of ranked collaborative tools; instead, any such lists that were found appeared in online magazines such as techmagazine.com, businessinsider.com, and digitizd.com; by user voting processes as used on meister.com; or by individual bloggers such as econsultant.com. Therefore, due to the lack of peer reviewed lists, the scarcity of tool rankings of any kind, and some natural points of differentiation evident in the search return data, the remaining 617 collaborative tools were divided into three quality tiers (high, middle, and low) for three separate assessments using the collaborative checklist.

For example, a high incidence of search returns for a particular tool—incidence based on search criteria of "top collaborative tools" and other similar strings—was a reasonable indication that such a collaborative tool may represent a truly "better" (or at the very least, more popular) collaborative tool. This is not to say that tools with low incidence of search returns did not or could support collaboration, only that they were not as popularly or as often perceived to be so, again, using incidence of search engine returns as a proxy measure for popularity or perceptions of high performance. Thus, the division of tools into tiers was based on the logical assumption that tools appearing on more lists may be more highly regarded by users, thus making them potentially better collaborative tools for use, and for study. By the same token, tools appearing on fewer lists may not be as well regarded, and therefore may not include all of the elements indicative of collaboration. The 617 tools were filtered using Microsoft Excel to identify the collaborative tools appearing on multiple lists.

All selected tools were subjected to three prerequisites. First, tools that were no longer available were discarded as assessment candidates. Second, tools that did not claim to be collaborative were eliminated because it seemed counterproductive to evaluate a tool against a collaborative framework if the tool did not claim to be collaborative in the first place. Therefore, a key-word search was completed on every piece of available documentation (every web page, manual, tutorial) for each tool to ensure a collaborative claim was established. Third, tools that did not offer free evaluation, a free trial period, or a free basic version were eliminated. This concession was needed to remain consistent with the assumption that better tools would be associated with more lists. Tools for fee would not likely be as widely used, and therefore would not be associated with as many lists as the free tools, and could provide misleading data. Although tools for sale may well support the collaborative elements, a different methodology is needed to evaluate tools associated with fees. In all, 29 tools were eliminated across the three tiers after initial identification. Four such tools were eliminated from the top tier and were not replaced due to a lack of alternatives; however, 25 tools eliminated from the middle and lower tiers were replaced by random selection from the pool of remaining tools.

The Pareto principle (80-20 rule) was used as a guide to identify top tier candidates (Narula, 2008). Specifically, if tools associated with more lists were truly the better tools, the Pareto principle suggests the tools on at least 20% or more of the lists may represent up to 80% of the underlying perceptions or assessments of all high performing tools (Kaplow & Shavell, 2001). In other words, tools that appeared on six or more lists (20% of 26 lists equates to 5.2 lists, which was rounded to six) were considered

top tier tools. This method is also in line with the assumption that better tools will be associated with more lists; as such, 12 tools appeared on 20% (or more) of the lists. Further breakdown indicated that seven tools appeared on 25% of the lists, two tools appeared on 42% of the lists, one tool appeared on 46% of the lists; no tools appeared on more than 47% of the lists, as depicted in Table 8 below. The 12 tools represent a wide array of collaborative activities including project management, web conferencing, document sharing, collaborative writing, and system sharing; and range from web-based to client/server based applications.

Table 8: Top Tier Candidates

Tool	Lists w/ tool	6 lists (20%)	7 lists (25%)	11 lists (42%)	12 lists (46%)
Zoho	12	✓	✓	✓	✓
BaseCamp	11	✓	✓	✓	
Central Desktop	8	✓	✓		
Google Docs	8	✓	✓		
Thinkature	8	✓	✓		
MindQuarry	7	✓	✓		
Vyew	7	✓	✓		
Bubbl.us	6	✓			
Dimdim	6	✓			
Skype	6	✓			
Writeboard	6	✓			
Yugma	6	✓			

As previously indicated, these 12 tools represented all candidates for the top tier assessment; however, four were eliminated during prerequisite screening. Specifically, two tools (Thinkature and MindQuarry) were no longer offered, and two tools (bubbl.us and Skype) did not claim to be collaborative. The remaining top tier tools were assessed and are briefly described in Table 9 below.

Table 9: Tool Characteristics (Top Tier)

Tool	Description	Type	URL
BaseCamp	Basecamp is the leading web-based project management and collaboration tool. To-dos, files, messages, schedules, and milestones.	Web based	www.basecamphq.com
Central Desktop	CentralDesktop is collaboration software, online Project management and a SharePoint alternative for business teams.	Web based	www.centraldesktop.com
Dimdim	DimDim is a free service that lets everyone everywhere to communicate using rich media in real time. It is free so web meetings could be democratized and made available to everyone.	Web based	www.dimdim.com
Google Docs	Google Docs allow creation and editing of web-based documents, spreadsheets, and presentations. Store documents online and access them from any computer.	Web based	www.docs.google.com
Vyew	Vyew came from of a vision to merge virtual space with human interaction and includes standard web conferencing tools plus first-of-its-kind asynchronous collaboration capabilities.	Web based	www.vyew.com
Writeboard	A Writeboard is a web-based text document that people can write, share, revise, and compare.	Web based	www.writeboard.com
Yugma	Yugma provides web conferencing, online meetings, and desktop sharing solutions.	Client based	www.yugma.com
Zoho	Zoho offers a suite of online web applications geared towards increasing your productivity and offering easy collaboration.	Web based	www.zoho.com

Further division into middle and bottom tier tool groups was based on a visual analysis of the search return data (Table 10 below) which indicated a rather dramatic break between tools appearing on 3 lists (25 tools) and tools appearing on 2 lists (75 tools). This apparent natural breaking point was used to distinguish candidates for the middle tier collaborative tools from those in the lower tier.

Table 10: Middle and Lower Tier Divide

Tier	Number of tools	Number of lists tools in previous column appeared on
Lower Tier	487	1
	75	2
Middle Tier	25	3
	7	4
	11	5

Twelve tools from the pool of 43 middle tier tools, and 12 tools from lower tier pool of 562 tools in the lower tier respectively, were randomly selected for further analysis. The number of selections was initially set at 12 to balance out inter-tier comparisons based on fact that only 12 tools were available at all for analysis in the upper tier. Tools in the middle and lower tiers also represented a wide array of collaborative activities including project management, web conferencing, document sharing, collaborative writing, and system sharing; and range from web-based to client/server based applications. Table 11 lists the tools selected for the middle and lower tier analyses.

Table 11: Middle and Lower Tier Candidates

Middle Tier Candidates		Lower Tier Candidates	
Tool	# of lists	Tool	# of lists
Campfire	3	Action Method	1
ContactOffice	3	Ajchat	1
Crossloop	3	Blogmarks	1
GoPlan	4	Egroupware	1
Mindomo	3	Groupmind express	2
OoVoo	3	iRows	1
Project Pier	5	Jooce	1
Socious	3	Mindtouch	1
WebBrush	3	Novlet	2
WebOffice	3	OpenMeetings	1
Writewith	3	Reddit code	1
Yammer	5	Taroby	1

Prerequisite screening eliminated 8 of the 12 tools in the middle tier; however, due to the fact that more tools were available, the rejected tools were randomly replaced with new candidates. Of the initial 12 tools selected, three (GoPlan, WebBrush, and WriteWith) were not available, three (Contract Office, Mindomo, and Socious) did not claim to be collaborative, and two (CampFire and CrossLoop) were eliminated to due to cost; therefore, seven more tools were randomly selected from the middle tier pool.

The seven additional tools were screened with the prerequisite requirements, and three more had to be eliminated: Two (Google Calendar and Ning) did not claim to be collaborative, and one (Neartime) was eliminated due to cost. After all of the previously discussed eliminations, a total eight tools were selected from the middle tier and appear in Table 12 below.

