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Generating Group Agreement in Cooperative Computer-mediated Groups: Towards an Integrative Model of Group Interaction

**A THESIS SUBMITTED TO THE DEPARTMENT OF MANAGEMENT
SYSTEMS OF THE UNIVERSITY OF WAIKATO**

By

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GENERATING AGREEMENT IN COOPERATIVE COMPUTER-MEDIATED GROUPS

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Nasrudin said:

“One day a marvellous horse was brought before the prince at whose Court I sat. Nobody could ride it, because it was far too mettlesome a steed. Suddenly in the heat of my pride and chivalry I cried out:

*‘None of you dare to ride this splendid horse; none of you!
None of you can stay on his back!’*

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And I sprang forward.”

Someone asked:

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“What happened?”

He replied:

“Oh, I couldn’t ride it either.”

(Shah, 1966)

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ABSTRACT

This study addresses the problem of generating agreement in computer-mediated groups.

The key entities of group interaction are proposed to be *the task*, *the other individuals*, and *the group*. Extending this three way categorisation across the input-process-output framework suggests an *integrative model* with three processes (task resolution, interpersonal relating, and group representation), three levels of social influence (informational influence, personal influence, and normative influence), and three types of output (task results, relationships, and agreement).

The background upon which these processes operate is the communication setting. A proposed taxonomy of communication settings suggests the natural setting for generating electronic group agreement is asynchronous, many-to-many interaction.

Describing non-task group activities as “process losses” denies group combining behaviour, and raises the “group effectiveness paradox”, where groups expend more effort to produce less. The integrative model accounts for group activities without paradox.

The generation of agreement in cooperative groups is attributed to the “identification” of individuals with the group. Members who identify with a group, tend to accept the group's decisions as their own. This process may use relatively simple position information embedded within multi-threaded communications, rather than complex “social” information. If so, computer-mediated groups can enact agreement across plain text networks.

Software was written to simulate asynchronous, many-to-many exchange of position information. Anonymous computer-mediated groups sat multi-choice tests under blind, group aware and confidence aware conditions. The exchange of position information alone produced a significant change in agreement, although neither medium nor exchanged information were “rich”, no reasons were given, and there was no personal “presence” or discussion.

It was concluded that computer-mediated groups can enact agreement. The method adopted, of isolating one process within a single communication setting, is recommended for research. However for practical implementation, a balance of all three processes is suggested, as all have a role in group interaction.

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1. INTRODUCTION

1.1 The importance of groups

For as long as there have been humans there have been groups, and even before we became what could be described as human, the genus *Homo* probably operated in groups. Human beings are group animals. This observation applies as much today, in civilised, technological society, as it did thousands of years ago in primitive hunter-gatherer cultures.

Therefore it is no surprise that whenever public or private institutions face important tasks, those tasks are usually assigned to groups (Hackman and Kaplan, 1974; Blackburn and Rosen, 1993). A study of 950 managers and technical professionals (from junior, middle and senior management) found that the average participant spent one quarter of their working time in meetings (Mosvick and Nelson, 1987). Another study found that managers spend up to 80% of their time communicating and Chief Executive Officers spend more than half their time in meetings (Mintzberg, 1973), leading to estimates that group meetings account for 30-80% of a general manager's time (Hymowitz, 1988). More recent studies suggest that most meetings are small, and 40% of all meeting time involves dyadic (two person) communication, so conference room style meetings probably account for only about 20% of a manager's day (Panko, 1991). Project teams (temporary groups set up for a particular purpose) are attaining increasing prominence as a basis for organisational activity in the *virtual corporation* (Davidow and Malone, 1992), and many leading organisations are already structured around such groups (Goshal and Bartlett, 1995).

1.2 Improving the group interaction

Given the pervasive nature of groups, it is not surprising that the question *How do groups work?* has been under investigation for a long time, followed very closely by the related question *How can we make groups work better?* Techniques for improving group activity have a long history, beginning with manual techniques involving whiteboards and show cards, such the Delphi Method (Dalkey, 1969), up to today's *groupware* (a loose term derived from "group software"), using sophisticated computers, software and networks. Since such systems aim to improve group interactions, the term "group support" has developed. Electronic groupware, beginning in the late 1980's (Holtham, 1994), was thus based on a tradition of intervention in group interaction processes that has had a long and chequered history (Linstone and Turoff, 1975). The culmination of this tradition has been the so called "Decision Rooms", which aim to combine the best aspects of face-to-face meetings and computer support, to deliver a better way of meeting.

1.3 The vision of electronic groups

Workers in the area of computer-mediated groups have a vision of real social groups interacting through computer networks. We imagine that in the future people will wonder how the information workers of today managed, when so much time was wasted travelling to and from face-to-face meetings, and when individuals spent much of their time in those meetings doing very little, just as we now wonder how people managed before the telephone. We imagine sophisticated, distributed computer networks that allow people to meet "anytime, anywhere", where the computer tells them what's new and what's due, where people write, draw, speak, and video information to each other, and where the restrictions of time and space are removed. The only problem with this vision is that it seems to be a long time coming about.

1.4 The problem with electronic groups

Even though many people are aware of the need to integrate electronic group support within the normal organisational information system (IS) environment, which is usually a distributed computer network (Nunamaker et al., 1989b; Turoff, 1991), successes have been very rare, if any (Grudin, 1994). Grudin cites a panel review of leading groupware researchers where Robert Kraut wrote, “the only successful CSCW [computer supported cooperative work] application has been E-mail”, and Lee Sproull wrote “groupware will never be practical and widely used in organizations if it follows its current trajectory.” (Ensor, 1990). A review of group decision systems concluded that after a decade of development:

Their use is far below what could be expected given their need and promise.

(Kraemer and King, 1988)

and a later review does not suggest any significant change in this status (Grudin, 1994).

Initial attempts to introduce computer mediation for distributed, task-orientated groups were, overall, relatively unsuccessful, both in the field (George et al., 1992) and in the laboratory (Gallupe and McKeen, 1990; Dufner and Hiltz, 1990; Cass et al., 1991; Jessup et al., 1987). These results reflect earlier general group support findings (Jarvenpaa et al., 1988; Watson et al. 1988; Zigurs et al., 1988). By contrast, same-time, same-place decision room studies have reported uniformly successful results (Nunamaker et al., 1989b; Grohowski et al., 1990), but require a carefully pre-planned, expertly facilitated, face-to-face meeting to be operating before computer support is applied, and offer no control groups for comparison.

In analysing the above results it will be suggested that a common factor in both the failures and successes is the inability of electronic groups to generate agreement, implying that the social forces which operate in face-to-face groups either cannot operate in electronic groups, or have not been correctly invoked by current computer-mediated group systems.

The relative lack of success with distributed electronic groups has been disappointing for researchers and practitioners alike, given that organisations are increasingly seeking to create and use groups whose members are at different physical locations and available at different times (being perhaps in different time zones).

1.5 New directions for computer-mediated groups

It has been suggested that the main obstacle to practical progress for group support system (GSS) practitioners and theorists alike, is a lack of understanding about how individuals, groups and organisations really work (Grudin, 1994).

Some researchers have pointed out the inherent failings in the *technocentric* approach or *technological determinism* (Lea, 1991), which regards group interaction as deriving from the physical nature of the communications environment. Such an approach can be taken to imply that the new electronic environment creates new forms of human interaction, where the old rules no longer apply (e.g. Dennis et al., 1991). An alternative position, which will be explored in this study, is that the technology, or communication medium, only provides the *communication setting* within which normal human interaction processes operate.

The narrow conceptual foundation adopted by many researchers and practitioners has also been criticised:

Most efforts have focused on the relatively narrow, rational view of the decision process But as experience shows, this is limited in its utility because it specifically excludes the baffling non-rational or quasirational behaviours individuals often exhibit.

(Kraemer and King, 1988)

Such *systems rationalist* approaches regard groups as rational processors of information, much as factories process raw material (Lea, 1991), and the criticism is less that this approach is incorrect, than that it is insufficient, because it does not recognise the non-rational, non-productive, off-task, activities of individuals and groups.

This study recognises the validity of the above points. It therefore not only focuses on human processes, rather than technological context, but also seeks to recognise aspects of human nature beyond systems rationalism. It will explore the idea that “non-productive”, off-task, activities may be productive in their own way.

Although this study began in a relatively narrow focused area (agreement in computer-mediated groups), it has become, to a greater degree than expected, a study of human nature, perhaps because human nature has a major impact on groups, whether electronic or not. The combination of psychology and technology seems to lie at the heart of electronic group research.

This study uses both *interpretive* and *objective* approaches. The theory is derived from an interpretive perspective, while the experiment follows an objective approach. The model proposed is *integrative*, because it seeks to represent not just the rational aspects of human behaviour, but human behaviour as a whole. Human beings may be at times rational and productive, but at other times they are emotional, irrational or playful. These other aspects of humanity not only need to be brought into our theoretical models, but also into groupware at a practical level.

1.6 An integrative model of group interaction

In addressing the issues of electronic groups it is necessary to take a step back, and reconsider the original question *How do groups work?* Over twenty years ago, two of the leading small group researchers of the day stated:

In sum, there is substantial agreement among researchers and observers of small group tasks that something important happens in group interaction which can affect performance outcomes. There is very little agreement about just what that “something” is . . .

(Hackman and Morris, 1975)

Today there seems to be still no generally accepted theory of *what interacting groups do*, and one wonders if we are not basically in the same position. For example Olson et al. (1992) describe the need for “a deep understanding of the phenomena of group work” (Olson et al., 1992, p252) as a requirement to move beyond the first stage of research in this area. It is difficult to support a group interaction, or anything else for that matter, without a clear understanding of what it is that is being supported.

Therefore this study begins with a review of previous GSS models, in order to provide a conceptual framework for the literature review that follows. This review leads on to an integrative model of group interaction, which has implications for the larger issue of how groups work, and leads to the proposition that there are three levels of operation within the black box of group interaction.

The integrative model will suggest that much early research into how to “improve” groups may have really been addressing the question *How can we improve the group task process?*, looking at one aspect of group performance, rather than group performance as a whole. A focus on a single process - the task resolution process - seems to have carried over into the design and implementation of group support systems, most of which tend to effectively recognise only one type of group output: task output. A key theme of this research is that there are other things going on in group interaction apart from task resolution, other processes that must be recognised, studied and supported.

To summarise, it is proposed that the behaviour of groups in an electronic environment arises primarily from the nature of individuals, and therefore psychological, rather than technological, factors may be limiting development in theory and practice:

The most significant and intractable obstacles to the implementation of groupware will not be technical, but will come from a source much deeper and long established than computer science - human nature.

(Dale, 1994, p186)

The proposed integrative model aims to reflect the compound and complex nature of human beings, to look beyond technical effects to social effects (Jones, 1994), and abandon “technological utopianism” in favour of “social realism” (Kling, 1991).

1.7 The experiment

Based on a taxonomy of communication settings, it will be shown that electronic media generally support asynchronous forms of communication, which can be one-to-one (E-mail), one-to-many (bulletin boards) and many-to-many (voting) interactions. It will then be suggested, somewhat contrary to the received view, that what we call voting is a slow, formalised expression of what can be a highly condensed and dynamic form of group communication, which may form the basis of agreement generation in face-to-face discussions. It will be suggested that the critical area of electronic group operation is many-to-many, asynchronous interaction. It will be predicted that the dynamic exchange of simple group member position information should allow groups, interacting only through the computer, to generate agreement.

This proposal contradicts views that the enactment of group agreement is a relatively complex social activity, which requires a rich medium, such as face-to-face interaction, to transfer complex social signals. From such a viewpoint, the absence of complex socio-emotional cues in computer-mediated text implies that electronic groups interacting only through lean computer channels will be unable to enact agreement. It also implies that only when computer software and hardware can reproduce the full richness of face-to-face audio-visual sensation will real groups be able to use electronic networks to generate agreement and resolve conflicts.

The integrative model separates Bale’s (1950) “socio-emotional” variable into separate “emotional” and “social” processes, and proposes that the latter, not the former, is the main method for the generation of agreement in groups. The prime force for generating agreement in groups is proposed to be based on normative influence, resulting from awareness of the positions taken by other members of the group. This information is not complex, and does not require a rich medium for transmission.

The position explored in this study, based on the integrative model, is:

That electronic groups, interacting only across a plain text computer network, can powerfully generate agreement, without any discussion and without any form of emotional or personal interaction.

The method chapter provides the experimental method to test this position, and the analysis chapter reports the results of that test. If this position is true, it suggests that the social dimension is not necessarily absent from electronic groups, and real group cohesion and agreement may be generated on distributed, plain text computer networks.

2. CONCEPTUAL FRAMEWORK

The main challenge encountered in undertaking a literature review in this area was the lack of an overarching theory, or even a common conceptual model, not only of electronic groups, but of groups in general (Valacich et al., 1992). Such a model is required to provide not only a framework within which research can operate, but also one within which it can be reviewed (Cook et al., 1987). The purpose of this section is to develop a conceptual framework, grounded in previous work, which can provide terminology and perspective for the literature review.

Electronic interaction has created a subject area of research into electronic groups which is new, and consequently relatively immature. This research is scattered across a wide range of disciplines, including computer and information science, communication, engineering, psychology, management and sociology. All provide valuable perspectives on a complex problem, but there is a clear need for an integrative conceptual framework (Post, 1992).

The first step to any theory is to define the *significant conceptual entities* of the situation - which are categorisations of the situation that can be agreed upon by researchers as reliable, valid and important. Before any theory about group interaction can be proposed it is necessary to develop categories which are robust enough to form the basic entities of a general theory (Lewis and Whiteley, 1992). As this chapter will show, there is currently no agreement regarding the significant conceptual categories within GSS. This chapter will address this problem, a problem which is central to any research or discussion, namely the selection and definition of the categories into which subject information is to be classified (Holsti, 1969). Such categories should aim to be exhaustive, mutually exclusive, modular (be derived from a single, clear classification principle) and have content validity (be well grounded in theory and practice).

There is an axiomatic aspect to the selection of the initial categorisation, which really amounts to a philosophical bias on the part of the categoriser about what they consider to be important. This bias is best made explicit. The assumption made by this author is that *the key variables of the group situation are cognitive constructs, created in the mind of the individual in the group*. This position can be described as *interpretive* (Lee, 1994), and is a well established scientific method in areas such as anthropology and sociology.

2.1 Initial definitions

As will be seen in the literature review, the area of electronic groups is an intellectual minefield of assumptions, contradictions and disagreements - disagreements which often have a long history. The following is a preliminary list of some of the definitions that will be used in this account. Further definitions may be developed throughout the literature review. They are not proposed as the only definitions, or even the view of the majority of researchers, but as accepted and recognised definitions. For example there are definitions of "group" other than that given below (e.g. see Hogg, 1992, p4), but the one given below is a generally accepted one.

A group is any set of people who consider themselves to be a group (Bales, 1950; De Sanctis and Gallupe, 1987).

A cooperative group is one where all participants are under a common reinforcement schedule (Shaw, 1981).

The **communication situation** is the entire situation within which communication occurs, including the communication environment, the sender(s) and receiver(s), and any task they may have, or any context they are working within.

A **communication** is defined as a single transmission of information between one or many sender(s) and one or many receiver(s) (Lim and Benbasat, 1991).

A **communication interaction** is any connected or related series of communications between fixed sender(s) and receiver(s), which has a start and a finish. It is an "encounter" or a "communication occasion" (Kraut et al., 1992).

A **channel** is a single, connected stream of signals of similar type, e.g. stereo sound has two channels.

A **transmission interface** is something which connects, or operates at the boundary between, communicating entities (Lim and Benbasat, 1991). It receives the sender's signal and transmits it to the receiver. A single transmission act involves a single transmission interface. A transmission interface may not only transmit, but also store and process communications.

A **communication setting** is that through which communication occurs, including the transmission interface and the manner of connection between sender(s) and receiver(s). For example, telephone and loudspeaker are different communication settings. Different senders and receivers may use the same communication setting. It is a broader definition than the term "communication medium" usually implies.

A **communication environment** is any combination of communication settings available to communicators. For example, a communication environment may involve both telephone and E-mail.

Computer-mediated communication (CMC) is any communication between people that is mediated by a computer system. CMC systems "... use computers and telecommunication networks to compose, store, deliver and process communication." (Hiltz and Turoff, 1985). CMC includes electronic mail, bulletin boards and computer conferences.

Group decision support system (GDSS). Defined as: "an interactive computer-based system which facilitates solution of unstructured problems by a set of decision makers working together as a group" (DeSanctis and Gallupe, 1985), or as "any technology used to enhance or support group decision making" (Beauclair and Straub, 1990).

Computer supported cooperative work (CSCW). A general term which includes any type of cooperative work, defined as "the melding of communications and computer technology to support work in groups of varying size, permanence, and structure." (Olson et al., 1992). CSCW is a broad term which covers all sorts of cooperative work, whether a group is involved or not. It includes work flow systems, where a transaction passes from person to person electronically, each contributing appropriately.

Electronic meeting system (EMS). EMS was proposed as a term to include both GDSS and CSCW, and was defined as "A system which allows group members to interact on a common task and which provides electronic support to the group interaction process." (Dennis et al., 1988).

Group support system (GSS). Also suggested as a generic term for the field (Nunamaker et al., 1989b; Vogel and Nunamaker, 1990), and defined as “an integrated combination of specialized hardware, software, and procedures to support group activity.” (Zigurs and Kozar, 1994).

Distributed group support system (DGSS). A DGSS (Hiltz et al., 1991) can be defined as a GSS which can support a distributed group, and thus does not require the participants to be face-to-face.

A **Computer-mediated group (CMG)** is a group where *all group communications are mediated by a computer system*. This case, where the group interaction is mediated solely by computer, has also been called a “pure” electronic group (Finholt and Sproull, 1990). This is the area which this study focuses on. A computer-mediated group need not be distributed, as participants could be in the same room, but interacting only through the computers. Conversely, although a distributed group is often also a computer-mediated group, computer mediation is only one way a distributed group can be supported (e.g. a distributed group could interact by telephone).

Computer-mediated group system (CMGS). CMGS refers to systems enable groups to interact entirely through the computer (computer-mediated groups). This term is more restrictive than GSS, CMC or CSCW. It excludes manual GSS and Decision Rooms, both of which may be included under the term GSS. It also excludes person to person communication where there is no sense of group, which is included under CMC. It also excludes many (but not all) work flow type transactions included under CSCW, where the sense of group may be weak. This category, of CMGS, will be broken down further in the communication setting section of the literature review.

2.1.1 Defining GSS

The term GSS has gained popularity because it avoids issues such as whether all group activities are “decisions” (Dennis et al., 1988; Kraemer and King, 1986), or whether the sort of dispersed, asynchronous, group activities possible on computer networks really involve a “coming together” or “meeting”, or whether what is being done is “work”. It has therefore come to represent much of the area of research relevant to this study. However the term GSS, in itself, is so broad, it can be taken to apply to any system that supports a group, not merely electronic ones, and could include non-computer group support systems, such as the Nominal Group Technique (Linstone and Turoff, 1975) or the Delphi Method (Dalkey, 1969). The term *electronic group support system* (EGSS) can be used to exclude manual methods.

A problem with general definitions of GSS, such as any system whose “purpose is to support two or more people performing a goal directed activity” (Watson et al., 1994), or “any technology which improves group productivity” (Briggs, 1994), is that the definition does not imply direct involvement by the GSS in the group interaction. Could a coffee machine be considered a GSS? It is an electronic system that supports people performing goal directed activity, and one that may significantly improve group productivity.

Since the term GSS is widely used, it will also be used in this study to refer to the generic area of group support, but will be defined as:

GSS: Any system which supports a group interaction by becoming an integral part of that interaction.

Another way of stating this is that a GSS must *mediate* the group interaction, either partially or wholly. This excludes support which is not part of the group interaction. However it still includes

both computer and non-computer support. A decision room, which offers a mix of computer interaction, face-to-face interaction, and facilitator support, would therefore be a GSS.

This definition of GSS excludes systems which support only the individual. For example, providing each member of a group with computer support (such as spreadsheets), even if on a network, is not in itself a group support system, although it supports members of the group.

The definition also excludes configurations which use computers as group members. The term *collaborative human computer system (CHCS)* describes “an integrated interacting assembly of human(s) and intelligent computer subordinates, designed to cooperatively reach the goal of solving a problem faced by the human decision maker(s).” (Dalal and Kasper, 1991, p377). While having computer group members may help the group interaction, it does not do so by becoming a part of the group interaction, so CHCS is excluded from this definition of GSS.

The term GSS, however, has some disadvantages. It connotes an interventionist attitude to groups, implying that groups are in need of improvement. Group support systems don't always “support” groups. A GSS could, under particular circumstances, significantly hinder a group. For example a GSS may only allow anonymous comments. Whether this is supportive or not may depend on the situation (as noted by Er and Ng, 1995). Therefore the terms *computer-mediated group* and *computer-mediated group system* (defined above) will be used where appropriate to clarify that the computer system is seen as *mediating* the group interaction, rather than necessarily supporting it.

2.2 Group interaction models

Most GSS models are based on an Input-Process-Output (IPO) framework (Hackman and Morris, 1975; Dennis et al., 1988; Pinsonneault and Kraemer, 1989; Finholt and Sproull, 1990; McGrath and Hollingshead, 1991; Fjermestad et al., 1993; Benbasat and Lim, 1993). In this framework input variables are those that exist prior to the group interaction, such as the task to be solved, and output variables are those that exist after the group interaction, such as the task outcome. Input variables normally comprise the independent variables of research, and output variables the dependent variables. Process variables are those that come into being only during the group interaction. They can be seen as either dependent or independent variables (for example group member participation in the interaction process). This section will first review previous models, and then develop the basic concepts of what will be called the *integrative model*.

2.2.1 Hackman and Morris's traditional model

Hackman and Morris (1975) present what they call a traditional model of group interaction (see Figure 1).

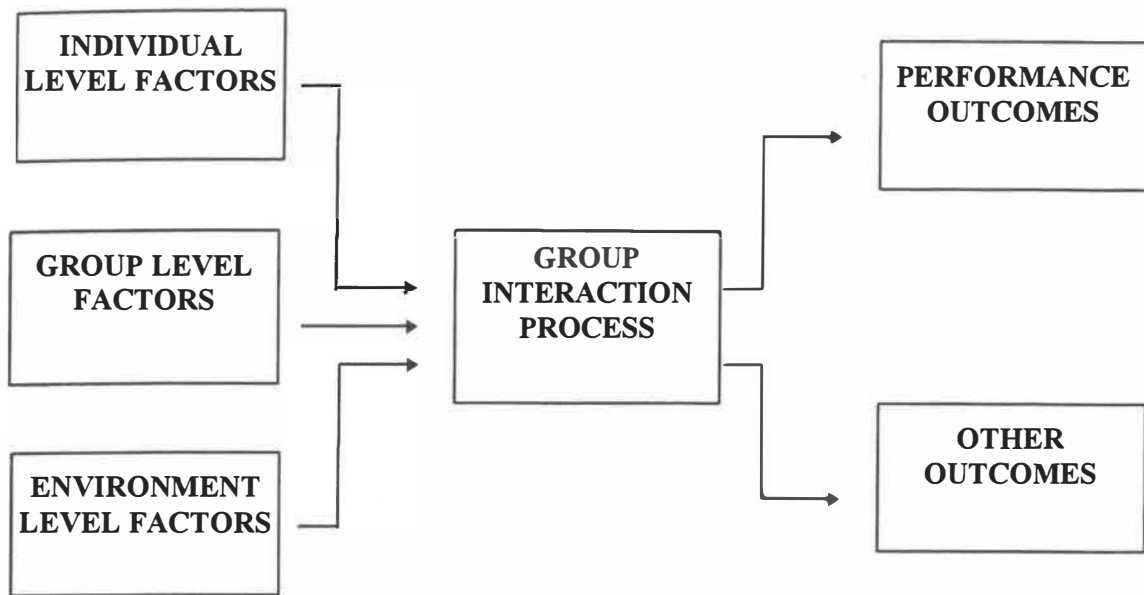


Figure 1. Hackman and Morris's traditional model

The details are as follows:

1. **Input variables:**
 - a) **Individual level factors.** Pattern of member skills, attitudes, personality characteristics,
 - b) **Group level factors.** Structure, level of cohesiveness, group size,
 - c) **Environment level factors.** Group task characteristics, reward structure, level of environmental stress.
2. **Group interaction process,**
3. **Output Variables:**
 - a) **Performance outcomes.** Quality, speed to solution, number of errors,
 - b) **Other Outcomes.** Member satisfaction, group cohesiveness, attitude change, sociometric structure.

In this IPO model, the key entities are individual, group and task environment, and these entities are used to define the input variable categories. The task is considered to be embedded in the environment of the group, and a distinction is made between the group and the group members, both concepts that will be taken up in the integrative model developed later.

2.2.2 Project Nick

The theory behind Project Nick (Cook et al., 1987) states that a meeting consists of:

1. Goals of the meeting,
2. Resources of the meeting,

3. Participants of the meeting,
4. Information manipulated within the meeting,
5. Activities that occur within the meeting,
6. Structure of the meeting,
7. Context in which the meeting takes place, and
8. Individual factors.

This model hypothesises an abstract repository called the *noumenon* in which all the above elements exist, and from which each individual creates their own personal repository, which they call a *pot*. A key idea of their “theory of pots” is that each individual takes from the meeting their own data based on their own perspective. Although not directly an IPO model, the meeting outputs are considered to result from the factors on the list interacting in a complex way. The basis for the given categorisation is not made clear (other than perhaps to be an exhaustive and mutually exclusive list of meeting variables).

2.2.3 Dennis and Nunamaker’s model

This model proposes the essential entities of the meeting situation to be *group*, *task*, *EMS* and *context* (Dennis et al., 1988; Nunamaker et al., 1991) (see Figure 2).

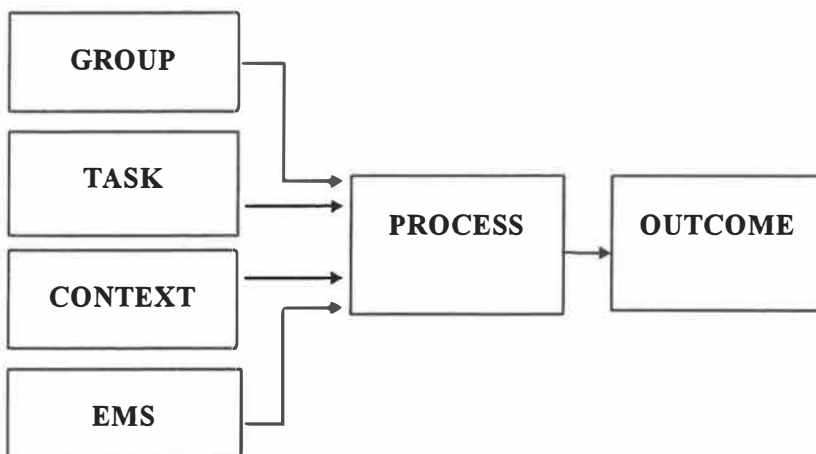


Figure 2. Dennis and Nunamaker’s model

The details are as follows:

1. **Input variables:**
 - a) **Group.** Group size, group proximity, group composition, group cohesiveness,
 - b) **Task.** Task type, task complexity,
 - c) **Context.** Organisational culture, time pressure, evaluative tone, reward structure
 - d) **EMS.** Electronic meeting system,
2. **Process variables,**
3. **Outcome variables.**

This is a standard IPO model. No distinction is made between the group and the individuals in the group. The proposed elements of the situation (group, task, context and EMS) are used to categorise the input variables. Incorporated within the model is the idea that GSS can improve group performance by:

1. **Process support.** The communications infra-structure,
2. **Process structure.** The techniques that structure communications,
3. **Task support.** Task information storage facilities (e.g. databases),
4. **Task structure.** Techniques for task analysis.

This seems to introduce a new entity - the process - and two GSS activities that can be applied to that entity: supporting and structuring. The distinction between support and structure raises interesting but confusing issues. For example is providing task structure also providing task support? If task structuring is a technique for task analysis, do task structuring methods also provide process support or structuring? If the task and process can be supported and structured, can one also talk about support and structuring for the group? The new entity of *process* lies uneasily alongside the original entities of *group* and *task*, and the proposed activities of support and structure do not rectify this, as they ignore the group entity.

2.2.4 Pinsonneault and Kraemer's meta-analysis model

The model presented by Pinsonneault and Kraemer (1989), and developed by Gray et al. (1990), was derived from a meta-analysis of extant research literature (see Figure 3).

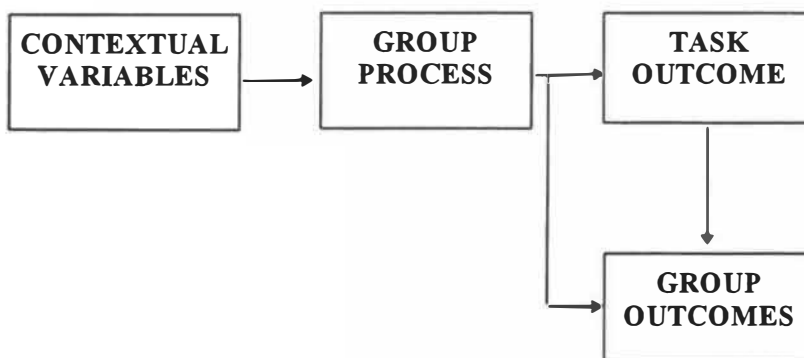


Figure 3. Pinsonneault and Kraemer's meta-analysis model

The model details are:

1. **Contextual variables:**
 - a) **Personal factors.** Individual attitudes, abilities, background and motives,
 - b) **Situational factors.** Social relationships among group members and stage of group development,
 - c) **Group structure.** Patterned relationships among group members (work norms, power relationships, status relationships, group cohesiveness and group density),
 - d) **Technological support.** GSS support (support type, degree of support, anonymity and facilitator),

- e) **Task characteristics.** Aspects of the task (task subject nature, task complexity and task uncertainty),
- 2. **Group process,**
 - a) **Decision characteristics.** How the decisions are made (depth of analysis, degree of group member participation, degree of consensus reached in making a decision and time taken to reach a decision),
 - b) **Communication characteristics.** Includes the amount and type of information exchanged,
 - c) **Interpersonal characteristics.** Including the degree of cooperation or domination by a few members,
 - d) **Structure imposed by the GSS,**
- 3. **Outcomes:**
 - a) **Task related outcomes,**
 - i) *Decision Characteristics.* Quality, reliability and breadth,
 - ii) *Decision Implementation.* Cost, ease of use and member commitment,
 - iii) *Member Attitude to Decision.* Acceptance, comprehension, satisfaction and confidence,
 - b) **Group related outcomes.** Attitude towards the group process (satisfaction, willingness to work with the group in the future).

The logic behind the categories in this IPO model is not as clear as for theoretically derived models. For example, why is the group process divided into decisional, communication and interpersonal aspects? Why are the social relationships among group members in a separate category from power relationships? Why is stage of group development separate from group cohesiveness? This is not to say these divisions are wrong, only that the reasoning behind the divisions is not clear to this reader. Even the input-process-output definitions are not clear - for example the *degree of consensus reached in making a decision* is listed as a process variable rather than an output variable (as will be the case in the integrative model) (Benbasat and Lim, 1993, noted the same).

Meta-analysis, being empirical, does not need to explain itself, but can claim to be a product of its input. That input is defined by what groups of researchers facing a new area have previously chosen to investigate, and so perhaps this approach tells us more where we have been than where we should be going. There is an element of circularity here - researchers investigate that which they don't know, and use those investigations to define directions for research into a subject that was unknown in the first place. Such models must be treated with caution because of this.

2.2.5 A social group model

Finholt and Sproull (1990) propose a model of group behaviour based on previous research on social groups in organisations (see Figure 4).

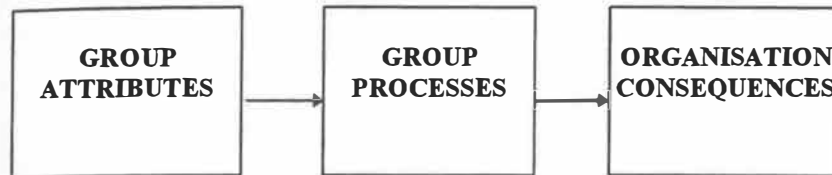


Figure 4. A social group model

In this model, *group attributes* lead to *group processes*, which in turn lead to *organisational consequences*. They define these components as follows:

1. **Group attributes:**
 - a) **Physical settings**
 - b) **Member characteristics.** Skills, appearance and attitudes.
 - c) **Membership criteria.** Which define the nature of the group
 - d) **Task type**
2. **Group process:**
 - a) **Interaction.** Information exchange
 - b) **Influence.** Social influence of one individual on another
 - c) **Identity maintenance.** The group differentiates itself from its environment
3. **Organisational consequences**
 - a) **Participation**
 - b) **Performance**
 - c) **Learning**

It is not very clear what the entities are in this model. However the definition of the group processes is almost identical to the three processes that will be proposed in the integrative model. Little else is the same, although what they have called “membership criteria” could be taken as that which describes and defines the group.

2.2.6 McGrath’s small group model - TIP theory

The model presented by McGrath and Hollingshead (1991) provides an extensive literature review, and has a clearly defined theoretical base (see Figure 5). In TIP (Time Interaction and Performance) theory, groups are regarded as “multi-functioned, goal directed social units, embedded within larger units” (McGrath, 1990). They continuously carry out, to varying degrees, three interdependent functions, namely production, member support and group well being.

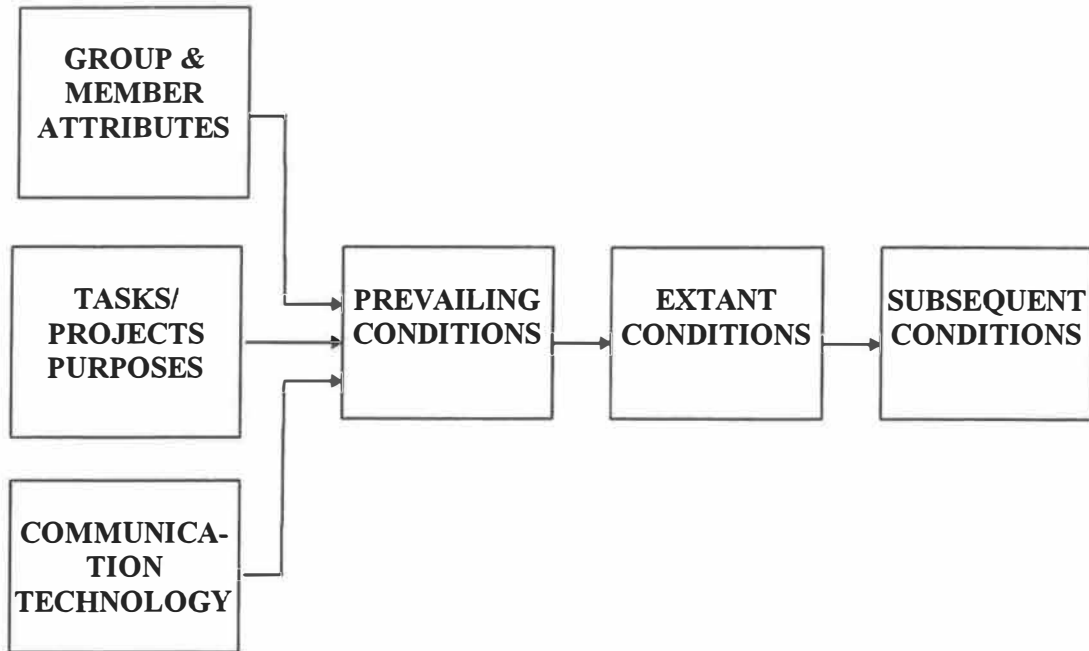


Figure 5. McGrath's small group model (TIP)

Any *work group* involves three entities, which must all be present, and which together define the input variables:

1. **A Group.** An organised set of people,
2. **A Project.** A set of purposes, often composed of tasks, and
3. **A Technology.** A set of tools for communication and task performance.

These entities operate within an embedding environment. This model considers the group and the set of individuals in the group to be equivalent. The combination of any two of the above also provides meaningful entities:

1. Group plus Project is a **task force** or team,
2. Group plus Technology is a **socio-technical system**, and
3. Technology plus Project is a **task structure**.

The group interaction process is seen as involving four types of variables:

1. **Input variables.** Variables which exist prior to the interaction, and are categorised in terms of group, technology and project,
2. **Intervening variables.** Variables which reflect the prevailing conditions on the given interaction occasion,
3. **Process variables.** Variables which reflect the conditions during the period when the group is carrying out its task,
4. **Outcome variables.** Variables which reflect conditions subsequent to the group's activities.

This model is clearly based on an input-process-output sequence of events, although four sets of variables are proposed not three. The distinction between input and intervening variables seems somewhat blurred, for example anonymity and time taken are quoted as intervening variables, yet anonymity is often built into the technology definition at startup, and time taken is usually considered an output (although it could also be part of the initial task definition). Although this model does not comment on group processes, it does recognise that important group effects are likely to involve the interaction of a number of variables, rather than the simple effects of a single variable.

2.2.7 Adaptive structuration theory model

This model also follows an input-process-output format (see Figure 6).

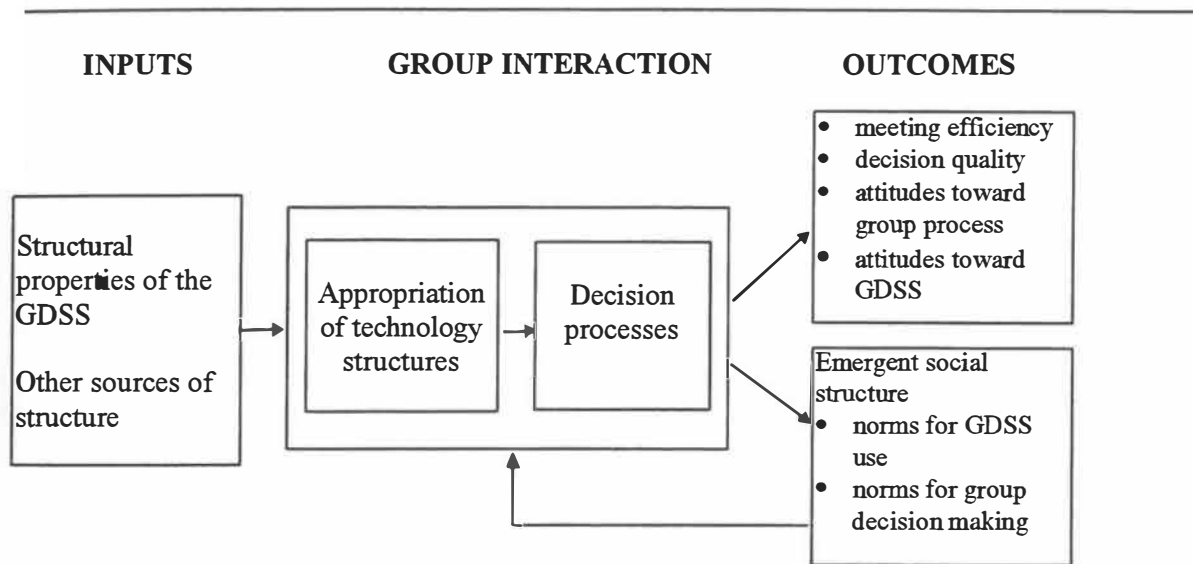


Figure 6. Adaptive structuration theory (AST) model

The model regards the key factor determining group outcomes to be the degree and manner of appropriation of the structures inherent in the GSS, task, or group practices. Therefore the simple offering of functionality, whether of GSS tools or communication media, is not sufficient to determine outcome:

To the extent that teams differ in appropriation of GDSS structures, outcomes are expected to vary across teams.

(DeSanctis et al., 1993, p9)

This interpretive approach represents group members as active, rather than passive, participants in group interaction. It proposes the following entities of the situation (DeSanctis et al., 1993):

1. **Inputs:**
 - a) **GSS structure.** Context, functionality, interface and holistic attributes,
 - b) **Other structure.** Task, total quality management, leadership, general management principles and approaches,
2. **Group interaction:**

- a) **Appropriation of technology structures.** Appropriation amount, appropriation moves, appropriation distribution, instrumental uses, attitudes towards appropriation,
 . . . leading to . . .
 - b) **Decision processes.** Idea generation, participation,
3. **Outcomes:**
- a) **General.** Meeting efficiency, decision quality, attitudes towards group processes, attitudes towards GSS,
 - b) **Emergent social structure.** Norms for GSS use, norms for decision making.

The entities in this model seem to be defined mainly in terms of structure, and the processes proposed operate on that structure. The social structural outcomes in turn feed back to influence the manner of appropriation that occurs during interaction. This model seems primarily a model of how social factors influence group interaction, not instead of, but in addition to, other factors such as communication medium.

2.2.8 A factors orientated control model

This model (Fjermestad et al., 1993) seeks to integrate previous theoretical models, in particular the basic elements of adaptive structuration theory (Poole et al., 1985) and Dennis and Nunamaker's model (see Figure 7).

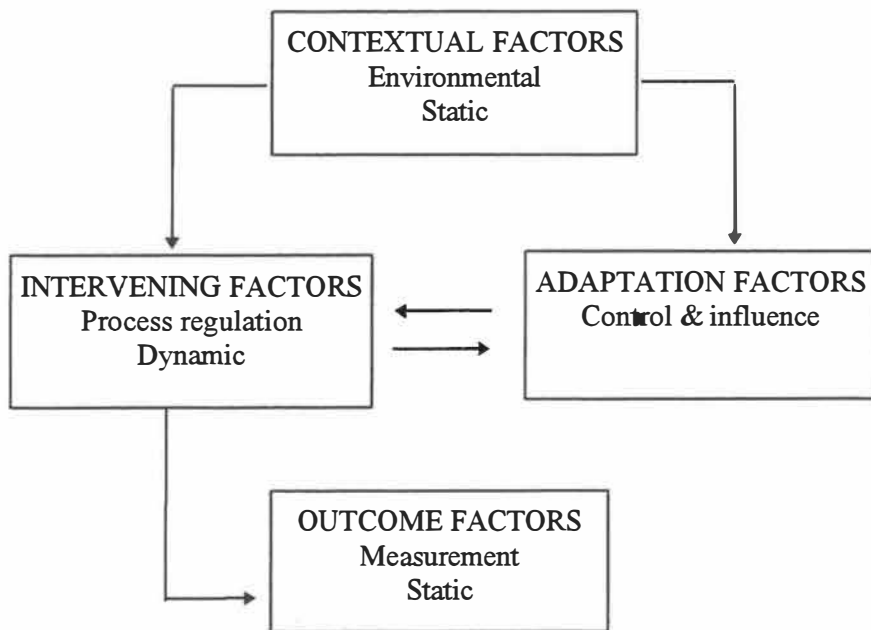


Figure 7. A factors orientated control model

The model proposes a four stage IPO model as follows:

- 1. **Contextual factors.** Assumed to be static or fixed throughout the interaction:
 - a) **Group.** Characteristics (e.g. size, proximity, time dispersion), composition (e.g. skills, shared norms, status), leadership, member characteristics (skills, attitudes and

- knowledge), meeting structure, initial levels (of cohesiveness, task understanding and agreement),
- b) **Task.** Type, task characteristics (e.g. complexity, structuredness, importance, predictability, equivocality, analysability, and enjoyability), degree of task knowledge, degree of agreement on values,
 - c) **Context.** Environmental (competition, uncertainty of outcome, time pressures and evaluative tone) and organisational (reward structure, culture and perceived leadership),
 - d) **Technology.** Tools, methods, levels, design and medium,
2. **Intervening factors** - variables arising from the “black box” of the interaction:
- a) **Resultant communication dimensions.** Band width, information richness and social processes,
 - b) **Methods.** Session supports, facilitator, structure, length and number of sessions, and training,
 - c) **Group member perception.** Tasks (importance, visibility, understanding and commitment) and individual (values, needs, interest and degree of frustration),
 - d) **Use of technology.** Structural features and general spirit,
 - e) **Use of group structures.** Roles and resources,
 - f) **Individual problem solving.** Psychological differences, biases and strategies,
3. **Adaptation factors** - variables reflecting the adaptation that occurs during the interaction, as proposed by adaptive structuration theory:
- a) **Group adaptation process.** Effort, emergent structure, emergent leadership, diffusion of responsibility, deindividuation, pressure to consensus, coordination, cooperation, and structuration,
 - b) **Process gains/losses.** Group interaction, agreement, resource utilisation, communication, cognitive loads, and learning adjustments,
4. **Outcome factors** - resultant goals, achievements and outputs from the interaction process:
- a) **Efficiency.** Decision time, number of decision cycles, time spent on activities, time spent waiting, and time to consensus,
 - b) **Effectiveness.** Decision quality and confidence, innovation, understanding, commitment, process quality and communication,
 - c) **Consensus.** Decision agreement and commitment,
 - d) **Satisfaction.** Participation, conflict management, cohesiveness, confidence, attitude, general satisfaction,
 - e) **Usability.** Learning time, willingness to work together again, system utilisation and number of errors,

The main entities of this detailed model seem to be similar to those used by Dennis et al. (1988). It follows a basic IPO structure, and uses the entities to categorise the input variables. It is not clear

why group and task are classified as contextual, and static for a given encounter. Group member skills, attitudes, and knowledge may change throughout an interaction, as may the leadership, meeting structure and even group composition (someone may leave the group). Likewise the task, which initially appears to be a “given”, can, and often is, in a constant state of redefinition throughout the interaction (Reeves and Lemke, 1991), and for equivocal tasks (Daft et al., 1987) this may even be expected. Even task type may change during the interaction, and what began as a difficult intellectual (right/wrong) task may end up being handled by the group as a preference task. Therefore it is difficult to sustain group and task as contextual variables which do not change throughout the encounter.

Overall, the model seems integrative in the additive sense, adding different theoretical positions but without a great deal of reduction. Due to the dynamic nature of group interaction, the difference between intervening and adaptive variables could be difficult to maintain, as the one shades into the other. The model does however represent recognition of the need for convergence between various models.

2.2.9 Benbasat and Lim’s meta-analysis model

This model (Benbasat and Lim, 1993), recognises Pinsonneault and Kraemer’s (1989) model, but develops a different approach in detail (see Figure 8).

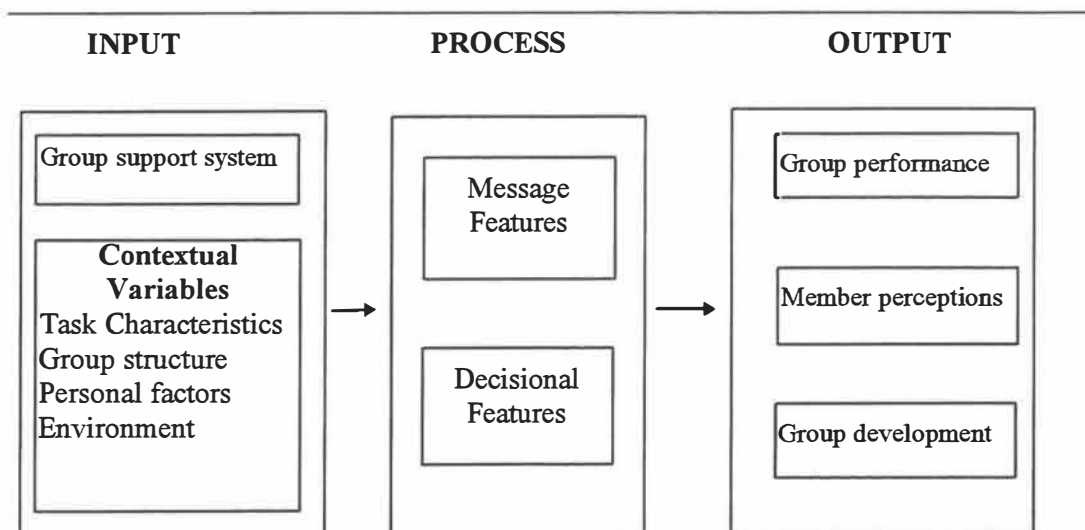


Figure 8. Benbasat and Lim’s meta-analysis model

The details of this model are:

1. **Input:**
 - a) **Group support system.** Type of support, facilitation,
 - b) **Contextual variables:**
 - i) **Task characteristics.** Task type, complexity, clarity,
 - ii) **Group structure.** Member proximity, group size, formal hierarchy, group history,

- iii) **Personal factors.** Member attitudes, experiences and abilities,
 - iv) **Environment.** Organisational culture, incentives and rewards,
2. **Process:**
- a) **Message features.** Uninhibited behaviour, task-orientated communication,
 - b) **Decisional features.** Depth of analysis, degree of rationality,
3. **Output:**
- a) **Group performance.** Decision quality, number of alternatives, degree of consensus, time to decision,
 - b) **Member perceptions.** Attitudes, satisfaction, confidence with outcome, perceived effectiveness, perceived efficiency, perceived equity,
 - c) **Group development.** Cohesion, choice shift, norms, status and power,

This model follows the IPO framework, and like Fjermestad et al. (1993), sees group and task variables as contextual (i.e. static rather than dynamic relative to the interaction). In areas the classification logic is somewhat unclear - for example cohesion and degree of consensus are classified in different categories. Both seem to refer to the degree to which the group acts as one. One might expect that highly cohesive groups would more readily achieve consensus, and that variables which vary together, and represent similar things, would be classified together.

2.2.10 Summary

The main conclusion of this review must be the sheer variety of categorisations, and the lack of agreement, on any level, about which categories apply, and which variables belong in what categories. The models reviewed can be seen to fall into three groups, according to whether the categories proposed are primarily:

1. **Theoretically defined.** Models where the entities of the situation are defined by a theory of group interaction, which is used as the logic for category definition, at least for the input stage (Hackman and Morris, 1975; Dennis et al., 1988; Finholt and Sproull, 1990; McGrath and Hollingshead, 1991; Fjermestad et al., 1993),
2. **Empirically defined.** Models where the categories have been discovered by investigation of prior research proclivities (Pinsonneault and Kraemer, 1989; Gray, 1990; Benbasat and Lim, 1993),
3. **Pragmatically defined.** Models which categorise relevant variables into sensible patterns (Cook et al., 1987).

In all cases the issue of category definition and validity has arisen, especially for the empirical and pragmatic models, which lack an explicit categorisation logic. For the theoretical models, category validity depends on the validity of the theory. The variety of categorisations presented, and the contradictions between them, suggest that not all are well founded.

It can be seen that while many models categorise the input variables according to the basic entities implied in that model, none carry the same categories across to the process and output phases. Most say relatively little about the process phase, with the exception of Finholt and Sproull (1990) and McGrath (1990), both of whom postulate three processes. Output is commonly divided into task and group output, as for example "performance outcomes" vs "other outcomes" (Hackman and Morris,

1975), “task related outcomes” vs “group related outcomes” (Pinsonneault and Kraemer, 1989), although Benbasat and Lim (1993) give three categories: “group performance”, “member perceptions” and “group development”.

What will now be proposed is similar in outer form to McGrath’s (1990) theory, both models proposing three interdependent and interacting group processes. The integrative model however approaches the situation from an interpretive or cognitive perspective, and hence the entities are somewhat different from those defined in McGrath’s model.

2.3 An integrative framework

This section aims to define the essential entities of the group interaction situation, and extend these across the input-process-output base commonly used in theoretical models. This will form the framework for the literature review.

Most models take an objective viewpoint, *looking at the group interaction as it were from above*. However it is proposed that the key variables of group interaction do not exist from such an objective view point because they are constructs, created in the minds of group members. In this case it is proposed that valid entities are best defined *from the point of view of a hypothetical individual in the group interaction situation*. This can be regarded as *looking at the group interaction from within*.

2.3.1 Entity definition

A hypothetical individual in an electronic group must deal with:

1. Communication setting,
2. Task and task environment,
3. Other individuals in the group.

The above entities are very similar to those presented in previous models. What is here called the *communication setting* is called by Pinsonneault and Kraemer (1989) *technological support*, by Finholt and Sproull (1990) *physical setting*, by McGrath and Hollingshead (1991) *technology*, by Nunamaker et al. (1991) *EMS (electronic meeting system)*, by Benbasat and Lim (1993) *GSS*, and by DeSanctis et al. (1993) *interface*. The term communication setting has been chosen because it allows a consistent terminology across both GSS and non-GSS environments. For example the telephone, E-mail and a face-to-face interaction could all be considered to provide different settings within which communication can occur. Terms such as technology, EMS and GSS do not have this generality. The term “transmission interface” will also be used (see section 3.1.1.3, p33, for details).

There is a fourth entity which, from the point of view of the individual, exists, namely *the group itself*. Although objectively the group can be considered to be comprised of a set of individuals (McGrath and Hollingshead, 1991), from a social psychological point of view, the group is a social entity in itself, mainly because it is seen as such by the individuals in the group. This conceptualisation of the group as an entity follows the traditional model of group interaction proposed by Hackman and Morris (1975). The distinction between individual-to-individual (or interpersonal) and individual-to-group (or social) will be developed in more detail further on, as it is a central theme, and the area in which what is proposed differs most from current models.

Thus, from an individual perspective, the proposed entities of the group interaction situation are:

1. **Communication setting.** The setting in which and through which the group interacts,
2. **Task.** The task and task environment, including task resources,
3. **Other individuals.** The other individuals in the group,
4. **Group.** The group as a social entity.

All of the above occur within an *embedding environment*, which does not change throughout the encounter. These entities are proposed to be the essential “things” upon which operations are carried out, and to which properties are ascribed, and are the conceptual base of the integrative model proposed in Chapter 4. For example one could talk about individuals in a group focusing their attention and energies on dealing with task issues, group issues, or with the other individuals in the group.

These entities are, by definition, *relative* to the perspective of a hypothetical individual in the group. For example, a transmission interface such as the telephone or E-mail is not in itself easy or hard to use, but only defined as such relative to a user or user group. The same can be said of properties of the task, such as task difficulty.

There is some empirical evidence that users do indeed recognise the division proposed. Hiltz and Johnson (1990) asked users of four computer conferencing systems a large number of questions regarding their feelings about the computer interaction. Factor analysis of the results produced four factors:

1. **Interface.** How users felt about the communication interface,
2. **Performance.** Whether the system was productive or not,
3. **Unexpressive.** Whether they felt a sense of personal contact with others and were able to conduct socio-emotional communication online,
4. **Mode problems.** Feeling constrained by the type of communication, overloaded by information, distracted by the interface or other problems with the communication mode.

The first three factors correspond to the *individual to communication setting*, *individual to task* and *individual to individual* categories proposed. The *individual to group* factor is not mentioned.

2.3.2 Input

Based on the defined entities, the input variables encountered in the models reviewed can be categorised into corresponding variable sets. In as much as the proposed categorisation is valid, these sets can be expected to be exhaustive, mutually exclusive, modular, and most importantly, valid. Definitions and examples of the categories developed are shown in Table 1, where each variable set is based on the entities proposed relative to an individual in the group. This approach seems recursive when the entity “other individuals” is considered relative to an individual in the group, therefore the term *interpersonal* is used to describe individual-to-individual variables.

Entity	Variable Set	Examples
Embedding environment	Properties of the embedding situation in relation to the individuals in the group.	<ul style="list-style-type: none"> • organisational culture • individual rewards
Communication setting	Properties of the setting in which and through which the group interacts, in relation to the individuals in the group.	<ul style="list-style-type: none"> • asynchrony • GSS type • GSS ease of use • medium • GSS tools • rules of interaction • facilitator • user training in use of GSS
Task	Task properties , including task resources, in relation to the individuals in the group.	<ul style="list-style-type: none"> • task type • task difficulty • task reward structure (competitive/cooperative tasks) • task equivocality or uncertainty • task resources • task time pressure • task process structuring
Other individuals	Relationship properties , describing individuals in the group in personal relation to the other individuals in the group.	<ul style="list-style-type: none"> • relationships • individual appearance • friendships • anonymity • informal communicative structures • evaluative tone
Group	Group properties , reflecting the group as an entity, in relation to the individuals in the group.	<ul style="list-style-type: none"> • group size • norms • structure and roles • assigned leader • formal relationships • membership criteria • group history • cohesiveness

Table 1. Integrative model: Input variable categorisation

The categorisation of variables presented in Table 1 is theoretically well defined and consistently applied. It provides a categorisation of variables which in detail is significantly different from the other models reviewed. This is mainly because each variable is categorised from the point of view

of the individual in the situation. For example time pressure is often considered a contextual variable (Dennis et al., 1988; Fjermestad et al., 1993), but from the point of view of an individual it is usually the time the task finishes, and therefore is a task variable. Interpersonal relationships and group identity may extend beyond the task completion time.

