SATISFACTION WITH WEB-BASED MEETINGS FOR IDEA GENERATION AND SELECTION: THE ROLE OF INSTRUMENTALITY, ENJOYMENT, AND INTERFACE DESIGN

by

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ABSTRACT

Despite the potential of group support systems (GSS) to increase productivity in virtual teamwork, most organizations still rely on email and teleconferencing for their distributed meetings. Low satisfaction with using the GSS has been identified as one reason behind the sluggish adoption of such systems.

To understand what factors constitute an affective response from GSS-based meetings, this thesis sought to unravel individual, social, utilitarian, and hedonic motives in virtual collaboration. An extended research model based on the Satisfaction Attainment Theory was proposed and tested with an experimental study. Twenty ad hoc student teams each met online to complete a relevant idea generation and selection task. An original GSS was deployed for these distributed and synchronous sessions, ending with a questionnaire that was completed by 126 participants.

Factor analysis and a Partial Least Squares structural equation model examined the correlations among reported satisfaction with meeting outcome and process and several antecedents. While no direct effects were found from perceived instrumentality of individual performance on meeting satisfaction, the latter was predicted by the hedonic constructs: perceived task enjoyment and GSS interface aesthetics.

Scholars of meeting satisfaction in virtual contexts are advised to include hedonic or other intrinsic motivation constructs in their research models. From a managerial perspective, this study demonstrated how a web-based collaboration environment structured for intra-group evaluability can induce positive affective responses in the majority of team members. For system designers, it was also shown how using lightweight social proxies and basic spatial positioning in the interface design contributed toward enjoyment, and ultimately toward satisfaction with process.

Keywords:
group support systems, meeting satisfaction, goal-attainment theory, idea generation, decision-making, virtual teams, performance feedback, task enjoyment, visual aesthetics, motivation, social translucence, social comparison, structural equation modelling, group creativity, graphical user interfaces
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DEDIICATION

I dedicate this thesis to my father, whose support of my education over the years went above and beyond what any son could have wished for.
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GLOSSARY

SO  Satisfaction with meeting outcomes
SP  Satisfaction with meeting process
PGA Perceived net value of goal attainment
INS Perceived instrumentality
ENJ Perceived (task or system) enjoyment
DES Perceived interface design aesthetics
EOU Perceived ease of use
USE Perceived usefulness
TAM Technology acceptance model
GSS Group support systems
EBS Electronic brainstorming systems
CSS Creativity support systems
DSS Decision support systems
IT Information technology
IS Information systems
EM Extrinsic motivation
IM Intrinsic motivation
PLS Partial least squares
EFA Exploratory factor analysis
CFA Confirmatory factor analysis
SEM Structural equation model
RIGA Relative individual goal attainment
FTF Face-to-face (meeting)
1 Introduction

1.1 Motivation

1.1.1 Adoption of group support systems (GSS)

This dissertation begins by quoting an intriguing set of statistics from the field of information technology (IT). Generally it has been estimated that:

- half of the typical manager's work day is spent in meetings, trying to solve problems, make decisions, and accomplish shared objectives (Roszkiewicz, 2007)
- half of that time is wasted as a result of various group process losses (Dufner, Hiltz, Johnson, and Czech, 1995).
- half of all organizations in the US make use of ongoing project teams (Devine, Clayton, Philips, Dunford, and Melner, 1999)
- half of all capital investment since the eighties has been spent on information technology (Dennis, Venkatesh, and Ramesh, 2003)

Despite the general nature of these figures, putting them together inevitably leads one to conclude that as a result of these needs and investments, technologies for group collaboration must have become ubiquitous. This may certainly be the case with email, chat, and teleconferencing applications. These days even teams located in the same building may rely on Instant Messenger for most of their collaboration (Quan-Haase, Cothrel, and Wellman, 2005; Cho, Trier, and Kim, 2005). But what about systems that support groups beyond communication and coordination, assisting them to generate more creative ideas, make more accurate decisions, and reach consensus more often than not? Such systems, commercially available since the nineties, are simply referred to as group support systems, or GSS (Gallupe, DeSanctis, and Dickson, 1988).

The problem is that—apart from some large North American organizations—the adoption of GSS has been sluggish (Agres, de Vreede, and Briggs, 2005; Dennis &
Reinicke, 2004; Roszkiewicz, 2007). At the same time, an abundance of studies have deployed GSS in experimental research investigating the reasons for such systems’ low acceptance in the field (Fjermestad & Hiltz, 2000; Reinig, Briggs, and de Vreede, 2009).

A qualitative review of GSS products from the last several years (conducted as part of this thesis) suggests that, in terms of graphical user interface, these systems have hardly evolved since the mid-nineties. This sentiment dovetails with the following critique from one of the world’s leading researchers on groupware system design:

“When we look at real-time groupware, little has happened since Engelbart. Instant Messaging is likely the only conferencing system that has had a significant impact, yet it is little more than text-chatting augmented with a simplistic presence indicator. While we are now seeing such systems augmented with video and other facilities, they tend to be unreliable, unimaginative and awkward. This failure of groupware is quite surprising, for groupware’s potential to eliminate distance barriers and to augment group work would seem far more compelling to society and likely to succeed than desktop productivity tools and hypertext” (Greenberg, 2007, p.141).

Greenberg’s criticism should not be applied to the feature set offered by most GSS. If anything, the opposite is true with the leading GSS product on the market, called GroupSystems1 (Austin, Drakos, and Mann, 2006). This suite’s electronic brainstorming module, for instance, boasts “19 configurable features, for a total of 524,288 possible combinations, which take up to a year to master” (Briggs, de Vreede, and Nunamaker, 2003, p. 49). Such rich functionality is typically wielded by professional facilitators (Selvin 2003), but for political and economic reasons the reliance on facilitators has become impractical—as noted by GSS field research veterans, de Vreede, Reinig, and Briggs (2002).

1.1.2 The case of electronic brainstorming (EBS)

As one of the more popular forms of GSS, EBS exemplifies the need for a holistic investigation into the technology’s low acceptance—one that looks beyond productivity (Dennis & Reinicke, 2004). So far the tendency has been to assess group performance through efficiency and effectiveness measures, including number of original ideas, decision time, degree of consensus, among others (den Hengst, Dean, Kolfschoten, and

---

1 GroupSystems, formerly known as Ventana Corporation, originated from the MIS research labs at the University of Arizona, which in turn have spawned much of the GSS academic research.
Chakrapani, 2006). Based on such measures, EBS can dramatically increase productivity of workgroups involved in ideation tasks, compared to the productivity in traditional, face-to-face (FTF) meetings (Massey & Clapper, 1995; Briggs, 2006). This is because a set of constraints inherent in face-to-face brainstorming limit its potential as an ideation method. Key are production blocking (the inability of group members to express ideas at the same time) and evaluation apprehension (the inhibition to contribute ideas due to fear of criticism, public speaking, etc.). These limitations are overcome by EBS, primarily due to its features for parallel and anonymous input (Potter & Balthazard, 2004).

EBS has resulted in an uninhibited flow of creative ideas, a more in-depth evaluation of proposed solutions, a reduction in decision time, and an improved group consensus (Dennis, Valacich, Connolly, and Wynne, 1996). As it allows for geographically groups to brainstorm quickly, EBS has established itself as one of the most popular forms of GSS (de Rosa, Smith, and Hantula, 2005). The system essentially circulates individual ideas around computer workstations, where each participant expands on someone else’s idea, argues with it, or generates a completely new idea (Dennis & Williams, 2002). A large upper window usually displays the entire list of ideas, and a smaller one below it is used to type new ideas (Martz & Shepherd, 2004). Once an idea is entered it becomes available for viewing by other group members in a shared space that appears in a section on the monitor in each workstation. GroupSystems’ EBS module, for instance, rapidly exchanges a series of discussion sheets to promote quick bursts of creative thinking. Another of its modules allows participants to drag ideas into desired categories that are displayed as buckets; in another, users can rate ideas using a variety of scales (Groupsystems.com).

The above-mentioned performance increases in EBS have rarely been accompanied by commensurate increases in participant satisfaction (Briggs, de Vreede, and Reinig, 2003; Reinig & Shin, 2002). The general preference exhibited by team members to meet face to face rather than electronically makes sense. Verbal brainstorming sessions at the product design firm IDEO, for instance, serve as a type of ‘status auction’ among designers and engineers. Not only are these sessions instrumental to professional growth, they are also perceived as one of the most enjoyable of work activities (Sutton & Hargadon, 1996; Kelley, 2001). In contrast to such conditions of high social comparison, consider the typical EBS interface, which displays
a flurry of anonymous ideas in a large document, “lost in a sea of information” (Dennis & Reinicke, 2004, p.7). Consider, as well, that failure to adopt the LotusNotes GSS in a management consultancy has been attributed to lack of incentive to share one’s best ideas if they were going to be pooled and seen as common (Orlikowski, 1992). A number of experimental studies in social psychology have also shown how in conditions of identifiability and evaluability group members are less motivated to participate (Weldon & Mustari, 1988; Harkins & Szymanski, 1989; Paulus, Dugosh, Dzindolet, Coskun, and Putman, 2002).

1.2 Objectives

1.2.1 Research questions

The reasons behind such lackluster experiences with collaboration technologies merit further investigation. Despite the importance of meeting satisfaction as a key indicator of IS success, the construct has had different connotations in the literature (Briggs, Reinig, and de Vreede, 2008). Further, although satisfaction has been examined in many GSS studies, there is a dearth of research on what actually causes various types of satisfaction in GSS meetings (Dennis, Venkatesh, and Ramesh, 2003; Paul, Seetharaman, and Ramamurthy, 2005). A better theoretical understanding of how to foster electronic meeting satisfaction generates useful implications for organizations seeking to enhance the long-term success of their work teams.

Technology’s limitation in supporting rich social presence is one obvious factor undermining GSS meeting satisfaction (Paul, Seetharaman, and Ramamurthy, 2005). This does not adequately explain, however, why systems that have been judged to be useful and easy to use, have still left users feeling dissatisfied from the GSS meeting (Reinig, Briggs, Shepherd, Yen, and Nunamaker, 1995). After all, according to the respected technology acceptance model (Davis, Bagozzi, and Warshaw, 1992) perceived usefulness and ease of use are the key determinants of user intention to adopt an information system.

According to Wixom and Todd (2005), two dominant approaches have been used in investigating the value of an IS: the technology acceptance model (TAM) approach (Davis, 1984) and the end-user satisfaction approach (Bailey & Pearson, 1983). Studies
using the latter have primarily utilized measures of system characteristics and
information content (Wixom & Todd, 2005). (Refer to Appendix A for details.) Such
emphasis on the medium, at the exclusion of psycho-social dimensions of teamwork, is
one reason to base this thesis on the technology-agnostic meeting satisfaction literature.
Researchers Briggs, Reinig, and de Vreede have been particularly active in this domain,
which includes meeting satisfaction in GSS contexts. At the same time their approach
may benefit from infusing a TAM perspective. Very few studies have explored similar
integrations. Dennis, Venkatesh, and Ramesh (2003) proposed a model aiming to
integrate collaboration technology within a TAM framework, but satisfaction was not
examined in that research. Hence the main theoretical objective in this thesis to build on
Briggs, Reinig, and de Vreede’s goal-attainment model by testing it with constructs
shown to have explanatory value in the formation of user attitudes as per the TAM
approach.

The discrepancy between a cognitive attribution of utility (a judgment) and the
affective arousal with respect to the meeting (an emotion) observed by Briggs, Reinig,
and de Vreede, has led these researchers to advance their goal-attainment theory of
meeting satisfaction. It operationalizes meeting satisfaction as an affective arousal with
respect to meeting outcomes and meeting process, and posits these two responses to
be a function of perceived net value of goal attainment (PGA) from a meeting. The
theory has been supported by several empirical studies in verbal FTF as well as co-
located GSS contexts. To what extent this model holds in the context of virtual
teamwork (i.e. web-based GSS) is not as clear; herein lies the first research question in
this dissertation.

The causal construct of Perceived Goal Attainment, however, is a high order
construct that does not tell us what actually constitutes a valued goal to a participant.
Thus, as a more original and challenging objective, this research also investigates what
motives actually constitute PGA in GSS meetings. Unravelling the complexity of
individual goals in relation to group goals, and utilitarian versus hedonic values in
teamwork, should improve researchers’ ability to successfully hypothesize about the
effects of various technological structures on meeting satisfaction.

Based on a motivational framework outline in Chapter Three, this thesis proposes
and tests several antecedents in place of PGA, testing their relationship to satisfaction
with outcomes and with process. Hence the following research questions:
First, what role could a ‘social utility’ construct play in predicting satisfaction with meeting outcomes (SO)? To facilitate this inquiry, perceived instrumentality is conceptualized and tested as an antecedent to SO.

Second, what role do hedonic constructs play in predicting GSS meeting satisfaction? Perceived task enjoyment (ENJ) is tested as an antecedent to satisfaction with process (SP), and a system design characteristic—perceived interface design aesthetics (DES)—is tested as a predictor to ENJ. Perceived ease of use is (EOU) also explored in the proposed research model, representing a utilitarian aspect of system quality perceptions.

1.2.2 System design emphasis

To investigate the above-mentioned research questions, an experimental study was conducted with twenty virtual ad-hoc teams meeting online for a 20-minute idea generation and evaluation task using an original GSS interface. The latter constitutes a secondary but key practical contribution of this thesis from a managerial and system design perspective.

Empirical studies of GSS meeting satisfaction have so far mostly used lab-based, artificial interventions. These have ranged from confederates positively evaluating individual team members (Connolly, Jessup, and Valacich, 1990) to real-time graphs of group productivity rate in comparison to some average (Shepherd, Briggs, Reinig, Yen, and Nunamaker, 1995-6). Other studies, on the other hand, did not measure satisfaction. Jung, Schneider, and Valacich (2005), for instance, measured productivity but not satisfaction, thus presuming that the experimental intervention “satisfied high performers’ innate feedback-seeking behavior” (Jung et al., 2005, p.4). Yet another limitation noted by these researchers was that participants—having realized the performance feedback mechanism displayed merely the quantity of their input—started to submit lower quality ideas. This limitation is also worth addressing, for idea quality is considered the most important indicator of group brainstorming performance (Barki & Pinnonseault, 2002).

A system design emphasis may seem peripheral to meeting satisfaction. Yet bear in mind that as far as the user is concerned, an information system acts like a ‘black box’; its interface represents the sole portion that is tangible and meaningful (Venkatesh & Ramesh, 2006). Still, most studies of GSS interfaces have been qualitative, lacking
the empirical rigor of positivist IS tradition. With a focus on system design alongside the above-mentioned theoretical research questions, this dissertation falls within the human-computer interaction (HCI) rubric of management information systems (MIS). It can be considered trans-disciplinary as it infuses an engineering perspective into the sciences of group psychology and information systems. To borrow an analogy given by Briggs (2006), a scientist would ask: What causes people to feel satisfied in technology-supported meetings? An engineer, on the other hand, would ask: How can we use technology to invoke these causes of satisfaction? Both of these perspectives are adopted by this dissertation.

1.2.3 Thesis structure

The remaining background sections of this chapter provide necessary concepts and definitions with respect to the group behaviours and technology artefacts under investigation. Following this background is Chapter Two with the theoretical foundation of this study. Reviewed are different perspectives of operationalizing and explaining meeting satisfaction, a proper review of TAM, all leading up to the first three ‘baseline’ hypotheses. The remaining hypotheses are developed in Chapter Three, which conceptually builds on the theory presented in the previous chapter. Reviewed here are theories of social comparison, teamwork motivation. The next two chapters present the methods and equipment used to test the propositions outlined. Chapter Four presents the research design and measures, recruitment and group formation procedures, task structure, protocol, and others. Given the special emphasis on system design in this dissertation, the experimental manipulation and technology used are thoroughly discussed separately in Chapter Five. Quantitative and qualitative results from this study appear in Chapter Six. Descriptive statistics are presented first, and discussed alongside the manipulation checks. The measurement model is presented next, supported by data from the factor analysis, and is followed by the structural equation model tested with the PLS technique. After the hypothesis testing, the chapter ends with qualitative data from the open-ended question responses and generated group session transcripts. Chapter Seven provides a discussion of the study’s results, in line with the research questions posed in the Introduction. The limitations and recommendations for future research are presented next, concluding with implications for theory and practice. A bibliography and appendices section appears at the end of this dissertation.
1.3 Background

1.3.1 Satisfaction from GSS meetings

Group collaboration outcomes have most broadly been classified as either task or group-related (McGrath, 1984). Group-related outcomes, which are completely outside the scope of this study, range from objective measures of group consensus about a particular task, to long-term assessments of group-wellbeing and team spirit (Dennis & Reinicke, 2004). Measures of a group’s attitude toward its work environment are also at the group-level of analysis, even though they are usually self-reported, perceptual measures (Mason & Griffin, 2002). Task-related outcomes, on the other hand, are about the results from a particular session. These, in turn, may be production-related and observed measures, such as time to reach a decision or quality of ideas generated. Task outcomes may also be participant’s subjective assessments of these performance measures, or of their individual satisfaction with the meeting outcomes or process used. A meta-analysis of GSS studies from the last two decades found that more than one quarter of all hypotheses (280 of 1,103) included meeting satisfaction (Fjermestad & Hiltz, 2000).

Although second to productivity as the most-popular measure, satisfaction is considered a key predictor of GSS repeat system use—regardless of the productivity gains that may be realized (Kahai, Avolio, and Sosik, 2003). In laboratory as well as field studies, GSS use has dramatically increased effectiveness and efficiency of workgroups involved in idea generation and evaluation (Massey & Clapper, 1995; Briggs, 2006). Yet, these performance increases have not usually been accompanied by increased satisfaction (Barclay, Higgins, and Thompson, 1995; Briggs, de Vreede, and Reinig, 2003; Reinig & Shin, 2002).

GSS treatments that produce higher levels of productivity have even resulted in lower scores of meeting satisfaction (Connolly, Jessup, and Valacich, 1990; Kerr & Murthy, 1994). A meta-analysis by Shaw (2002) revealed mixed impact from GSS on outcome and process satisfaction. Almost no evidence was found that satisfaction in GSS groups was higher in comparison to unsupported, face-to-face (FTF) groups, with the exception of field studies of GSS idea-generation tasks (Shaw, 2002). Similar results are reported by Kerr and Murthy (2004), who examined GSS satisfaction with a realistic business-consulting task that required idea generation and evaluation.
Participants in the GSS groups were generally less satisfied with their team experience, and with their team’s list of client recommendations, than participants in FTF groups (Kerr & Murthy, 2004).

1.3.2 Defining GSS

Use of information systems to support collaborating knowledge workers dates back to the early eighties (Michinov & Primois, 2005). Such information and communication technologies (ICT) have often been dubbed groupware: an umbrella term for software that supports people engaged in a common task by providing an interface to a shared environment. Groupware includes various teleconferencing applications, but of interest here are systems that go beyond communication and coordination. Simply called group support systems, or GSS, this type of software or web-based tool purposely alters interaction processes within groups, to optimize problem formulation, idea generation and evaluation, decision-making, and consensus building in workgroups. GSS assist such shared intellective tasks by creating, sustaining, and changing useful patterns of collaboration (George, 2003). GSS have more simply been described as “interactive systems that support meeting processes, and aid in electronic brainstorming and voting” (Srite, Galvin, Ahuja, and Karahanna, 2007, p. 535).

Some of the features supported by GSS are synchrony, restrictiveness, level of support, parallelism, and anonymity (Salisbury, Parent, and Chin, 2008). DeSanctis and Gallupe (1987) classified GSS into three levels. Level One GSS merely remove common communication barriers, using large screens for instantaneous and anonymous display of ideas, etc. Level Two GSS reduce uncertainty with features like automated planning and risk analysis, while Level Three GSS offer expert advice for customizing rules to be applied in the meeting.

GSS for idea generation tasks often go by the name of electronic brainstorming systems (EBS), while those geared toward decision-making are referred to as decision support systems (DSS). Related to DSS are negotiation support systems (NSS) (Lee, Kang, and Kim, 2007; Ackermann & Eden, 2005), although these tend to be used in specialized contexts like legal argumentation mapping (Kirschner, Buckingham, and Carr, 2003). NSS, like teleconferencing systems, are outside the scope of this thesis—as are systems for the support of specialized technical work. Computer-aided 3D design applications would be considered outside our scope, for instance. Group interfaces for
sophisticated information visualization have also been called creativity support systems (CSS), and are covered extensively in the literature of computer-supported cooperative work (CSCW) (Shneiderman, 2002).