Table 12: Tool Characteristics (Middle Tier)

Tool	Description	Type	URL
Comapping	Comapping is an online mind mapping software to manage and share information. Use it to take notes, plan and organize. It's a way to have one set of notes or files for everyone.	Web/client based	www.comapping.com
Concept Share	ConceptShare is a simple, cost-effective tool for gathering feedback from team members and clients. Easily share media and invite others to add and reply to comments, approve artwork, and markup on visuals.	Web based	www.conceptshare.com
ooVoo	OoVoo is a free video conferencing service. Also offers the ability to leave video messages.	Client based	www.oovoo.com
Project Pier	Project Pier is an application for managing tasks, projects and teams through an intuitive web interface. Documentation, community, blog, and download pages are provided.	Client based	www.projectpier.org
Stixy	Stixy is an online bulletin board. Users may create as many Stixyboards as they like, one for each project.	Web based	www.stixy.com
Webex	Webex is an Online meeting tool.	Web based	www.webex.com
Web Office	Web Office in a powerful online intranet for sharing calendars, databases, and content with the largest family of award-winning web tools.	Web based	www.weboffice.com
Yammer	Yammer is a tool for making companies and organizations more productive through the exchange of short frequent answers to one simple question: What are you doing? It is a social networking site for the office.	Web/client based	www.yammer.com

Similar to the procedures noted for the top and middle tier evaluations, 9 of the initial 12 tools selected for the lower tier assessment were eliminated. Specifically, of the initial 12 tools selected, two (iRows and Jooce) were not available, five (Ajchat, Blogmarks, Egroupware, Open Meetings, and Reddit Code) did not claim to be collaborative, and two (GroupMind Express and MindTouch) were eliminated to due to cost. Eight more tools were therefore randomly selected from the remaining pool of lower

tier tools. The eight additional tools were screened for prerequisites and four had to be eliminated, two (Beanstalk and Colligo) for cost, and two (Notepub and Opinity) did not claim to be collaborative. One additional tool was randomly selected and met prerequisites for test. The eight final candidates for the lower tier test are shown in Table 13 below.

Table 13: Tool Characteristics (Lower Tier)

Tool	Description	Type	URL
Action Method	Action Method is an intuitive approach to productivity, designed to help creative thinkers push their ideas into action. Based on the power of capturing and managing "Action Steps" (tasks you need to complete), Action Method ensures nothing falls through the cracks, and ideas are accomplished.	Web based	www.actionmenthod.com
Hot Office	HotOffice lets you access your e-mail, calendar, and files from any web browser anywhere in the world.	Web based	www.hotoffice.com
Noodle	Vialect's (parent company) mission is to help companies of all sizes & industries experience the benefits of having all corporate knowledge in one central location.	Client/web based	www.vialect.com
Novlet	Novlet is a web application designed to support collaborative writing of non-linear stories in any language. With Novlet you will be able to read stories written by other users, create your own ones, and choose the plot you like most from several alternatives.	Web based	www.novlet.com
Planzone	Planzone is collaborative project management software that enables teams to collaborate by sharing to-dos, documents, wiki pages, and schedules.	Web based	www.planzone.com
Revizr	Revizr is a document revision tool that allows users to select of any portion of a document, and then rewrite or comment on it.	Web based	www.revizr.com
Taroby	Taroby is a Unified Messaging System (UMS) and collaboration application suite for private and professional use. It is accessible from anywhere directly through a normal internet browser. Services & Features include E-Mail Sharing, Customer Support and Ticketing System, Calendar and Task Management as well as Event based Reminders.	Web based	www.taroby.org
Yuuguu	Yuuguu is an instant screen sharing, web conferencing, remote support, desktop remote control and messaging tool.	Client based	www.yuuguu.com

Procedures

The collaborative framework was applied to the final collections of tools corresponding to each of the three tiers. First, each tool was assessed using the sub-element exemplars to determine full support (FS), partial support (PS), or no support (NS) of the corresponding major collaborative element. These assessments were determined as follows. First, full support for a major collaborative element was documented when all of the sub-elements under that particular major element yielded positive ratings. For example, if evidence for sub-elements *members are mutually aware of other members* (S1a), *members can potentially interact with one another* (S1b), and *scalability* (T5) was recorded, the major collaborative element *two or more people* (C1) would be marked "FS." Partial support, "PS," was recorded for elements that included a mix of positive and negative sub-element observations. Finally, no support, "NS," was recorded when all of the associated sub-elements yielded negative results for evidence of collaborative support.

Without any theoretical justification to indicate otherwise, each major element of collaboration (C1-C9) was equally weighted in the collaboration framework; all major elements were deemed necessary for full collaboration support, but none more so than any others. Therefore, if any individual major element of collaboration was determined to be not supported (NS), the tool was not labeled as collaborative. Conversely, if all of the major elements were determined to be fully supported (FS), the tool was fully collaborative. Tools exhibiting a mixture of fully and partially supported ratings (FS and PS) were considered partially collaborative.

IV. Results

"For every complex problem, there is an answer that is clear, simple, and wrong"
-H. L. MENCKEN

Three groups of collaborative tools were evaluated using the collaborative framework discussed in Chapter 3. All of the tools required user accounts or software downloads before they could be assessed. The average time required to download and/or register, log in, learn, and ultimately apply the collaborative framework to each tool was approximately 50 minutes; total time to assess all three tiers was 19 hours; 7.7 hours for the upper tier, 4.3 hours for the middle tier, and 7 hours for the lower tier.

Top Tier Assessment

The collaborative framework was applied to the eight tools in the top tier such that each major element of collaboration (C1-C9) received a rating of full support (FS), partial support (PS), or no support (NS), and based on assessments of each sub-element receiving either a positive (Y) or negative (N) rating. The results of the evaluation are captured in Table 14; the major elements of collaboration are highlighted in grey and the negative responses are highlighted in red. One tool (Zoho Suite) received all FS ratings; six tools (Basecamp, CentralDesktop, Google Docs, Vyew, DimDim, and Yugma) received a mix of FS ratings and PS ratings; and one tool (Writeboard) received all four of the NS ratings.

Overall, the top tier evaluation consisted of 72 possible ratings across the major elements of collaboration (9 major elements of collaboration x 8 tools) and 168 possible

ratings across the sub-elements (21 sub-elements per tool x 8 tools). The major elements of collaboration received 53 FS ratings, 15 PS ratings, and 4 NS ratings, while the sub-elements received 145 positive ratings and 23 negative ratings.

Table 14: Top Tier Assessment Results

	Zoho Suite	Basecamp	Central Desktop	Google Docs	Vyew	DimDim	Writeboard	Yugma
C1. Two or more people	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**PS**	**FS**
S1a. Members are mutually aware of other members	Y	Y	Y	Y	Y	Y	Y	Y
S1b. Members can potentially interact with one another	Y	Y	Y	Y	Y	Y	N	Y
T5. Scalability	Y	Y	Y	Y	Y	Y	Y	Y
C2. Recognized relationship	**FS**	**FS**	**FS**	**PS**	**PS**	**PS**	**NS**	**PS**
S4. Have a recognized relationship	Y	Y	Y	Y	Y	Y	N	Y
S8b. Roles	Y	Y	Y	Y	Y	Y	N	Y
S8c. Status	Y	Y	Y	N	N	N	N	N
C3. Common interests	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**NS**	**FS**
S2. Common interests	Y	Y	Y	Y	Y	Y	N	Y
C4. Organized interaction	**FS**	**PS**	**PS**	**FS**	**PS**	**FS**	**PS**	**PS**
S8a. Rewards	Y	N	N	Y	N	Y	N	N
S8d. Rules	Y	Y	Y	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	Y	Y	Y	Y	Y	Y
C5. Common goals	**FS**	**FS**	**FS**	**FS**	**PS**	**PS**	**NS**	**PS**
S6. Common goals	Y	Y	Y	Y	N	N	N	N
T2. Horizontal implementation	Y	Y	Y	Y	Y	Y	N	Y
C6. Mutual benefits	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**PS**	**FS**
T1. Technology linked to overarching strategies	Y	Y	Y	Y	Y	Y	Y	Y
T2. Horizontal implementation	Y	Y	Y	Y	Y	Y	N	Y
C7. Mutual accountability	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**
S7. Hold themselves mutually accountable	Y	Y	Y	Y	Y	Y	Y	Y
S9. Feedback	Y	Y	Y	Y	Y	Y	Y	Y
C8. Provide useful contribution	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**NS**	**FS**
S5. Complimentary Skills	Y	Y	Y	Y	Y	Y	N	Y
T4. Degree of synchronicity	Y	Y	Y	Y	Y	Y	N	Y
C9. Create value	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**PS**	**FS**
S3. Engage in purposeful activities	Y	Y	Y	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	Y	Y	Y	Y	Y	Y
T3. Work versus benefits	Y	Y	Y	Y	Y	Y	N	Y

Next, the percentages of the major collaborative elements earning FS or PS ratings were reviewed to determine which elements were best (or most frequently) supported across the top tier tools. Evidence of full support was observed for the following major collaborative elements: full support for *mutual accountability* (C7) was documented in all tools (8 of 8); 88% (7 of 8) of the tools demonstrated evidence of full support for *two or more people* (C1), *common interests* (C3), *mutual benefits* (C6), *provide useful contribution* (C8), and *create value* (C9); 50% of the tools (4 of 8) demonstrated full support for *common goals* (C5); and 38% of the tools (3 of 8) demonstrated full support for *recognized relationship* (C2) and *organized interaction* (C4). The relative percentage jumps in representation across all major collaborative elements when adding evidence for partial support into the comparisons are also illustrated in Table 15 below.