There are also significant similarities between what is proposed and previous models, as shown in Table 2. It shows that there is no entity proposed that has not been proposed before.

Model	Embedding Environment	Communication Setting	Task	Interpersonal	Group
Hackman and Morris (1975)			Environment level factors	Individual level factors?	Group level factors
Cook et al. (1987)	Context	Resources	Goals	Participants	
Dennis et al., (1988)	Context	EMS	Task	Context?	Group
Pinsonneault and Kraemer (1989)		Technological support	Task characteristics	Situational factors?	Group structure
Finholt and Sproull (1990)		Physical setting	Task type	Member characteristics ?	Membership criteria
McGrath and Hollingshead (1991)	Embedding environment	Technology	Project	Group	
DeSanctis et al. (1993)		Interface	Task		
Fjermestad et al. (1993)	Context	Technology	Task	Group	
Benbasat and Lim (1993)	Environment	GSS	Task	Group Structure	

Table 2. Proposed entities by previous models

The main distinguishing feature, compared to the models reviewed, is the distinction between interpersonal and group variables (Hogg, 1992). Most models which recognise what is here called interpersonal variables either:

1. Implicitly include them within individual level attitudes (Hackman and Morris, 1975; Finholt and Sproull, 1991 ; Benbasat and Lim, 1993);
2. Consider them part of the set of group variables (McGrath and Hollingshead, 1991; Fjermestad et al., 1993). For example McGrath and Hollingshead categorise “group and member attributes” together ; or
3. Include interpersonal aspects as contextual variables (Dennis et al., 1988). For example Dennis et al. (1991) consider evaluative tone, to be part of the “context” category.

Sometimes the situation with regard to this distinction is unclear. For example Pinsonneault and Kraemer (1989) seem to include interpersonal relationships under the category “situational factors”, but also include in that category group development, which the integrative model would categorise as a property of the group. They also categorise the degree of group cooperation under “interpersonal characteristics”, which here would also be categorised under group.

A related difference is that most previous models include category of variables for the properties of the individual. For example, “individual factors” (Hackman and Morris, 1975; Cook et al., 1987), “personal factors” (Pinsonneault and Kraemer, 1989; Benbasat and Lim, 1993), or “member characteristics” (Finholt and Sproull, 1991; Fjermestad et al., 1993). The categorisation proposed here does not have such a variable set, *because all the entities proposed are already relative to the individual*. Individual level variables are partitioned into:

1. Individual attitudes, knowledge and skills regarding the *task* and task resources,
2. Individual attitudes, knowledge and skills, in relation to the other *individuals* in the group, and
3. Individual attitudes, knowledge and skills relative the *group* per se.

The individual’s perspective, it is argued, *is an inherent part of all the relevant entities of the situation*, and what is left after this partition is not relevant. Generally when researchers refer to “individual factors” they have already extracted characteristics of the individual with regard to the context, transmission interface, task, and group, and usually mean attitudes and personality characteristics which largely affect the dealings of the individual with other individuals.

In summary, the main ways in which this categorisation of input variables differs from those previously presented are that:

1. GSS/EMS/technology variables are included under the category communication setting,
2. Facilitator, in the sense of a non-member of the group, is also categorised as part of the communication setting (which mediates the interaction),
3. Task contingencies and resources are included under the task variable set, and
4. Individual to group variables are distinguished from individual to individual variables.

2.3.3 Process

The categorisation applied to input variables (communication setting, task, interpersonal, and group) can be extended into the black box of group process interaction. Dealing with the communication setting however is considered to be a background factor, a contextual process, rather than an interaction process. In a face-to-face setting for example, the “process” of dealing with the communication setting itself is done by our sense organs, is usually considered contextual, and provides the background against which group interaction processes operate.

Hence the four main entities proposed give rise to a three-process theory of group interaction, based on dealing with the task, dealing with the other individuals in the group, and dealing with the group. The three processes proposed are *resolving the task*, *relating to others*, and *representing the group* (see section 4.1.2, p124, for more detail).

These three proposed processes are not without precedence. They match well with the three group processes proposed by Finholt and Sproull (1990):

1. **Interaction.** Information exchange,
2. **Influence.** Social influence of one individual on another, and
3. **Identity maintenance.** The group differentiates itself from its environment.

The processes provide members of the group with information resources, emotional resources and identity support, respectively.

The processes proposed match two of the three functions which McGrath (1990) proposes that groups carry out, namely:

1. **Production,**
2. **Member support,** and
3. **Group well being.**

The first and last correspond to the *task* and *group* entities. Although member support could be considered a form of interpersonal or relational support, as a concept and process it is defined by McGrath quite differently from the way the interpersonal relating process is defined here.

2.3.4 Output

Valid entity definition should define not only input and process phases, but also the output - what has changed after the group interaction. The three processes imply three purposes, or group output categories, namely:

1. **Task.** Changes in the task relative to individuals in the group. For example the task has been redefined, rejected or resolved, individual learning with respect to the task, time to resolve the task, task solution quality, or innovativeness or quantity, and number of errors;
2. **Interpersonal.** Changes in the individual relative to other individuals. For example friendships formed or broken, personal relationships, opinions of others formed; and
3. **Group.** Changes in the group or group structure as seen by the individual. For example increase or decrease of group unity and cohesiveness, amount of agreement, changes in group structure, time to consensus, and roles in the group.

These three outcomes partially relate to the three criteria in Hackman's (1983) normative model of group effectiveness:

1. Task output is acceptable,
2. Members individual needs are more satisfied than frustrated, and
3. Capability of the group to work together as a unit is strengthened .

The first and last correspond to the *task* and *group* entities. Whether individual member needs largely reflect interpersonal outcomes is an open question.

Hiltz and Turoff (1991) factor analysed questionnaire results from a project involving senior executives preparing papers to improve productivity in the US, using EIES (Electronic Information Exchange System), and obtained three factor indexes which they called:

1. Outcome Index,
2. Richness (or expressiveness) Index, and
3. Satisfaction Index.

The Outcome Index is a *task outcome* measure, the first process proposed. The Richness Index found by the study was based on subjects' views of :

. . . the relative frequency with which subjects felt able to get an impression of personal contact with others, to express their views, or, by contrast, felt constrained in the type of contributions they could make.

(Hiltz and Turoff, 1991, p63)

This definition of richness seems to describe whether or not individuals felt they could *relate* to other group members (using the computer system), which is the second process proposed in the integrative model. Further study would be needed to confirm this interpretation. The Satisfaction Index found raises, in terms of this model, more questions than answers, as there can be satisfaction with the communication setting, with the task output, with one's relationship to the other individuals, or with one's membership of the group.

2.4 An integrative model

The categorisations proposed will lead directly to a *three-process, integrative model*, which will be described in more detail in Chapter 4. It is summarised in Figure 9.

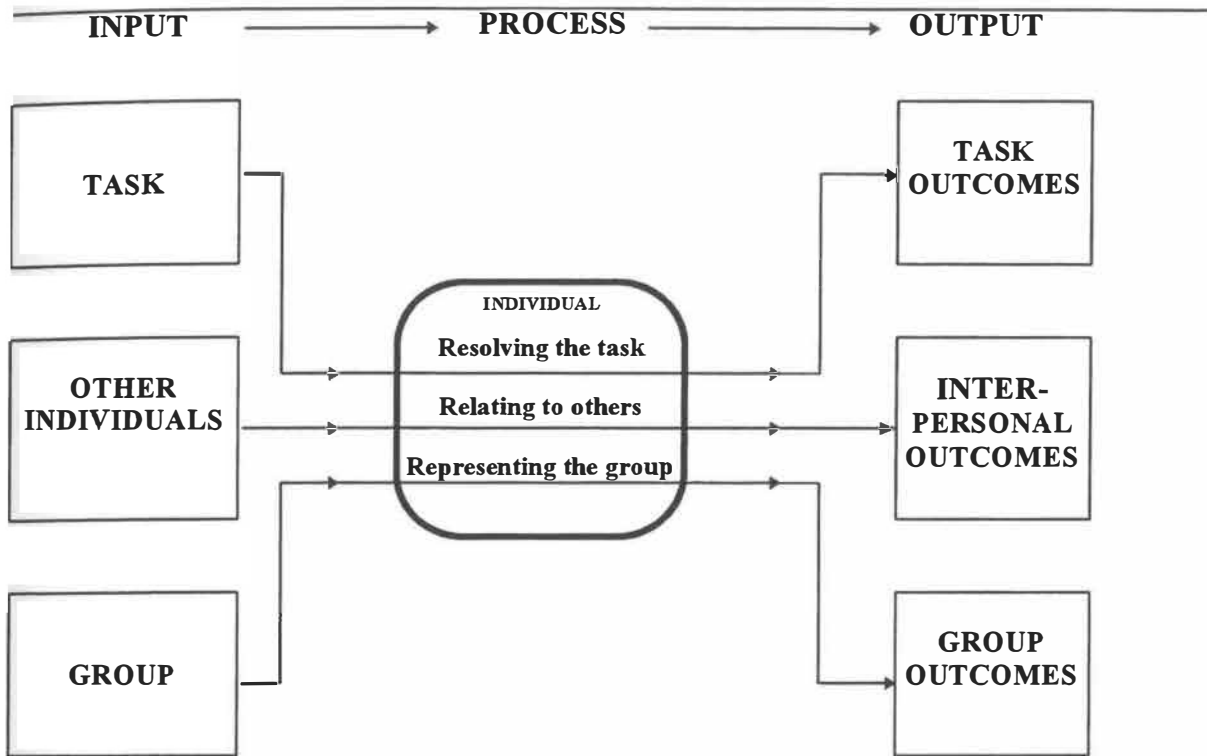


Figure 9. An integrative model of group interaction (simplified)

The bolded oval in the centre of the diagram, labelled “Individual”, represents that the model derives from the perspective of the individual in the group. The integrative model proposes that the input-process-output framework can be viewed on three levels: three categories of input variables, three processes occurring within the individual during the group interaction, and three types of output. The integrative model operates on both an individual and a group level, the latter derived from the former.

While other models recognise divisions, often based on the task and socio-emotional categories, few recognise three distinct theoretical levels of interaction, and none apply this distinction clearly across the input-process-output time line. This model therefore has the advantage of consistency, because its categorisation applies not only to the input variables (as was also done by several of the models reviewed), but also to the process and output phases. The consistency of the model across the input-process-output stages should be expected from valid entity definition, and in itself provides support for the model. It will be later suggested that these three processes derive from the essential elements of the communication situation, and therefore may be exhaustive, as well as mutually exclusive.

What has been presented so far establishes a framework that is philosophically explicit, conceptually clear, theoretically consistent, and has some precedence in previous research, i.e. that is *feasible*. It has the advantage of conceptual parsimony, while retaining broad applicability. Whether it is *empirically valid* is a bigger issue which will occupy the rest of this document. Nothing proposed in

the integrative model is new, and every idea in it has been proposed before, but the integration seems new. It will now provide the structural framework and conceptual basis for the literature review (Chapter 3), leading to a more detailed presentation of the integrative model (Chapter 4, p121) and the development of the experimental hypotheses which will guide the experimental side of this research.

3. LITERATURE REVIEW

The literature on group and GSS theory and research will now be reviewed under the following headings:

1. Communication setting,
2. Task resolution,
3. Interpersonal relating, and
4. Group representation.

3.1 Communication setting

This section aims to define more clearly what is meant by a computer-mediated group system (CMGS), and hence define the setting of this research. A CMGS is considered to provide a communication setting, just as a face-to-face environment does. Much of this section will analyse the properties of communication setting. The result will be a taxonomy of communication settings which can accommodate the variety of electronic communication situations now available. The setting for this research will be defined as a cell within that taxonomy. Alternative theories in this area which impact on the principles behind the taxonomy, such as media richness theory, will be considered. The taxonomy will raise design issues regarding comparisons of GSS and face-to-face interactions, and suggest a design for the experiment carried out in this research.

3.1.1 Communication model

This sub-section develops the communication model upon which the taxonomy is based.

3.1.1.1 *Simple communication model*

The essential elements of any communication system are a sender, a channel and a receiver (see Figure 10) (Cherry, 1978). To receive the intended information the receiver must decode the signal using the same protocol used by the transmitter to encode it, i.e. the sender and receiver must have a shared understanding (Cherry, 1978). The situation is defined as one in which a signal is transmitted from sender to receiver through a single channel, the signal carrying information by means of the common protocol.

A communication channel can be characterised by its *capacity* - the amount of information it can transmit. The channel capacity depends on both the *band width* (the amount of information the channel can transmit in one signal) and the *baud rate* (the number of signals that can be sent per second). The signal can be characterised by its *type*, such as digital or analogue. The communication as a whole is characterised by its *communications protocol* (the rules of the communication) such as the asynchronous or synchronous protocols.

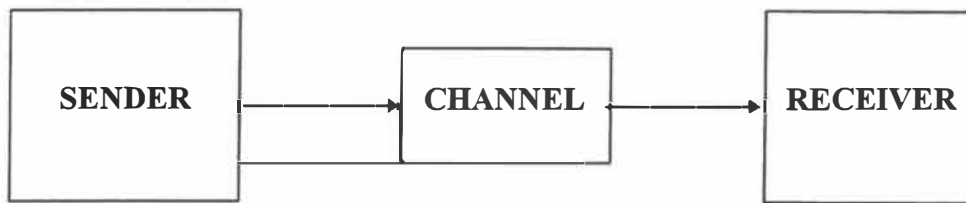


Figure 10. Simple communication model

3.1.1.2 Multiple channels

In multi-media communications however a *single transmission* involves multiple, parallel channels, each channel carrying its own stream of information, representing aspects of *the same signal*. For example a single video signal may involve both sound and vision channels. Even within a single physical medium, there can be more than one channel. For example a stereo system transmits two channels to the receiver, even though there is only one signal. Consequently although a single channel implies a single physical medium, a single medium does not necessarily imply a single channel.

If single signal transmissions typically involve multiple channels, the original communication model must be enhanced, as shown in Figure 11, to include multiple channels (see Briggs and Nunamaker, 1994 for an example of an enhanced communication model of this type).

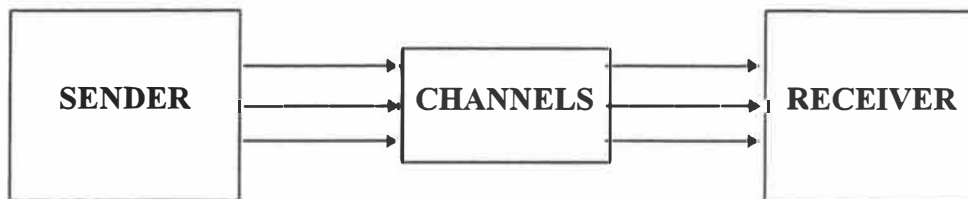


Figure 11. Multiple-channel communication model

Multiple channels carrying *independent* signal transmissions are conceptually different from what has just been proposed (multiple, parallel channels carrying aspects of a single signal transmission). While the number of channels per signal may increase signal impact, as in multi-media signals, adding independent signal channels does not necessarily do the same.

Jarvenpaa et al. (1988) gave high level unstructured software design tasks to computer professionals in teams of seven, provided with either work stations, allowing message broadcasts and a public electronic display, or conventional notepads and a flip chart. This appears to have provided *two different (alternative) communication settings* within a single communication environment. The experiment showed that where computer support was available for messaging (work station case), the number of verbal exchanges decreased significantly, but the total of electronic plus verbal messages remained equivalent to the non-computer case. The electronic channel seemed to partially supplant the normal verbal channel, suggesting that the availability of multiple communication settings does not necessarily add to the total communication which occurs, and in this case, only distributed it differently. If the number of messages sent is a property of the task and individuals, these results imply that subjects wishing to send a particular message, in an environment which

offers multiple communication settings, tend to use one setting or the other. They do not use alternative settings to supplement communication.

3.1.1.3 *Network communication model*

The communication model thus far developed still implies a passive transmission medium, such as a copper wire or fibre optic cable, where overload of channel capacity means transmission failure. However modern packet switched networks, like the Internet, can not only store overload signals, they can also make routing decisions, and when one route is overloaded, choose another. In this case the transmission “medium” has both *memory* and *processing power* at its disposal, and fulfils in an increasingly intelligent way its role as the intermediary between sender and receiver. Likewise in modern CMC systems, the computer is no longer a simple store and forward device. It can tell you what is new or changed in a set of items, allow or disallow anonymity, or screen your incoming mail (Hiltz and Turoff, 1985). It can enforce complex rules such as *no-one can see the vote result until they themselves have voted*, as was developed for the software used in this research (Turoff, 1991, p92, reports using a similar rule).

Terms like medium or channel no longer adequately describe the activity that occurs in such situations. It is better to talk about the *transmission interface*, defined as anything which connects, or operates between, communicating entities (Lim and Benbasat, 1991). Communications passing through a transmission interface can be *stored* or *processed* before being passed to the receiver. In a face-to-face situation, the physical world is the transmission interface. Cherry’s original model can be enhanced to include a transmission interface, as shown in Figure 12.

Another key property of network transmissions is whether they are point-to-point or multi-point (broadcast). A point-to-point transmission goes to a single receiver, while a multi-point transmission goes to many receivers at once. The sending of a signal to many receivers on a point-to-point network (e.g. a star network) can be represented by the original model (Figure 10), because it is achieved by duplicating the sender-receiver transmission for each receiver. However multi-point or broadcast transmission sends from one sender to many receivers *in a single operation*. It is a fundamentally different form of transmission. Therefore it is proposed that Cherry’s original model be enhanced to include broadcast transmission by allowing many receivers for a single signal, as shown in Figure 12.

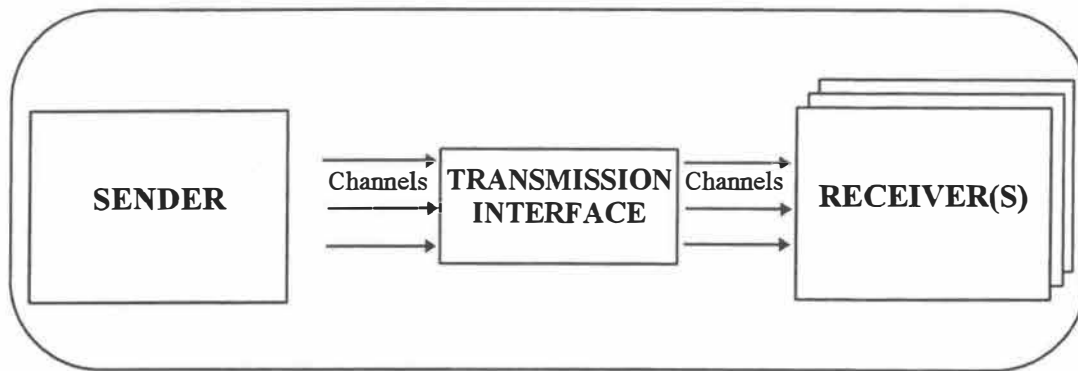


Figure 12. Network communication model

3.1.2 Media richness theory

Media richness theory has aroused great interest, both favourable and unfavourable, and has been a powerful theoretical influence on CMC research. It implies that various communication settings can be defined along a single dimension, that of “richness”. This uni-dimensional approach to the communication setting does not match well with the multi-dimensional view to be developed shortly.

3.1.2.1 Description

Daft et al. (1987) categorise media according to their “richness”, which they define as the “capacity of the media to facilitate shared meaning” (p358), having earlier defined “rich” information as “the ability of information to change understanding within a time interval” (Daft and Lengel, 1986, p560). The term information, as used in their definition, clearly implies not only the transmission of data, but also the transmission of meaning. Based on their definition of media richness, Daft and Lengel (1987) organised media in decreasing order of richness, as follows: face-to-face, telephone, written addressed (letters) and written unaddressed (posters). They then categorised managerial tasks according to uncertainty (absence of information) and equivocality (ambiguity), noting that in real organisations the challenge of the new media is not to deal with uncertainty (by exchange of information) but to resolve equivocality (by enacting agreement). They found a positive relation between the equivocality of the message and the “richness” of the preferred medium. This effect was greater for high performing managers, who were presumably better communicators. Good managers would consider a medium like electronic mail inappropriate for such tasks as exchanging confidential information, resolving disagreements, getting to know someone, and negotiating. It will be pointed out later that all of these “equivocal tasks” are also tasks that require individuals to relate to other individuals.

The authors suggest that rich media are preferred by managers facing equivocal situations, because the rich cues and higher levels of information exchange possible allow individuals to better reduce ambiguity and enact agreement. The media richness model predicts that when plain text is the sole communication medium, groups will be unable to generate or enact agreement, because plain text is incapable of transmitting the amount of information that is necessary for social interaction.

There has been considerable criticism of this theory on both theoretical and practical levels, which will now be considered.

3.1.2.2 *A media richness dimension?*

Media richness theory implies a linear dimension of richness, from text to telephone to face-to-face. In practice the dimension is not so clear. Lea (1991) cites Sumner (1988) who found, as expected, that subjects preferred face-to-face communication for resolving disagreements, providing criticism, discussing alternatives and building consensus. However Sumner also found that users preferred E-mail over the telephone for many of the same socio-emotional tasks for which the most preferred communication setting was face-to-face. The same result was also found by Sproull and Kiesler (1986).

A study by Suh (1996) investigated intellectual and negotiation tasks under different communication settings, which were varied in order of theoretical richness as follows: E-mail, telephone, audio-visual and face-to-face. They found no difference in task performance (correctness and payoff, respectively) between the different communication settings. In terms of time taken for the intellectual task however, although text (as expected) was the least efficient, audio (not face-to-face) was the most efficient. Media richness theory, which clearly places the telephone in a middle position between face-to-face and E-mail in terms of richness, cannot explain these findings.

Media richness theory implies that audio-visual or face-to-face communication is a significant improvement over a simple audio connection. However investigation of the impact of a variety of communication media (from text to face-to-face) on cooperative problem solving groups shows the presence of an audio channel to be the single most significant factor (Ochsman and Chapanis, 1974). A recent follow up study confirmed this, showing no difference in performance between groups supplemented by audio-only (telephone), slow motion video, full video and face-to-face communication modes when completing a jigsaw puzzle type task (Masoodian et al., 1995). The authors had expected that the face-to-face interaction would provide a higher communication bandwidth, and hence better performance than voice alone, as a pilot study by the same authors did show the clear advantage of a voice link over lean text for groups working on a design problem (Masoodian et al., 1995).

These results do not support media richness theory.

3.1.2.3 *Lean medium - rich message?*

Media richness theory links the transfer of meaning directly to the richness of the medium of transmission, implying that a rich medium allows a rich message and a rich message requires a rich medium. By Daft et al.'s (1987) definition of media richness, most CMC is relatively impoverished, so computer interaction should be limited to low equivocality exchanges which involve routine and straightforward matters (such as are usually dealt with by memo or note). In other words it should be a relatively "cold" medium of exchange. In practice however E-mail has been found to be a relatively convivial medium of communication (Ord, 1989), and able to transmit rich messages (Lee, 1994). Despite the predictions, many users report that CMC (E-mail and bulletin boards) are surprisingly "warm" communication settings, that actually foster the development of intimate relationships (Boshier, 1990). Boshier (1990) summarises current theory on E-mail (and CMC in general) with the line from an old song "something is happening here but we're not sure what", echoing Hackman and Morris's (1975) earlier observation (see page 3). It appears that people are genuinely *relating* to others through CMC, not something predicted by media richness theory.

Recent laboratory experiments verify the above field reports, showing that a lean medium can transmit a rich message, if the transmission occurs within an established social context (Huang et al., 1996). Since nearly all practical communication occurs within a social context, it follows that in

general a lean medium can transmit a rich message. The error in media richness theory is to assume that meaning is transmitted solely through the physical message, and hence affected by the medium of transmission, an error that has been pointed out by interpretive theorists (Fulk and Boyd, 1991; Lea, 1991; Lee, 1994).

3.1.2.4 *Confounding properties*

The interpretive nature of meaning is not the only problem of media richness theory. An more fundamental problem is that media richness is defined in terms of attributes of things outside and beyond the medium of transmission alone. Daft et al. (1987) state that media richness arises from:

1. **Feedback time,**
2. **Multiplicity of cues,**
3. **Language variety, and**
4. **Personal focus.**

In terms of the communication model just presented, only one of these four aspects of “media richness”, multiplicity of cues, could be said to be a property of the transmission interface alone, namely the number of channels available within the transmission interface. Immediacy of feedback and language variety clearly vary within media - for example sound may involve feedback delay (as in an answer phone) or not, and may or may not involve language variety. Personal focus seems more a function of the message content than the medium.

A property of an entity should be defined in terms of that entity alone, not that entity plus other things. To do otherwise creates only confusion about what is under discussion.

Media comparison experiments which operate in terms of “richness” as defined above, therefore tend to confound media properties with variables which are properties of the communication as a whole. For example, feedback time depends not only on the medium of communication, but also on the availability of the receiver to respond, and language variety depends on the messages sent, as well as the medium through which they are sent. One therefore should talk about communication richness rather than media richness. Even so, it remains unclear how the different sources of richness defined above should be combined to give a single richness measure for the whole communication situation (Fulk and Boyd, 1991).

Kraut et al. (1992), seeking to develop the ideas of Daft et al. (1987), illustrate the confounded and multiple nature of the concept of richness. They suggest that studies comparing media confuse the *expressiveness* of the media, defined as multiplicity of cues, language variety and ability to infuse personal feelings (Daft et al., 1987), with its *interactivity* - the quickness and appropriateness of feedback. They therefore rephrased Daft and Lengel’s theory to be that when people are dealing with uncertainty they tend to use interactive media (rather than expressive media). Defining “media richness” to include both interactivity and expressiveness is non-intuitive to this writer, as they seem to be independent factors. Also both expressiveness and interactivity as defined are still properties of the communication situation as a whole, rather than of the communication medium alone, and therefore, like media richness, will tend to confound and confuse rather than clarify.

In conclusion, the term “richness” will be used here in the following ways:

1. **Rich channel.** A rich channel is one that has a high signal capacity or bandwidth,
2. **Rich communication setting.** This either contains a rich channel, or has multiple channels.

In addition, it will shortly be suggested that any channel which can transmit language, has the potential to transmit messages with rich meaning.

3.1.2.5 Task equivocality

Media richness theory assumes that the equivocality or ambiguity of the task determines the media preferences found. However what Daft and Lengel call equivocal situations - exchanging confidential information, resolving disagreements, getting to know someone, and negotiating - all also happen to be situations where the other individual is salient. Rich media could be preferred by managers in these situations because they wish to better *relate* to the other person. If so, rich media may be preferred not because they better support information exchange, but because they better support interpersonal interaction. For example, so called rich media also provide highly interactive communication situations (Kraut et al., 1992), which are well suited to interpersonal relating.

Kraut et al. (1992) studied groups producing collaborative documents, seeking to identify links between task equivocality and media preference. They found students preferred a rich (face-to-face) medium for equivocal tasks, such as planning or revising a document, but preferred lean text E-mail medium for less equivocal tasks, such as drafting a document. Planning however was also generally a joint activity, while usually a single person wrote the first draft (converting the plan into text), and so the tasks differed again not only on equivocality, but also on the presence or absence of salient personal relations. In a second experiment Kraut et al. (1992) found that when commenting on missing the main point of a passage, project status, or on the success of the collaboration, subjects strongly preferred voice over text, while for commenting on problems of spelling and grammar, they preferred text communication.

These results were interpreted in terms of task equivocality, but the tasks for which voice was preferred also seemed to be tasks which involved an element of person-to-person relating. For example a comment on the success of the collaboration or missing the main point of a passage could, if taken the wrong way (e.g. to imply that the other person was stupid), jeopardise one's personal relationship with a collaborator. Consequently if forced to use the written medium, subjects tended to limit their corrections to the fixing of small copy-editing errors, i.e. to corrections where task definition was clear, and therefore unlikely to result in personal conflict.

Perhaps the most telling reason for proposing interpersonal relating as the basis for choice of communication setting is the authors' direct observation:

Speaking rather than writing one's comments led subjects to shift their goal from simply revising text to the associated task of communicating with a co-author. Spoken comments frequently contained elements that went beyond the task at hand.

(Kraut et al., 1992)

The authors concluded that with voice communication, subjects were not only trying to solve the task but also have a social interaction. It also provides an example of how two of the integrative model processes (task resolution and interpersonal relating) can operate together (simultaneously), to affect interaction behaviour, as the integrative model would predict.

3.1.2.6 Message ambiguity

Media richness theory assumes that high information capacity (rich) media are required to counteract equivocality or ambiguity. The interaction of group members facing an equivocal situation is seen as involving disambiguation by information exchange, and presumably the more ambiguity there is, the more information exchange is required to nullify it. In the Kraut et al. (1992)

experiment, subjects in voice modality tended to more often use phrases like “a little unclear” to soften directives and avoid giving offence, compared to text exchanges. However, changing “unclear” to “a little unclear” can be seen as increasing ambiguity not decreasing it.

Ambiguity within the interpersonal relating process may serve quite a different role from that which it occupies in task resolution. In task resolution ambiguity is to be avoided. In relating to other people this may not be so. This suggests an alternative interpretation of the role of ambiguity in communication from that offered by media richness theory, namely that *in relational communication, rich communication settings may be preferred because they support ambiguity, rather than because they nullify or remove ambiguity*. This position will now be considered in more detail.

Message ambiguity can be defined as occurring when the same message can be interpreted in more than one way. In interpersonal situations people may *intend to be ambiguous for relational reasons*, such as trying not to offend either of two recipients who are in conflict (Nagasundaram and Wagner, 1992). Otherwise one may “tell the truth and lose a friend”. In an interactive situation, ambiguity allows ideas to be developed from tentative beginnings, rather than being issued fully formed. If the message receiver starts to take offence, an ambiguous comment can be qualified, rephrased, or even disowned (e.g. “that’s not what I meant at all”) with less loss of face. Communication ambiguity can therefore operate as a valuable, and perhaps necessary, “social lubricant” (Nagasundaram and Wagner, 1992).

Rich communication settings may facilitate ambiguity through language, through rich channels, or through multiple channels. An example of the use of modifiers to make language more ambiguous was given above. Non-language sounds, such as “hmmmmmm” can be used to indicate vague ideas such as “Maybe I agree and maybe I don’t, and at the moment I am leaning towards don’t.”

Multiple channels also allow transmission of conflicting messages. For example, while spoken words may indicate “request denied”, the tone of voice (or the body language) may indicate friendliness. From an information exchange perspective, exactly what non-language message channels, such as tonality in speech, transmit is not clear. It has been found that the non-verbal aspect of a message is often redundant to the verbal one, the ability of receivers to decode non-verbal messages varies widely, and receivers are often misled (Eckman and O’Sullivan, 1991). These findings match the concept of deliberate ambiguity better than that of disambiguation.

In summary, the differences in media preference which media richness theory attributes to task equivocality, could equally arise from increased salience of interpersonal relating to other individuals. The choice of rich communication settings could therefore be because they better support the interpersonal relating process, rather than because they allow greater resolution of task ambiguity. The personal impressions from one experiment support the conclusion that the use of voice evokes interpersonal relating in a way that does not occur in text exchange. Subjects naturally begin to relate to the other person when using a voice channel, and prefer the voice channel for tasks where relating to others is important. The “signature effect” of rich communication settings will be later suggested as a reason for the evocation of interpersonal relating in such cases (see 3.3.3.1, p95)

3.1.2.7 Summary

To summarise, the findings of Daft et al. (1987) are less in dispute than their interpretation. Three main problems arise for media richness theory:

1. Assuming media richness is a single dimension oversimplifies the concept of communication setting,
2. Assuming properties of the communication situation as a whole (e.g. meaning), can be attributed to the medium of communication alone, confounds variables in media comparisons, and
3. Assuming that rational information exchange is the basis of group interaction implies that that in communication people wish to avoid ambiguity, when they may prefer it for non-task reasons.

Media comparison experiments compare different *communication situations* rather than different media, situations which differ on many features which the theory does not consider.

In order to explain the reduced performance of lean media, media richness theory, being a two-process model, must also imply that computer-mediated groups will be unable to generate agreement across lean media. The integrative three-process model, by contrast, adequately accounts for the findings of media richness experiments without linking the process of group agreement generation to media richness.

3.1.3 Reduced social context theory

Studies by Sproull and Kiesler (1986) also focus on the concept of media richness, or lack of it, arguing that people's social context is reduced in computer-mediated communication, because the cues which define social context, such as clothes, desk, appearance, and tone of voice, are not available. Social context indicates the status of other, the nature of the situation, and the relation between sender and receiver. People adjust their communication behaviour according to the social context within which the communication is taking place. In terms of the integrative model, social context, as used by Sproull and Kiesler, does not distinguish between relational context (which defines the relationship) and group context (which defines formal group roles, status and positions), but seems more akin to the former.

The reduced social context model implies that when social context cues are weak, *social influence* is reduced, which in turn causes:

1. **Disinhibition.** Communications which would have been inhibited by social influence are expressed,
2. **Individuation (more self-focus).** Communications are more self-centred (focused on the sender's feelings and thoughts) rather than other-centred,
3. **Less status differentiation.** Communications from different status individuals are not differentiated,
4. **Less evaluation apprehension.** Senders feel less stressed by the possibility of being evaluated by others, and
5. **Polarisation.** Computer-mediated groups make more extreme decisions than face-to-face groups (Siegel et al. 1986).

It is theorised that disinhibition occurs because, when social influence is reduced, social constraints break down, and people engage in "deviant" or anti-social behaviour, which they would otherwise inhibit (Hiltz et al., 1989). For example, they violate norms such as that against giving bad news (Sproull and Kiesler, 1986). Individuals using computer mail and teleconferencing systems tend to

exchange more extreme views, have more antisocial behaviour and make more extreme decisions than when face-to-face (Siegel et al. 1986). The same cuelessness that has these effects causes electronic messages from superiors to look the same as messages from subordinates which, it is proposed, creates more equality and less role differentiation (Kiesler et al., 1984; Boshier, 1990), and reduces the likelihood that one individual will dominate. People consequently prefer to use electronic messages to communicate with superiors but not to subordinates (Sproull and Kiesler, 1986).

Restricted cues may be an advantage. As Chafe (1986) notes “. . . speakers are under constant pressure to make what they say informative and relevant; the social context imposes an on-line evaluation of their product.” Writers of E-mail messages do not experience such audience pressure, and can review and revise their thoughts before communicating them. The second thoughts and revisions of face-to-face speakers however must be done under a spotlight of audience attention. Hence reduced social (relational) context can be expected to reduce self consciousness and evaluation apprehension. Kiesler et al. (1984) noted that students are more willing to approach a professor for assistance with assignments through electronic mail than in face-to-face encounters, and subjects seem to be willing to reveal more about themselves through CMC than in face-to-face situations (Siegel et al., 1986).

Reduced social context theory has many similarities with media richness theory. Like media richness theory, it proposes that the properties of the technology determine the nature of the interaction. This theory regards social context as being transmitted through the medium, just as media richness theory regards meaning as being transmitted through the medium. It assumes that effective social influence arises from the physical exchange of rich social cues. However social context, like shared understanding, may be a property of the sender and receiver as a whole, not just the communication or the medium, and may exist even before information is transferred, as for example in established relationships or groups. A comparison of peer groups of managers in a conservative organisation under anonymous and signed conditions found no differences in uninhibited behaviour, suggesting that disinhibition is not an inevitable consequence of using an electronic medium, given groups with an existing social structure (Hiltz et al., 1989).

Reduced social context theory assumes only two processes operate, task and social. In the integrative model, evaluation apprehension and individuation will be associated with the interpersonal process, while polarisation will be attributed to the group normative process. In this theory both are assumed to be “social” effects. This gives rise to contradictions within reduced social context theory. For example, it proposes that CMC groups show increased polarisation, which implies increased group influence on the individual, and at the same time show greater disinhibition and individuation, which implies greater individual focus (Lea and Spears, 1991). These issues will be taken up in detail in section 3.4.3.9, p106.

Because it operates from a two-process perspective, reduced social context theory also predicts that when plain text is the sole communication medium, groups will be unable to generate or enact agreement, because the social context cues necessary for social influence will not be transmitted.

3.1.4 Contingency theory

Contingency theory says that group behaviour is contingent upon combinations of task and technology, and successful use of technology depends upon the matching of technology (or transmission interface) with task demands (Kraut et al., 1992). An example is Daft et al.'s (1987) suggestion that good leaders select a rich communications medium for equivocal tasks. In as much

as contingency theory is built around media richness, it has the problems already dealt with. As a theory apart from media richness, it states that subjects choose the communication setting appropriate to the task. Without any statement guiding how this matching occurs, for example through models of task or technology categorisation, it is very broad and general theory, providing only relatively weak predictive power.

Contingency theory is derived from *structural contingency theory*. Structural contingency theory has been highly influential in guiding research into organisation design and performance. It states that organisations must achieve a good fit between technology and the structure or context of the organisation. For example a highly centralised and hierarchical organisation may have difficulty using technology that assumes that everyone connects with everyone else. The criticisms which have been made of structural contingency theory are that the entities of the theory (structure, technology) are not well defined, and that the theory is so general as to provide few specific predictions (Gutek, 1990). A review of structural contingency theory concludes:

Clearly structural contingency theory is flawed, but a flawed theory may be better than no theory. Although structural contingency theory makes few predictions, it does provide a perspective to guide research.

(Gutek, 1990, p74)

It appears that contingency theory has similar position in GSS research as structural contingency theory does in organisational research.

3.1.5 Interpretive perspectives

Media richness and cues-restricted theories have both been referred to as “cues-filtered-out” theories (Walther and Burgoon, 1992), and highlight some of the problems which occur when the objective approach used in the physical sciences is applied to social or group activity. The problems of such deterministic approaches are not new. They have always existed in the social sciences, and the lessons learned there over years of research can fruitfully be applied to the area of GSS. Fulk et al. (1990) point out two false assumptions that can be made regarding social communication. The first is to assume that the capacity for meaning is an inherent property of the physical medium of communication. The second is to assume that communication primarily involves the exchange of rational information.

Both of these assumptions have already been touched on, and will now be considered in more detail. The rejection of these assumptions and the alternative positions adopted, constitute an *interpretive approach* to theory development, and this is the approach taken throughout the theory development in this chapter.

3.1.5.1 *The constructed nature of meaning*

Lea and Spears (1991) argue against the positivist approach they call *technological determinism*, which runs through cues-filtered-out theories. Positivist approaches, where objects are considered to have a defined meaning in themselves, have had limited success in areas where the meaning of an object or action lies primarily in the minds of the participants, such as anthropology or sociology (Lee, 1994). These are subject areas where abstract group conceptualisations, such as tribe, nation, organisation, family etc., are significant determinants of behaviour.

Anthropologists for example, deal with this by taking an *interpretive* approach, attempting to think as the subjects they are studying think, arguing that only by seeing through the eyes of the people in the situation can they see the anthropological realities of the situation. The same approach was used

to develop the integrative model used in this research. The approach is not subjective because different anthropologists can reach the same conclusions, and discover the same realities, about a given society. However unlike positivism, these realities are not physical.

Lee (1994) points out that positivist and interpretive approaches are simply different perspectives, rather than competing philosophies. Not only are they compatible, they are mutually beneficial perspectives. The integrative model used in this research is based on an interpretive perspective, while the experiment derived from it is based on a positivist perspective.

Turning to the issue of whether text E-mail can transmit rich meaning, Lee (1994) suggests that it is natural to refer to an area of study that focuses on the extraction of meaning from text, *hermeneutics*, often used to interpret ancient religious texts. This avoids the need to rediscover what academics in that field already know. In hermeneutics, meaning is considered to be an *objective, socially constructed reality*.

Lee gives the example of Euclidean Geometry. It is socially constructed because it is created and shared by a social group. It is, strictly speaking, a fiction, but only in the sense that it is not physical. Although abstract, it is an objective reality, because it remains the same across many individuals. The reader of a Euclidean research paper must “appropriate” or construct the meaning behind the text. Because the social construct we call Euclidean Geometry has internal consistency, it is possible for the reader to understand what the author said better than the author themselves, and the text can take on a life of its own (“autonomization”). Despite the separation of sender and receiver (“distanciation”), the receiver “enacts” the meaning of the message in accord with the social construction behind it.

Applying these concepts to GSS supports the idea of the group as a social construct:

. . . there is the world of the organization standing behind any E-mail communication. An organization is a social construction with an existence independent of the people who, at the moment, are populating it and the buildings that are housing it. The socially constructed world of an organization is what would persist even if there were complete turnover in its personnel and even if it were to relocate to different buildings in a different city.

(Lee, 1994)

The original simple communication model implied shared *communication protocols* between sender and receiver. Sproull and Kiesler (1986) extended this into the need for a shared *social context*, but suggested that the context arose from the signals transmitted. The contribution of Lee and hermeneutics is to extend this concept even further. Sender and receiver share an objective, *socially constructed reality* with internal consistency and imperatives of its own, an abstract world that can be appropriated by the receiver, as a tool to extract meaning from physical signals which may inherently have no meaning.

This leads Lee to conclude that richness is not in the physical message, but rather in the constructions shared between sender and receiver. It follows that, given shared social constructs, apparently lean channels such as plain text can transmit rich messages, and he reports data from a study of E-mail transcripts which show this is so in a practical organisational setting (Lee, 1994).

These ideas were tested experimentally by Huang et al. (1996), who manipulated the shared social context in groups solving a preference task which required the enactment of agreement. Groups with

shared social context spent time prior to the interaction discussing their individual goals and agreeing on group goals, which goals the authors point out were not only shared but socially constructed. They found that when there was a shared social context, subjects perceived the CMC medium to be just as rich as the face-to-face medium. They conclude that while media richness theory may apply for groups with no social context (e.g. ad hoc groups that have never met before), groups who have a history which gives a social context can create communication richness on lean media. Since most communication occurs within a context and involves shared constructs, these findings considerably restrict the applicability of media richness theory.

3.1.5.2 *Criticisms of systems rationalism*

Cues-filtered-out theories also adopt a *systems rationalist* approach to group activity, which assumes that groups exist to solve problems, that task productivity and efficiency are the key issues of groups, and that communication occurs to exchange rational information (Lea, 1991). For example the concept of a rich medium implies a greater capacity to transfer information, which presumes that the primary aim of communication is to transfer information. Lea (1991) argues, from a symbolic interactionist position, that the *social meaning* of CMC is more significant than its *task productivity*.

Lea (1991) suggests that the classification of communications media should be derived from user perceptions, rather than the rationalist perspective of the experimenter. He used a repertory grid technique to derive the social constructs users attached to a variety of communication media, including E-mail. A principal components analysis of these constructs gave the following components (and % variance explained by each component):

1. Spoken vs written (41%)
2. Spontaneity (spontaneous, informal vs planned, formal) (24%)
3. Inconsequentiality (inconsequential vs important) (16%)
4. Emotionality (rich vs impoverished) (8%)
5. Technology mediated (4%)

This analysis did show a “richness” factor, defined as the ability to transmit interpersonal, affective information. As might also be expected from media richness theory, E-mail rated low on this component, well below telephone and face-to-face communication. However this richness was the fourth factor, accounting for only 8% of the variance, suggesting that richness may not be the key feature that media richness theorists think it is, and that factors other than capacity to transfer information are important to users operating within a communication setting. The taxonomy of communication settings will support this view.

3.1.5.3 *Summary*

In summary, the interpretive perspective suggests that in communication, meaning is constructed using shared abstract realities, rather than inherent in the signal transmitted. Therefore the signal capacity of the transmission medium may be less important than a positivist perspective might imply. Interpretive theories suggest that the problems found in applying richness theories to GSS may arise from a fundamental misconception of the nature of communication. They also cast doubt upon the assumption that information exchange capacity is a primary factor in group communication.

3.1.6 Previous taxonomies

The advent of computer support for groups has made possible group interaction environments not before feasible, and a number of criteria have been used to define the variety of types of communication setting. Previous taxonomies will now be reviewed.

Cook et al. (1987) propose four types of *meeting classes*:

1. **Constrained by space and time.** Face-to-face meetings,
2. **Constrained by time but not space.** Distributed synchronous meetings,
3. **Constrained by space but not time.** Not a common form of meeting, and
4. **Not constrained by space or time.** Asynchronous meetings.

This taxonomy is still commonly used (e.g. Watson et al., 1994).

Dennis et al. (1988) provide a taxonomy of *EMS environments* based on:

1. **Group proximity.** Multiple individual sites, one group site, multiple group sites,
2. **Time dispersion.** Synchronous, asynchronous, and
3. **Group size.** Small, large.

Lim and Benbasat (1991) offer a more generalised framework for *group interactions* based on:

1. **Concurrency:**
 - a) **Time dispersion.** Synchronous, asynchronous,
 - b) **Spatial.** Collocated, dispersed.
2. **Message content.** Task orientated, social-emotional,
3. **Path.** Who the communicator is connected to,
4. **Channel:**
 - a) **Technological support.** Computer-mediated, non-computer-mediated,
 - b) **Mode:**
 - i) **High social presence.** Auditory, visual,
 - ii) **Low social presence.** Textual, graphical.

Burke and Chidambaram (1995) classify *meeting mode* in terms of:

1. **Technology support.** The GSS,
2. **Dispersion.** Collocated or distributed,
3. **Synchronicity.** Degree of interactivity,
4. **Channel capacity.** Capacity to transmit amounts and types of cues.

As can be seen there is some variation in what are considered relevant factors and in the interpretation of those factors. It is not clear whether the categorisations *meeting classes*, *EMS*

environments, group interactions and meeting modes are the same or different things, since the basis upon which each categorisation is made is not explicit.

3.1.7 Analysis of communication setting

This section will attempt to provide an explicit foundation for a taxonomy of communication settings by:

1. Stating a model of the communication situation,
2. Defining what is meant by communication setting in terms of that model, and
3. Analysing the properties of communication setting to produce the taxonomy.

3.1.7.1 An enhanced communication model

Adding the concept of shared social constructs (Lee, 1994) to the model of the communication situation developed earlier gives the enhanced communication model shown in Figure 13. The model also allows for many senders, which will be used in developing the concept of many-to-many communication shortly.

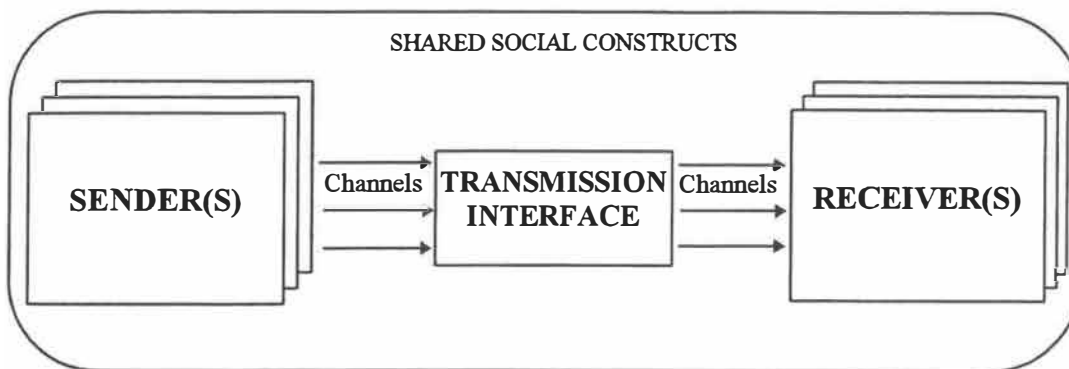


Figure 13. Enhanced communication model

Since this model will now be used to categorise communication settings, it is worthwhile to briefly recap its concepts. The *communication setting* is defined by the *transmission interface*, which mediates the transmission of a *single signal* between sender(s) and receiver(s). A single signal involves the single transmission of information from sender(s) to receiver(s). A complex signal may involve many *channels*, each carrying different aspects of the signal. Each channel carries a separate stream of information. Each channel involves one, and only one, *physical medium* (although the reverse is not true - a single physical medium may involve several channels). The transmission interface may apply *storage* and *processing* capabilities to the transmission. A single transmission from a sender may go to only one receiver, or may go to many, depending on how the sender and receiver are *linked*. The transfer of information requires shared *social constructs* between sender(s) and receiver(s) and is not simply a property of the message or the transmission interface. A *communication environment* may provide many alternative communication settings, as for example where a subject may interact by telephone or by memo.

3.1.7.2 Definition of communication setting

The communication setting is *that through which group communication occurs*. It is what exists before the sender and receiver begin to transmit a message. It includes any communication tools

available, whether a chalkboard, GSS hardware and software or even a facilitator. It is defined to include not only the physical setting, but also includes any rules, filters or modifications that the transmission interface applies in its handling of what is transmitted. The “normal” communication setting is the physical face-to-face environment, but technology is changing that normality, first with the telephone and other devices, and increasingly now with the computer. In a computer-mediated settings (CMC, CMG), the communications setting is provided entirely by a computer network.

The communication setting can also be called the medium of communication, but the term “medium” will here generally be avoided, because it can result in confusion with the term “media”, which usually refers to the physical media of vision, audition, and so on, as in the term “multi-media”. It also carries connotations of passivity which tend to oversimplify what is being described in the electronic case (Fulk and Boyd, 1991).

3.1.7.3 Analysis principles

The taxonomy developed here will be consistent with the following three principles:

1. It will be based on the enhanced communication model,
2. Its dimensions will be defined solely by the transmission interface, and
3. It will, as far as possible, use principles that can be applied to all communication interactions, not just computer-mediated ones.

Communication setting is not described by any variable or property of sender, receiver, message or context, since that would mean that the communication setting would change with these factors. Based on the above principles, some of the terms in the previously reviewed taxonomies must be excluded, namely:

1. **Colocated.** Colocated communication is not a communication setting in the sense used here, since it is expressed in terms of sender and receiver position. Colocated communication, according to the communication model used, equates to communication using the very high bandwidth face-to-face environment,
2. **Distributed.** Distributed communication is also not an aspect of the transmission interface - communication settings like the telephone provide all that is necessary for distributed interaction, but could equally operate within the same room. The treatment *colocated vs distributed* is better described as what it is, say *face-to-face vs audio*, which terminology current experiments tend to adopt (e.g. Suh, 1996), and
3. **Task, group and individual variables.** Variables such as group size and message content, are excluded as they are not properties of the transmission interface.

The following properties of the communication setting will be developed:

1. **Complexity.** The number of different communication channels provided by the transmission interface for a single signal.
2. **Asynchrony.** The time period for which the transmission interface is available to send or receive for a given signal.
3. **Linkage.** The power of the connection between sender(s) and receiver(s) for a single transmission operation.

4. **Transmission cost.** Average effort required by communicating users of the transmission interface in sending a signal.
5. **Interface processing.** Protocols and transformations used by the communications interface in mediating between sender(s) and receiver(s).

These will now be considered in detail and the first three will be used to define the taxonomy.

3.1.7.4 Complexity

For a single transmission, the sort of signal a transmission interface can carry depends more on the number of channels than the capacity and media type of each channel. The concept of transmission interface complexity involves more than simple media bandwidth or information capacity, because complex transmissions present multiple channels of information. For example a film show offers both sound and vision channels in a single transmission. Signals in the physical world offer a channel for each sense, such as vision, audition, olfaction, touch, and taste.

Complexity will be defined as the total sum of significant channels provided by the transmission interface for a single signal, and considered to be what defines the signal complexity possible in the transmission interface.

Language can be considered to offer a secondary channel of communication, which operates in the same way as the primary channels provided by the physical senses, but on a higher level. For interacting groups, this means there are at least three available channels of communication:

1. **Vision.** Communication through form,
2. **Audition.** Communication through sound, and
3. **Language.** Communication through symbol.

Speech can be seen as a combination of a language channel and a sound channel (tonality), and video a combination of visual, sound and language channels. Since plain text conveys relatively little information through its visual form (for example compared to the face of a person speaking), it will be considered to be primarily a language channel only.

It could be argued that language as a channel for meaning is different from the senses, because language symbols are interpreted differently by different individuals, while the senses are fixed in meaning. However each sensation is also an interpretation, carried out by common biological mechanisms, and individuals may differ in their interpretation of apparently objective sensations, as for example when one is colour blind. Although common to all humans, sense interpretations are really arbitrary biological conventions - there is no "colour" inherent in the electromagnetic spectrum, nor are there "notes" in the physical frequency range. Language can therefore be regarded as an extension of the same principles operating in the physical sense channels. Non-physical meanings, such as "love", are arbitrary conventions of meaning imposed by the brain on specific signal input (words), in the same way that colours and notes are. The only difference is that language interpretations arise from social constructs, which are created during ontogeny rather than phylogeny.

Does language allow the transfer of rich information? Experiences with E-mail suggest it can (Ord, 1989; Lee, 1994). Symbols have been used since time immemorial, and although their meaning is not inherent, their potency for emotional impact is without doubt (e.g. the sign of the cross). Based

on the previous discussion on the constructed nature of meaning, language will be considered to offer a channel which can potentially convey rich meaning.

In summary, the complexity of the communication setting, as relevant to group interaction, can be described as shown in Table 3.

Communication setting	Example	Complexity
Plain text	E-mail	Primarily one channel: language
Speech	Telephone	Two channels: Audio and language
Video	Television	Three channels: Audio, visual and language
Face-to-face	Conversation	Three+ channels: As for video, plus other channels

Table 3. Communication setting complexity

Combinations such as audio only (music) have been left out because they do not apply to relating groups (although an orchestra might disagree). Some combinations have been left out because they are rarely used. For example the old silent movies offered a visual plus language communication setting (not auditory). Other combinations have been left out because they are not yet common. For example video cameos may in the future be inserted in electronic text to enhance the variety and type of channels available (Lanham, 1993), giving truly rich text.

3.1.7.5 *Asynchrony*

Asynchrony, as a property of the transmission interface, can be related to *message storage* by the transmission interface, *message delay* due to transmission, and to the *interactivity* of the situation (Burke and Chidambaram, 1995), all of which tend to refer to the same property of the transmission interface. Since this property can be quite confusing it is better to begin with the concept of synchrony.

Synchrony can be defined as the sender and receiver being involved in the same interaction at the same time. Such a definition makes synchrony a property of the time relationship between sender and receiver, rather than a property of the transmission interface. Sender and receiver could thus be “synchronous” even for communication that involves storage and delays, such as E-mail or letter writing. For example sender and receiver could sit at their computers, simultaneously, waiting for delayed E-mail transmissions. A definition of synchrony in terms of sender and receiver would have to describe this as “synchronous communication”.

Synchrony could also be defined as when messages are sent and received almost simultaneously, i.e. transmission time is very low, but then if E-mail transmission times were to reduce to a fraction of a second, E-mail would become synchronous. E-mail is seen by users as being just as asynchronous as letter writing, even though transmission times for letters (“snail mail”) are much longer than for E-mail (Lea, 1991). It appears that even if the transmission time for electronic communication were to reduce to almost zero, it would still be seen as an asynchronous transmission interface by users. The E-mail feature users are calling “asynchronous” is not distinguished by transmission times.

It is better to define synchrony solely in terms of the communication setting, as follows:

A synchronous communication setting is one that requires sender(s) or receiver(s) to coordinate their sending or receiving with the transmission operation.

For example face-to-face conversation is synchronous, because if you are not there when it occurs, you miss it. The reason for including sender(s) in this definition will become clear shortly, when many-to-many communications, such as a show of hands in a meeting, are discussed.

Asynchrony is usually achieved electronically by message storage, either in temporary form, such as E-mail, or in a more permanent form, such as in a book or stone tablet. Such stored transmissions are also usually not immediate, but involve transmission delays. Asynchrony has been expressed in terms of these delays. Lea's (1991) primary user construct of Written/Spoken was further analysed and found to include constructs representing the communication delays experienced by users of written compared to spoken media, which followed the categorisation of Bowers and Churcher (1989):

1. Asynchrony 1: **Preparation time** - simultaneous creation and transmission vs delayed transmission (with the possibility of editing),
2. Asynchrony 2: **Transmission time** - immediate reception vs delayed reception,
3. Asynchrony 3: **Response time** - immediate feedback vs delayed feedback..