GSS as covered in the IS field are used more for the support of relatively short-term problem-solving and decision-making teamwork (Connolly, Jessup, and Valacich, 1990; Leinonen, Jarvela, and Hakkinen, 2005). A self-managed group of dispersed knowledge workers formed ad-hoc to perform an information-processing task, has also been called a virtual team (Curşeu, Schalk, and Wessel, 2008). Virtual teams are formally defined as “a socio-technical system composed of two or more geographically or temporally dispersed persons collaborating interactively to achieve a common goal via electronic communication media” (Curşeu et al., 2008, p. 630).

The original GSS prototypes developed at the University of Arizona in the nineties were meant for co-located corporate settings (sometimes called ‘decision rooms’) but since then GSS usage has expanded to teams in geographically dispersed locations (Saunders & Ahuja, 2006). Increasing globalization has made virtual teamwork quite common in business organizations, governmental agencies, and educational institutions (McDonald, Weng, and Gennari, 2004). GSS are now used by managers working to solve an ill-defined problem, or by student groups completing a school project (Sarker, Sarker, Joshi, and Nicholson, 2005).

GSS sessions can range from half-hour real-time meetings to week-long discussions. All take place online. IBM has been using web bulletin boards for its Innovation Jam, a global and asynchronous brainstorming session for new product ideas with over 150,000 employees; NATO, on the other hand, recently held a synchronous electronic meeting of engineers from dozen countries to brainstorm on better anti-terrorism technologies (Jung, Schneider, and Valacich, 2009). All these examples notwithstanding (mostly coming from large North American organizations) the adoption of GSS has been sluggish (Agres, de Vreede, and Briggs, 2005; Dennis & Reinicke, 2004).

1.3.3 Task types

The range of work-related group tasks includes conferencing, presentation, joint authoring, idea generation, decision-making, scheduling, and others (Andriessen, 2003). Worthy of more investigation, however, are occasions when groups need to meet
because a task or problem requires greater effort and insight than a single individual can provide (Paulus, Dzindolet, Poletes, and Camacho, 1993). Professionals frequently interact in teams to generate ideas on how to solve complex or ill-structured problems (Voss & Post, 1988, Kraut, 2003). Such tasks abound in knowledge-based organizations like management consultancies, product design firms, and advertising agencies (Kerr & Murthy, 2004). Collaborative knowledge-work typically involves ideation: the process of deriving new concepts through free-association, analogies, and combinations of elements into new ideas that may be useful when addressing a problem or opportunity (Briggs, 2001).

Most group tasks can be situated on the widely-accepted taxonomy developed by McGrath (1984). Shown in Appendix K, the taxonomy classifies tasks into eight types according to a number of dimensions. Yet, for purposes of most GSS contexts, tasks usually fall into one of five types:

- **planning**
- **creativity**
- **intellective**
- **decision-making**
- **mixed motive**

Creativity tasks may also be referred to as idea generation or brainstorming, while decision-making is often called preference-ranking. These two task types, representing most GSS research plus the one presented here, shall be elaborated in the next section. Mixed motive tasks tend to be supported by systems that fall into the category of negotiation support systems (NSS), reviewed in the next section. Planning tasks, on the other hand, are often carried out via traditional media, such as email or teleconferencing, and are simply not of interest in this research.

Intellective tasks, as well, are not so typical in GSS research (Fjermestad & Hiltz, 2000). Unlike decision-making tasks, which require that group members align individual preferences to reach an agreement, groups in intellective tasks attempt to discover the one correct solution (Toth, 1994). This usually requires convincing with facts and logical arguments (i.e. *informational* influence), while in decision-making tasks arriving at
decisions is based on personal values and judgments (i.e. normative influence) (Nel, Pitt, Berthon, and Prendergast, 1996).

**Table 1. Contexts of group collaboration**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Key instances explored in GSS, and the foci of this thesis (shown in grey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place</td>
<td>Collocated</td>
</tr>
<tr>
<td>Time</td>
<td>Synchronous</td>
</tr>
<tr>
<td>Group size</td>
<td>Dyad</td>
</tr>
<tr>
<td>Group history</td>
<td>Ad-hoc</td>
</tr>
<tr>
<td>Interdependence</td>
<td>Additive</td>
</tr>
<tr>
<td>Facilitation</td>
<td>Practitioner-driven</td>
</tr>
<tr>
<td>Technology</td>
<td>None</td>
</tr>
<tr>
<td>Identifiability</td>
<td>Identified</td>
</tr>
<tr>
<td>Evaluability</td>
<td>In-group: auto display</td>
</tr>
</tbody>
</table>

Other typologies exist, as in Steiner (1972), whose four types of unitary tasks deserve mention. In additive tasks the group outcome is the sum of the individual contributions, as opposed to conjunctive tasks (where the group outcome is determined by the least capable member) but also disjunctive tasks (where the best performer determines the outcome). In discretionary tasks—the type deployed in this study—the group chooses how to weigh the contributions of its members in determining the group’s output.

Table 1 outlines additional dimensions of teamwork. The shaded cells serve to indicate (in some cases, tentatively) the type of task deployed in this study. Most tasks in practice are complex tasks involving not only a mix of the above in parallel, but also in sequence (Cheng, Li, and van de Walle, 2001; de Vreede, Briggs, and Reinig, 1999).

### 1.3.4 Brainstorming

Producing creative solutions to problems is a key outcome of teamwork (Paulus, Larey, and Dzindolet, 2001; Kerr & Murthy, 2004). Not surprisingly, idea generation is
acknowledged as an important stage in organizational innovation, and encompasses all techniques that structure and stimulate creativity in group work (Litchfield, 2008). Methods include Synectics, the Buffalo method, and deBono’s lateral thinking (van der Lugt, 2000). Brainstorming, however, has established itself as the most prominent method (Brown & Paulus, 1996; Dennis & Williams, 2001) and popularized by Osborn (1957), who formulated four rules of idea generation in groups. These rules are usually given in experimental sessions as the following set of instructions: i) do not criticize other people’s ideas; ii) be open to wild or unusual ideas; iii) generate as many ideas as you can, and iv) build and expand on other people’s ideas (Briggs, 2006). Participants are basically encouraged to voice or record as many ideas as possible, regardless of their practicality. A key rationale behind this method is that quantity usually breeds quality, and that exposure to others’ ideas (wild as they may be) could spark the generation of other, better ideas. Brainstorming is primarily verbal, as group members speak their ideas out loud, sometimes with the presence of a facilitator. Ideas may also be recorded in some form of group memory, like a flipchart. In some brainstorming practices group members may even sketch their ideas on Post-It notes, to be then pasted and organized (Palus & Horth, 2002).

The effectiveness of brainstorming has been studied extensively (Diehl & Stroebe, 1997; Fjermestad & Hiltz, 2000) with mixed results as to whether it is actually more productive than ‘nominal’ brainstorming, where individuals generate ideas on their own that are finally aggregated into a single group list. Outcomes from brainstorming have been measured in a number of ways: fluency, or the number of ideas generated; flexibility, the number of conceptual categories created; originality, the novelty of each idea; and usefulness, the practicality of a set of ideas (Barki & Pinnonseault, 1999).

The process of idea generation is about making new connections between familiar things, a process of divergent thinking (de Bono, 1957). Divergent thinking promotes the generation and sharing of as many different ideas and options as possible. In knowledge-based organizations, however, most tasks are not about merely coming up with ‘wild’ ideas. Large numbers of ideas is never the ultimate goal of a brainstorming session, but a limited number of good ideas to select for further development and, eventually, implementation (Rietzschel, Nijstad, and Stroebe, 2006). Convergent thinking is predominant in this phase, as groups funnel down and select among the available options, distinguishing between relevant and irrelevant ideas (Milliken, Bartel, and
Kurtzberg, 2003). For creativity to become innovation divergent idea generation must be followed by convergent idea selection (Nov & Jones, 2005). During ideation a team compares, rearranges, combines, reduces, and evaluates concepts, crafting a solution for a client (Kerr & Murthy, 2004). Thus, while Osborn’s formal brainstorming procedure is supposed to be devoid of judgment, some degree of evaluation is inherent in most brainstorming.

1.3.5 Anonymity vs. evaluability

A rich stream of empirical research has investigated the effects of anonymity in group collaboration environments (Jessup, Connolly, and Galegher, 1990; Valacich, Dennis, Jessup, and Nunamaker, 1992; Pinsonneault & Heppel, 1997; Pissarra & Jesuino, 2005). GSS, and especially EBS, by default do not identify participant contributions, to avoid the process loss resulting from evaluation apprehension. Anonymity has indeed been shown to promote the participation of timid individuals and the expression of unpopular opinion. On the other hand anonymity has also reduced motivation to contribute.

What adds to the complexity is that at least two different kinds of anonymity have been acknowledged by GSS researchers (Jessup, Connolly, and Galegher, 1990). Process anonymity occurs when the real-life identity of participants cannot be determined by direct observation of the process. Content anonymity occurs in the absence of embedded visual or textual representations linking the submissions that came from one contributor. If comments are marked or labelled, as well as linked to some virtual or real identity, conditions of identifiability result (Sylvester, 2000).

Whereas conditions of identifiability are usually instantiated by labels, usernames, icons, or avatars, evaluability stems from any feedback that relates participant or group performance to some subjective, objective, inter-group, intra-group, or external comparison standard. Jung, Schneider, and Valacich (2005), for instance, used an objective, within-group comparison standard, as a bar chart automatically displayed idea generation rates of each team member. In terms of identifiability, Jung et al. (2005) randomly assigned predefined usernames to group members in the experimental conditions. The anonymity level could thus be defined as pseudonymity, or virtual identities not obviously related to a specific group member. Overall, the enhanced identifiability-evaluability in Jung et al. (2005) led to significantly greater productivity
compared to groups brainstorming in anonymous conditions and without performance feedback.

In line with these lab experiments as well as several field studies (Stenmark, 2000; Sutton & Hargadon, 1995-6; Orlikowski, 1992), this thesis assumes that the advantages of anonymity should not be taken for granted in today’s more hierarchically-flat organizations. We thus take a deeper look at evaluability, rather than identifiability (or lack there of), and do so from a more qualitative point of view. This study therefore measures subjective rather than objective outcomes, and relies on content evaluability of contribution as its technological intervention.

1.3.6 Empirical studies of the GSS interface

The GSS interface has been compared to a porous barrier that constrains the information flow between individuals and the group and back (Roy, Gauvin, and Limayem, 1996). According to Dufner, Hiltz, Johnson, and Czech (1995) the challenge for designers is to imbue GSS with enough ‘richness’ to retain the information quality of the communication that exist in face-to-face contexts. Yet research on the interface aspect of GSS is scattered and fragmented. One stream explores usability aspects of interface elements like avatars and menus (Kang & Yang, 2006; Kim, Baker, and Song, 2007; Sia, Tan, and Wei, 1997), while another experiments with various facilitation and creativity cueing techniques (Santanen, Briggs, and Vreede, 2004; Garfield, Taylor, Dennis, and Satzinger, 2001). Some explore visualization in contexts of CSCL (computer-supported collaborative learning) (Janssen, Erkens, Kanselaar, and Jaspers, 2007). Cheng, Li, and van de Walle (2001) is one of the very few papers published specifically on the topic of voting in GSS, but the lessons offered are more conceptual than interface-related.

Only several EBS experimental studies rigorously examined the effects of different interfaces on collaboration outcomes. Dennis, Aronson, Heninger, and Walker (1997) compared a basic dialogue structure to one supported by a triple-window interface, where team members could start in one dialogue, add ideas, then switch to a new dialogue. This partitioning encouraged the development of different stimuli and improved performance by 50%. Splitting discussion into many dialogues, however, makes it harder for a group to converge to a consensus, observed Dennis et al. (1997).
EBS simulations predict that the more attention one pays to fellow members’ contributions, the better the group performance (Dennis & Williams, 2001).

Others have explored ways to reduce information overload in EBS. According to Chen, Nunamaker, Orwig, and Titkova (1998), the 30-line computer screen is a severe constraint for someone browsing hundreds of lines of text while trying to synthesize ideas. When moving from idea generation to idea organization participants may overlook as much as 80% of the potential solution space (Santanen, Briggs, and de Vreede, 2004). In a rigorous empirical study, Grise and Gallupe (1999-2000) measured cognitive load of participants from two GSS conditions. These researchers surprisingly found that mental workload was higher—and comfort lower—in the experimental treatment that automatically regulated idea generation. Very few studies of EBS interface have also measured satisfaction. One exception is Aiken, Rebman, and Vanjani (2007). They compared two EBS interfaces: pool vs. gallery writing, and generally found the latter to support better performance and satisfaction.

Most innovative deployments in the field can be found in a number of qualitative or CSCW studies (Speier, 2001; Swaab, Postmes, Neijens, Kiers, and Dumay 2002; Ackerman & Eden, 2005, 2008). The majority include graphically depicting ‘positions‘ of different participants in mixed motive tasks via multi-dimensional scaling techniques. Electronic deliberation via collaboratively built structures has also been proposed by Turoff, Hiltz, Bieber, Fjermestad, and Rana (1999) where nodes and links have attributes such as the degree of agreement on meaning about the concept.

In the EBS category of note is Brainstorm by Kratschmer and Kaufmann (2002), where color nodes allow each member to recognize her own ideation structure, and relate it to concepts that would be distant in her own cognitive network. Specifically for the advertising domain, Reesink (2004) presents a node-link map application that allows consumers to externalize their perceptions of a brand, while the “Ideaquarium” by Mengis and Eppler (2005) allows advertising agency staff to upload and rate ideas on a shared canvas using the aquarium metaphor.
2 Theoretical Foundation

2.1 The Satisfaction Construct

2.1.1 Operationalization

Satisfaction in a given situation is the sum of one’s feelings or attitudes toward a variety of factors affecting that situation (Bailey & Pearson, 1983). For consumer behaviour contexts, satisfaction has been regarded as a post-purchase evaluation of product quality, given pre-purchase expectations (Anderson & Sullivan, 1993). A ‘before and after’ assessment is also part of the conceptualization of satisfaction experienced by end-users of information technology (Chin & Lee, 2003; McKinney, Yoon, and Zahedi, 2002). Of interest here, however, are groups using a single interface at the same time.

The objects of satisfaction in technology-mediated meetings may be the outcomes, the process, the group, and the technology (Applegate, 2004). Not all researchers use this distinction. Hiltz and Johnson (1997) examined satisfaction with the system interface, with the system performance, and with the mode of communication. What complicates matters is that one sub-type of satisfaction may impact another. System satisfaction, for example, defined as the contentment of the group with the particular GSS application used (Paul, Seetharaman, and Ramamurthy, 2005), was found to impact satisfaction with the whole process. Despite the different approaches, most researchers agree that understanding the meeting satisfaction phenomenon requires an instrument addressing at least satisfaction with outcomes (SO) and satisfaction with process (SP) (Shaw, 1988; Briggs, Reinig, and de Vreede, 2002). Further, these measures should be kept distinct, argues Reinig (2003), giving examples of the possibility to be satisfied with a meeting outcomes yet not with the process, and vice versa². Another limitation of a general satisfaction measure is that the subject is uncertain of what is in the researcher’s mind when the question is set (Shaw, 1998).

² A dull policy session may produce an agreeable outcome for all (low SP, high SO); whereas in another group, dedicated team members may end up feeling proud they all did their best in a controversial meeting that actually failed to produce consensus (high SP, low SO) (Reinig, 2003).
Some studies of GSS meeting satisfaction, such as Nel, Pitt, Berthon, and Prendergast (1996) and Reinig (2003), have used the Green and Taber (1980) instrument for satisfaction with solution (an instance of SO) and with decision scheme (an instance of SP). This scale basically involves a cognitive attribution of utility. For SO, it asks for a judgment of the degree to which certain group requirements had been met as a result of the meeting. For SP, the judgment is about the extent to which the tools and procedures used in the problem-solving process were efficient, coordinated, fair, and understandable (Green & Taber, 1980). Table 2 outlines and compares these measures of meeting satisfaction (a judgment) to an alternative and more recent conceptualization of meeting satisfaction (as an emotion), by Briggs, Reinig and de Vreede (2006). It is defined as

*an affective arousal with a positive valence on the part of a participant toward a meeting, generating a good feeling about a particular group session*

Under this conceptualization of the meeting satisfaction construct—the one adopted in this thesis—such affective arousal might also be labelled as delight or elation when positive, whereas a negative valence like distress or frustration would denote dissatisfaction (Briggs, Reinig, and de Vreede, 2006).

### Table 2. Four dimensions of meeting satisfaction

<table>
<thead>
<tr>
<th></th>
<th>Emotion (Briggs et al., 2006)</th>
<th>Judgment (Green &amp; Taber, 1980)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO</td>
<td>Agree/disagree Likert scale</td>
<td>To what extent...</td>
</tr>
<tr>
<td></td>
<td>• I liked the outcome of today’s meeting.</td>
<td>• are you confident that the group solution is correct?</td>
</tr>
<tr>
<td></td>
<td>• I am happy with the results of today’s meeting.</td>
<td>• does the final solution reflect your inputs?</td>
</tr>
<tr>
<td>SP</td>
<td>• I feel good about today’s meeting process.</td>
<td>How would you describe your group’s problem solving process?</td>
</tr>
<tr>
<td></td>
<td>• I feel satisfied with the procedures used in today’s meeting.</td>
<td>• efficient–inefficient</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• fair–unfair</td>
</tr>
</tbody>
</table>
2.1.2 Affective arousal in meetings

Emotions are induced affective states that typically arise as reactions to important stimuli in one’s environment; they are one type of motives that energize and direct behaviours (Zhang, 2008, p.145). Studies in organizational behaviour, marketing, and management have confirmed the strong impact of affect on job satisfaction, decision-making behaviour, and consumer’s shopping behaviour (Sun & Zhang, 2006). An early study investigating the impact of affect on GSS adoption is Reinig, Briggs, Shepherd, Yen, and Nunamaker (1995-6). These researchers had observed many instances of users, who judged the deployed GSS to be useful and easy to use, but with which they nonetheless felt dissatisfied (Reinig et al., 1995-6). In one case executives from a Fortune 500 company had used a GSS for their annual tactical planning meeting. After accomplishing the task in considerably less time than they would have in traditional meetings, the executives were satisfied with the outcome quality. When questioned how they liked the GSS, however, the executives were unenthusiastic. Many found the session mundane; some were left feeling ‘flat’. Despite being productive, these participants were essentially reluctant to use the technology again.

Reinig et al. (1995-6) explain this phenomenon as lack of affective reward—a phenomenon that sometimes arises in face-to-face (FTF) meetings, yet is separate from satisfaction with outcome. While it may be associated with goal attainment, affective reward is in fact a result of the physiological arousal experienced during the meeting (Reinig et al., 1995-6, p. 171). Based on excitation transfer theory (Zajonc, 1965), the argument mentions how frequent occurrences in FTF meetings like table pounding and heated debates may lead to such excitement. The affective reward construct (measured with items such as, “It felt like we won” and, “We really accomplished something here today”) was not actually influenced by the experimental manipulation in that particular study. As the authors try to reason in hindsight, perhaps the goal was set too high, or affective reward is not an excitation transfer phenomenon, but a function of other factors like group cohesion (Reinig & Shin, 2002).

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3 The cited study employed the same research design as in Shepherd et al. (1995-6), which reported the productivity increases as a result of social comparison.
2.1.3 Individual goal attainment

A goal is an outcome that an individual wishes to achieve; it is a desired end-state (Locke & Latham, 1990). Individual goal attainment at its most basic level is the accommodation of things that help one survive and thrive in the environment (Briggs, 2008). In collaborative social contexts, of course, goals can be individual-based or group-based (Duivenvoorde, Kolfschoten, Briggs, and de Vreede, 2009). While we tend to make conscious efforts to fulfil our individual goals, our effort expended toward attaining group goals may be discounted by a variety of factors. One of these is goal congruence—the degree to which the group goal is compatible with the individual’s private goals (Briggs, 2007).