Table 15: Elements versus Tools (Top Tier)

Elements of Collaboration	FS by X% of tools	FS + PS by X% of tools
C1. Two or more people	88% (7 of 8)	100% (8 of 8)
C2. Recognized relationship	38% (3 of 8)	88% (7 of 8)
C3. Common interests	88% (7 of 8)	88% (7 of 8)
C4. Organized interaction	38% (3 of 8)	100% (8 of 8)
C5. Common goals	50% (4 of 8)	88% (7 of 8)
C6. Mutual benefits	88% (7 of 8)	100% (8 of 8)
C7. Mutual accountability	100% (8 of 8)	100% (8 of 8)
C8. Provide useful contribution	88% (7 of 8)	88% (7 of 8)
C9. Create value	88% (7 of 8)	100% (8 of 8)

The ratings for each of the sub-elements of collaboration were also examined to determine whether any of the sub-elements were more commonly observed than others. Table 16 below shows that evidence of nine sub-elements of collaboration were observed in 100% of the tools (8 of 8), nine sub-elements were observed in 88% of the tools (7 of 8), one sub-element was observed in only 50% of the tools (4 of 8), and two sub-elements were observed in 38% of the tools (2 of 8).

Table 16: Sub-Elements and Percentages of Supporting Tools (Top Tier)

Elements and Sub-Elements of Collaboration	Positive responses in sub-elements in X% of tools
C1. Two or more people	
S1a. Members are mutually aware of other members	100%
S1b. Members can potentially interact with one another	88%
T5. Scalability	100%
C2. Recognized relationship	
S4. Have a recognized relationship	88%
S8b. Roles	88%
S8c. Status	38%
C3. Common interests	
S2. Common interests	88%
C4. Organized interaction	
S8a. Rewards	38%
S8d. Rules	100%
TE1. Task type	100%
C5. Common goals	
S6. Common goals	50%
T2. Horizontal implementation	88%
C6. Mutual benefits	
T1. Technology linked to overarching strategies	100%
T2. Horizontal implementation	88%
C7. Mutual accountability	
S7. Hold themselves mutually accountable	100%
S9. Feedback	100%
C8. Provide useful contribution	
S5. Complimentary Skills	88%
T4. Degree of synchronicity	88%
C9. Create value	
S3. Engage in purposeful activities	100%
TE1. Task type	100%
T3. Work versus benefits	88%

Middle Tier Assessment

As in the top tier assessment, there were 72 possible ratings for the major elements of collaboration and 168 possible ratings across the sub-elements. None of the middle tier tools received all FS ratings; five tools (Comapping, Concept Share, ooVoo, ProjectPier, and Webex) received a mix of FS and PS ratings; and three tools (Stixy, WebOffice, and Yammer) received all seven NS ratings (see Table 17 below). The overall ratings for the major elements of collaboration were recorded as follows: 35 FS ratings, 30 PS ratings, and 7 NS ratings, while the sub-elements yielded 123 positive ratings and 45 negative ratings.

Table 17: Middle Tier Assessment Results

	OoVoo	WebOffice	Yammer	Comapping	Concept Share	Project Pier	Stixy	Webex
C1. Two or more people	**FS**	**PS**	**FS**	**FS**	**FS**	**PS**	**NS**	**FS**
S1a. Members are mutually aware of other members	Y	Y	Y	Y	Y	Y	N	Y
S1b. Members can potentially interact with one another	Y	Y	Y	Y	Y	Y	N	Y
T5. Scalability	Y	N	Y	Y	Y	N	N	Y
C2. Recognized relationship	**PS**	**FS**	**FS**	**PS**	**PS**	**FS**	**NS**	**PS**
S4. Have a recognized relationship	Y	Y	Y	Y	Y	Y	N	Y
S8b. Roles	N	Y	Y	Y	Y	Y	N	Y
S8c. Status	N	Y	Y	N	N	Y	N	N
C3. Common interests	**FS**	**NS**	**FS**	**FS**	**FS**	**FS**	**NS**	**FS**
S2. Common interests	Y	N	Y	Y	Y	Y	N	Y
C4. Organized interaction	**PS**	**PS**	**FS**	**FS**	**PS**	**PS**	**PS**	**PS**
S8a. Rewards	N	N	Y	Y	N	N	N	N
S8d. Rules	Y	Y	Y	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	Y	Y	Y	Y	Y	Y
C5. Common goals	**PS**	**PS**	**NS**	**FS**	**PS**	**PS**	**NS**	**FS**
S6. Common goals	N	Y	N	Y	N	Y	N	Y
T2. Horizontal implementation	Y	N	N	Y	Y	N	N	Y
C6. Mutual benefits	**FS**	**PS**	**PS**	**FS**	**FS**	**PS**	**PS**	**FS**
T1. Technology linked to overarching strategies	Y	Y	Y	Y	Y	Y	Y	Y
T2. Horizontal implementation	Y	N	N	Y	Y	N	N	Y
C7. Mutual accountability	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**PS**	**FS**
S7. Hold themselves mutually accountable	Y	Y	Y	Y	Y	Y	N	Y
S9. Feedback	Y	Y	Y	Y	Y	Y	Y	Y
C8. Provide useful contribution	**PS**	**PS**	**PS**	**FS**	**PS**	**PS**	**NS**	**FS**
S5. Complimentary Skills	N	Y	N	Y	N	Y	N	Y
T4. Degree of synchronicity	Y	N	Y	Y	Y	N	N	Y
C9. Create value	**FS**	**PS**	**PS**	**FS**	**FS**	**PS**	**PS**	**FS**
S3. Engage in purposeful activities	Y	Y	Y	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	Y	Y	Y	Y	Y	Y
T3. Work versus benefits	Y	N	N	Y	Y	N	N	Y

The percentages the major collaborative elements earning FS or PS ratings were reviewed to determine which elements were best (or most frequently) supported across middle tier tools. Evidence of full support was observed for the following major collaborative elements: 88% (7 of 8) of the tools demonstrated full support for *mutual accountability* (C7); 75% (6 of 8) of the tools demonstrated full support for *common interests* (C3); 63% (5 of 8) of the tools demonstrated full support for *two or more people* (C1); 50% (4 of 8) of the tools demonstrated full support for *mutual benefits* (C6) and *create value* (C9); 38% (3 of 8) of the tools demonstrated full support for *recognized relationship* (C2); and 25% (2 of 8) of the tools demonstrated full support for *common goals* (C5) and *provide useful contribution* (C8). The relative percentage jumps in representation across all major collaborative elements when adding evidence for partial support into the comparisons are also illustrated in Table 18 below.

Table 18: Elements versus Tools (Middle Tier)

Elements of Collaboration	FS by X% of tools	FS + PS by X% of tools
C1. Two or more people	63% (5 of 8)	88% (7 of 8)
C2. Recognized relationship	38% (3 of 8)	88% (7 of 8)
C3. Common interests	75% (6 of 8)	75% (6 of 8)
C4. Organized interaction	25% (2 of 8)	100% (8 of 8)
C5. Common goals	25% (2 of 8)	75% (6 of 8)
C6. Mutual benefits	50% (4 of 8)	100% (8 of 8)
C7. Mutual accountability	88% (7 of 8)	100% (8 of 8)
C8. Provide useful contribution	25% (2 of 8)	88% (7 of 8)
C9. Create value	50% (4 of 8)	100% (8 of 8)

The ratings of each of the sub-elements were also examined. Table 19 below reveals that evidence of six sub-elements of collaboration were observed in 100% of the

tools (8 of 8), four sub-elements were observed in 88% of the tools (7 of 8), two sub-elements were observed in 75% of the tools (6 of 8), two sub-elements were observed in 63% of the tools (5 of 8), five sub-elements were observed in 50% of the tools (4 of 8), one sub-element was observed in 38% of the tools (2 of 8), and one sub-element was documented in 25% of the tools (2 of 8).