All three delays affect *interactivity*, normally defined in terms of the time to send and receive messages, or speed of interaction (Kraut et al., 1992). In highly interactive communications, such as face-to-face conversation, messages are sent, received and responded to almost immediately, without any feedback delays due to the transmission interface or receiver absence. However response delay depends upon whether the receiver is present, and willing to respond immediately upon message receipt, and thus is not solely a property of the transmission interface. It can be concluded that interactivity is a complex property of the whole communication situation, and therefore cannot be used as a defining feature of the communication setting (because aspects of interactivity are defined in terms of sender, transmission interface and receiver).

For example in the experiment carried out in this research, groups of five had to reach agreement on the answers to a test of 12 multi-choice questions, working solely through the computer. Communications were asynchronous, and each member could be working on a different question at any one time. After the first vote, subjects were able to see how the rest of the group responded. Slow users received immediate feedback from the responses from the rest of the group, since everyone had usually voted before them, and for them the situation was very interactive, involving no feedback delays. However fast users found the same communication setting not so interactive, as they always had to wait for the slow users to catch up before they could get a feedback response. For them feedback was always delayed, and thus the situation was a far less interactive one. The communication setting, or transmission interface, however was the same for all users.

It is proposed that asynchrony be defined not in terms of delay, but *in terms of the ability of a transmission interface to receive and deliver messages for a given transmission operation over an extended time period*. Thus asynchrony frees users from the need to be synchronously present at the moment of transmission in order to send or receive. In this definition, speed of message transmission and user response delays are irrelevant. The defining feature of asynchronous transmission is that it allows

individuals to decouple themselves from a particular communication operation, without fear of missing the contributions of others, or of being unable to contribute.

In conclusion, it is proposed that synchrony/asynchrony is a key property of the communication setting from a user perspective. The definition of these terms is summarised in Table 4.

	Definition	Similar Terms
Synchronous	Requires the sender or receiver to synchronise themselves with the transmission operation	Immediate, interactive, transient, not stored
Asynchronous	Does not require the sender/receiver to synchronise themselves with the transmission operation	Delayed, stored

Table 4. Communication setting synchrony/asynchrony

3.1.7.6 Linkage

An important feature of a GSS is the type of connection it provides between sender(s) and receiver(s), usually categorised as one-to-one or one-to-many (DeSanctis et al., 1993). The nature of the link between sender and receiver(s) can be defined in terms of what occurs *in a single signal transmission*, as shown in Table 5.

Type of Linkage	Label	Definition
One-to-one (1:1)	Point-to-point	In a single transmission operation, data from one sender is transmitted to one receiver
One-to-many (1:n)	Broadcast	In a single transmission operation, data from one sender is transmitted to many receivers
Many-to-many (m:n)	Vote	In a single transmission operation, data from many senders is transmitted to many receivers, often the same people as the senders

Table 5. Communication setting linkage

The last category shown, many-to-many, is a form of communication that is not commonly recognised, but one which, it is proposed, is a natural extension of the other two. Many-to-many communication is not reducible to broadcast communication, just as broadcast communication is not reducible to point-to-point communication. The transmission interface offers fundamentally different forms of communication service in each case.

A distinction will be made between many-to-many *task situations* and many-to-many *linkage*. A many-to-many *task* situation is where many people *wish* to communicate with many others, as for example, in a meeting. A meeting or discussion task situation can be handled using a one-to-one, one-to-many or a many-to-many communication setting, with of course varying degrees of success

depending on the situation demands. The various combinations of situation and linkage will now be described:

1. **Broadcast task situation.** A broadcast task situation can be dealt with by:
 - a) **One-to-one linkage.** According to the definition, E-mail provides one-to-one linkage, even though one E-mail can be sent to many receivers, because each E-mail receiver requires a separate transmission operation, and each receiver gets their own individual copy of the E-mail message. A one-to-one transmission interface deals with a one-to-many requirement by *duplication*, e.g. list E-mail. This duplication means that using a one-to-one communication setting becomes increasingly expensive as the number of receivers increases, e.g. sending a mail message to all US citizens.
 - b) **One-to-many linkage.** By contrast to list E-mail, a bulletin board provides true one-to-many communication, because the sender communicates with the many readers of the board by the single transmission act of posting a notice. Unlike list E-mail, all receivers are reading the exact same message. Clearly this is more efficient than the duplicating method used by one-to-one transmission interfaces, e.g. sending a message to all US citizens by TV broadcast.
2. **Meeting task situation.** A meeting situation involves a many-to-many communication task requirement, and can be dealt with by:
 - a) **One-to-one linkage.** One-to-one communications are particularly inefficient when dealing with discussion type situations, and information overload can be a problem in this case (Hiltz and Turoff, 1985). For example, a manager requesting policy feedback using E-mail from a group of 20 staff could expect 20 messages in reply. The many-to-many task situation means everyone wishes to keep everyone else informed of what they are saying, so each staff member will send their reply to 20 people. The result, after a single question and response, in a discussion situation, is 400 one-to-one E-mail responses. Each of the 400 replies could in turn generate a response, which would also need to go to the entire group, so replies to replies could number over 8,000. It is not difficult to see how information overload occurs in this case.
 - b) **One-to-many linkage.** By contrast, a one-to-many communication setting, such as a bulletin board, offers a far more efficient communication operation for discussion situations. In the example given above, there will be at most 21 items, the original item plus 20 reactions, which is a considerable reduction in transmission operations for the same information transferred. A broadcast communication setting deals with discussion situations by duplicating the transmission operation for each sender, just as point to point communications, such as E-mail, deal with broadcast situations by duplicating the transmission operation for each receiver. In this case, each sender transmits one broadcast message to the group. In a face-to-face setting, each sender gets to "share the microphone", or take their turn at speaking, and in this way many people are able to communicate with many others. For most discussion situations this type of duplication is satisfactory. However for highly interactive discussion situations, where a group is dynamically acting as one, true many-to-many linkage may be necessary, where the group transmits and the group receives all in the one communication operation.

- c) **Many-to-many linkage.** Many-to-many linkage follows the principles established for one-to-one and one-to-many communication. The communication of many senders to many receivers is a single communicative operation, as for example in a show of hands in a meeting. The senders and receivers are all part of the same communication act. In the example given, of a manager raising a policy issue with 20 staff, many-to-many linkage would allow the entire question and reply to occur in a single communication operation, which would be called a vote.

In the framework presented here, what is called voting is only one example of a many-to-many communicative act. This is not a new idea. Hiltz and Turoff (1985) point out that voting can be a “highly condensed form of human communication”. Many-to-many communication however is a more general concept than is implied by the term voting.

The key requirement for many-to-many communication is that the information from the many signals coming into the transmission interface can be combined in some way, without significant loss of information, to form a single output signal, which can then be broadcast to the many receivers. For example if the sender messages are in numeric form, they can be combined, giving a result, such as the mean of the group choice distribution.

The same process in principle can occur in the natural face-to-face setting. For example, many sounds can naturally merge together to create a single larger sound. Audience clapping is a many-to-many communication situation that is the natural equivalent of voting. But while the merging of 200 clap sounds creates a single powerful group clap sound, the merging of 200 E-mails on the same subject does not create a single powerful E-mail (unless it be powerfully long, repetitive and boring). The medium of sound *has the ability to merge many signals into one signal* in a way that does not occur within a setting like text based E-mail.

However if the responses are numeric, the processing power of the computer communication system can provide many-to-many communication, and the combination of 200 votes agreeing with a position does create a group voice that is more powerful than that of any individual. What we call “voting” in a face-to-face setting is usually a slow formal process that is costly to carry out, and often disrupts the flow of group interaction. Computer processing of course changes that.

In conclusion, group voting can be considered to be a communicative act, from all group members to all group members. It is an example of many-to-many communication, which differs from other more commonly recognised forms of communication only in linkage. It is a form of communication that can be well supported by a computer communication system.

3.1.7.7 Transmission cost

It might be expected that CMC transmission cost will be high, since message preparation requires the user to type their message. However communicating involves a variety of factors in addition to message typing. The factors are message:

1. Preparation,
2. Addressing,
3. Administration, and
4. Reception.

These will now be considered in more detail.

The cost of message preparation for CMC may be not as high as it appears, especially for short messages. Electronic templates allow the greeting, goodbye and sender address information to be pre-loaded, and if the communication is a reply, then the original sender's title is also carried forward, so that for a short reply like *OK. Do it*, the typing cost is literally only the few words of the message itself. By contrast, for a similar short letter, over half the work may involve writing the self address, salutation, subject reference and farewell. As well as requiring less layout effort, CMC is easier to amend than a hand written letter or memo because it is electronic, and provides services like copy, cut and paste. The cost of making an error in message preparation is also less for CMC.

CMC automatic addressing and address lists however offer great savings, compared to either manually addressing an envelope or dialling a telephone number. Kiesler et al. (1984) reported that someone posted a new idea on a computer network which in one minute was sent to 300 colleagues in branches across the country, and within two days enough replies were received to launch a new project. That the message was transmitted in one minute may be less relevant than that it is physically much easier to send an E-mail to 300 people than to post 300 letters or telephone 300 people. In this example, CMC provided the user with the equivalent of a secretary to make, in letter terms, 300 copies of the message, place the messages in 300 envelopes, address 300 envelopes, and then stamp and post the 300 letters.

Once sent, the electronic mail system also usually keeps a date/time registered file copy, saving the sender this administrative trouble.

Finally, although the cost of message preparation may be higher for text than speech, the cost of message reception may be equivalently less. While typing is less than one third as fast as speaking, reading is faster than speaking or listening (Chafe, 1982). Research by Weeks and Chapanis (1976) suggests that an idea requiring 100 spoken words can be conveyed in about 25 words of typewritten text, so written text may be up to four times as dense as speech. In general it would appear that with CMC, typing speed losses may be offset by gains at the other end, especially for large groups, where each individual receives data from many others.

Voice in contrast, although offering a complex signal, is inherently sequential, and inefficient for information alone. For example, there are so many pauses in tape recordings that students can speed up tapes by a factor of two when listening to them (Chang et al., 1991). Since "reception cost", in terms of message length, is often a factor in the cost-benefit assessment users carry out in deciding whether or not to process a particular incoming item (Malone et al., 1987), it may also be relevant when users are considering whether to send a message.

In conclusion, CMC communications, such as E-mail, although at first sight more expensive, may actually offer significant cost benefits to users, in the form of effort reduction for message addressing, administration, reception and even message preparation.

This may explain why CMC seems to generally result in more information transfer (Hiltz and Turoff, 1985), and over half of the CMC message information is "new information", which the respondents felt they would not have received or sent except through the electronic channel (Sproull and Kiesler, 1986, report 62%, while Finholt and Sproull, 1990, report "over half"). One group of users reported that the majority of organisational E-mail (58%) came from strangers, persons the recipient did not know, and a majority also came from outside the recipient's building (Finholt and Sproull, 1990).

Although introducing CMC may replace traditional media, it can produce a net gain in all media communications (Lea, 1991) by increasing the “social connectivity” of individuals:

The most fundamental impact of CMCs is to increase the social connectivity of users (i.e. the number of people in regular communication) by about tenfold.

(Hiltz and Turoff, 1985)

The total increase in communications suggests that CMC increases the number of interpersonal relationships that people enter into, which relationships in turn may generate more of other forms of communication, such as FAX and memo.

In terms of user perceptions, computer-mediated communication such as E-mail is seen by users as a much more *spontaneous* medium than letter writing (Lea, 1991):

Since around a quarter of all user's constructs loaded on this component, spontaneity emerges as an important comparative dimension on which E-mailing is seen to be similar to telephoning and different from letter writing.

(Lea 1991, p169)

Both the increase in communication that follows CMC, and its perceived spontaneity, can be attributed to the reduced transmission cost of computer-mediated communication, which thus emerges as an important property of communication settings.

The transmission cost that is acceptable to a user for a particular message has been called the “messaging threshold”, defined in terms of the psychological cost to the user of sending the message (Reid et al., 1996). If the cost imposed by the transmission interface is greater than the individual's messaging threshold for a given communication, then it will not be sent. Only messages whose urgency or relevance exceeds the message threshold are sent. If this view is correct, E-mail seems to reduce the cost of many messages compared to the message threshold, resulting in more communication.

Transmission cost may also explain why systems which attempt to facilitate interaction by increased message structuring, such as the Information Lens (Malone et al., 1987), gIBIS (Conklin and Begemann, 1988), and the Coordinator (Winograd and Flores, 1986), have not been particularly successful (Galegher and Kraut, 1990; Holtham, 1994). The rational structure such systems impose increases the psychological cost to the user of sending a message. In developing the FORUM DGSS software used in this research, users adding a comment were asked to first type the title of their comment, then the comment itself. It was then noticed that even this simple structuring formed a barrier - users would stop and pause while they tried to think what the title of their comment was. In the end, the software was redesigned so users could type their comment first, and then add a title afterwards, on the principle that often users often did not know what they were going to say before they said it.

In summary, cost of transmission seems to be a significant property of the communication setting. Written text may be a surprisingly cost effective medium for the exchange of factual information, overall, especially in large groups. E-mail is seen as a more spontaneous transmission interface than letters, probably due to its reduced cost. This can also explain the increase in communication which occurs when E-mail is introduced, in terms of more communications falling under the messaging threshold. The increase in volume of communication observed due to E-mail may be due to the transmission of messages which were previously perceived as not worth the effort required to send (Finholt and Sproull, 1990).

3.1.7.8 *Transmission processing*

Transmission processing can be defined as the transformation by the transmission interface of the incoming message(s) passing through it. The possibility that the transmission interface can process inputs, as well as just pass them on, is an interesting one. It cannot be discussed in any detail here, except to note that this seems to be an area where there are important differences between GSSs. One form of processing by the transmission interface has already been mentioned - the merging or combining of many signals into one. Other forms of processing include:

1. **Filtering.** The transmission interface only passes on communication items that fulfil certain criteria,
2. **Ordering.** The transmission interface presents communication items in a certain order, e.g. date order or alphabetic, and
3. **Marking.** The transmission interface marks communication items that fulfil certain criteria, e.g. items not seen before by the receiver.

The processing offered by a GSS may also control who can do what in which situation. For example, in Cognoter, once an item is added it can be edited by anyone (Stefik et al., 1987), whereas in Group Systems, once items have been added to the public area they cannot be edited, even by the item contributor. Each GSS environment provides its own such rules, with built in assumptions about how people do things such as make decisions (Mandviwalla et al., 1991). Usually this is implicit, but some GSS designers recognise this explicitly:

*Designers of Colab tools are therefore necessarily creating more than just tools:
They are also designing and enforcing meeting processes.*

(Stefik et al., 1987)

As Turoff (1991) notes, GSS designers are not merely designing computer systems, they are designing *social systems*, which derive from the rules of activity built into the GSS when it is programmed. This cannot be avoided. For example allowing every group member access to every system function at all times is not an absence of a social system, but a type of social system in itself (*laissez faire*).

In the GSS system used in this research (FORUM DGSS), the social system rules were not hard coded into the program, but as much as possible were left to the control of the “designer” of the communication setting for the particular group interaction. The setting designer was able to set up different social rules for different groups, tasks and occasions, adapting each setting in terms of who could do what in the situation. For example the system could be set up like Cognoter, so anyone could edit any item, or like Group Systems so that no-one could alter an item once it was made public. It was usually set up to respect ownership - items could only be edited by the item owner. In this way it offered a flexible communication environment.

In summary, the processing carried out by the transmission interface in electronic groups is a complex but important aspect of the communication setting, one in which GSSs differ significantly. It need not however be a fixed aspect, since, as was done in the software written for this research, the rules of activity can be made adaptable to the situation.

3.1.8 **The taxonomy**

The first three properties of the communication setting just discussed (complexity, synchrony and linkage) give the taxonomy of communication settings shown in Table 6. Each cell in the table is a particular class of communication settings.

Complexity	One-to-one (1:1) (point-to-point)		One-to-many (1:n) (broadcast)		Many-to-many (m:n) (network)	
	Synchrony	Asynch.	Synchrony	Asynch.	Synchrony	Asynch.
Plain text	Sign-language	E-mail, Note, Letter, Braille	Semaphore	Bulletin- board, List Server*, Noticeboard, Sign, Pamphlet*, Book*	Show of hands, TV studio voting, Online chat#	Formal vote
Speech	Telephone	Answer- phone	Radio,	Tape*, CD*	Radio net#, Radio- talkback#	
Video, Face-to-face	Conversation, Video-phone	Video- answer- phone	Speech, TV	Video tape	Discussion, Video- conference#	
				* = 1:1 Duplicated	# = 1:n Duplicated	

Table 6. A taxonomy of communication settings

The settings within each class are listed in order of increasing transmission cost to the user, which cost affects the likelihood of that particular setting being used. Transmission interface processing differences are not shown on the table, as this property generally applies to computer-mediated interaction only. The taxonomy is based on properties of the transmission interface alone, not of sender, receiver or message, so each cell of the table describes a communication context, which can be used by any senders and receivers to communicate any messages possible in that context.

A few examples may help clarify the taxonomy described in the table. From the table it can be seen that a telephone generally provides a synchronous, one-to-one, audio-language communication setting, while an answer-phone allows the same type of communication to occur asynchronously. A letter also offers asynchronous, one-to-one communication, but without the audio channel. A book, although essentially a one-to-one communication (because each book goes only to one receiver), typically provides one-to-many communication by duplication (making copies of the book). Hence it is shown as one-to-many communication, but marked with a star (*), to indicate that it does so by duplicating one-to-one linkage. The message is asynchronous, which means the user can read the book at their leisure. Because considerable effort goes into preparing, printing and distributing a book, transmission costs are reasonably high, and so Book is at the bottom of the list in its cell.

A speech given over the radio by contrast provides one-to-many communication. It not only provides the language channel, but also voice sound and tonality provide another channel to carry meaning. In this case, the receiver must be synchronous with the transmission operation, or they will not receive the message. A tape or CD of a speech, however, allows asynchronous voice communication to occur, in much the same way as for a book. Transmission to many listeners requires a tape to be reproduced and distributed, i.e. one-to-one duplicated communication. A particular tape message could however go to a particular individual, creating a one-to-one communication setting. By contrast radio, by its broadcast nature, must go out to all, and hence it is a true one-to-many form of communication. Television offers the same sort of communication setting as radio, except it adds a visual channel, and video tapes extend sound tapes in the same way.

It can be seen that this taxonomy provides a common way of looking at a wide variety of communication settings. The implications of the taxonomy will now be considered.

3.1.9 Implications

3.1.9.1 *Implications for contingency theory*

Contingency theory states that subjects choose the communication setting appropriate to the task situation. Without any statement guiding how this matching occurs, it is a very broad and general theory, providing only relatively weak predictive power (Gutek, 1990). The principle behind contingency theory seems sound, but its application depends on correct definitions of technology and task. The taxonomy of communication settings proposed gives a more detailed and, it is believed, a more valid definition of “technology” than that provided by the single dimension of media richness. Contingency theory also aids interpretation of the taxonomy, by suggesting that one communication setting is intrinsically neither better nor worse than any other. For example although telephone offers an expressive medium with high interactivity, it usually has only one-to-one connectivity, and also reveals the sender’s emotional state more. There are times when a simple, non-interactive, broadcast notice is a better context of communication. This is the essence of contingency theory - that choice of communication setting is contingent upon the situation (Lea, 1991).

Thus the concept proposed by Daft et al. (1987), suggesting that good leaders select the appropriate communications medium for the task, can be extended to the taxonomy shown in Table 6 as follows:

Good communicators, once the communication task and target(s) are known, will select the appropriate communication setting, according to setting complexity, synchrony, linkage, and transmission cost.

In other words contingency theory can be extended from the simplistic concepts of media richness to the general properties of communication settings given in the taxonomy.

3.1.9.2 *Implications for electronic meetings*

The taxonomy suggests that computer communication is not really creating new communication settings, but rather expanding existing ones. Its contribution appears to be mainly to reduce the cost to the user of communicating in certain settings. Computer mediation has generally made asynchronous forms of communication cost less, and hence become more attractive and useful. The main factor Lea (1991) found from user’s perceptions after the main *spoken vs written* factor, was *spontaneity*, which can be interpreted as a user perception of lower transmission cost. E-mail is seen as more spontaneous than letter writing because it costs less.

The taxonomy suggests that the contribution of computer media lies primarily in the area of asynchronous communication. For example we now have electronic mail, electronic books, and electronic notice boards, in addition to ordinary mail, books and notice boards. Can the same transformation be applied to meetings, giving electronic meetings? It has long been an aim of GSS to do just that, as the alternative name of “electronic meeting system” implies. Looking at the taxonomy however, one difference from the previous cases is immediately apparent - mail, books and notice boards provide asynchronous communication precedents to the electronic versions, while face-to-face meetings are typically synchronous events.

This difference may explain why the electronic conversion has been relatively successful for mail, books and notice boards, but the development of pure electronic meetings has been much less successful. The problem seems to be that electronic media are inherently asynchronous while meetings are naturally synchronous. Asynchrony, as the author found when designing the FORUM DGSS software, is less a virtue than a necessity on computer networks.

This suggests that the natural setting for electronic meetings may be the shaded cell shown on the taxonomy table. This suggestion will now be considered in more detail.

3.1.9.3 *A communication setting for electronic meetings*

A meeting is a task situation where, to a greater or lesser degree, the entire group interacts dynamically. That means many people wish to communicate with many others. From the point of view of selecting a communication setting, the primary problem in meetings is how to support many people who each want to communicate with many other people.

Other features which have been mentioned as possibly defining GSS are anonymity (separation of owner and message) and task structuring (Dennis, 1991). However many other communication settings shown in the taxonomy also allow anonymity (e.g. the telephone, letters), so this is hardly a distinguishing feature. Anonymity is an option available in GSS, rather than a key defining feature. Task or task process structure is a complex issue, but there is evidence that real-time, collaborative work is already highly structured, and it is not clear that there is either a need for, or any benefit to be gained from, an electronic system providing further structuring (Olsen et al., 1992). Studies of the effect of structured processes in distributed computer-mediated groups suggest it has little effect (Ocker et al., 1996). Again it does not seem to be a defining feature.

The reader may have noted that while *conversation* and *speech* appear on the taxonomy, *meeting* does not. This is because the term "meeting" is considered to refer to a communication *environment*, rather than a communication setting. A meeting may allow distinct one-to-one, one-to-many and many-to-many communication settings. Although face-to-face meetings offer one-to-one communication, as when two individuals chat personally together, this form of communication is usually frowned upon. A one-to-one type of interaction seems to be considered inappropriate for a many-to-many task situation, and if everyone chats personally to the people around them, the meeting is usually considered to have "broken up", and ceases to be a meeting. This suggests that many-to-many communication is the defining feature of group meetings. In formal or semi-formal meetings or conferences, each person takes a turn to speak to the rest of the group. In this case many-to-many information exchange occurs by one-to-many duplicated communication. However in small groups involved in interactive, face-to-face discussions, it is proposed that genuine many-to-many communication occurs.

How this occurs is not yet clear. One possibility has already been mentioned, where there is a show of hands to gauge group feeling on some issue. It can also be suggested that non-verbal channels of communication in small face-to-face groups may serve the same purpose. By means of body language, facial expressions, various behaviours (such as drumming the fingers) and non-language sounds (e.g. groans or gasps), group members could provide the same communication effect as would be achieved by a show of hands or a vote. Another possibility is that in group discussions, each communication has a valence, a single value such as agree or disagree, representing the behavioural position of the sender with regard to some task issue, and the combination of valences operates much like voting, as was found by a study by Hoffman and Maier (1961). Many-to-many

communication may be what allows the group members to stay in touch with the group in a dynamic discussion situation, and what makes a group meeting more than just a series of speeches.

If the above is correct, the challenge for computer-mediated groups may be to provide many-to-many interaction, rather than to increase the richness of interaction. The provision of true many-to-many communication may be how computer-mediated group systems (CMGS) will provide a step up in functionality from that provided by E-mail or bulletin boards. For example a brainstorming tool, where each group member adds ideas to a public screen, offers essentially the same functionality as provided by a bulletin board, namely duplicated, one-to-many linkage to support a many-to-many information exchange requirement. Such tools do not distinguish CMGS from bulletin boards. A loose definition of CGSS in terms of "group support" could define bulletin boards as examples of CMGS. However the taxonomy suggests that CMGS be defined as providing support for an *interactive* group, i.e. *a group requiring dynamic many-to-many information exchange*. If CMGS is to provide the electronic equivalent of a face-to-face meeting, it must provide the sort of many-to-many interaction not offered by E-mail or bulletin boards.

However providing a *synchronous*, multi-media, many-to-many interaction across a computer network is a difficult task. For example a meeting of twenty people would generate twenty video streams. If the GSS simply showed them on the screen within 20 separate video mini-windows, that would generate information overload immediately. Many-to-many linkage would require the computer to somehow combine all input streams into one common "space", and to do so in a synchronous manner would require the resolving of any contention, such as two people speaking at the same time. The problems that arise in setting up a synchronous, many-to-many setting, which provides the electronic equivalent of a meeting, go well beyond any lack of media capacity or richness.

However for small groups of up to three, Converse, developed at Carnegie-Mellon University, provides a limited solution. It provides a screen split into three mini-windows, one for each group member, and as members type their comments, the windows are updated in real time (Siegel et al., 1986). This CMGS seems to provide support for "few-to-few" interaction, and notably does not experience the problem of lack of group agreement experienced by other software designs (Lea and Spears, 1991).

However the asynchronous nature of previously successful computer-mediated settings (E-mail and bulletin boards) points to another possibility, that an *asynchronous, many-to-many, communication setting* may be the key to electronic meetings. If this is so, looking at the taxonomy shows that while electronic groups might seem to be a brave new world, there is in fact a precedent. The other many-to-many, asynchronous interaction is formal voting. It is slow, costly, and not usually very interactive, but nonetheless a formal vote is a many-to-many, asynchronous, interaction. It has the property of true many-to-many communication, namely that it *combines many input signals into one signal that can be broadcast to group members*.

Voting may be the slow, formal expression of the essential form of group interaction that defines face-to-face meetings. Fortunately, voting using the computer is anything but slow. The contribution of computer mediation to this communication setting may therefore be the same as its contribution to letter mail and physical notice boards - to reduce the cost of the communication, thereby making it more spontaneous. In the case of formal voting this is not difficult. The power of the computer allows votes that would take 5-10 minutes to carry out formally to be completed in seconds. In the experiment carried out in this research, each group voted 84 times over about 40 minutes, without

apparent strain, or anyone complaining about having to “vote” so many times. Subjects were happy to vote because that is how they found out what the rest of the group was doing.

In conclusion, this analysis implies that the “voting tool” rather than being just one of the ways that GSS differs from other forms of electronic communication, may be the defining difference. It also suggests that the development of dynamic computer voting may be the key to development of electronic groups. Comparison with face-to-face meetings suggests that the critical defining feature of electronic meetings, as distinct from E-mail and bulletin boards, may be *their ability to deal with many-to-many interaction across an asynchronous transmission interface*. This is a more stringent definition than usually applied, where any sharing of low level resources across a network is considered to be “groupware” (Holtham, 1994). This communication can be achieved either by duplicating one-to-many communication, or by providing true many-to-many interaction. Perhaps the demands of many-to-many situations can be met not only by “rich” media, but by processing power.

This defines the communication setting that will be explored by this research. It will investigate whether the sort of many-to-many dynamic interaction it is proposed occurs in face-to-face discussion can be simulated on an electronic network, and whether it provides the same benefits that are experienced by face-to-face discussion groups, regardless of media richness.

If successful this may bring an added benefit. Computer systems provide each group member with their own input terminal, allowing member input to occur in parallel (Nunamaker et al., 1991), while face-to-face groups must all share the same communication medium. As group size increases this sharing becomes increasingly difficult, and group performance becomes increasingly inefficient as group size increases (Steiner, 1972). By contrast the effectiveness of electronic interactions has been found to be independent of group size (Dennis et al. 1990a, 1991; Valacich et al., 1992). Face-to-face groups deal with the problems of increasing group size by increasing formality and restrictiveness, but large electronic groups do not show this effect and remain just as lively and vital as small groups (Finholt and Sproull, 1990). This suggests that if many-to-many, asynchronous interaction is successfully simulated, the effect can be expected to apply to groups of any size.

3.1.9.4 Implications for media richness

Daft et al. (1987) organised media in decreasing order of “richness”, as follows: face-to-face, telephone, written addressed (letters) and written unaddressed (posters). From the point of view of the proposed taxonomy, this uni-dimensional categorisation of communication settings seems a considerable over-simplification (Fulk and Boyd, 1991). The categorisation of plain text as “lean” for example, depends on which signal channel is focused on, the “lean”, visual channel (typed letters) or the “rich” language channel.

3.1.9.5 Implications for research design

The taxonomy proposed has implications for both research design and the interpretation of research results.

Firstly, if the research design seeks to vary the communication setting, it is better if only one property of the communication setting is varied at once. Otherwise, as has been shown for media richness experiments, treatment effects can be confounded between different media properties, such as capacity and synchrony (Kraut et al., 1992). Comparisons of electronic vs face-to-face meetings confound many variables, as do comparisons of compound communication environments, such as

decision rooms vs face-to-face. These designs run counter to the standard research procedure of varying only one variable at a time.

Another problem arises when comparing fundamentally different types of communication setting. By analogy, one could compare humans walking on land with humans walking underwater, but there would be little point, since when underwater humans tend to swim, not walk. It may be a mistake to consider the challenge of electronic groups to be the automation of the face-to-face group environment (Hiltz and Turoff, 1985), or see face-to-face interaction as the standard against which CMGS should be measured (Lea, 1991). Electronic groups are probably better regarded as a group environment that exists in its own right, not merely as a pale shadow of face-to-face meetings (Hiltz and Turoff, 1985).

Secondly, if it is intended to research group processes, this is best done within a given class of communication settings, otherwise effects could be modified by variations in communication setting as well as the treatment variable.

Even within a given class of communication settings, as defined in the taxonomy table, differences between GSSs can be as great as their similarities, particularly in the area of transmission interface processing. Therefore when investigating process operations, it would be better to make treatment comparisons within a single fixed communication setting. For pure electronic groups, this means within the same CMGS. The research design proposed can be called *CMGS vs Altered CMGS*, where the same software is used for all values of the treatment variables (e.g. Lea and Spears, 1991; Burke and Chidambaram, 1995). Consequently factors such as ease of use and processing by the interface are kept constant (unless they are treatment variables).

This suggests a special type of CMGS, as described by DeSanctis and Gallupe in their foundation GDSS paper:

. . . how do researchers begin? A critical first step is to construct a software environment in which alternative GDSS designs and features can be compared for their relative effectiveness.

(DeSanctis and Gallupe, 1987)

The authors note that such an approach requires effectively a “GDSS generator”, comparable to the DSS generator referred to by Sprague (1980). The software written for this experiment (FORUM DGSS) was built on this principle, to operate as “CMGS generator”. Over 150 parameters within FORUM DGSS allow the communication setting to be altered, each parameter changing some property of the transmission interface, often in subtle ways. FORUM DGSS operates effectively as a different GSS in each case. This was a crucial factor in being able to implement the *CMGS vs Altered CMGS* design used in this research.

3.1.9.6 Interpretation of GSS vs non-GSS studies

There have been a large number of studies comparing subjects with and without computer support, that were “matched” on all but the purported variable of “GSS” or “GDSS” (e.g. Lewis and Whiteley, 1992). Meta-analysis of these studies has yielded some general conclusions about GSS, although the results of these studies are often contradictory and inconsistent (Pinsonneault and Kraemer, 1989; McGrath and Hollingshead, 1991; McLeod, 1992; Dennis et al., 1996).

It can be concluded that in most but not all cases, using a GSS:

1. Increases task focus (Pinsonneault and Kraemer, 1989; McGrath and Hollingshead, 1991; McLeod, 1992),
2. May improve task performance, although the results here are somewhat mixed, (Pinsonneault and Kraemer, 1989; McGrath and Hollingshead, 1991; McLeod, 1992; Dennis et al., 1996),
3. Increases equality of participation among members, (McGrath and Hollingshead, 1991; McLeod, 1992),
4. Generally increases time to decision, (McGrath and Hollingshead, 1991; McLeod, 1992; Dennis et al., 1996),
5. Generally results in less consensus, and lower decision acceptance (McGrath and Hollingshead, 1991; McLeod, 1992), and
6. May result in lower reported participant satisfaction (McGrath and Hollingshead, 1991; McLeod, 1992) or may have no effect (Dennis et al., 1996).

Most of the above general results must be qualified. For example, although participation is more equal across computer-mediated groups, dominant group members contribute more in both computer-mediated and face-to-face groups (Straus, 1996). Changing the transmission interface does not eliminate the effect of human dominance. Likewise for tasks with low needs for coordination, computer-mediated groups may report higher satisfaction than face-to-face groups (Straus and McGrath, 1994).

That the results of this type of research are mixed is not surprising for two reasons. The first is the composite nature of GSS as a communication setting, and the second is that a GSS is only a communication setting, a background within which natural human processes occur.

The statement by Pinsonneault and Kraemer (1989) "Yet there is no consensus in the literature on what exactly constitutes a GDSS." appears to apply equally today to GSS, and a wide variety of functionally different systems are included in the term. As noted by McGrath and Hollingshead (1991) the above generalisations are "weak" because they confound communication system, task type, and research designs, and generally ignore group and member variables. It is clear that treating all electronic group systems as having a common factor is a big assumption, since GSS systems differ considerably not only in system functionality, but also in social rules (Gray et al., 1990).

McLeod (1992) also considers the differences between GSS technologies to outweigh the similarities, and cites differences in the availability of shared views, anonymity, support of verbal and non-verbal communication, provision of task structure, and the specific software used. To that could be added use of a facilitator, rules of ownership, activity sequence control, and the availability of face-to-face interaction in addition to the GSS, not even to mention details of the functions or tools available. As can be seen from the taxonomy given in Table 6, a GSS environment can include any or all of at least three distinct types of communication setting - point to point E-mail, broadcast bulletin board, and many-to-many voting - and these can be instead of or in addition to face-to-face interaction.

Pinsonneault and Kraemer (1989) attempt to resolve this situation by distinguishing between a *GDSS*, which focuses on the group decision process, and a *GCSS*, which focuses on the communication process between group members. According to them, the *GCSS* category contains

DeSanctis and Gallupe's (1987) level 1 and 2 type of support, while GDSS contains their Level 2 and 3 type of support. They then go on to suggest that GDSSs increase consensus, while GCSSs either have no effect, or decrease it.

However a later meta-analysis of research using both types of systems did not show clustering into these two broad categories, but seemed to cluster according to research institute and GSS design philosophy (Gray et al., 1990). Another meta-analysis also challenged the operational basis of the GDSS/GCSS distinction, and in particular concluded that both GDSS and GCSS decreased consensus (McLeod, 1992). The GDSS/GCSS distinction seems to be a difference in naming convention by different researchers rather than a fundamental difference in operation.

It can be concluded that the usefulness of the simple GSS/Non-GSS (EMS/Non EMS, GDSS/No GDSS) design has been exhausted, and the mixed results so far achieved will get no clearer with repetition. Experiments comparing computer supported groups with those without computer support now generally add little to our knowledge, because the variable GSS/Non-GSS includes too many independent factors which are not disambiguated (Lim and Benbasat, 1991). Looking at the taxonomy table shows that a comparison between GSS and face-to-face groups changes not only the communication setting complexity, but may also change the synchrony, linkage, transmission cost and interface processing properties of the communication setting. As already concluded, it would be better if only one aspect of the communication setting was changed at a time (see Sia et al., 1996, for a good example of this).

3.1.9.7 Decision rooms

Decision rooms represent the desire to get the best of both worlds, by providing a communication environment which includes both electronic and face-to-face communication settings. Experiments with decision rooms, known as field studies, have a different design from studies that compare face-to-face vs electronic groups. They compare a face-to-face communication environment with one that includes *both* face-to-face *and* electronic support communication settings, as in decision rooms subjects meet in the same place and at the same time, and may break out from computer interaction for a face-to-face discussion at any time, as decided by the facilitator.

A decision centre involves a computer network established at a permanent location with permanent, trained staff (3-5 people). Set up costs are anywhere from about US\$67,000 to over US\$285,000 (Jessup and Van Over, 1996). Even a low cost facility can be expected to take at least a month to ready, with user training at least another two months (Post, 1992). Meeting process structure is planned in advance with each meeting phase involving one software tool (e.g. brainstorming, followed by idea organising, then voting), all under the control of a facilitator. The learning curve for facilitators is considered to extend up to two years (Post, 1992).

Group Systems. Group Systems, the GSS used in most decision rooms, provides "tools" for stake holder identification and assumption surfacing, electronic brainstorming, idea analysis (developing categories of ideas) and voting. The software is "tool based" and its designers distinguish "first generation" GSS - designed to support one task - from "second generation" GSS, which provide a software tool kit to support various tasks (Daniels et al., 1991). These tools are used sequentially in a centrally controlled fashion (e.g. phase 1: Brainstorming, phase 2: Idea organisation, phase 3: Voting). Such centralised control, and the ability to use only one tool at a time, does not match the sort of informal discussion group this research intends to simulate. A further level of support can be proposed, one more suited to pure computer mediated groups, where participants are not restricted to one "tool" at a time, and can direct their own actions within the constraints of the electronic

environment, as provided by FORUM DGSS. This type of support better matches the type of support provided by the face-to-face environment.

3.1.9.8 *GSS vs Face-to-face plus GSS*

Field studies, where the decision room is established at the user site and used for real meetings, uniformly report very positive results. For example, Grohowski et al. (1990) report 61% man-hours saved over thirty sessions based on comparison with initial project estimates, for groups with an average size of eight. Reduction in project calendar time was even higher, as the number of meetings required to finish a project dropped. Each GSS work group hour was equated to 2.61 estimated historical (unsupported by GSS) hours.

The success of the field studies is in marked contrast to the mixed results from the experimental studies discussed earlier. Dennis et al. (1988) explain this in terms of member experience (real world users vs student subjects in experimental studies), more complex tasks, and larger groups, however these differences are hard to sustain.

Three reasons can be suggested for the apparently uniform success of decision room research in field situations compared to that found in other studies. The first has already been mentioned, namely that the design is not *FACE-TO-FACE vs GSS*, as the other studies tend to be, but *FACE-TO-FACE vs GSS + FACE-TO-FACE*.

Secondly, decision room meetings differ from the face-to-face meetings with which they are compared in significant ways other than GSS (computer support), namely:

1. **Pre-meeting session.** A pre-meeting session is "particularly important in clarifying the goals and objectives of the group" (Grohowski et al., 1990), and
2. **Trained facilitator.** A trained facilitator is considered a key success factor in decision rooms (Grohowski et al., 1990).

Because these features would provide significant improvements to any meeting, the effect of computer support is confounded with that of expert facilitation and meeting preparation. The question such studies ask is whether meetings with extended pre-meeting planning, a trained facilitator, *plus* GSS support are any better than ordinary meetings. Not surprisingly the answer is yes.

Thirdly none of these studies use control groups, but compare their results with hypothetical subject estimates of what would have occurred without GSS (and without the facilitator or the pre-meeting planning, one must presume) (McGrath and Hollingshead, 1991). When compared to a control group in the laboratory, GroupSystems users took longer to reach a decision (George et al., 1990). Adding a control group seemed to bring the Group Systems results into line with those found in other studies, which show that current CMGS increase task time.

In conclusion, decision rooms are effective hybrids of face-to-face and computer-mediated technology. However the research design they present makes it difficult to draw conclusions about computer-mediated technology, and they provide little guidance for future development in CMGS. The contradiction between their highly positive results and the more modest performance of purely computer-mediated groups can be attributed to a variety of factors which have little to do with electronic support.

A recent study illustrates these points and suggests that, when other factors are removed leaving only the contribution of GSS, the computer support adds little if anything to face-to-face interaction (Chidambaram, 1993). The study compared face-to-face and dispersed telephone groups with and without electronic support (GroupSystems). The design was:

FACE-TO-FACE (FTF)	AUDIO CONFERENCE
FACE-TO-FACE + GSS	AUDIO CONFERENCE + GSS

The main finding of interest was that while perceived social presence was lower for FTF + GSS than for FTF, this did not occur for the audio-conferencing plus GSS. The authors conclude that “The conventional wisdom that computer support lowers social presence was borne out in face-to-face settings but not in dispersed settings.”, quoting an early study by Siegel et al. (1986). However the Siegel et al. (1986) study describes the effect of GSS alone, i.e. CMGS. It does not predict the effect of *the addition* of GSS to a face-to-face setting.

The use of multiple communication settings also raises the issue of process structure. For example subjects could be allowed to use the communication setting as they wished, or could be directed to use the communication setting in a particular way. In this experiment, the face-to-face groups were facilitated in a way which matched the task structuring used by GroupSystems (generate ideas, evaluate alternatives, choose a solution), but used a white board as a public display instead of computer screens. In the audio setting the facilitator acted as the group secretary, recording ideas, merging similar ideas, and editing unclear ones “as determined by the group”. It is not clear what the facilitator did if the group disagreed. The facilitator took down group member ranking of the alternatives proposed and reported the results to the group over the telephone. “Exporting” the decision room method to other environments raises the walking/swimming problem discussed earlier when comparing land and sea environments. The face-to-face interaction was not a face-to-face interaction where the group freely discussed to consensus, but was a *face-to-face simulation of the GroupSystems process structure*, a method designed to favour decision rooms. If any design can be expected to show the benefit of decision room technology, this one should.

However the experiment found that the addition of GSS to face-to-face interaction did not alter subjects’ perceptions of communication effectiveness, and did not increase the quality of the final decisions, but did reduce subjects’ perception of social presence. The authors do not report whether adding GSS increased or reduced time taken, a notable omission given that field studies primarily report this.

This experiment shows that in a structured and facilitated face-to-face interaction, GSS adds little if anything to the group output. This result is quite surprising, given the number of field studies which suggest that GroupSystems offers major improvements over face-to-face interaction, and the general position that computer support improves on inefficient face-to-face interaction. This seems to answer quite clearly the question of the effect of computer support on a small face-to-face group - it does not add significantly to task performance, and provides decreased social performance. In the next section a similar conclusion will be reached for the effect of GSS even with tasks such as electronic brainstorming.

Since computers can connect people far more than is possible through small, synchronous face-to-face groups, perhaps a more relevant question is *What does CMGS take away from face-to-face interaction?* For example, students taught both with and without access to a GSS showed a clear

preference for the computer supported lecture theatre, which gave, as one student stated, “the opportunity to pursue other’s comments; to draw on others’ experiences and thought processes without ever having to ask them” (Alavi, 1994). In this case, the computer provided connections that did not exist before, in line with the earlier suggestion that the main contribution of GSS is to facilitate otherwise difficult or impossible communications.

3.1.10 Conclusions

The general conclusions that can be drawn from this section regarding the communication process are:

1. Regarding the communication setting:
 - a) The traditional communications model of Sender-Channel-Receiver must be extended to a Sender(s) - Transmission interface - Receiver(s) enhanced model, to account for multi-media signals, network transmissions and intelligent communication interfaces,
 - b) The communication setting is defined by the properties of the transmission interface,
 - c) Attempts to characterise communication settings based on the single media dimension of “richness”, over-simplify the real variety inherent in communication settings,
 - d) Media “richness”, even as one feature among many, appears to be less significant to users than previously thought,
 - e) Comparisons between communication settings (e.g. face-to-face vs CMGS) tend to confound many properties, including some properties of the communication as a whole, and therefore are difficult to interpret,
2. Media preferences attributed to task equivocality may equally be attributed to interpersonal relating, and if so, choice of rich types of communication setting may be less because they remove ambiguity than because they support it, as a social lubricant,
3. In communication, the transfer of meaning or information is not solely a property of signal transmission, but depends also on abstract shared constructs by which the receiver creates meaning,
4. Media richness and cues filtered model predictions that CMC and CMG provide “cold”, socially ineffective communication settings, must be moderated by whether a relational or social context is in place,
5. Regarding many-to-many communication:
 - a) The well known one-to-one, and one-to-many, forms of communication linkage, can be extended to the concept of many-to-many communication, this dimension giving increasingly powerful and condensed forms of communication,
 - b) The defining feature of many-to-many communication is the ability of the transmission interface to process many signals into one without losing significant information,
 - c) A task situation that requires many to communicate with many seems to be the critical defining characteristic of informal discussion meetings,

- d) Many-to-many linkage provides a highly condensed form of communication, which is especially suited to discussion situations, and occurring either through non-verbal back channels or through comment valence, may be what allows group members to contribute to and keep in touch with the group position in a dynamic group discussions,
 - e) Formal voting is an example of many-to-many communication, but in face-to-face situations takes so long that it is unsuitable for discussion situations, and is infrequently used,
6. Communication setting complexity, asynchrony, linkage, and transmission cost were suggested as important features which could be defined independently of sender, message and receiver, and which could be used to define a taxonomy of communication settings, which suggested that:
- a) The natural communication settings for successful computer-mediated interaction seem to be asynchronous ones,
 - b) Computer-mediated interaction reduces transmission cost and lowers the messaging threshold, allowing more spontaneous interaction, rather than creating new communication settings,
 - c) A single GSS may include several distinct communication settings (e.g. E-mail, bulletin board, and voting),
 - d) Processing by the transmission interface embodies the rules of the computer-mediated social environment created by the CMGS designer, whether intentional or not, and there are marked differences between different systems in this regard,
 - e) CMGS research into the differences between communication settings will be clearer if it varies only one property of communication setting,
 - f) Comparisons should recognise that different communication environments may evoke naturally different methods for the same task (cf. locomotion is achieved by swimming in water and walking on land),
 - g) CMGS research into electronic group process activities will be clearer if it is carried out within a single communication setting, and preferably within the same CMGS
7. Comparisons between GSS and face-to-face groups suggests the weak generalisations that GSS improves task focus, may improve task performance, and increases equality but results in less consensus and decision acceptance, lower process satisfaction, and usually takes longer,
8. Very positive decision room findings seemed to contradict general GSS findings, but on closer examination the differences were attributable to confounding variables, a favourable research design, and a lack of controls. When these conditions were rectified decision room style results seem to fall in line with the results of other studies,
9. The exception to the trend that CMGS has difficulty generating agreement was Converse, which offers limited “few-to-few” linkage over a plain text network, which suggests that linkage is more important in agreement generation than media richness.

The main conclusion of this section is as follows:

If

- Media richness is less significant than supposed
- The natural communication setting for computer-mediated interaction is asynchronous
- The critical defining characteristic of informal meetings is many-to-many interaction
- Voting is a form of asynchronous, many-to-many communication that is very slow
- The main contribution of computer support is to reduce communication transmission cost

Then

An asynchronous, many-to-many, plain-text communication setting may provide a natural base for computer-mediated groups, one where the computer could provide the processing power to manage a many-to-many interaction which simulates the informal vote type process it is proposed occurs in dynamic, face-to-face group discussions.

This conclusion is contrary to what would be expected from media richness, cues-filtered-out and rational information exchange theories.

The research focus deduced from this section is a plain text, many-to-many, asynchronous communication setting, as a possible natural context for electronic meetings, and the research design suggested is a CMGS vs Altered CMGS design to demonstrate a treatment effect.

3.2 Task resolution

This section considers how individuals in computer-mediated groups deal with the given task, and how they carry out the process of task resolution. It will begin with a definition of task on an individual level, and move to the concept of task as it applies to a group. This will raise some interesting issues with regard to the well known theory of process loss, and the integrative model will provide an alternative approach.

3.2.1 Individual tasks

Individual tasks are tasks carried out by individuals acting as individuals.

3.2.1.1 Definition

While one might initially consider a “task” to be a requirement existing independently in the external environment, considerable work in small group research has led to the conclusion that tasks are best defined in terms of the subject behaviours that they usually elicit (McGrath, 1984; Zigurs and Kozar, 1994). McGrath has integrated research into individual task types to give the categorisation summarised in Table 7 (McGrath, 1984).

1	GENERATING TASKS a. Planning. Generate an action orientated plan. b. Creative. Generate or brainstorm ideas.
2	CHOICE TASKS a. Intellective. Choose correct or optimal answer. b. Preference. Choose preferred/agreed answer.
3	NEGOTIATION TASKS a. Cognitive conflict. Resolve conflicts of viewpoints. b. Mixed motive. Resolve conflicts of interests.
4	EXECUTION TASKS a. Contest. Compete to win. b. Performance. Perform to a standard.

Table 7. McGrath's task types

McGrath's typology forms the basis of most current task categorisation in GSS (e.g. Tan et al., 1991; McGrath and Hollingshead, 1993). Each task type is defined in terms of the kind of things *individuals do* when facing that task, namely generate, choose, negotiate or execute. Consequently measures of performance change markedly with task type, as shown in Table 8, where each task type introduces a different criterion measure for task success.

Task Type	Individual Performance Criteria
Planning	Plan quality, workability, and lack of errors
Creative	Number of different valid ideas
Intellective	Correct answer
Preference	Degree of consensus or agreement
Cognitive Conflict	Common understanding achieved
Mixed Motive	Negotiated joint benefit (payoff)

Table 8. Performance criteria for McGrath's task types

In summary, each of McGrath's task types can be seen as defining a type of *activity carried out by an individual*, namely planning, generating ideas, problem solving, deciding on a preference, discussing and negotiating with another, in that order. Two aspects of this definition are crucial. The first is that the typology is not defined in terms of task output in the external world, but rather in terms of the type of behaviour that individuals typically bring to the task. Secondly the definition is

designed for *individuals* carrying out tasks, not groups carrying out tasks. These two aspects of the definition of task will now be considered in more detail.

3.2.1.2 *Task as goal directed behaviour*

Definitions of task such as:

... the behaviour requirements needed to accomplish stated goals, via an explicit process, using given information.

(Zigurs and Kozar, 1994, p280)

define task in terms of the behaviour of the doer(s) of the task. This means that task is not simply an objective statement of something in the physical environment that needs to be done. It is something that is *relative to the individual* or individuals to whom the task has been given. For example an experimenter may present an intellectual task, one that normally evokes rational or logical analysis ("What is the right answer?"), but the individual or group may treat it as a preference task ("Which answer shall we go for?"). In other words, subjects may redefine the given task as they think appropriate (DeSanctis et al., 1993).

This raises the same interpretive issues encountered earlier. For example consider the task *To entertain a class of students*. There are a large number of sets of specific behaviours that could be considered to carry out that task - singing, dancing, telling jokes, providing food, etc or any combination. These behaviours have nothing in common except their effect. In fact they do not even have that - a subject telling bad jokes that entertained no-one would also be considered to be carrying out the task (unsuccessfully) because *they were trying to entertain*. Hence the key to the definition of task is not even subject behaviour per se, but "behaviour to accomplish stated goals" (quoted from Hackman, 1969). The common feature of all the behaviours in the example given is the goal of those behaviours - to entertain.

In conclusion, an **individual task** can be defined as: *behaviour to accomplish a stated goal that is carried by an individual with respect to their environment.*

This defines task to be an interpretive entity, the same as *group* and *relationship*, the other key elements of the integrative model. Assuming that task is an objective entity has led to the assumption that a task given to an individual and to a group are the same task. As will now be shown, by the above definition, tasks presented to individuals and to groups are different types of tasks.

3.2.2 **Group tasks**

Group tasks are tasks given to groups. McGrath's task typology was essentially defined in terms of the behaviour of individuals. Applying these concepts, derived from individuals, to groups raises complex issues, beginning with *What is a "group task"?*

3.2.2.1 *What is a group task?*

If an individual task represents individual goal directed behaviour, can a group task be defined in the same way, as goal directed behaviour by group? The integrative model defines "group" as a perceived entity, but does not attribute to groups the sort of individuality implied by the concept of goal. If a group does not have individuality, then a group cannot have a goal, so it cannot have goal directed behaviour, and the term "group task" has no meaning.

However the term “group task” could be taken to mean that all the individuals in that group took the group task to be their individual tasks. This definition of group task implies a cooperative group, where all group members share a common goal. If one individual, a “saboteur”, did not share the group aim, then while the rest of the group was trying to achieve the group task goal, the saboteur might be trying to prevent the goal from being achieved. Such possibilities raise issues of power, politics and negotiation beyond the scope of this research. This research must therefore apply only to groups where all group members subscribe to a common task goal, and the integrative model and analysis presented here applies only to cooperative groups.

However this definition of group task would apply equally to non-interacting individuals (nominal groups) as to interacting individuals. If each individual in a nominal group were given a negotiation task, then each would attempt to negotiate as an individual with the other party. This of course would tend to create confusion, and a successful outcome would be unlikely. However if an interacting group were given a *group negotiation task*, this would be taken to mean that *the group must negotiate with the other party*.

Although each individual has apparently accepted the same task in a group as when alone, the behavioural goalposts have in fact shifted, and the “task” is no longer carried out as it would be if it were given as an individual task. For example, before any negotiating begins, the group would probably discuss their position, and then appoint a negotiator to act on behalf of the group. The group has an additional problem which individuals carrying out tasks do not encounter - that of combining the contributions of group members - because the term “group task” implies that individuals *carry out the task as a group*, not as individuals. A *group task* requires members to produce a *group solution*, and introduces *group* behavioural requirements over and above the *task* requirements presented to individuals.

3.2.2.2 *Group tasks and McGrath’s categories*

When individuals go about McGrath’s task activities of planning, generating ideas, problem solving, and preference enactment *in groups*, they inevitably have an additional behavioural requirement laid over and above the original task: *to work to combine their behaviour with that of the other members of the group*.

If tasks existed independently in the external environment, a task given to a group and a task given to an individual would be the same. But if tasks are defined in terms of elicited behaviour, and if the “same” task given to a group and to a set of individuals consistently elicits additional behavioural requirements from individuals in the group, then, by definition, it cannot be held that the tasks are the same. Another way of putting this is that the behavioural goals of individuals alone and in a group are markedly different.

Individuals carrying out a task in a group, seek to combine their behaviour with that of other group members, while individuals alone have no concern about this. This *combination requirement* means that the behavioural effort required for individuals carrying out a group task is not equivalent to the sum of individual efforts for what is apparently the same task on an individual level. From the point of view of the behaviour elicited from the individual given the task, which is the criteria used by McGrath to classify tasks, *group tasks* involve behavioural requirements over and above those summarised in the task circumplex, which therefore does not classify group tasks. Group tasks (any task given to a group), must be classified as a different type of task from any listed in McGrath’s list, because *from an individual perspective they elicit different behaviour*.

3.2.3 The group difference

The difference between individual and group tasks revolves around how group members transform their individual ideas, decisions, actions or feelings, into group ideas, decisions, actions or feelings. This makes a task presented to a group different from the apparently identical task presented to an individual.

The transformation necessary to produce a group result is carried out in the group interaction, and can involve at least four aspects:

1. **Combination.** Application of a particular method of combining group member contributions to give a group output;
2. **Coordination.** The adaptation required when the relation between one individual's activities and another individual's activities affects group outcome;
3. **Control.** Control or management of group member behaviour or interaction sequence to avoid interference between group members; and
4. **Confidence.** Generating member confidence in the group output, especially among those initially against or indifferent to it.

Although the last three are optional, the first is required - there must always be a way that individual contributions are combined to give the group results. Coordination, control and confidence can be seen as aspects of, or arising from, the central combining requirement. These demands, in particular the first, provide the group aspect of a group task. If not carried out, as is the case with a nominal group, the task is not a group task.

The extra demands of group tasks can involve members in considerable extra effort and work above and beyond what would be required if they carried out the same task as an individual. For example jury members may spend time electing a chairperson and agreeing on a discussion protocol such as not interrupting (control), and convincing each other that their decision is the right one (confidence), as well as considering the case. A given juror may decide the case as an individual almost immediately, but then spend days trying to convince others of that position. These group task demands require real work on the part of individuals, work that is just as valid as work on the legal case itself.

The extra work required in group tasks will now be considered in more detail.