Just like the individual effort that is put into teamwork varies, so does the individual perception with respect to the teamwork outcome. Thus, relative individual goal attainment (RIGA) is the extent to which an individual’s preferences are congruent with the collective group product (Reinig, 2003). When group members disagree on their preferences for a proposal, resulting RIGA for some group members is likely to be lower, negatively impacting their resulting satisfaction. RIGA’s effect on meeting satisfaction was tested in Reinig (2003). SO and SP were measured with Green and Taber’s items for solution satisfaction (an instance of SO) and decision scheme satisfaction (an instance of SP). This instrument was appropriate in view of the strictly preference-ranking task employed, the Lost at Sea task. (Groups are given 15 items to consider, discuss and finally rank, in terms of their usefulness for assisting with survival while lost in a life raft in the Pacific ocean). Reinig (2003) concludes that participants succeeded in assessing their RIGA, and these assessments were the basis for differences in PGA, which in turn led to differences in SO.

2.1.4 The goal attainment model

Briggs, Reinig, and de Vreede (2003; 2006) derive their goal attainment model of meeting satisfaction from several axioms of goal setting theory regarding human behaviour (Locke & Latham, 1990). Specifically, it is assumed that we have evolved a variety of mechanisms of making automatic (and oftentimes subconscious) assessments with respect to goal fulfilment. Most notably, humans tend to:

4 In logical positivism, a theory’s axioms are simply accepted; they need not be defended but are advanced as a starting point for the logic that follows (Briggs, Reinig, and de Vreede, 2008).
• seek a manner of goal fulfilment in which benefits exceed costs incurred

• ascribe some level of utility to attaining a given goal, and assess the likelihood that this goal will be attained

• respond with affective arousal in perceived changes of the above

As shown in Figure 1, meeting satisfaction is a function of perceived net value of goal attainment (PGA) (Net value recognizes that individuals often seek to fulfil multiple goals, and that some of these may be competing or mutually exclusive.) Note that RIGA is an observed variable while PGA, SO and SP are perceptual variables. Further, while SO and SP are emotions, PGA is a judgment—an assessment of the perceived benefits expected from attaining the goals, minus the perceived costs of this fulfilment attempt. (Costs refers to the effort expended in this attempt, but also to the associated opportunity costs.)

Figure 1. The goal attainment model

Judgments of value and likelihood of attainment of meeting goals would take place from one time period to the next, for the duration of the task. When either value (utility) or likelihood of attainment (probability) with respect to an individual goal is perceived as being advanced by the results of the group effort, a positive meeting satisfaction
response is likely to manifest (Duivenvoorde et al., 2009). If, on the other hand, one’s assessment holds at a constant state from one period to the next, no affective arousal is likely to manifest in this duration. Satisfaction may actually manifest not only when outcomes match expectations or desires, but also when one advances toward a goal (Briggs, Reinig, and de Vreede, 2008). For all practical purposes we are interested in responses—that is, satisfaction responses indicated via reported survey responses—that take place at the end of a meeting. This ‘cost-benefit’ assessment in PGA is measured by items like, “The meeting was worth the effort put into”, or, “The value received justifies the efforts”. Refer to Chapter Five for the complete scale.

2.1.5 Testing the model

The model was tested and validated in a field experiment with American and Dutch teams (Briggs et al., 2006). Participants worked in 19 different groups ranging in size from 4 to 35. Although tasks varied, all were real world problems. In one instance ten airport employees discussed ways to speed up landing and takeoff strip maintenance with minimal impact on traffic flow. (All groups used the Work Group Edition GSS by GroupSystems.com.)

Reported results by the researchers show PGA to be very highly correlated with SO (.85), explaining 71% of its variance. Hence the first hypothesis in this study, which tests whether PGA will predict SO from an idea generation and evaluation task in distributed meetings.

**H1.** Reported levels of perceived goal attainment (PGA) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with outcomes (SO).

Results from the same study show that PGA’s influence on SP was also highly significant (.64), explaining 37% of the variance in SP (Briggs et al., 2006). Hence the hypothesis:

**H2.** Reported levels of perceived goal attainment (PGA) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with process (SP).
While the goal-attainment model also posits a SO→SP causal path, results in the above-mentioned study for this relationship were not as significant (.24), explaining only 7% of the respective variance (Briggs et al., 2006). Another concern with respect to this thesis are studies that found an inverse relationship. Indeed, SP was found to impact SO in Green and Paul (2002), consistent with procedural justice theory. People care about the process used to reach a decision in addition to the decision itself, note these researchers. Nevertheless, the following hypothesis will be formulated considering the theoretical rogour and presumed causality of our ‘baseline’ model by Briggs et al. (2002; 2006).

**H3.** Reported levels of satisfaction with outcomes (SO) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with process (SP).

Figure 2 graphically summarizes these hypotheses.

**Figure 2.** Hypothesized paths in the baseline model
2.2 Technology Acceptance Model

2.2.1 Basic tenets

The goal of TAM was to provide a general explanation of the determinants of end-user behaviour toward a range of computing technologies. The model was developed by Davis (1984) based on the theory of reasoned action (Fishbein & Ajzen, 1975). The latter posits a causal path from one’s beliefs leading to one’s behaviour, or beliefs $\rightarrow$ attitude $\rightarrow$ intention $\rightarrow$ behaviour.

From one’s interaction with a technology, TAM posits, an individual formulates a perception toward this technology. Behavioural intentions to use the technology (BI) can be predicted by two separate but interconnected variables: perceived usefulness (USE) and perceived ease of use (EOU). This central tenet of TAM has been shown to explain about 50% of the variance in acceptance levels for many routine office applications (Sun & Zhang, 2000). TAM is graphically depicted in Appendix A.

USE is the belief that using a technology will enhance an individual’s job performance. In countless studies, USE has positively and significantly correlated with BI. Whereas USE is an outcome-expectancy variable, EOU—the extent to which using the technology is perceived to be free of effort—is a process-expectancy variable (Koufaris, 2004). Less important than USE, EOU has also been shown to be critical in a wide variety of technologies (Sun & Zhang, 2006). Via these USE and EOU pathways BI has been shown to predict actual technology usage. Actual usage is considered a surrogate of adoption; hence the latter’s omission in most studies.

Another construct oftentimes omitted is the mediator to BI, or attitude toward use (Aact), defined as the “user’s positive or negative feelings—or evaluative affect—toward some behavior (Malhotra et al., 2008, p. 274). Despite being frequently bypassed in TAM studies, Aact can be considered the link between TAM and the model of meeting satisfaction underlying this thesis. Of course, TAM focuses on predicting intentions to perform a future behaviour (technology use), rather than predicting resulting satisfaction from technology-supported group and work-related contexts. Nevertheless, TAM studies cited in this study will be those exploring the ‘front-end’ or antecedent relationships in TAM: determinants to USE and EOU and the latter’s impact on attitude formation.
2.2.2 Augmented TAM

Determinants to beliefs such as USE and EOU found to play a role have included user and task characteristics (Burton-Jones & Hubona, 2006). Affective qualities of the system interface have only recently been found to play a similarly significant role in the formation of overall usage attitudes. This line of research is worth pursuing. For we know that a system can be used for both utilitarian and hedonic reasons, as users can be driven by both internal and external loci of causality (Sun & Zhang, 2006).

Utilitarian systems aim to provide instrumental value to the user, and are aimed at outcome-oriented tasks. When performing such tasks users are said to be driven by an external locus of causality, performing an activity in as much as it is instrumental for achieving valued outcomes (such as pay and promotion). Such activities are said to be extrinsically motivated. Hedonic systems, on the other hand, aim to provide self-fulfilling rather than instrumental value to the user; they focus on the fun aspect of usage, and encourage prolonged rather than productive use (van der Heijden, 2004). As in playing a video game, users are said to have an internal locus of causality, and are typically said to be intrinsically motivated. Intrinsic motivation refers to performance of an activity for no apparent reinforcement other than the process of performing the activity per se (Davis et al., 1992, p. 1112). For hedonic systems perceived enjoyment and perceived ease of use are stronger determinants of intentions to use than perceived usefulness (van der Heijden, 2004).

The distinction between productivity-oriented (utilitarian) and pleasure-oriented (hedonic) borders on the related issue of intrinsic vs. extrinsic motivation. Thus a recent investigation by Malhotra, Galletta, and Kirsch (2008) looks beyond the dichotomy of extrinsic versus intrinsic motivation (EM–IM). Drawing on organismic integration theory (Deci & Ryan, 2002), Malhotra et al. (2008) describe the endogenous and exogenous dimensions of both EM and IM. One instance of IM is video game-related enjoyment. The pleasure from such a sensory-stimulating activity is derived from an external technology artefact; hence its exogenous dimension. In contrast, one instance of exogenous EM is working for pay—for an external reward. Both of these examples are exogenous with respect to users’ locus of causality. Endogenous motivations, on the other hand, are not driven by external artefacts. The latter can only serve as affordances for satisfying either internal self-development needs (endogenous IM, like learning activities) or social norms that have been internalized as personally meaningful.
(endogenous EM, as ‘good employees don’t play computer games at work’).

Endogenous motivations, according to Malhotra et al. (2008) “broaden our view of performance from the narrow satisfaction of external instrumental contingencies to seeking self-development, growth, and fulfilment” (p. 275). Such motives, in the researcher’s study of students using a web-based educational IS, turned out to be the strongest predictors of attitudes toward using a technology.
3 Extending the Research Model

3.1 The Role of Perceived Instrumentality

3.1.1 Social comparison and collective effort

Social comparison theory (Festinger, 1954; Suls & Miller, 1977) posits that people generally tend to compare themselves to others. Social comparison in group performance settings entails assigning a value that is a joint function of one's own performance and that of referent others. Individualistic motives for such comparisons include the goal of positive self-evaluation and self-esteem maintenance. There is often a degree of uncertainty about our abilities that we seek to resolve through positive confirmations, usually by comparing to those close to us in ability (Munkes & Diehl, 2003). In line with this theory, studies have shown that group collaboration environments without some form of performance feedback tend to leave participants insecure about their contribution, possibly leading to the lower reports of satisfaction (Barr & Conlon, 1994; Paulus et al., 2002). GSS studies that enhanced conditions of social comparison via performance feedback (Connolly et al., 1995, Shepherd et al. 1995-6, Jung et al. 2005, Michinov & Primois, 2005) have induced a sense of inter-group or intra-group competition, leading to performance gains. With their bar chart display of members’ rate of contributions, Jung et al. (2005) is perhaps the most relevant example of motivation increases in group idea generation via lightweight modification of the GSS interface in order to induce positive social comparison processes. A more recent analysis of the same data even found that goal-setting by itself was ineffective, and that in anonymous contexts it actually lowered productivity (Jung et al. 2008).

Such effects can also be explained by the socio-cognitive model of brainstorming proposed by Brown and Paulus (1996), shown top of Appendix C. On the bottom side of the same appendix, on the other hand, appears a more general social psychology theory, the collective effort model (CEM) by Karau and Williams (1993). What this model better explains are the reasons and magnitude of motivation losses that occur in groups when individual efforts are not identifiable and evaluable (Latane, Williams & Harkins, 1979; Harkins & Szymanski, 1987). The phenomenon, also known as social loafing,
been observed in over 200 group studies (Karau & Williams, 1993) and found to be robust across settings and age (although somewhat lower for females and members of Eastern cultures). The dimensions of social loafing and collective effort are well illustrated by Kerr and Bruun (1983). In conditions of low identifiability or evaluability, slackers may ‘hide’ in the crowd to avoid taking blame for their low performance; achievers feel ‘lost’ in the crowd, unable to receive credit for their high performance; and the average group member ‘free-rides’, feeling his or her input is not essential to a high-quality group product. Put another way, individuals exert effort on a collective task according to the degree that they expect their efforts to be instrumental in obtaining valued outcomes (Price, Harrison, and Gavin, 2006).

3.1.2 Perceived indispensability of contribution

So far we have seen how motivation to perform is much dependent on identifiability and evaluability of individual performance. But there are some additional aspects of how perceived value of one’s performance relates to the performance of others as well as to expected group outcomes. For one, there is little reason to contribute when individuals believe their contributions are redundant with those of fellow group members (Cheng & Vassileva, 2001). This brings us to the conceptualization of perceived indispensability of contribution as in Hertel, Deter, and Konradt (2003) and Hertel, Niemeyer, and Clauss (2008). In these lab experiments, plus in at least one field study (George, 2003), this construct has been found to correlate with performance. Similarly, performance appears to be a function of perceptions of contribution criticality in social dilemmas (Hertel et al., 2008), and of contribution uniqueness in online discussion forums. In Cheshire and Antin (2008) a mere ‘gratitude’ intervention in the form of a Thank You note was not as effective a motivator as a percentile that ranked the community member’s contribution in relation to others.

A number of interaction effects from individual, group, and task characteristics may confound the above-mentioned correlations. Group size, for instance, negatively influences perceptions of indispensability for obvious reasons, just as evaluation apprehension will negatively impact motivation to contribute. Nevertheless, on average, it seems reasonable to conclude that individual performance in meetings is a function of the beliefs that one’s contribution is: i) identified at least in content (if otherwise anonymous); ii) evaluable according to some (intra-group or external) comparison
standard; iii) indispensable or unique relative to that of others. We aggregate these motives for a teamwork context into the following proposed conceptualization for perceived instrumentality (INS)

_The level of importance that a meeting participant ascribes to his or her performance in the meeting toward achieving valued group outcomes_

The proposed measure of this construct includes items using terminology from the above discussion, such as essential input to the team outcome, and unique contribution to the task. Six items are proposed and tested in this study, and appear in the instrument section in Chapter Four.

3.1.3 The goal of being instrumental

At this juncture, the following logical argument is presented. Assuming that perceived instrumentality (INS) positively relates to performance motivation (as argued in the preceding sections) it follows that INS must be perceived to some extent as a motive in teamwork, i.e. a valued individual goal in meetings.

INS can only be an individual goal. Yet its value may exist separate from group outcomes (as when actual quality of group product is low but you know you were appreciated as a ‘fighter’). Furthermore, even though INS can only be a valued goal for the individual and not for the group, its value stems from both self- as well as social identity motives. Self-identity is derived from one’s unique attributes; social identity is about the roles we fill in a group and how well these are performed. This duality gives INS a potentially double importance, as it may serve self-evaluation and/or social utility (i.e. impression management) needs. Put another way, INS refers to one’s own assessment of his or her performance toward achieving the group goal, as well as to peer assessments as to this performer’s instrumentality. Such ‘social utility’ motives, of course, are likely to depend on individual, group, and other characteristics. And yet, INS could be held dear by members with differing personality traits. To use a stereotypical yet still relevant example, an individualist male could easily value demonstrating one’s leadership potential, whereas a collectivist female might aim to not let her group down.

These and other motives are elaborated in Table 3. It includes sufficient reasoning to suggest that INS may be salient enough to the average meeting participant and is thus perceivable as a valued goal in itself.
First, note that an instance of exceptionally high instrumentality is likely to be ‘at the expense’ of others, but at the same time others’ low performance is a prerequisite for the high performer’s instrumentality to stand out. One can nonetheless assume that low performers risk losing in social comparison processes, negatively affecting mood and self-worth (Kemmelmeier & Oyserman, 2001).

**H4.** Reported levels of perceived instrumentality (INS) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with the meeting outcomes (SO).

### 3.1.4 Connecting motivation with satisfaction

The last section of Chapter Two reviewed the ‘intrinsic–extrinsic’ and ‘exo–endogenous’ dichotomies by Malhotra et al. (2008). A reframing of this framework as it appears on the respective paper (p. 272) leads to a useful illustration of how motivation related to satisfaction—as they may apply to GSS contexts. The resulting matrix in Table 3 aims to shed light on how these concepts could be linked, something prior studies in GSS have not ventured to propose. Jung, Schneider, and Valacich (2005), for instance, measured productivity but not satisfaction, merely presuming that the experimental intervention “satisfied high performers’ innate feedback-seeking behavior” (Jung et al., 2005, p.4)

### Table 3. Satisfying needs, motives and values

<table>
<thead>
<tr>
<th>Value</th>
<th>Type</th>
<th>Mechanism</th>
<th>GSS illustration</th>
<th>Constructs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tangible utility</td>
<td>exo–EM</td>
<td>Pursuing concrete external rewards (pay, promotion)</td>
<td>Prize congruent with own performance; enhanced by status-seeking motives</td>
<td>EOU, SO</td>
</tr>
<tr>
<td>Social utility</td>
<td>exo–IM</td>
<td>Social rewards like praise may satisfy need for belonging</td>
<td>Belonging enhanced by perceptions of shared goal and task interdependency</td>
<td>INS, SO</td>
</tr>
<tr>
<td>Self–hedonic</td>
<td>endo–EM</td>
<td>Engage in optimal challenge to satisfy competence need</td>
<td>Learn new (class) material, master new tools, self-evaluate creative ability</td>
<td>ENJ, SP</td>
</tr>
<tr>
<td>Senso–hedonic</td>
<td>exo–IM</td>
<td>Sensory stimulation to satisfy innate pleasure-seeking</td>
<td>Have fun with group around technology (a valued goal for diversion-seeking students!)</td>
<td>DES, ENJ</td>
</tr>
</tbody>
</table>
3.2 The Role of Hedonic Motives

3.2.1 ENJ → SP

MIS researchers have traditionally regarded user enjoyment on the job as wasteful (Dennis & Reinicke, 2004). This view is limited, as the preceding discussion on collections of motives has tried to illustrate. Most recently, some researchers have made great strides, at least conceptually, in arguing for a less normative view of work (Malhotra et al, 2005-6). Combining goals, challenge, and feedback may produce an ‘energizing mixture’ (Zhang, 2008) that is reminiscent of flow—a state of such complete absorption in the activity that one would even perform it at a cost (Csikszentmihalyi, 1996). The argument has yet to be applied to teamwork contexts. Yet, as we have seen from studies like Sutton and Hargaddon (1995-6) and Jung et al (2005), perhaps it should be. Even if social competitiveness is lacking, however, one may also compete with the self. Self-based ‘mastery’ goals focus attention on developing competence with the task at hand (Zhang, 2008). The need for competence arises from people’s desire to use their skills for mastering optimal challenges.

Such a Inner-hedonic motive (as per Table 3) was inherent under the construct of involvement examined in solitary decision-making IS contexts by Hess, Fuller, and Mathew (2005-6). Their rigorous research model included an examination of the effects of involvement (INV) on process satisfaction (SP). INV was positively and significantly to—and explained as much as 60% of the variance in—SP. The strongest predictor of INV, on the other hand, was perceived playfulness, which in that study was an individual characteristic variable⁵.

Playfulness has also been examined as a system characteristic. Most notably, in Venkatesh (2000) users that underwent training sessions based on a fantasy game reported higher BI than users given traditional training sessions. An enhanced state of playfulness must have been created, making the training process intrinsically motivating to employees, argues Venkatesh (2000). As a system design characteristic, playfulness is quite similar to enjoyment (ENJ). The latter’s role in GSS contexts, however, has only

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⁵ Perceived playfulness has been defined as “the degree of cognitive spontaneity in micro-computer interactions” (Webster & Martocchio, 1992, p. 204).
been examined by Chin and Gopal (1995), who found that ENJ accounted for 15% of the intention to adopt a GSS.

All these robust hedonic effects warrant an examination of the extent to which ENJ will correlate with SP in the context of the current study. Further justification can be found in Table 3 by looking beyond the basic Senso-hedonic motive for insights as to how the Inner-hedonic motive as well as the Social-utility motive may transform enjoyment into satisfaction with process.

**H5.** Reported levels of perceived task enjoyment (ENJ) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with the process (SP).

ENJ and SO will be examined only tentatively. Considering the Hedonic motive in Table 3, meeting participants may very well perceive value in undergoing an affective state whenever possible. On the other hand, ENJ is clearly a process-related construct (Venkatesh, 2000) and thus more likely to impact SP than SO.

### 3.3 The Role of System Quality Perceptions

#### 3.3.1 Interface design aesthetics (DES)

According to Zhang (2008), information systems should provide motivational affordances. Affordances are the actionable properties between an object and an actor; when perceived, they allow actors to take actions that may satisfy certain needs (Norman, 1988). When technology use involves our motivational needs, we feel interested, attentive, and engaged. We enjoy the process, and “thus want more”, notes Zhang (2008, p.145).

Perceived aesthetics of the system interface is one example of an hedonic dimension found to play a role in consumer websites (Lavie & Tractinsky, 2004; Zhang & Li, 2004). Perceived aesthetics refers to the emotional appeal of the graphical user interface of an IS, or the degree to which an interface is considered pleasing to the eye. These perceptions are mostly determined by the choice of colors, shapes, typography, and layout—all parts of a construct that has also been termed perceived visual attractiveness by van der Heijden (2003). The concept has also been described in the
professional literature as visual design (Garrett, 2003). (The abbreviation DES will be used throughout to refer to this construct, with measures listed in Chapter Four.)