Table 19: Elements and Percentages of Supporting Tools (Middle Tier)

Elements and Sub-Elements of Collaboration	Existed in X% of tools
C1. Two or more people	
S1a. Members are mutually aware of other members	88%
S1b. Members can potentially interact with one another	88%
T5. Scalability	63%
C2. Recognized relationship	
S4. Have a recognized relationship	88%
S8b. Roles	75%
S8c. Status	38%
C3. Common interests	
S2. Common interests	75%
C4. Organized interaction	
S8a. Rewards	25%
S8d. Rules	100%
TE1. Task type	100%
C5. Common goals	
S6. Common goals	50%
T2. Horizontal implementation	50%
C6. Mutual benefits	
T1. Technology linked to overarching strategies	100%
T2. Horizontal implementation	50%
C7. Mutual accountability	
S7. Hold themselves mutually accountable	88%
S9. Feedback	100%
C8. Provide useful contribution	
S5. Complimentary Skills	50%
T4. Degree of synchronicity	63%
C9. Create value	
S3. Engage in purposeful activities	100%
TE1. Task type	100%
T3. Work versus benefits	50%

Lower Tier Assessment

As in the top and middle tier assessments, there were 72 possible ratings for the major elements of collaboration and 168 possible ratings across the sub-elements.

Evidence of full support for any of the major elements was not observed in any of the lower tier tools two tools (Action Method and Planzone) received a mix of FS and PS ratings; and six tools (Hot Office, Noodle, Novlet, Revizr, Taroby, and Yuuguu) received all seven NS ratings (see Table 20 below). The overall ratings for the major elements of collaboration were recorded as follows: 27 FS ratings, 32 PS ratings, and 13 NS ratings, while the sub-elements yielded 102 positive responses and 66 negative responses.

Table 20: Lower Tier Assessment Results

	Action Method	Novlet	Taroby	Hotoffice	Noodle	Planzone	Revizr	Yuuguu
C1. Two or more people	**FS**	**NS**	**PS**	**FS**	**FS**	**PS**	**PS**	**FS**
S1a. Members are mutually aware of other members	Y	N	Y	Y	Y	Y	Y	Y
S1b. Members can potentially interact with one another	Y	N	N	Y	Y	N	N	Y
T5. Scalability	Y	N	N	Y	Y	Y	N	Y
C2. Recognized relationship	**PS**	**NS**	**NS**	**FS**	**FS**	**FS**	**PS**	**NS**
S4. Have a recognized relationship	Y	N	N	Y	Y	Y	N	N
S8b. Roles	N	N	N	Y	Y	Y	Y	N
S8c. Status	N	N	N	Y	Y	Y	N	N
C3. Common interests	**FS**	**FS**	**NS**	**FS**	**FS**	**FS**	**NS**	**FS**
S2. Common interests	Y	Y	N	Y	Y	Y	N	Y
C4. Organized interaction	**FS**	**PS**	**PS**	**PS**	**FS**	**PS**	**PS**	**PS**
S8a. Rewards	Y	Y	N	N	Y	N	N	N
S8d. Rules	Y	N	Y	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	N	Y	Y	Y	Y	Y
C5. Common goals	**PS**	**NS**	**PS**	**NS**	**NS**	**PS**	**NS**	**PS**
S6. Common goals	Y	N	N	N	N	Y	N	N
T2. Horizontal implementation	N	N	Y	N	N	N	N	Y
C6. Mutual benefits	**FS**	**PS**	**NS**	**PS**	**PS**	**FS**	**PS**	**PS**
T1. Technology linked to overarching strategies	Y	Y	N	Y	Y	Y	Y	Y
T2. Horizontal implementation	Y	N	N	N	N	Y	N	N
C7. Mutual accountability	**FS**	**FS**	**NS**	**FS**	**FS**	**FS**	**FS**	**FS**
S7. Hold themselves mutually accountable	Y	Y	N	Y	Y	Y	Y	Y
S9. Feedback	Y	Y	N	Y	Y	Y	Y	Y
C8. Provide useful contribution	**PS**	**NS**	**PS**	**FS**	**FS**	**PS**	**PS**	**PS**
S5. Complimentary Skills	N	N	N	Y	Y	Y	Y	N
T4. Degree of synchronicity	Y	N	Y	Y	Y	N	N	Y
C9. Create value	**PS**	**PS**	**PS**	**PS**	**PS**	**PS**	**PS**	**FS**
S3. Engage in purposeful activities	Y	Y	N	Y	Y	Y	Y	Y
TE1. Task type	Y	Y	N	Y	Y	Y	Y	Y
T3. Work versus benefits	N	N	Y	N	N	N	N	Y

The percentages the major collaborative elements earning FS or PS ratings were reviewed to determine which elements were best (or most frequently) supported across lower tier tools. Evidence of full support was observed for the following major collaborative elements: 88% (7 of 8) of the tools demonstrated full support for *mutual accountability* (C7); 75% (6 of 8) of the tools demonstrated full support for *common interests* (C3); 50% (4 of 8) of the tools demonstrated full support for *two or more people* (C1); 38% (3 of 8) of the tools demonstrated full support for *recognized relationship* (C2); 25% (2 of 8) of the tools demonstrated full support for *organized interaction* (C4), *mutual benefits* (C6), and *provide useful contribution* (C8); 13% (1 of 8) of the tools demonstrated full support for *create value* (C9); and *common goals* (C5) was not fully supported by any tool (0 of 8).

Table 21: Elements versus Tools (Lower Tier)

Elements of Collaboration	FS by X% of tools	FS + PS by X% of tools
C1. Two or more people	50% (4 of 8)	88% (7 of 8)
C2. Recognized relationship	38% (3 of 8)	63% (5 of 8)
C3. Common interests	75% (6 of 8)	75% (6 of 8)
C4. Organized interaction	25% (2 of 8)	100% (8 of 8)
C5. Common goals	0% (0 of 8)	50% (4 of 8)
C6. Mutual benefits	25% (2 of 8)	88% (7 of 8)
C7. Mutual accountability	88% (7 of 8)	88% (7 of 8)
C8. Provide useful contribution	25% (2 of 8)	88% (7 of 8)
C9. Create value	13% (1 of 8)	100% (8 of 8)

Finally, the ratings of each of the sub-elements were examined to determine the relative frequency with which they were observed. Table 22 below indicates that no single sub-element of collaboration was observed across all of the tools (8 of 8), evidence of eight sub-elements was observed in 88% of the tools (7 of 8), one sub-element in 75%

of the tools (6 of 8), two sub-elements in 63% of the tools (5 of 8), four sub-elements in 50% of the tools (4 of 8), two sub-elements in 38% of the tools (2 of 8), and four sub-elements in 25% of the tools (2 of 8).

Table 22: Elements and Percentages of Supporting Tools (Lower Tier)

Elements and Sub-Elements of Collaboration	Existed in X% of tools
C1. Two or more people	
S1a. Members are mutually aware of other members	**88%**
S1b. Members can potentially interact with one another	**50%**
T5. Scalability	**63%**
C2. Recognized relationship	
S4. Have a recognized relationship	**50%**
S8b. Roles	**50%**
S8c. Status	**38%**
C3. Common interests	
S2. Common interests	**75%**
C4. Organized interaction	
S8a. Rewards	**38%**
S8d. Rules	**88%**
TE1. Task type	**88%**
C5. Common goals	
S6. Common goals	**25%**
T2. Horizontal implementation	**25%**
C6. Mutual benefits	
T1. Technology linked to overarching strategies	**88%**
T2. Horizontal implementation	**25%**
C7. Mutual accountability	
S7. Hold themselves mutually accountable	**88%**
S9. Feedback	**88%**
C8. Provide useful contribution	
S5. Complimentary Skills	**50%**
T4. Degree of synchronicity	**63%**
C9. Create value	
S3. Engage in purposeful activities	**88%**
TE1. Task type	**88%**
T3. Work versus benefits	**25%**

Summary Comparisons

The data suggest that tools appearing in higher tiers exhibit more frequent evidence of support for more of the major elements and sub-elements of collaboration. Table 23 below shows a comparison of the ratings recorded for each major element and sub-element of collaboration observed across the three assessments. The clearly consistent and linear relationships between tiers and indications of degree of collaborative support suggests at least some face validity to the practice of using search hit popularity as a proxy measure of "goodness" of the tool. The consistent trend is such that top tier tools appear to afford or provide support for more major elements and sub-elements of collaboration and are associated with fewer non-supported major elements and sub-elements than the middle and lower tiers. Additionally, these associations are linear such that the middle tier tools show evidence of support for more elements and sub-elements of collaboration and are associated with fewer non-supported major elements and sub-elements than tools in the lower tier.