3.2.3.1 *Combination method*

A group task requires some method of combining group member contributions. A task rational approach results in a "truth wins" approach, and the criteria used to determine truth can be categorised according to the nature of truth, for example into deductive, inductive and relative methods (Hiltz and Turoff, 1993). Such categorisations tend to presume that member combination is a rational process, and that groups can make deductions etc. It will be proposed that groups generally use *social combination* (Baron et al., 1992) to reach a group position.

Steiner (1972) classifies tasks as disjunctive, conjunctive or additive:

1. For a *disjunctive task*, only one response, hopefully the best, can become the group response and all other responses are lost. An example is intellectual tasks where there is only one correct answer. In so called "eureka" tasks, there is a correct answer so compelling that if an individual expresses it, the group accepts it. For such tasks the group success probability is equal to the

probability that the group contains at least one member who would, if working alone, be able to solve the problem. Theoretical predictions based on such a “truth wins” model, where the group is as good as its best member, systematically over predict group performance (McGrath, 1984).

2. By contrast for *conjunctive tasks*, group performance is determined by the weakest link in the chain of group member contributions, and the group is as good as its weakest member. For example an entire plan can be invalidated by one error, irrespective of its brilliance in parts.
3. For *additive tasks*, such as brainstorming, everyone must contribute and the group performance depends on the contributions of all group members. Models which “average” the inputs of all group members systematically under predict the real performance of groups (McGrath, 1984).

These results suggest that the combining method actually used by groups is neither a rational “truth wins” one or a mathematical group averaging method, but somewhere in between (Laughlin et al, 1995). The derivation of group position may be formally defined by a *decision rule*, for example by consensus (all must agree) or by majority (usually 51% must agree) (Winniford, 1991). In this situation the combination is defined by the amount of agreement among group members.

Steiner’s scheme regards the combination as a task property, but it could equally be regarded as a property of the group, and the combining of group member contributions considered a social issue not a task issue.

3.2.3.2 *Task dependency*

Task dependency is sometimes also proposed as a basis for task categorisation. Task dependency occurs when many tasks combine together to give a larger complex task or *project*. This combination of tasks should not be confused with the combination of member contributions discussed in the last subsection. The traditional task categories are *pooled*, *sequential* and *reciprocal* tasks (Thompson, 1967).

Pooled task contributions can combine in any order and thus can occur in parallel. Sequential tasks must be completed in sequential order, as each task forms the basis for the next, and when all tasks are done the complex task is done. Reciprocal tasks are where the output of two tasks each affects the other. These definitions seem to describe all possible dependencies between two tasks (none, one-way and two-way). Project management software further defines one-way dependencies as finish-start, finish-finish and start-start, and these few basic dependencies allow the description of complex networks of task interdependencies in large projects.

Attempts have been made to develop Thompson’s categories, for example “matrix interdependency” is defined as when individuals working on pooled tasks use input from each other (Watson et al., 1994). This definition confuses *task* dependency with *member* interaction, so the result does not extend Thompson’s schema along the same dimension as originally proposed, but introduces a new one.

Another suggested extension of Thompson’s categories is:

1. **Parallel.** Each individual works independently of the others and the group result is the simple summation of member contributions (e.g. idea generation),
2. **Pooled.** As above, but some structured process is used to combine member inputs (e.g. voting),

3. **Sequential.** The task must be undergone in time sequence phases, (e.g. an agenda), and
4. **Reciprocal.** Changes in one part of the solution can affect other parts, (e.g. consistency relations are imposed).

(Turoff et al., 1993)

This is referred to as the *coordination dimension* of the CMC environment (Hiltz and Turoff, 1993, p496). Again the task dependency categories defined by Thompson are mixed with how member contributions are combined. The difference between parallel and pooled is in the combining process used to create a group response, while sequential and reciprocal describe task dependencies.

The interdependency of *tasks*, which combine to give a project outcome, should not be confused with the social interdependency of *individuals*, which define how member contributions are combined to give a group output. For example who communicates with who affects how members combine contributions, but has no relationship to dependencies between tasks.

The original categorisation by Thompson (1967) defines the basic *task dependency relationships* that can exist between two tasks (which are part of a larger project), namely no dependency (pooled), a finish-start dependency (sequential) and a mutual dependency (reciprocal), and seems to do so exhaustively. Combinations of these elemental relationships can describe complex project networks, and it is doubtful whether more recent additions and modifications add anything to this.

In conclusion, Thompson's (1967) categories are not really a basis for task categorisation, but rather a basis for task dependency categorisation. As such they form a valuable extension to the integrative model by adding recognition that tasks do not usually exist alone, but are normally in the context of a larger project. However to add the concept of task dependency to group member combining would create confusion, and therefore this factor has been left outside the model.

3.2.3.3 *Coordination*

Coordination is the case where group members must use other group members as task resources in a dynamic situation. An example of coordination is a tug of war, where teams will do quite poorly unless some method is devised to ensure group members pull together at the same time. Another example is team sports. Nearly 90% of the variation in baseball team effectiveness was predictable from measures of team member skill, but the same figure for basketball teams was only about 35%, reflecting the greater importance of team coordination in basketball (Jones, 1974). This issue is generally of importance in complex execution tasks and lies outside the scope of this study.

3.2.3.4 *Control*

The control of group interaction can be determined by the communication system, which may favour for example a sequential interaction, or by the norms and practices of the group, or both. Shimanoff (1992) identified various classes of rules for structuring communication in small groups including who speaks, to whom, about what, when (turn taking), and with what duration and frequency. It was suggested that these rules serve to maintain the cohesiveness of the group by regulating and restricting the behaviour of its members, to balance the needs of each individual against the needs of the group (Shimanoff, 1992). Control is a complex subject which also lies outside the scope of this study.

3.2.3.5 *Confidence*

Confidence, as generated by the interaction, is relevant and will be considered in a later section (3.4.6, p114), where it will be found to be an inherent part of the process generating agreement.

3.2.3.6 Conclusions

The difference in work required between individual and group tasks can be dealt with by:

1. Describing the difference as due to a “process loss”,
2. Differentiating “group tasks” from individual tasks, or
3. Considering the difference as due to the introduction of a group social process, one than occurs in addition to the task resolution process.

The “process loss” approach considers the combining work done in groups to be a loss, and will be considered in more detail as an alternative explanation in section 3.2.5, p77.

The second approach regards the work done by an interacting group aiming to combine their behaviour as an “internal group task”. In this case group members would have two tasks to complete, the given task and the task of combining their responses with that of other group members. This approach leads to two distinct uses of the word task, as the group combining “task”, and as the given “task”. It also allows the possibility for other “non-task tasks” such as “making friends”. It raises issues of task dependency, such as whether the individual carries out the combining task in order to achieve the given task. Working through this approach has led the author to conclude that calling all human purposes “tasks” creates confusion, and it is better to reserve the word task for the given task, defined in terms of individual task behaviour, and which does not include group combining behaviour.

The integrative model provides an alternative and possibly more elegant way of looking at the situation. The defining feature of group tasks is the basis of what Baron et al. (1992) call the *social combination approach* to the theory of group processes (e.g. Laughlin et al, 1995), as opposed to the *social communication approach* (e.g. Siegel et al., 1986). Although the combination methods used can vary, the integrative model proposes that *in general group combination is a social process rather than a rational one*. While individual tasks only require individuals to carry out a task process, group tasks require them to carry out both a task process and participate in the group combination process. This position renders the concept of “group task”, and all the complex issues it raises, as unnecessary, as “task” no longer encompasses all that groups do. It allows the individualistic concepts of task to be retained, and used in a group situation without modification, without changing the meaning of the task, or raising the sort of paradox that process loss theory does.

The three positions above approach the same problem from different perspectives. The integrative model is proposed to be a better approach, not only because it clearly distinguishes task from group combining activities, but also because it regards both as of potentially equal importance. Alternative theoretical positions to the integrative model will now be reviewed.

3.2.4 Systems rationalism

A systems rationalist approach sees the group as primarily aiming to rationally structure its information exchange to best solve the group task. The sharing of task information and argument is seen as a key activity occurring within groups and consequently a key service provided by GSS, leading to definitions of the purpose of GSS/GDSS such as:

. . . to increase the effectiveness of decision groups by facilitating the interactive sharing and use of information among group members . . .

(Huber, 1984, p186)

This definition suggests that using GSS to facilitate information exchange will improve task performance, just as computers have improved performance in organisations by providing improved means of sharing information (Huber, 1990). It also implies that the basic activities in need of computer support are the standard information functions of storage, sharing, retrieval and processing (Huber, 1984). In their foundation paper, DeSanctis and Gallupe (1987) define a decision making group as two or more people jointly responsible for detecting a problem, elaborating it, generating possible solutions, evaluating them and formulating strategies for implementing those solutions. This follows Simon's (1957) early model of decision making as intelligence, design and choice, and implies that decision making groups follow a rational process, a process that will clearly benefit from GSS support. Many of the activities DeSanctis and Gallupe propose should be supported by a GSS (such as proposal exploration, opinion exploration, analysis, argumentation and information seeking) primarily support a group interaction process conceived in terms of rational task resolution. This approach leads to predictions that:

1. The ability of GSS to more effectively exchange information will increase the task performance of groups,
2. Groups will follow a rational strategy in approaching tasks and will welcome improvements in rational task structuring, and
3. Individuals in groups will welcome improvements in rational structuring of their communications, and will seek to avoid or reduce communications which confuse or obfuscate, such as ambiguous communications.

In the sense that GSS usually supports task resolution at least as well as other methods, the first expectation has been borne out. However there is very little evidence that GSS significantly *adds* to group task performance, as will shortly be shown when reviewing process gain theory.

Experimental and practical results have not fulfilled the expectations of the other two predictions.

Firstly, most groups devote so little time to discussing task strategy that there could almost be said to be a norm against it (Weick, 1969) although the rational benefits of "deciding how to decide" (Silver, 1991) apply regardless of which process the group eventually follows (Hackman and Kaplan, 1974). Even when group members know it is to their advantage to plan a task strategy, and can do so without difficulty, such planning activities tended to be lower in priority than task performance activities (Shure et al., 1962). These findings suggest that the interaction among group members tends not to be a particularly task rational process. The integrative model will suggest that member combination strategy tends to be mainly a social process rather than a task process.

Venkatash and Wynne (1991) varied task strategy from undefined to very defined using Group Systems software on the parasol assembly problem (Maier, 1970). They found that higher task structuring produced the best task results, but it was perceived by subjects as the setting with the lowest communication quality, and giving the least gain in problem understanding. They attribute these results to a curvilinear relation between process satisfaction and GSS restrictiveness (Silver, 1988), where completely unstructured groups perform poorly while rigidly structured groups may do likewise (Fisher, 1974). These results also support the existence of processes outside the task process. The curvilinear relationship could arise when the focus on the task process begins to seriously hinder the other activities, and satisfaction, agreement and eventually overall performance (including task performance) declines.

Finally, systems rationalism, leads to what Malone et al (1987) call the *information sharing problem*, and to the development of systems to facilitate accurate and relevant information exchange. The Coordinator for example is based on John Searle's theory of speech acts (Winograd and Flores, 1986), which defines message intentions into categories such as offer, acceptance, rejection, counteroffer and promise. This system, like the Information Lens (Malone et al., 1987), was designed to reduce ambiguity in information transfer and thus improve the communication of precise meaning. These systems have not been particularly successful, as users tend to object to the rigid message typology (Holtham, 1994; Galegher and Kraut, 1990). It was suggested earlier that increased transmission cost may partly explain this. However if information exchange is the main thing groups do, surely the sort of benefits these systems offer would be worth the cost?

However if rational task resolution is only one of three directives that users respond to, it is understandable why individuals in groups might tend to resist attempts to focus entirely on rational structuring of communication and interaction activities. Systems which focus solely on the detail of task analysis, for example by clarification of message type and intent, may tend to interfere with the correct operation of other processes the individual considers to be important (such as person to person relating), and thus be resisted. The integrative model suggests that such task process enhancements may have their place, but must be introduced without denying other processes.

3.2.5 Process loss theory

This theory sees the group interaction as providing interference for the task-focused group. In explaining "the group difference" it provides an alternative, and essentially contradictory, explanation to that provided by the proposed integrative model.

3.2.5.1 The group effectiveness problem

Hackman and Morris (1975; 1983) first pointed out that while most significant decisions are assigned to groups, the experimental research suggests that such groups are generally less task effective than their most effective member working alone (Lorge et al., 1958, p348). They also drew attention to one of the most reliable and repeatable results in small group literature, namely that "... individuals working separately generate many more, and more creative (as rated by judges) ideas than do groups." (McGrath, 1984, p131). Hackman and Morris call these findings the *group effectiveness problem*. They noted that while it was often presumed that groups produce higher quality results (or are at least less likely to be grossly mistaken) than individuals, experimentation showed this was not the case, leading the authors to suggest (perhaps tongue in cheek) that groups be used as infrequently as possible, at least until the reasons for this anomaly became apparent. They posed the question *Why aren't groups more effective than they are ?*. The answer to this question provided by process loss theory is *Because groups introduce a process loss arising from the group interaction*.

3.2.5.2 Process loss theory

Hackman and Morris (1983) proposed that group members must interact successfully in three areas for a meeting to be effective:

1. Coordination of effort,
2. Task performance strategy, and
3. Combining member knowledge and skills.

Task strategy was considered in the last sub-section, and can arise with individuals as well as groups. Combining and coordination have been earlier identified as definitive of group tasks. Since each of the above interactions are usually carried out by a less than perfect process, Hackman and

Morris suggested that there are *process losses* which cause the group to perform below its theoretical optimal level, following Steiner (1972), who proposed that groups have the potential to enhance individual processes or to degrade them. The term “process” here really refers to the group interaction process, rather than any particular psychological process, and process losses could equally well be described as interaction losses.

For example, in a situation where group members have more information collectively than each does individually, information exchange theory would predict that, given time, all information would be shared among all members. However this does not occur. What has surprised researchers is how often groups *don't* share information. For example Stasser and Titus (1985) asked groups to make decisions about job candidates, and distributed some information to all group members but other information to selected group members. The shared information dominated discussions, while the unique information was often ignored. This apparent inhibition of individuals in groups to completely share any unique information they may have occurs even though disagreement and diversity have been shown to be associated with superior decision making (Sniezek and Henry, 1989). If the individual holding critical information is of low status, the effect is enhanced for both computer-mediated and face-to-face groups (Hollingshead, 1996).

These and other examples of the apparent ineffectiveness of groups are explained as caused by process losses occurring in the group interaction. Process loss theory raises the paradox that groups meet, and by the expenditure of extra effort, produce less output than if they had not met at all. It suggests that the belief people have, that the effort put into meetings produces results, is an illusion. Process losses are like the friction that occurs when the moving parts of a machine interact, and group support systems, it is suggested, are like the oil that makes the machinery run better, by reducing process losses. The analogy breaks down as the process loss “friction” seems to cause the group machine to produce negative work. The idea that the effort group members put into the meeting interaction, not only goes nowhere, but produces a loss, is not sensible to this author, this being the psychological equivalent of energy being destroyed in physics.

What Hackman and Morris call process losses seem very similar to what was earlier defined as the extra work required of individuals when given a task in a group. The process loss paradox assumes that “task” is an objective entity, which can be applied equally to individuals and groups. If the combining requirement of group tasks is recognised as a required effort with reasonable purpose, the paradox largely disappears.

3.2.5.3 *Analysing group effectiveness*

The ineffectiveness of groups described by process loss theory involves an expectation of how effective groups *should* be. This expectation is based on comparisons of the group's performance with:

1. Single individuals in the group (best, average, or worst),
2. Nominal groups (a matched set of individuals working in isolation), or
3. The groups “potential”

each of which will now be considered in turn.

Group vs Best individual. Compared to the individual, the group interaction could produce the following levels of performance:

1. **Better than best (synergy).** No member can individually resolve the task but the group succeeds,
2. **Best.** The group result is equal to the result of its best individual,
3. **Group average.** The group result is equal to the average of the individual results, and
4. **Below average.** The group result is worse than that of its individual members.

The theoretical possibility of synergy (where one group member contributes an idea, a second expands it, and a third combines the two previous ideas to reach a result that no individual had initially), turns out in practice to be a very unlikely event for groups working on intellectual tasks (McGrath, 1984). In fact, as mentioned, generally groups do not even perform at the level of their best member (Lorge et al., 1958, p348). This might be surprising if the same person was “best” for every situation, but in most groups the best group member for one task may not be the best member for another task. Expecting groups to perform at the level of their best member begs the question of who is the best member. If the best member is determined in hindsight, comparing groups to their best member is like comparing an individual’s response to the best response from all those they might have given. The group, like the individual, must always fall short in such a comparison.

The average of the individuals in the group is a more reasonable baseline (or expected value) for group performance than the performance of the group’s best member. Since groups generally perform better than the group average (McGrath, 1984), *the interaction process has from the average group member’s point of view generated a gain not a loss*. McGrath concludes that, in general, freely interacting groups perform at about the level of their second best member, and while this is below their idealised post hoc potential, the majority have improved their performance by being part of the group (McGrath, 1984). Since the average group member achieves a result (through the group) that is better than that which they would achieve alone, it does not make sense to talk of the group interaction process producing a loss. In this case there is no group effectiveness problem, only an unrealistic expectation.

Interacting group vs Nominal group. Comparison of interacting groups with matched nominal groups is interesting, and possibly the most compelling argument for process loss theory. The nominal group differs from the interacting group only in the absence of interaction. According to process loss theory, comparing nominal and interacting groups shows whether the group interaction produced a gain or loss, and the result for face-to-face groups, facing a brainstorming task for example, is always found to be a “process loss”.

It has already been suggested that the group interaction is precisely what makes such comparisons invalid, as it either changes the fundamental nature of the task, or introduces a new process, depending on how the difference is viewed, and this means that like is not being compared with like.

It will now be argued that even from the perspective of the task process itself, there are learning outputs which are not recognised, due to the assumption that tasks given to individuals and to groups are equivalent. Since brainstorming by groups vs individuals is commonly quoted to illustrate process loss theory, this task type will be used as an example, although the principles apply equally to all task types.

When a group faces a group task there is a group outcome. All group members “own” that outcome because they are part of the group. For example, a group member may have to respond to questions

about the group's position. In groups carrying out an act generation task (Casey et al., 1984) the same principles apply. Therefore it is proposed that when a group brainstorms as a group, individual members attempt to internalise *the group's ideas*, and consequently most individuals will learn some new ideas. By contrast, individuals in nominal groups have no sense of group output, and do not learn any new ideas, because each individual does not even see the responses of others, and individuals do not seek to operate as members of a group. Based on the assumption that "task" is objective, experimenters have naturally applied the measure of brainstorming designed for individual tasks (the total number of different ideas generated) to the group task. However this does not recognise the additional task just proposed for individuals in brainstorming groups, namely to learn and own the group output.

For example suppose ten subjects each generated ten ideas. If all the ideas were different, a task-focused performance measure would record 100 ideas, regardless of whether the group had interacted or not. A nominal "group" made from these ten subjects would not have a single shared idea, and an outsider asking members of the nominal group what the group's ideas were on the subject concerned, would get no consistency. If the same nominal group were then to meet, it would take time and effort for them to share their ideas, but by the end of the discussion, each individual would know more than their original ten ideas. Their "performance" however according to the traditional individual task based brainstorming measure is unchanged (the group has still only generated 100 ideas). The group interaction and discussion, which may have taken several hours, has apparently created no result.

If however a measure is used which recognises the learning occurring in groups, for example the absolute number of task relevant ideas held by all group members (or even the number of ideas shared by all group members), then the real performance of interacting groups might be better recognised.

Such a group orientated measure of brainstorming would register that after group interaction, individuals in interacting groups knew more than ten ideas they began with, and the number ideas shared by all group members would have increased, while for nominal groups there would be no change. This example illustrates where some of the group interaction "process loss" may go - into group outputs that are not measured by the individual task-focused yardstick traditionally used.

Individual learning may explain why group members themselves often report face-to-face group interactive situations as better. Among a variety of questions about subject's perceptions of face-to-face, information exchange and nominal conditions, the only one to show a significant difference in the Casey et al. (1984) experiment quoted earlier was in response to the question "The computer/my partner helped me think of new ideas.". Subjects rated the face-to-face condition significantly more helpful than the information exchange (electronic brainstorming) condition. Given their finding that from an objective perspective IE groups generated more ideas, the authors concluded this reflected the unjustified assumptions of subjects that face-to-face groups are better. The same gap between subject perception and objective task measures continues to be found and reasons found for subject's erroneous perceptions: "Unexpectedly, across both idea generation and evaluation, subjects reported that FTF meetings were more effective than CMC meetings." (Olaniran et al., 1996). From the point of view of the individual, face-to-face groups may indeed have increased the number of new ideas they internalised, perhaps more than occurred computer interacting groups, which have no social forces operating. In other words looked at from the point of view of the individual in the group, rather than an external experimenter, subjects may have been correct in stating that they personally ended up with the most new ideas in the face-to-face groups.

In conclusion, comparison of real and nominal groups is unreasonable for two reasons:

1. Individuals in interacting groups have behavioural requirements over and above those experienced by individuals in nominal groups, and
2. Outputs from the group combining activities are not recognised by individualistic, task-focused performance measures.

Interacting group vs Theoretical best. According to Hackman and Morris (1983) members of a tug of war team experience process losses due to the inability of the group to coordinate their effort perfectly. It is difficult for this author to see why in cases like this, and in any coordination cases, the group interaction is considered to have introduced a "loss". From the perspective of an individual in a tug of war team, their interaction with the other team members has provided a gain, rather than a loss, since they do better in the team than they would alone. If comparison with theoretical perfection defines a loss, then nearly everything human beings do can be described as such.

Summary. The comparisons upon which process loss theory are based, namely between groups and individuals, groups and nominal groups, and groups and their theoretical best, which purportedly show that group interaction has a deleterious effect on group performance, do not in fact do so. The "group effectiveness problem" research may say as much about our own task-focused, individualistic culture as it does about the real effectiveness of groups. Group effectiveness is best measured from the point of view of what individuals in the group see as important (Lea, 1991). Processes that produce results considered useful by individuals in the group, such as generating group agreement, or developing common understanding or confidence, are not well described as "process losses". As noted by McGrath (1990) when discussing the non-task group activities:

A researcher who is attending to only one function (e.g. the production function) may mistake such complexities of process for group performance inefficiencies, or in Steiner's (1972) perjorative term 'process losses'.

McGrath (1990)

The process loss paradox raised by Hackman and Morris (1983) is the equivalent of saying that an active machine produces negative work. The paradox only exists from a one process, individual task-focused perspective, and disappears when it is recognised that there are group outputs in addition to the individual task output, and when these outputs are measured by the experimenter.

3.2.6 Process gain theory

With the advent of computer networks, decision rooms and GSS, process loss theory was extended to explain the successes of decision rooms in terms of "process gains" introduced by the technology (Nunamaker, 1991). Group performance is explained in terms of the balance of process losses against process gains:

GroupSystems . . . effectively minimises the probability of process losses and maximises the probability of process gains especially in the context of a large group.

(Vogel, 1993, p239)

In the lists of losses and gains, the former appears to be anything seen as bad about a group interaction, and the latter anything seen as good about it (Nunamaker, 1991). For example "information overload" is listed as a process loss, while "more information" is listed as a process

gain, although the same information exchange operation that generates “more information” among group members surely also generates “information overload” (Hiltz and Turoff, 1985). Similarly “socialisation” is listed as a process loss with the comment “although some socialising is necessary for effective functioning”, which suggests that it can also be a process gain (Nunamaker, 1991, p46). It is then suggested that face-to-face interaction causes all the listed process losses, while GSS introduces all the process gains and avoids the same process losses. The comparison between face-to-face and nominal groups upon which process loss theory was based has now been altered to be a comparison between GSS and face-to-face interaction. This comparison, and the problems which accompany it, have already been discussed. It provides a very shaky theoretical foundation.

Process gain theory also uses the word *process* to refer to both the group interaction process, which is the way the term was used by Hackman and Morris (1983), and psychological processes, the latter being the way the term is used in the integrative model. For example, air time fragmentation and evaluation apprehension are both listed as face-to-face process losses (Nunamaker, 1991). The former occurs because each individual in the interaction must take turns to speak, and arises from the nature of the communication setting mediating the interaction. It is not a psychological process. Evaluation apprehension, by contrast, is a psychological process, one that is conceived of as occurring in the mind of an individual who is concerned about negative evaluation by others. The more generic term for this process is social facilitation (Geen and Gange, 1983). Social facilitation does not always cause a loss in performance. It is well established that while social facilitation reduces performance for complex or new tasks, it improves it for well learned or simple tasks (Geen and Gange, 1983).

3.2.6.1 GSS process losses and gains

Some commonly quoted “process losses”, such as air time fragmentation, production blocking, and forgetting are attributable the nature of computer networks, which offer:

1. **Parallel Input.** Contributions in a GSS environment need not be sequential - everyone can input at once across the network (Adrianson and Hjelmquist, 1991),
2. **Storage.** Storage holds the “group memory” in easy editable and accessible form, maintaining a permanent database of task data (Hiltz and Johnson, 1990), and
3. **Processing.** The computer interface can control the interactions, setting the “rules of engagement” or providing process structure.

The above are perhaps better regarded as communication setting differences, since they are not tools aimed at any individual or group process, but simply properties of the environment. Contingency theory suggests that such properties can provide both advantages or disadvantages. For example parallel input allows many to input information at once, storage frees up participants from the need for synchrony, and processing provides the ability to enforce any necessary interaction protocols. By comparison in face-to-face interaction participants must take turns contributing in a sequential fashion, what is said is not “held” but volatile, and any structure is enforced by participant choice rather than the interface itself. However the same properties of the face-to-face environment can give advantages also. Synchrony provides a group control mechanism, and volatility allows unfortunate statements to be forgotten, while no interface processing means that communications can less easily be faked. Face-to-face groups control their own interaction rules, and hence can be more flexible. Each communication setting, whether CMGS or face-to-face, provides its own advantages and disadvantages. The differences between GSS and face-to-face communication settings are not necessarily losses one way or the other.

3.2.6.2 Synergy

The question considered in this subsection is whether GSS provides positive support for the task process, i.e. a process gain. This would demonstrate synergy, a positive benefit arising from the ability of the GSS to exchange information more effectively.

Dennis et al. (1991) found that 18 member brainstorming groups generated more different ideas of greater quality than two nine member groups, who in turn outperformed 18 individuals, with six groups of 3 members last. Small groups of three seemed to suffer a performance reduction compared to individuals, before the benefits of increasing group size took effect. The only statistically significant (at $p = 0.05$) pairwise comparisons were between the pooled 3 member groups and the single 18 member groups, and between the pooled 3 member groups and pooled 9 member groups. The effect was not particularly strong. The difference between the 18 member groups and the nominal groups was not significant. The study was repeated with another sample using combinations 12, 4 and 1 with the essentially the same results.

The authors concluded that "this study has challenged the consistent findings of more than 80 studies that have found the performance of nominal groups to exceed that of groups" (Dennis et al., 1991, p577), although the findings of the other studies were not in fact questioned. Dennis et al. (1991) interpret their results in terms of a process gain provided by GSS and propose that each participant's creativity was stimulated by viewing the ideas of others, demonstrating a synergy effect.

A study by Casey et al. (1984) provided an estimate of the synergic effect on an *act generation* task, defined as the creative generation of the various courses of action available to the decision maker, in this case thinking up solutions to a parking problem scenario. The study compared groups of two, operating under face-to-face (FTF), nominal group (N), and information exchange only (IE) conditions. In the IE treatment subjects believed they were being aided by a computer, but were in fact receiving the ideas of other subjects in their group. Thus the IE group got the same level of information as they would have from face-to-face interaction with other group members, but without the "group interaction effect". This allowed the effect of information exchange alone to be assessed.

Casey et al. (1984) found that in terms of *number of unique acts generated*, information exchange groups generated significantly more acts than nominal groups, while face-to-face groups generated significantly less. This supports the idea of synergy. Face-to-face groups, by contrast, did not generate significantly more acts than individuals working alone. In terms of overall *quality of act generation*, while face-to-face groups still performed significantly worse than the other two, the difference between the IE and nominal groups was not significant. This does not support the idea of synergy. Again a face-to-face group of two was not found to be any better than an individual working alone. The same results were found when the comparison was made between the single best solution for each group under each condition. IE and nominal groups were not significantly different (nominal groups produced a slightly higher score than IE groups), and face-to-face groups performed at about the level achieved by single individuals. This result is relevant because if responses were mutually exclusive, the best quality act would be the one likely to be implemented.

The authors concluded that the IE condition primarily improves act generation task performance by increasing the number of different ideas generated, not the quality of ideas generated. There was an inconsistency here, as the number of different ideas generated is normally correlated with the quality of act generation (Stein, 1975), and in this case IE groups produced no better quality. This led the authors to suggest that even the small IE effect on quantity may be an artefact, due to "tweaking",

where an individual suggests an idea by slightly modifying one that another person has suggested, but really is no different. They identified a need to clearly define “different” when counting generation task results (Casey et al., 1984). This is a possibility not at all considered by Dennis et al. (1991).

Based on their data, Casey et al. (1984) were also able to estimate the magnitude of the synergy effect attributable to information exchange, and found it was quite small, contributing only a 6.5% increase in performance.

A recent review of brainstorming experiments analysed five studies which compared GSS and nominal groups and concluded:

In every study, for one treatment or more, nominal brainstorming was found to be at least as productive (and possibly more productive) than EBS [electronic brainstorming].

(Pinsonneault et al., 1997)

They then set out to establish whether electronic information exchange provided any benefit (or process gain) over nominal groups by modifying experimentally conditions expected to favour EBS interaction. The results showed that *nominal* brainstorming groups generated significantly more ideas than groups using either electronic or verbal brainstorming, and even under conditions thought to be favourable to electronic brainstorming (EBS), nominal brainstorming was at least as productive. They also found that the nominal brainstorming groups were less satisfied than the EBS groups, and that satisfaction was negatively correlated with the number of unique ideas generated. They concluded that:

EBS's superiority over nominal brainstorming is an unfounded illusion . . . it is actually nominal brainstorming which is superior to EBS, and not the other way around.

(Pinsonneault et al., 1997).

It can be concluded that *information exchange provided by GSS probably does not produce significant brainstorming process gains over that provided by nominal groups*. This means that process gains may also be an “illusion”. The synergic role of task information exchange, although possibly relevant, seems at best to be much less than supposed, and the positive contribution of GSS in providing process gains by facilitating information exchange may have been considerably over estimated. If so, this matches the earlier conclusion, based on a number of face-to-face group studies, that synergy is rare (McGrath, 1984), and brings GSS findings in to line with those for face-to-face groups.

3.2.6.3 Conclusions

From an integrative perspective, both process loss theory and process gain/loss theory are *single process theories*, which lead to the paradox that groups meet, feel they gain something from meeting, expend considerable effort in meeting, and yet in the end produce less output than if they had not met at all. This position leads to statements such as:

However idea generation research has shown that groups tend to be quite dysfunctional.

(Anson et al., 1992, p73)

The integrative model takes a broader view. It attributes the behaviour of individuals in groups to any or all of three distinct processes. Each process has its own purpose, directives and output, and

“group performance” is the sum total output of all the processes, not just the task process. Since the effort of nominal groups goes into only one process, the task process, they are not comparable to groups that interact. Group process losses can be seen mainly as a reduction in the *task process* output relative to nominal groups that occurs when groups have to carry out the additional *group combining activities*. Nominal groups do well by individual task-focused performance measures, however interacting groups put effort into at least two processes (task and group). They only appear to do poorer, either because the individual task-focused measures of performance are insensitive to the outputs of the group process, such as agreement and common understanding, or because of interference between the processes. Most of the benefits conferred by GSS seem to arise from the communication setting, rather than direct support for the task process itself, and synergy effects are small or non-existent.

The assumption behind process loss theory is that what is called a task is an objective entity that can be applied equally to individual and group. It does not recognise that group tasks require individuals to carry out additional work over and above that required of them when operating singly. In presenting TIP theory, McGrath (1990) noted the same contradiction with process loss theory as found here:

It is not reasonable, from my perspective, to regard all group activity that is devoted to group well-being, to member support, and even to the solution of technical and political problems within the production function, as wasteful or as evidence of inefficiencies of process.

(McGrath, 1990, p35)

The integrative model also recognises that individuals in groups carry out non-task activities which can be just as beneficial in the long run as task analysis, giving results such as group agreement, coordination, structure and individual confidence, arousal and morale. This model does not recognise any process losses other than those arising from differences in communication settings, which by contingency theory are not necessarily losses, only differences. Nor does it need to create new “group tasks” to recognise the non-task purposes of interacting groups.

3.2.7 GSS results by task type

Different types of tasks are dealt with in different ways, and group performance cannot be studied generically without regard to task type, although as noted in a recent GSS review “In general GSS literature has not addressed the issue of task types.” (McLeod, 1992). GSS research will therefore be reviewed by task type, and some general conclusions drawn.

If task type is the sort of behaviour evoked by an individual facing the task, it is likely that the effect of GSS will be different for each task type. Therefore GSS results will now be reviewed by the following task types:

1. Planning,
2. Creative,
3. Intellectual, and
4. Preference

In each case the role played by the other two processes in this task type may also be mentioned where appropriate.

3.2.7.1 *Planning tasks*

Planning tasks involve the generation of a plan or document, and the combining of group member contributions into a single coherent structure. With this type of task it is important not only that member contributions are effective individually, but also that there is coherency or consistency between the parts, which must hold together to form a final result that all group members are satisfied with.

Horton et al. (1991) compared computer-supported (CS) groups writing managerial memoranda with groups using conventional writing tools (NC = no computer). In the CS case, only one user controlled the public computer at any time, using the clipboard transfer function to move text from individual's computer to the public computer. The normal document drafting sequence for face-to-face groups involves an extended group planning period, followed by a shorter period of individual activity composing the document, and finally a brief period of review. The quality of the end product was the same in both groups, but computer interaction technology significantly altered the way the group interacted. CS group members spent significantly less time on the group planning activity (NC = 22.8 minutes, CS = 12.8 minutes planning), but spent significantly more time composing and reviewing (NC = 5.1 minutes, CS = 41.2 minutes composing). In the computer condition group members typically planned alone, if at all, often did not share their plans, and tended to produce individually for extensive periods of time. Questionnaire data indicated that, given the choice, 75% of participants who had tried both preferred conventional writing tools to the computer, although 90% preferred computer tools for revising group documents only.

The computer groups, although they ended up producing equally good results, had more difficulty combining their individual work to give a group result. On the other hand the task of individual composing was made easier by the computer. In terms of the integrative model, the computer system supported the task process (as carried out by individuals) better than traditional tools, but supported the group unifying process much less. These two effects seem to have cancelled each other out in overall performance. Computer support changed the group's activity focus from being *group centred* to being *individual centred*.

Kraut et al. (1992), also investigating a group writing task, found similarly that subjects who used computer-mediated communication had substantially more difficulty coordinating their work than students who worked face-to-face.

3.2.7.2 *Creative tasks*

Generation tasks ("brainstorming") are in many ways the simplest group tasks, because they require the minimum of group combination activity. Combination can even be carried out by the experimenter after the session. Group members do not need to coordinate with each other, they do not need to generate agreement, and there is no need for control of group member activity. Each individual can generate contributions in their own time, which are then added to the common pool. This is a *divergent* task, in that there is no single solution, but any number of solutions depending on the creativity of the subjects.

Nominal groups. This sub-section considers why generating ideas in a group is less effective than pooling the efforts of individuals who have worked alone into equivalent "nominal groups" (McGrath, 1984). When groups carry out divergent tasks, what counts is the number of *unique or non-redundant* ideas added by the individual - duplicated ideas do not add value. If all group members produce the same idea set, the group's task performance is the same as that of one individual working alone. If however all group members produce unique idea sets, the group's task

performance is as many times that of each individual working alone as there are group members. In the simplest case, if two individuals have the same idea in their heads then the old adage “two heads are better than one” is not true, whereas if they have two different ideas, then two individuals are twice as good as one individual working alone (for a brainstorming task).

Therefore anything which increases the diversity between individuals, increases brainstorming task performance, and anything which decreases diversity, decreases task performance. Hence the reduced task performance of groups may arise because individuals in face-to-face groups offer less diversity of response than the same individuals working alone. In terms of the integrative model this is hardly a surprising finding, since there is proposed to be a group process operating during face-to-face group interaction whose precise aim is the unification of the group, and the generation of agreement. To the degree that this process operates effectively, the group will tend to operate as a unity, and individual diversity will be reduced. Reduction of diversity reduces the number of different ideas generated, which is the measure of act generation task performance.

The reduction in *number* of ideas generated can also account for findings that idea generation *quality* is reduced in face-to-face groups, as the number of quality ideas generated is directly related to total number of ideas generated. When quality of ideas is measured as a function of the number of ideas generated, no difference is found between face-to-face groups and nominal groups (Stein, 1975), or between face-to-face groups and groups interacting through the computer (Casey et al., 1984), the computer interacting groups generating not only more good ideas but also more bad ones.

In conclusion, for a brainstorming task, the group process generating agreement can be expected to seriously interfere with task process performance, including both quantity and quality of ideas generated.

Social vs Information exchange effects. The study by Casey et al. (1984) mentioned earlier provides one of the few experimental attempts to separate out the threads of group activity in an act generation task. The study compared groups operating under face-to-face (FTF), nominal group (N), and information exchange only (IE) conditions. In the IE treatment subjects believed they were being aided by a computer, but were in fact receiving the ideas of other subjects in their group, and so received the same information as the face-to-face group, but without social influence.

Using the terminology provided by Casey et al. (1984), the difference in performance between the IE group (P_{IE}) and the nominal group (P_N) represents the performance contribution, S_{IE} , provided solely by the exchange of information or informational influence (there was no social interaction in the IE group):

$$S_{IE} = P_{IE} - P_N$$

The difference between the performance of the face-to-face group (P_{FTF}) and the IE group represents the performance contribution (S_{NI}) provided by the non-information exchange, or face-to-face social interaction, i.e. the group social influence separated from the effect of the exchange of task information:

$$S_{NI} = P_{FTF} - P_{IE}$$

Their model then seeks to explain the difference between face-to-face performance (P_{FTF}) and nominal group performance (P_N), in terms of the contribution of two factors arising from the group interaction, an information exchange component (S_{IE}) and a non-information exchange (or social) component (S_{NI}):

$$P_{FTF} = P_N + S_{IE} + S_{NI}$$

Expressed in words the model states:

FTF Performance = Individual Performance + Informational Influence + Social Influence

This model suggests two distinct group interaction processes, one involving the exchange of task information (in absence of any form of social interaction), which is provided by computer interaction, and the other which arises from social interaction, and is provided only by a face-to-face setting. It is thus a two-process group interaction model, not just a one process model as is process loss/gain theory. If social influence is taken to equate to the group normative process, then this model is entirely in accord with the proposed integrative model.

Based on their data, Casey et al. (1984) were then able to estimate the magnitude of the components of their model. They found that the major component was the strongly negative effect of the purely social or group influence component, contributing a 41% decrement in performance. The positive synergy effect, as mentioned earlier, was quite small, contributing only a 6.5% increase in performance.

It can be concluded that *group normative influence tends to reduce face-to-face brainstorming groups to the level of a single individual*. Face-to-face groups may perform at the level of a single individual because that is precisely the aim of the face-to-face social process - to make the group operate as one unit, with common ideas and agreement on task output.

Summary. The success of both computer-mediated and nominal groups at act generation tasks seems to mainly due to the absence of the group process that generates agreement in face-to-face groups. It seems that a face-to-face group trying to operate as a unified group is not the best place to generate individual diversity. Comparison of nominal and GSS brainstorming groups suggests that, at best, brainstorming GSS groups work like nominal groups, in other words like a set of individuals that do not interact, and the GSS "gains" seem to derive primarily from this. Real GSS process gains seem to be very small, if they exist at all. Thus the success of GSS for brainstorming tasks may reflect the same property of computer groups identified when considering planning tasks, namely less group focus and more individual focus, caused by the weakening or absence of the agreement generation process.

3.2.7.3 Intellectualive tasks.

Intellective tasks have a right or wrong answer based on some commonly accepted criteria, such as for example a mathematics question. They may also involve act generation, where alternative solutions are suggested, followed by rational assessment and choice.

Gallupe et al. (1988) presented groups of three subjects with a company in crisis problem at high and low levels of difficulty and asked them to provide solutions. All data was available and there was one best solution. The task type was intellective/creative - problem analysis with some idea generation. GSS significantly increased the number of alternatives generated compared to non-GSS groups. Decision quality was higher for the GSS groups but not significantly, and decision confidence was slightly lower for GSS groups, but again not significantly. However process satisfaction, perceived conflict, and agreement with the final solution, were all significantly worse for the GSS.

More recently Chidambaram (1993) compared face-to-face groups with and without electronic support (GroupSystems) carrying out a decision task that required groups to act as the board of directors of a winery, and deal with global expansion problems facing the company. They found that the addition of GSS to face-to-face interaction did not increase the quality of the final decisions, but did reduce subject's perception of social presence. It may be that the lack of social presence, which can be attributed to the cues-filtered-out nature of CMC, provides a major reason for the lack of process satisfaction often found with computer-mediated groups.

While GSS seems to support the resolution of intellectual tasks at least as well as face-to-face interaction, this appears to be at the cost of the social values of group agreement and satisfaction. These results again show GSS as able to support the task process as well as occurs in the face-to-face setting, but considerably less successful at supporting group agreement.

3.2.7.4 Preference tasks.

Preference tasks (e.g. allocating money to charity) have no right/wrong answer, or any agreed logic for choosing one outcome over another, and therefore a group must fall back on social influence to make an agreed decision. Thus the group agreement process can be expected to be particularly important, as there is no rational basis for problem solution. The right answer is whatever the group decides it to be, and agreement is more important than validity.

Watson et al. (1988) compared 3-4 person groups of undergraduates doing the foundation task under three decision aid conditions: GSS (SAMM), manual (given a flip chart and proposed meeting structure paralleling SAMM menus) and baseline (given nothing - own resources). In the foundation task subjects must allocate money to projects and each project represents one of Spranger's (1928) six basic human values: theoretical, economic, aesthetic, social, political and religious. Post meeting consensus was not improved by GSS interaction, suggesting that GSS was providing little support, if any, for group consensus building. The authors noted that use of the GSS tended to reduce face-to-face communication - meetings consisted of periods of quiet work on the terminals broken with short periods of discussion. As found before, the computer setting seemed to shift the focus from group to individual, and GSS groups worked more as individuals than as a group.

Tan et al. (1991) compared the effect of a GSS used to support face-to-face groups on group consensus for both an intellectual task, of selecting the best applicant for a job, and a preference task, of selecting how to distribute money amongst a set of worthy charitable projects. For the intellectual task, GSS support produced slightly higher (but not significant) post meeting consensus, but for the preference task, it produced significantly lower post meeting consensus ($p < 0.1$) compared to face-to-face baseline groups. This study provides evidence that GSS provides significantly less support for preference tasks than for intellectual tasks. The authors conclude that if GSS is to be used for preference tasks, it should include features to raise consensus and resolve conflict.

Cass et al. (1991) compared face-to-face GSS (decision room), dispersed GSS (GSS + phone link), and dispersed and no GSS (conference call only). They used the SAMM software and subjects carried out the foundation task. They found that distributed subjects without GSS support were more satisfied with both the process and the outcome than subjects using GSS, including those face-to-face ($p = .001$). This was a surprising result to the authors who noted that "access to the tools that are supposed to make groups run more efficiently and effectively" had precisely the opposite effect. Subjects perceived the GSS as providing little if any support for the group process in a preference task.

In summary, these results suggest that GSS support for preference tasks is poor, which implies that current GSS do not support the agreement generating process which normally occurs in face-to-face groups.

3.2.7.5 Summary

GSS results apparently vary markedly by task type, sometimes successful (brainstorming), sometimes apparently unchanged (planning, intellectualive) and sometimes not very successful at all (preference), and at first glance the ability to generalise GSS effects across task type seems limited. However in terms of the integrative model, all these results can be explained by the same conclusions, namely that:

1. The task process operates as well in electronic groups as it does in face-to-face groups, and
2. The group unifying process operates poorly in electronic groups, if it operates at all.

The information exchange power of GSS seems to provide what is necessary for task resolution, but no more than is provided by a face-to-face setting. However GSS seems to relieve groups from both the burden and the benefits of group agreement. For tasks like brainstorming, where agreement reduces task performance on the measure used, GSS is notably successful, while for preference tasks, where the generation of agreement is the main requirement, GSS is notably unsuccessful. For planning and intellectualive tasks, which involve both task and agreement processes, the effects seem to cancel out, and there is no overall difference.

3.2.8 Conclusions

It can be concluded that:

1. Tasks are usually defined in terms of the behaviours they elicit in the individual, and McGrath's commonly used task type classification is based on this property of tasks,
2. Since the behavioural set elicited by a task can be very large, this equates to defining a task as goal directed behaviour,
3. Unless *group task* is to imply a group can have a goal, it must mean all members of the group hold a common behavioural goal, which implies a cooperative group,
4. The behaviour elicited from an individual given a task in a group is different from the behaviour elicited when the same task is given to them alone, therefore the "same" tasks given to individuals and to individuals in a group are not the same tasks, and "task", as defined, is not an objective entity,
5. The extra interaction work required by group tasks includes combination, coordination, control, and confidence generating activities, and the first, (combining group member contributions, either additively, conjunctively or disjunctively), is a necessary requirement for group tasks,
6. Individual task-focused measures, such as number of different ideas brainstormed, are not sensitive to non-task group output, such as the development of common understanding, generation of agreement, and development of personal relationships,
7. The combination of individual contributions could be considered to be a task in itself, but this approach generates confusion regarding the term "task",
8. Process loss theory interprets non-task interaction activities as "process losses", implying they are best eliminated, and explains the "group effectiveness problem" in terms of process

- losses. It raises the paradox that people join groups, exert effort to interact, and yet generate a negative result in task terms (compared to what they would have done had they worked alone). It is a one-process model,
9. The integrative model provides a more positive perspective to group interaction, and attributes (task) process losses to aspects of the model outside the task process, namely:
 - a) **The group process.** Group combining activities are attributed to a purposeful individual and group process generating group unity,
 - b) **The interpersonal relating process.** Evaluation apprehension (a proposed process loss) and other interpersonal effects are attributed to a purposeful process of relating to others, and
 - c) **The communication setting.** Production blocking and similar proposed process losses are attributed to the synchronous nature of the communication setting, which makes turn taking necessary, and does not store communications,
 10. The integrative model explains group interaction in terms of positive processes, rather than as a task distraction, and does so without paradox.
 11. It avoids the need for the concept of *group task* by recognising the *group combining process*, which, although it can occur in many ways, is generally considered by the integrative model to be a *social* combination process,
 12. In face-to-face brainstorming groups, the process generating group agreement reduces member diversity, which reduces the number of task ideas produced by the group, and hence task performance,
 13. Process loss theory has been extended to include process gains, theoretically introduced by GSS, but:
 - a) The success of both computer-mediated and nominal groups at act generation tasks, seems to mainly reflect the absence of the group process that generates agreement in face-to-face groups, and, i.e. like a set of individuals that do not interact.
 - b) GSS groups seem to work like nominal groups. The information exchange provided by GSS does not appear to produce significant process gains, compared to nominal groups, matching the earlier finding for face-to-face groups that synergy is generally a rare occurrence,
 - c) Other GSS gains seem mainly due to the communication setting, and contingent upon task,
 14. Across a variety of task types, the task process operates as well in electronic groups as it does in face-to-face groups,
 15. Across a variety of tasks, the group process responsible for cooperation and the generation of agreement operates poorly in electronic groups.

The main conclusion of this section is that computer mediation changes the normal balance in groups to favour the individual, rather than the group. It is able to support the task resolution process effectively, but not the process generating group agreement. Therefore this study has focused on the generation of agreement as the major weakness that must be addressed by computer-mediated groups.

3.3 Interpersonal relating

Everyone is queer, save me and thee, and even thee art a little queer.

(Attributed to a Quaker, speaking to his wife)

This section aims to define how individuals in a computer-mediated group respond to the presence of other individuals, carry out the process of relating to those other individuals, and the variables which influence the operation of that process. The interpersonal relating process is relevant to the experiment carried out primarily in that this process is excluded. It is necessary to define the process sufficiently to exclude it, rather than evoke it, and therefore this section will be briefer than the others. It will consider the constructed nature of relationships, the theoretical implications, and finally review understanding, identification, interactivity and affect as aspects of relating.

3.3.1 General concepts

3.3.1.1 Definition

Relating is here defined as:

Relating. A one-to-one, interactive process, involving first recognition, then a developing understanding of the other person, self-disclosure, accompanying arousal and affect, and the carrying forward of this to future encounters.

The aspects of this definition will be developed throughout this section.

3.3.1.2 Social information processing theory

Social Information Processing (SIP) theory (Walther, 1992; 1995) states that social identity and relational cues can be transmitted by plain text, but this occurs at a slower rate than would occur in a richer channel such as voice, and therefore CMC relations should require more time for social information to get through. This theory is a variant of the cues-filtered-out theories discussed earlier (Sproull and Kiesler, 1986), suggesting that rather than socio-emotional cues being filtered out entirely, they are just weakened. The same moderating criticisms that were applied to cues-filtered-out theories can be applied to SIP, in as much as it implies that the "relationship" is a product of transmitted signals, and hence necessarily subject to media effects. Earlier it was suggested that since social context involves creating a mental construct, subjects may create context in the absence of signal transmission or based on very limited signal information. The same argument can be applied to the creation of the construct "a relationship", and a relationship can be said to exist in a situation if the subject sees themselves as being in a relationship with another person.

SIP theory predicts that subjects relating using CMC will begin with low values on a variety of relationship measures, but over time (and with the transfer of the requisite information) these measures will improve to the level of face-to-face groups. Walther (1994) studied relational communication over time in the context of social information processing (SIP) theory. Subjects were in groups of three, and discussed issues such as the mandatory student ownership of personal computers, in order to reach a consensus on policy recommendations to give to university administration. No group members knew each other beforehand.

Neither the expected initial difference between CMC and face-to-face groups, nor the expected development over time was found. From the beginning of the longitudinal study, CMC groups achieved more positive levels on several dimensions of interpersonal communication than face-to-

face groups, and in no case did they express less intimacy (Walther, 1995), contradicting both cues-filtered-out and social information processing theories. The author concludes:

The most striking finding in the current results suggests that when CMC participants are interdependent over time, they adopt more intimate and sociable relational behaviour from the inception of the interaction, and throughout.

(Walther, 1995, p198)

This result, surprising to SIP theory, is in accord with the position that relationships are mental constructs, which once evoked in the mind of the participant have an immediate effect on behaviour. Walther suggests that anticipation of future interaction is the determinant of relational behaviour, in other words the perception of subjects that there is, or will be, a relationship operating over time. It appears that simply telling subjects they will be in a long term relationship is sufficient to evoke this perception of a relationship, and the relational behaviour that goes with it.

3.3.1.3 *SIDE Model*

The social identification/deindividuation model (SIDE) predicts that in the absence of individuating cues about others, communicators judge one another on the basis of group similarity or difference (Walther, 1997). It predicts that in computer-mediated communication, when group identity is salient, group norms will be more likely to be adopted, while in face-to-face conditions these norms will be undermined by the individuating information about others. It is thus essentially a theory combining both the group normative process, derived from social identity theory (Hogg, 1992), and the interpersonal relating process. This model is very supportive of the more general position taken in the integrative model.

3.3.2 Properties of interpersonal relating

3.3.2.1 *Recognising, understanding and intimacy*

In analyses of the dimensions of relational communication, the first factor found is usually some measure of understanding of the other person. For example the first three dimensions along which relationships develop, as proposed by Gabarro (1990), are *openness and self-disclosure, knowledge of each other, and predictability of the other's reactions and responses*. The main dimension for relational communication proposed by Burgoon and Hale (1987), and used by Walther (1995), is *intimacy*, which is comprised of the sub-dimensions of *immediacy/affection, receptivity/trust, and similarity/depth*.

Understanding of the other implies behavioural predictability, and having a relationship reduces the unpredictability of the other person. A relationship means the carrying forward of previous data learned about the other person, and a reduction of uncertainty about their nature and motives, clearly a valuable process. The more similar two people are, the easier it will be for them to understand each other, and the better they will be able to predict the response of the other.

Relating is the exchange of information about *who one is, including one's personal state*. In a face-to-face setting it usually begins in a relatively standard manner, for example the shaking of hands and exchange of names which identify the person. *Sender recognition* is thus a key aspect of relating, and *anonymity*, where the identity of the communicator is unknown, is inimical to it. This may explain some of the interpersonal problems which arise from anonymous interaction (Yellen, 1993; Er and Ng, 1995). While from a solely task perspective, anonymity is an advantage (e.g. Jessup and Van Over, 1996), from the perspective of the interpersonal relating process it is a clear disadvantage.

3.3.2.2 *Personal affect, social facilitation and evaluation apprehension*

Relating also involves an affective component (Burgoon and Hale, 1987), which can express positively (as friendship) or negatively (as enemies), and both seem common outcomes of interpersonal relating.

The effect of the awareness of the presence of another individual is one of the oldest psychological phenomenon - *social facilitation* - where the “mere presence” of another or others acts as a stimulus for increased drive (Zajonc, 1965). In a word, the presence of others is stimulating, it reduces boredom and creates a higher level of arousal. Drive can be translated into either positive or negative affect, and social facilitation may be the fundamental psychological process behind relating. Current interpretations suggest social facilitation is engendered by a sense of personal competition with another and feelings of evaluation apprehension - concern lest the other evaluate us negatively (Geen and Gange, 1983; Valacich et al., 1992). Such negative evaluation could damage or destroy a relationship. However the arousal identified in social facilitation could equally be translated into positive affect, where the other is not a potential critic, but a friend and supporter.

Evaluation apprehension and conformity influences are often regarded as almost equivalent effects (e.g. Straus, 1996). The integrative model however distinguishes concern over what another *individual* thinks (evaluation apprehension), from concern about being the odd one out in an impersonal *group* (conformity).

Relational affect can “colour” communication, attaching positive affect to communications from or to those we like, and attaching negative affect to communications from or to those we dislike. For example those who disliked the other members of their online group felt less able to express their socio-emotional feelings online (Hiltz and Johnson, 1990), or choose not to communicate at all (Zack and McKenney, 1995).

3.3.2.3 *Interactivity*

Relating can be seen not only as the recognition of the other as an individual like oneself, but also as the expression of oneself as an individual. Self disclosure however involves a degree of risk, and requires trust of the other, which may not always be well founded. At any stage a relationship can go bad, sometimes with serious results for the participants, since the desire for revenge for a perceived wrong or slight seems as integral a part of human nature as the desire for friendship. Hence relating tends to occur in an interactive manner, i.e. each person contributes in a turn based sequence. Interactivity allows immediate adjustments to be made according to the response of the other person. In this, as noted earlier, ambiguity may be a useful tool, allowing the speaker to “test the water” as it were, without going in. Friendship is mutually reciprocated affect, which consequently requires an interactive situation to manifest. The development of understanding therefore tends to be mutual. This is the Social Penetration model of Altman and Taylor (1973), which proposes that the development of relationships involves a systematic process of mutual self-disclosure, which progresses from superficial to deeper areas of exchange, involving increasingly central aspects of each person’s personality.

3.3.2.4 *Anonymity*

If exposed to a series of anonymous messages, the receiver would not know whether they were from the same or different people, and would be unable to carry forward previous relational information. Anonymity therefore makes the establishment and continuance of relationships difficult, and can be seen as largely negating the interpersonal relating process. Anonymity has been linked to absence of evaluation apprehension, defined as fear of direct reprisals or negative evaluation of contributions

by others (Valacich et al., 1992). Evaluation apprehension can also be seen as part of the interpersonal relating process (see 3.3.2.2).