While much research has explored GSS interfaces (some of which is reviewed in Chapter Five) no such study tested a theoretical model with a system design-related latent construct. The following hypothesis aims to fill this gap, supported by findings for DES in general IS contexts. For instance, Cyr, Head, and Ivanov (2006) examined the role of DES in forming attitudes toward a mobile browsing service task, and included ENJ alongside USE in their investigation. The strongest relationship found was for DES→ENJ (.55); The DES antecedent in Cyr et al. (2006) explained as much as 43% of the variance in ENJ.

**H6.** Reported levels of perceived system interface design aesthetics (DES) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of perceived task enjoyment (ENJ).

### 3.3.2 Ease of use

EOU has been found to be critical in both utilitarian and hedonic systems (Davis, Bagozzi, and Warshaw, 1992; Venkatesh, 2000; van der Heijden, 2004). While in some of these studies, EOU has been found to predict ENJ, Sun and Zhang (2006) note that a temporal precedence between EOU and ENJ is hard to detect. In Cyr, Hassanein, Head, and Ivanov (2007), EOU's influence on ENJ was positive yet modest (.26). For our GSS contexts, the EOU→ENJ relationship will therefore be examined only tentatively. It seems more reasonable to hypothesize that EOU may be influenced by DES, as was the case for a mobile browsing task in Cyr et al. (2007).

**H7.** Reported levels of the system's perceived interface design aesthetics (DES) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of the system's perceived ease of use (EOU).

Finally, we examine EOU's impact on SP. In all Bruner and Kumar (2004) and Cyr et al. (2006; 2007), EOU directly influenced beliefs about the usefulness of the system and indirectly contributed to ultimate attitude formation toward the service as a whole. The connection of EOU to SP in GSS meeting contexts is easy to see. Like SP, which refers to the effectiveness of the tools and procedures used in the meeting. EOU is a
process-expectancy variable. Participants may not relate EOU to procedures, but its connection to the tools (i.e. the interface) should be clear. Thus:

**H8.** Reported levels of the system’s perceived ease of use (EOU) by participants in a GSS meeting will be positively and significantly correlated with their reported levels of satisfaction with meeting process (SP).

### 3.4 The Structural Model

#### 3.4.1 Situating the constructs

The schematic in Figure 3 is given as a framework to situate the proposed constructs in what could be considered a GSS activity system. In an activity theory framework (Gay & Hembrooke, 2004) a goal would be termed an *object* while a participant would be the *subject*. Such a perspective would embed the subject and object within a community of practice, which would be supported by rules, roles, and norms. Finally, mediating tools and instruments would be used in this activity system to perform actions and operations. The purpose of a GSS is to support the concerted efforts of the group toward a goal (Briggs, 2006).

**Figure 3.** An activity system perspective

<table>
<thead>
<tr>
<th></th>
<th>Hedonic Value</th>
<th>Utilitarian Value</th>
<th>Evaluative Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td>ENJ</td>
<td>INS</td>
<td>SO</td>
</tr>
<tr>
<td><strong>System</strong></td>
<td>DES</td>
<td>EOU</td>
<td>SP</td>
</tr>
</tbody>
</table>
The purpose of this framework is to justify the choice of these particular constructs at the possible expense of others. A research model should be parsimonious, covering as much ground as possible with the fewest number of constructs. Group cohesion, for instance, has been shown to impact meeting satisfaction. Had it been included in this research model, it would have occupied the top left, Group / Hedonic cell. (While its omission can be considered a limitation of this study, one reason for its exclusion was the choice of newly-formed groups.)

Satisfaction with meeting outcomes (SO) was defined as the affective arousal with respect to that which was created and accomplished in the meeting (Briggs, Reinig, and de Vreede, 2006). Consider what ‘that’ above may refer to. A meeting product by definition is always a group product. Even if what was created is not a tangible product such as a group proposal, but an individual-based impression management goal, it would still be a group-related, social identity product. So we situate SO between Group and Task.

Satisfaction with meeting process (SP) was defined as the affective arousal with the tools and procedures used in the meeting (Briggs, Reinig, and de Vreede, 2006). SP’s connection to System is obvious from this definition, via the term ‘tools’. Strictly speaking SP should also relate to Group, but considering the tentative nature of this framework, and for purposes of graphical presentation that is analogous to the goal-attainment model structure, here it is positioned below SO.

Perceived instrumentality (INS)—as defined by this thesis—is the importance that a meeting participant ascribes to his or her performance toward achieving valued group outcomes. The ‘dual’ (individual and group) nature of INS has already been discussed. To reiterate, INS is ultimately about perceptions; its value derives from one’s own perception of how well he or she performed plus one’s own perception of how others are likely to have perceived this individual’s performance with respect to the task. Based on the dual (individual and social) nature of INS, we position the construct between Group and Task. It is also position under Utility, for its utilitarian nature of INS should be almost self-evident by virtue of its definition including the term instrumentality.

Perceived task enjoyment (ENJ) was defined as the extent to which the task activity is perceived to be enjoyable in its own right, apart from any performance consequences (Davis, Bagozzi, and Warshaw, 1992). Unlike the majority of TAM studies that include an enjoyment-related construct, ENJ here refers to task rather than
to system (refer to the ENJ scale in Chapter Four) in an attempt to avoid cross-loading with the system perception constructs. (Hence its position in the Task (and under Hedonic, for obvious reasons.)

Perceived interface design aesthetics (DES) is defined as the aesthetic quality or visual attractiveness of the graphical user interface used for the task (van der Heijden, 2004).

Perceived ease of use (EOU) is the degree system use is perceived to be free of effort (Davis, 1984). EOU is a system perception like DES, yet clearly distinct from DES in its utilitarian and instrumental nature.

Figure 4. The Extended Structural Model

Note: Thin wavy lines indicate relationships to be examined as research questions
4 Methods

This Chapter provides details on the experimental design. The experimental manipulation via technology used in the sessions is described separately in Chapter Five. Details on the data analysis methods appear alongside the results in Chapter Six.

4.1 Research Design

4.1.1 Lab experiment or free simulation

While this study aims to apply the quantitative, positivist research methods in information systems (Jenkins, 1985; Briggs, Reinig, and de Vreede 2008), it can be considered trans-disciplinary with its infusion of a system design perspective into the sciences of group psychology and information systems.

Lab study with students is the most popular method in GSS research (Fjermestad & Hiltz, 2000). Despite obvious limitations of experimental designs using student volunteers, the method may offer higher explanatory power than field studies taking place in complex organizational contexts (Davis et al. 1992). In laboratory experiments the researcher has control over the random assignment of research participants to various treatment and non-treatment conditions, as well as over the manipulation of independent variables and controlling confounding variables.

As shall become evident throughout the remainder of this thesis, a number of limitations inherent in GSS research, plus several weaknesses of the current research design, compromise the rigor of internal control required for a proper lab experiment. Therefore this study should more accurately be classified as a free simulation experiment (Jenkins, 1985). In this methodology the researcher designs a closed setting to mirror the real world, and measures the response of subjects as they interact within the system. Events are determined by both the researcher and the behaviour of the participants and their interaction, as the values of the independent variables reflect the natural range of the subjects’ experiences (Straub, 1989).
A two-condition, between-subjects design was employed, manipulating only the GSS interface used. The two conditions differed only with respect to system design. Sessions were conducted using a GSS originally developed for this thesis. Specifically, one of the GSS interfaces included pictorial brainstorming in Phase 2, as participants could upload images in addition to submitting text. Participants using the more basic GSS generated ideas via text submission only. Except for this difference, both interfaces included the same features for evaluability: i) social proxies identifying contributions in all phases, ii) Phase 2 proposals restricted to one per member, and iii) graphical voting in Phase 3.

4.1.2 Data collection and analysis

Data collection was conducted over a ten-day period. The experimental sessions were synchronous and web-based, as participants interacted remotely, each from their own home via a high speed Internet connection. Participation was distributed, as each group member worked from his or her own home. They were randomly assigned to groups and then to conditions, forming 20 ad-hoc virtual teams (ten for each condition, with group size from six to eight).

Teams worked on a 20-minute idea generation and evaluation task. Members first brainstormed ideas in a chat dialog for ten minutes, then each team member took ownership of one text field to develop their own proposal. This convergent and evaluation phase took another ten minutes during which teams could still use the dialog window for discussion. Preference-ranking completed the task, as the number of individual ideas (by default equivalent to group size) was reduced to the top-three ranked proposals. This set would later be rated by two independent judges. Two teams with the most creative and workable proposals (one per condition) would be rewarded $30 per member. All participants were given course credit for participating.

The main unit of analysis in this study was the individual. Subjective measures were self-reported via the online post-experimental questionnaire. Two open-ended questions and group transcripts were analyzed qualitatively, but the main data analysis method employed structural equation modeling (SEM).

SEM is a multivariate technique combining aspects of multiple regression (examining dependence relationships) and factor analysis (representing unmeasured concepts with multiple variables) to estimate a series of interrelated dependence
relationships simultaneously. It is characterized by a structural model, or ‘path’ model that relates independent to dependent variables. Theory or prior experience usually allow the researcher to distinguish which independent variables predict each dependent variable. (Additional details on the data analysis methods is given in the next chapter.)

4.1.3 Participants

Using Business students in GSS research is particularly appropriate, as this population represents the future GSS users in a business organization (Dasgupta, Granger, and McGarry, 2002). This study recruited participants from a large undergraduate Business class, typical of a North American university. All 200 students were given the opportunity to participate outside of class time. The only requirement was a minimum of three years experience using an instant messenger application in English. Since the experimental task was a real-world marketing problem, course credit was given as incentive to participate in addition to the prize offered.

A preliminary class announcement described the general purpose of the study as part of a doctoral dissertation that investigated web-based group collaboration, and only briefly mentioning the nature of the experimental task. The entire class was then sent a recruitment email containing a one-page PDF attachment that described the study, and further provided a URL through which interested students could sign-up as participants. (The attachment included in this email is shown in Appendix D.) Upon visiting the sign-up webpage volunteers could select from either a morning or afternoon time slot, but for any day of the week (Monday through Friday) that the entire data collection process was conducted. Volunteers could thus select a session on the day of their preference, and were given the choice of a morning or afternoon session. Four sessions were planned for each day, two consecutive morning and two consecutive afternoon sessions, so that volunteers could be randomly assigned to the two conditions with the time slot they selected.

For instance, if both John and Jane signed up for a Tuesday morning session they might end up being both assigned to the 10 am session, which in turn could happen to be either condition A or B. Just as likely would be the chance that one of them would be assigned to the 10 am session, while the other would be assigned to the subsequent 11 am session (which would necessarily offer the other condition). This system aimed to maximize the randomness within the practical constraints imposed by students’
schedules. This is because students would be more reluctant to sign up for a session that might happen anytime within a five-hour time slot.

A reminder message was sent to all volunteers during the evenings, and in batches, to those who had signed up for any one of the next-day time slots. The timing of this reminder email was also important, to accommodate the contingency of last-minute changes. Indeed, on several occasions, some of the volunteers replied right back to the researcher, and either cancelled their participation, or requested another time slot. Thus, it was not until the early morning of each day that actual groups were formed and assigned a condition. Due to uneven time slot preferences, not all were selected by the same number of volunteers, which contributed to the unequal group sizes and greater gender imbalance than initially planned for.

After groups were formed for each two-hour time slot two email messages were sent out to two respective groups (teams) assigned to the first and second sessions. The only difference in these messages was the URL leading to one of the two GSS tutorials. Each participant received the actual instructions ten minutes before their session was going to start. Each URL led to a five-minute long Flash-based tutorial, leading up to the consent form. (The latter is shown in an appendix here as well.) At the bottom of the consent form was a button that, upon clicking, would indicate consent, as well as launch the login screen of the respective GSS interface in another browser window. Once there, participants had to type in a username of their choice, then click a button to actually join the group session in real-time.

Not all participants completed these steps at the same time, and arrived in the chat room one by one over a period ranging from roughly one to four minutes. The arrival of each group member was visible to all participants that were already logged in. Group members identifiers in the GSS consisted of the username each of them had typed in during login; these appeared right below an icon that was automatically assigned based on the time of login relative to preceding group members. (These icons are discussed in detail in Chapter Five.)

Each session could accommodate a maximum of eight participants. No session commenced unless at least six participants were logged in and appeared to be successfully interacting with the interface. The researcher officially started the session from his own interface, which set off the timer, but also locked the chat room so that any latecomers would not be able to join the session. (It was deemed that such latecomers
would not be exposed to the same experience as the rest of the group.) Participants were told they should generate ideas for 20 minutes, then spend a minute or two at most voting on their team's three best ideas. They were also instructed about the brainstorming procedure, as well as the prize involved.

Table 4 lists age, gender and group breakdowns. Web chat experience reported ranged from five to 11 years, with a mean of 5.8.

<table>
<thead>
<tr>
<th>Age</th>
<th>21.8 (Mean)</th>
<th>19–23 (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male / Female</td>
<td>73 / 53</td>
<td>58 : 42 (%)</td>
</tr>
</tbody>
</table>

| PIC (male / female) | 64 (37 / 27) |
| TXT (male / female) | 62 (36 / 26) |

Table 5. Groups per size and condition

<table>
<thead>
<tr>
<th>Group size six</th>
<th>Group size seven</th>
<th>Group size eight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants (total #)</td>
<td>47</td>
<td>30</td>
</tr>
<tr>
<td>Groups in PIC</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Groups in TXT</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Average group size in the study was 7.3, ranging from six to eight as shown in Table 5. Researchers have frequently used unequal group sizes in GSS lab studies (Dennis & Garfield, 2003; Karahanna, Ahuja, Srite, and Galvin, 2002). Briggs, Reinig, and de Vreede (2006) even had a rather wide range of ten to thirty. For this study it was deemed that seven was the ideal group size for a virtual team, being on the threshold of small (3-6) and medium-sized groups (7-15) (Fjermestad & Hiltz, 2000). Groups were ‘over-recruited’ with one member, to accommodate the lack of control in distributed settings. Eight-member groups were therefore accepted, when everyone signed up for a session slot successfully joined the group. No session started unless at least six participants had joined, however.
Of all 150 students that signed up for the study, 143 successfully joined and completed their GSS session. The final data points were lower than 143 as several participants dropped out from their groups for technical reasons⁶; a few others were excluded from the analysis due to incomplete questionnaires. 126 observations remained, consistent with prior GSS studies. For reference, the 159 student subjects in Reinig (2003) were aged 19 to 23, and were assigned to teams that averaged 6.2 participants per group.

4.1.4 Session structure

**Group interaction** First, distributed rather than collocated settings were employed given the interest in virtual teams, but additionally also to minimize any artifacts arising from social presence. Second, naturally occurring interaction between team members was allowed in the brainstorming chat. Laboratory research often suppresses all social aspects of group interaction, but this practice may not be desirable in organizations (Dennis & Reinicke, 2004; Litchfield, 2008). The importance to freely elaborate in brainstorming sessions has been argued in de Vreede, Reinig, and Briggs (1999). Litchfield (2008), as well, observes that a prohibition against evaluation (in line with Osborn’s rules) would stifle expressions like ‘Wow, that’s great, have you thought about...’, which could aid incubation while preserving individual credit for the initial idea (Litchfield, 2008, p. 653). Thirdly, sessions were minimally-facilitated, in line with the system design objective stated in Chapter One. The researcher participated like a technical assistant as per Dufner, Hiltz, Johnson, and Czech (1995), answering only procedural problems. Details of the task process and the three phases are given in Appendix I, which also includes the experimental protocol. The following steps serve as a summary of the experimental sessions:

- **Five minutes before announced start time, recruited subjects receive email with full task description and URL leading to GSS.**

- **On the hour, participants begin self-paced GSS tutorial (shown in Appendix G), leading to Consent Form (shown in Appendix I). After indicating agreement, participants wait until five minutes after the hour to join group**

---

⁶ Otherwise, no serious lags with respect to typing were experienced throughout sessions.
session. Participants log in to GSS individually from different locations. At login screen each types username of choice and upon joining chat room is also randomly assigned ‘dice’ icon.

- **Session begins ten minutes after the hour, with a three-phase task:**
  - Freeform brainstorming in chat dialog window (10 min);
  - Submission and editing of individual proposals in Ideacells (10 min);
  - Voting for the three best proposals from all Ideacells (1–2 min)

- **Post-experimental survey and debriefing (5–10 min)**

  **Goal setting and reward structure**  Kahai, Avolio, and Sosik (1998) provided a reward of $100 ($25 per member) based on an evaluation of group contribution by independent judges. A similar reward structure was adopted in this study, where $30 per member would be awarded to the two teams that proposed the most creative yet workable ideas, as judged by two creative directors from local advertising agencies. Appendix F gives the rating criteria used. Not all final individual proposals made up the group product, in line with a realistic marketing or advertising agency scenario (Nel, Pitt, Berthon, and Prendergast, 1996; Ivanov, 1999). Instilling a clear perception of fulfilling a team goal is vital in meeting satisfaction research (de Vreede, Briggs, Duin, and Enserink, 2000). Participants were therefore clearly instructed that only the three top-ranking individual proposals as voted within the group would be counted and judged against the competing final sets from the other nine groups (per condition)\(^7\). This preference-ranking procedure is similar to what in consistent with Dufner et al. (2000) where team members reduced the number of ideas to a manageable number, then each group member selected their top-two choices, resulting in a rank-ordered set of between six and ten proposals. Presenting the best three proposals from ideation sessions to clients is also common practice in advertising agencies (Ivanov, 1999).

  **Identified participation** is more appropriate for brainstorming meetings where employees with exceptional ideas can be recognized for their respective team contributions (Stenmark, 2000). Several GSS studies indicate that conditions of

\(^7\) Participants whose proposals did not make the ‘final cut’ could still have been instrumental in the idea development phase.
identifiability accentuate both process losses and process gains (Connolly, Jessup, and Valacich, 1990; Mejias, 2007). In Jung, Schneider, and Valacich (2005) team members were assigned pre-selected usernames, leading to virtual identities that could not be attributed to a real person. Such pseudonymity capitalizes on anonymity (no evaluation apprehension) as well as identifiability (no social loafing). The current study simply allowed participants to type in a username of their choice; this seemed an optimal way to achieve a balance between image management and identifiability concerns. Those who desired visibility could type in their own names, while those who preferred a low profile could create fictitious names. Note that these were newly-formed, ad-hoc groups without any prior history.

4.1.5 Task description

Prior experimental studies have drawn from a number of tasks described in the GSS literature. Tasks should be relevant and somewhat challenging yet not too controversial or requiring specialized knowledge (Fjermestad & Hiltz 2000). Some have required mainly divergent thinking, such as coming up with as many creative ideas on what fruit might look like on an alien planet or on all possible uses of a hypothetical sixth thumb. A widely-used problem-solving task involves brainstorming on the chronic problem of campus parking, while specifically for business students, the Business School Task has been oftentimes deployed (Mejias, 2007). The latter requires mostly analytical rather than creative thinking, and thus can be considered intellective rather than generative. Even less idea generation is called for in the Lost at Sea Task, where participants rank order 15 items in terms of their usefulness for survival while lost in a life raft in the South Pacific (Reinig, 2003).

The experimental task for this study was devised to cover both idea generation (brainstorming) and decision-making (voting) categories in McGrath’s taxonomy.

In terms of content, advertising the University’s Bachelor of Business program to high school graduates was deemed as particularly appropriate. Such a problem would not only be relevant and challenging to the student subjects, but is representative of teamwork in knowledge-based organizations such as management consultancies and product design firms (Nel, Pitt, Berthon, and Prendergast, 1996; Kerr & Murthy, 2004). Tasks in advertising agencies, specifically, involve a mix of divergent and convergent thinking. Writers may use divergent thinking to verbally sketch fresh ways to present a
message whereas the essence of that message can be further distilled or refined via convergent thinking (Ivanov, 1999; Nov & Jones, 2005). This originally-devised task was pilot-tested, and described in the main study as follows:

Imagine that Simon Fraser University’s Bachelor of Business Administration program is losing applications to the competing program at UBC. Your team should brainstorm ideas for advertising our BBA program in the SkyTrain. Do not aim for a polished ad, but roughly describe ideas for an appealing message or communication strategy. Your team’s 20 minute online session using a group support system (GSS) will have three phases: first, brainstorming on possible directions for the ad, then distilling the ideas into a headline or visual description, and finally, voting for the group’s three best ideas.