Table 23: Element and Sub-element comparison

	Top Tier	Middle Tier	Lower Tier
Fully Supported (FS) Elements of Collaboration	53	35	27
Partially Supported (PS) Elements of Collaboration	15	30	32
Not Supported (NS) Elements of Collaboration	4	7	13
Supported (Y) Sub-elements	145	123	102
Non Supported (N) Sub-elements	23	45	66

Table 24 shows a comparison of the three assessments and indicates of the percentage of tools that exhibited evidence of full support for each major element of collaboration. In the top tier, with the exception of *recognized relationships* (C2) (the

only major element of collaboration for which evidence was found at consistent levels across the three evaluations), evidence of all the major elements of collaboration was observed in more tools than the middle and lower tiers (see green text -- Table 24). In the middle tier, the distinguishing major elements that separated the middle from the lower tier were elements *two or more people* (C1), *common goals* (C5), *mutual benefits* (C6), and *create value* (C9), evidence of which were observed in more tools than in the lower tier (see orange text -- Table 24). Tools in the lower tier exhibited evidence of full support for the fewest number of major elements of collaboration; distinguishing elements of the lower tier tools were *two or more people* (C1), *common goals* (C5), *mutual benefits* (C6), *provide useful contribution* (C8), and *create value* (C9) (see red text -- Table 24). Finally, evidence indicating full support for major elements *recognized relationship* (C2), *common interests* (C3), *organized interaction* (C4), *mutual accountability* (C7), and *provide useful contribution* (C8) were observed with equal frequency between the middle and lower tiers (see black text -- Table 24).

Table 24: Overall Test Results (Full Support)

Elements of Collaboration	Top Tier	Middle Tier	Lower Tier
C1. Two or more people	**88% (7 of 8)**	**63% (5 of 8)**	**50% (4 of 8)**
C2. Recognized relationship	38% (3 of 8)	38% (3 of 8)	38% (3 of 8)
C3. Common interests	**88% (7 of 8)**	75% (6 of 8)	75% (6 of 8)
C4. Organized interaction	**38% (3 of 8)**	25% (2 of 8)	25% (2 of 8)
C5. Common goals	**50% (4 of 8)**	**25% (2 of 8)**	**0% (0 of 8)**
C6. Mutual benefits	**88% (7 of 8)**	**50% (4 of 8)**	**25% (2 of 8)**
C7. Mutual accountability	**100% (8 of 8)**	88% (7 of 8)	88% (7 of 8)
C8. Provide useful contribution	**88% (7 of 8)**	25% (2 of 8)	25% (2 of 8)
C9. Create value	**88% (7 of 8)**	**50% (4 of 8)**	**13% (1 of 8)**

The assessments clearly indicated that certain sub-elements of collaboration were more often associated with top tier tools, a smaller set of sub-elements with the middle tier tools, and an even smaller number of sub-elements in the lower tier tools (see Table 25 below). With the exception of *rewards* (S8a), a consistent downward trend is observed when comparing the sub-element ratings for top, middle, and lower tier tools. Specifically, top tier tools were associated with more ratings indicating full sub-element support than tools in the other tiers; distinguishing sub-elements of the top tier were *members are mutually aware of other members* (S1a), *common interests* (S2), *complimentary skills* (S5), *hold themselves mutually accountable* (S7), *rewards* (S8a), *roles* (S8b), *horizontal implementation* (T2), *work versus benefits* (T3), *degree of synchronicity* (T4), and *scalability* (T5) (see green text -- Table 25). Middle tier tools exhibited evidence of support for a greater number of sub-elements of collaboration than the lower tier; distinguishing sub-elements of the middle tier were *rewards* (S8a), *roles* (S8b), and *horizontal implementation* (T2) (see orange text -- Table 25). Tools in the lower tier exhibited evidence of support for the fewest number of sub-elements; distinguishing sub-element ratings in the lower tier were *members can potentially interact with one another* (S1b), *engage in purposeful activities* (S3), *have a recognized relationship* (S4), *common goals* (S6), rewards (S8a), *roles* (S8b), *rules* (S8d), *task type* (TE1), *technology linked to overarching strategies* (T1), *horizontal implementation* (T2), and *work versus benefits* (T3) (see red text --Table 25).

Evidence of support for the following sub-elements of collaboration was evenly distributed across the top and middle tiers: *members can potentially interact with one*

another (S1b), *engage in purposeful activities* (S3), *have a recognized relationship* (S4), *common goals* (S6), *rules* (S8d), *feedback* (S9), *task type* (TE1), and *technology linked to overarching strategies* (T1). Evidence of support for the following sub-elements was also evenly distributed between the middle and lower tiers: *members are mutually aware of other members* (S1a), *common interests* (S2), *complimentary skills* (S5), *hold themselves mutually accountable* (S7), *rewards* (S8a), *degree of synchronicity* (T4), and *scalability* (T5) (see black text -- Table 25). Finally, evidence of tool support for *status* (S8c) remained consistent across the three assessment tiers.

Table 25: Overall Test Results for Sub-Elements

Elements and Sub Elements of Collaboration	Top Tier Existed in X% of tools	Middle Tier Existed in X% of tools	Lower Tier Existed in X% of tools
C1. Two or more people			
S1a. Members are mutually aware of other members	**100%**	**88%**	**88%**
S1b. Members can potentially interact with one another	**88%**	**88%**	**50%**
T5. Scalability	**100%**	**63%**	**63%**
C2. Recognized relationship			
S4. Have a recognized relationship	**88%**	**88%**	**50%**
S8b. Roles	**88%**	**75%**	**50%**
S8c. Status	**38%**	**38%**	**38%**
C3. Common interests			
S2. Common interests	**88%**	**75%**	**75%**
C4. Organized interaction			
S8a. Rewards	**38%**	**25%**	**38%**
S8d. Rules	**100%**	**100%**	**88%**
TE1. Task type	**100%**	**100%**	**88%**
C5. Common goals			
S6. Common goals	**50%**	**50%**	**25%**
T2. Horizontal implementation	**88%**	**50%**	**25%**
C6. Mutual benefits			
T1. Technology linked to overarching strategies	**100%**	**100%**	**88%**
T2. Horizontal implementation	**88%**	**50%**	**25%**
C7. Mutual accountability			
S7. Hold themselves mutually accountable	**100%**	**88%**	**88%**
S9. Feedback	**100%**	**100%**	**88%**
C8. Provide useful contribution			
S5. Complimentary Skills	**88%**	**50%**	**50%**
T4. Degree of synchronicity	**88%**	**63%**	**63%**
C9. Create value			
S3. Engage in purposeful activities	**100%**	**100%**	**88%**
TE1. Task type	**100%**	**100%**	**88%**
T3. Work versus benefits	**88%**	**50%**	**25%**

V. Conclusions and Recommendations

"You can never tell when you make up something what will happen with it"
- DONNA SHIRLEY

The premise of the opening chapter was that, before we can improve collaboration across agencies, we need to better understand the nature of collaboration itself. With that understanding in hand, emphasis can then be shifted to the tools built or selected to support collaboration. Specifically, this research aimed to gain an understanding and appreciation of the features, functionalities, and design elements that might prove beneficial to collaboration.

Based on the works cited in Chapter 2, collaboration was defined as interaction that occurs between *two or more people* with clearly *recognized relationships,* where the interaction seems to be *based on common interests* and occurs in an *organized* manner. Collaborative efforts are executed in pursuit of *common goals* and include *mutual benefits* and *mutual accountability* for all parties involved. Finally, for successful collaboration to occur all parties *must bring something useful* to the relationship and the effort should *create value*. A series of collaborative tools was assessed across multiple dimensions of comparison for the degrees of congruence or alignment between tool functions and features and the scholarly perspectives of collaboration as developed in Chapter 2.