In terms of the integrative model, although recognition vs anonymity may be a central issue for the interpersonal relating process, it is predicted to be largely irrelevant to the other two processes (task and group). The task resolution process is concerned only with the analysis of task information per se, and the group normative process does not distinguish one individual group member from another. There is some evidence to support these predictions. For example, in electronic brainstorming, which is a simple task that can be carried out by individuals working independently, performance is unaffected by anonymity (Valacich et al., 1992). However introducing sender recognition into this situation resulted in fewer critical remarks than anonymous groups of the same size (Valacich et al., 1992). This can be attributed to the evocation of the interpersonal relating process when subjects are non-anonymous and can thus be recognised in future encounters. When relating, criticism of a contribution can be taken personally, i.e. to be criticism of the owner of the contribution. Since this could have an adverse effect on the relationship, critical behaviour can be expected to go down when relating is relevant. Larger groups (of 9) generated more critical comments than smaller groups (of three), even when both were named, perhaps because as the number of relationships in the group increases, less value is attached to each one. It was also interesting that non-anonymous groups were more satisfied, supporting the idea that relating to others raises drive and arousal, and may be a factor in process satisfaction.

It has been proposed that anonymity can affect group unity:

Groups operating under higher levels of anonymity will have lower levels of group cohesiveness, unanimity, and member influence than will groups operating under lower levels of anonymity.

(Valacich et al., 1992, p106, Proposition 4)

The integrative model suggests that anonymity will have little effect on the impersonal normative process, which generates group unity. Support for this is found in another phenomenon that can be attributed to normative influence, polarisation (Hogg, 1992), where anonymity in computer-mediated groups has been found to have no effect (Sia et al., 1996).

3.3.3 Media effects

3.3.3.1 Signature effect

When people interact through communication settings that provide high bandwidth channels, the signals sent may provide a unique “signature” that is just as effective as giving a name, and perhaps more so because it is more difficult to fake. For example a voice or face can be recognised as the same voice or face on a consequent encounter. In these cases it is not correct to talk about anonymity, and it can be expected that subjects know they are recognised and therefore their current behaviour may carry forward to a future encounter. Plain text, as occurs in CMC, tends not to carry such unique sender identification marks, and this may also account for the “flaming” found in early studies of e-mail (Sproull & Kiesler, 1986), and the lack of it in e-mail among established groups (Hiltz et al, 1989). Based on first hand experience with a student bulletin board, the author noticed that the “*I am the greatest*” type of message required anonymity, and when flaming individuals were identified and approached personally, they reduce their flaming considerably if not entirely. This suggests that *flaming occurs when operate in a contextual vacuum*, and reinstatement of context reduces flaming.

The natural signature effect of rich communication settings, as Walther (1994) points out, can make manipulating anticipated future interaction difficult. Face-to-face groups who were told they would interact with some partners only once, and with others several times, did not take this entirely on face value (Kellermann, 1986; Douglas, 1987). Later treatment checks showed that those who were told they would not meet again still showed a moderately high anticipation of future interaction. On reflection this was seen as plausible since subjects attending the same university would infer that they could easily recognise one another if they met again. However such recognition is much less likely for one shot CMC interactions where the interaction medium is plain text.

Walther (1994) attributes the early differences on relational measures found between CMC and face-to-face interactions to the anticipation of future interaction by face-to-face groups (because they can be recognised), which does not occur for CMC participants (because they cannot be recognised). He points out that in one of the few experiments where subjects were led to believe that they would be interacting further with other subjects in the experiment, no difference was found between CMC and face-to-face groups in terms of interaction quality (Matheson and Zanna, 1990).

Walther (1994) investigated the effect of likelihood of future interaction on zero-history, student groups of three, carrying out an academic dilemma task over a six week period. Half the groups were led to expect an ongoing relationship with the same people, while half were led to expect different partners for each of the three tasks. For the CMC groups, those who were led to expect a longer term relationship showed higher scores on a measure of anticipation of future interaction. However in face-to-face groups, anticipation was unaffected by the longevity of the groups. In face-to-face groups, subjects expected to encounter their partners in the future, even after a brief meeting, whereas for CMC groups, a brief encounter did not raise this expectation. This can be attributed to the better "signature" of the individual provided by rich media compared to text interaction, which increases the likelihood of recognising the individual again. The study also found that relational perceptions for synchronous CMC were much the same as for face-to-face groups, but those for asynchronous CMC were significantly lower.

These results offer another explanation for the better relational communication of richer media to that that provided by a cues-filtered-out approach. They suggest that the higher intimacy experienced in face-to-face communication can arise from the expectation of a continued relationship due to the signature effect of rich media, and when this effect is controlled for, CMC groups can experience just as high a relational intimacy as face-to-face groups do. Lower intimacy for asynchronous communication implies that relational intimacy drops as interactivity is reduced, which would be expected from what is known of the interpersonal relating process.

Media richness theory, reduced social context theory, and social information theory are all equally challenged by these results, and for the same reason. Higher level processes, such as interpersonal relating, are based not only on quantity of stimuli or information exchanged, but on complex mental models which can be evoked by the "set" or salience of the situation. The relationship can exist therefore, and relating begin, from the moment the subject perceives the relationship.

Such experiments illustrate the value of theories that provide some insight into the complex psychological processes which lie behind interactions. As a further example, in another experiment Walther (1995) noted that CMC communication transcripts showed much more self-disclosure (such as what night-clubs they liked) than was the case for face-to-face communication. Understanding the interpersonal relating process as described, suggests the reason for this may arise from the difference in communication setting linkage rather than the difference in richness. CMC is one-to-one

communication, while a face-to-face group is a one-to-many or many-to-many interaction. Relating is also a one-to-one process, perhaps because if self-disclosure to one other involves risk, then self disclosure to many others involves considerably more risk. It can be concluded that relating occurs better in situations where the communication is one-to-one.

3.3.3.2 *Richness*

If media richness experiments have confounded equivocality with interpersonal relating, then these experiments imply that individuals prefer richer media when personally relating to other people (Kraut et al., 1992; Webster et al., 1996). This seems to contradict the findings that CMC can be just as intimate, if not more so, than face-to-face interaction, and that bandwidth is no barrier to relating (Walther, 1995). Is it possible that these contradictory findings can be entirely explained by the signature effect in rich media? In other words, can it be claimed that given an anticipated future relationship, there is no difference between CMC and face-to-face interpersonal relating? It seems unlikely (Chidambaram, 1996). Subjects could be adding warmth to CMC communicating to compensate for the absence of cues, as suggested by Hiltz and Turoff (1993, p 112). The finding that high bandwidth channels are not *necessary*, does not imply that they are *preferred*, or have no effect, and criticisms of cues-filtered-out approaches must avoid “throwing the empirical baby out with the theoretical bathwater” (Walther, 1996).

That constructs can be created with little or no informational base can be compared to visual illusions, where subjects will “see” perhaps a face, based on minimal cues, if they are expecting to see it, because their mind fills in the perceptual gaps. Likewise subjects may “see” a relationship, even at the beginning of the communication (Walther, 1995). However that is not to say that visual cues have no effect on what is seen, or that a visual illusion is the same as a complete picture of the real thing. While a minimal cues visual illusion of a face can be destroyed by the addition of marks which suggest another interpretation, a full detail picture of a face is not so fragile.

Interpersonal interaction messages may likewise confirm rather than create the relationship. New relationships may be created even before any information is communicated, because they are mental constructs, however the interpersonal process (which will confirm or disconfirm the expected relationship) may still operate better through rich communication channels. One possible reason is that non-language aspects of voice and face are more directly linked to the emotional state and feelings of the sender than language is. Other reasons given earlier are a preference for the sort of ambiguity possible in multiplexed signals, and a better ability to recognise the other person. In conclusion, there is no contradiction between the operation of relational context and a preference of subjects for rich, multiplexed communication settings.

3.3.4 **Personal relating as a “task”**

One way of dealing with research that indicates the importance of interpersonal relating is to consider it to be a sort of “task”, and some research on equivocal tasks has taken this approach. Webster et al. (1996) propose that message equivocality, defined as multiple and conflicting interpretations, can arise from two different attributes of the message: ambiguity and personal nature. Messages were considered to be of a personal nature if they involved confidential, private or delicate information or involved feelings or emotions. They found that when task equivocality was held constant, the personal nature of the message significantly influenced media choices. Subjects considered face-to-face and telephone to be much more appropriate than E-mail, FAX and memo for sending personal messages. In a further experiment, subjects reported on the ambiguity and personal nature of the last message they had sent, via one of four media: face-to-face meeting, letter, E-mail and FAX. Messages communicated via face-to-face were significantly higher on personal nature

than the other three communication settings, which did not differ from each other. There was also a high correlation between message ambiguity and personal nature (0.56, $p < 0.01$).

However in suggesting that media richness theory can be extended to include both ambiguity and personal relating within the concept of equivocality, Webster et al. (1996) are also suggesting that interpersonal relating be viewed as a “task”, a point not really made clear in their paper. A similar problem was discussed earlier, when it was considered whether the group combining process could be considered to be a “task”. The conclusion then and here are the same. To consider either representing the group or relating to other individuals as “tasks” is a possible perspective, but to do so will create considerable confusion between these activities and the traditional concept of task. Such extensions of the concept of task would mean that virtually everything group members do would be a task.

Although the findings of this series of experiments (Webster et al., 1996) are couched in terms of media richness theory, they support the proposed integrative model, because they recognise and separate out interpersonal effects from the traditional concept of task equivocality. Webster et al. (1996) show as the model would predict, that subjects significantly distinguish personal relating from task equivocality, that they prefer richer media such as telephone and face-to-face for personal relating, and that personal relating is closely linked with ambiguity.

3.3.5 Conclusions

The main conclusions from this section are that interpersonal relating:

1. Involves the creation of a cognitive construct, the relationship, which may have an effect even before relational communication starts,
2. Allows information about the other person as an individual to be carried forward from one communication to the next, giving a basis for familiarity and predictability,
3. Operates in a one-to-one manner,
4. Begins with personal identification and recognition of the other person,
5. Does not operate well if the other person is not recognisable, or are anonymous,
6. Involves arousal and affect, perhaps based on the psychological process responsible for social facilitation (the change in behaviour that occurs when individuals feel they are being watched), which may be either positive or negative,
7. Is a two way turn taking process,
8. Develops through interactive steps of mutual self disclosure to increasing levels of understanding and intimacy,
9. May use ambiguity to support this process of mutual adjustment to the other person,
10. Is evoked when subjects believe they will meet the other person again and be recognised,
11. May be naturally evoked by rich communication settings where communication involves unique sender information, such as face or voice, even without verbal interaction,
12. May occur across electronic channels, using plain text, especially if subjects have a relational context.

Relating as a process has benefits which go well beyond the relationship itself. For example, the development of trust and willingness to self-disclose may mean disclosure, not only of personal information, but also of task information, information that might otherwise not be forthcoming. The value of developing relationships, or personal “rapport”, extends into all communications. Relating also provides recognition of the other person as a person, which can be a social signal. For example when faced with the job of sacking an employee, although the *information* could be conveyed by memo or telephone, most managers would regard the right way to do it to be to talk to the employee in person. This shows concern and respect for the other’s feelings and well being, and recognition of them as a person, and not just an object.

The main conclusion of this section is that interpersonal relating is a one-to-one interactive process, distinct from group influence, and relational context should be distinguished from the group or social context shortly to be discussed. If communications in a group are anonymous, and contain no sender signature information, this prevents the relationship from developing, as it prevents relational information about the sender from carrying forward from one communication situation to the next.

3.4 Group representation

A lion used to prowl about a field in which four oxen used to dwell. Many a time he tried to attack them; but whenever he came near they turned their tails to one another, so that whichever way he approached them he was met by the horns of one of them. At last however they fell a-quarrelling among themselves, and each went off to pasture alone in a separate corner of the field. Then the lion attacked them one by one and soon made an end to all four.

(Aesop’s Fables, ca. 600BC)

This section considers how individuals in computer-mediated groups respond to their status as members of a social group and how they represent the norms of that group. It is the study of small group behaviour extended into the computer networked environment. It also investigates the question: *How do face-to-face groups generate agreement?* and the closely related question: *Can computer-mediated groups generate agreement in the same way that face-to-face groups do?* Agreement generation, which has been identified as a common weakness of computer-mediated groups, is reviewed on both an individual psychological level and on a group process level. The purpose of the experiment to follow will be to simulate what is proposed to be the essence of the face-to-face group agreement process in a computer-mediated group setting.

3.4.1 Agreement in computer-mediated groups

The earlier review of GSS performance in general, and across task types (see 3.2.7, p85), suggested that computer-mediated groups had difficulty getting group agreement or consensus. For example, a comparison of groups communicating face-to-face and by CMC, for both a preference (or “value laden”) task and an intellectual (or technical) task, found that the computer groups had much more difficulty generating agreement (Adrianson and Hjelmquist, 1991). Only one of the eight CMC groups reached consensus while seven of the eight face-to-face groups did so. Subjects rated the function “resolving disagreements” much higher for face-to-face compared to the CMC interactions, as were all communicative functions. In the computerised interaction, individuals had a much less accurate perception of the group’s decision, compared to face-to-face ($p < 0.0002$), and the influence of the group’s decision on the subject’s pre-discussion ranking was greater in the face-to-

face case ($p < 0.003$). As expected, there were no differences between the groups in terms of solution quality.

The authors attribute the lower agreement and conformity to the lack of complex non-verbal messages in the CMC interaction, preventing social influence. They interpret social influence in terms of functions such as resolving disagreements, persuasion and getting to know someone, all of which got the lowest ratings for the CMC interactions. However in the integrative model these functions would be largely determined by the interpersonal relating process, which is not seen as a key aspect of generating agreement. Kraut et al. (1992) also attributed the difficulty the computer groups had in developing consensus on a group writing task to differences in the medium, in this case its lack of interactivity. They note:

But the major problem, achieving consensus about how to proceed, seems much less amenable to technological intervention.

(Kraut et al., 1992)

In these cases, the failure of electronic groups to generate agreement has been attributed to the nature of the computer medium, and in particular, its inability to transmit social influence. It will now be suggested that this view is incorrect, and has arisen from the confusion of interpersonal and group processes.

In terms of the proposed integrative model, lack of agreement in groups means lack of operation of the group process generating agreement, either because the process has not been initiated, or because one of the conditions necessary for the process to operate has not been satisfied. This raises the following issues:

1. What is the process by which groups generate agreement?
2. What are the necessary and sufficient conditions for the operation of this process?
3. Can this process occur across current computer networks which are plain text based?

These issues will now be considered in more detail.

3.4.2 Cohesion

The traditional measure of "groupness" is group cohesion. Very cohesive groups are considered to strongly influence their members to consensus, and to exert this unifying social influence against the naturally diverse tendencies of individuals (Schacter, 1951). Cohesive groups generally have common attitudes and conduct, i.e. they tend to agree. This cohesive force, common in face-to-face groups, seems to be what is missing in dispersed and computer-mediated groups.

3.4.2.1 The concept of "group" in psychology

Early researchers conceptualised group activity in terms of the entity "group", conceived of as something with an existence of its own, giving rise to the idea of a "group mind" which operated on a different level from those of its members (McDougal, 1921). Campbell (1958) argued that just as people perceive an aggregate of rock particles as "rock", they can perceive a group of individuals, a social aggregate, as an entity under appropriate conditions, such as there having a common fate. This is the position adopted in this study. Lewin, often called the father of experimental social psychology, considered a group to be represented as a single entity in the individual's "life space" or "field", defined as the totality of psychological events experienced by the individual (Lewin, 1948). However these conceptualisations of a "group" as something in itself were cut short by Floyd

Allport who proposed that the term “group”, except as meaning the sum of its members, is a nominal fallacy, putting the question:

When the group dynamicist speaks of ‘attraction of the group for the individual’ does he not mean just the attraction of the individuals for one another?

(Allport, 1962, p23)

The answer to this question, based on the research that followed, seemed to be a resounding “Yes”, as researchers took to heart Allport’s famous dictum “there is no psychology of groups which is not essentially and entirely a psychology of individuals.” (Allport, 1924, p4). As a result, cohesion was defined as “the total field of forces acting on members to remain in the group” (Festinger et al., 1950). These “forces” were conceptualised as either the relationships and friendships between members, or the extent to which the group mediates goals which are important for members (Festinger et al., 1950). Although cohesion was conceptualised as due to many “forces”, the force most commonly researched has been interpersonal attraction, and cohesiveness has generally been operationalised as sum of the interpersonal attractions between members of the group (Shaw, 1992). Interpersonal attraction is conceived of as “the ‘cement’ binding together group members” (Schacter et al., 1951, p229), and is widely treated as the main cause of group cohesiveness (McGrath and Kravitz, 1982). As noted by Hogg (1992) this approach tends to liken the group to a molecule, in which individual atoms are people, and the interatomic forces are interpersonal attraction. This approach suggests we are attracted to form groups, and to conform to group norms, both to receive positive responses from others and to avoid negative feedback from them (Schacter, 1951). Group agreement is regarded as arising from such interpersonal influence (Sia et al., 1996b).

3.4.2.2 Problems with cohesion as interpersonal attraction

The conceptualisation of group cohesiveness as arising from interpersonal attraction has not been particularly successful, which may explain why after a burst of activity from 1940 to 1960, research in this area waned so much that “For almost a quarter of a century, very little of significance on group cohesiveness has been published in mainstream social psychology.” (Hogg, 1992, p51). The problems with cohesiveness as interpersonal or task attraction have been:

1. Cohesiveness occurs in groups whose members dislike each other (Billig and Tajfel, 1973; Hogg and Turner, 1985). Lenk (1969) found that although members of a rowing eight disliked each other, they worked together as a cohesive team.
2. Cohesiveness occurs in groups that mediate failure (Turner et al., 1984).
3. Cohesiveness does not correlate with interpersonal relations. Among successful basketball teams (Fiedler, 1954), rifle teams (McGrath, 1962), soccer teams (Veit, 1970) and bowling teams (Landers and Luschen, 1974), more cohesive teams had less interpersonal attraction than less cohesive teams.
4. Attraction among members of a social group seems to depend more on whether members are seen as prototypical of the group norms than on personal likes and dislikes (Hogg and Abrams, 1988).

For example Turner et al. (1984) allowed individuals to choose to join laboratory groups for a synonym task, and then provided feedback on success or failure. Members of groups that had failed showed greater cohesiveness (as measured by attraction to the group) than groups that had not failed. A similar experiment showed that unpopular groups were more cohesive than popular groups (Turner et al., 1983). Hogg and Turner (1985) found that randomly categorised individuals were more cohesive when members disliked, rather than liked, each other.

Perhaps the most telling argument against group cohesiveness as arising from interpersonal attraction is that large groups show cohesiveness and solidarity just as small groups do, implying a common process (Hogg 1992). It is difficult to sustain the concept of interpersonal attraction as the basis for cohesiveness in very large groups, such as “America” or “Britain”, implying that interpersonal attraction is not the basis of cohesion in small groups either.

3.4.2.3 Social influence

If group cohesiveness and the generation of agreement is not to be attributed to the influence of interpersonal attraction, it is nonetheless usually attributed to some form of social influence. In traditional definitions, social influence between members of a group can arise from compliance, internalisation or identification (Mann, 1969). Compliance involves direct pressure, where as soon as the pressure is released the individual reverts to their original opinion, and is not common in cooperative groups. In fact compliance is not a true change at all, involving merely public compliance rather than private acceptance. Internalisation occurs when the persuasiveness of communications is such that the influence is accepted and becomes part of the receiver's internal value system.

The degree of internalisation depends on both the trustworthiness of the source and the validity of the information or argument (Hovland et al., 1953). In information exchange terms, internalisation can be seen as requiring the exchange of both rational task information and the sort of complex cues which are used in relationships to generate trust. These two aspects seem to correspond to the division by Bales (1950) between task and socio-emotional communications, and also match the first two processes (task resolution and interpersonal relating) of the integrative model.

However social influence through identification operates in quite a different way from internalisation, and will now be considered as the basis for the third process of group influence.

3.4.3 Identification

Identification as a force for group cohesion is based on the perceptions that precede behaviour than the reinforcement contingencies which follow it. Perceptions determine behaviour by defining the “reality”, or background, within which behaviour occurs. Because perceptions have their effect before behavioural contingencies can operate, they are possibly a more powerful and subtle influence on behaviour than behavioural consequences, as anyone who has had experience with the mentally ill can testify. The influence of perceptions can be difficult to recognise.

One of the most fundamental human perceptions is of who we are, and what we stand for - our *identity*. A great deal of the behaviour of individuals involves them in developing and defending their idea of themselves. Without a sense of self we could not operate as sentient beings, because we would be operating in an existential vacuum.

3.4.3.1 Social identity theory

Social identity theory (Abrams and Hogg, 1990) provides a cognitive approach to group behaviour which applies regardless of group size. It solves the problem of how to account for group-level phenomena in terms of the psychological processes that occur within individuals, by reinventing the concept of group, not as a concrete, positivistic reality, but as a perceptual (or cognitive) reality.

When an individual joins a group, *social identity theory* (Hogg, 1992) proposes that their sense of self identity is extended to incorporate (to a greater or lesser degree) the group identity, and the

individual is said to be identified with the group. The "social identity" of the group then becomes part of the personal identity of the group member (Tajfel, 1978). Social identity theory argues that a great deal of our sense of who we are stems from our membership of and affiliation to various social groups. In other words group membership tells us who we are and what we are. The essential point is that individuals acting as group members are primarily attached to *the group*, rather than personally connected to the individuals in the group, or to the activities of the group. In this sense "group" (as an entity distinct from its members) is a mental construct or perception, as in the common definition of group as any set of people who consider (perceive) themselves to be a group (DeSanctis and Gallupe, 1987; Shaw, 1981). Such perceptions can operate whether the group is computer-mediated or face-to-face.

3.4.3.2 Categorisation

The behaviour of members identified with a group can be explained in terms of the cognitive process of *categorisation*, which is known to accentuate the similarities of stimuli falling within the same category, and the differences between stimuli falling within different categories. Where the entities categorised are people, this leads to the well known in-group and out-group accentuation carried out by group members (Tajfel, 1982). Self-categorisation theory, developed from social identity theory, emphasises this aspect (Turner, 1985). It proposes that people categorise and define themselves as members of a distinct social category, that they learn or discover the norms of that category, and then they assign those norms to themselves.

3.4.3.3 Cognitive dissonance and cognitive balance

As well as categorisation, identification involves the psychological theories of cognitive dissonance (Festinger, 1957) and cognitive balance (Heider, 1958), which propose an inherent human need to hold internally an integrated and coherent set of cognitions (Abelson, 1968). Consequently once an identity is established, behaviour tends to conform to that identity.

Failing to agree with a group that we identify with generates cognitive dissonance, which can only be resolved by agreeing with the group, getting the group to agree with us, or leaving the group. If we see ourselves as part of a group, that perception becomes part of our identity, and many people would rather change their current views than lose any part of the identity that defines their individuality. The sanction of being excluded from a salient group therefore has a special potency, involving a psychological cost to our sense of being, as well as any physical consequences. Given a perception of equivalence between the individual and the group, the thoughts and feeling that individuals have about themselves are applied to the group and vice versa. A threat to the group may be seen as a direct threat to the individual, even though the individual themselves may not be personally or directly affected by the threat.

Group identification implies that group members respond as one for the simple reason that they see themselves as one. For example, on his or her first day at a new job, a new employee who has never met any of the other staff, may still seek to arrive dressed and behaving like the others. The person identifies themselves as an employee of the company, even though they do not yet personally know anyone in that group, and will "conform" to the behaviour which is expected of members of that group from the first day. This type of group influence is not mere compliance (which only produces a temporary change), nor is it internalisation due to personal influence.

The individual *incorporates the identity of the group into their own identity, and then continues to behaviourally represent their identity*. Cohesion occurs when group members take on a common identity, the identity of the group. The common identity leads to the creation of common behaviour

and the dropping of idiosyncratic behaviour. For example Owen (1985) sampled the speech of five person groups over four months, and found that idiosyncrasies of metaphor usage gradually disappeared, until at the final meeting a single category of metaphor (visual) dominated. The group had developed a shared meaning structure, a consensual reality, which Owen saw as an essential part of the sense of the group's cohesion, or "we-ness".

This theory of social identification can explain a wide variety of social phenomena, including conformity, group think, deindividuation, group polarisation and the generation of agreement in groups. For example it explains the well known information suppression that occurs when some members of the group have unique information that is relevant to the task, but do not share it, an effect that is found in computer-mediated as well as face-to-face groups (Hollingshead, 1996).

3.4.3.4 Conformity

Identification is an implicit form of social influence distinct from the explicit, external influence caused by internalisation. It is not an external "pressure" exerted on the individual by the individuals around them, because the other members of the group need do nothing at all to the "pressured" individual. They need not even be present (or even exist). It is an implicit influence, but one which is just as powerful as any external pressure would be. Conformity experiments demonstrate this, as most subjects will agree (wrongly) with a group, against their own better judgement, on a simple perceptual task, without any coercion or persuasion (Asch, 1952).

Asch's work was replicated with subjects in booths, who could not see the other group members, and only knew of the responses of the others through an array of lights (Crutchfield, 1955). The tasks were extremely easy, they were of no particular importance to the subjects, the participants hardly knew other members of their group personally, and no attempts at all were made to influence the subject's views by either the experimenter or the other group members, yet the results were remarkably uniform across different occupations, suggesting the operation of a basic human process. The "group pressure" shown by conformity experiments does not involve any summed personal influence, nor any form of interpersonal influence. It is a process that operates in an entirely different way from personal influence, which can occur without face-to-face "rich" contact, from group members the subject does not know, has never met, and perhaps will never meet.

3.4.3.5 Groupthink

Groupthink occurs when group member's desire for unanimity overrides their rational appraisal of the situation (Janis, 1972). In terms of the integrative model, groupthink can be attributed to the group influence process operating without the balance normally provided by the other two processes. Consequently studies that have manipulated cohesiveness in terms of friendship, have either found no significant relationship between cohesiveness and groupthink (Flowers, 1977), or a negative relationship (Leana, 1985). Groupthink is not related to interpersonal relating.

3.4.3.6 Deindividuation

Deindividuation is proposed to involve a loss of self awareness, as the identity of the individual is submerged in that of the group, leading to unregulated behaviour (Diener, 1979). Later interpretations (e.g. Hiltz et al., 1989) distinguish between individuation as attention to private self, expected to produce independence and self-consistent behaviour, and deindividuation, as attention to the group self, which can be expected to produce conformity and socially desirable behaviour. This distinction matches the processes proposed in the integrative model well. Personal relating implies that one is disclosing one's individuality to another individual, and therefore one's individual identity is salient. Interpersonal relating is thus individuating. Representing the group

implies that one sees oneself primarily as “group member”, and thus the group identity is salient. Group identification is thus deindividuating.

3.4.3.7 Group attraction and personal attraction

Social identity theory makes a *clear distinction between social attraction based on group identification and interpersonal attraction based on like and dislike of individual members of the group*. This distinction is fundamental to the extension of current two-process models to a three-process approach. It also illustrates that while the originating processes are distinguished, specific individual behaviour is multi-threaded, and can arise from either or both processes. Interindividual conduct can be based on either social attraction, as shown in Figure 14, or personal attraction, as shown in Figure 15, or both.

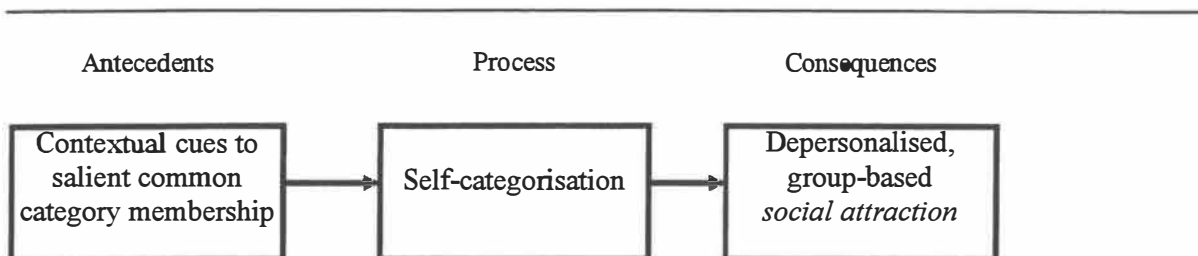


Figure 14. Social (group) attraction (from Hogg, 1992)

In social attraction the object of affection is not the individual, but the group prototype they represent. Personal attraction, by contrast, is idiosyncratic and individual specific. Popularity in a group appears to depend on the extent to which a person exemplifies the group ideal (Hare, 1962), and operates as a one-way affair, manifesting more as respect and liking, and requires no personal reciprocation. By contrast personal affect (friendship) is usually reciprocated (Segal, 1979). Each process operates in a different way, and the properties of personal relationships are different from the properties of social relationships.

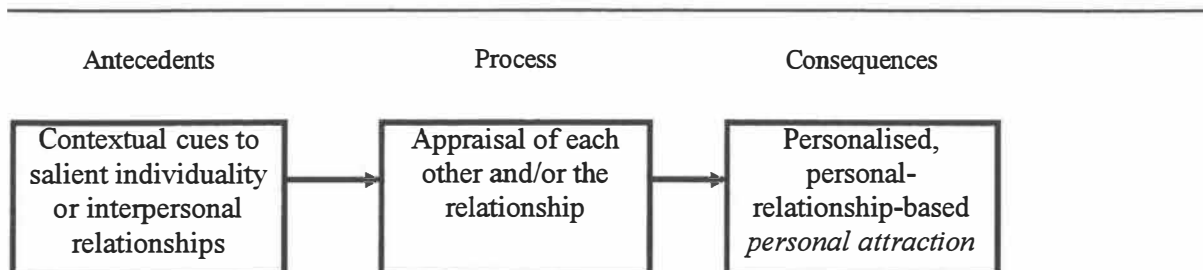


Figure 15. Personal attraction (from Hogg, 1992)

Experimental attempts to directly manipulate these variables have produced the expected results. Hogg et al. (1992) manipulated social orientation, to accentuate either group membership or interpersonal relationships and individuality, by varying the similarity to the group prototype of the affect target. They found that in the interpersonal condition, attitude was not affected by whether the target was prototypical or not, but in the group condition, a significantly more favourable attitude was expressed towards prototypical targets.

3.4.3.8 Identification in computer-mediated groups

Do computer-mediated groups show evidence of this group identification process? Finholt and Sproull (1990) studied electronic groups formed from E-mail distribution lists in a large Fortune 500 firm employing over 100,000 people. They reported that groups in the electronic environment, despite the relative lack of contextual cues, did manage to establish unique identities by using group names, norms, message content and message style to differentiate themselves. They argued that electronic groups could enhance member's sense of self, just as conventional group membership does. Many of their electronic groups had explicit statements saying "who we are" and explicit rules for expected member behaviour. They conclude that ". . . at least some of these groups behaved like real social groups - despite the fact that they shared no physical space, their members were invisible, and their 'interaction' was asynchronous." and "Despite its limitations, this study identifies and begins to characterize a new social phenomenon in organisations - the large scale electronic group."

Ethnographic studies of groups on the Internet show that groups relying entirely on textual interaction show many of the properties of group behaviour - development of group identity, group norms and a sense of community (Giese, 1996; Surratt, 1996). One such study concluded:

In each computer-mediated setting, the results were the same: participants worked together to establish cultural frameworks for interaction (including language systems, social norms, beliefs and values); they developed systems for the socialization of new members into these cultural frameworks; they developed the means of defining social deviance and the corresponding strategies of social control; and they developed systems of stratification based upon criteria defined as relevant for the environment. . . . in every instance, participants defined themselves as members of real communities in which they engaged in real communication.

(Surratt, 1996)

It can be concluded that electronic groups may not only behave like real groups, they may in fact be real groups, simply in a different communication environment.

3.4.3.9 Group polarisation

A corollary of the proposal that individuals represent the position of groups they identify with is that this same process will cause changes in the position of individuals. Research into changes in the position of individuals in groups has a long history, especially in the area of choice shift, also called "risky shift", or *group polarisation* (Kaplan, 1977). Group polarisation is the finding that groups make more extreme decisions than individuals when faced with the same problems. This section will look at group polarisation as an effect brought about by group influence pushing the group to unity, and research in this area will be used to exemplify some of the issues surrounding the application of the normative process to computer-mediated groups.

The first issue arises from the two explanations for polarisation that have developed. *Persuasive arguments theory* (Vinokur and Burnstein, 1974) proposes that individuals change their position according to the extent that individuals are exposed to good arguments against one alternative and for another alternative. For this approach, task discussion and argumentation are necessary for individuals to change position. This approach is similar to the rational information exchange approach in GSS identified earlier.

The second position, *social comparison theory* (Sanders and Baron, 1977), is that as long as group members are made aware of one another's positions, they will change in the direction they regard to be the group norm, typically represented by the position of the group majority. From this point of

view, no task discussion is necessary, and mere knowledge of the position of others is enough to cause individuals to change their position. This is the same as the group process proposed in the integrative model. One mechanism proposed for the effect by social comparison theory is one-upmanship, in which each group member seeks to be better than the others in representing the group position. Social identification theory provides a more fundamental explanation, based on the same principles of cognitive dissonance (Festinger, 1957) and identification (Hogg, 1992), and leads to the same conclusions as social comparison theory.

A meta-analysis of over ten years of choice shift studies concluded that, while there was evidence for both theories, the effects attributable to persuasive arguments theory tended to be stronger than those attributable to social comparison theory (Isenberg, 1986). However more recent studies have questioned this, suggesting that the fundamental impact of member position may be greater than realised. Group members tend only to present arguments favouring their preferred position, and refrain from sharing arguments that contradict their preferred position (Pavitt, 1994), suggesting that discussion groups are involved more in rationale construction than simple information exchange (Heath and Gonzalez, 1995), and the normative process may be operating beneath the surface of persuasive information exchange. This position would be supported by the integrative model, where the two processes are not regarded as mutually exclusive.

Initial studies of computer-mediated groups suggested that they polarised more than face-to-face groups (Siegel et al., 1986). If polarisation in distributed CMC groups is due to a group normative influence, then this directly contradicts proposals that CMC reduces social influence and causes deregulated behaviour, such as flaming (Siegel et al., 1986). Deregulated, individual focused behaviour should result in non-polarised group behaviour, as individual differences should cancel each other out, giving diffusion rather than polarisation. The contradiction, pointed out by Lea and Spears (1991), is that CMC subjects cannot be both more individualised and self-focused (as in flaming) and also more influenced by the group (as in polarisation). The integrative model does not face this contradiction, as flaming could be linked to a weakness in interpersonal interaction and polarisation attributed to group normative influence.

A later study compared face-to-face and computer-mediated groups of three facing risk/benefit problems (McGuire et al., 1987). Research into individual biases has shown that, according to prospect theory (Kahneman and Tversky, 1979), when facing such problems people tend to be risk averse in situations of gain, and risk seeking in situations of loss. When face-to-face groups are exposed to the same type of risky gain/loss problems, they not only show the same biases as individuals, but develop them more extremely so (Davis et al., 1974). In other words groups make more extreme decisions than individuals, whether it be risk seeking or risk aversion.

In their study, McGuire et al. (1987) found that the computer-mediated groups did not show the expected risk bias biases after interaction, although matched face-to-face groups did. The experimenters were surprised not to find the expected pre-discussion risk biases, and attributed this to subject misinterpretation. For both groups, while pre-discussion unanimity predicted group choice, a non-unanimous majority (2-1) did not. Analysing the interaction transcripts showed that while both face-to-face and computer-mediated groups proffered the same number of position statements (e.g. "lets go for 3 in question 10"), in the face-to-face groups a lot more argumentation occurred before anyone took a position in the group. The authors conclude from this in favour of persuasive arguments theory as the basis for individual change. It was also found that the first statement of choice preference made was a good predictor of the group final position.

This experiment illustrates some of the difficulties which arise when the three processes proposed in the integrative model are intertwined in group behaviour. The GSS used, Converse, presented three windows on the screen, each of which scrolled independently and reflected what group members typed in real time. If the subjects did misinterpret the problems prior to the experiment, it may be that exchange of task related information in the face-to-face groups resolved this, so that the expected bias occurred. By contrast the computer-mediated groups, where typing messages “costs” more, appear to have spent most of their time exchanging, or trying to exchange, position information, so perhaps this exchange of task argument did not occur.

Both task and individual position information could be exchanged, but as the input was neither synchronised (as in a sequential face-to-face discussion), nor combined (as in a vote), in this experiment it is not clear whether normative information could operate or not - there was no control for sequence effects in the McGuire et al. (1987) study. In groups of three, where initially no position is clear, the first group member to state a position takes a risk. If they propose a position the group adopts, they are a leader. If they propose a position different from that the group majority eventually adopts, then they must either retract their publicly stated position and go with the group, or find themselves in the minority situation. Therefore we can expect the first position statement to be made by an individual who is fairly confident in their position. The first proposer has now pointed the group decision in a certain direction. The second person to take a position can, in a small group of three, define a group majority. Either of the other two group members can do this. If they do so, social identification predicts that the third member will tend to go with the other two.

If however the second group member strongly disagrees with the first position, and opposes it, they may still find themselves in a minority depending on the position taken by the third member. The likelihood of ending up “with the group” is clearly higher for the second member if they go with the first. Thus the finding that the first member’s position predicted the group position is quite in accord with a group normative process operating.

For group influence to operate, group members *must know the positions of other members*. In other words, the pre-discussion majority can only be expected to have a normative effect if that positional information is available to all group members before they respond. This was not so in this case. Group members had to “discover” the position of other group members in a dynamic way as described above. For the first contributor in a computer-mediated setting there is no normative influence, because they do not know what position the others will take. By contrast for the last contributor it can be expected to be at maximum, so the sequence of contribution is significant. This experiment thus does not properly test for normative influence in computer-mediated groups.

A more recent experiment did control the sequence of position information exchange through the GSS (SAGE) and thus better tests for normative influence (Sia et al., 1996). Subjects were allowed to enter their opinions simultaneously on their computer terminals, but these opinions were only presented to the rest of the group when everyone had given an opinion. The group then proceeded to the next round of opinions. This method avoided the complication of sequence effects, where initial group responses affect those following. The study found that distributed computer groups showed a significant polarisation effect, indicating group influence was operating.

The study found that whether the communications were signed or anonymous had no effect on the choice shift, as predicted by the integrative model. To investigate persuasive arguments theory, Sia et al. (1996) presented information exchange at two levels, positions without arguments and positions with arguments. In the former case subjects exchanged positions without giving their

underlying reasons. This had no effect on the polarisation which occurred in the distributed groups. In other words arguments are not necessary for polarisation to occur. Sia et al. (1996) conclude that these results do not support persuasive arguments theory. Again this is as predicted by the integrative model.

The same procedure was also carried out for proximate computer groups. The proximate groups were face-to-face, but were not allowed to talk to each other, and still interacted only through the computer. This design changes only one aspect of communication setting - the rich non-language visual channel. This small change reduced polarisation considerably over that which occurred in the distributed groups. The authors concluded that since the distributed groups lacked social presence, the lack of social presence somehow caused the observed choice shift.

The integrative model offers a simpler explanation of these results. It attributes polarisation solely to normative influence, not to personal influence or to informational influence. When groups are distributed, anonymous, and can exchange position information (with no arguments), then it is proposed that group influence is the main process operating. Hence polarisation was high in this condition. Variations in anonymity and the amount of information exchanged had no effect because they are relevant to interpersonal relating and task resolution, respectively, which were not effective, and in general have little to do with the generation of agreement. However when subjects could see each other, the other individuals became salient, deindividuation was reduced, and the interpersonal process was evoked. This meant that subjects operated more as individuals, which interfered with the group identification process, causing less polarisation.

In conclusion, these results suggest that polarisation is due to group normative influence, and occurs more in computer-mediated groups than in face-to-face groups, rather than less. It seems that this process does not require a rich medium of exchange. It leads to the surprising conclusion that *computer-mediated groups should be able to generate more group agreement than face-to-face groups, rather than less.*

3.4.3.10 Summary

Social identity theory provides a general theory of group interaction, based on cognitive processes, that applies to groups of all sizes, and accounts for a wide variety of social phenomena (conformity, stereotyping, discrimination, prejudice, in-group cohesion, deindividuation, inter-group competition and polarisation), without positing the operation of anything beyond that which occurs in the mind of the individual (Hogg, 1992). It suggests that much of what has passed as "social" research is really the study of interpersonal rather than group processes (Hogg, 1992).

Group members conform to the expectations of a group they identify with for the same reason they conform to their own expectations of themselves. Disagreeing with a group one identifies strongly with is as difficult as disagreeing with oneself. Groups are cohesive not due to external pressure of individual on individual, but because members who identify with the group implicitly represent what they see as the group norms. We accommodate the group position, not because of any rewards, reasons, rationality or friendships, but because to disagree contradicts our sense of who we are. Cohesion occurs, not due to any direct or external pressure from group members, but because group members take on a common identity, the identity of the group.

There is a tendency to see the group unifying process only in a negative light, as labels like "conformity" and "groupthink" (Janis, 1972) imply. "Conforming" to "group pressure" is seen as a weakness of individuality. By contrast, the integrative model suggests that what is elsewhere called

conformity, is really the essential "glue" which holds all human groups together in an equivocal world, where most of the decisions groups make every day cannot be logically or rationally derived, and where charismatic leaders are not always to be found. This natural in-built process is what makes us a social animal. Operating alongside a task resolution process and a personal interaction process, its contribution is generally beneficial. Operating in isolation it can malfunction, as the term groupthink implies (Janis, 1972), but the same could be said of rational task analysis operating without fellow feeling or group awareness.

Changing individual behaviour is inherent to the generation of agreement. Unless a group starts with agreement, if no-one changes their individual position then no agreement can occur. How the group process generates agreement is illustrated by a classic study reported in Lorge et al. (1958), where the experimenters tried two ways to get new mothers to increase the amount of orange juice and cod liver oil they fed their babies (Radke et al., 1947). The *individual* condition involved a 25 minute personal discussion with a hospital nutritionist, followed by pamphlets. The *group* condition involved meeting with other new mothers for a 25 minute instruction and discussion session. Follow up, after two and four weeks, showed that significantly more of the *group* mothers were behaving in the desired fashion, although mothers in the *individual* condition had received more individual attention, and more of the nutritionist's time. It was noted that the subjects were farm mothers, who were unacquainted before the group session, and had no contact with each other after it. It was concluded that the reason a 25 minute discussion among six strangers produced a greater effect than a 25 minute consultation with an expert individual was that the former method generated greater individual involvement.

However the integrative model suggests that the behaviour change in the group mothers was due to normative influence, because they identified with their discussion group, a group that accepted what the nutritionist said as a norm. It predicts that normative influence does not require personal involvement, and even if a mother contributed nothing to the group discussion, the influence would still operate. The experiment shows that implicit group influence can be more powerful than one-to-one influence by an authority figure.

In conclusion, the group unification process not only successfully accounts for the generation of agreement in groups, but appears to be a process that can operate effectively across dispersed, computer-mediated networks. It is proposed to be, like the other two processes, an in-built part of human nature, with clear evolutionary benefits. Is it just "herd instinct"? Whether it is or not, without it we would not have cities or societies. Rather than trying to eliminate it, computer-mediated groups need to recognise and use this cohesive force. They need it for precisely the same reasons face-to-face groups need it - to generate group unity.

3.4.4 Adaptive structuration theory

Poole et al. (1985) developed *adaptive structuration theory* (AST) to explain how technology such as CMC is "appropriated" by groups to reinforce their social structure or social context. Social context in this sense is described as "the culture, distribution of power, and the social norms, habits, practices, expectations and preferences held by a group regarding its present and past interaction." (Zack and McKenney, 1995). AST is based on *structuration theory*, which states that social context defines the nature of a group interaction, which group interaction in turn defines the social context of the group for future interactions (Yates and Orlikowski, 1992). Structuration theory proposes three ways social context can affect the group interaction (Poole et al., 1985):

1. Interpretive context, which provides extra meaning to communications,

2. Power context, which provides facilities for the application of power, and
3. Normative context, which provides schemes for the legitimisation of action.

AST predicts that CMC such as E-mail will be appropriated by groups in a manner that reflects the group's social context. Groups should adapt asynchronous technologies to their modes of working (Markus, 1992) just as occurs in other communication settings. In terms of the integrative model proposed, AST provides the bigger picture, recognising that individuals are members of not just one group, but many, an entire social structure. AST states that individuals draw on their surrounding social structure to provide rules and resources for the group interaction (DeSanctis et al., 1993). The concept of appropriation stresses the choice available to individuals, and the group in general, of manifesting social structure in a particular setting, and their ability to re-invent the appropriate structures for the given situation.

Zack and McKenney (1995) applied case study methods to investigate AST by comparing two newspaper sites, both within the same parent corporation, both established in their use of E-mail, and both carrying out essentially the same task, but known to have different management styles or social contexts. They wished to discover whether these groups were significantly different in the way they used E-mail and face-to-face interaction, as AST would predict. One group operated in a very open and cooperative atmosphere, where managers delegated a lot, and individuals put the good of the group first. The other group had much more competition and individualism, each section spent time "protecting their turf", and managers delegated a lot less. In other words, in one group members identified with the group, and the group operated as a unity, whereas the other group was split into factions and there was less agreement, more individualism and more conflict. As the authors report:

At Regional, interpretation and context building was a collaborative and consensual process. At Statewide the ME was attempting to impose his vision and world view on others, while the reporting and production functions were attempting to defend and impose their own perspectives on each other.

(Zack and McKenney, 1995, p417)

When they asked subjects what communication medium in theory they would prefer to use in what task situation, they found no difference between the two groups. However in practice, they found a significant difference between the groups:

. . . even though a potential [E-mail] link might be salient, it would not be made because the communicators plainly did not want to interact with each other, either for political, personal or normative reasons.

(Zack and McKenney, 1995, p417)

They conclude that while the technology provides a communication setting, with a given capability for communication, group or social context dictates the willingness to communicate. The observable social differences between these two groups was very evident in the way the groups used CMC and in the communication patterns found. They recommend that researchers attempt to experimentally control for social context.

Generally AST suggests that CMC and GSS only provide individuals and groups with a communication environment. What occurs within that environment reflects the social and personal realities of individuals and groups. For example status differences arising from occupational roles (e.g. doctor and nurse) not only persist in the use of computer conferencing (despite its supposed equality), but became more established with greater use (Saunders et al., 1994).

AST proposes that the organisation, group or sub-group that individuals identify with, their social context, affects how individuals behave and use technology. It suggests that although the integrative model presents only a single group, in reality individuals are identified with many groups, whose salience varies from situation to situation. Social context, as used by AST, however is defined very broadly, to include not only normative influence, but also personal influence. The integrative model suggests that the normative and personal contexts can be usefully discriminated.

3.4.5 Generating agreement

This section aims to define the group agreement generating process in more detail.

If the primary process generating group agreement involved either task analysis or interpersonal relating, one would expect cooperative group interaction to begin with extended discussion, each group member seeking to convince, or be convinced by, others of the best task solution. In the end, the best reasoned or best presented position should be adopted, when the majority have been convinced (internally) that it is the best solution. While this sort of extended discussion can occur, groups have a tendency to begin with a focus on solutions rather than task understanding (or personal relationships) (Hirokawa, 1983).

Group members immediately proposing solutions however is exactly how a normative group decision process could be expected to operate. Each group member would state their individual position, without explanation or justification, and if a group position was evident, group identification with the manifest position the group has taken would generate unity. If the group agreed initially, there would be no need to discuss the various alternatives (and degrade confidence due to the confusion of information), or to relate on an interpersonal level (and risk relational conflicts). If group agreement was not reached, confidence would be reduced, and some members would tend to change position, so the process could be repeated until agreement ensued. Unsure members would tend to change position as group identity is threatened by disunity. For cohesive groups this could be a quick and effective decision method.

Can the generation of group agreement be such a simple process? If it were more complex it probably wouldn't work. Personal affect is not necessary for this process - group members do not even need to know each other. Nor is there any necessary rationality in the process - that must occur on the individual task analysis level. This theory supports the view *groups don't think - only people do*.

The change of the individual to the group position brought about by this process cannot be seen as ". . . mere compliance with the majority, as may be found in many Asch-type judgemental situations." (McGuire et al., 1987), since compliance implies a temporary change brought about by external pressure. Normative influence as proposed here *involves no external pressure from other group members* and remains effective as long as the individual is identified with the group, whether the group is physically present or not, and operates even when members of the group are not known personally.

The integrative model suggests that in real groups the normative process does not operate alone, but merges with two other processes. It may however pre-direct the other processes, for example by determining friendships, or requiring members to find reasons for established group positions.

3.4.5.1 *Media richness*

The relationship between media richness and group influence is complex. In a computer-mediated group it can take some time to deduce the group position from many written text comments. However, in small, face-to-face groups, members can scan the faces and/or postures of the others, seeking to discern the group position from such cues. In a theatre the volume of clapping (or groans) can indicate the group's common reaction, even in a group of thousands. As noted earlier a medium such as sound *has the ability to merge many signals into one combined signal that can represent the group position*, and this is also true, to a lesser degree, of vision. The effectiveness of rich media in mediating social influence may be less because they carry complex emotional information than because they can naturally generate group position information.

Secondary information "back channels", such as voice tonality, facial expression and body posture, may, in face-to-face groups, contribute valuable information about the position of group members and hence the position of the group as a whole. Since the ideal size of face-to-face groups seems to be only about five or six, such continuous scanning may be less effective in dynamic groups as group size increases. If so, it would be predicted that such methods as seating group members in a circle could facilitate the generation of agreement.

It is concluded that the property of so called rich media that permits the generation of agreement in small groups may involve what was earlier called the ability of the transmission interface to process transmissions, or more specifically its ability to combine multiple transmissions. This can either be by presenting them side by side as is done in vision (and in systems like Converse) or by merging them as is done in sound (and in voting).

3.4.5.2 *Face-to-face discussion*

There is evidence that the group normative process, based on the exchange of position information exactly as demonstrated in Asch's conformity experiments, may play an underlying role in apparently rational face-to-face discussion. Hoffman and Maier, building on Lewin's concept of valence as the degree of acceptability of a solution (Lewin, 1935), measured the sum of favourable minus unfavourable comments on problem solutions to generate a "valence index" for alternatives in a decision task (Hoffman and Maier, 1961). This index can be taken as an indicator of the group position on each alternative. During the discussion, each person contributed any number of comments, or none at all, and negative ones cancelled out positive ones in the index.

As expected, the decision valence index correlated with decision adoption. However the existence of a threshold effect (at about 15), and the independence of that effect from rational discussion, was more interesting, implying a non-reversible cohesive group process. A further study involved subjects selecting personnel (an intellectual task), and purportedly following a rational two phase procedure - first reject the unacceptable to get a short list, then select positively from the short list. The choice valence index (which correlated strongly with group outcome) often passed the valence threshold well before the rejection phase was complete. It appeared that long before the manifest rational decision process had been completed, on an implicit level (as measured by the valence index), the group had already made its decision.

In group discussions, each communication can be considered to have a choice valence, a single value such as agree or disagree representing the *behavioural position* of the sender with regard to some task choice. The combination of such valences can provide an estimate of group position, as was done in the Hoffman and Maier (1961) study. Once the group valence for a particular choice alternative reaches a commonly understood threshold level, members perceive the group to have

made its decision, and group normative influence generates agreement through identification. Hence an alternative offered after a solution has already passed the adoption threshold is much less likely to be considered seriously by the group than if it had been suggested before, causing groups to tend to ignore less obvious alternatives in problem solution (Hirokawa, 1983).

3.4.5.3 Cognitive conflict

It is often assumed that generating agreement requires the surfacing of disagreement latent in individual views (e.g. Sambamurthy and Chin, 1994). This task focused approach suggests that it is necessary to resolve cognitive conflicts before “real” agreement can be achieved. While this may be true of the task resolution process, it is not a requirement of the group normative process as proposed. In this process each individual simply seeks to avoid adopting a position that is “outside” the position, or range or positions, accepted by the group they have identified themselves with. Why the group has taken the position that it has, and why they should change their current position, are not issues for this process. Therefore there is no necessity in this process for conflict surfacing or conflict resolution to precede group agreement. In fact frank and open exchange of one’s opinions is, in this process, unwise, as although one may be “right”, one may also find oneself adopting a position outside the group norm.

There are advantages in checking the positions of other group members before adopting one’s own position. It can be expected that initial statements will tend to be “exploratory”, perhaps indicating a position, perhaps not, and will tend to be made by the most confident individuals. In this context ambiguity is an advantage, because it allows the individual to indicate a position without actually adopting it. For example the question “What about the Hong Kong option?” can be interpreted as a factual question, or as a hint that the questioner is considering adopting the “develop in Hong Kong” option. Depending on perhaps tone of voice, it may carry a valence either for or against the Hong Kong option. Thus ambiguity, which is well supported by rich media, may play a role in avoiding conflict, and the movement of the group to agreement may occur without the surfacing of any prior conflict, or resolution of such conflicts. Resolution of cognitive conflicts may however provide a more stable basis for agreement, as group members would have dealt with the opposing argument, and thus have been “inoculated” against it. However the same effect can be achieved by rationalisation against conflicting views after agreement has been reached.

3.4.5.4 Summary

In summary, it is proposed that the generation of agreement in face-to-face discussion, does not occur through the exchange of complex “social” information (Fulk and Boyd, 1991), but through the encoding of relatively simple position information, or valence, within multi-threaded communications that may be quite ambiguous in rational task terms. Valence may be conveyed using message content, or through non-verbal, secondary channels of information exchange. If the transmission interface processes individual position information in a manner that presents the group position to group members, group identification will unify the group. The operation of the group unifying process is not considered to be an exclusive process, but one that can occur in addition to task discussion and interpersonal relating .

3.4.6 Outcome confidence and acceptance

3.4.6.1 Introduction

It has long been argued that outcome confidence and acceptance is as important in group activities as outcome quality (Maier, 1963), since member confidence and acceptance of a group decision can affect the success of any implementation that may follow the meeting. It is not enough for a group

simply to produce the right answer to be effective, group members must also believe it to be the right answer, and may have to convince others outside the group of this (others who may hold the authority necessary to implement the decision) (Boje and Mumighan, 1982). A good group decision may come to nothing if members have no confidence in it. A poor decision made with great confidence can be equally disastrous for the group, possibly more so (Janis, 1972). Consequently it has been argued that member confidence is just as important a product of group activity as task solution, and time spent by groups generating member confidence is not wasted (Sniezek, 1992). Group interaction therefore involves not only the resolution of the task, but also members convincing themselves and other members that the group solution is the right one. If successful members will not only be confident in the group's outcome, they will also agree. Confidence in a common group position can be seen as an alternative measure of agreement, and the generation of individual confidence is closely linked to the generation of group agreement.

3.4.6.2 *Definitions*

Confidence has been defined in a variety of ways which must be clearly distinguished. *Individual confidence* is the confidence of the individual in their own decision. Sniezek (1992) defines *group member confidence* as the confidence of an individual in the group's decision, and *group confidence* as the confidence of the group in the group's decision, formed through the collective response of the group to the question of how confident they feel about their answer. This latter definition elevates the group itself to the position of an entity which can think, decide, and have confidence (Janis, 1972), and confounds the measurement of group confidence with properties of the group interaction, such as communication setting and personal relationships, since the group must interact to define its confidence. This study has explicitly taken the approach that groups are not "beings", and therefore cannot adopt psychological states, such as confidence, as individuals do. Asking groups how confident they feel confounds the confidence of individuals with the group interaction process. This research will therefore *define group confidence as the average individual confidence of the members of a group in the group's decision.*

Sometimes a distinction is made between outcome confidence and *decision acceptance*. For example a subject could have little confidence in a group decision, but accept it completely as being the group decision, and therefore not go against it. The distinction is between positive endorsement (confidence) and absence of an objection (acceptance).

A distinction can also be made between outcome confidence and *commitment to implement*, where a subject may report being very confident in a group decision, but fail to take steps to implement it. Commitment to implement can be seen as the expression of confidence (or not) at a period of time after the interaction. If confidence reflects the probability of behavioural expression, then commitment to implement later can be seen as a measure of the degree to which confidence decays over time. Experimental comparison of confidence and commitment has shown little difference between the two measures when confidence is stable (Sniezek and Henry, 1990), high confidence leading to high commitment. This suggests that confidence and commitment are linked. However for groups who had little opportunity to resolve disagreements, member confidence during the meeting did not match post meeting commitment, reflecting the fragility of that confidence. Thus commitment can provide a measure of the stability of confidence, or likelihood of decay of confidence, over time.