A 20-minute time period was given for this task completion, not counting the two minutes that would be allotted for the voting phase. 20 minutes is the most common task duration in lab studies, with a range of 15 to 45 minutes (Fjermestad & Hiltz, 2000). (Here, the outlier again is the study by Briggs, Reinig, and de Vreede (2006), who collected data from meetings that lasted from three to eight hours!)

4.1.6 Task procedures and protocol

Email introduction Thanks for volunteering to participate in this session as part of my doctoral research on Group Support Systems, or GSS. Today you will use one such GSS for idea generation and evaluation. This GSS is web-based, and works like a chat application. It also comes with a couple of easy to use additional features for distilling ideas, which you’ll learn about in a minute via the web-based tutorial. Then you will read about the task. In appreciation for your participation tonight, your team will have the chance to win $210 ($30 per team member). At the end of all experimental sessions next week, all ten teams will be judged by two independent judges, who are creative directors at local advertising agencies. The winners will be announced, and the prizes distributed, during the following class. Ideas will be judged based on creativity and practicality.

Phase 1 This phase took place in the main discussion window, as in most Instant Messenger chat applications, although die icons were used instead of usernames. After a welcome remark participants were asked to begin brainstorming in this space, which was also used to announce phase transitions or answer technical or procedural questions. Participants were also instructed as to the four rules of brainstorming. At all times an abbreviated task description was prominently displayed at the top of the GSS interface; so was a timer that counted down from 20 to 0.
Welcome! I’m Alex. . . . Let’s just wait another minute for the others to join . . . Did you all go through each slide of the tutorial? . . . Can you all see each other’s dice icons? . . . You are ready to begin your 20 minute session. As you saw in the tutorial 10 minutes into the session I will enable the feature for individual proposals and refinement. 20 minutes into the session I will tell you to stop the discussion and idea submission and enable the final voting feature. If you have a technical problem, please let me know in the main discussion window.

Phase 2  Ten minutes into the session participants were asked to end the freeform brainstorming session, and move into idea organization and distillation. They could still chat in the main discussion window, but each had to propose their favourite idea. This idea could be their own or a modification on someone else’s idea, as long as the essence of the idea was not already proposed. Each participant had to type their proposal—with a maximum of 50 characters and/or five lines of text—into their own Ideacell. Ideacells were rectangular text fields vertically stacked and positioned on the right side of usernames and dice. Each participant was meant to take salient ownership of one Ideacell, displaying one idea/proposal. Each could edit the content of their Ideacell throughout this phase, which lasted ten minutes. They could refine their individual proposals if they chose to, based on others’ input in the main discussion window. Team members could thus participate in two locations: in their Ideacell to propose and refine their proposed idea, as well as asking or responding to fellow team members in the main discussion window. In the PIC GSS treatment, members could participate in a third way: by uploading pictures.

Phase 3  After the ten-minute brainstorming in phase 1, and ten minute idea refinement and distillation process in phase 2, it was time for final idea evaluation (preference-ranking). Participants were given two minutes for this phase, which was essentially a process of ranked voting. At this time they could no longer edit their Ideacells, yet could continue chatting in the main discussion window. Each participant had to select what he/she perceived to be the three best team proposals (including their own), and rank these three as the top, second best, and third best idea. This process was quite transparent, as each individual vote was graphically displayed right next to the Ideacell that was receiving the respective vote. These voting displays, or grids, were arranged vertically alongside the Ideacells. At the end of this process, all votes cast were clearly visible adjacent to the respective individual Ideacell in the form of a grid visualization that was meant to indicate the ranking of all individual ideas. The entire
GSS layout, in fact, was meant to instantiate conditions of evaluability. Participants could presumably tell, at-a-glance, which idea was proposed by whom, and how many votes it had received. This was in addition to the brainstorming comments in the main discussion window, which were also clearly labelled with the die icons. At this time, or approximately 22 minutes after the session commenced, participants were told that they all ‘did a good job’, and reminded that only the three top-ranking proposals would be counted for the competition. The URL to the post-experimental questionnaire was then pasted in the main discussion window. Participants were asked to exit the GSS by clicking this link, proceed to fill out the survey, then return for one-minute debriefing. The completion of this last step was required for each participant to receive their bonus points towards class participation.

Closing remarks Thanks for your effort, everyone. Now take ten minutes to complete the survey about your experience with the session today and the Group Support System you used. Your performance at this stage is not evaluated, but you do need to complete the survey in order to receive the course credit.

Debriefing Thank you so much for your participation today. As I already mentioned, at the end of all experimental sessions next week all 20 teams ideas will be judged by two local creative directors. The winners will be announced and the prizes distributed. Ideas will be judged based on creativity and practicality. If anyone wishes to see the detailed criteria for judging, please email me. If your team happens to be the winning team, I will email each one of you, and make arrangements for you to receive the $30. Finally, I should mention that the true purpose of this experiment was to understand how you evaluate the brainstorming session as compared to another group who used a different system. Their system was designed to include a feature for visual brainstorming by uploading pictures. Let me know if you wish to see this interface or the results of this study as they become available. If you wish, you may withdraw your consent even at this point, in which case your input today will not be used in the data analysis. Thanks again for participating!
4.2 Subjective Measures

The post-experimental questionnaire was administered via the web-based service, SurveyMonkey.com. This package has been used in other academic studies (Cyr, Hassanein, Head, & Ivanov, 2006) due to its rich filtering features and intuitive interface.

4.2.1 Instrument

All 28 items were based on a seven point Likert scale where 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neutral, 5 = somewhat agree, 6 = agree, 7 = strongly agree. Items appeared one after the other without any vertical separators or spacing between the constructs. In line with Briggs, Reinig and de Vreede (2006), the multi-item scales were preceded by the following segment:

You may find that some of the questions seem similar. This is because testing the is subtle variations of wording is part of this research. Please respond to each question as best you can, as it is written, even if it seems similar to a question you have already answered.

The first page of the questionnaire listed the items for PGA, SO, and SP taken directly from Briggs, Reinig and Vreede (2006), except referring to session instead of meeting.

PGA-1. Today’s session was worth the effort that I put into it.

PGA-2. The things that were accomplished in today’s session warranted my effort.

PGA-3. The result of this session was worth the time I invested.

PGA-4. The value I received from today’s session justified my efforts.

SO-1. I liked the outcome of today’s session.

SO-2. When the session was finally over, I felt satisfied with the results.

SO-3. I am happy with the results of today’s session.

SO-4. I feel satisfied with the things we achieved in today’s session.

SP-1. I feel satisfied with the way in which today’s session was conducted.

SP-2. I feel good about today’s session process.

SP-3. I feel satisfied with the procedures used in today’s session.
SP-4. I feel satisfied about the way we carried out the activities in today’s session.

The second page started with the items for perceived instrumentality (INS), including terminology borrowed from prior studies (Kerr & Bruun, 1983; Hertel, Deter, & Conradt, 2003; Green & Taber, 1998; and Sylvester, 2000).

INS-1. My individual effort was essential to the team outcome.
INS-2. My contribution in today’s task was unique.
INS-3. My contribution to the team outcome was very important.
INS-4. Our team’s success depended on my participation.
INS-5. I was instrumental in today’s task outcome.
INS-6. I played a key role in today’s task.

Perceived task enjoyment (ENJ) was measured with items taken from Bruner and Kumar (2003), and Chin and Gopal (1995), but referring to task instead of system.

ENJ-1. This task was exciting.
ENJ-2. I had fun with this task.
ENJ-3. It was cool to participate in this task.
ENJ-4. I found the task enjoyable.

Perceived interface design aesthetics (DES) used items from Cyr et al. (2006)\(^8\):

DES-1. The GSS interface was attractive.
DES-2. The overall look and feel of the interface was visually appealing.
DES-3. The interface was professionally designed.

\(^8\) Some DES scales also include the item, *The graphics are meaningful.* This was not included here as images in the PIC GSS were *user-generated*, rather than an inherent part of the GSS interface.
Perceived ease of use (EOU) was measured by the standard items in TAM studies, also used for GSS contexts by Dennis and Venkatesh (2004).

EOU-1. The interface was easy to use for the task given.
EOU-2. This was a user-friendly interface.
EOU-3. My interaction with this interface was clear and understandable.

4.2.2 Open-ended questions

Open-ended, short answer questions are often posed at the end of a survey as a qualitative measure. In Reinig et al. (1995-6) two such questions served as an auxiliary measure of affective reward. We wish to do the same in the current study with respect to the system perceptions and meeting affect.

Q1. What is your overall feeling about the session today?
Q2. Which part of the system interface did you like most?

The survey ended with two additional open-ended questions, which were optional. One asked participants for their specialization within the Bachelor of Business track, while the other queried them about what username they had used in the session.

4.3 Performance Measures

4.3.1 Actual instrumentality

A measure of actual (observed) instrumentality of each team member’s group-related performance was developed to ascertain the objectivity relevance of INS—a self-reported perceptual measure. This actual INS measure is additionally motivated by the glaring inconsistency found by Connolly, Jessup, and Valacich (1990) between the subjective and objective measures of group effectiveness. Their correlation was not simply low, but “substantial and negative (−0.37)” (Connolly et al., 1990, p. 700). No prior empirical study, however, has measured a variable that is close enough to actual INS; hence the following improvised measure.

Proposal rankings. The first indicator was whether an individual proposal was selected by team members to rank within the final top three. It is the content appearing only in these top-three ranked Ideacells that constituted the final group product to be
judged for the contest. In sum, objectively-speaking, instrumentality in this phase came
down to whether one’s Ideacell made it or did not make it in that top-three. Thus, a
binary value was used here, as in “qualified” or “not-qualified”.

The right part of Figure 5 shows these rankings, and although it should be self-
explanatory, refer to the next Chapter for details on the actual voting system. It should
also be mentioned that participants were allowed to vote for their own Ideacells, and that
shown here in this figure is the Admin GSS version of the interface with the voting grids
identifying voters. Participants interfaces merely visualized these as solid dark blue
boxes.

Discussion participation  The second indicator was performance instrumentality in
the initial brainstorming (Phase 1) and idea evaluation and refinement (Phase 2)
discussions. Such instrumentality could easily be manifested in a number of ways,
including but not limited to suggesting initial directions for the ad, giving unique
information that could be used for support, and encouraging active collaboration. (For
an instance of the latter, see Figure 12 in Chapter Seven, while Figure 11 in the same
chapter gives some telling examples of participation inequality.) Determining such
instrumentality required content analyses of all chat transcripts. The number of task-
relevant utterances submitted in the discussion window by each participant was counted
(excluding expletives, emoticons or abbreviations) as per the coding scheme of
Connolly, Jessup and Valacich (1990). Here, the value recorded was simply discussion
productivity relative to the group, and could technically assume values from one to eight
(in the largest groups). The actual value used, however, also included a somewhat
subtle measure of instrumentality with respect to discussion content. Thus a more in-
depth qualitative discourse analysis was also conducted, counting supportive comments
and elaborations by each participant, and ignoring overly critical remarks and disruptive
comments, again as per Connolly, Jessup and Valacich (1990). It is assumed that a
supportive or constructive comments is more instrumental than a critical and
unconstructive comments. In the final analysis of discussion participation, the value
here ended up being a five-point scale: as 1 (very passive or unsupportive); 2 (below
average; 3 (average); 4 (average); and 5 (very active or leader).

While the measure for actual INS described did not aim to be maximally objective,
its biggest weakness is completely ignoring the Ideacell content from Phase 2. (This
omission results from efficiency concerns.) Another weakness is treatment of instances
when there may be a tie for qualifying among the top-three ranked choices. As shall be
described in the next Chapter, such a contingency was anticipated and the voting
system designed to minimize chances of this happening. In the case of the twenty
sessions conducted in this study, no such cases occurred with respect to determining
top-three proposals, although a number of ties occurred for the lower ranked spots.

**Actual INS scores** The total and final score for actual instrumentality per group
member was thus a combination of the two indicators mentioned above, and took values
of, 3 for high, 2 for medium, and 1 for low INS. Figure 5 illustrates this assignment
process using the final generated output by the PIC condition winning teams (TXT
winners are shown in the next chapter). In this particular group the clustering of high
performers near the top is coincidental; vertical arrangement of participants in all
sessions was determined solely by chronological order of login.

![Figure 5. Actual INS in one winning team (admin GSS shown)](image)

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9 The administrator’s interface actually identified voters’ social proxies, to ensure every team
member had voted.
The proposal by participant with green die #1 has received a total of 13 votes, and is clearly the most supported of all six. This member was also the second most active in the brainstorming chat, with 193 words. Most active in that phase was grey die #2 (with 293 words), whose final proposal was second-best rated overall (with nine votes). These two team members were therefore determined to be the most instrumental performers in the session. Of course the third best-rated idea gets selected also, but its author (orange die #5) was below average with her brainstorming participation, thus receiving the medium actual INS score of 2. Exemplifying extremely low performance was red die #6. This member was second least active in Phase 1, was the only one without an uploaded visual in Phase 2; did not receive a single vote in Phase 3; and even group’s selection did not include a single proposal that this member voted for (i.e. low RIGA). Obviously a very low actual instrumentality is the case here (score 1), which happened to be consistent with this individual’s self-rated INS (a composite mean of 3 on the seven-point Likert-scale).

4.3.2 Other performance measures

Measuring participation as part of assigning actual instrumentality was mentioned above. This measure also served a broader purpose for qualitative analysis, presented in Chapter Seven.

Note that idea quality was measured only for purposes of prize disbursement by two independent judges employed as creative directors in local advertising agencies. Appendix F presents the rating criteria, while Chapter Seven mentions some of the themes proposed.
5 Experimental Manipulation and Technology

5.1 Experimental Manipulation

5.1.1 Prior GSS manipulations

Few studies in GSS rely on interface treatment to induce variations of an independent variable. Connolly, Jessup, and Valacich (1990), for instance, manipulated evaluative tone in the group interface via research confederates participating as team members. Depending on the condition, confederates submitted either supportive or critical comments with respect to ideas generated by the ‘real’ members. Other teamwork experiments employ even more artificial interventions. Bruun and Kerr (1983) manipulated perceived relative ability of individual participants. In a pre-test individual briefing, researchers told each team member that he or she had been assessed to be among the least or the most capable from the group.

While effective, such interventions have limited practical value for real organizational contexts. Clearly, managers cannot rely on confederates to induce social facilitation or other process gains in real meetings. The quantitative performance feedback used in Shepherd et al. (1995-6) was actually based on a fake comparison standard—a mythical average group. No such limitation was inherent in the feedback mechanism of Jung et al. (2005). The graph in their GSS displayed within-group individual productivity as it actually occurred during the session. Participants in that study, however, apparently realized that the feedback referred to the quantity of their input, and began submitting lower quality ideas. Appendix B gives a comparative summary of these three key studies of evaluability in GSS. The current study’s experimental manipulation, instead, employs a realistic modification of the GSS interface (as did Jung et al., 2005) for instantiating conditions of qualitative evaluability (as did Connolly et al. 1990).
5.1.2 Manipulating perceived instrumentality

This experiment’s objective was to invoke maximum and clear variability in perceived instrumentality (INS), while keeping all other factors as constant as possible. Teams were randomly assigned to one of two conditions, which differed only in terms of the interface deployed. Higher INS scores were expected in the condition where teams used a GSS with one additional feature: the ability to upload images.

The presumption was that by taking advantage of pictorial brainstorming, team members could perceive their individual contributions to be more instrumental, compared to participants in the text-only condition. Visual representations are after all simply more impressive than text, and the impression management motive in brainstorming has been found to be important (Sutton & Hargadon, 1995-6). Brainstorming participants may even hold the goal to put their peers in a good mood with some funny ideas, thus achieving status through humour (Litchfield, 2008). More concrete evidence for a similar motive appears in an experiment by Tractinsky and Meyer (1999). The study tested whether managers, about to make a public presentation, would choose a ‘plain’ or a ‘3D’ information graphic for their slides. Most subjects chose the 3D (presumably more impressive) format—a tendency which the researchers attribute to an urge to satisfy self-presentation objectives. Benefits of using imagery in teamwork have also been noted in field studies (Palus & Horth, 2002; Eppler, 2006). Knowledge Visualization, in fact, is all about giving people richer visual means of expressing what they know (Burkhard, 2005). Fidelity of representation is irrelevant in such ‘knowledge design work’ (Nakakoji, Yamamoto, and Ohira, 1999); more important is allowing users to decide how they want to express themselves, and do things in distinctive ways (Zhang, 2008).

The interface treatment for pictorial brainstorming (PIC GSS) thus supported uploading of images (in Phase 2, and after selecting a GIF, JPG, or PNG file of up to 500KB. Task instructions called for using Google image search.) Another interface (TXT GSS) supported only text submission. Textual and pictorial content could be resubmitted. Both interfaces were also designed for enhanced within-group evaluability, which constituted a ‘fall-back’ mechanism for inducing variability in INS. Prior GSS studies have shown that task re-structuring may accentuate differences in emergent beliefs among team members (Schwartz & Schwartz, 2006; Mejias, 2007; Kahai, Avolio, and Sosik, 1998). Differences in perception were expected to manifest in the current
experimental sessions, which in fact were free simulations using a closed setting to mirror the real world. As subjects interact within the system, values of the independent variables reflect the natural range of their experiences (Jenkins, 1985; Straub, 1989).

**Figure 6. Schematic of task structure** (in both conditions)

<table>
<thead>
<tr>
<th>Phase 1: Idea generation</th>
<th>Phase 2: Idea development</th>
<th>Phase 3: Idea selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorming discussion</td>
<td>Each participant promotes an idea in their own text field, which he or she may edit and refine</td>
<td>Each individual proposal is ranked by all team members</td>
</tr>
<tr>
<td>'chat' window (with scroll bar)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| User 5 | User 1’s proposal: ...... | x✓✓✓ |
| User 3 | User 2’s proposal: ...... | x✓ |
| User 2 | User 3’s proposal: ...... | ✓xx✓✓ |
| User 7 | User 4’s proposal: ...... | x |
| User 5 | User 5’s proposal: ...... | |
| User 2 | User 6’s proposal: ...... | ✓✓ |
| ... | User 7’s proposal: ...... | x✓ |

5.2 Technology Development

5.2.1 Design iterations and pilot tests

Several pilot studies were conducted as part of this thesis. An informal, non-verbal idea generation session was first held with five students, who were given Post-It notes to paste on a white-board. Each of them would stack his or her notes one above the other, thus building some line of thought. At the same time they could elaborate on team members’ ideas by adding notes on their stacks. This two-dimensional structure, presumed to enhance the visibility of one’s instrumentality, was described in Ivanov and Cyr (2006). The format was then applied online with the first GSS prototype—shown in Figure 7—which also tested the feature for pictorial brainstorming. This was better utilized than the two-dimensional structure, as in both sessions participants could not easily decide when to submit a new idea in their own column or to elaborate on someone else’s idea, by adding to their stack. This novel structure was hence abandoned.
Figure 7.  The first GSS prototype in use

Figure 8.  The second GSS prototype in use
From these tests it also became apparent that a channel for synchronous
discussion was needed, at least to support procedural questions and answers. A basic
chat dialog, in fact, serves as the only GSS feature in some studies, such as Vick and
Johnson (1999). The second interface was therefore designed to support free-form
brainstorming, and kept just one set of text boxes for individual ideation. These were
combined with a ‘multiple dialog’ format (Dennis, Valacich, Carte, Garfield, Haley, and
Aronson, 1997). As shown in Figure 8, separate dialogs unfold after each team member
proposes an idea (preceded by a ‘warm-up’ brainstorming in the common chat window
on the very left). Several sessions were conducted with this interface; each time
members reported information overload in trying to follow five or six conversations. This
interface design was therefore abandoned as well, leading up to a final version that
combined elements from the last two. Boxes for individual proposals were stacked
vertically this time, making room for a new feature of graphical voting.

No usability problems emerged after testing two treatments of this particular
design. One treatment included the pictorial brainstorming feature (as shown in Figure 5
in the previous Chapter), while the text-only version appears in Figure 9 (screen-
captured by a member from that condition’s winning team). Callouts identify the
additional graphical features drawing on principles of social translucence and information
design. These are reviewed next.