Of course, it is important to remember that not every aspect of the collaborative problem space was readily apparent and or explicit in the design of the tools situated for use within that problem space. Specifically, tools that did not address or demonstrate

support for one or more of the major elements of collaboration were not necessarily "bad tools" in of themselves; such features may simply not have been needed depending on the specific purpose of any given tool. However, using an academically inspired definition of collaboration as a starting point, the obtained results seem to offer strong evidence for functionality and design considerations that might be incorporated in the automated tools/ systems designed to support collaboration such as the tools assessed in this thesis. The degree of agreement between the academic standards of collaboration and the tools assessed in this study are in Table 26 below.

Table 26: Elements Fully Supported

Elements of Collaboration	Academic Standard	Top Tier	Middle Tier	Lower Tier
C1. Two or more people	✓	88% (7 of 8)	63% (5 of 8)	50% (4 of 8)
C2. Recognized relationship	✓	38% (3 of 8)	38% (3 of 8)	38% (3 of 8)
C3. Common interests	✓	88% (7 of 8)	75% (6 of 8)	75% (6 of 8)
C4. Organized interaction	✓	38% (3 of 8)	25% (2 of 8)	25% (2 of 8)
C5. Common goals	✓	50% (4 of 8)	25% (2 of 8)	0% (0 of 8)
C6. Mutual benefits	✓	88% (7 of 8)	50% (4 of 8)	25% (2 of 8)
C7. Mutual accountability	✓	100% (8 of 8)	88% (7 of 8)	88% (7 of 8)
C8. Provide useful contribution	✓	88% (7 of 8)	25% (2 of 8)	25% (2 of 8)
C9. Create value	✓	88% (7 of 8)	50% (4 of 8)	13% (1 of 8)

The efficacy of the proposed assessment framework was predicated on the selection of relevant collaborative tools for analysis. Without any other authoritative measure or listings of "collaborative tool quality," a proposed measure based on frequency of search engine returns was devised and implemented as described in Chapter 3 of this thesis. The clearly consistent and linear relationships between specified tiers and the commensurate degree of collaborative support demonstrated by tools within those

tiers suggest at least some degree of face validity when using search hit popularity as a proxy measure of "goodness" of the tool. Specifically, a consistent or downward trend in degree of support is observable across the three tiers. The data suggest that elements of the academically derived definition of collaboration are clearly observable and supported in a majority of the top tier tools assessed in this research.

Top Tier Tools

The obtained findings indicate that virtually all of the top tier collaborative tools largely provided visibility of, or afforded functional support for, several major collaborative elements: *Two or more people* (C1), *common interests* (C3), *mutual benefits* (C6), *mutual accountability* (C7), *provide useful contribution* (C8), and *create value* (C9); successful implementations of these elements may be indicative of better collaborative tools in general. Three major elements were not as well supported in the top tier: *Recognized relationship* (C2), *organized interaction* (C4), and *common goals* (C5); however, these elements were also largely unsupported across the middle and lower tiers as well. Qualities of top tier tools are suggested in Table 27 below.

Middle Tier Tools

Tools in the middle tier appeared to provide less consistent and less often support for fewer elements of collaboration; however, *two or more people* (C1), *common interests* (C3), and *mutual accountability* (C7) seemed to be relatively well supported and may be indicative of an average tool. Additionally, although four major elements, t*wo or more people* (C1), *common goals* (C5), *mutual benefits* (C6), and *create value* (C9), were not *as well* supported as those in the top tier, they were still observed more often than in the

lower tier. The incidence for the remainder of the major elements of collaboration: *recognized relationships* (C2), *common interests* (C3), *organized interaction* (C4), *mutual accountability* (C7), and *provide useful contribution* (C8), were indistinguishable between the middle and the lower tiers. Qualities of middle tier tools are suggested in Table 27 below.

Lower Tier Tools

Finally, lower tier tools supported the fewest number of elements. In fact, no distinguishing major elements were observed in the lower tier. In other words, without other tools for comparison, a lower tier tool may be difficult to distinguish from a middle tier tool at this point; however, the fact that a relatively high incidence of support for *common interests* (C3) and *mutual accountability* (C7) was observed in the lower tier suggests that even lower ranked tools are likely to consider these elements. Qualities of lower tier tools are suggested in Table 27 below.

Overall Trends

Two major elements of collaboration received consistently high support across all three tiers: *Common interests* (C3) and *mutual accountability* (C7). This may be an indication that common interests and accountability are relevant to a majority of collaborative tools, regardless of their focus areas, or of virtually any IT-enabled group support system; or are simply relevant to the collaborative enterprise in general. It seems logical to assume that because common interests bring people together, and accountability improves decisions and enhances interaction, accommodation or reinforcement of these elements may be foundational to any collaborative tool.

Interestingly, three elements, *recognized relationship* (C2) *organized interaction* (C4), and *common goals* (C5), were rated consistently low in all three assessments (as indicated by low incidence of FS ratings). With respect to *recognized relationships* (C2) and *organized interaction* (C4), it is possible that tools designed to support collaboration may simply not need to afford visibility for these collaborative elements because we can reasonably assume that rational people working together will already have some form of established relationships, and that rational people working together will already organize themselves in some way to complete the task at hand. Because these elements of collaboration are likely satisfied before a tool is even selected and used (or perhaps, even in spite of the use of the tool itself), collaborative tools may therefore not need to incorporate these factors as major elements of design and functionality. Instead, they are likely candidates to be addressed within the social or contextual dimensions of the collaborative problem space rather than mediated, negotiated, or implemented explicitly within the tools themselves.

Table 27: Elements by Tiers

Top Tier	Middle Tier	Lower Tier
C1. Two or more people	C1. Two or more people	*Consistently low ratings*
C3. Common interests	*C3. Common interests	*C3. Common interests
C6. Mutual benefits	*C7. Mutual accountability	*C7. Mutual accountability
C7. Mutual accountability		
C8. Provide useful contribution		
C9. Create value		

* Indistinguishable between tiers

Discussion

Although the obtained evidence is suggestive of the efficacy of the collaborative framework as articulated in Chapter 3, the intent of this research was not to develop a grading scale to criticize collaborative tools, but rather to identify areas or issues of relevance to be considered when developing or selecting tools to support collaborative efforts. As such, this research implies a number of relevant contributions to academia and practice. First, the majority of the academically inspired definition of collaboration seemed relatively well and frequently supported by an initial assessment of a small group of (ostensibly) collaborative tools. Thus, it appears that the current practice or state of art in collaborative tool design, at least as represented herein by the tools selected and analyzed, do address or afford functionality to support most of the major elements of collaboration as specified in the academic literature.

Second, this study provided a foundational means by which to identify and stratify top, middle, and lower tier collaborative tools. The method assumed that tools appearing on a greater number of search engine hits for "top" or "good" collaborative tools may be more popularly cited because they are more highly regarded by users, thus indicating they may indeed be better collaborative tools. This proxy measure was demonstrate to be a reasonably viable means of discriminating good collaborative tools from lesser collaborative tools; similar foundational or exploratory research may be able to make use of this approach to identify potential candidates for study or investigation.

Third, the results of the assessments suggest that certain major elements of collaboration that may be expected in top, middle, and lower tier collaborative tools.

This information may prove useful when selecting tools that facilitate collaboration by identifying areas elements of collaboration not supported by the tool. Unsupported areas can then be satisfied by other means, thus resulting in a more complete collaborative environment.

Limitations of Research

There were several limitations in the design and execution of the study that should be addressed. First, independent raters were not used to assess each collaborative tool, thus increasing the possibility of subjectivity and individual bias within the assessment ratings themselves. To limit the likelihood that such subjectivity unduly influenced the results within and between tiers, the collaborative framework was fully developed and articulated before any initial ratings were recorded. Thus, the same standards and exemplars were used across all three assessment tiers rather than developed iteratively or post hoc.

The second limitation concerns the issue sample size. Although only 53 tools were selected (29 were eliminated) from a total pool of 617 tools for eventual analysis, this was not in fact a statistical study, but rather a theoretical study. Therefore the relatively small sample size was not a concern at this stage of theory exploration and development. Indeed, the theoretical sampling frame used in this research was based on presumably objective criteria where the selected objects for analysis were ones that were likely to best represent varying levels of automated collaborative support.