3.4.6.3 *Confidence appropriateness*

If the task has an objective measure of success, group member confidence can be compared with task correctness to see if it is too high or too low. Confidence which shows neither under confidence

nor overconfidence has been described as *well-calibrated* (Sniezek, 1992). This concept distinguishes between high group confidence and appropriate group confidence.

3.4.6.4 *Improving confidence*

Most methods designed to “improve” group interactions seem to fail to increase confidence in group members. A comparison of discussion to consensus, dialectic, Delphi and dictator (i.e. best member) methods for groups facing a real time judgmental forecasting problem found that only the consensus method increased confidence (Sniezek, 1989), supporting the earlier suggestion that confidence and agreement are linked in groups. This would be expected from the integrative model, since group improvement methods such as Delphi are largely designed to improve the task resolution process, while agreement and confidence, it is proposed, arise mainly from the group unification process.

3.4.6.5 *Confidence and information exchange*

Comparisons of the confidence of individuals in groups and alone lead to the general conclusion that individuals are more confident in groups than when working alone on the same type of tasks (Sniezek, 1992). This section considers how various theories might predict that the confidence of individuals would be affected by being part of a group interaction.

Anchoring. In making judgements individuals typically use a process called “anchoring”, where an estimate is made by starting from an initial value, and adjusting it to produce the final answer (Tversky and Kahneman, 1982). Typically the adjustment is insufficient and the result is “overconfidence”. In a group where member solutions differ, there are competing “anchors”, offering multiple potential starting points for the group decision. This should result in a “debiasing” of individual overconfidence (Sniezek and Henry, 1989). If many individuals, each making their decision using anchoring, interact together, the result should be a lowering of confidence compared to their confidence when alone, which is not the case.

Domain of Information. Another robust individual finding is that confidence in individuals is significantly reduced if the number of alternatives considered, or the domain of information to be processed, is increased (Sniezek, Paese and Switzer, 1990). This result suggests that exposure to the differing opinions of other group members, as occurs in a group interaction, should increase the domain of information of each individual, and hence reduce the confidence of all group members. Clearly information exchange theory cannot explain why groups tend to be more confident than individuals.

In summary, it is difficult to explain the extra confidence of groups by summing the tendencies of the individuals in those groups, which would, if anything, predict a reduction of confidence for individuals in groups.

3.4.6.6 *Group normative influence*

Empirical studies which follow changes in confidence over time are relatively rare, but provide insight into how confidence develops in interacting groups. One such study was carried out by Sniezek and Kolzow (reported in Sniezek, 1992), and used subjects’ initial response choices and confidence judgements to create groups which matched a two by two design of group confidence (Confident vs Uncertain) by group agreement (group members Agree vs Disagree). Prior confidence, as expected, predicted the level of confidence achieved after discussion, suggesting a not surprising consistency in confidence on the individual level. Face-to-face discussion raised confidence *for all groups*. Confidence was also measured at the pre-discussion phase, after members

had been informed of the position of others, but before any discussion had taken place. For groups that already agreed, simply being made aware of the position of other group members (without discussion) was enough to raise confidence significantly ($p < 0.05$), as would be predicted from the effect of the normative process, and showing that the exchange of task information is not necessary for the generation of agreement.

However for the disagree groups, the opposite occurred, and confidence went down. Being made aware of the disagreement in the group lowered confidence significantly ($p < 0.05$), as would be predicted by the domain of information theory. Such lowering of confidence can be expected to be accompanied by an increased willingness on the part of individuals in the group to change their position. By the end of the discussion, both the initially agree and initially disagree groups were approximately the same, each having raised their confidence by about two points on a 7 point scale. This suggests that the quality of final agreement generated is not affected by the presence or absence of prior disagreement. The experiment carried out in this research will report similar results those found in the above study.

3.4.6.7 Effect of confidence on the agreement process

If agreement generation is based on positional statements, does the confidence of those positions affect the process? The integrative model would suggest not, as individual confidence is not relevant to group position. A recent study investigated this, comparing CMC subjects whose initial choice position was exposed to majority disagreement from confident and non-confident other group members (Lowry, 1993). The other group members were not anonymous, and were in theory working from other parts of the building, but in reality were simulated by the experimenter, allowing the extent of disagreement to be fixed at four against and two for the subject's position. Subjects could change position throughout a 20 minute discussion. Whether the majority were confident or not had no significant effect on subject position change, on the probability of the group reaching a consensus, or even on the final confidence of the subject in their decision. The author was surprised by these results, and concludes:

This finding is counter-intuitive; one would expect a subject to change his or her opinion more often when the majority has a high confidence than when they have a low confidence.

(Lowry, 1993, p17)

From the perspective of the integrative model these results are predictable. They imply that agreement and confidence arise largely from group normative influence alone.

Subjects in this study did however feel more effective when they knew the other member's confidence ratings, and preferred knowing them. Further investigation suggested that confidence information affected the subject's argument strategy, i.e. it was used to determine their chances of getting other group members to change their position by personal argument.

3.4.7 Conclusions

From this section it can be concluded that:

1. Cohesive groups generally have common attitudes and conduct, and tend to agree. The cohesive force, common in face-to-face groups, seems to be missing in most computer-mediated groups,
2. Cohesion has traditionally been conceptualised and operationalised as sum of the interpersonal attractions between members of the group,

3. However cohesiveness occurs in groups whose members dislike each other, does not correlate with measures of interpersonal relations, and occurs equally strongly in large groups where interpersonal relations are not feasible,
4. Identification is one of the traditional forces of social influence, and has a powerful but implicit effect on behaviour,
5. Social identity theory states that when an individual joins a group, the "social identity" of the group becomes part of the personal identity of the group member,
6. Social identity theory makes a clear distinction between social attraction, based on group identification, and interpersonal attraction, based on personal like and dislike of individual members of the group,
7. In conformity experiments, people adjust to the group position, not because of any rewards, reasons, rationality or friendships, nor due to any direct or external pressure from other group members, but because they have taken on a common identity, the identity of the group, and to disagree would contradict the identity they have assumed,
8. Social identity theory provides a general theory of group interaction, based on cognitive processes, that applies to groups of all sizes, and accounts for a wide variety of social phenomena (conformity, stereotyping, discrimination, prejudice, in-group cohesion, deindividuation, inter group competition and polarisation), without positing the operation of anything beyond that which occurs in the mind of the group member,
9. There is a tendency to see the group unifying process only in a negative light, as labels like conformity and "groupthink, particularly if it is operating in isolation, but operating alongside a task resolution process and a personal interaction process, its contribution is generally beneficial,
10. Polarisation is due to group influence. It occurs more in computer-mediated groups than in face-to-face groups, not less, and does not require a rich medium of exchange. Polarisation research suggests that individual salience, as when face-to-face, negates group influence, even if subjects do not communicate face-to-face,
11. Adaptive structuration theory proposes that technology is appropriated according to the larger social context, and only systems that support existing social patterns will thrive,
12. Confidence is raised when the subject is in agreement with the group position, and lowered when the subject finds themselves disagreeing with the group position,
13. The generation of agreement in groups may occur through the exchange of relatively simple position information, or choice valence, rather than through the exchange of complex "social" information, i.e. social information (as opposed to interpersonal information) is neither complex nor "rich",
14. The major force generating agreement in groups may involve an impersonal group normative process, based on the identification of the individual with the group, where individuals position themselves relative to the group until a clear group position emerges,
15. In cooperative groups involved in informal face-to-face discussion, a process of many-to-many exchange is proposed to occur, via back-channels or comment valence, which effectively involves an on-going informal "vote", which elicits the group's position, and evokes normative influence. This implies that in group discussions,:

- a) Group members will tend to immediately propose solutions, as part of the process by which the group position is elicited,
 - b) Group members will show a marked interest in the positions of others,
 - c) They will position themselves relative to what they perceive as the group position,
 - d) Rational information exchange is not necessary for this process,
 - e) Rational conflict resolution is not required for agreement to be generated in this way,
 - f) If the group cannot agree, group member confidence will go down, and likelihood of individual position change will go up,
 - g) There will be a threshold effect, and once a group position emerges, any alternative proposed after this is unlikely to be accepted.
16. The necessary and sufficient conditions for the operation of the group unifying process are:
- a) **Common group task.** The group is facing a situation or task which requires a cooperative group response, and whose consequences accrue to the group as a whole,
 - b) **Available group position information.** The individual group member is aware of the group position (if any) and can easily compare the group position to their own position,
 - c) **Group identification.** The individual perceives themselves as a member of the group and expects congruence between themselves and the group in this situation,
17. Since there is nothing in any of the above conditions that obviously demands a rich medium of communication, group normative influence should be able to operate in distributed computer-mediated groups interacting through plain text communication channels.

The main conclusion of this section is that the group unifying process is a powerful influence on behaviour, separate from interpersonal relating and rational task analysis, which can operate in a computer-mediated environment. The view that agreement is generated in meetings only when some group members successfully win others to their position by personal influence (Sia et al., 1996b) is challenged. Rather it is suggested that although personal or rational influence may be used to tip the balance, group influence provides the main social driving force for the generation of agreement.

4. CONCEPTUAL MODEL

4.1 The integrative model

Many studies regard group interaction as a scientific "black box", which receives input and generates output. They seek to explain and connect input and output without making assumptions about the process in between. However where multiple processes are likely, the processes are complex, and the variables are numerous, as is surely the case in GSS, such research without theory is extremely difficult and unlikely to be fruitful (McGrath, 1990). The number of possible combinations between variables quickly becomes immense. In addition, for interacting groups, apparently minor differences (such as someone watching) often produce major differences in results. If, as is proposed, the black box involves not one but three independent and complex human processes, each with its own thread of input and output variables, processes which usually interact with each other, then the chances of general exploratory experimentation giving anything but very weak results are surely low.

Therefore this research has begun by postulating what occurs within the black box of group interaction, in terms of generic processes proposed to occur primarily at an individual level, and secondarily at a group level. This theoretical framework will allow the prediction of the effects of empirical intervention in a reasonably specific way, particularly when one process is isolated. Although there is danger in proposing and describing that which cannot be seen (an internal psychological process), it can also result in a much richer model, whose value lies in its usefulness to direct research, explain results, and predict outcomes.

Before presenting details of the integrative model, the following section will consider the alternative of using a two process approach to explain research findings.

4.1.1 A two-process approach

This section considers firstly the issue of whether there is more than one type of process occurring in group interaction, or only a single generalised process, such as information exchange (DeSanctis and Gallupe, 1987), and secondly, whether two processes adequately explain group behaviour. It will draw mainly on studies already presented in the literature review.

4.1.1.1 *Bales IPA*

Bales (1950) category system for Interaction Process Analysis (IPA) has been one of the endearing measures of group research over the last forty years, proving to be immensely popular with researchers, even to the point of the development of a computer system (Group Analyzer) to assist in the coding of group interactions (Losada and Markovitch, 1990). The system makes use of 12 categories of communication, half of which are task orientated and half socio-emotional. Group communications are placed in three dimensional space using the axes Dominant-Submissive, Positive-Negative, and Task Orientated-Emotionally expressive. This system requires every communication to be categorised as either task or socio-emotional. It provides the foundation to postulate two group processes - *task and socio-emotional*.

4.1.1.2 *The need for two processes*

As noted earlier, one of the ironies of GSS studies is that GSS groups can produce results of better quality than face-to-face groups, and yet subjects report dissatisfaction with the GSS interaction process, achieve less agreement and display greater conflict (Gallupe and McKeen, 1990; Venkatash

and Wynne, 1991). Adrianson and Hjelmquist (1991, p293) report a case where subjects judged their performance as better in a face-to-face discussion than in a computerised conference, but actually performed worse. They conclude that the individuals subjective judgements were based mainly on social considerations rather than on task efficiency considerations. Such findings are not new. In a simple but elegant experiment, Boje and Murnighan (1982) showed that group interaction (both written and face-to-face) resulted in lower group accuracy in simple intellectual tasks but greater confidence among group members in the accuracy of their responses!

One explanation of these apparently paradoxical results is that there are two potentially independent processes operating, a task resolution process and a social influence process, one generating decision quality and another generating confidence and decision acceptance. This would also help explain why member acceptance of a group decision is often poorly correlated with its objective quality (Hoffman and Maier, 1961). The two processes can be linked to Bales (1950) proposal that information exchange can be of two types, task information and socio-emotional information. Later work has suggested that a single message can comprise more than one communicative act (Ord, 1989), and a communication can carry both task and socio-emotional messages (McGrath, 1984), implying two processes that can operate in parallel.

The task process aims at a valid solution to the task based on exchange of task information and argument. The social process aims at maintaining social norms by the exchange of social influence. If group interaction is as much about *What is agreed?* as about *What is right?*, then this helps explain why groups meet at all, in view of the fact that most groups are less task effective than their best member working alone (Lorge, Fox, Davitz and Brenner, 1958; Hackman and Morris, 1983; McGrath, 1984).

A two-process model can explain GSS findings in terms of support for one process but not the other. GSS groups tend to make good task decisions (McGrath and Hollingshead, 1991; Nunamaker et al., 1988; Pinsonneault and Kraemer, 1989) because GSS supports the task process by its ability to effectively exchange task information between members. GSS groups agree less because the GSS is less able to support the social influence process which generates group agreement and acceptance. This can explain why GSS can help resolve intellectual tasks (which have a right answer based on shared logical criteria), but is of less help resolving preference tasks, where the answer depends on personal values and the group must use social influence to enact a solution (Tan et al., 1991). Limited support for the group social process also explains why in planning tasks, the normal balance of power (between group and individual) shifts away from the group in favour of the individual in computer based interactions (Horton et al., 1991; Kraut et al., 1992). Lack of GSS support for social influence even explains why brainstorming GSS groups perform *better* than face-to-face groups (Casey et al., 1984; Dennis et al., 1991).

This two-way division, originating with Bales (1950), appears in various forms, and is very common in GSS research. For example a study of GSS development states:

Variables . . . can be categorized as relational and performance-orientated, respectively. Relational variables include such factors as group cohesion, social influence, and leadership skills, while performance-orientated variables include task correctness, decision quality, and degree of participation.

(Burke and Chidambaram, 1995)

4.1.1.3 *Problems with only two processes*

A two-process approach explains a great deal. However it implies that the difference between computer and face-to-face interaction is that computer subjects have difficulty using social influence to generate agreement. This has been attributed to the low bandwidth medium of text, which is unable to transmit the necessary "rich" socio-emotional signals (Sproull and Kiesler, 1986; Daft et al., 1987). A two-process model relegates CMC to "bit player" status in real organizations, which usually deal with equivocal problems (that require social influence) rather than ones which have a logical "right" answer (Mintzberg et al., 1976), and people in real organizations like to relate to each other socially (Walther, 1995). Computer systems which can only exchange "cold", factual task information can be expected to be of little use dealing with equivocal problems that require the group to *enact a solution* by generating agreement and confidence (Daft and Lengel, 1986). A simple two-process model thus implies that, until computer networks can easily transmit rich video-style communication, group agreement for equivocal and preferential tasks will be difficult to achieve, because the social signals necessary to transmit social influence will struggle to get through.

Evidence that people do indeed relate via CMC (Walther, 1994; 1995), that CMC can exchange rich messages (Lee, 1994), and can provide a "warm" and friendly interaction environment (Ord, 1989; Boshier, 1990) contradict the above view, as do suggestions that the "lean medium, lean message" approach is theoretically unsound (Fulk and Boyd, 1991; Lea, 1991; Lee, 1994). Equally the idea that electronic groups are individuated and suffer from an absence of group influence does not match well with the finding that such groups demonstrate more polarisation than face-to-face groups. In addition certain types of discussion GSS report that distributed CMC groups generate *more* agreement than when the same groups are placed face-to-face (Lea and Spears, 1991). Finally ethnographic studies of Internet groups show evidence of real group behaviour (Giese, 1996; Surratt, 1996).

These findings suggest there is a third process which is not being considered and that Bale's dichotomy could partition into three categories. There is some evidence for this from a study using Bale's IPA for computer mediated teams of four, carrying out a group writing task (Reid et al., 1996). They found CMC groups just as task effectual as face-to-face teams, but took longer to complete the task. Face-to-face groups generated about seven times as many IPA communicative acts as CMC groups, and communicated them faster. The IPA breakdown showed the expected division between task and socio-emotional, i.e. individuals who specialised in task comments tended not to express socio-emotional comments, and vice versa. However, while the IPA socio-emotional categories of *shows tension release*, *shows agreement*, and *negative reactions* were significantly lower in the CMC setting, as expected, the IPA socio-emotional category of *shows solidarity* was significantly higher in the CMC setting (CMC mean of 16.87% of acts, vs FTF mean of 3.85%). This suggests that Bale's socio-emotional category could well be split into a social (or group) category, and an emotional (or interpersonal) category. The authors conclude:

The present findings suggest that it is essential to differentiate acts that function to regulate conversation (e.g. Shows Agreement) or express fleeting emotional states (e.g. Shows Tension Release), from those linked to group formation and cohesiveness (Shows Solidarity).

(Reid et al., 1996, p1034)

The findings presented in this section raise contradictions that can only be resolved by extending Bales' (1950) two-process model, which has served well for over forty years, into a three-process model of cooperative group interaction. This integrative model will draw on more recent findings in

social psychology which imply that the social influence necessary to enact agreement is different from the emotional type of interaction which occurs in person-to-person relationships (Hogg, 1992).

4.1.2 An integrative three-process model of group interaction

The general details of the integrative model have been presented earlier. This section will consider the three processes in more detail.

4.1.2.1 Three processes

The three processes proposed are *resolving the task, relating to others, and representing the group*. Each process occurs within an individual in a group, avoiding the nominal fallacy of reifying the group and its processes independently of the group members (Allport, 1924). The three processes each operate in a fundamentally different way within the individual, are capable of independent operation, and can be isolated or separated out in research.

The model is summarised in Figure 16.

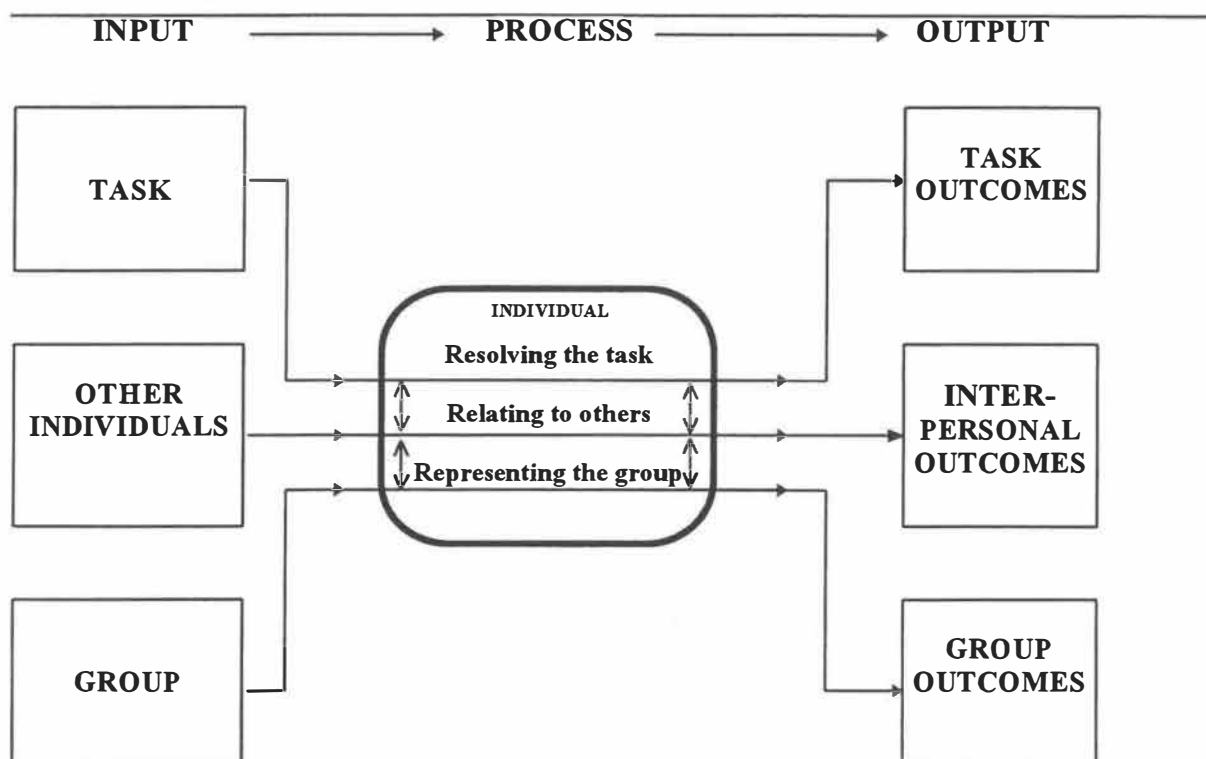


Figure 16. The integrative model

The figure is the same as the one presented earlier, except the interaction between the processes that occur within an individual are now shown. All three processes are proposed to occur within the same individual, who will naturally attempt to resolve obvious contradictions. Therefore, the processes will tend to interact to be consistent with each other (in as much as individuals are consistent within themselves). Being separate processes they may operate simultaneously, each process with its own function, yet all processes may access the same input and output. The parallel operation of the processes is possible because communicative acts in groups are essentially *multi-threaded*. Each process can access its own thread in any communication input or provide a thread of influence to any communication output.

A summary of aspects of the three processes proposed by the integrative model is shown in Table 9.

Process	Question	Individual Activity	Social Influence	Communication Aspect
1. Task resolution	"What is correct?" "What will work?"	<i>Resolving</i> - the task	Informational	Content
2. Interpersonal relating	"Who do I like?" "Who do I trust?"	<i>Relating</i> - to others	Personal	Context
3. Group unification	"What is the group position?" "Am I with the group?"	<i>Representing</i> - the group	Normative	Position or valence

Table 9. The integrative model: Process aspects

Thus it is proposed that a single communication can simultaneously provide not two but three types of information, namely *content*, *context* and *position information*. For example the statement "This is good value, lets buy it" could convey information on three levels:

1. **Content.** Information about the task (e.g. the item is good value),
2. **Context.** Information about the message sender (e.g. tone of voice could indicate that the speaker is friendly and to be trusted),
3. **Position.** Information about the sender's position or intended action (e.g. an intention to buy the item).

In other words, as well as informational content and personal context, each communication contains information representing *the position of the individual, as an action or intention to act*.

The separate origin of the three processes means that these three aspects of a single communication, although usually complementary, may contradict each other. For example a comment's content may suggest agreement while its sarcastic tone may suggest disagreement. Group level paradoxes, such as better task performance but lower group agreement and satisfaction can be attributed to the separate nature of the processes.

Position information from one person alone is not normative influence, just as a single communication does not make a relationship. Normative influence requires the exchange of information perceived as representing the position, or behaviour, of the group as a whole. How this is formed will depend on the social combination method in use. For example in an autocratic group it may simply be the position of its leader, whose person is seen as representing the entire group. In a cooperative group, as considered here, it tends to be the position of the majority. The term normative influence as used here relates specifically to the individual's perceptions of expected *group* behaviour (see Deutsch and Gerard, 1965, for alternative definitions).

Each process may operate in a different time frame. For example personal relations may continue over many tasks, and group membership may persist even if friends in the group come and go. The task time frame may be the shortest and most temporary of the three, as tasks change frequently. A single meeting may deal with many tasks. Being more permanent, personal friendships and group membership may be more important to the individual than the current task. These non-task processes may therefore provide a significant influence on behaviour in real groups, because they represent more enduring concerns to the individual.

Each process implies a different unit of research analysis. Task resolution is an individual process, carried out within the head of one person, leading to the individual as the unit of analysis. Relating defines the relationship dyad to be the key unit of analysis, rather than the individual (Fulk and Boyd, 1991). When individuals represent the group, then "Groups not individuals are the fundamental unit of work in modern organizations" (Finholt and Sproull, 1990). Thus depending on the question being asked, and the process involved, the unit of study could validly be the individual, the dyad, or the group (Bikson and Eveland, p285).

It can be expected that individuals will give attention to one process or another depending on the attention given to entities from which the processes are derived, namely the task, the other individuals, and the group. Which process is given priority by group members will depend on which entities are salient in the given situation, and different situations will focus attention differently. Forming ad hoc groups and presenting them with task demands, as is common in GSS studies (Dennis et al., 1990), clearly focuses the individual on the task process. Increasing the task difficulty or time pressure can be expected to further increase the task salience (e.g. Reid et al., 1996). Requiring the group to work as a group will make the group and group combination process relevant. Any focus on the state of the other person, as for example through their facial expression or tone of voice, or exposure of the individual's personal state to others, can be expected to make the interpersonal relating process relevant. In summary, manipulations of the salience of the entities of the interaction situation should alter process focus. Since each process absorbs time and effort on the part of the individual, effort put into one process may not be available for another. For example individuals spending time on task resolution can be diverted from the task into establishing a relationship with another group member.

No superiority or inferiority between the three processes is implied. Depending on contingencies, any or all processes can be important. Sometimes task resolution is critical, other times relating is the key to success, and sometimes the only important thing is to stick together. Although it is proposed that the combination of member contributions is generally a social process, the decisions of groups may not always be best predicted by a simple normative model, but may arise from a combination of models, as found by Laughlin et al (1995). The normative model however can be expected generally to have the greatest influence on how members combine to reach a group position, rather than rational or "truth wins" combination methods.

Because output is multi-threaded, any process can influence behavioural outcomes. For example social combination to create group unity may result in task resolution (although not necessarily a valid resolution). Conversely task analysis may lead to apparent group unity, if each individual comes to the same conclusions (this could also occur in nominal groups). Time spent relating may generate important task information, or may improve (or reduce) cohesiveness. Group norms may be the key to personal friendships. Task discussions may alter relationships. This complexity of group interaction arises because, as individuals, human beings operate on more than one level.

The integrative model suggests that group agreement (beyond what was present before the group interaction) can be generated by any or all of three types of influence:

1. **Informational influence.** Exchanged task information leads all group members to the same conclusion (Deutsch and Gerard, 1965),
2. **Personal influence.** One or more charismatic or trusted members convince the others of their position, or
3. **Normative influence.** Members agree because they see themselves as one of a group which has adopted that position (Ross et al., 1976).

The next section considers each of these methods of generating agreement in more detail.

4.1.3 Process details

Each process will now be briefly summarised, and the issue of how they could contribute to the generation of group agreement addressed.

4.1.3.1 Task resolution

Task resolution involves the individual seeking to resolve the aim provided by the task. Group members can be said to exert informational influence on one another if the information exchanged is taken as representing reality and internalised (Deutsch and Gerard, 1955). Changes in position may arise from internalisation of new knowledge, by the group members. The process aim, to *resolve* extant task information, can occur either by analysis (working forward from reasons to solution) or by rationalisation (working backwards from solution to reasons). The strength of this process for decision tasks is that it can produce a *valid* decision or quality result. Its weakness is that since everything cannot be thought through from first principles, it requires a conceptual context, some axiomatic assumptions that are accepted as given. It also depends on valid information being fed into the process (garbage in can produce garbage out).

For idea generation tasks it has been hypothesised that during the first minutes the provision of stimuli is irrelevant, and the subject records all their possible solutions right away. Once this reservoir of evident ideas is exhausted, the subject looks for stimuli to generate more ideas (MacCrimmon and Wagner, 1991). For decision problems the task resolution process has been long defined as involving the phases of intelligence, design, choice (Simon, 1960), which fits well with task structures used in current GSS implementations (Valacich et al., 1992). Other steps have been added before these three steps (problem awareness and problem definition) and after them (implementation and feedback) (Briggs and Nunamaker, 1994), however the central steps have not been altered for over 30 years.

While each individual may be expected to have a self-consistent knowledge structure, the exchange of such knowledge, as implied in the intelligence stage of the process, can be expected not only to expand the domain of knowledge but also introduce inconsistencies or contradictions. In this process, these must be resolved by rational analysis alone. This is a “truth wins” approach to agreement generation.

One need look no further than the world of academia to see that rational discussion is a dubious basis for the generation of agreement, and while in the long run, truth may indeed win, there are usually as many reasons for disagreement as there are for agreement. This process would also be ineffective for preference tasks, which have no logical basis, and for equivocal tasks, where the task itself is unclear. Simple intellectual tasks, for which this process would generate agreement, form by

far the minority of tasks for which real groups meet (Mintzberg et al., 1976; Daft et al., 1987). Such considerations challenge claims like:

The thinking process . . . is at the core of what groups do, but as we have noted before meetings are rich in distractions.

(Briggs & Nunamker, 1994, p65)

In conclusion, rational task analysis seems a relatively weak basis for the generation of group agreement.

4.1.3.2 Personal relating

Personal relating is an interactive two way process that involves the building and maintenance of personal relations, where one individual “connects” to another as an individual person like themselves. It involves arousal and emotions, and seems to satisfy a basic need for personal warmth and absence of loneliness.

Personal relationships can “colour” communications, depending on how we relate to the sender. The interpersonal relating process could lead to group agreement by enhancing some communications, those sent by people who are liked or trusted, and de-emphasising those sent by people who are not liked. In such a case, agreement would occur if one charismatic individual convinced all the other people in the group of his or her preferred solution. If the group’s most competent member is also its most charismatic, this group decision method would be very effective, and the group would perform at the level of its best member. If the most charismatic member was not the most competent, then the group using this process would operate below the level of its best member.

The requirement that there is one member who is trusted implicitly by all other group members however provides a considerable restriction on the usefulness of interpersonal relating as a method of generating group agreement. Experience suggests that in normal groups, “personality clashes” can be as much a source of disagreement as friendships are a source of agreement.

In conclusion, interpersonal influence is an unlikely basis for the generation of agreement.

4.1.3.3 Group representation

Group representation offers a process for the generation of group agreement that avoids issues of right and wrong, and who likes or dislikes whom, but is based simply on what is. The decision of the group is accepted by the individual because they are a part of that group. It also seems to satisfy a basic need to belong to something bigger than ourselves. The absence of a group identity, as embodied by a common position, threatens the identity of all group members, and the reduction in confidence “loosens” the positions of all individuals in the group, and the likelihood of individual position change goes up. Once some agreement forms, even if it is only a randomly occurring choice, a group position will tend to coalesce around that position.

In its pure form, this group process involves no rational task analysis - this is assumed to have occurred on an individual level. It is ideally suited to situations where what is done is less important than that the group do something, and do something together. It can not unreasonably be compared to “herd instinct”, since a grazing herd provides just such situation, where safety in numbers is more important than which direction the herd moves, and a herd that splits up will probably soon be destroyed one by one. Before we dismiss the relevance of such instincts today it is important to reflect on the normal impact of separation from the group in these situations - which is death. Therefore it is not surprising that this process still operates, and highly unlikely that this situation

will change in the near future. The benefits of group cooperation are many, even on an individual level, and anyone who has been part of a divided group, where each member operates without regard for the group, will know that “united we stand, divided we fall”.

We must be careful not to judge this process as “primitive”, unless we also categorise other basic human processes (such as vision and breathing) in the same way. In the natural design of things the group combination process works in with the other processes, and if the individuals in the group are analysing the task individually, as they should, then the process provides valuable closure for the group. How the processes work together will now be considered.

4.1.4 Multi-process interaction

In this research one process will be isolated, but these processes more naturally operate together. Investigation of multi-process interaction is complex, and the discussion below is more to provide suggestions for future research than provide answers. The pair combinations are task/interpersonal, task/group and interpersonal/group. In each case, either process can affect the other. Each combination will now be briefly considered.

4.1.4.1 Task and interpersonal

A rational disagreement, either of fact or argument, can lead to a personal dislike. A personal dislike can lead to argument, as when the individual goes looking for points of disagreement to discredit an opponent. Task and interpersonal processes may interact.

4.1.4.2 Task and group

The combination of task information exchange and group normative processes can be expected to result in a common knowledge structure, based on ideas held by the majority. This matches the observation that group discussions tend to disproportionately reflect common information that is known by all group members, at the expense of unique information (Stasser and Titus, 1985). That this tendency is associated with suboptimal decisions (Stasser and Titus, 1985) may simply reflect an inevitable trade-off between the output of the two processes, agreement and task correctness. In this trade-off, agreement may be just as important as task correctness. For example, even a random answer may be correct, but if the group cannot agree it may have no chance of being correct.

Generating a common knowledge structure appears to be an important part of what groups do, as groups spend significant amounts of time *clarifying the group position*, defined as “time devoted to establishing common ground” (Olson et al., 1992, p368). Thus while individual task analysis benefits from considering a larger domain of information and alternative positions, group unity benefits from all members utilising a single domain of information. The group unifying process, by generating agreement, tends to reduce the domain of information, and, in certain cases, task performance suffers.

If the normative process operates before valid individual task analysis occurs, or if the majority simply have an incorrect position anyway, then the normative process may simply “crystallise” incorrect or irrational positions. A study of 220 groups of 4-6 members showed that when at least 70% of subjects were correct before discussion began, the group discussion gave a gain in correctness of 11%, but when less than 50% were correct before discussion began, the group discussion gave a loss in correctness of 7% (Thomdike, 1938).

In using FORUM DGSS over the years many people carefully pointed out to the author that voting was all right as long as people first voted without seeing the votes of others, but that letting people

see the votes of others from the beginning was very dangerous. They warned that if this was done, people could behave like sheep, and just follow the leader without using their own brains. In terms of the integrative model, they were stating that the individual task analysis process should be allowed to operate independently first, before the group normative process.

4.1.4.3 *Group and interpersonal*

Social position can affect the development of personal relationships. For example Sherif (1966) allowed close interpersonal friendships to form on the first few days of a boys camp, and then formed groups so that each boys' best friend was in an opposing group. By the end of the study 90% of the boys nominated in-group members as their best friends. Another study had subjects conceive of themselves as *six unique individuals*, then *two groups* of three people, and finally *one group* of six people (Gaertner et al., 1989). In the two-group condition, as expected, subjects preferred in-group members over out-group members, but then in the one-group condition, liking for previously out-group members went up, while liking for previously in-group members went down. This shows how social attraction can change what is apparently simple interpersonal attraction. Social attraction may be limited to the group situation. Groups playing a prisoner's dilemma game were found to show increased friendliness and solidarity, but this did not generalise beyond the context of the game (Bonacich, 1972).

4.1.4.4 *Interpersonal and group*

The interpersonal process seems to interfere with the normative process. In the polarisation experiment considered earlier (Sia et al., 1996), the personal presence of others seemed to somehow cancel the group normative effect, as the polarisation found in distributed computer-mediated groups was not observed in face-to-face computer-mediated groups. This effect occurred even though the face-to-face subjects only interacted through the computer, and did not discuss face-to-face. This ruled out the task process as an explanation for the difference. Social facilitation, proposed to be the basic psychological process in interpersonal relating, however operates without interaction (simply being watched changes behaviour). A possible explanation is that when face-to-face subjects are, or feel, individually recognised by another person, and are in a situation where a relationship could begin, this evokes the interpersonal process, where one presents oneself as an individual to another. Assuming an identity as an individual in a personal relationship could reasonably be expected to negate or reduce group identification and polarisation.

Message anonymity did not change or reduce this counteracting effect, presumably because subjects were still visually identifiable. However when colocated groups were *anonymous and exchanging positions with arguments, a significant choice shift occurred, nearly of the order of that experienced when the groups were distributed*. Allowing task arguments introduces a third process to the two already proposed in the situation. Interpreting such results is difficult when three processes are potentially interacting. However these results suggest that argumentation, as long as the argumentation is anonymous (or impersonal), can combine with normative influence to overcome the nullifying effect of personal presence, allowing the normative process to operate again. This could occur if the arguments presented tended to always support the group norm, i.e. were rationalisations. Such rationalisations could provide "permission" for the individual to go with the group position, even against their own individual position.

In a 2x2 study Lea and Spears (1991) attempted to experimentally manipulate individuation vs de-individuation and group vs individual salience. In the de-individuated condition subjects were anonymous and physically isolated, not only during the experiment but also in training. When "individuated", subjects were seated face-to-face, but interacted only through the computer. This

corresponds to presence or absence of a relational context, which would evoke or not interpersonal relating.

In the group salient condition, it was implied to subjects that they were expected to operate as group members. In the individual salient condition it was implied that subjects were expected to operate as individuals. This treatment could be expected to evoke the group combination process, and can be regarded as presence or absence of group context. Groups of three interacted using Converse and had to discuss issues and reach agreement.

For polarisation, Lea and Spears' (1991) results were the same as found by McGuire et al. (1987), that polarisation was greatest given a group context but no relational context (i.e. distributed and isolated), and adding relational context (i.e. putting the groups face-to-face) considerably reduced group polarisation. Group salient, distributed subjects operated like normal distributed CMC groups. They not only generated the most polarisation, but also the most group agreement, exchanged the least task relevant comments and exchanged the most "social" comments. It can be concluded that the group salient, isolated condition allowed the group normative process to operate largely unhindered by either personal or informational influence. The number of social comments in this condition was considerably higher than in any other condition, all others showing similar low counts. The authors conclude that group norms can operate in CMC conditions, especially when individuals are isolated.

However if distributed, isolated subjects were instructed to act as individuals, and not group members, polarisation reduced to its lowest value. Removal of group salience in this case leaves no interaction process operating. This is the effect that it was predicted earlier would occur if group interaction was the combination of individuals operating as individuals. Thus this condition demonstrates the result of combination based on individuals operating as sets of individuals, without any form of social influence. This condition generated the most task messages, as would be expected from this interpretation.

When individuals were co-present and expected to operate as a group, then both interpersonal and normative influences were evoked. The study found that in this case subjects generated significantly more disagreement than if they were co-present and expected to operate as individuals. The authors suggest that under individuating conditions subjects try actively to express their individuality against normative influence, and doing produce more disagreement than they would if they were not in a group setting.

In summary, this experiment provides a valuable insight into how the three processes proposed can operate together, one that is fully in accord with the integrative model.

4.1.4.5 All processes

In face-to-face interactions all three group processes naturally operate together, and a balanced activity, like a group discussion, can be seen as operating on three levels at once.

The first, through the exchange of task information, aims to resolve task problems by information analysis. The second, perhaps through cues such as body language and tone of voice as well as what is said, aims to develop and affirm personal relationships, which provide predictability of interaction as well as emotional support. On the third level, each individual is carefully "positioning" themselves so as not to be out of step with the rest of the group, maintaining the identity of the group and consequently their own identity as a part of that group.

If in such a situation the normative process did not operate, the group may have difficulty reaching agreement. If the interpersonal relating process did not operate, group members may feel the meeting was dull, unemotional and unsatisfying. If the task resolution process did not operate, bad task decisions may be made.

4.1.4.6 *Process sequence*

The combination of the three processes raises the issue of sequence effects. There is a natural order to these processes based on the communication event. To deal with a communication act the individual must establish the following three things in the given order:

1. Who am "I"? (and what do I represent),
2. Who is the sender? (and what is my relation to them), and
3. What is the communication about? (and how should I resolve it?).

In other words to respond, the receiver of a communication must not only form a mental model of the meaning of the message, and a mental model of the message sender (based on their previous relationship), but must also have a mental model of who they themselves are. This latter is just as "constructed" as the other two, and is the factor which has generally been omitted in previous theorising, perhaps because it tends to be an axiomatic assumption of the situation, a "given", which provides the perceptual background upon which the other two processes proceed.

Social identity theory however suggests that this background moves, and who "I" am changes with the groups I currently see myself as belonging to. For example, if a man talking to a stranger discovers that the stranger is really his long lost son, he will experience a shift in identity, and the nature of the interaction would suddenly change. He is now in the category of "father" and will tend to behave as he perceives fathers should. He may not have even liked the stranger to this point, but fathers usually care for their children regardless of personal like or dislike, and so the change in his identity would require a redefinition of the personal relationship, probably for the better. Only when the first two processes have "defined the field" as it were, can even the simplest message from the other, such as "I need money", be resolved.

A simpler example occurs when a telephone caller does not identify themselves. To an initial inquiry statement of "How are you feeling today?" the reply is usually something like "Who am I talking to?". For most people, before they begin the exchange of meaning, it is necessary to establish who is calling, because *who* we are talking to changes the meaning of *what* is said.

Changing a salient group, for example changing religion or culture, therefore has major ramifications, because it not only requires all relationships dependent on that identity to be re-evaluated, and all communications within those relationships, it also changes the individual's identity, and the sort of behaviours they expect of themselves. It is not difficult to see why individuals do not like to change their identity.

The order of sequence outlined implies that earlier processes will tend to interact with later ones rather than vice-versa, as shown in Figure 17.

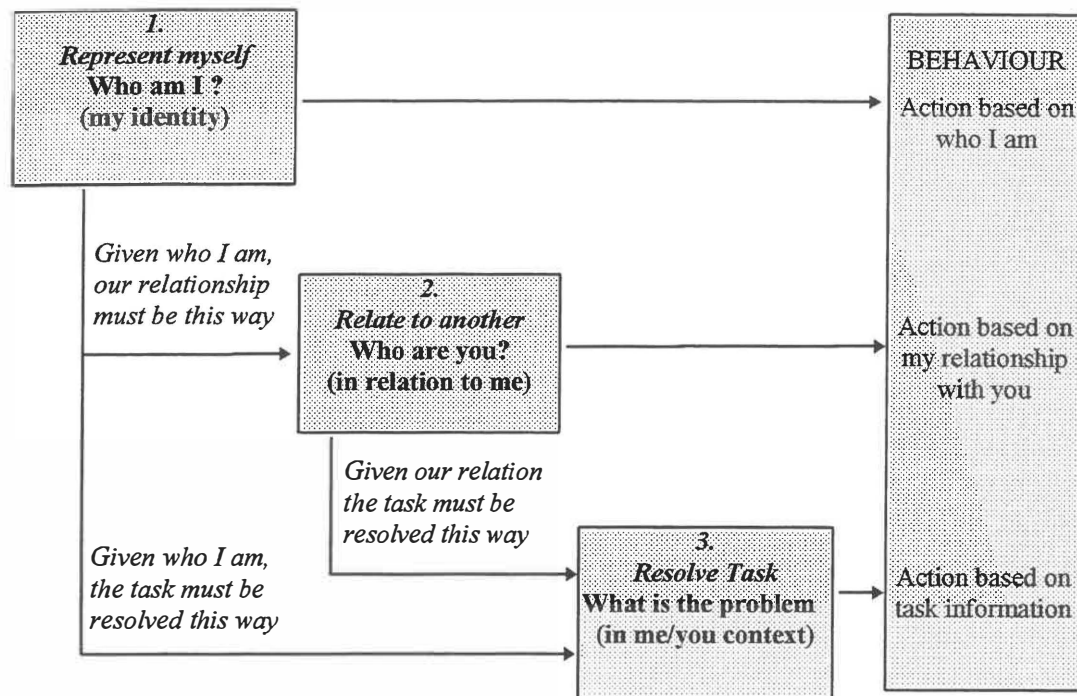


Figure 17. Process sequence and interactions

For example a task response could be pre-defined by the values of one's group, or the nature of the relationship. In this case the task resolution process appears still to proceed, but really involves generating *justifications* for a decision already made, rather than task resolution acting independently. In this case the task *solution* may be a pre-defined axiom of the task analysis process.

Looking from the communication model perspective suggests that there are not any number of further entities awaiting addition to the equation, as the sender, the sent, and the receiver, (and of course the communication setting) are all the essential entities of the situation. This resolves the concern that if three is better than two, would not four or an even larger number of processes explain even more? As has been observed:

The need to construct more robust conceptualizations is not simply a question of adding an infinite number of predictors. Rather, the need is to develop multi-level theory that encompasses a variety of interdependent processes. The challenge is to refine our models of the core processes involved.

(Fulk and Boyd, 1991, p413)

The three processes proposed by the integrative model are proposed to be core processes, both of the situation and of the act of communication.

4.1.5 General implications

Some implications of this model will now be considered, first on a practical level, for the design of computer-mediated group systems, and second on a theoretical level.

4.1.5.1 *Practical implications*

The integrative model implies that CMGS applications will in the long run be more successful if they can support all three group processes in a balanced way, since each process has its purpose and all are needed on different levels. Decision room methods successfully provide this balance by mixing face-to-face and computer-mediated interaction (Nunamaker et al., 1991). This paper however has looked at the options for “pure” CMG, which are group support systems that can operate across existing distributed business networks.

For normative influence to operate, the individual must feel they are a member of a cooperative group that shares a common goal, and must be aware of the group position relative to their position. If, as in the conformity experiments, simply knowing the group position (without direct persuasion, reward or face-to-face exposure to others) is enough to produce group cohesion, then this is a force of social influence that can be mediated by a computer across a distributed, plain text electronic network.

In most current groupware such group position information, if available at all, is buried in menus, is not continuously available, or is not in a comparable form (e.g. a group mean vote of 2.3 compares poorly to an individual’s vote of “Slightly Agree”). GSS voting tends to be isolated from other activities and often reflects only the *formal vote style - a single, blind, mandatory vote*. It has been argued that during discussions members may be continuously “voting” informally, through the valence of their comments. These “votes” are visible to all (in a discussion everyone hears everyone else), not mandatory (one may just keep silent), and can usually be easily changed or repeated. After some discussion, such implied “voting” can soon make a majority group position clear to all. This is why in natural groups, formal votes are rarely needed. The vote function in GSS software should be designed around what occurs in discussions, that is based on *informal voting*, not formal voting.

The “toolbox” approach to the design of GSS (Anson et al., 1992) requires groups to use one tool at a time, in a sequence, as controlled by a central coordinator. Such central control is much less feasible in CMGS, especially if asynchronous, and so such toolbox techniques are less than suitable for CMG. This approach tends to mitigate against the sort of informal voting just proposed, and the simultaneous operation of more than one process is difficult. The alternative approach suggested involves providing a communication environment, where the “rules of the environment” can be defined by the situation leader to suit the situation. In this case individuals can contribute ideas and vote on them in a seamless fashion, allowing simultaneous generation of ideas and group evaluation. The software used in this study provided this.

The availability of group position information in a communication environment should allow what was recommended by Hiltz and Turoff over ten years ago:

. . . CMC’s should also be designed to foster the emergence of cohesive groups that can exert social control over member’s behaviour.

(Hiltz and Turoff, 1985)

In conclusion, a three-process model suggests potential for genuine group activity on limited bandwidth distributed networks. The current limitations of distributed groupware may reflect more the philosophical bias of software designers towards a rational, task-focused process rather than practical limits of what can be done, and future directions in CMGS design may be found as much in psychology as in technology. In a culture that emphasises individual freedoms and rationality, perhaps we have created electronic group tools in that image, tools that ignore the beneficial role of

personal relations and group cohesion. In the future CMGS may be designed as much with psychology in mind as technology.

Recognition of the beneficial role of non-rational group processes is essential to progress in this area. The importance of group unity lies not in its denial of individuality ("conformity") but in that it expands the conviction of its members, increasing their confidence and willingness to participate, because they know they are not alone but a part of something larger than themselves. Until normative influence is accepted as a valid group process, CMG systems will reflect only part of what occurs in real groups.

4.1.5.2 Implications for theory and research

The integrative model removes the focus from the communication setting and returns it to the processes operating within that setting. It suggests that CMGS research will be more fruitful if it occurs within a single communications setting. It seems sensible to isolate a single process for study, rather than investigating process combinations, where there can be interference between processes. The previous discussion suggests how this can be done. For example anonymity can be used to minimise interpersonal relating, and the task resolution process can be minimised by using equivocal tasks (it is difficult to resolve a problem when you are not sure what the problem is) or preventing the exchange of task information.

This model will be of value if it gives a richer interpretation of existing research and leads to new knowledge. It suggests that a group's "output" should be measured as more than just the task output, and what researchers often call "off task" activity may be "on task" for the processes of personal interaction or group identity support. Researchers therefore perhaps need to be more aware of, and able to measure, the output of these other processes. For example the devil's advocate approach has been shown to improve task performance (Valacich and Schwenk, 1995), but what effect does it have on personal relations? What effect does it have on group unity? If it is accepted that group performance is not simply task performance, then these are not idle questions.

The integrative model suggests an re-evaluation of process gain/loss theories (Nunamaker et al., 1991), since gains to one process may be offset by losses to another. What appears to be process loss may be rather the transfer of effort from one process to another, such as from task performance to the generation of group agreement.

The integrative model suggests that some applications of the classic task and socio-emotional division could be revisited with a three way division of task, interpersonal and social. For example group communications could be classified as task communications, personal communications, and group or social communications. For example, group member roles are typically divided into task and socio-emotional roles (Zigurs and Kozar, 1994), but could be divided into task, personal and group roles, matching a much earlier three way division into task roles, individual roles, and "socio-emotional" group building (Benne and Sheats, 1948). In situations like this, the integrative model may clarify important distinctions. For example the suggestion that "we might expect that anonymity would reduce role clarity and strength." (Zigurs and Kozar, 1994) could be expected not to apply to group roles (such as agenda keeper).

The integrative model suggests GSS may be classified in terms their degree of support for different processes, namely:

1. Task process support,

2. Interpersonal process support (one-to-one interactive), or,
3. Group normative process support,

or any combination of the above. Support for individual task activity can occur in isolation, such as decision modelling or expert system tools, or can occur by allowing information exchange between group members. Interpersonal process support can be provided by interactive, signed messaging. Finally support for agreement generation requires effective exchange of position information, possibly in many-to-many form. Different CMGS will provide different emphasis on different aspects of the overall group process, and can be classified according to the particular blend they offer.

Another example of the possible widespread application of this model is the area of leadership and power, where five types of power are usually quoted (Hodgetts, 1990). Any individual who can use any of the three processes proposed effectively, can influence others, giving three types of power: expert power (based on task knowledge), referent or charismatic power (based on interpersonal attraction or admiration), and legitimate power (based on position in the group). The other two types of power, reward power and coercive power, arise from control of individual behavioural consequences rather than influence on people. This also implies three types of leadership: expert or task leadership, personal or charismatic leadership, and group leadership, where the leader focus is on group unity. This contrasts with most current leadership models, which are two-dimensional, for example Blake and Mouton's managerial grid is based on *concern for production* and *concern for people* (Blake et al., 1962). The integrative model suggests that perhaps *concern for group* could add another dimension to the grid.

4.1.6 Conclusions

The integrative model can be summarised by the following propositions:

1. The nature of group activity derives from the nature of individual activity,
2. Group activity operates on three levels, attributable to three separate individual and group processes, and can only be partially explained by a one or two-process approach,
3. Each process has a different nature and arises from a different source, is subject to different conditions, uses different inputs and generates different outputs, and can therefore operate independently, and be isolated experimentally,
4. The processes generally interact to create consistency, because they arise within a single individual,
5. Because the three processes arise independently, and can operate in parallel, they give rise to occasional paradoxical inconsistencies in behaviour,
6. Process inputs and outputs are multi-threaded to accommodate the parallel processes,
7. The three processes represent the three aspects of the communication situation - the sender, the message, and the receiver (the communication setting is considered to be background),
8. The unit of operation for the task process is the individual, for interpersonal relating it is the dyad, and for the group unifying process it is the group,
9. Cooperative groups produce not only task output, but also relational connections, and group unity or agreement,

10. Individuals in cooperative groups may work not only to resolve the given task, but also to relate personally to others in the group, and to develop and represent the group identity, depending on the salience of the task, the other individuals, or the group,
11. The three processes are normally intertwined with respect to behavioural outcomes of group activity, and may interact in complex ways.

The author is well aware of the limitations of the model proposed, which is perhaps less a formed theory, than a framework for research. It however presents enough to form the framework for the research to follow. The integrative model does not in any part present anything new, except perhaps in the collation of existing ideas from a variety of sources. For example key distinctions such as identification vs internalisation, informational vs normative influence, and task vs socio-emotional communication have all been with us for over quarter of a century. However electronic groups have stimulated a fresh look at old problems, by separating out what in face-to-face situations tends to be inextricably intertwined. Social identity theory however, more than anything else, has unravelled the knot confounding personal and social processes, and has allowed this model to be proposed.

What has been described are three distinct but interwoven processes which arise from the nature of the communication situation. An individual in a cooperative group, facing a group task, looks to three fundamental aspects of the situation: the task, the other group members, and the group itself, seeking three types of resources: information resources, emotional resources and identity support (Finholt and Sproull, 1990). During the group interaction, three types of influence operate on the individual: informational influence, personal influence, and group or normative influence. While the first two operate explicitly from outside, and if successful are internalised, the latter operates from within the individual, and is implicit and often unrecognised. The individual in a cooperative group setting is all at once *resolving* task information, *relating* to other group members and *representing* their identity as a group member, and every communicative act can be involved in any or all of these three processes.

In conclusion, while we may accept that message meaning is constructed, and that our perception of another is constructed, it is easy to forget that our own identity is also a construct. Equally, while most models recognise that exchange of message content information can provide the basis for a task resolution process, and some recognise that analysis of the sender context information could form the basis of a relational process, few have recognised that that the receiver also changes from one situation to another, and there is a psychological process by which this occurs. Lack of recognition of even the existence of this last process may be why computer-mediated groups have generally failed to generate agreement, rather than any barrier offered by the communication media or technology. It now remains to demonstrate this experimentally.

4.2 Hypotheses

This section looks first at the research question, and then the proposes hypotheses that will be experimentally tested.

4.2.1 Research question

The research question that arises from the previous theoretical considerations is:

Given a group that members identify with, facing a cooperative group task, is the exchange of group position information alone sufficient to allow the group to enact agreement, generate group cohesion, and elevate member confidence in the group decision, even for problems which have no logically correct answer?

To answer this question, it must be demonstrated firstly that group position information does have the expected effect, and secondly that this effect is unlikely to be due to personal or informational influence.

Personal influence will be unlikely if all group feedback is anonymous, and group members cannot determine who contributed what. Informational influence can be minimised by not allowing any task information exchange. It may not be possible to entirely disassociate normative and informational influence (Deutsch and Gerard, 1965; McGrath, 1984), because positional information could be interpreted to be task information. However all information about the task can be suppressed.

The experimental situation used was designed to maximise normative influence and minimise personal and informational influence, so that any differences found relative to the blind control treatment could be attributed to normative influence. The control treatment was identical in every way, except that it did not allow exchange of valence information, and thus could not support the normative process.

The following hypotheses relate to the effect of the exchange of group member position information on various variables.

4.2.2 Disagreement

H1a *That in an anonymous electronic group, facing a group task, the availability of group position information alone, in plain text form, will result in significantly less disagreement compared to when such group position information is not available.*

This is expected because it has been proposed that:

1. The normative process is a separate process which can operate independently of task analysis and interpersonal relating ,
2. Awareness of group position is in itself sufficient to allow the operation of the normative process, and
3. Normative influence tends to generate unity of position

The null hypothesis in this case is that there is no interaction effect between group members.

H1b *That in an anonymous electronic group, facing a group task, the addition of plain text confidence information will not result in less disagreement, compared to when such vote confidence information is not available.*

This is expected because:

1. Person to person interaction is unlikely to occur under conditions of anonymity and plain text information exchange, as under these conditions, a sense of personal presence is difficult if not impossible to achieve. Therefore this process will have little if any effect on disagreement.
2. Individual confidence reflects the state of the sender, is primarily part of the personal influence process that generates trust, and is usually given in the form of complex emotional cues across a high capacity channel such as hearing the person's voice or seeing their face. It is not a relevant part of the group normative process, which does not generally concern itself with individuals.

3. Vote confidence is not expected to have any effect if the process of which it is a part is not activated.

It is of course not meaningful to share vote confidence without also sharing vote position. This treatment provides a contrast to **H1a** where the exchange of lean position information is expected to have an effect because the necessary and sufficient conditions for the normative influence process are satisfied - here the information is provided in the same way but the necessary conditions for the personal influence process to operate are not present.

A negative hypothesis of this nature cannot of course be proven because a null hypothesis cannot be formulated, but it remains a prediction.

- H1c** *That in an anonymous electronic group interaction, the availability of group position information alone, in plain text form, will exert a continuing but decreasing effect on disagreement across repeated votes.*

This is expected because it has been proposed that group normative influence *tends* to generate unity of position, and operates against the individuals tendency to maintain their original independent position in a consistent fashion. In other words it is an influence on behaviour.