In socially translucent group environments (Erickson & Kellogg, 1999) participants
share visibility of their interactions, as well as an understanding of how the special
nature of the setting enables a process of social computation. Exemplary of these
principles is the Babble interface much used by researchers at IBM’s Social Computing
Group. Key to its design are ‘social proxies’ of individual participation, or small colored
dots positioned within a circle and moving toward its center as messages get posted. A
more recent version of Babble also supported ‘spatial persistence’ (Erickson, Kellogg,
Laff, Sussman, Wolf, Halverson, and Edwards, 2006). Participants no longer had to use
naming tactics in the chat dialog to ensure visibility of their contributions; they could now
submit announcements in a highly visible pane, note the authors.

By ‘offloading’ pertinent details to the environment, visualizations increase the
amount of working memory devoted to problem solving (Card, Mackinlay, and
Schneiderman, 1999). Two-dimensional ‘small multiple’ plots, for instance, can reduce
the effort for pattern detection, by portraying a large amount of data aggregated in a
small space (Tufte, 1997; Chabris & Kosslyn, 2006). No wonder that participants in collective decision-making tasks tend to prefer a fully-integrated, global view of the information (Barone & Cheng, 2006). In one specific GSS study, Dufner, Hiltz, Johnson, and Czech (1995) found that groups using a simple ‘list’ feature for visualizing group convergence perceived the medium as richer and less ambiguous than did control groups. The latter had to “comb through many comments without seeing at a glance the extent to which consensus had been reached” (p. 240).

5.2.2 Features common to both GSS interfaces

The general layout reflected the structure from Figure 6, meant to afford an at-a-glance association of the generated and then evaluated content with individual team members.

Figure 9. The final GSS interface (text-only condition)
**Dice for social proxies**  After logging in the GSS with a username of their choice participants are assigned user icons in the form of colored dice, which appear above the respective usernames. A green die numbered ‘1’ is always assigned to the first person to enter the session; grey die number ‘2’ goes to the second arrival, and so on and so forth (up to six, seven, or eight, depending on the group size). Each die & username combination is arranged vertically top to bottom, serving as prominent label to the individual contributions in Phase 2. The dice represent users dynamically in the chat dialog as well (including a black solid die assigned to the administrator). Color-coding of dice and their numbering supported maximum identifiability throughout all phases.

**Graphical voting system**  The ‘average rating’ voting protocol was implemented, giving each voter a fixed amount of scores to be split up and assigned to different proposals (Cheng, Li, and van de Walle, 2001). The visual structure of this system was original, based on the web-polling format developed prior to this thesis (Ivanov, Cyr, and Erickson, 2005). Adjacent to Ideacells were *Rankplots*, or small multiple grids displaying the preference-ranking of Phase 3, as it occurred in real-time. Team members selects their top, second-best, and third-best choice among the individual proposals in each Ideacell. Ranks are assigned by clicking one of the three Voting buttons, then clicking the Ideacell to be ranked. (Red borders around Ideacells indicate submissions already voted for.) Each team member gets to allocate six votes, each represented by a single solid square. A box of three squares is plotted for the top choice, two squares for the second, and one square to the third-best choice. The maximum number of squares or votes a single Ideacell could receive (if all eight voters, including the author, selected it as their top choice) was obviously 24. Hence the five-by-five square grid (even though the maximum number of votes any Ideacell from all twenty sessions received was 14.)

### 5.2.3 Technical platform

The GSS was designed as a web application built around the client-server architecture. The client provides the user interface, connecting only with the server component, which is responsible for relaying communication to all other clients that are part of the session. One instance of the client must be run in a special ‘admin’ mode, providing an extended user interface for the session administrator. The client was implemented as an Adobe Flash applet that is accessible through an ordinary web browser over the Internet or an intranet. All client functionality was coded using
ActionScript 2.0. For the server component, an ‘off-the-shelf’ socket-server was used: ElectroServer 3.7.3. The server manages persistent socket connections from clients and relays messages to all clients participating in the same session over a custom protocol. On the client side, communication with the server is handled by the ElectroServer API plug-in, written in ActionScript 2.0 and provided with the ElectroServer distribution. Technically speaking, from the client’s perspective, communication with the server is asynchronous; the client sends requests to the server and continues execution while the server’s response invokes registered event handlers on the client following the Observer design-pattern. The session is controlled by the Admin client, which sends special control messages to synchronously switch all clients in the session to the appropriate session phase. The transcript of the session is available on the Admin client at the end of the session.
6 Results

6.1 Descriptive Statistics

6.1.1 Composite means and controls

Composite means for all constructs from the instrument responses were tabulated. An unpaired, two-sample t-test was conducted for means differences between conditions, gender, and group evaluation. Key significant results are shown in Table 6, below the means for the entire sample in the top row.

Overall, composite means for all constructs were significantly higher than the midpoint response (4 on the Likert scale). This was expected and is consistent with other studies. For reference purposes, consider Kerr and Murthy (2004), who compared outcomes and process satisfaction from GSS and FTF groups. SP means were 5.5 (GSS) vs. 6.0 (FTF) (p<.023); SO means were 5.0 (GSS) vs. 5.9 (FTF) (p<.001).

Both GSS interfaces were perceived relatively easy to use (note the highest EOU means overall), but PIC significantly less so than TXT (p<0.05). This difference is higher than expected, and likely a result of the lack of image uploading functionality in TXT. Also higher than expected were some differences between genders.

Females gave significantly higher ratings than males on all constructs except INS and EOU (where differences were insignificant). As genders were well-balanced within condition and within group size (refer to Table 4), these differences are not likely to confound the research model results.

Nor were any other significant interaction effects detected when the data was analyzed with the SAS module, crossing group size and treatment. Nevertheless, refer to the Limitations section in the next Chapter for other threats to internal validity in this study.
### Table 6. Breakdown of composite means per construct

<table>
<thead>
<tr>
<th></th>
<th>INS</th>
<th>ENJ</th>
<th>EOU</th>
<th>DES</th>
<th>PGA</th>
<th>SO</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>All (126)</td>
<td>4.93</td>
<td>5.3</td>
<td>5.7</td>
<td>5.1</td>
<td>5.30</td>
<td>5.31</td>
<td>5.27</td>
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<td>SD</td>
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<td>1.1</td>
<td>1.2</td>
<td>1.2</td>
<td>0.99</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>PIC (64)</td>
<td>5.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TXT (62)</td>
<td>5.92*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualified (49)</td>
<td>5.36***</td>
<td>5.54</td>
<td>5.26*</td>
<td>5.48*</td>
<td>5.45*</td>
<td>5.41*</td>
<td></td>
</tr>
<tr>
<td>Non-qualified (70)</td>
<td>4.57</td>
<td>4.92*</td>
<td>4.76</td>
<td>5.07</td>
<td>5.08</td>
<td>5.08</td>
<td></td>
</tr>
<tr>
<td>Male (73)</td>
<td>5.06</td>
<td></td>
<td>4.85</td>
<td>5.11</td>
<td>5.24</td>
<td>5.07</td>
<td></td>
</tr>
<tr>
<td>Female (53)</td>
<td>5.54**</td>
<td></td>
<td>5.22*</td>
<td>5.56**</td>
<td>5.45*</td>
<td>5.61**</td>
<td></td>
</tr>
</tbody>
</table>

Note: * p<0.05, ** p<0.01, *** p<0.001.

### 6.1.2 Variation of perceived instrumentality

The primary experimental manipulation varied the PIC and TXT GSS between conditions. Groups using the PIC treatment could utilize an additional feature for visual brainstorming. These participants were expected to report higher scores of perceived instrumentality (INS) than participants who used the text-only interface.

The average INS mean in the PIC condition was 5.04; that in the TXT condition was 4.81. A t-test for this (relatively small, 0.23) difference returned a p-value of 0.13—not low enough to consider INS significantly different between conditions. Therefore, the main experimental manipulation was not successful, which was further confirmed by the insignificant correlation from the SPSS regression results.

**INS vs. Actual INS** The experimental design included a secondary, built-in mechanism in the GSS deployed to both conditions for enhancing within-group evaluability. Outlined in Figure 6 of the previous chapter, this combination of task structure with group interface was expected to induce heightened INS variability across the entire sample. Such variation in perceived instrumentality was indeed achieved, when splitting the sample according to actual INS. A pronounced pattern of high vs. low

---

10 The sample for this breakdown was smaller by seven members, whose rankings were either below or above the cutoff line by just one vote. Despite the graphical voting format, it was assumed that these participants may have trouble ascertaining their ranking.
Actual INS shown like the one shown in Figure 5 of the previous chapter was observed for all group sizes, and in both conditions. A correlation between Actual INS and INS, calculated as part of the SPSS multiple regression with SPSS, was also positive and significant (.48). Refer to Figure 9.

It was unexpected, however, that a binary measure of Actual INS based only on the ranking indicator (Qualified vs. Non-qualified) yielded almost the same correlation with INS (.46) as did the three-point measure of Actual INS. (60 participants from all teams qualified, while the remaining 66 did not.) The t-test here showed a very significant difference (p<0.001) in reported INS between Qualified and Non-qualified team members. As shown by the shaded area in Table 6, this difference of 0.79 between composite means is higher than the difference in means for PGA and SO (borderline significant, while the other mean differences did not approach any significance). In fact, not only did Qualified members report much higher INS (5.36) that those Non-qualified (4.57) but the Qualifieds’ INS scores were higher than the INS mean from the PIC condition (5.04). In sum, whereas the GSS treatment manipulation failed to instantiate significantly different means between the two conditions, sufficient variability was achieved via the intra-group enhanced evaluability across the entire sample.

**Figure 10.** Manipulation check coefficients
6.2 Measurement Model

6.2.1 Exploratory factor analysis (EFA)

EFA was conducted to test the measurement properties of the baseline research model presented in Chapter Two. EFA (also referred to as principal component analysis) identifies the underlying latent factors explaining the pattern of correlations within a set of measurement items (Gefen & Straub, 2002). Once this data reduction method identifies a small number of factors that explain most of the variance in the set (typically that number with an Eigenvalue exceeding 1.0) the loading pattern of the measurement items is revealed in the statistical output (Hair, Anderson, Tatham, and Black, 1995). An optional second stage may rotate the matrix creating orthogonal factors with minimized high loadings of the items on other factors (Chin, 2002).

In this study the EFA included all items for INS, PGA, SO, and SP. The set included INS in order to test the measures of this new construct with respect to the baseline model. Content validity considers how representative and comprehensive the indicators (items) are in creating the experimental constructs. Constructs should draw representative items from a universal pool (Cronbach, 1971). In the case of INS, conceptualized by this thesis, each item was phrased after reviewing relevant terminology from a number of prior studies plus post-session comments from the current pilot sessions. Content validity of SO and SP should be considered particularly high, since items were tested by Briggs, Reinig, and de Vreede (2006) with hundreds of participants and multiple calculations of inter-item reliabilities. (The remaining constructs used previously validated items and were not included in this EFA.)

Results from the EFA with Varimax rotation using SPSS appear in Table 7, and reveal four distinct factors. All items loaded heavily on the factor they were supposed to, and did not load heavily on the remaining factors. An item is considered to load highly if its coefficient is above 0.6, and does not load high enough if the coefficient is below 0.4 (Hair et al., 1995). As shown in Table 7, all item loadings met the cut-off criteria. Finally, reliability in EFA (also called internal consistency) is measured with Chronbach’s α, and should exceed the .70 threshold recommended by Nunnally (1978). All four constructs exhibited values in the .9 range, indicating very high reliability.
Table 7. Exploratory factor analysis (EFA)

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
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<td>INS-1</td>
<td>.814</td>
<td>.080</td>
<td>.141</td>
<td>.259</td>
<td></td>
</tr>
<tr>
<td>INS-2</td>
<td>.805</td>
<td>-.144</td>
<td>.018</td>
<td>.316</td>
<td></td>
</tr>
<tr>
<td>INS-3</td>
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<td>.114</td>
<td>.156</td>
<td>.936</td>
</tr>
<tr>
<td>INS-4</td>
<td>.867</td>
<td>.162</td>
<td>.099</td>
<td>.049</td>
<td></td>
</tr>
<tr>
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<td>.869</td>
<td>.157</td>
<td>.152</td>
<td>.047</td>
<td></td>
</tr>
<tr>
<td>INS-6</td>
<td>.847</td>
<td>.256</td>
<td>.120</td>
<td>.038</td>
<td></td>
</tr>
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<td></td>
</tr>
<tr>
<td>PGA-2</td>
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<td>.303</td>
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<td>.909</td>
</tr>
<tr>
<td>PGA-3</td>
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<td>.647</td>
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</tr>
<tr>
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<td>.314</td>
<td>.673</td>
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<tr>
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<td>.793</td>
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<td>.790</td>
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<td>.310</td>
<td></td>
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<td>.340</td>
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<tr>
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<td>.239</td>
<td></td>
</tr>
</tbody>
</table>

Note: EFA used Varimax rotation; Eigenvalues: 4.67, 3.71, 3.46, 2.88. N=126. Boldface indicates heaviest factor loading for an item.

INS: Perceived Instrumentality; PGA: Perceived Goal Attainment; SP: Satisfaction with Process; SO: Satisfaction with Outcomes
6.2.2 Confirmatory factor analysis (CFA)

A CFA was performed to test the measurement properties of the extended research model presented in Chapter Three. CFA differs from EFA in that the number of factors and loading pattern of items is specified in advance (Gefen, Straub, and Boudreau, 2000). Used here was the PLS method (Chin, 1999; Chin, Marcolin, and Newsted, 2003), as it simultaneously models the measurement paths as well as the structural paths (described in the next section). As in EFA, all scale items should first load significantly on their hypothesized latent constructs. Table 8 shows all item loadings met the criteria of 0.6 (Hair et al., 1995).

In CFA construct validity is assessed by computing the average variance extracted (AVE) for all scale item loadings. As shown in Table 9, AVEs for all constructs are above .75, which means that the items used to measure the constructs account for more than 75% of their respective variance. At the same time low correlations should be exhibited between items of different constructs, indicating discriminant validity (Straub, 1989). Recommended here is examining the ratio of the square root of AVE for each construct, which should be larger than the correlations among the constructs (Fornell & Larcker, 1998). As shown in Table 9, all figures (in bold) exceed the off diagonal inter-construct correlations, indicating internal consistency (composite reliability).

6.2.3 Common method variance

A significant threat to the validity of statistical results is common method variance, also known as common method or mono method bias. This potential issue may arise when relying upon a single survey to collect both the independent and dependent constructs. The relationship between the constructs could then be due to the method by which the data was collected, rather than the actual phenomenon of interest. If a single factor accounts for a large proportion of the variance in the data, one can conclude that it may be due to a common methods bias. In this case one should not draw conclusions from the results. The most widely-known approach for assessing common method variance is Harman’s single-factor test (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003), which was conducted in this study. The results from this test show that just over 41% of the variance was due to a single factor, indicating that common methods bias is unlikely to have been a significant issue in this data collection.
Table 8. Confirmatory factor analysis (CFA)

<table>
<thead>
<tr>
<th></th>
<th>INS</th>
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<th>EOU</th>
<th>DES</th>
<th>SO</th>
<th>SP</th>
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</thead>
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### Table 9. Discriminant validity

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</tbody>
</table>

*Note:* Square root of Average Variance Extracted (AVE) are shown in bold; CR is Composite Reliability. Shaded cell represents borderline discriminant validity between SO and SP. INS: Perceived Instrumentality; ENJ: Perceived Task Enjoyment; EOU: Perceived Ease of Use; DES: Perceived Interface Design Aesthetics; SP: Satisfaction with Process; SO: Satisfaction with Outcomes.

In conclusion, the instrument employed in this study encompassed satisfactory content validity (using measures rigorously validated by prior studies); satisfactory convergent validity (as evidenced from high item loadings); and satisfactory discriminant validity (as evidenced from low cross-loadings of factor items) with the exception of SO and SP, which were borderline. Just barely on the acceptable side was the score on Harman’s single-factor test for common method bias. Definitely on the plus side are the measurement properties for INS in particular. These six items exhibited the highest Eigenvalue and a very high α in the EFA (using SPSS). The INS construct also correlated positively and significantly with the corresponding observed measure, or Actual INS.

### 6.3 Structural Model

#### 6.3.1 Path analysis

Multiple regression was performed with SPSS to test the first three hypotheses. Figure 11 shows the standardized parameter estimates, which emerged as positive and significant.
Figure 11. Baseline model results (SPSS)

Figure 12. PLS structural model results
The second data analysis phase used partial least squares (PLS) structural equation modelling (SEM) (Chin, 1999; Chin, Marcolin, and Newsted, 2003). The SmartPLS\textsuperscript{11} software was used for the CFA and SEM. PLS was chosen over the alternative LISREL, EQS, or AMOS techniques, which are more suited to theory-testing (Gefen, Straub, and Boudreau, 2000). PLS is more appropriate for theory-building involving complex predictive models. It can be run as long as the number of observations exceeds by ten times the number of items in the construct with most indicators, given that no more than three independent variables impact a dependent variable.

PLS also offers the ability to model constructs both formatively and reflectively. Formative observed variables cause the latent construct. Its items do not need to co-vary, as they represent different dimensions of it.

The PLS SEM results are shown in Figure 12. As recommended by Chin, Marcolin, and Newsted (2003) bootstrapping was performed to test the statistical significance of each path coefficient using t-tests. All except one of the hypothesized paths were positive and significant at the p<.001 level. The exception, plus one of the tentatively-examined paths, were not at all significant (shown with dotted lines).

PLS does not generate fit indices of the model like other SEM techniques, but calculates $R^2$ values representing the amount of variance in each dependent variable explained by the predictor variables. These will be discussed in the section after the hypothesis testing, but first a basic regression model was calculated with all the constructs leading to satisfaction.

6.3.2 Hypothesis testing

Table 10 summarizes the results with respect to the eight hypotheses. Hypotheses 1 and 2 were supported as the PGA→SO and PGA→SP relationships emerged as highly significant. In this SPSS regression analysis, the SO→SP relationship was found to be significant also, yet as was shown, the subsequent PLS CFA revealed a potential problem with discriminant validity. Not surprisingly, the structural model returned a suspiciously high correlation between SO and SP of 0.58. In

\footnote{The SmartPLS package is freely available for download at www.smartpls.de. It was developed at the University of Hamburg by Christian Ringle and colleagues.}
light of these findings, it appears that Hypothesis 3 cannot be supported. Other than this exception, the structural and measurement models fit the ‘baseline’ goal-attainment theory by Briggs, Reinig, and de Vreede (2006) described in Chapter Two.

Next, Hypothesis 4 tested INS as a predictor of satisfaction with outcomes (INS→SO), but was not supported. Its correlation was not at all significant (.05), nor was its correlation with SP. (INS was found to predict ENJ, an unexpected finding discussed in the next Chapter.)

Hypotheses 5 and 6 (ENJ→SP and DES→ENJ, respectively) tested the effects along a hedonic pathway to SP. Both hypotheses were supported, as were Hypotheses 7 and 8 (DES→EOU and EOU→SP, respectively) which tested the roles of system perceptions in predicting SP.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path</th>
<th>Coefficient</th>
<th>T-value</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>PGA→SO</td>
<td>.71***</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>H2</td>
<td>PGA→SP</td>
<td>.45***</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>H3</td>
<td>SO→SP</td>
<td>.36***</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>H4</td>
<td>INS→SO</td>
<td>.05</td>
<td>1.28</td>
<td>No</td>
</tr>
<tr>
<td>H5</td>
<td>ENJ→SP</td>
<td>.45***</td>
<td>7.19</td>
<td>Yes</td>
</tr>
<tr>
<td>H6</td>
<td>DES→ENJ</td>
<td>.47***</td>
<td>6.73</td>
<td>Yes</td>
</tr>
<tr>
<td>H7</td>
<td>DES→EOU</td>
<td>.43***</td>
<td>4.34</td>
<td>Yes</td>
</tr>
<tr>
<td>H8</td>
<td>EOU→SP</td>
<td>.38***</td>
<td>2.45</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The variances accounted for in the dependent variables of the PLS structural equation model (R² values) ranged from 18% to 48%, which is consistent with typical PLS results. Values of relatively low magnitude are actually quite significant in PLS SEM. In Cyr, Head, and Ivanov (2006), for instance, approximately 46% of the variance in user attitudes toward the technology use was accounted for in the model.
The low \( R^2 \) value for EOU (.18), for instance, is understandable given that DES cannot possibly be a major determinant of such a utilitarian characteristic, despite the significant correlation. ENJ also served as a dependent variable of INS and DES. Together these two significant predictors accounted for 40% of ENJ’s variance, and a separate regression showed their individual influence to be the same, at around 20%.