Third, several concessions were made based on the lack of visibility into the motivations and composition of the user groups that might be at work behind the tools. Specifically, it proved difficult to impractical to develop completely objective and distinct exemplars that would otherwise demonstrate evidence for elements of tool design that afforded or supported *purposeful activities* (S3), *complimentary skills* (S5), *task type* (TE1), *technology linked to overarching strategies* (T1), or *work versus benefits* (T3). However, these limitations were mitigated to some degree by operationalizing the sub-elements with the most logical concrete exemplar that could reasonably be found or observed within the tool.

For example, *complimentary skills* (S5) was linked with *roles* (S8b). The rationale for this association was derived from the idea that roles may be evidence of complementary skills, because roles, if assigned, are likely to be so according to individual strengths and weaknesses. In fact, role differentiation, in and of itself, suggests that certain people will be providing for some element or function relevant or even crucial to task completion that others may not. Second, evidence of *work versus benefits* (T3) was not directly observable in the tools alone without an understanding of how the tool was to be used. However, because *horizontal implementation* (T2) increases interoperability and decreases the effort required to translate, move, or apply the inputs and outputs of this tool to other tools, *horizontal implementation* was used as an indicator of *work versus benefits.*

Technology linked to overarching strategies (T1), *purposeful activities* (S3), and *task type* (TE1) were also not directly observable within the extant features or design of

the tools and were therefore assessed with alternative criteria. These criteria were based on the assumptions that groups would be drawn to select use tools that support the group's strategy or were selected because of that strategy. Similarly, a group is likely drawn to a tool because of the purpose it serves as a tool, by its very nature, is developed to *do* something, some type of task. As such, the only explicit indicator that seemed to capture the essence of these concerns was a comparison of the tool's documentation versus its actual capabilities. Thus, as long as a tool's claims and actual capabilities matched, support was documented for these three sub-elements. But, this concession meant that three major elements of collaboration, *organized interaction* (C4), *mutual benefits* (C6), and *create value* (C9), would receive credit for the same factor; however, each of those major elements had other supporting sub-elements to balance the ratings.

Fourth, tools that did not offer free evaluation, a free trial period, or a free basic version were not assessed. Although it is likely that many fee-based collaborative tools may well be "good" collaborative tools, this concession was consistent with the assumption that better tools would be associated with more lists. Specifically, it was reasonable to assume that tools for fee would not likely be as widely used and therefore might not be associated with as many search return lists as free tools. However, many of the tools assessed in this study *were* in fact for-fee; they simply offered a trial of the underlying service/program. Thus, the fee-based collaborative tools that were not examined or eliminated from this study were as such based on marketing decisions from the owning or controlling company rather than for anything specifically related to a tool's "collaborative potential" that might have had significant impact on the obtained results.

Nevertheless, this limitation could be addressed with an expanded study that simply investigated the efficacy of the newly developed collaborative assessment framework against an array of various fee-based collaborative tools.

Recommendations for Future Research

There are a variety of opportunities to widen the door of the collaborative framework. Some specific recommendations for future research include the need to assess a greater number of collaborative tools. This research ultimately assessed only 24 tools, more tools could further validate these initial results. Although the number of tools assessed was also limited by the sheer lack of numbers of alternative tools in the top tier, other methods of identifying top tier tools could expand testing. For example, the 26 lists found for this study were not static and should only be considered a snapshot of collaborative tool design and implementation relative to the time period in which this study was conducted. More such lists are likely to appear in the near future; therefore, more frequent searches may identify an increased selection of tools to assess. Additionally, those interested in the subject matter should review publications such as Management of Information Systems Quarterly Journal, Information Systems Journal or other relevant journals/trade publications for any more authoritative lists or rankings.

Second, future research should include the use of independent coders for assessment ratings as independent coders would further validate the research. Even though the framework was fully developed and articulated before any ratings were recorded, there is still some amount of subjectivity. Independent coders and assessments

of inter-rater reliability would help alleviate additional subjectivity and increase the overall internal validity of the research.

As indicated in the limitations section, fee-based collaborative tools may also support many of the elements of collaboration. In fact, it would be telling to see just how well a fee-based collaborative tool might "hold up" against the relative assessments of the freely available tools examined herein. Although clearly the collaborative assessment framework is not mature or robust enough at this point to warrant informing purchasing or deployment decisions, the results obtained in this study using only stratification of free available collaborative tools as a sampling frame could provide at least a potential baseline against which to measure expectations about fee-based tool performance and support for collaborative activities.

Finally, additional research could focus on linking the proxy measure of popularity used to rank the tools to actual performance of the tools. Exploring this linkage could help establish whether higher rated tools (i.e., the more popular ones) are actually higher performing tools.

Conclusions

Despite the disagreement among academics and experts on a common definition of collaboration, the framework developed in this research does appear to capture or embody important elements of collaboration as a construct describing a particular form of organized human activity. Although there may be additional elements that were not captured in this study, the collaborative framework can be useful in selecting tools to

support a collaborative environment, or the framework may identify shortfalls in tools currently in use.

Recall that one of the recommendations from the 9/11 Commission report was to improve collaboration across agencies. This research may be the first of many steps needed to increase collaborative capabilities, and collaboration per se, across government agencies. For instance, the results of this research may provide some guidelines for designing or selecting tools that might facilitate inter-agency collaboration or improve the success of ongoing collaborative efforts that already employ some form of automation or IT-based support. Additionally, this knowledge can help guide leaders and managers by identifying some areas of consideration regarding the elements, activities and interactions relevant to the collaborative problem space that may actually need to be cultivated "behind-the-scenes," rather than looking for a "silver bullet" or "magic system" to automate and provide the necessary capabilities or functions. Specifically, decision makers could benefit by a better appreciation for the spectrum of collaborative issues that need to be considered and weighed against the degree of support that tools that are designed, selected, and used to provide for various issues of relevance to an organization.

Table 28: Suggested Elements of Collaboration

Elements of Collaboration
C1. Two or more people
C3. Common interests
C6. Mutual benefits
C7. Mutual accountability
C8. Provide useful contribution
C9. Create value

Finally, the results of this study yield evidence suggesting that six key elements or considerations may typically be present (fully supported) in better collaborative tools—and to such a degree that their presence is distinguished from lesser such tools. These elements are listed in Table 28. Ultimately, increased information sharing and better collaboration may prevent future attacks against the United States and its allies.

Bibliography

About StumbleUpon. (2009). Retrieved Nov 2009, 2009, from StumbleUpon: http://www.stumbleupon.com/aboutus/

Ariyur, K., Azpurua-Linares, F., Bekel, J., & Cleaver, M. (2007). *The Wikinomics Playbook.* Retrieved Sept 21, 2009, from Wikinomics: http://www.socialtext.net/data/workspaces/wikinomics/attachments/wikinomics:20080213154459-1-3411/original/the%20wikinomics%20playbook%2002%202008.pdf

Benford, S., Greenhalgh, C., Rodden, T., & Pycock, J. (2001). Collaborative Virtual Environments. *Communications of the ACM, 44, (7)* , 79-85.

Buckley, W. (1967). *Sociology and modern systems theory* . Englewood Cliffs, NJ: Prentice Hall.

Coleman, J. (1986). Social theory, social research, and a theory of action. *Amercian Journal of Sociology, 91, (6)* , 1309-1335.

DeSanctis, G., & Gallupe, B. (1987). A foundation for the study of group support systems. *Management Science, 33, (5)* , 589-609.

Design News. (2007). *Boeing's Global Collaboration Environment Pioneers Groundbreaking 787 Dreamliner Development Effort*. Retrieved Dec 16, 2009, from Design News: http://www.designnews.com/article/13616-Boeing_s_Global_Collaboration_Environment_Pioneers_Groundbreaking_787_Dreamliner_Development_Effort.php

DeVito, J. (1991). *Human Communication.* New York, NY: Harper-Collins Inc.

Dittes, J., & Kelley, H. (1956). Effects of different conditions of acceptance on conformity to group norms. *Journal of Abnormal and Social Psychology, 53* , 100-107.

Dykstra, C. A. (1939). The Quest for Responsibility. *American Political Science Review, 33, (1)* , 1-25.

Ellis, C. A., Gibbs, S. J., & Rein, G. L. (1991). Groupware: Some issues and experiences. *Communications of the ACM, 34, (1)* , 38-58.

Feld, C. S., & Stoddard, D. B. (2004). Getting IT Right. *Harvard Business Review* , 72-79.

Franklin, U. (1999). *Real World of Technology.* Toronto: House Of Anansi.

Gibson, J., Ivancevich, J., Donnelly, J., & Konopaske, R. (2003). *Organizations.* New York, NY: McGraw-Hill/Irwin.