4.2.3 Confidence

- H2a** *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more confidence for a group task, compared to when group position information is not available.*

This is an expected consequence of increased group agreement. Providing information on the judgements of others in their group tends to elevate confidence if there is relatively little variance within the group but reduce it if the variance is great (Sniezek, 1992). Therefore if group agreement is increased, and subjects are aware of this, vote confidence should go up.

- H2b** *That in an anonymous electronic group interaction, the addition of plain text vote confidence information, will not result in more individual confidence, for a group task, compared to when vote confidence information is not available.*

This is expected for the same reasons as **H1b**, namely that where the group interaction environment does not support the personal influence process, confidence information which is relevant primarily to that process will have no effect.

- H2c** *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will exert a continuing but decreasing effect on choice confidence across repeated votes.*

This is expected for the same reason as given in **H1c**.

4.2.4 Score correct

It was difficult to form a hypothesis regarding the number of correct answers given because group agreement and score correct are confounded. Increasing group agreement must automatically improve number correct, as it reduces the number of cases where the group is unable to make a

decision. Where subjects tend to be correct (i.e. the task is relatively easy), group normative influence can be expected to improve the score correct, but where they tend to be incorrect, e.g. where there is a cognitive bias to be incorrect, this influence can be expected to reduce the score correct. Since what has been set up is a situation which primarily supports the normative process, the effect on the score correct will be expected to be dependent on the percentage correct on the first (blind) vote. If that percentage is above chance (25%), then normative influence should improve the score correct.

4.2.5 Subject perceptions

H-PS *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in significantly more perceived process satisfaction, compared to when group position information is not available.*

This is expected because:

1. The normative process is one of three fundamental social influence processes operating in human interaction,
2. Awareness of group position is in itself sufficient to allow the operation of the normative process, and
3. Subjects will expect this process to be available in any group interaction and will recognise its unavailability as a deficiency in the group environment and its availability as an improvement.

H-PA *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will result in significantly more perceived group agreement compared to when group position information is not available.*

Subjects are expected to perceive more group agreement if there actually is more group agreement (**H1a**).

H-GA *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will result in a significantly more perceived group awareness compared to when group position information is not available.*

This is expected because:

1. The normative process is one of three fundamental social influence processes operating in human interaction,
2. Awareness of group position is crucial to the operation of the normative process, and
3. Subjects will be expected to attend carefully to information accepted by them to indicate the group position and thereby feel that they are aware of the group.

H-TC *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will result in a significantly more perceived task correctness compared to when group position information is not available.*

This is expected because perceived task correctness generally correlates with task confidence (Sniezek, 1992), and vote confidence is expected to go up with group agreement.

H-DA *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will result in a significantly more decision acceptance compared to when group position information is not available.*

This is expected because decision acceptance and agreement with the group are seen as very similar concepts.

The corresponding confidence influence expectations will not be formulated, but are expected to all produce no effect.

4.2.6 Question type

H3a *That groups will generate more disagreement on the preferential questions than the intellective ones.*

It was expected that groups would find it more difficult to generate agreement on the preferential questions, which had no right/wrong solution, than the intellective ones, which offered a rational basis for choosing one option over another.

H3b *That groups will have lower confidence on the preferential questions than the intellective ones.*

This is expected because group disagreement should lower confidence.

4.2.7 Time taken

The process of generating agreement was expected to take more time, as generating more output requires more time. If group agreement is considered an output, then those treatments where more agreement is generated should involve more time. There was not expected to be any difference in time taken between the with and without confidence exchanged treatments, as no extra process was involved.

5. RESEARCH METHOD

5.1 Introduction

The theory outlined in the previous chapter suggests that in a computer-mediated group environment, group cohesion based on identification may operate to generate agreement, even where no person-to-person persuasion is possible. This chapter describes a research method to determine, under experimental conditions, whether or not normative influence is a significant factor in generating agreement in a plain text, computer-mediated setting. The experimental situation was designed to minimise task and personal information exchange. Writing the CMGS software interface allowed the experimenter to artificially disassociate normally interwoven group processes, something which is difficult to do in face-to-face groups. This facility makes the CMG environment a rich field of research for small group behaviour.

5.1.1 Exploratory studies

Prior to the main study, two exploratory studies were carried out. The first exploratory study (April, 1993) sought to link group agreement to information exchange. This was essentially following the model that information exchange was the basic operation that groups required. The task was for groups of students to generate feedback on a computing course which they had just completed and then vote on all the statements made. The number of statements for which there was majority agreement was measured under three levels of information exchange. The first involved no interaction, the second allowed members to publicly comment on the statements of others, and the third also allowed person to person mail. It was expected that the increased information exchange would enable increased agreement. However the results showed that although the groups spent a lot more time in the interaction where commenting was allowed, they reached no more agreement, in fact the number of agreed statements seemed to go down as information exchange increased. Many of the comments seemed to be of a personal, interactive nature rather than exchange of task information, often in the form of trivial grandstanding. Although the result was disappointing at the time, in terms of the theory previously outlined it can be seen as predictable. The students had little need to exchange task information about courses they had all recently attended and probably already discussed. The situation did not present groups with a common fate that made group identification salient. The voting was blind so normative influence could not operate. The students appeared to have appropriated the commenting function for the purpose of relating to other members of the group, for example by trying to establish dominance and generating humour.

The second study involved a group of seven lecturing staff completing matched language tests under two conditions, the first in which they could see the votes of others and make public comments (*Interacting*) and the second in which they could not (*Blind*). When Blind, the group reached agreement on 25 out of 30 questions, while under the Interacting condition the group reached agreement on 27 out of 30 questions. This was not a large difference because the subjects found the language questions relatively easy. More interesting was the markedly different attitude of the group towards the two methods. The Interacting method seemed to evoke more interest during the session - there were gasps and oohs and ahs as subjects took a keen interest in how the others had voted. The Interacting group also took a lot longer to finish (26 minutes) and all finished together. By contrast the Blind group took from 7 minutes (first person) to 16 minutes (last person) to finish the task. It seemed that in the Interacting condition the group was operating as a group, whereas in the Blind condition they were simply a collection of individuals. In the discussion after the experiment the subjects clearly indicated they preferred the Interacting method, but that the commenting (which

exchanged task information) really hadn't been much use and the most useful information was how other members of the group had voted. Their preference was borne out by their response to a feedback questionnaire taken after each Blind/Interacting session. The results for each feedback question are shown in Table 10, as the majority decision of the group on a seven point scale (Strongly Disagree, Disagree, Disagree Slightly, In the Middle, Agree Slightly, Agree, and Strongly Agree). The numbers are the order the questions were given.

Construct	Question Number. Question Text	Blind	Interacting
Process satisfaction	12. The session was enjoyable.	AGREE	AGREE
	6. I enjoyed taking part in this session.	AGREE	AGREE
	5. This is a good way for groups to solve problems together	IN MIDDLE	AGREE
	10. This group task would be done better in a face to face meeting	IN MIDDLE	DISAGREE
Perceived agreement	3. I think I would agree with most of the answers of the group	AGREE SLIGHTLY	AGREE
	8. There wouldn't have been much agreement in our group	DISAGREE	DISAGREE
	11. Our group (would have) disagreed on many items	IN MIDDLE	DISAGREE
Group awareness	4. I was aware of the other members of the group through the computer.	DISAGREE	AGREE
	9. I didn't really think about the others in the group during the meeting.	AGREE SLIGHTLY	DISAGREE
	2. We worked together as a group to answer the questions	IN MIDDLE	AGREE SLIGHTLY
Task correctness	1. I think our group did quite well on this exercise	IN MIDDLE	AGREE
	7. Our group did not get very good results	DISAGREE SLIGHTLY	DISAGREE

Table 10. Exploratory study: Questions and group responses

As can be seen the group saw the interacting method as a better procedure. The group also thought they got a higher score correct under the Interacting method. This was true because when interacting, the group got 25/30 correct, and when blind, the group only got 23/30 correct. This difference of two questions was not very large and was attributable to the fact that the group were hung on five questions in the blind condition and only hung on three questions in the interacting condition. The group got only two questions wrong in both conditions. None of these differences was significant because of the small numbers.

The author concluded that perhaps the difference in the subject's perceptions of the two treatments found could be attributable to the relevance of vote position information, rather than the expected information exchange effect due to commenting. It was also apparent that simply recording whether their was a majority or not was losing information, and a more sensitive measure of agreement was required.

5.2 Measuring disagreement

5.2.1 Introduction

Since how much groups agree or disagree among themselves is the key dependent variable of this research, it is crucial to have a sensitive measure of agreement. A simple measure is *commonality*, or the number of people who have the same idea (Lorge, 1958, p364). This measure however ignores the amount of disagreement among the remainder of the group, giving only the agreement for one solution option not the entire group. Another method is to instruct the group to reach *consensus* or unanimity (Winniford, 1991; Cass et al., 1991; Sniezek, 1992), and to count the number or percentage of groups that reach unanimity. This measure however ignores the varying degrees of agreement possible in groups who achieve less than complete unanimity, and valuable information on the degree of group unity is lost. Instructing the group to form a majority is better but encounters the same problem. Recent experiments with electronic groups have used a more sensitive measure of group agreement (Sambamurthy and Chin, 1994; Tan et al., 1991; Watson et al., 1988) derived from the complex mathematics of fuzzy set theory (Spillman et al., 1980), and calculated only by means of a computer program (Watson et al., 1988). However this method only works with interval data, not nominal or ordinal data, such as multi-choice questions. This section outlines a measure devised by the author, and developed in conjunction with Roy Felton of MIT, which seems to be just as sensitive but much simpler to calculate, and for small groups can be done without the aid of a computer and can be applied to interval, ordinal and nominal data. It provides similarly derived measures of disagreement for both individuals and groups.

5.2.2 The measures (D and d)

5.2.2.1 Definition

It was found to be easier to develop a measure of *disagreement* rather than agreement, although the two obviously relate. Disagreement was conceptualised in terms of the *distance apart* of two positions held by two group members. Hence if two members held the same position their distance apart would be zero, and their disagreement would be zero. The situation under consideration is where N ($N > 1$) group members face a problem with K ($K > 0$) mutually exclusive response options A, B, C, Suppose N_i group members choose response option i . Let the disagreement of one individual choosing option i be defined as the number of disagreements they have with the rest of the group ($N - N_i$) divided by the number possible disagreements ($N - 1$):

$$d_i = \frac{N - N_i}{N - 1}$$

This gives a disagreement value for the individual, d_i , in the range 0-1, where 0 is perfect agreement with the rest of the group and 1 is disagreement with everyone else. The disagreement of the group can then be calculated to be the average of the d_i values for each member of the group.

$$D = \frac{\sum_{1 \leq i \leq K} N_i d_i}{\sum_{1 \leq i \leq K} N_i} = \frac{N^2 - \sum_{1 \leq i \leq K} N_i^2}{N^2 - N}$$

Where $N = \sum_{1 \leq i \leq K} N_i$ and the minimum value of D is 0 when all members of the group agree.

This then defines two related measures of group and individual disagreement, where for a given group, the group disagreement is equal to the average of the individual disagreements of the members of that group.

This definition of **D** can be compared to the use of the index of the actual number of mutual friendships in a group divided by the number of possible mutual friendships as “one of the best indicators of a group’s cohesion” (Dimock, 1986, p123)), although in this research what is being considered is solution choice, not friendships formed. **D** is a measure of how much disagreement occurs relative to how much is theoretically possible for the group.

Table 11 gives an example of how individual disagreement could be measured for a group of five members (N=5) given four solution choices (K=4), namely A, B, C and D.

Individual Disagreement (d)	Individual Response (example)	Rest of Group Response (example)
0.0 (0/4)	A	AAAA
0.25 (1/4)	A	AAAB
0.5 (2/4)	A	AACD
0.75 (3/4)	A	ABBC
1.0 (4/4)	A	BCCD
1.0 (4/4)	A	BBBB

Table 11. Individual disagreement (d) for N=5 and K=4

The table shows that if the group response was AAAAB, an individual who had responded A would have one disagreement out of a possible four, giving a d score of ¼ (0.25). This measure seems to be logically consistent in concept, although some writers feel that disagreement is a concept which does not apply on the individual level:

The process of judging or choosing in a group involves phenomena, such as disagreement, that do not exist for individuals.

(Sniezek, 1992, p125)

Table 12 shows the possible group disagreement (**D**) measures for the same situation. The **D** values are obtained by averaging all the d values. Thus **D** is the sum of all the possible pairwise disagreements in the group, divided by N(N-1), which in the example given is 5x4 or 20. As can be seen the maximum **D** value of 1.0 (everyone disagrees) is not possible in this case, because there are five group members but only four choices. The line indicates where the group moves from majority agreement to being unable to make a majority decision.

Group Disagreement (D)	Group Response	Example
0.0 (0/20)	Unanimous	AAAAA
0.4 (8/20)	All but one	AAAAB
0.6 (12/20)	3-2 split	AAABB
0.7 (14/20) <small>agreement</small>	3-2 majority	AAABC
0.8 (16/20) <small>disagreement</small>	Hung group	AABBC
0.9 (18/20)	Maximum disagreement	AABCD

Table 12. Group disagreement (D) for N=5 and K=4

The above presents the case for nominal data, which is often the case for questionnaires. A generalised measure of **D** can be calculated, for the case when the response choices are ordinal, interval or ratio scale data rather than nominal data (e.g. choices 1,2,3,4. . . rather than A,B,C,D. . .), allowing this measure to be used for Likert scales. In this case the disagreement between 1 and 4 is greater than the disagreement between 1 and 2 (by comparison the disagreement between A and D and between A and B are the same). Appendix A shows that for such data, the generalised disagreement measure is equal to twice the variance of the response scores. This provides some basis for confidence in **D**, since variance seems a reasonable and reliable measure of disagreement.

5.2.2.2 Maximum value of D

The maximum disagreement of 1.0 is only possible if the number of people in the group is less than or equal to the number of choices ($N \leq K$), making it possible for everyone to disagree. If the number of choices available is less than the number of group members ($N > K$) it is not possible for everyone to disagree. In this case the maximum group disagreement **D** is less than 1.

The maximum value for **D** is attained when the group is spread as evenly as possible over all **K** options. Suppose **r** is the integer division of **N** by **K**, and **a** is the remainder when **N** is divided by **K**, in other words $N = rK + a$, then **D** will be maximised when the N_i values are as close to **r** as possible.

Thus let $N_i = r$ for $i = 1, 2, \dots, K - a$ and $N_i = r + 1$ for $i = K - a + 1, \dots, K$.

Then the maximum value of **D** will be:

$$D_{\max} = \frac{N^2 - (K - a)r^2 - a(r + 1)^2}{N^2 - N}$$

If $N \leq K$ then it can be shown that $D_{\max} = 1$. However if $N > K$ then the maximum value of **D** is less than 1. This reflects the fact that if there are less choice options than people in the group some people must agree (select the same choice option). Table 13 shows how the maximum value of **D** reduces from 1.0, as the group size increases, for selected vales of **K**. In general as **N** gets very large, D_{\max} tends towards $1 - 1/k$. For example in the case where there are two solution choices ($K = 2$), as **N** becomes very large, D_{\max} tends to 0.5. This suggests that large groups facing limited choice

problems may experience only half the disagreement than that experienced by small groups facing the same problems. However this is a property of the measure, not the measuring, and may or may not be valid empirically.

Maximum D Group Size (N)	Number of Choices (K)			
	K = 2	K = 3	K = 5	K = 10
2	1.000	1.000	1.000	1.000
3	0.667	1.000	1.000	1.000
5	0.600	0.800	1.000	1.000
10	0.556	0.733	0.889	1.000
100	0.505	0.673	0.808	0.909
1000	0.501	0.667	0.801	0.901
1000000	0.500	0.667	0.800	0.900

Table 13. Maximum D by increasing N for various K

5.2.3 Discussion

5.2.3.1 Advantages of the measures

D and d have several advantages as measures of group disagreement:

1. **Simple.** They are simple enough to be calculated manually for small groups;
2. **Sensitive.** As can be seen from Table 12, D recognises that a group response of AAABC (D = 0.7) shows more disagreement than a group response of AAABB (D = 0.6);
3. **Valid.** D and d are derived from a definition of the disagreement between individuals which is meaningful in terms of what is normally understood to be disagreement;
4. **Scaled.** For nominal data both D and d have a fixed scale, from 0 (unanimity) to 1 (everyone disagrees) regardless of group size, although the maximum value of D will be less if there are more people than choices (N > K); and
5. **Related.** There are many advantages in group research in having related measures of individual and group disagreement.

5.2.3.2 Properties of D

It is an interesting question whether or not the properties of the measure D relate in any way to what is known about group disagreement, or whether the measure itself has any implications in this area. For example the reduction of D_{max} shown in Table 13 suggests that for a problem with a relatively low number of solution choices, increasing group size can considerably decrease the maximum disagreement possible in the group. Thus a possible benefit of larger decision groups is a reduction in the maximum group disunity that can occur, counterbalancing task orientated views that the optimal group size for face-to-face interactions is low (Shaw, 1981).

Table 11 shows that when a group of five moves from consensus to one person disagreeing, the dissenting individual's disagreement changes from $d = 0.0$ to a maximum of $d = 1.0$. This seems to reflect the nature of the situation. To break unanimity an individual must disagree with all the other members of the group - it is not possible for them to disagree with only one or two of the others. This can be expected to be difficult for an individual to do as it involves a change from no disagreement to maximum disagreement. Thus there is a certain stability in consensus. Table 12 shows that for the consensus group as a whole, when one person disagrees, the group D registers a change of almost half the scale ($D = 0.4$), suggesting that for a group of this size the disagreement of one person is a major event. This effect however reduces as group size increases. For a group of ten, one person disagreeing gives a D value of 0.2 , and for a group of 100 the D value is only 0.02 . Thus the larger the group, the less important one person disagreeing is, which seems reasonable.

D is a function not only of the group size N but also the number of solution choices, K . The number of solution choices, K , can be taken to be a measure of the complexity of the problem. More complex problems provide more choices. For a given size group, the more choices confronting it the more disagreement can occur, up to the point where there are as many choices as there are members in the group. This suggests that for a given problem complexity there is a group size at which the maximum possible group diversity starts to become less than 1. At above this group size the problem would be increasingly handled with less threat to group unity. Larger groups should therefore tend to be chosen to deal with more complex problems. Equivocal problems (Daft et al., 1987) are problems which are ambiguous - it is not even clear what the problem is. Could such problems be taken to be the special case where the number of solution options, K , is infinitely large? Such problems could generate maximum disagreement in any size group.

5.2.3.3 Ecological diversity

An equivalent formula to that derived here can be found in mathematical ecology, where a given habitat can have N creatures and K species. If all N creatures are of the same species ($K = 1$) then the ecological diversity is low, whereas if every animal is a different species ($K = N$) then the ecological diversity is high. Simpson's measure of ecological diversity [Pielou, 1969 #1275, p223] applies to the case of N animals of which N_j belong the j 'th species ($j = 1, 2, \dots, K$). The probability of choosing one animal without replacement from species j is (N_j / N) , and the probability of choosing a second from the same species is $(N_j - 1) / (N - 1)$. Summing the probability of choosing two animals of the same species over all species and subtracting from 1 gives Simpson's measure:

$$D = 1 - \sum_{1 \leq i \leq K} \frac{N_i(N_i - 1)}{N(N - 1)} \text{ which may be rearranged to give } D = \frac{N^2 - \sum N_i^2}{N^2 - N}$$

which is the same as the group disagreement measure defined earlier for the nominal case. It is interesting that two situations so different as group disagreement and ecological habitat diversity can give rise to the same formula, derived in different ways. The measure is the same, although the situations seem different. For example subjects asked to choose again may show a test-retest correlation less than one, while animals by contrast do not change their species on re-sampling. There may be a higher concept that incorporates both group disagreement and ecological diversity in the same theoretical framework, where the species of an animal equates to the choice of an individual.

5.2.3.4 Probability distribution

Assuming all solution options are equally likely to be chosen by all group members gives a probability distribution as shown in Table 14. As can be seen the distribution of **D** is positively skewed, suggesting that there are more ways a group can disagree than there are ways they can agree. The mean value of **D** given the random distribution shown is 0.75, which is half way between the smallest majority (a 3-2 majority) and a hung group, as represented by the line in Table 14. This line represents the point at which the group loses the ability to form a majority decision and moves into disorder.

Group Disagreement (D)	Group Response Form	Example	P()
0.0 (0/20)	Unanimous	AAAAA	4/1024
0.4 (8/20)	All but one	AAAAB	60/1024
0.6 (12/20)	3-2 split	AAABB	120/1024
0.7 (14/20) mean=0.75	3-2 majority	AAABC	240/1024
0.8 (16/20)	Hung group	AABBC	360/1024
0.9 (18/20)	Maximum disagreement	AABCD	240/1024

Table 14. Probability distribution for D (N=5 and K=4)

The distribution shown represents the case where all solution options are equally likely, and can be used to define a null hypothesis. It also represents a situation where subjects have no reason to select one option over another, as for example when the problem is very difficult. For an easy problem such as $2 + 2 = ?$ one solution option (the correct one) will have a very high probability and the others very low ones. This definition does not recognise the distinction between intellectual problems (which have a right/wrong answer) and preference problems (whose answer depends on user preference), as defined in McGrath's task circumplex (McGrath, 1984). An even distribution of the probability of selecting solution options could occur either because subjects found an intellectual problem very difficult, or because they had no particular bias on a preference problem. The key factor in both cases is that all response options have equal probability, rather than whether it is an intellectual or preference task.. A very difficult intellectual problem could become in effect a preference problem for a particular subject. Likewise a very uneven distribution of the probability of selecting any option could occur either because subjects found an intellectual problem very easy, or because they all had the same strong bias on a preference problem. Again the response probabilities of the subjects define these as very similar rather than different situations.

In this experiment the **D** value was averaged over 12 questions for 126 vote series. To confirm that in such a situation, the expected distribution would be normal, random samples of size 12 were taken from the distribution shown in Table 12 and the average **D** value calculated. This was repeated 100 times and the resulting theoretical distribution is shown in Figure 18. This is essentially normal, as would be expected by the central limit theorem, although slightly positively skewed.

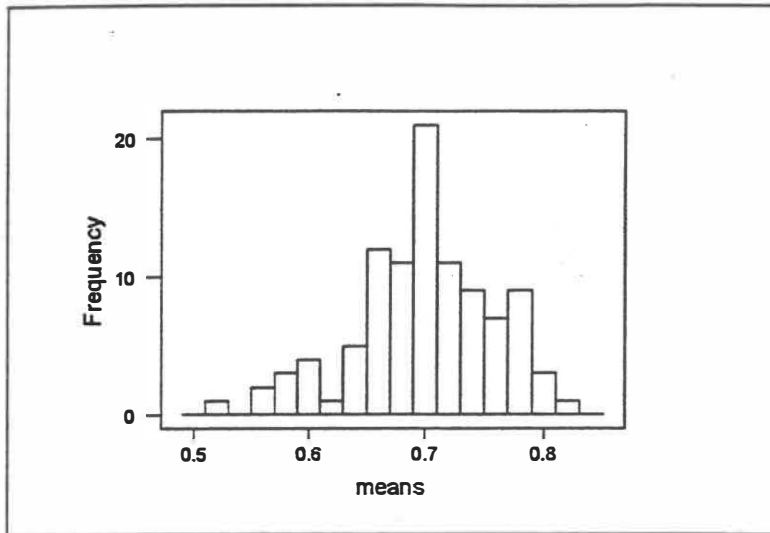


Figure 18. Distribution of average D for 100 samples of size 12

5.2.3.5 Group disagreement and score correct

Unfortunately group disagreement as a measure is confounded with the score correct for intellectual questions. For example if the group cannot agree on the answer to any question, then their score correct must be zero. The relationship between group disagreement and score correct can be predicted. If the group on average solves the task correctly more often than not, i.e. if the task is relatively easy and the majority of the group get it correct, then increasing agreement will generate a higher score correct. If however the questions are difficult and only few people in the group know the correct answers, then increasing agreement can be expected to produce a lower score correct.

5.2.4 Summary

Measures of group and individual disagreement, D and d , have been proposed which are easy to calculate, meaningfully derived and appear to have the sort of properties desired. D can be extended to numerical response data in which case it is a simple transformation of the response variance. D and d provide sensitive measures of disagreement in groups facing problems with a given number of solution alternatives. They are also meaningfully related, as the group disagreement D is the average of the individual disagreements, d , of all the group's members. The concepts used in these measures could also provide operational definitions for terms such as problem complexity, problem difficulty and possibly even problem equivocality.

5.3 Experimental design

The experimental design used was based on a randomised block factorial design with repeated measures, as shown in Table 15. This type of design has been under emphasised in the statistical literature (Howell, 1992, p433), and the best coverage was found in Winer (1971), from which the following discussion is taken. In this design each group is subjected to all treatments, i.e. it is a

group-by-treatments design, so it was not necessary to randomly allocate subjects to groups, because every subject was under every treatment.

5.3.1 Repeated measures design

The design used is shown in Table 15.

Group	Treatment				Total	Mean
	1	2	... j ...	k		
1	X_{11}	X_{12}	X_{1j}	X_{1k}	P_1	\bar{P}_1
2	X_{21}		.	.	P_2	\bar{P}_2
.	.		.	.		
.	.		.	.		
i	X_{i1}		X_{ij}	.	P_i	\bar{P}_i
.	.		.	.		
.	.		.	.		
n	X_{n1}	.	.	X_{nk}	P_n	\bar{P}_n
Total	T_1	T_2	T_j	T_k	G	
Mean	\bar{T}_1	\bar{T}_2	\bar{T}_j	\bar{T}_k		\bar{G}

Table 15. Repeated measures design

where:

X_{ij} is the dependent measure. This can be disagreement, vote confidence, or score correct.

P_i is the sum of k observations for group i .

$$\bar{P}_i = \sum P_i / k$$

T_j is the sum of n observations for treatment j . The treatments were information exchanged, vote number or question type.

$$\bar{T}_j = \sum T_j / n$$

G is the grand total of all X values.

The four values calculated for computation were:

(1) G^2 / kn

$$(2) \sum \sum X_{ij}^2$$

$$(3) \left(\sum T_j^2 \right) / n$$

$$(4) \left(\sum P_i^2 \right) / k$$

The sums of squares calculated in this design are:

Source of variation	SS	df
1. Between Groups	$SS_{b.groups} = (4) - (1)$	n-1
2. Within Groups	$SS_{w.groups} = (2) - (4)$	n(k-1)
3. Treatments	$SS_{treat} = (3) - (1)$	k-1
4. Residual	$SS_{res} = (2) - (3) - (4) + (1)$	(n-1)(k-1)
5. Total	$SS_{total} = (2) - (1)$	kn-1

The F-ratio calculated was

$$F = MS_{treat} / MS_{res}$$

where the mean square value is obtained by dividing the corresponding sums of squares by its respective degrees of freedom. This F value provides a test of the hypothesis that the dependent variable does not vary with the treatment. In most cases there were 17 groups, and the F value required for an overall effect was:

$$F_{(0.99)(2,32)} = 5.32$$

The F values reported were obtained from SPSS for Windows. The ANOVA calculations were also done using a spreadsheet, which gave the same main results as generated by SPSS, but also allowed a variance/covariance matrix to be calculated. Theoretically the difference between the mean of the variances and the mean of the covariances must be equal to MS_{res} (Winer 1971, p237). This comparison was done in every case and provided a check that there were no errors in the analysis.

In many of the cases below the main difference expected was between treatment I and treatment II, and the experiment was exploring whether there may be a difference between treatments II and III. The F value required for such pairwise comparisons was:

$$F_{(0.99)(1,32)} = 7.49$$

This analysis does not have any correction for the fact that multiple tests are being carried out on the same data, so the required significance level was taken to be $p = 0.01$

5.3.2 Design assumptions

The assumption of this analysis is that the variance/covariance matrix show a pattern of constant variances on the diagonal, and constant covariances off the diagonal, or what is known as compound symmetry. Winer (1971) shows that the more general necessary and sufficient condition that the F statistic has an F distribution is when the covariance matrix is *circular* in form. This occurs when a variable which is a normalised orthogonal transformation of the observations is spherical in form (Winer 1971, p246). This can be tested using the Mauchly test, which results in a chi-square value which, if significant, means that the circularity assumption may not hold. Because routine use of the Mauchly test is not recommended, it was evaluated (using SPSS) only for the main effects.

5.3.3 Multi-factor design

It was possible to analyse the data as a three factor repeated measures design. In this case rather than analysing by group, each case was an individual, so N=90 people rather than 18 groups. This design can be expected to be more sensitive. Since subjects completing the blind treatments only had one vote, not all cells of the design were used, as shown in Table 16. Also since the first vote was always blind, information exchange treatment comparisons could only be done on votes 2 and 3, and in fact were primarily done on vote 3, the final vote.

Treatment	Vote 1	Vote 2	Vote 3
Treatment I (blind)	a. Intellectualive	Not Used	Not Used
	b. Preference	Not Used	Not Used
Treatment II (group aware)	a. Intellectualive	a. Intellectualive	a. Intellectualive
	b. Preference	b. Preference	b. Preference
Treatment III (confidence aware)	a. Intellectualive	a. Intellectualive	a. Intellectualive
	b. Preference	b. Preference	b. Preference

Table 16. Multi-factor repeated measures design

5.4 Subject demographics and motivation

Subjects were obtained by organising a competition at the Manukau Institute of Technology, with a prize (movie tickets) for the top scoring group. A small course credit was also given as an additional individual incentive to participate. The group included a balance of first and second year students, from both business and computer courses, and was approximately evenly divided between males and females (56% male and 44% female). Not all the subjects were young, but most were between 18 and 20 years of age, as is typical for first and second year students. Few had any previous business or professional employment experience.

Students in each class were invited to form themselves into groups of five and enter the quiz competition. This was designed to ensure that group members knew each other and joined their groups voluntarily. It was hoped that the sense of choice, and familiarity with other group members would encourage a sense of identification with the group. Students were asked to think up names for their group, and generally took this very seriously, coming up with such names as the

“Lamborgreenies” or the “Smelly Cats”. This was also designed to foster a sense of group identity. Judging by the interest shown in the competition, and comments made by subjects, these measures did appear to help create a sense of group identity in subjects. However from an experimental design point of view, allowing the groups to select themselves meant that the experimenter did not control group composition.

Subjects had no prior experience of groupware at the institute, as there was none available, and were unlikely to have had any experience with it elsewhere for the same reason.

5.5 Task

The task was to answer simple multi-choice questions. Since what is being tested for is proposed to be one of three primary influence processes operating in a group situation, a simple group task was chosen in order to better isolate this process from the other two. Any realistic group task inevitably involves all three processes in a complex interaction, in which the operation of one process is difficult to separate out.

The group had to complete a test of 12 questions, each multi-choice, with four alternative answers. There were three tests, one for each treatment level. For each test question the group's answer was taken to be the answer of the majority. Each question was to be marked as either right (1 mark) or wrong (no marks) and each group was aiming to get the highest number correct overall. If group members could not agree on an answer then that question gained no marks. The questions used are detailed in Appendix E.

Voting was the only subject response. This allowed the many-to-many communication of position information that is proposed as the basis of group agreement generation.

For the first two of the three votes allowed (the “straw votes”), as well as the answer options A-D, subjects also could choose the option *Don't Know*. This meant that for these tests there were five possible response options, while for the final vote there were only four response options.

After they had answered each question subjects were asked how confident they felt about that answer.

5.6 Experimental process

The overall sequence of the experiment from the participant's point of view was:

1. Consent and commitment,
2. Allocation to computers,
3. Preliminary questionnaire,
4. Introduction to session,
5. Practice session,
6. Carry out test 1 or 2 or 3,
7. Subject perceptions of the session (return to 6 for next test if any) =,
8. Overall comments, and

9. Publication of results

5.6.1 Consent and commitment

Students were shown the consent form in class and asked to participate (see Appendix B for consent form details). It was made clear that all five members must participate as a group, or not at all, and if for example only four people turned up on the day, the entire group would be unable to participate. This put group pressure on the individuals to attend the experiment on time, as if they did not show they would be letting down the rest of their group. This was possibly part of the reason for a very low rate of failure to attend - only one person did not show up and had to be substituted. Even that person did show up, in the end, only very late.

5.6.2 Allocation to computers

Before entering the experimental session subjects were not told of the process that would be followed.

When participants entered the room each computer had a colour coded sticker with the name of their group. They were told the colour of their group and that they could sit at any computer with their group's name on it (e.g. "J Team may choose any computer with a yellow sticker on it"). Subjects had no difficulty finding the correct computers. Allowing this choice of seating encouraged a sense of anonymity with regard to the experimenter, i.e. that subjects were not being individually identified. Computers allocated to the same group members were strategically placed around the room so that subjects could not see the screens or the faces of other members of their group.

5.6.3 Preliminary questionnaire

Subjects were first given a short questionnaire to measure their group's general cohesiveness before the task was given, in terms of *belonging* and *morale* (Bollen and Hoyle, 1990; Chin et al., 1996). The questions were:

1. I feel that I am a member of this group (B)
2. I feel that I belong to this group (B)
3. I see myself as part of this group (B)
4. This group is a very good group (M)
5. I am happy to be part of this group (M)
6. I am content to be part of this group (M)

where B = *belonging* and M = *morale*. The response was a five point Likert scale from *Strongly Agree* to *Strongly Disagree* (see Appendix C for details). It was hoped that groups might differ in their original cohesion, and if so, it was thought that groups with higher cohesion might enact agreement more effectively. However it was also recognised that these groups had formed to carry out a specific task, and outside of that task may have little sense of group.

5.6.4 Introduction

Subjects were told their task and the purpose of the experiment, which was to compare three methods of making decisions over a computer network. They were told to treat the experiment like a test, and so they must not communicate with each other, and that any group that did so could be disqualified from the competition. Subjects were monitored throughout by one or two

experimenters, so that any group which attempted face-to-face interaction could be noted and their data excluded. This did not occur, and subjects were very cooperative with this aspect of the experiment. The details of the introduction script are given in Appendix D.

5.6.5 Practice session

5.6.5.1 Practice questions

Subjects first answered three factual practice questions under the full awareness condition (treatment III) while able to talk to each other. At this point they could ask questions about the process. The aim of this section was partly to train users in the system mechanics, partly to confirm group identity, and partly to establish that the group information provided through the computer communication setting was operating as it should. Subjects voted on the first question and then noted if a decision was made. One or two groups were asked to publicly disclose who had voted which way and all groups were asked to vote again. It was pointed out to all groups, by example, that a group could not go on to the next vote series on a particular question until *everyone* had first completed the current vote series. In this way the salience of group activity was established.

5.6.5.2 The “To Do” function

They were also shown how to use the “To Do” search function built into the software - when they pressed the *ENTER* key one of three things could happen:

1. **Next item.** The cursor would jump to the next item where a vote was required, and the Vote prompt would flash,
2. **Test completed.** A message would say *TEST COMPLETED* and suggest that they exit the test, or
3. **To do, please wait.** A message would say *No Votes To Do - Not Completed* when they just had to wait for other group members to catch up with them.

In the latter case the subjects themselves still had votes to do, but were waiting for other members of the group to complete their votes. Fast group members could only go so far ahead, before they had to wait for the rest of the group to catch up with them.

The “To Do” feature of the software was originally included as a “nice to have” extra. It turned out to be crucial to the practical success of the experiment, because it provided a check which largely prevented subjects moving ahead to the next test without completing all three vote sets of the current set. If they did move ahead without finishing, it caused a major problem for the rest of the group, which was left waiting for their vote, a vote that would never come. Subjects were therefore clearly instructed not to move on to the next test until they had received the *TEST COMPLETED* message. Even so, some subjects did not listen to the instructions at all in this regard. Fortunately the software allowed the experimenter to monitor this and in three cases subjects were asked to return and complete a test when they moved on prematurely. It would have been better if the software had warned subjects on leaving the test if there was more to do. The missing data, which occurred in group 2, was because one subject did not complete the third vote of a series. The rest of the group in this case were still able to move on, because it was the final vote that was left out.

5.6.5.3 Question start number

Group members were asked to each begin at a different question number as allocated (see Appendix D). This was intended to avoid the possibility that one person had first vote on every question,

because they were quickest, and thereby have more influence (this possibility could only occur on votes 2 and 3).

5.6.6 Complete test(s)

5.6.6.1 Screen layouts

The main menu of the FORUM DGSS software, as adapted for this experiment, is shown in Figure 18.

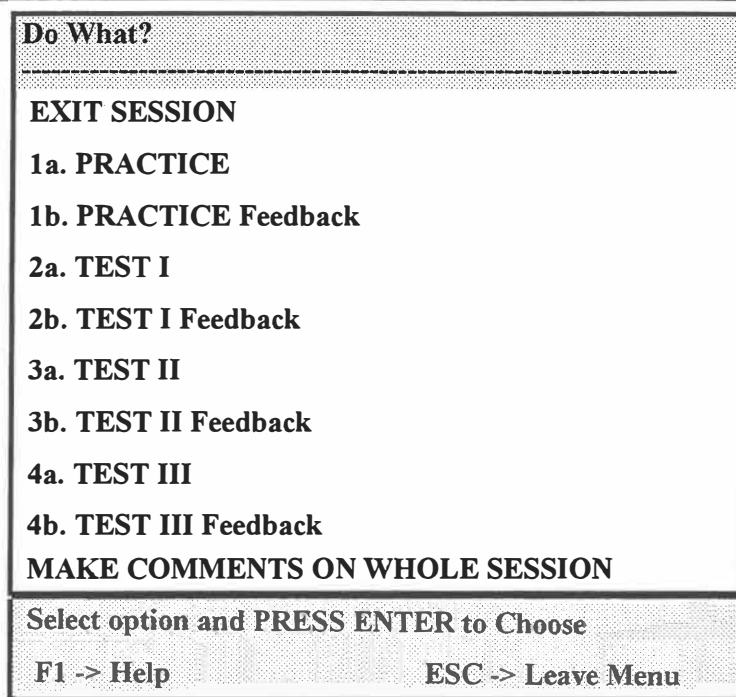


Figure 19. FORUM DGSS software main menu

Subjects were walked through options 1a and 1b in the Practice Session, after which they moved through the tests at their own pace, with only the occasional request for help. The main menu provided a sort of road map which they followed and experimenter interaction with subjects during the session was minimal.

When subject selected the test menu options (2a, 3a and 4a) they faced a screen like that shown in Figure 20. The screen was divided into two areas. First, in the centre, the **Main List Area** showed a list of the questions in the test with one question, the *current question*, highlighted. Above the main list area, at the top, was the **Detail Area**, which showed the details of the current question, and whatever information was available about how the rest of the group had voted on that question.

A **vote prompter** appeared in the Detail Area, at the right, indicating which vote the person was up to for the current item. If the user had not voted on the current item, this prompt, would appear in flashing, eye catching, bright white on black, and say:

*Press V
to Vote*

This was necessary to catch the users attention and prompt them to vote. If the user had completed all necessary votes for this question, the prompter displayed *VOTE COMPLETED*.

The **vote line** showed the votes of the other members of the group (depending on treatment) and the group decision (if any). Users could also look down the right hand side of the main list to compare their vote with the group's vote on each question.

The very top of the screen recorded the group number, member letter and treatment level. This was necessary for checking purposes, when setting up the computers.

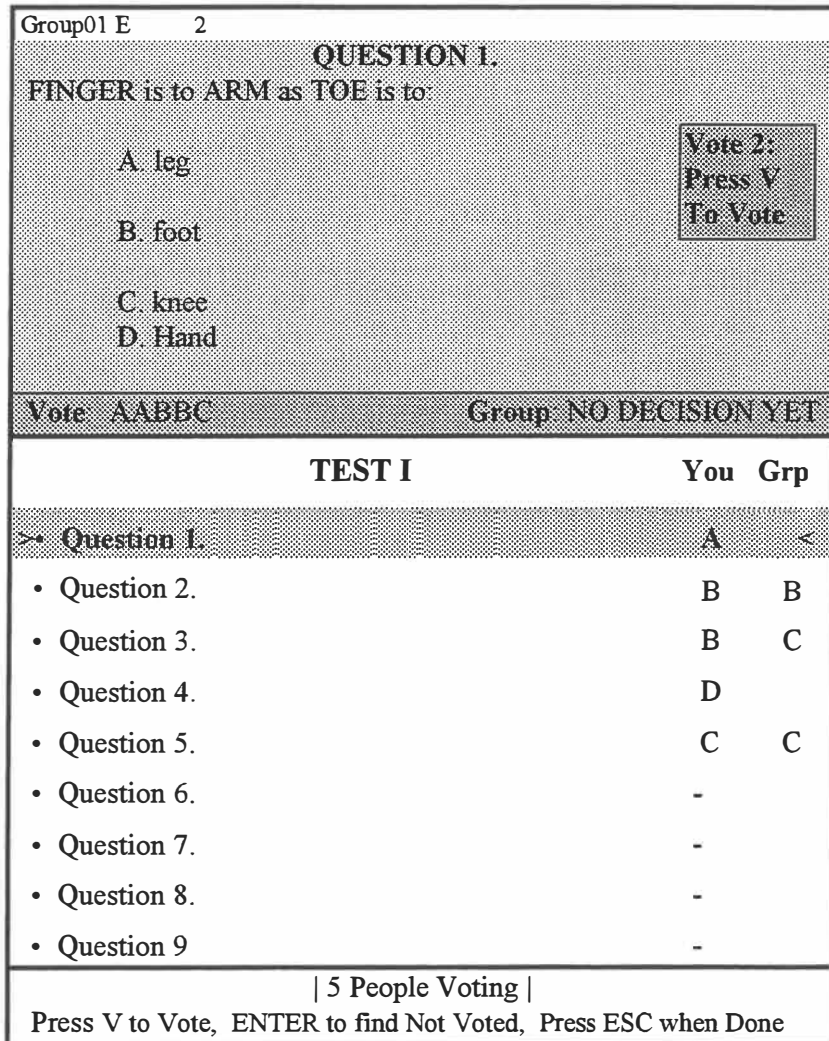


Figure 20. FORUM DGSS software main screen

5.6.6.2 Discussion simulation

The software was designed to simulate the process of reaching consensus in a discussion, by allowing people to first register an opinion, and after looking at the opinions of others, give another opinion, and finally come to a decision. It was felt that after three votes most change, if any was to occur, would have occurred. People were not forced to give a solution choice in either of the two

preliminary steps (they could choose *Don't Know*), but in the final vote they had to choose one of the four solution options.

5.6.6.3 *Process synchrony*

The computer process design differed from the traditional face-to-face discussion in that it was not synchronous. For example the group did not all work on question 1 together, and then move to question 2, and so on. It is difficult to describe the asynchronous voting process used in terms of normal face to face voting procedure. Initially, some subjects tried to follow a synchronous process, trying to wait after they had voted on their first question, until all the other group members had voted on the same question, in order to deal with this question before moving on to the next one. However, they quickly learned that this approach did not suit the asynchronous computer environment, and soon began to use the "To Do" service mentioned earlier, using the computer to hop from question to question, wherever their vote was required. They could do this because the computer knew what they had and hadn't done, stored all the necessary information about each question, and revealed it again any time they came back to it. The need for synchrony to keep track of things was gone, because the computer kept track of things.

At any one time, all the members of the group could be working on different questions, but as each looked at their current question, they could see both their last vote (if any), and the responses of others - so it was as if the others were there at the moment. The responses of the other members of the group were mediated by the computer, and therefore time was not an issue.

One of the reasons why asynchronous activity was necessary for these computer-mediated groups was that the software was not run on a dedicated LAN (as in a Decision Room), but on the same general network used by students for classes, and response time depended on what other classes were running. The experimenter had no control over what other laboratory classes were running. Real-time synchronisation in this case was difficult, if not impossible, to achieve. From one moment to the next, it took variable amounts of time for information put in at one point to appear at another, depending on such things as network load and position of the node. Typically this was found to be 1-3 minutes but could occasionally be much higher.

The possibility of presenting questions one at a time to the group was considered, and the software could have been designed this way, but this would have involved a noticeable delay on each item. Allowing asynchronous operation made such delays almost irrelevant, and favoured much more the strengths of a computer network.

Although groups were not synchronised at an item level, they were synchronised at a test level, which meant that the group could not move on to the next test, until the slowest person had finished. The fast workers had to wait for others to catch up. This was however an artificial restriction of the experiment, and if this type of technology were applied in a business setting, quick people would be able to go on with something else (or go and have a cup of coffee) while waiting for others.

5.6.6.4 *Question type*

Although the first six questions had right/wrong answers the last six did not. No-one at any stage queried this but all seemed to accept that they were valid questions and there were valid answers to them.

5.6.7 Subject perceptions

After completing each of the three tests, subjects were asked to answer ten questions on how they felt about that method of interacting as a group. The software looked almost exactly as in Figure 20 except the questions were now the questions given in Table 10. Each person gave their own opinions and was blind to the responses of the others. At the time these questions were answered subjects did not know whether their test answers were correct or not.

5.6.8 Overall comments

On selecting the last item in the main menu the system asked them:

How in general did you feel about these sessions?

and subjects were able to add free text comments on the whole experience.

5.6.9 Publication of results

The scores of all the groups were calculated and published. The winning group was given movie tickets. All other groups were given consolation prizes of a packet of sweets.

5.7 Independent variables

The independent variables for this experiment were:

1. **Information Exchanged,**
 - I. **Blind.** Subjects could not see other group member's votes,
 - II. **Group aware.** Subjects saw other group member's votes, and
 - III. **Confidence aware.** Subjects saw other group member's votes and vote confidence.
2. **Vote Number,**
 1. **First vote.** Was always blind,
 2. **Second vote.** Only after all group members had first voted, or
 3. **Third vote.** Only after all group members had second voted.
3. **Question Type.**
 - a. **Intellective questions.** Had a right/wrong answer, or
 - b. **Preference questions.** Did not have a right/wrong answer.

5.7.1 Information exchanged

Information exchanged was the main repeated measures treatment which, as shown in Table 17, allowed increasing exchange of information between group members. Treatment I (Blind) essentially allowed no information to be exchanged, and acted as a control.

Treatment	Information Exchanged
I. Blind	None
II. Group aware	Valence e.g. A A A B B
III. Confidence aware	Valence and Confidence e.g. A½ A½ A½ B!! B!!

Table 17. Information exchanged treatment

For all treatment levels, no commenting was allowed. Vote feedback from other group members was given in order of choice option, not of person voting, so voting was anonymous. Subjects were not aware of which individual voted which way.

5.7.1.1 Treatment I. Blind

In this treatment, subjects had only one vote and made that choice *blind*, that is unaware of how other group members had voted. This treatment equated to the traditional, formal, blind voting format, but applied in an electronic environment. Individuals were essentially working alone, in nominal groups. This treatment operated as a control. For example, if subjects were secretly exchanging information without going through the computer, they would also do so in this treatment.

5.7.1.2 Treatment II. Group aware

Subjects in this and the next treatment had three votes per question. The subject's first vote was still blind, but after they had voted once, the group position became visible. The first two votes were *straw votes*. **Only the third or final vote represented the group's answer.** In the first two votes subjects could vote *Don't Know* if they had no opinion, but in the final vote they could not vote *Don't Know*, and were expected to take a position. A group answer required a simple majority, and subjects were told it would be taken solely from the final vote.

Subjects could not vote a second time on a question until everyone in their group had voted the first time. This was to ensure that when they did second vote, all group members could see the votes of all the others. Likewise subjects could not third vote on a question until all members of their group had second voted.

The group position for a given question was shown on the vote display line in the form:

AAAB?	Group Position: Option A
-------	--------------------------

For example, the above results display indicates that three group members chose answer option A, one group member chose answer B, and the single ? indicates that one person voted *Don't Know*.

Group Position. The vote display line had three display options:

1. **No Decision Yet.** The group had not yet formed a majority - the computer displayed a blank field,
2. **A Majority.** The computer stated the majority position, e.g. *Group Position: Option A*, and,
3. **Hung.** The group had not yet formed a majority and further voting this round will not alter that - the computer reported "*Group Vote Hung*".

5.7.1.3 Treatment III. Confidence aware

In this condition, as well as seeing the above group summary, subjects also saw how confident each member of the group was about their choice. A variety of methods were considered for conveying confidence, limited somewhat by the non-graphical DOS environment. For example colour was tried, also duplicating or bolding the option, but after trials it was found that combining a single

confidence character with the option letter was the clearest to understand. The confidence characters used are shown in Table 18.

Degree of confidence	Label
Very Confident	!!
Confident	!
Fairly Confident	<i>blank</i>
Not Very Confident	$\frac{1}{2}$
Not Confident at All	$\frac{1}{4}$

Table 18. Vote confidence labels

For example:

A $\frac{1}{4}$ A $\frac{1}{4}$ A $\frac{1}{4}$ B!! B!!	Group Position: Option A
---	--------------------------

shows that while a majority of three went for option A, they were not very confident, and the minority feel very strongly that the correct answer was B. In the confidence aware treatment the vote display not only shows who voted which way, but also how strongly they felt about their vote. This method of giving confidence information, using fractions and exclamation marks, was found on trials to be meaningful, easy to understand, and easy to remember. After the first explanation, it only took a few moments before subjects were able to routinely recognise the meaning attached to these symbols.

5.7.2 Vote number

Subjects had three votes which also provided a repeated measures treatment. The first vote was always blind, regardless of information exchanged level, and provided a baseline value within each of the main treatment levels. No difference was expected between information exchanged treatments for Vote 1, because all were blind. The GSS software automatically detected whether a person had voted for the first time or not, and if they hadn't, it suppressed the display of information about how others had voted.

5.7.3 Question type

For each test of 12 questions, the first six questions were intellectual (right/wrong), while the second six questions were preferential, and although appearing factual, had no objectively correct answer (McGrath, 1984). Examples of the two types of questions are:

1. Intellective question	2. Preference question
<p>FINGER is to ARM as TOE is to:</p> <p>A. leg</p> <p>B. foot</p> <p>C. knee</p> <p>D. hand</p>	<p>What is the best length of stay when parents visit their grown children's families once a year?</p> <p>A. 20 days</p> <p>B. 10 days</p> <p>C. 5 days</p> <p>D. 1 day</p>

The intellective questions were taken from the TOSCA and B40 IQ tests, used in New Zealand. Each of the three experiment tests had matched questions of similar type and difficulty. The six preference questions were chosen following the style of the Estimates and Information sub-tests of the Motivational Analysis Test (MAT), and were also matched across the three experiment tests to be as similar as possible. These questions were originally designed to vary with personality, and had no objectively correct answer. Although they had no correct answer these questions were not equivocal, because the questions themselves were not ambiguous or in doubt. However since the questions were not presented as preferential, but rather in the context of an intellective test, it could be argued that they were taken by subjects as being simply difficult intellective questions. Either way, subjects were expected to vary widely in their preferred answer, so groups would need to enact agreement to come to a common position.

A full copy of the three tests used is given in Appendix E.

5.7.4 Control variables

There were six possible treatment orders, and six possible ways the three different tests (A, B and C) could be allocated to the treatments. This gave a total of 36 possible types of session which would require 180 subjects. Only 90 subjects however were able to be accessed. Because an order effect was expected, all treatments were randomly allocated equally to order positions 1, 2 and 3. All three tests (A, B and C) were also randomly allocated equally to order positions 1, 2 and 3. Since it was not possible to also allocate tests equally to all treatments, the selected allocation combination (from among those available) was done by random throw of a dice. The test allocations are shown in Table 19.

TEST	Treatment I	Treatment II	Treatment III
A	3	5	10
B	9	4	5
C	6	9	3

Table 19. Allocation of test to treatment

As can be seen, the allocation was not equal, which could have created a problem during analysis. Fortunately the effect found was so strong that it could not be attributed to this minor difference.

5.8 Dependent variables

5.8.1 Overview

The following dependent measures were taken:

1. **Group disagreement (D).** How unified the group was,
2. **Individual disagreement (d).** How much the individual disagreed with the rest of the group,
3. **Vote confidence.** How confident the individual was of their vote choice,
4. **Group and individual score correct.** How many of the intellectual questions the group and the individual got correct,
5. **Subject perceptions.** How subjects perceived the group interaction (or lack of it),
6. **Time taken.** How long the group took to complete the test.

The disagreement measures are discussed in another section (see 5.2, p145).

5.8.2 Vote confidence

After they had answered each question subjects were asked how confident they felt about that answer as shown in Figure 21.

How confident do you feel that this answer is correct?

- 5. Very Confident**
- 4. Confident**
- 3. Fairly Confident**
- 2. Not Very Confident**
- 1. Not Confident at All**

Figure 21. Confidence question screen

If subjects voted *Don't Know* to the question solution, it was felt that this response implied they were not very confident of any response option, and so the confidence question did not subsequently appear.

5.8.3 Score correct

The group's final answers to the first six intellectual questions of each test were marked correct or not. For a group vote, as well as correct and incorrect, the outcome could also be a hung vote, if the group could not reach agreement. The group score correct was the total number of correct answers, which could take a value from 0 to 6 for each test.

The same calculation was done for individuals. A group member could give the correct answer individually, but be over-ruled by the group majority who voted for another option. Therefore the group score correct and the individual score correct are two different measures.

5.8.4 Subject perceptions

After completing each test under a particular treatment, subjects answered 10 questions on how they felt about that treatment session. The questions were intended to measure the following constructs:

1. **Process satisfaction (PS).** The individual feeling that the group decision process used was a good process, without negative emotional connotations,
2. **Perceived agreement (PA).** The individual feeling that they agreed with the group, and did not disagree with the group,
3. **Group awareness (GA).** The individual feeling that they were aware of the group, and thought about the group during the session,
4. **Task correctness (TC).** The individual feeling that the answers produced by their group were correct, and
5. **Decision acceptance (DA).** The individual being willing to support, and be associated with, the group decision in public.

Constructs 1-4 were used in the exploratory test. The group awareness questions (GA) were included as a control to ensure participants were at least aware of the main treatment effect. If there was no effect on these questions, then the validity of the treatment would be called into question.

The *Decision Acceptance* construct was suggested by Murray Turoff, in case subjects saw a difference between agreeing with the group and supporting the group in public. Each construct was defined relative to the individual perspective.

The questions designed based on these constructs are shown in Table 20. Because the questions were going to be asked within the same software that ran the tests, all the questions had to be phrased so that they could be used with the same response scale. Each of the constructs had a positive question and a negative question, to counter any bias caused by the way the question was phrased. Where there was more than one way to look at a construct both alternatives were used, one positively phrased and one negatively phrased. This also had the advantage that it wasn't too obvious that it was the same question in reverse. The questions were given in a mixed order (the order was: 5a, 1a, 2a, 3a, 4a, 5b, 1b, 2b, 3b, and 4b).

Perception construct	Question
1. Process satisfaction	1a. This is a good way to make decisions.
	1b. I didn't enjoy using the computer system this way.
2. Perceived agreement	2a. I think I agreed with most of what the group decided
	2b. I think I generally disagreed with what the group decided
3. Group awareness	3a. I was aware of the other group members through the computer.
	3b. I didn't really think much about others during this test.
4. Task correctness	4a. I think our group gave good answers
	4b. Our group probably got quite a few questions wrong
5. Decision acceptance	5a. I 'd be happy to sign my name to the answers our group produced.
	5b. I wouldn't like the answers of our group to be made public

Table 20. Subject perceptions: Constructs and questions

Subjects answered the questions using the seven point scale shown in Table 21.

Value	Meaning
7	Strongly Agree
6	Agree
5	Agree slightly
4	In the middle
3	Disagree slightly
2	Disagree
1	Strongly disagree

Table 21. Subject perceptions: Response scale

5.8.5 Time taken

The time taken by a group to complete a test depended on the time taken by the slowest member of the group. The fast members had to wait for the slow members to complete vote 2 before they could start vote 3 and finish the given test. Therefore there was little point in getting an individual measure of time taken. If the software and method had been developed differently, it might have been possible to get a measure of individual time, by asking people to indicate when they were “done”, and thus stop their individual time taken clock, but this was not considered at the time of the experiment.