Consistent with the goal-attainment theory, SP was the most heavily impacted dependent variable. To compare respective variances in SP explained by EOU versus ENJ, the PLS model was also calculated without a link from EOU. This lowered the SP variance by 8 points. We can therefore conclude that approximately one third of the variance in SP is explained by ENJ.

To delve into the dubious relationship between SO and SP, the PLS was also calculated with these two dependent variables combined into one general satisfaction (SAT) construct composed of eight indicators. Appendix H shows this output from the SmartPLS software, which confirms most of the relations in the prior model, only here the role of EOU has become non-significant with respect to the combined satisfaction measure. The overall path from ENJ to SAT is a highly significant 0.6, and explaining as much as 50% of the variance in SAT (EOU only adds another 5% or so).

6.4 Qualitative Analysis

Two types of qualitative data were analyzed: session transcripts and open-ended question responses. Session transcripts revealed interesting patterns of participation, which are discussed later. Presented next are the insights gleaned from content analyzing the open-ended questions, which received an average of 98 percent response rate. A grounded theory approach (Strauss & Corbin, 1998) was applied to allow for key shared concepts to emerge.

6.4.1 Overall affective response to session

56 respondents (about one half of all who answered Q1) clearly indicated perceived enjoyment. These responses included the words *fun, great, interesting, awesome, or cool*. Representative quotes are:
• it was a fun activity. i really want to use this kind of program and activity for my other group activities in school

• way more enjoyable than i expected

24 respondents (or one fifth of those who answered Q1) expressed problems that are indicative of insufficient satisfaction with process. About half of these participants found the task somewhat hectic, due to either time pressure or too much input from a lot of sources. (Understandably most of this number of participants came from the larger groups.) The remaining dozen who had issues with the process either complained about technical problems with the system or felt that other team members were either not serious enough about the task or unappreciative of the respondent’s point of view. Again, two examples:

• I found most didn’t take the assignment seriously and this frustrated me

• I received little response to my suggestions, which caused me to be less motivated to comment on others’ suggestions.

Consider the following quotes as good examples of how satisfaction from a meeting could result from hedonic social interaction, but also from a task-related utilitarian purpose.

• i liked it. interacting with people is great

• it was cool to work with my peers to accomplish a task

• felt good for my opinion being selected as the 2nd choice

• would feel great if it helps the SFU BBA program compete with UBC

• It was fun and I like thinking of advertising slogans. Feels great that my slogan was ranked first.

6.4.2 Interface preferences

By far the most mentions in response to Q2 were about the discussion dialog. Even some of the more reticent participants mentioned that they liked the discussion!
The chat was most appreciated even in the PIC condition, where one might have expected that the somewhat novel visual brainstorming feature would steal the show.

40% of the respondents to Q2 explicitly mentioned they liked the identification system in terms of die icons and voting system\textsuperscript{12}. Less clear is whether those who loved the dice did so because of their identifiability function or by virtue of their association with an activity (i.e. chatting) that most found fun anyway.

When all comments were parsed and analyzed, six aspects of the interface emerged as objects of affect. These are shown in Table 11, yet do not include the responses from PIC. (A comparison with the entire sample would have been confounded by the image uploading feature in just one treatment.) That particular feature actually received eight mentions by PIC respondents. We can conclude that the visual brainstorming was appreciated, with two caveats. First, it is surprising that more preferences were expressed in support of the chat dialog over the image uploading, and second, the latter may have contributed to the relatively low EOU in that treatment.

<table>
<thead>
<tr>
<th>GSS feature</th>
<th>#</th>
<th>Representative quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dice/ID</td>
<td>19</td>
<td><em>I liked the dice icons, that indicated the presence of a member</em></td>
</tr>
<tr>
<td>Voting</td>
<td>13</td>
<td><em>The voting part of the ideas is very exciting.</em></td>
</tr>
<tr>
<td>Chat dialog</td>
<td>11</td>
<td><em>The chatroom of course, because that allowed us to generate more ideas</em></td>
</tr>
<tr>
<td>General EOU</td>
<td>10</td>
<td><em>the clear font and big window for the messages</em></td>
</tr>
<tr>
<td>Aesthetics</td>
<td>5</td>
<td><em>I liked the visual look of it</em></td>
</tr>
<tr>
<td>Ideacell</td>
<td>4</td>
<td><em>instant input of headline was easy to see and use</em></td>
</tr>
</tbody>
</table>

Finally, consider the following quotes:

- *Voting. Seeing how much was of your idea was accepted*

\textsuperscript{12} In support of this strong preference it should be mentioned that instrument items preceding open-ended questions did not contain wording that may have cued some predisposition toward these interface features.
• *Clean appearance and easy to use*

• *I liked how it was easy to distinguish which users were making each comment*

• *Hard to brainstorm without being face-to-face with such a big group. The voting was fun though.*

• *How we could actually submit a picture file of our design for everyone to see*

What such responses indicate is the role played by the social translucence features of the interface: spatial positioning of Ideacells and Rankplots voting system. They also lend support to the motives outlined in Chapter 3: that of Social Utility alongside Senso-hedonic. These will be finally discussed in the next Chapter.

### 6.4.3 Username disclosure (Q3)

First of all, as much as 96% of participants chose to reveal their username used in the session. Usernames were then compared to participants real names (which were collected for purposes of prize disbursement). It appeared that roughly one third of participants typed a username that included either their first or last name, and in its entirety. Another third included initials only, while the remaining third chose pseudonyms without an obvious connection to their real names.

These findings suggest that (at least as far as this student population is concerned) anonymity was not a sought after condition. Conditions of identifiability would most likely be preferred to conditions of forced anonymity. The current GSS featured an open-ended system, which may actually be ideal, as it allows for individual characteristics to be accommodated by the system and thus controls for their impact as to the research model.

### 6.4.4 Participation (in)equality

No serious typing lags or other delays were encountered during the discussions in Phases 1 and 2. The Ideacell submission feature worked as planned. Everyone except one participant managed to submit a text proposal in their Ideacells. As for uploading images (PIC GSS only) 95% chose and succeeded to upload at least one. About half of these participants submitted a second image, and a few submitted three or more. The
tendency was to first upload an image, wait for feedback on it, and then leave it or replace it with another.

To measure individual and group productivity, a basic word count of the discussion dialog was performed as outlined in Chapter Four. Counts per group ranged from approximately 700 to 1,100 (somewhat corresponding to group size).

Individual participation in that phase ranged from just three to as much as 335 words. The mean was 111.

Figure 12 displays relative individual participation for six groups (with number in horizontal legend indicating group size).

Figure 13. Discussion participation in six groups

Even a cursory look at the above chart reveals that individual participation in the discussion varied a great deal, although more so within than across groups. Some of the more active members assumed roles as leaders, yet no instances of extreme domination were encountered. Some members, after having participated well above their group average in the discussion, did not end up with their proposals ranked within the top three. Even ideas that received good support within the conversation and were clearly displayed in an Ideacell, were sometimes not selected among the top three. In

13 Based on the goal attainment and collective effort models reviewed in Chapter Two, it is tempting to speculate that participants who expended more effort than their peers would be likely to report low meeting satisfaction if their proposals did not qualify. This was not the case as shown by a qualitative analysis correlating these specific individuals with their reported SO.
some cases the converse was observed: top-ranked ideas proposed by participants who barely entered a comment in the discussion dialog. Some passive users seemed to lurk until it was time to post ideas in their Ideacell. (When asked by the researcher if they were still logged in, a couple responded they were “just thinking”.)

This observation is consistent with a conclusion (upon inspection of the voting patterns) that no overt instances of confirmation bias took place in these sessions. Participation inequality notwithstanding, a collaborative spirit predominated in most sessions. Supportive and encouraging remarks were frequent; critical ones were rare. Figures 14 presents a good example of social facilitation from the brainstorming chat of one session. In the last line, note the emergent playful banter alongside a reference to the group goal.

**Figure 14. Instance of social facilitation and enjoyment**

![Chat message example]

**Idea quality** No group output measure was included in this study’s research model. Final group output was therefore rated only for purposes of prize disbursement. Not a reliable measure for an empirical study, these scores are omitted from the discussion. Noteworthy is the substantial overlap of themes observed within and across groups. The most popular theme proposed (and selected) was that for the University’s co-op program (i.e. industry internships) *being a key advantage* (over the competing program).
7 Discussion

The following section distils the results from Chapter Six into useful implications for theory and practice. Noteworthy limitations of this study along with emerging methodological implications are given next, before concluding this thesis.

7.1 Key Findings and Implications

The overarching motivation of this study was to unravel the complexity of individual goals in relation to group goals, and of utilitarian versus hedonic values, in GSS meetings. A baseline objective sought to validate the goal-attainment model in the context of a virtual meeting on an idea generation and evaluation task. The model (Reinig, 2003; Briggs, Reinig and de Vreede, 2006) operationalizes meeting satisfaction as an affective arousal with respect to meeting outcomes and meeting process, and posits these two responses to be a function of perceived goal attainment (PGA) from a meeting.

An exploratory factor analysis (EFA) first verified the measurement model, then an SPSS regression analysis found the three hypothesized paths in the structural model to be positive and significant. SO and SP appeared to be each a function of PGA. The subsequent PLS analyses, however, revealed a lack of discriminant validity between SP and SO. For this reason, as well as due to prior findings that SP could impact SO (Green & Paul, 2002), it was deemed that the SO→SP hypothesis cannot be supported.

More central to the current investigation was exploring the motives that constitute PGA, and thus cause satisfaction, in GSS meetings. It appears, however, that even if we focussed on idea generation tasks (excluding a convergence phase), examining goal perceptions can be a challenge. The issue is quite evident from a recent critique by Litchfield (2008), who in the following excerpt unravels some of the ambiguities involved in analyzing goals in brainstorming sessions.

"The first rule—to generate as many ideas as possible—seems to constitute an obvious goal for quantity; however, it may also trigger goals for matching one’s outputs to others. The second—to avoid criticism—suggests a goal to suppress evaluation of alternatives,
but it may also prompt a goal to avoid conflict. The third rule—to combine and build—relates to a still broader variety of additional goals, including paying attention to others’ contributions, integrating ideas into categories, or even competing with others to suggest the best ideas. Finally, the fourth rule—to encourage free-wheeling—is most directly associated with goals for creativity, but it also might relate to other goals for personal status (e.g., to achieve status through humor or through providing the most creative ideas; or goals about affect (e.g., to put everyone in a good mood with some funny ideas)” (Litchfield, 2008, p. 651).

A similar variety of goals was illustrated in this study’s diversity of user comments. It is worthwhile to revisit some here in relation with the motives derived in Chapter Three.

First, note that traditionally utilitarian goals are about pursuing tangible external rewards like pay and promotion (Davis, Bagozzi, and Warshaw, 1992). Expressions of such motives were the exception; one appears in the dialog screenshot given in Figure 13 where one member has typed, *we need the 200 bux please.* Clearly distinct from such extrinsic motives are the intrinsic, sensory-hedonic stimulation driven by innate pleasure-seeking (Malhotra, Galletta, and Kirsch, 2008). In the current context this can be the goal of having fun around technology in a group setting, as in the quote: *it was cool to work with my peers to accomplish a task.* More original to this thesis was the introduction of a “social utility” motive, or pursuing social rewards like praise, need for belonging, and status-seeking. A good candidate for this category would be the comment: *felt good for my opinion being selected as the 2nd choice.* Finally, a comment that falls under social utility but also under the self-hedonic motive: engagement in optimal challenge to satisfy a competence need: *it was fun and I like thinking of advertising slogans... feels great that my slogan was ranked first.*

The potential role that a ‘social utility’ construct could play in predicting GSS satisfaction was the first research question of this study. To facilitate this inquiry, perceived instrumentality of one’s performance (INS) was conceptualized and tested as an antecedent to satisfaction with outcomes (SO).

7.1.1 Perceived Instrumentality

First, the study was successful in testing the measures for this construct. In an exploratory factor analysis using SPSS, the six indicators of INS loaded significantly on their respective factor, yielding the highest reliability of all four factors included in the analysis. As well, the INS construct exhibited good measurement properties in the
confirmatory factor analysis conducted with PLS. The study also examined the correlation between INS as a latent construct and the observed values of INS, or actual instrumentality of participants within their respective teams (Actual INS). The correlation was positive and significant (0.45, with paths to all other constructs either weakly or not at all significant). While expected, this finding is important. Prior seminal GSS studies, such as Connolly et al. (1990), have actually revealed negative correlations between objective and subjective measures of effectiveness.

Unlike the success with measuring INS, this study failed to support the key hypothesis that INS would predict satisfaction with outcomes (SO). It is unlikely that the experimental manipulation was the reason, however. While the between-treatment variation indeed failed to instantiate significantly different means of INS between the two conditions, sufficient variability was achieved via the *intra-group* scores for INS, across the entire sample. This was likely due to the enhanced evaluable that was built-in as part of the group collaboration interface of both conditions. Extremely high and low composite means for INS were not uncommon, and the standard deviations were as high as 1.5 on the Likert scale for many of the groups.

Why, then, the insignificant correlation between INS and SO? We should consider that the actual quality of group output was not included in the research model as a separate control variable. Such output is likely to differ between groups, and from this perspective, 20 groups is a limited sample. Alternatively, it could be that individual participants did not explicitly and directly attribute utility to their perceived instrumentality in the meeting. Lastly, a post-hoc statistical analyses was conducted to examine the relationship of INS with other constructs for any interaction effects.

A classic article by Baron and Kenny (1986) explains moderating effects as follows. Moderators (MOD) typically affect the direction or strength of the relation between an independent variable (IV) and a dependent variable (DV). Both IV and MOD are causal (i.e. antecedent) to the DV. A MOD, which may be a categorical variable such as gender but also a latent construct, explain the researchers, is typically introduced when there is an unexpectedly weak path between IV and DV. In contrast, mediators (MED) usually take place in strong IV→DV relationships, as in a case where a stimulus causes a response, but not before the "organism" intervenes and transforms the effects in some way. In essence, the article concludes, while a MOD specifies when certain effects will occur, a MED speak to how or why such effects occur.
In the current research model we are mainly interested in the unexpectedly weak relationship between INS and SO. In examining this relationship, one can refer to the study by Chin, Marcolin, and Newsted (2003). These researchers tested the relationship between perceived usefulness (USE) and behavioural intention to adopt a system (BI), including enjoyment (ENJ) as a predictor alongside USE. Without including the interaction effect into the model, their correlations were 0.52 for USE→BI and 0.27 for ENJ→BI. When ENJ was included as a moderator, the influence of USE dropped to 0.45. This interaction effect of -0.209, the authors point out, is between a small and medium yet twice the average for past IS studies. As Chin et al. (2003) explain:

In essence, when the usage experience is more enjoyable, the impact of perceived usefulness (at whatever level) on future intention to use is lower. Conversely, the less enjoyable one perceives the IT to be, the stronger the impact of one’s perception of usefulness on intention to use. This phenomenon is based on a cognitive consistency argument where the underlying rule is that when IT usage is extremely enjoyable, instrumental issues such as perceived usefulness ought not to come into one’s decision making criteria for future usage (pages 22 and 33).

The same analysis was carried out here for INS and ENJ with respect to SO, yet no interaction effect was detected. This is consistent with the mediating role of ENJ between INS and SO, but further discussion of the hedonic effects appears after we examine the role of the second utilitarian construct, perceived ease of use.

7.1.2 Perceived Ease of Use

The above-mentioned interaction analysis revealed perceived ease of use (EOU) to have a moderating effect in the relationship between INS and SO. Specifically, after a bootstrap procedure with 200 resamples, the –0.31 correlation was significant at the 0.01 level. What this medium effect seems to indicate is that the easier-to-use a system is, the less impact of perceived instrumentality on SO. Consider how such an effect is consistent with the goal attainment model. As stated in Chapter Two, perceived goal attainment (PGA) is an automatic and subconscious cost-benefit assessment (Briggs et al., 2006). Costs, in the context of GSS meetings, refers to effort in terms of cognitive load, part of which must be related to system use. Under this assumption, it stands to reason to expect participants, who rated the system as relatively easy to use, to have exerted less effort on the task than others. Since less costs were incurred by these participants, as it were, they cared less how instrumental their efforts were. Future
researchers might consider testing the viability of this intriguing line of reasoning with respect to INS and EOU.

What about the main effects of EOU? The construct represents a key utilitarian aspect of perceived system quality, and its inclusion is warranted given that the system deployed in this study is novel. We hypothesized that EOU would be influenced by DES and that EOU itself would influence SP. Both expectations were confirmed, although the variances explained from both paths (DES→EOU and EOU→SP) was merely eight percent. The introduction of ENJ in the relationship between EOU and SP did not reduce the latter’s relationship as much as the reduction in INS→SO from the inclusion of ENJ. The influence of EOU on SP, then—albeit relatively small—seems to be a more direct effect relative to INS→SO.

Such a conclusion for a small yet robust influence from EOU to SP is logical, if we consider that a certain minimum level of usability is clearly an absolute prerequisite for a satisfying experience. This reasoning is also supported by some open-ended responses indicating rather low SP, such as “the system kept freezing up”. These were very rare (and therefore not mentioned in the qualitative section) yet not surprisingly, resulted in very low composite scores for both EOU and SP.

7.1.3 Perceived task enjoyment

The third and fourth research questions examined the roles of hedonic antecedents to satisfaction. Perceived task enjoyment (ENJ) was first proposed as representative of such an antecedent. Akin to intrinsic motivation, perceived enjoyment has been operationalized by the IS literature in one of two ways: enjoyment with respect to the task (Koufaris, 2002) or to the system (Chin & Gopal, 1995). In this study, ENJ items referred to the task, since perceptions of overall “fun” were of interest. The exogenous aspects of intrinsic motivation were already being tapped in by DES and EOU. The results clearly show ENJ to be a highly significant predictor not only of SP, but of SO as well. Nearly one half of all participants expressed “perceived enjoyment” from the sessions, via words like fun, great, interesting, awesome, or cool. Note, as well, the ludic behaviour evident in the discussion shown in Figure 13.

From the second PLS model calculated with both satisfaction measures combined, shown in Appendix H (top), we can see that ENJ accounted for nearly one half of the overall meeting satisfaction (SAT). The one study including an enjoyment construct in a
research model tested with GSS use is Chin and Gopal (1995). Perceived system enjoyment in that study was positively and significantly correlated with, and accounted for 15% in the variance of, intention to adopt the system. This effect was twice smaller than the effect from Relative Advantage (an instrumental construct similar to perceived usefulness), whereas in the current study the explanatory power between the key utilitarian and hedonic construct is reversed. Unlike the results by Chin and Gopal (1995), here ENJ appeared to fully mediate the effects from INS to SO. When INS was regressed on SO individually and with no other antecedents, the resulting correlation was significant; with ENJ added as a mediator, the INS→SO path was drastically reduced to an insignificant 0.1.

In conclusion, the strong predictive power of ENJ, supported by qualitative data, imply that ENJ must have actually caused a sizeable portion of meeting satisfaction. The inclusion of ENJ in future research models of GSS meeting satisfaction is clearly warranted. From the qualitative data we further conclude that—while the discussion was generally perceived as most fun overall—the voting process was the most exciting part of the task.

7.1.4 Interface design

Perceived interface design aesthetics (DES) was included in this study’s research model due to its robust hedonic effects in prior TAM studies (Cyr, Head, and Ivanov, 2006; Cyr, Hassanein, Head, and Ivanov, 2007). As expected, DES correlated positively and significantly with both ENJ and EOU. DES accounted for about a fifth of the variance in ENJ (as much as INS) but less so in EOU. This is understandable given that EOU is mainly composed of non-affective usability perceptions (Davis, 1984). The results of this study support findings from prior research arguing for the importance of improving the system interface not only via enhancing the traditionally important EOU (Sia, Tan, & Wei, 1997; Martz & Shepherd, 2004), but also through hedonic components such as perceived aesthetics. However, whereas most prior research examining effects of aesthetics was primarily concerned with hedonic systems for mostly solitary use (van der Heijden, 2004; Cyr et al., 2006; Cyr et al., 2007) the current study demonstrates the importance of aesthetics for systems supporting group work, traditionally considered a utilitarian activity. From the relatively lower importance of EOU compared to DES in predicting ENJ, we can infer that increasing the affective quality of a system via graphic
design could be an effective method of fostering meeting satisfaction. One implication for GSS system designers is to transcend a sole focus on usability and incorporate affect into the interface design equation. This study’s qualitative data also reveal two dimensions of affect. While a number of comments revealed instances of the GSS being appreciated in terms of pure aesthetics (as in, nice coloring gamma), we count at least as many instances of the social proxies and voting system appealing to participants for their identifiability-evaluability role. (Recall respondents saying they liked how easy it was to distinguish which users were making each comment, to actually submit a picture for everyone to see, as well as seeing how much your idea was accepted.) What these comments illustrate is the role played by the graphical features of evaluability in inducing an affective response as well, one that is also part of the social utility motive.