Google Docs. (2009). Retrieved Nov 17, 2009, from Google.com: http://www.google.com/google-d-s/intl/en/tour1.html

Gruden, J. (1994). *Computer supported cooperative work: History and focus.* Irvine, CA: University of California Press.

Grudin, J. (1994). Groupware and social dynamics: Eight challenges for developers. *Communications of the ACM, 37, (1)* , 93-104.

Hackman, J. R. (1968). Effects of task characteristics on group products. *Journal of Experimental Psychology, 4* , 162-187.

Halverson, C. (2002). *Activity Theory and distributed cognition: or what does CSCW need to do with theories* . Yorktown Heights, NY: Social Computing Group, IBM T.J.Watson Research Center.

Hord, S. (1981). Working together: Cooperation or collaboration. Austin, TX, US.

How Much did the September 11 Terrorist Attack cost America? (2004). Retrieved October 27, 2009, from Institute for the Analysis of Global Security: http://www.iags.org/costof911.html

Information Sharing Environment. (2004). Retrieved October 28, 2009, from Information Sharing Environment: http://www.ise.gov/

Kanter, R. (1994). Collaborative Advantage. *Harvard Business Review (July - August)* , 96-108.

Kaplow, L., & Shavell, S. (2001). Any Non-welfarist Method of Policy Assessment Violates the Pareto Principle. *Journal of Political Economy, 109 (2)* .

Kling, R. (1991). Cooperation, coordination, and control in computer supported work. *Communications of the ACM, 34, (12)* , 83-88.

Kyng, M. (1991). Designing for cooperation: Cooperating in design. *Communications of the ACM, 34, (12)* , 65-73.

Lanier, J. (1979). *Exploring issues in teacher education.* Austin TX: Austin Research and Development Center for Teacher Education, University of Texas.

Laughlin, P. R. (1980). Social combination processes of cooperative groups as problem solving intellictive tasks. In M. Fishbein, *Progress in social psychology, volume 1*. Hillsdale NJ: Erlbaum.

Lyytinen, K. J., & Ngwenyama, O. K. (1992). What does computer support for cooperative work mean? A structurational analysis of computer supported cooperative work. *Accounting, Management and Information Technologies, 2, (1)* , 19-37.

Mathieu, J., James, J., Mahoney, P., Boiney, L., Hubbard, R., & White, B. (2007). *Hybrid Systems Dynamic, Petri Net, and Agent-Based Modeling of the Air and Space Operations Center.* Retrieved October 20, 2009, from MITRE: http://www.mitre.org/work/tech_papers/tech_papers_07/07_0455/07_0455.pdf

Mattessich, P. (2005). *Collaboration: What makes it work.* Wilder Research Center.

McGrath, J. (1984). *Groups: Interaction and Performance.* Englewood Cliffs, NJ: Prentice-Hall Inc.

McGrath, J. (1993). Time, Interaction, and Performance (TIP): A theory of groups. In R. Baecker, *Groupware and Computer Supported Cooperative Work* (pp. 116-129). San Fransisco, CA: Morgan-Kaufmann Publishers Inc.

Merriam-Webster. (2009). *Common Interest*. Retrieved Dec 16, 2009, from Merriam-Webster Online Dictionary: http://www.merriam-webster.com/dictionary/common_interest

Microsoft Office Online. (2007). Retrieved Dec 7, 2009, from Microsoft Live Meeting 2007: http://office.microsoft.com/en-us/livemeeting/HA102415201033.aspx

Microsoft SharePoint. (2009). Retrieved November 17, 2009, from Microsoft: http://sharepoint.microsoft.com/businessproductivity/products/pages/try-it.aspx?CR_CC=100193181&WT.srch=1&WT.mc_id=Search&CR_SCC=100193181&fbid=SRiSDDBnUeQ

Moran, T. P., & Anderson, R. J. (1990). The workday world as a paradigm for CSCW design. *CSCW 90* (pp. 381-393). Cambridge, England: Rank Xerox Eurpac.

Narula, A. (2008). *80/20 Rule of presenting ideas*. Retrieved January 22, 2010, from 80-20 presentation rule: http://www.80-20presentationrule.com/whatisrule.html

National Commission on Terrorist Attacks Upon the United States. (2003). *The 9/11 Commission Report.* New York, NY: W.W. Norton & Company Ltd.

Nunamaker, J. F., Briggs, R. O., Mittleman, D. D., Vogel, D. R., & Balthazard, P. A. (1997). Lessons learned from a dozen years of group support systems research: A discussion of lab and field findings. *Journal of Management Information Systems, 13, (3)* , 163-207.

Office of the Director of National Intelligence. (2008). *United States Intelligence Community Information Sharing Strategy.* Washington D.C.

Orilikowski, W. (1992). *Learning from the notes: Organizational issues in groupware implementation, Technical report #134.* Cambridge, MA: MIT Sloan School of Management.

Pepinsky, Hemphill, & Shevitz. (1958). Group decision support systems: a new frontier. *Journal of Abnormal Social Psychology, 57* , 47-54.

Poole, M. (1998). The small group should be the fundamental unit of communication. In J. Trent, *Views from the helm of the 21st century* (pp. 94-97). Boston, MA.: Allyn & Bacon.

Public Law 107-306. (2002, November 27). Retrieved October 22, 2009, from http://www.archives.gov/legislative/research/9-11/public-law-107-306.pdf

Schachter. (1951). Deviation, rejection and communication. *Journal of Abnormal Social Psychology, 46* , 190-207.

Shaw. (1973). Scaling group tasks: a method for dimensional analysis. *JSAS Catalog of selected documents in psychology, 3* , 8.

Shaw, M. (1959). Some effects of individually prominent behavior upon group effectiveness and member satisfaction. *Journal of Abnormal Social Psychology, 59* , 382-386.

Steiner, I. D. (1966). Models for inferring group size and potential productivity. *Behavioral Science, 11* , 273-283.

The American Heritage Dictionary. (2009). Retrieved October 23, 2009, from The American Heritage® Dictionary of the English Language, Fourth Edition: http://dictionary.reference.com/browse/collaborate

Theater Battle Management (TBM) C4I. (2006, Feb). *RDT&E Budget Item Justification: 07 Operational System Development.* Retrieved Oct 20, 2009, from http://www.dtic.mil/descriptivesum/Y2007/AirForce/0207438F.pdf

Wathen, A. (2006). Joint Airspace Management and Deconfliction. *Air & Space Power Journal, Fall* .

Wikipedia: About. (2009). Retrieved Nov 17, 2009, from Wikipedia.org: http://en.wikipedia.org/wiki/Wikipedia:About

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
03/2010	Master's Thesis	Sept 2009 – March 2010

4. TITLE AND SUBTITLE

An Analysis of the Elements of Collaboration Associated with Top Collaborative Tools

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Nagy, Kristopher C., Captain, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
Graduate School of Engineering and Management (AFIT/EN)
2950 Hobson Way, WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GIR/ENV/10-M01

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Intentionally left blank

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

United States government agencies have historically had problems with inter- agency information sharing and collaboration. In fact, the National Commission on Terrorist Attacks upon the United Stated recommended that the U.S. government "increase information sharing" and "improve collaboration across government agencies." To this day, no collaborative tools are being used to satisfy that recommendation. In fact, there is little agreement on what collaboration means and what characteristics are best suited for collaborative tools. Before we can improve collaboration across agencies, we need to better understand the nature of collaboration itself, and the hallmarks of better collaborative tools. As such, this research developed an academically inspired definition of collaboration. With the definition in hand, the foundational elements of collaboration were documented in a collaborative framework. The framework was then used to assess collaborative tools and identify the key elements of better collaborative tools. Six of the nine academic elements of collaboration were strongly supported in the assessments. The greatest advantage of this framework is that it provides a methodic and logical process for selecting collaborative tools based on the academic elements of collaboration.

15. SUBJECT TERMS

Collaboration; Collaborate; Collaborative; Elements of collaboration; Top collaborative tools; Best collaborative tools;

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Turner, Jason M., Lt Col, USAF
U	**U**	**U**	**UU**	97	**19b. TELEPHONE NUMBER** *(Include area code)* (937) 255-6565, ext 7407 (Jason.turner@afit.edu)

Standard Form 298 (Rev. 8-98
Prescribed by ANSI Std. Z39-18