It is important, however, for future research to elucidate the benefits of interface design irrespective of task structure. One respondent commented that, even though it was hard to brainstorm without being face-to-face, the voting was fun. A future study could attempt to rigorously examine if, indeed, a visual form of voting incites more affect than a numerical system may. The current study is a notable contribution nonetheless, as almost no studies have been conducted on GSS voting tools (Cheng, Li, and van de Walle, 2001). An examination of the two facets of design: perceived visual attractiveness (van der Heijden, 2004) compared to graphic design more akin to information visualization (Toth, 1994; Tufte, 1997; Card et al., 1999) is also likely to provide useful insights from a design practitioner perspective. Infusing such rigorous investigations into system design practice may lead to the eventual deployment of systems no longer assessed as being “unimaginative and awkward”, in the words of Greenberg (2007) quoted in the Introduction chapter.

7.1.5 Managerial implications

The findings of this study have important implications for teamwork managers as well. We know that a predominantly normative view of teamwork is no longer relevant in today’s knowledge-based organizations. That work should be at least partially enjoyable is obvious (Csikszentmihalyi, 1996), but the same assumption does not seem as intuitive for team work (Roszkiewicz, 2007). The design of the virtual group collaboration environment could therefore play a critical role in determining the level of enjoyment experienced by meeting participants. The importance of a well-designed graphical user
interface has been demonstrated for online consumer contexts (Traktinsky, 2004) but its role in the GSS literature has been overlooked. This study has provided qualitative evidence that GSS environments designed to support social translucence are likely a better alternative to traditional and anonymous computer-mediated communication. Anonymous settings would surely still be appropriate in groups where hierarchy and conformity are a factor of teamwork, as in military contexts (Agres, de Vreede, and Briggs, 2005). On the other end we have design firms like IDEO (Sutton & Hargaddon, 1995-6) where the playing field is level and rewards based on overt originality. Somewhere in the middle of such a continuum would be management consultancies, but even there, recall the study of Orlikowski (1993), who found that pooling everyone’s contributions was one reason why Lotus Notes was not adopted.

Some implications also emerge from a post-hoc analysis that explored the significantly higher responses (see shaded areas in Table 11) of INS from Qualified vs. Non-qualified responses, and of higher SP scores by females compared to males. The gender difference, while substantial and somewhat intriguing, did not manifest in any of the PLS paths. It is not the case that design perceptions for females were more predictive of satisfaction than for males. Nor did a detailed parsing through all the responses in the current study reveal any notable qualitative difference in design elements preferences between males and females. In Cyr et al. (2006, 2007), for instance, females tended to favour softer, more emotional aspects of the interface, while the preferences of males were more utilitarian. The lack of evidence for any major differences in design perceptions between genders in the current study may have positive implications for GSS system designers, who need be less concerned with interface customization.

The analysis next looked at the INS reported by Qualified and Non-qualified team members. Much like in the gender analysis, no differences were found either in the PLS or qualitative data with respect to design preferences. In other words, it is not the case that mostly participants whose ideas ended up being selected were the ones who liked the voting system. This finding is further supported by several positive open-ended responses, and may have the following positive implication for system designers and managers: conditions of social translucence and high intra-group evaluability do not necessarily lead to a “zero-sum” game, as it were, where satisfaction increases by winners tend to be cancelled out by commensurate decreases in losers.
7.2 Limitations and Methodological Recommendations

Outlining all limitations of such an interdisciplinary study would require a lengthy chapter. Earlier in this one, we discussed a key conceptual limitation of examining perceived goals in group brainstorming. This section focuses on methodological limitations, suggesting remedies whenever possible.

7.2.1 Threats to external and internal validity

First of all, student groups cannot be expected to have the same vested interests as real employees (de Vreede, Briggs, Duin, and Enserink, 2000). Despite the experimental realism aimed for in this study, we can at best generalize its findings to groups of concerned participants asked to develop proposals on some issue relevant to their background. A more serious threat to external validity is that single-test lab experiments cannot accurately identify dynamic issues like learning curves, and the novelty factor (Suchman, 1987). Inherent in campus-based studies is also a self-selection bias, when volunteers from a student population have different individual traits from others that were approached yet opted not to participate (Wixom & Todd, 2005). Cultural traits can also be a factor influencing teamwork, as shown by several studies (Earley, 1989; Tan, Wei, Watson, Clapper, and McLean, 1998; Lucas, Diener, Grob, Suh, and Shao, 2000).

Moving onto more internal factors, we should first consider that group collaboration outcomes can only partially be attributed to experimental conditions (de Rosa et al., 2005; Mejias, 2007). In this study, one potential group-related threat are the numerous mentions of enjoyment related to peer interaction. Socialization, after all, is not the main objective in most tasks. Mukahi and Corbitt (2004) actually found that level of chatting during a GSS meeting significantly influenced SP and SO (with correlations of .46 and .27, respectively). While this limitation is inherent in naturally-occurring interaction, future studies should at least control for group cohesion. Perceived group cohesion has been shown to be a strong predictor of SP (Chin, Salisbury, Pearson, and Stollak, 1999)—even stronger than individual characteristics (Srite et al., 2005). (In this study’s questionnaire, items for group cohesion were omitted due to concerns of excessive length for a web-based contexts.)
One way to eliminate some group-related artefacts, as well as reduce the cognitive load that some participants complained of, is to use smaller groups. Four to six-member teams are recommended over the six to eight figures, as in this study. A number of participants also complained of not having enough time. It appears that 30 minutes should be given for tasks with both idea generation and selection, although studies that run longer than an hour (including tutorial and survey) can be hard to recruit for.

In light of these limitations, researchers could even consider a GSS simulator as an alternative to naturally interacting ‘real’ groups. In a GSS simulation (Dennis et al., 1997) subjects are tested individually, yet led to believe they are interacting with remotely located team members. Exposing each participant to the same socio-technical environment may approximate the high internal validity common to studies of solitary IS use. On the other hand, designing a realistic (i.e. credible) GSS simulation will obviously require removing the real conversation phase of the task. Researchers interested in developing a simulation should review the various ‘brain-writing’ interfaces designed and tested in Aiken, Rebman, and Vanjani (2007). Last but not least, many of the limitations noted above could be eliminated if the task involved either idea generation or idea selection, but not both. While a complex task was part of this study’s objective, researchers wanting to replicate this study are strongly advised to simplify the task.

7.2.2 Measurement limitations and potential remedies

Generally speaking, survey instruments are hardly the most accurate measure of affective response (which can be fleeting, difficult to verbalize, but easy to fake). While using galvanic skin response has been suggested for IS contexts (Picard, 1997), it may be more practical to improve on the already established Likert or semantic differential scales. Masthoff and Gatt (2006), for instance, measured affect in group recommender system use, by having subjects rate their mood on a slider going from a sad face to a happy face. Clearly, such methods bring their own set of limitations. Two-dimensional scaling could be a boon, however, to the oft-critiqued field of psychometrics, considering so much recent evidence that human cognition is primarily based on spatial reasoning (Hunt, 2007; Pinker, 2007).

Most IS research methods suffer from another serious limitation: linear regression can only demonstrate that correlations are in accordance with the directions assumed by the theory. Establishing actual causation, however, also requires demonstrating
temporal precedence of the independent variable, as well as the isolation of other
influences (Gefen, Straub, and Boudreau, 2002). As this is difficult to show in structural
models with conceptually coupled constructs, Sun and Zhang (2006) recommend using
Cohen’s path analysis as an alternative. This, or other analytical techniques, may be
worthwhile to consider in future research inclusive of the SO and SP constructs.
According to the goal-attainment model (Briggs, Reinig, and de Vreede, 2006)
participants may misattribute the positive affect derived from outcomes to the process
instead. Hence their SO→SP hypothesis, which is the inverse to findings by Green and
Paul (2003) that outcomes are mostly a function of process in terms of fairness
perceptions. Now, consider how temporal precedence is more likely to occur in a
SP→SO relationship. Process, by virtue of its temporal nature, spans the entire session,
whereas outcomes are not fully realized until the meeting’s ending. This would apply
especially to voting tasks. Future studies should therefore take into consideration how
the nature of the experimental task determines the temporal nature of process, and its
relationship to outcomes.

A more specific recommendation can be made with respect to the SP scale, which
this study borrowed directly from Briggs et al. (2006). SP items included four statements
of positive feeling toward: i. the way the session was conducted, ii. the session’s
process, iii. the procedures used, and iv. the way the activities were carried out. By
referring to procedures, the third item (i.e. SP-3, as given in Section 1.3.4) is clearly
most specific of all, and likely to draw more variation in tasks involving idea selection. In
most idea generation tasks some variant of Osborn’s rules is likely to be followed; yet
such well established protocol exists for idea selection (Cheng, Li, & van de Walle,
2001). Moreover, idea selection by nature necessitates idea rejection. Thus,
participants are more likely to form opinions about process as it relates to idea selection
rather to idea generation. The SP scale, in sum, may benefit from further refinement.

7.2.3 GSS treatment critique

We could speculate as to why the study’s GSS treatment manipulation failed to
induce higher scores of perceived instrumentality (INS) in the experimental condition.
Note that the mechanism was not based on theoretical grounding and precedent, but
merely on the presumption that pictorial representations are richer (in content) and more
salient (in form) than text. Being more impressive in form, pictorial contributions would
be more noticeable; by virtue of their depicting more information, they would also be perceived as more *unique* than simple text. Perceived uniqueness, we should recall, was argued to be a component of INS; hence the expectation for positive correlation. A post-hoc analysis of the one INS item referring explicitly to uniqueness (i.e. INS-2 in section 4.2.1), however, revealed an insignificant difference in mean INS scores between conditions. Useful insights may be derived from Hess et al. (1995-6), who found a significantly negative relationship between the independent variable of perceived vividness and the dependent variable of perceived involvement. Perceived vividness—the ability of the interface to produce a sensually-rich mediated environment, was instantiated by adding an auditory channel (Hess et al. 2005-6). Further discussion of how to induce variations in INS may not be worthwhile, given lack of evidence for the hypothesized role of INS in this study’s research model.

We end this section by pointing out another limitation: lack of knowledge as to whether any cognitive load had resulted from the image search process in the PIC condition. Instead of relying on Google Search, a future experiment involving pictorial brainstorming should instead provide participants with a set of previously collected pool of images. This method should increase the study’s validity in two ways. First, participants in the experimental condition would likely spend similar amounts of time and effort selecting images. Second, the finite number of images to choose from is likely to generate less variation in pictorial output across teams. What the current PIC treatment did demonstrate, at least, is that an image uploading feature in GSS is actually easier to use than one might suspect. This conclusion can be inferred from three sources: the generated content (as everyone successfully submitted an image); the relatively high EOU scores in the PIC condition; and a number of open-ended mentions of enjoyment derived from the image uploading.

### 7.3 Conclusion

The results from this thesis research may appear to be rather mixed. The addition of a pictorial brainstorming feature in the experimental treatment—although well utilized by participants—failed to induce higher scores of perceived instrumentality (INS). The key hypothesis that INS would be significantly and positively correlated to satisfaction with outcomes (SO) was not supported, either. On the other hand, several significant
findings serve to compensate for the lack of structural viability of INS and the failed attempt to manipulate it.

First, the subjective measures of INS correlated positively and significantly with its observed measures, and sufficient variation of INS was exhibited within groups and for the entire sample. The latter was likely a result of the enhanced evaluability that was purposely built in both GSS interfaces, and justified proceeding with the structural equation model (SEM). This leads to the most important finding in this study, statistically and conceptually: the robust role played by the hedonic pathway, DES→ENJ→SAT. The research model unequivocally demonstrated the strong predictive power of perceived task enjoyment (ENJ) with respect to meeting satisfaction, and shed sufficient empirical evidence that intrinsic motives—whether endogenous or exogenous—play a key role in the formation of satisfaction from GSS use. Future GSS studies on meeting satisfaction should definitely include a hedonic construct in their research models.

Last but not least, the qualitative data from the open-ended survey questions revealed more than expected. The variety of motives contained in over one hundred user comments is indicative of the multifarious nature of goal perceptions in virtual teamwork. Much more remains to be unravelled in understanding the interplay between individual and group goals and utilitarian and hedonic motives in GSS meetings. Yet mixed and even conflicting results are the norm in this field. A theory can be deemed useful if it resolves paradoxes, unifies existing literature, and creates new insights in the field (Briggs, Reinig, and de Vreede, 2008). At the very least, the current study attempted to bridge the gap between a normative view of job performance with views of positivist psychologists such as Zhang (2008). Also infused were theories from social psychology into a design practice perspective.

The mixed results notwithstanding, the study described in the preceding pages should serve as a solid stepping stone for future interdisciplinary research.
8 Bibliography and Appendices


Sun, H. & Zhang, P (2006). The role of moderating factors in user technology acceptance. *International Journal of Human-Computer Studies, 64*(2), 53-78.


APPENDIX A  TECHNOLOGY ACCEPTANCE MODELS

Diagram showing the relationships between perceived usefulness, attitude towards using, behavioral intentions to use, and actual system use. The diagram includes external variables influencing perceived ease of use, which in turn affects perceived usefulness.

Additional diagram showing the relationships between completeness, accuracy, format, currency, reliability, flexibility, integration, accessibility, timeliness, system quality, information quality, information satisfaction, system satisfaction, usefulness, attitude, intention, ease of use, and actual use. The diagram includes coefficients and R-squared values for each relationship.
### APPENDIX B  THREE EBS EXPERIMENTS ON EVALUABILITY

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Feedback mechanism</th>
<th>Comparison standard</th>
<th>Dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shepherd et al. (1995-6)</td>
<td>Goal setting</td>
<td>External fixed standard of productivity</td>
<td>Group productivity</td>
</tr>
<tr>
<td></td>
<td>Social comparison</td>
<td></td>
<td>Affective reward</td>
</tr>
<tr>
<td>Jung et al. (2005)</td>
<td>Identifiability</td>
<td>Within-group productivity rates</td>
<td>Individual Productivity</td>
</tr>
<tr>
<td>Connolly et al. (1990)</td>
<td>Evaluative tone</td>
<td>Confederates submitted positive or critical comments in discussion</td>
<td>Within-group idea quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Idea quality</td>
</tr>
</tbody>
</table>

In their experimental collocated EBS sessions, an electronic graph was projected on the front screen, displaying in real-time how many lines of text had been contributed by group members in total since the start of the session. A horizontal line in this graph showed the ‘baseline’ performance of a typical average group. The background colour of the graph was varied also, whenever the group started generating ideas at a rate that would exceed this baseline. The final variation was a series of announcements throughout the session as to how much time was remaining, which used either a dull or encouraging comment. All these mechanisms allowed for the manipulation of two independent variables: sense of competition and goal difficulty (Reinig et al. 1995-6, p. 177).
APPENDIX D  RECRUITMENT POSTER

How would you present SFU’s BBA as the ‘business program of choice’ to SkyTrain riders?

Imagine the following problem: SFU’s BBA program is losing high school senior applications to UBC’s Bachelor of Commerce. Using what you know about these programs and the target audience, your team of nine should brainstorm ideas for advertising SFU’s BBA in the SkyTrain. Do not aim for a polished ad, but simply describe an appealing message. The 20 minute online session will have three phases:

1. Brainstorm in the chat window on possible directions. Be open-minded and build off each other’s ideas.

2. Distill the ideas into a headline or visual description: your ad concept.

3. Finally each member votes on the team’s three best concepts, ranking their first, second, and third choices.

Two domain experts will later judge and compare each team’s top three choices. At least two winning teams will each receive $2000, distributed equally among members. This is separate from the 3% extra credit for BUS978, which all participants will receive. (Participation means you must be logged in the entire session, and fill out the one-page survey at the end. Flash Player 8 or 9 is also required.)

Sign-up at: sfubba.blogspot.com
APPENDIX E  PROPOSAL RATING SYSTEM

All proposals were rated by two independent judges, who held positions as creative directors in local advertising agencies. They each judged the proposals separately, and had no involvement with the study.

Judges were given two sets of proposals, as per the PIC and TXT conditions. Each set contained 30 proposals, comprising all top-three ranked proposals from each team (ten teams per condition). Each proposal consisted of phrases or sentences up to a maximum of 50 words. In addition—and only for the set from the PIC condition—a small image appeared alongside the text proposals. Each entry from this set was thus judged holistically, by considering the text in combination with the image.

Assignment of scores began only after judges went through the entire pool of 60 proposals. Within each set, the 30 proposals were randomized and anonymized, so that each proposal—regardless of which team it belonged or which rank it was given—was rated independently. Judges then go over each proposal a second time one by one to assign scores, first completing the TXT set and then the PIC set. In this process judges apply their own judgment and expertise, but also take into account the pool of ideas proposed by all teams within the respective set (i.e. condition).

The criteria used were creativity (the extent to which the idea is novel, out of the ordinary) and practicality (the extent to which the idea is practically feasible). Scores were assigned as a combination of these two criteria, and as follows: 0 = Unacceptable; 1 = Mediocre; 2 = OK to good; 3 = Very good; 4 = Exceptional. When all 60 proposals have been assigned scores by the two judges, a team’s total score is then calculated by the researcher, and involves adding six numbers: scores for each of the three ideas by each of the two judges.

A team could thus potentially receive 8 on each proposal (if each judge rated it as exceptional), yielding a maximum total score of 24. This figure would be compared to the nine other scores from the respective condition. No ties within sets were encountered. Thus, in each condition there was clear winner, although in both conditions that score happened to be 20.
APPENDIX F  SCREENSHOTS FROM TUTORIAL FOR PIC GSS

1. Brainstorm with your team in the chat window.
   - For more speed and beauty, include each other's ideas.
   - Your team members are shown at the right edge of the window.

2. Present your main idea on text or image.
   - Place ideas to the left and right of a headline.
   - Your ideas may be presented with bullets or another visual.
   - It is recommended to find interesting images on Google for relevant data.
   - uploads files or images to your server.
   - You may upload a PDF, PNG, and JPEG.

3. Pick your three favorite ideas, then rank them.
   - Vote for your top three ideas, ranking them one by one.
   - Click a rank button first, then measure or person's idea.
   - Add a border around the selected box below.
   - Vote for the combination of visual and headline to see your vote, and do the same for your other choices.

Results are ready when all three ideas fall into the grids. The three ideas with the highest grids will be considered as your team's selected choices, and assigned for the competition.
APPENDIX G   CONSENT FORM

The University and those conducting this study subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This research is being conducted under permission of the Simon Fraser Research Ethics Board. The chief concern of the Board is for the health, safety and psychological well-being of research participants. Should you wish to obtain information about your rights as a participant, or about the responsibilities of researchers, or if you have any questions, concerns or complaints about the manner in which you were treated in this study, please contact the Director, Office of Research Ethics, by email at hweinber@sfu.ca or phone at 604-268-6593.

You are about to voluntarily participate in a study on web-based, group idea generation and evaluation. This study is part of Alex Ivanov’s doctoral dissertation, and you will be asked to answer questions in a survey about your experience with the session. You were shown an online tutorial on how to use the computer system, and have read the task description. Your group is encouraged to compete for one of two $210 prizes. The final proposals that your team generates and selects will be evaluated by two independent judges this weekend, according to the proposals’ creativity and practicality. If your team is a winner, $30 will be paid to each member of your team.

Your individual participation, comments and answers in today’s study will NOT influence the way you are evaluated in this class. Your responses to the survey questions will be anonymous. Only I will have access to the responses you provide in this survey. Your real name is required only for prize disbursement. By clicking the button below, you indicate your consent, that you were informed about and understand the procedures of this study, and that you voluntarily agree to participate. If you have any questions or would like to see the results from this study, email aivanov@sfu.ca.

Title: Web-based, group idea generation and evaluation

Investigator Name: Alex Ivanov; School of Interactive Arts and Technology

Having been asked to participate in the research named above, I certify that I have read the procedures describing the study.

AGREE and SUBMIT