5.9 The software interface

This research has involved both building and using a CMG system, as well as developing the relevant theoretical constructs (see Cook et al., 1987 for a similar approach, and also Ackof et al., 1962). To simulate the natural group normative process, it was necessary for the author to write an electronic groupware system with a vote function that:

1. Allowed more than one vote in a decision sequence, and
2. Reported the group position in an effective way, but
3. Did not show the group position until the person had made their first vote, and
4. Controlled the sequence of voting.

The software had to allow a distributed group to work at their own pace, i.e. it had to work without any facilitator or event sequence control. Thus in the middle of the experiment, no-one knew who was working on what (except the computer), as people might be all at different stages on different questions. Group members had to be able to work independently and asynchronously.

In addition the experimental design required a control treatment situation, where there was no exchange of vote information, but otherwise everything was the same. The key to this research question then was a software interface that provided the right functionality, distributed control, and the ability to vary that functionality to give treatment levels.

5.9.1 The software - FORUM DGSS

The GSS software used was called FORUM DGSS, and provided not only a suitable vote function for this experiment, but also offered brainstorming, commenting, and person to person mail. It has been used informally at MIT for a variety of tasks such as setting meeting agendas, a student electronic magazine, and class student feedback, carried out as background work to this project. It involves over 10,000 lines of code written in Clipper, has been through many editions, and has been used by well over a thousand people during three years of use. The system has been adapted to be relatively easy to use at the lowest level, although it was written for a non-graphical DOS environment. Appendix G provides a copy of the table of contents of the FORUM DGSS user manual.

FORUM DGSS was designed to be an **electronic environment**, within which the user chooses what they wish to do. It differs from "tool kit" type systems (e.g. Group Systems) in that *any available tool (such as voting, commenting, mail and brainstorming) is available at any time during the session*. For example consider a group that is brainstorming, and then voting on the ideas brainstormed. Normally these are two separate phases. In FORUM DGSS, a participant, who is in the middle of voting on the group's ideas, may suddenly think of another idea, stop voting, add their new idea to the list, and then continue voting. The group would be automatically informed that a new item had been added for voting. In an environment style of GSS, activities are initiated at the individual level, not through a central facilitator who starts and stops, say, the voting tool.

The functionality of the FORUM DGSS environment is defined by over 150 parameters, controlling such things as the availability of mail, who can add headings, and whether votes are visible to the group. These parameters can be set by the experimenter, and were used to define the information exchange treatment of this experiment. FORUM DGSS is effectively a GSS environment generator (as recommended by DeSanctis and Gallupe, 1987), and as such it is ideal for comparing different GSS environments. Because the same software is used for all treatments, no other factors are changed between treatments (as would be the case if different GSS systems were required to create the different treatment settings).

The computer software was also programmed to record all subject activity (although it did not *identify* subjects). Every action and every key press was recorded in a log file for use in analysis. Yet unlike face-to-face groups being observed by video cameras, there was no subjective sense by participants of being observed. This overcame some major difficulties faced by group researchers in the face-to-face groups:

1. The effort required to record the group interaction process as it develops and changes over time (Hackman and Morris, 1983),
2. The sense of being observed changes subject behaviour (Reid et al., 1996), and,
3. The categorisation of subject actions (Bales, 1950).

Thus while empirical studies of group changes over time are currently relatively rare (Sniezek, 1992, p139), there is no reason why this should continue to be so, with suitable computer software support.

These three features of the software, distributed user initiated activity, a variable GSS environment, and automatic recording of subject actions, are the features of this software that made this experiment possible.

6. ANALYSIS

6.1 Data conversion

This section outlines how the data was prepared for analysis. The reader may wish to skip to the results at section 6.2, p173.

6.1.1 Overview

There were three independent sets of data sources generated by this experiment:

1. **Main Results Data.** A direct record of participants votes, vote confidence and number correct in response to the test questions. The results data was transformed into two forms:
 - a. **Group data.** Data pertaining to the whole group, e.g. group disagreement (**D**), group confidence, and group score correct, and
 - b. **Individual data.** Data pertaining to individuals, e.g. individual disagreement (**d**), individual confidence, and individual score correct. This also included the *individual subject's perceptions* of the treatment process taken after each of the three sessions.
2. **Event Log data.** A log of the actions of all participants recorded along the time line, and
3. **Qualitative data (Mail).** General text comments made by participants sending a mail message after the experiment.

6.1.2 Main results data

The *raw data* was the direct output from the FORUM DGSS system. It consisted of 54 dbase III files, in 18 separate directories. Because of the complex nature of the initial data conversion a program was written to convert the 54 dbase files to a single file, involving combining and converting the votes. Similar conversions for confidence and score correct were done at the same time. The conversion was verified by manually calculating the conversion for two groups.

The conversion details for creating the *main results file* are given in Appendix B, including a conversion plan and the data values. Each record (or case) in the main results file represented one group carrying out a group vote on one question. There were 1,512 records in this file, as there were 12 questions, answered by 18 groups, repeated for 7 vote sets (treatment I had only one vote set, while treatments II and III had three vote sets each). As each such record involved five people in 2 decisions (one for the vote and one for the confidence), the complete experiment involved over 15,000 individual vote decisions (not counting responses to the questions on how the subjects perceived the sessions).

6.1.2.1 Missing data

There were only 12 missing values in this data set - one person did not complete the third vote series for one set of 12 questions, in group 2, treatment II. This missing data meant that the main values for that group treatment were also missing. Therefore group 2 results were omitted from all the ANOVA calculations.

6.1.3 Group data

This contained data about the group as a whole. To calculate the ANOVA tables, the results file was combined to create a file where each record was one group (18 cases). A program had to be written to carry out this conversion. The conversion was verified by manually calculating the conversion for two cases.

6.1.3.1 Group disagreement.

Subject votes A, B, C, D were converted to the values 1 to 4. The group disagreement was then calculated to give a value from 0.0 to 1.0 for each vote in the results file (see Table 10, 144). For the group file, the average group disagreement over the twelve questions in the test was calculated, to represent the group disagreement for that treatment.

6.1.3.2 Group score correct.

Again a computer program was written to mark the first six questions against the correct answer. The “group answer” also had to be calculated by the program, based on the majority decision rule. This could also return a group answer of “hung”, or no group answer, which was marked incorrect. The score correct for each group was averaged over the six questions, to give a value 0 to 6.

6.1.4 Individual data

To calculate the ANOVA for individual measures, the main results file was processed to give a file where each record was one individual (90 cases). A program had to be written to carry out this conversion. The conversion was verified by manually calculating the conversion for two cases.

6.1.4.1 Individual disagreement

For each of the 12 test questions, the disagreement of an individual with the rest of the group could take a value of 0.0 (agree with everyone else) to 0.9 (disagree with everyone else) (see Table 11, p146). In a few cases where individuals chose the *Don't Know* option, a d value of 1 was possible. An individual's disagreement score for a given treatment was the average of their disagreements over 12 test questions. For the straw votes (votes 1 and 2 in treatments II and III), subjects could vote *Don't Know*. If they did then this vote was taken to be a separate position, or option, for the purposes of calculating the **D** or **d** value.

6.1.4.2 Individual vote confidence

After each vote the subject was asked how confident they felt about the vote they had just given, on a scale from 1 (Not Confident at All) to 5 (Very Confident) (see p166 for the full scale). The average individual confidence over the twelve questions in the test was calculated to represent the individual's confidence for that treatment.

When a subject voted *Don't Know*, the software did not ask how confident they felt, as this was thought to be inappropriate. Subjects were asked to choose the *Don't Know* option only if they did not feel confident enough to select one of the vote options, so where subjects voted *Don't Know* their confidence was scored as 1 (“Not Confident at All”) in the group confidence score. Of the 4320 first and second votes cast, only 89 (or 2.1%) were *Don't Know*, so in most cases this category was not used.

6.1.4.3 Individual score correct.

This was calculated as for the group score correct, except the individual's answer was marked, not the group's. The score correct for each individual was averaged over the six questions to give a value from 0 to 6.

6.1.5 Event log data

The original log data file provided by FORUM DGSS provided a record of all events occurring along the time line. Each time a user carried out an action, a record was placed in the log file, which recorded the action, and the time that action occurred. Fortunately, because all the computers in one room were booted from the same server, all of the computer clocks were initially set to the same time. Therefore the session log represented a time line of events for a particular group.

Each of the 18 group sessions generated a separate log file. These were combined to give a single file with 18,463 records. The following log records were then removed:

1. Actions carried out by the experimenter in setting up the system,
2. Replies to questions about subjects perceptions,
3. Searches students had done text for items, and
4. Mail feedback given at the end of the session.

The resulting file had 9,416 recorded events, and was used to calculate the time taken.

This file was then further culled to include only the vote records, which added up to 7,548 records. This was what exactly as expected, as there were:

18 groups
x 7 sessions (see Table 16)
x12 questions
x 5 people
<hr style="width: 20%; margin: 0 auto;"/>
7560 vote events
- 12 (less one final vote set omitted)
<hr style="width: 20%; margin: 0 auto;"/>
7,548
<hr style="width: 20%; margin: 0 auto;"/>

showing that the software had worked correctly.

6.1.5.1 Time taken

Each time a user entered and left one of the three treatments/tests the computer recorded the event and the current time. Each of these entries and exits generated a record in the event log file, but combining all this information to obtain total times was not a simple matter. The calculation of the time spent in each treatment/test was complicated by the fact that people did not always do as they were requested, and would sometimes jump ahead when they had not finished, or accidentally press the ESC key and exit the session, after which they would have to re-enter. One person did this several times and left the FORUM software entirely, returned to the DOS prompt, and had to be restarted. Therefore a program had to be written to calculate the times spent for each individual as

the sum of the times of all their meeting events. These results were verified manually in two cases. The individual times were then averaged across all group members. There was little point calculating individual times because individuals were held up from finishing by other members of the group.

6.2 Disagreement

6.2.1 By information exchanged

The group disagreement (**D**) values shown in Table 22 were calculated from the main results data file, using the final votes for each treatment.

Group disagreement (D)	I Blind	II Group aware	III Confidence aware
Mean	0.59	0.16	0.16
SD	0.232	0.235	0.241
N	216	204	216

Table 22. Group disagreement by information exchanged

The mean disagreement for the blind sessions was 0.59, which equates approximately to a 3-2 split. However, for the groups which were able to see and adjust to the position of other group members, the disagreement averaged 0.16, which was close to unanimous. The mean **d** values showed that while individuals in the blind sessions, on average, disagreed with two or more people, those in the group and confidence aware sessions averaged disagreement with less than one person.

Table 23 shows how the % frequency distribution of **D** changes dramatically with treatment for the final votes.

D =	Majority agreement				Hung		
	0.0	0.4	0.6	0.7	0.8	0.9	N
I Blind %	8.8	18.1	25.9	20.8	22.2	4.2	216
II Group aware %	66.7	22.1	7.8	3.4	0.0	0.0	204
III Confidence aware %	65.3	23.1	6.9	3.7	0.9	0.0	216

Table 23. Distribution of group disagreement by information exchanged

As can be seen, blind treatment groups were unanimous in only 8.8% of 216 group votes. By contrast, under the group aware condition approximately two thirds of votes were unanimous. A **D** value of 0.8 or higher indicates that the group was “hung”, and no decision could be reached, while a value of 0.7 or less indicates that a majority was achieved for one of the decision options. For blind interactions, a group majority decision was made in 73.6% of cases, while under the group aware treatment, agreement was reached in 100% of cases.

Looking at the box plots showed there was no overlap at all between the mean D values (over 12 questions) for the blind treatment (I), and those of the group and confidence aware treatments (II and III).

The ANOVA in Table 24 shows a highly significant overall effect was obtained for D, based on the group data file.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability
Group disagreement (D)					
Treatments (I,II,III)	2	2.107	1.053	160.946	0.000***
Treatments (I vs II)	1	2.106	2.106	242.653	0.000***
Treatments (II vs III)	1	0.000	0.000	0.003	0.958 ns
Individual disagreement (d)					
Treatments (I,II,III)	2	10.42	5.21	477.93	0.000***
Treatments (I vs II)	1	10.41	10.41	711.93	0.000***
Treatments (II vs III)	1	0.000	0.000	0.36	0.552 ns

Table 24. ANOVA for disagreement by information exchanged

Nearly all of this overall variation was caused by differences between the blind treatment and the other two treatments. There was no significant difference between treatments II and III. The significance of the Mauchly sphericity test was 0.247, giving no reason to suspect that the F test assumptions were not satisfied. The effects found for individual disagreement (d) are the same as for group disagreement, except that the significant F values are much higher, suggesting that this measure is more sensitive, but there is still no significant difference between the group and confidence aware treatments (II and III).

The null hypothesis that there is no difference in disagreement between the blind and group aware treatments can be rejected, giving support for hypotheses **H1a** and **H1b**, as predicted.

6.2.2 By vote number

Treatments II and III both involved a process of three votes - two straw votes and one final vote. Analysis by vote number addressed the question of *when* the movement to the group position was occurring. Were group members influenced immediately by knowing the group position, or did they hold on to their initial position right up until the final vote and then change?

As shown in Table 25 group disagreement dropped steadily with each vote number.

Group disagreement (D)	Vote 1	Vote 2	Vote 3
Mean	0.58	0.26	0.16
SD	0.252	0.270	0.238
N	648	432	420

Table 25. Group disagreement by vote number

Though most of the change occurred between votes 1 and 2, there was still a noticeable drop from vote 2 to vote 3. The individual disagreement again showed the same results. Both treatments II and III individually also showed an almost identical vote change pattern.

As expected, the ANOVA analysis showed that D varied significantly by vote number (Table 26).

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Group disagreement (D)					
Vote number (I,II,III)	2	1.573	0.787	411.13	0.000***
Vote number (I vs II)	1	1.503	1.503	569.15	0.000***
Vote number (II vs III)	1	0.083	0.083	69.58	0.000***
Individual disagreement (d)					
Vote number (I,II,III)	2	32.5	16.12	1060.86	0.000***
Vote number (I vs II)	1	30.79	30.79	1459.34	0.000***
Vote number (II vs III)	1	1.46	1.46	157.06	0.000***

Table 26. ANOVA for disagreement by vote number

Although the most significant change occurred between votes 1 and 2, there was still a significant reduction in disagreement between votes 2 and 3. Mauchly sphericity test significance of 0.274 indicated no deviations from the expected assumptions. The results for d were the same except the F values were higher. The null hypothesis that there is no difference between the vote stages can be rejected, giving support for hypotheses H1c, as predicted.

6.2.3 By question type

Table 27 shows the mean disagreement for groups facing intellectual questions compared to preference questions, taken from the original results data.

Group disagreement	Question type	
	Intellective	Preference
Mean	0.36	0.39
SD	0.31	0.32
N	750	750

Table 27. Group disagreement by question type

The preference questions were expected to be seen as harder by groups, and as can be seen, the preference questions gave slightly more group disagreement.

An analysis of variance carried out on the individual data file, (Table 28) shows that the difference, although not large, was a significant effect. Subjects had significantly more disagreement on the preference questions than the intellective questions, as expected.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Intellective vs Preference	1	2.850	2.850	17.32	0.000***

Table 28. ANOVA for individual disagreement by question type

6.3 Vote confidence

There was no need to calculate group vote confidence as well as the individual vote confidence, because the group confidence is the average of members' individual confidences. The confidence values used are taken from the individual data file, using the final vote values.

6.3.1 By information exchanged

Table 29 shows the individual vote confidence by information exchanged.

Vote confidence	Blind	Group aware	Confidence aware
Mean	3.44	4.00	4.03
SD	0.78	0.83	0.78
N	90	89	90

Table 29. Vote confidence by information exchanged

The main change in confidence was from blind to group aware, group members moving on average from half way between *Fairly Confident* and *Confident*, to being *Confident*. Being aware of the confidence of other member's position confidence during the interaction did not seem to make any difference to the confidence of participants.

ANOVA analysis (Table 30) shows that the group aware treatment brought about a significant increase in vote confidence, but being aware of the confidence of other voters produce no additional benefit. The Mauchly sphericity test significance indicated no deviations from the expected assumptions.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Treatments (I,II,III)	2	19.89	9.94	41.09	0.000***
Treatments (I vs II)	1	19.69	19.69	61.51	0.000***
Treatments (II vs III)	1	0.20	0.20	1.22	0.273 ns

Table 30. ANOVA for vote confidence by information exchanged

The null hypothesis that there is no difference in choice confidence between the blind and group aware treatments can be rejected, giving support for hypotheses H2a and H2b, as predicted.

6.3.2 By vote number

Table 31 shows the changes in vote confidence by vote number.

Vote confidence	Vote 1	Vote 2	Vote 3
Mean	3.35	3.92	4.03
SD	0.75	0.75	0.72
N	90	90	89

Table 31. Vote confidence by vote number

The main increase in vote confidence occurred after subjects had been able to view the votes of other group members for the first time, and when they were making their second vote. Confidence on the third vote changed very little from that obtained on the second vote.

Table 32 shows the ANOVA analysis of vote confidence by vote number.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Vote number (1,2,3)	2	90.47	45.23	87.95	0.000***
Vote number (1 vs 2)	1	89.25	89.25	115.64	0.000***
Vote number (2 vs 3)	1	1.21	1.21	4.72	0.033 ns

Table 32. ANOVA for vote confidence by vote number

As expected, mean individual confidence varied significantly by vote number, but while confidence significantly increased between votes 1 and 2, vote confidence did not significantly increase from vote 2 to vote 3. This result does not support H2c, which predicted a continuing effect.

6.3.3 By question type

Table 33 shows the mean vote confidence for groups facing intellectual questions compared to preference questions, taken from the original results data.

Vote confidence	Question type	
	Intellective	Preference
Mean	3.78	3.64
SD	0.76	0.72
N	750	750

Table 33. Vote confidence by question type

The preference questions were expected to be seen as harder by groups, and the preference questions did give slightly less vote confidence.

Table 34 shows the ANOVA for vote confidence by question type, carried out on the individual data file.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Intellective vs Preference	1	2.853	2.853	15.26	0.000***

Table 34. ANOVA for vote confidence by question type

An analysis of variance shows that the difference, although not large, was a significant effect. Subjects had significantly less vote confidence on the preference questions than the intellectual questions, as expected.

6.3.4 Persistence of confidence

Table 35 shows the correlations between vote confidence by vote number.

	Group aware		Confident aware	
	Vote 1 C	Vote 2 C	Vote 1 C	Vote 2 C
Vote 2 confidence	0.808 *** (p=0.000) N = 90	N/A	0.760 *** (p=0.000) N = 90	N/A
Vote 3 confidence	0.621 *** (p=0.000) N = 89	0.859** (p=0.000) N = 89	0.553 *** (p=0.000) N = 90	0.867** (p=0.000) N = 90

Table 35. Vote confidence by vote number correlations

The table shows that individual vote confidence was highly consistent from one vote to the next, for both the group aware and confident aware treatments. Confidence on the first (blind) vote was a measure of how confident the individual was in their own judgement. The correlations indicate that confidence on each vote is a good predictor of confidence on the next vote, suggesting that people tend to be consistent in their confidence. This predictability seems to increase with vote sequence, so that vote 2 was a better predictor of vote 3 (predicting 74% and 75% of the variance), than vote 1 was of vote 2 (65% and 58% of the variance).

6.3.5 Effect of disagreement on vote confidence

There was expected to be an inverse relationship between how much the individual disagreed with the group and how confident they felt about their position (Sniezek, 1992). Table 36 shows the correlations between vote confidence and *d*, as the voting progressed for the group aware treatment.

	Vote 1 disagreement	Vote 2 disagreement	Vote 3 disagreement
Vote confidence, vote 1	-0.071 ns	N/A	N/A
Vote confidence, vote 2	-0.154 ns	-0.190 ns	N/A
Vote confidence, vote 3	-0.230 ns	-0.283** (p=0.007)	-0.218 ns

Table 36. Correlations between vote confidence and disagreement (group aware treatment)

All of the correlations are negative, as expected, but only one was significant. If the amount of disagreement with the group affects the confidence of the individual, the size of the correlations would be expected to increase from vote 1 to vote 3, as they do. Initially there was no correlation between vote disagreement and confidence, as would be expected, since voting was blind and subjects at this stage were unaware whether the group agreed or disagreed with them. At the second vote subjects were aware of how much they disagreed with the rest of the group and the correlations increase. At the third vote the confidence of the individual was even more highly correlated with *d*,

and not only with the current *d* but also the previous *d* values. The results show a weak (but significant) correlation between the disagreement at vote 2 and the vote confidence at vote 3. The same analysis for treatment III is shown in Table 37 where again the size of the correlations increases from vote 1 to vote 3. This time the first (blind) correlation was higher and most of the subsequent correlations between vote confidence and individual disagreement are significant. Such correlations of course do not prove any causal relations.

	Vote 1 disagreement	Vote 2 disagreement	Vote 3 disagreement
Vote confidence, vote 1	-0.269 (p=0.01)	N/A	N/A
Vote confidence, vote 2	-0.362*** (p=0.000)	-0.250* (p=0.018)	N/A
Vote confidence, vote 3	-0.350** (p=0.001)	-0.367*** (p=0.000)	-0.3916*** (p=0.000)

Table 37. Correlations between vote confidence and disagreement (confidence aware treatment)

The problem with analysing such data is that it is not a record of what was occurring at the *moment of voting*. **Vote 2 d** records the disagreement *at the beginning* of the third vote round and **vote 3 d** records the disagreement *at the end* of the third vote round. However in between these two points the group situation was dynamic. What the voter saw at the moment they were making their third vote was not necessarily as suggested by **vote 2 d**, unless they were the first person in the group to third vote on that item. Likewise **vote 3 d** did not necessarily represent how they intended to affect the group disagreement (unless they were the last person to vote).

For example, a person may have voted to increase agreement with the group, but if the others all changed their positions they could end up with more disagreement with the group than they started with. Such changes introduce an error factor into any correlation that existed. Thus while noting evidence that individual disagreement before and after the final vote was weakly correlated with final confidence, this question is better met by a direct analysis of log data which records specific events in the time line (see p209).

6.4 Score correct

6.4.1 By information exchanged

The question considered in this section is whether or not awareness of the responses of other group members improves group and individual task performance, i.e. the number of correct answers given.

6.4.1.1 Group score correct

The average group score correct results are shown in Table 38.

	Blind	Group aware	Confidence aware
Mean group score	3.11	3.94	4.39
SD	0.268	0.246	0.199
N	18	17	18
Total questions	108	102	108
Number of correct group decisions	56	67	79
% Correct (of total)	52%	66%	73%
Number of agreed decisions	82	102	108
% Correct (of agreed)	68%	66%	73%

Table 38. Group score correct by information exchanged

The average group score correct increased by 0.83 from blind to group aware, and then increased again by 0.45 from group aware to confidence aware. The same information was calculated as a percentage correct of all the questions asked. For treatments I and III this percentage was out of 108 (18 groups x 6 questions) and for treatment II it was out of 102 (17 groups x 6 questions). The percentage of correct group decisions increased by 14% from blind to group aware, and then increased again by 7% from group aware to confidence aware.

The ANOVA results given in Table 39 show which of these changes were significant.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Treatments (I,II,III)	2	14.39	7.20	5.20	0.011
Treatments (I vs II)	1	12.01	12.01	9.08	0.008**
Treatments (II vs III)	1	2.38	2.38	1.65	0.217 ns

Table 39. ANOVA for group score correct by information exchanged

While overall the change in group score correct was not quite significant at the 0.01 level, the difference between the blind and group aware treatments (I and II) was. Any additional effect produced by the confidence aware treatment was not significant. This led to the conclusion that group score correct was influenced by the treatment.

Can this be interpreted to mean that normative influence provides task support? The result may indicate how the processes interact, rather than direct task support. Group score correct is not logically independent from increased group agreement, since giving a correct answer is dependent

on the group first gaining agreement. If a group cannot agree on any question, then their score correct must be zero. Conversely, if they reached agreement on all six questions, then even if they are guessing randomly, they will tend to get some questions correct (by chance). Therefore anything which increases agreement from will tend to also increase the absolute number correct, simply because there are less cases where the group is “hung” (could not agree on an answer, i.e. $D > 0.7$).

This effect can be estimated, because the groups in treatments II and III reached agreement in every single case for questions 1-6. In the blind case, groups were getting 52% of all questions correct, which would be a minimum estimate of likelihood of giving a correct answer (a maximum would be the 68% of agreed answers that were correct). Table 38 shows that in the blind treatment, groups were hung on 26 questions. If all this disagreement were removed, as was the case for the other two treatments, one could expect at least 52% of these 26 hung questions to be answered correctly, an additional score of approximately 13, raising the score correct to 69, or 64%. This minimum improvement brings the blind score up to nearly the same as the group aware result. A similar effect can be obtained by calculating the score correct as a percentage of the number of agreed responses, when the score correct percentage actually goes slightly down from blind to group aware treatments (see Table 38).

The results then provide little evidence that the exchange of either group or confidence information caused an improvement in the group score correct over and above that which would be expected from the increase in group agreement. This might be expected since groups did not exchange any task information about the questions. The significant increase in absolute group score correct which was found, can be attributed almost entirely to the increased agreement in the group. This result demonstrates how task output can be affected not only by the task process, but also by both the group social process, and increasing group agreement does not merely have social implications for the group, it can also cause significant task implications.

6.4.1.2 Individual score correct

A participant could give the correct answer individually, but be over-ruled by the group majority who voted for another option. Therefore the group score correct and the individual score correct are two different measures. The mean scores correct by treatment were 3.07, 3.97, and 4.26, similar to the group scores correct shown in Table 38. The ANOVA results are given in Table 40.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Treatments (I,II,III)	2	72.01	36.00	22.26	0.000***
Treatments (I vs II)	1	67.60	67.60	36.94	0.000***
Treatments (II vs III)	1	4.40	4.40	3.14	0.080 ns

Table 40. ANOVA for individual score correct by information exchanged

As can be seen, the treatment effect is now clearly significant, and most of the effect is due to the difference between blind and group aware treatments, the addition of vote confidence information not having a significant effect compared to vote position information. The change in individual score correct brought about by exposure to group position information can be interpreted in two ways. From a rational information exchange perspective, subjects could be taking the votes of other group members as rational task information, and since other group members have been correct in the

past, it is reasonable that they will be correct in the future (Deutsch and Gerard, 1965). This view predicts that the additional information increases task correctness. In this case, adding how confident group members are about their position should provide extra information, and so treatment III would be expected to be higher than treatment II.

However from the perspective of the integrative model, the vote positions of other group members is not strictly speaking task information, and should not make a major contribution to the task resolution process (although it may in the absence of any other information, as in this case). The model suggests that group majority influences the individual to its position through a normative process, not through a rational process. This means that if the majority tends to be right, individual scores will go up, but if the majority tends to be wrong (e.g. where there is some bias) individual scores may go down. In this case, the average group response (52%) is considerably above chance (25%), and therefore individual scores are expected to go up, as they did.

If task resolution was not operating the addition of vote confidence should have little effect on score correct, as it had little effect on agreement. The results in Table 40 show a borderline non-significant effect for treatment III, and thus are inconclusive. Either way, the effect is relatively weak.

6.4.2 By vote number

As expected, individual score correct increased with each vote (Table 41), most of the change occurring between votes 1 and 2, and very little between votes 2 and 3.

Score Correct	Vote 1	Vote 2	Vote 3
Mean	3.15	3.99	4.12
SD	1.09	1.04	0.96
N	90	90	89

Table 41. Individual score correct by vote number

The ANOVA analysis is shown in Table 42.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Vote Number (1,2,3)	2	95.58	47.79	61.06	0.000***
Vote Number (1,2)	1	94.09	94.09	73.28	0.000***
Vote Number (2,3)	1	1.49	1.49	5.28	0.024 ns

Table 42. ANOVA for individual score correct by vote number

Individual score correct varied significantly by vote number, but while the second vote significantly increased score correct, the third vote did not (at the 0.01 level).

6.5 Interactions

A multi-factor repeated measures analysis, as described in Table 16, p154, was carried out to test if there were any interactions. For example it could be that one of the effects found occurred for one treatment but not the other. Table 43 shows the results. Where two interaction contrasts were calculated the average is given.

Source of variation	Disagreement (d)	Confidence	Score Correct
Main Treatment by vote Number	0.330 ns	0.444 ns	0.220 ns
Main Treatment by Question Type	0.460 ns	0.182 ns	N/A
Vote Number by Question Type	0.394 ns	0.532 ns	N/A
Main Treatment by vote Number by Question Type	0.741 ns	0.234 ns	N/A

Table 43. F test significance values for interaction effects

There were no interactions between information exchanged, vote number and question type, suggesting that the results were very clear cut.

6.6 Control variables

6.6.1 Order

Because it was expected that the groups would develop over time, the effect of sequence order was controlled for - each treatment was equally first, second and third. A breakdown of the group disagreement and confidence by order, taken from vote series 1 (blind voting) is shown in Table 44.

Measure	First	Second	Third	Chi-Square Sig
Disagreement	0.59	0.56	0.59	0.84 ns
Confidence	3.34	3.33	3.47	0.08 ns

Table 44. Disagreement and confidence order effects

The Chi-square values show no significant order effect at the .05 level, as expected.

6.6.2 Test

As noted earlier, given the number of subjects, it was not possible to control for the treatment order, test order, and test by treatment, so the latter was allocated randomly. Table 45 gives a breakdown of the results by test, taken from vote series 1 (blind voting), and shows there were significant differences between the three tests.

Measure	Test A	Test B	Test C	Chi-Square Sig
Disagreement	0.55	0.61	0.59	0.004**
Confidence	3.42	3.27	3.45	0.001***

Table 45. Disagreement and confidence by test

Disagreement was lower for Test A than the other two, and vote confidence was lower for Test B than for the other two.

Could these differences have caused the main effects? It is unlikely, as the absolute differences between the tests are of a much lower magnitude than the main effects. Even if treatments II and III had been only Test A, and treatment I had been only Test B (which was not the case), the expected difference for **D** would be 0.06. The actual difference found was 0.42, which is seven times larger. However while difference between the tests is unlikely to account for the main effect, the main effect could account for the differences between the tests. The differences shown Table 45 are all in the direction that would be predicted by the allocation of test to treatment (see Table 19, p165). For example, Tests A and C were allocated 15 and 12 times respectively to the group aware and confidence aware treatments, while Test B was only allocated 9 times. The test differences found are as would be predicted from the main effect.

Given that the main effect is not in doubt due to its magnitude, that the test effect is as would be predicted from the main effect, and that the allocation of test to treatment was determined randomly, it is concluded that the test differences found are due to the main effect.

6.7 Pre-test cohesion

Before beginning the experiment, groups completed a short questionnaire to measure group cohesiveness, broken down into two factors of belonging and morale. While belonging and morale correlated highly together ($r = 0.794, p = 0.000$), none of these measures correlated significantly with any measure of disagreement, confidence or subject perceptions during the sessions, perhaps indicating that the groups were not permanent, but only formed for the purpose of the given task.

6.8 Subject perceptions

While the previous sections have analysed the direct responses of the subjects, this section analyses their perceptions immediately after each session, when subjects answered 10 questions on how they felt about the session they had just completed. The questions were intended to measure the following constructs (see 5.8.4 for a detailed definition):

1. Perceived agreement (PA),
2. Task correctness (TC),
3. Process satisfaction (PS),
4. Decision acceptance (DA), and,
5. Group awareness (GA).

The last measure was included mainly as a control of the main treatment effect.

In this section, because so many correlations are calculated, a correlation result will be considered significant if it occurs at the 0.01 level (marked as **). Subject perceptions cannot be analysed by vote number or question type, because they apply to the entire test session.

There were no significant correlations in the individual data between any of the session perception questions and the direct measures of the same subject's mean disagreement, confidence or score correct taken during the sessions. This is expected, since subject's were being asked their perception of the method of the session as a whole, rather than their particular performance in it.

6.8.1 By information exchanged

Each perception question could be answered on an anchored 1-7 scale, where 1 was *Strongly Disagree*, 4 was *In the Middle*, and 7 was *Strongly Agree* (See Table 21, p168). The mean responses and standard deviations are shown in Table 46. The table also gives the mean response in descriptive terms. This was done by regarding ± 0.2 about a scale value to be that value, and otherwise taking the value to be intermediary between two scale values.

Question	Blind	Group aware	Confidence aware
PA+. I think I agreed with most of what the group decided	4.08 (1.52) In Middle	5.60 (0.99) Agree Slightly/ Agree	5.40 (1.19) Agree Slightly/ Agree
PA-. I think I generally disagreed with what the group decided	3.43 (1.46) Disagree Slightly/ In Middle	2.60 (1.31) Disagree/ Disagree Slightly	2.74 (1.41) Disagree/ Disagree Slightly
TC+. I think our group gave good answers	4.27 (1.70) In Middle/ Agree Slightly	5.42 (1.19) Agree Slightly/ Agree	5.46 (1.07) Agree Slightly/ Agree
TC-. Our group probably got quite a few questions wrong	4.00 (1.59) In Middle	3.21 (1.62) Disagree Slightly/ In Middle	3.32 (1.66) Disagree Slightly/ In Middle
PS+. This is a good way to make decisions.	3.09 (2.04) Disagree Slightly	4.59 (1.69) In Middle/ Agree Slightly	4.89 (1.65) Agree Slightly
PS-. I didn't enjoy using the computer system this way.	3.86 (1.94) In Middle	3.34 (1.70) Disagree Slightly/ In Middle	3.07 (1.75) Disagree Slightly
DA+. I 'd be happy to sign my name to the answers our group produced.	4.38 (1.76) In Middle/ Agree Slightly	5.30 (1.36) Agree Slightly/ Agree	5.40 (1.19) Agree Slightly/ Agree
DA-. I wouldn't like the answers of our group to be made public	3.60 (1.71) Disagree Slightly/ In Middle	3.39 (1.51) Disagree Slightly/ In Middle	3.38 (1.57) Disagree Slightly/ In Middle
GA+. I was aware of the other group members through the computer.	2.37 (1.86) Disagree/ Disagree Slightly	5.30 (1.55) Agree Slightly/ Agree	5.44 (1.61) Agree Slightly/ Agree
GA-. I didn't really think much about others during this test.	4.42 (2.02) In Middle/ Agree Slightly	2.82 (1.47) Disagree	2.83 (1.39) Disagree

Table 46. Subject perceptions by information exchanged (N=90)

A repeated measures ANOVA was then carried out for each question and a summary of the results are shown in Table 47.

Question	All Treatments	Treatments I vs II	Treatments II vs III
PA+. I think I agreed with most of what the group decided	50.10 (0.000***)	78.93 (0.000***)	2.22 (0.140 ns)
PA-. I think I generally disagreed with what the group decided	12.87 (0.000***)	22.30 (0.000***)	1.04 (0.311 ns)
TC+. I think our group gave good answers	30.88 (0.000***)	46.30 (0.000***)	0.02 (0.873 ns)
TC-. Our group probably got quite a few questions wrong	10.28 (0.000**)	15.46 (0.000**)	0.67 (0.417 ns)
PS+. This is a good way to make decisions	48.91 (0.000***)	60.79 (0.000***)	5.51 (0.021 ns)
PS-. I didn't enjoy using the computer system this way	7.47 (0.001***)	10.89 (0.001***)	2.27 (0.135 ns)
DA+. I 'd be happy to sign my name to the answers our group produced	24.52 (0.000***)	34.46 (0.000***)	0.66 (0.420 ns)
DA-. I wouldn't like the answers of our group to be made public	0.84 (0.435 ns)	1.23 (0.271 ns)	0.00 (0.943 ns)
GA+. I was aware of the other group members through the computer	110.90 (0.000***)	128.58 (0.000***)	1.38 (0.243 ns)
GA-. I didn't really think much about others during this test	38.05 (0.000***)	44.91 (0.000***)	0.01 (0.924 ns)

Table 47. ANOVA F values (significance) of subject perceptions

In general subjects saw a significant difference between the blind and group aware situations, but no significant difference between the group aware and confidence aware situations. This supports the results found based on direct measures of the sessions.

In order of strength of ANOVA effect, subjects thought *that in the group aware process*:

1. GA+ They were more aware of other group members. (+2.93)
2. PA+ They agreed more with what the group decided. (+1.52)
3. PS+ They felt it was a better way to make decisions. (+1.5)
4. TC+ The group gave better answers. (+1.15)

-
- | | |
|--------|---|
| 5. GA- | It was less true that they didn't think much about others during the test. (-1.6) |
| 6. DA+ | They would be more happy to sign their name to the group answers. (+0.92) |
| 7. PA- | They generally disagreed less with the group. (-0.83) |
| 8. TC- | The group probably got fewer questions wrong. (-0.79) |
| 9. PS- | It was less true that they didn't enjoy using the computer system this way. (-0.52) |

The numbers in brackets represent the average difference in mean response between the blind and group aware treatments. Apart from the questions on more group awareness (which was put in as a control), the biggest perceived difference was that subjects felt they agreed with the group more (+1.52) and that this was a better way to make decisions (+1.5). Comparing the blind and group aware sessions, subjects essentially moved from feeling undecided whether they agreed with the group to feeling that they did, and from feeling it wasn't a good way to make decisions to feeling it was.

The only question that did not produce a significant effect was DA-. Subjects did not see a difference between the treatments regarding their attitude to making their group's results public. There was however a significant difference in whether they would be happy to sign their name to the results. The difference seemed to be whether they were personally involved with the results. Simply making the group results public however seemed not to raise an issue, perhaps because the individual was not personally accountable.

6.8.2 Factor analysis

This section analyses whether the intended conceptual structure of the questions was reflected in the way subjects actually responded. Treatments II and III represented the situations of interest, so the analysis was carried out for responses to both. Since both treatments appeared to be treated similarly by subjects with respect to these variables, an analysis was also carried out on the average response to treatments II and III.

Cluster analysis does not load negatively, so it clustered all the positive questions into one group and all the negative ones into another, giving two clusters, firstly PA+, TC+, DA+, PS+, and GA+ (clustering in that order), and secondly PA-, GA-, TC-, DA- and PS- (also clustering in that order). Therefore a principle components factor analysis was calculated, with the expectation that at least some of the constructs that the subject perception questions were based on would appear. The result are shown in Table 48. Factor loadings under 0.3 not shown.

Factor	Question	Loading		
		II + III	II	III
1. Group identification	PA+. I think I agreed with most of what the group decided	0.82	0.76	0.79
	TC+. I think our group gave good answers	0.78	0.73	0.75
	PS+. This is a good way to make decisions	0.76	0.69	0.76
	DA+. I 'd be happy to sign my name to the answers our group produced	0.74	0.77	0.67
2. Individual identification	PA-. I think I generally disagreed with what the group decided	0.71	0.45	0.66
	TC-. Our group probably got quite a few questions wrong	0.68	0.73	0.51
	DA-. I wouldn't like the answers of our group to be made public	0.65	0.60	0.71
	GA-. I didn't really think much about others during this test	0.55	0.67	0.37
	PS-. I didn't enjoy using the computer system this way	0.53	0.29	0.62
	TC+. I think our group gave good answers	-0.27	-0.41	-0.09
3. Other awareness	GA+. I was aware of the other group members through the computer	0.88	-0.81	-0.83
	GA-. I didn't really think much about others during this test	-0.70	0.56	0.77
	PS-. I didn't enjoy using the computer system this way	-0.37	0.60	0.26
	TC-. Our group probably got quite a few questions wrong	---	---	0.40
	PA+. I think I agreed with most of what the group decided	---	---	-0.33
	Total % variance explained	62.1	59.2	58.4

Table 48. Factor analysis of subject perception questions

Three factors emerged, which accounted for 62% of average response variance, and will now be considered in more detail.

6.8.2.1 Factor 1. Group identification

Factor 1 was clear for both treatments, and seemed to represent how much members identified with the group. It consisted of the positive questions from the four main constructs proposed (perceived agreement, task correctness, process satisfaction and decision acceptance), and therefore was called *group identification*, and taken to indicate how much the individual valued the group. This factor alone explained about one third of the response variance. All of the questions in this factor correlated strongly and significantly with each other, as shown in Table 49.

Factor 1	TC+	PS+	DA+
PA+ I think I agreed with most of what the group decided	0.656***	0.504***	0.549***
TC+ I think our group gave good answers		0.535***	0.553***
PS+ This is a good way to make decisions.			0.393***
DA+ I 'd be happy to sign my name to the answers our group produced.			

Table 49. Correlations between subject perceptions: Factor 1

The correlation between TC+ and PA+ is particularly high (about 43% variance in common), indicating that agreement with the group tends to go strongly with a belief that the group answer was correct. There is no evidence here of participants agreeing with what they see as a bad group answer, just to “go along” with the group, which would give a negative relation between TC+ and PA+. This correlation implies that a significant amount of the confidence of subjects in task solution correctness (perhaps up to 50%), may arise from the normative process, rather than the task resolution process.

GA+ loaded weakly on this factor (0.22) in treatments II and III, although in the treatment I analysis it loaded strongly with the other four positive qualities (at 0.67). This could reflect the high group awareness scores obtained for treatments II and III.

The clarity of this factor suggests that group members have one attitude towards the group which covers what might logically be seen as distinct features, namely perceived agreement, task correctness (or decision quality), process satisfaction and decision acceptance. This would accord with theories of cognitive consonance, which hold that it is difficult to agree strongly with a position that one feels is wrong, or to feel a decision is correct while the process that derived the decision was not good. Therefore this factor was called group identification, and represented how much the individual identified with the group, and hence agreed with the group answer, felt the group answer was the correct answer, felt the group process that achieved that answer was a good one, and would support the group's decision in public. As one subject commented, they felt that a group adjusted answer was *good*:

This will work really well if there big decisions to be made. I liked working with our group. . . . being able to see the votes and confidence of other team members enabled me to make a good answer.

Overall, these results suggest that there is a single process in operation in this situation, and therefore all these results are strongly related.

6.8.2.2 Factor 2. Individual identification

The second factor in Table 48 was loaded mainly all the negative responses to the group situation - how strongly the individual disagreed with the group position, how they felt the group position was wrong, and how they would not wish to be associated with that position in public. Lack of awareness of the group and lack of enjoyment of the process also loaded in with this factor. The disassociation of the individual from the group can be interpreted as an assertion of individual identity, and therefore this factor was called *individual identification*, and taken to represent how much the subject felt themselves to be operating as an individual apart from the group.

6.8.2.3 Factor 3. Other awareness

The third factor loaded mainly with the two group member awareness questions. The strongest component was GA-, which is not being aware of others. The appearance of these two as a factor was not a surprise. In this factor the PS- question correlated strongly with the GA- question ($r = 0.418^{***}$), but not significantly with GA+, suggesting that not enjoying the session was related to not thinking about others, but not to being aware of them. Again this suggests that either positive and negatively framed questions are taken differently or the wording “enjoy using the computer system this way” and “a good way to make decisions” evoked different responses. Either way this result raises the interesting issue of whether people find electronic group processes less enjoyable when they are not aware of other group members, and whether some form of social facilitation may occur over computer networks. This is an area for future study.

6.8.2.4 Construct correlations

It had been expected that the negative responses would load with their corresponding positive versions. Table 50 shows the results of the correlations between positive and negative construct questions.

Construct	Correlation	Significance
Group awareness (GA+, GA-)	-0.441	0.000 ***
Task correctness (TC+, TC-)	-0.389	0.000 ***
Process satisfaction (PS+, PS-)	-0.283	0.007 **
Decision acceptance (DA+, DA-)	-0.250	0.018 ns
Perceived agreement (PA+, PA-)	-0.218	0.039 ns

Table 50. Within construct correlations

The highest within construct correlation reported in Table 50 was 0.44, for group awareness, and this is only just higher than the lowest of the between construct correlations reported for factor 1 (Table 49). In every other case the factor 1 correlations are higher than the within construct correlations. It is difficult to see why PA+ (*I think I agreed with most of what the group decided*) did not correlate significantly with PA- (*I think I generally disagreed with what the group decided*).

This result was surprising, and suggests that agreeing and disagreeing with a group are not simple opposites. The two main factors found suggest that being identified with a group, and being disassociated from it, can be two relatively independent as well as co-related attitudes within an individual. While this sounds initially strange, it does fit with the integrative model, where it is possible to be strongly attracted to a group, and at the same time hold strongly to a personal view that contradicts the group's view. Therefore factor 2 has been interpreted as the individual tendencies which sometimes lead people to reject groups.

6.9 Event log data

FORUM DGSS recorded the action type, action details and the time of action, for each user action in an event log file as it occurred. Fortunately because all the computers in one room were booted from the same server, all of their clocks were initially set to the same time. The session log provided a record of events occurring along the time line for a particular group.

6.9.1 Time taken

The session times taken by subjects are shown in Table 51. For treatments II and II, the average group time to complete a test of 12 questions was 16½ minutes, and during this time the group completed 36 group votes. This corresponds to one group vote every 31 seconds. When working alone, subjects took slightly longer, averaging 35 seconds per question.

Time Taken	Blind	Group aware	Confidence aware
Mean	419 seconds (7 mins)	991 seconds (16.5 mins)	976 seconds (16.3 mins)
SD	93.8	316.7	225.3
N	18	18	18

Table 51. Group time taken by treatment

As can be seen from the ANOVA in Table 52 there is a clear effect for the group aware treatment, but no difference at all between group aware and confidence aware. The confidence aware sessions, which provided more information, showed much the same time per question as the group aware session where confidence was not displayed. No extra time was taken up processing the extra vote confidence information exchanged, as might be predicted by information exchange theory.

Source of variation	Degrees of freedom	Sum of squares	Mean square	F Value	Probability of F
Treatments (I,II,III)	2	3830066	1915033	53.9	0.000***
Treatments (I vs II)	1	3828214	3828214	251.0	0.000***
Treatments (II vs III)	1	1851	1851	0.04	0.859 ns

Table 52. ANOVA for group time taken by treatment

These times are probably over estimates as they represent the time of the slowest member of the group. If individuals had been able to move at their own pace the times for treatments II and III would have been shorter.

6.9.2 Vote event analysis

In the case of vote events the log file not only stored the vote and confidence, but also recorded the view the user had of the group position at the moment of voting. This allowed group and individual disagreement measures to be calculated for the vote event, and by providing a snapshot of what was occurring at the moment of voting, avoids the problem discussed in section 6.3.5, *Effect of disagreement on vote confidence, p179*.

Since the first vote was blind, the effect of the rest of the group on the individual was only seen in the second and third votes. This involved only four sessions, involving a total of 4,308 second and third vote events. Each vote event was one subject voting on one question for either vote 2 or 3 under either treatment II or III. Each of the 90 subjects generated 48 vote events (4 x 12 questions), giving 4,320, less the 12 missing values.

6.9.2.1 Vote event snapshot

The log file gave a unique view of events as it recorded what the participant was actually looking at when they made their vote. The display of how other group members had voted was dynamic, and was refreshed from the common data server every 60 seconds or so. FORUM DGSS recorded *the vote display as the user saw it at the moment of voting*. The event log file provides a clearer picture of the voter’s intent than the before and after snapshots from the results file discussed earlier. For example, consider a situation where the vote pattern after the first vote is:

Vote: AABBC	Group: No Decision Yet
-------------	------------------------

The group is undecided between options *A* and *B*, and one person wants *C*. Now suppose everyone came to vote at about the same time on this particular question, and those who voted *A* decided that *B* was a better option and voted for *B* thinking that the group would then be decided. However unknown to them those who voted *B* have decided that *A* was a better option and voted for *A*. The end result is a vote pattern of *BBAAC* which is unchanged in terms of group disagreement, even though *four group members clearly intended to decrease group disagreement*. The event log record therefore gives a much clearer picture of what was occurring, providing a snapshot of the situation at the user interface at the moment of decision, and allowing the subject’s vote to be interpreted in terms of the group situation as they saw it.

6.9.2.2 *Vote event variables*

Each vote event record held the view of the group vote display as seen on the screen by the user at the point when the vote was being taken, as well as the individual's old vote and confidence and their new vote and confidence. Therefore it was possible to calculate the individual's perceived disagreement with the group before they voted and their perceived disagreement after they voted. These disagreement values were relative to what they saw on the screen. Again this conversion was sufficiently complex to require a program to be written to carry it out.

For each vote event the *prior vote variables* were:

1. **dOld.** How much the group disagrees with the individual before the vote,
2. **DRest.** How much the other four members disagreed among themselves before the vote, and,
3. **cOld.** How confident the individual was on their previous vote (1-5).

The *post vote variables* were the outcomes of the vote event, namely:

1. **vChange%.** The percentage of the individuals who changed their vote, and,
2. **dNew.** How much the individual disagrees with the group after they vote, assuming the other group members remain with the same votes.

The post vote variables could be dependant on the prior vote variables. The word prior is used, rather than independent, because these variables were not under the experimenter's control.

The vote change variable had to be amended slightly to account for the forced choice in the final vote. On the first vote, 70 people voted *Don't Know*, but only 15 of them also voted *Don't Know* on the second vote. In addition 4 people voted A-D on vote one, but voted *Don't Know* on vote 2. The 19 people who voted *Don't Know* on vote 2, were forced to take a vote position on the third vote, and therefore they were recorded as missing values for the vote change variable, as there was no element of choice in their vote change. This gave 4285 vote events for which a vote change value could be calculated.

After voting, subjects then gave their vote confidence. The *prior confidence variables* were those which were established before the confidence was measured, namely all five of the previous variables (**dOld**, **DRest**, **cOld**, **vChange**, **dNew**). The *post confidence variable* was the new vote confidence, called **cNew**. Again the post confidence variable could be dependant on the prior confidence variables.

In order to better reflect what was occurring, for each event, the *change* in disagreement (**d**) and vote confidence (**c**) were also calculated, and called Δd and Δc respectively. These variables represent the *movement* which occurred in disagreement and confidence during the event, for increased disagreement and increased confidence.

6.9.2.3 *Theoretical questions and expectations*

The following questions were of interest:

- QVI.* How did the disagreement of the individual with the group, affect the likelihood of vote change?

A simple normative threshold model was predicted here. It was expected that group members in a majority would tend hold the position they saw as representing a group they identified with, regardless of the size of the majority. There should be a relatively

sudden increase in vote change once subjects became in the minority, and tended to see themselves as out of step with the group.

QV2. When a group member disagreed with the group, how did the amount of agreement among the rest of that group affect the likelihood of vote change?

The expected answer to this question was that the likelihood of change to an alternative would be higher if the rest of the group agreed on that position.

QV3. How did prior vote confidence affect the likelihood of vote change?

The expected answer to this question was that if prior vote confidence was low, individuals would be more likely to change their vote.

QC1. How did prior vote confidence affect vote confidence?

The expected answer to this question was that confidence before the vote should be strongly related to confidence after the vote.

QC2. How did prior disagreement affect vote confidence?

It was expected that subjects who found that the group disagreed with them, would become less confident in their vote, while subjects who found that the group agreed with them, would become more confident..

The above questions of causality arise because the events occurred sequentially in time, as the experiment unfolded. However the design cannot be used to formally conclude causality, because the cases which appear in the various categories (for example of disagreement with the group), are not as chosen by the experimenter, but as they eventuated. For example a significant (but small) correlation was found between disagreement and vote confidence even on the first (blind) vote. This correlation does not imply that initial disagreement reduces confidence, which would be impossible because subjects were not aware of the group disagreement at the time. One would expect that questions perceived by a group as difficult, for reasons that may be individual to the members of that group, would generate both more disagreement and also less confidence. The correlation can be explained in terms of a common factor to both group disagreement and confidence - question perceived difficulty. This example illustrates the importance of a theoretical context. The log event data however is useful in terms of whether (or not) connections were found to occur in the expected way, and where unexpected results are found (or where current theory does not predict), the results can provide useful directions for further, more controlled, experimentation.

6.9.2.4 QV1: Effect of prior disagreement on vote change

Vote change occurs when a subject has an original position, and then, on revisiting the same question later, something occurs to cause them to alter that position. In this experiment the questions were simple and did not require a great deal of analysis. The software, at the time of revoting, reminded subjects of the previous vote they had made. Therefore it was expected that people would stay with their previous position unless influenced by the group. Of all the vote 2 and 3 events, 83.6% involved no change in vote position, so by far the majority of vote event cases involved no change in vote position. This percentage was almost identical between the group aware treatment (82.9%) and the confidence aware treatment (84.3%). Most of the change occurred in vote

2, where 24.5% of the vote events involved a change in position. On the third (and final) vote, only 8.4% of subjects voting changed their position.

Before voting, subjects could find their position to be in a minority ($dOld \geq 3$), or to be as a part of a group majority ($dOld \leq 2$). It was expected that those in the minority would tend to change their vote, and those in the majority would not, and there would be a threshold effect occurring at the minority/majority boundary as has been found in other studies (e.g. Hoffnan, 1978). The percentage who changed their vote as a function of $dOld$ is shown in Table 53, where $dOld$ is the perceived disagreement of the individual with the rest of the group before the vote. A value of $dOld = 0$ means that everyone else was seen to agree with their position, and a value of $dOld = 4$ means everyone else disagreed with them.

Prior disagreement =	Majority			Minority	
	0.0	0.25	0.5	0.75	1.0
% of N who changed their vote	1.0%	2.9%	6.2%	34.6%	66.8%
N	1625	886	550	462	762

Table 53. Vote change by prior disagreement

The table shows slight increases in position changes as one or two others disagree with the voter, but a clear threshold effect once the voter moves from being in the majority ($dOld = 0, 1, 2$) to being in the minority ($dOld = 3, 4$). The percentage vote change increased rapidly once a person became in a minority, and continued to change as the level of minority increased, four people against producing almost twice as much change as three people against. Pearson's r for the relationship between vote change and perceived before vote disagreement was 0.60, with a significant pearson chi-square probability of 0.000.

These results were almost identical for both the intellective and preference questions. There was also very little difference when the results were broken down by treatment II or III. Pearson's r for prior vote disagreement ($dOld$) with vote change was 0.608 for treatment II, and 0.605 for treatment III.

At vote 2 a decision was not required, it was a straw vote, but at vote 3 a decision was required, because this was the group's final vote. It could be that the threshold effect found in Table 53 was primarily due to the closure required on vote 3. However an analysis by vote number showed that the normative effect was at least as strong if not stronger at vote 2 as at vote 3 (Table 54).

Prior disagreement =	Majority			Minority	
	0.0	0.25	0.5	0.75	1.0
Vote number 2					
% N who changed their vote	0.8%	2.0%	7.1%	36.3%	72.6%
N	479	403	368	355	551
Vote number 3					
% N who changed their vote	1.1%	3.7%	4.4%	29.0%	51.7%
N	1146	483	182	107	211

Table 54. Vote change by prior disagreement for vote number

This result is expected given the earlier finding that most of the change effect occurs between votes 1 and 2.

It could be argued that subjects stayed with the majority in the situations where there was agreement because they were very confident of those questions, and changed in the cases where they were a minority because those questions were ones where they were very unsure. The only way to control for this would have been to have the computer act as a “stooge”, and generate the group feedback independently of the question and controlling for question number. This is an option for future research. However if this was the case then one would expect a correlation between the amount of disagreement and vote confidence for the blind votes. The correlation between confidence and disagreement for the blind first votes was only $r = -0.179$, which although statistically significant was not strong enough to account for the effect as found here. It must be concluded that the groups are generating, not finding, agreement.

These results show a clear effect, however a simple threshold model proposed would have predicted a clearer one, namely a very low and constant % vote change when the subject is in the majority, jumping to a high and constant value once they are in a minority. The first percentage would represent the amount of change due to individual variation, and the second the amount of change due to group influence. Although the threshold occurred, there also appears to be a trend effect within the majority and minority categories, indicating an influence more sensitive to disagreement than simple majority/minority dichotomy.

The results in Table 53 were further analysed to find out whether the vote changes increased or decreased group disagreement for each category of prior disagreement. The results are shown in Table 55. The initial disagreement, **dOld**, is shown in the left column. Some cells in are marked *n/a* for “Not Applicable” because the initial disagreement restricts what changes are possible. For example if the group is unanimous (**dOld** = 0), the subject can either stay with the group (**dNew** = 0) or vote against the group (**dNew** = 4).

Prior agreement	Intended disagreement (dNew)				
	0.0	0.25	0.5	0.75	1.0
0.0 Disagree with no-one AAAAA	99.0 (1608)	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	1.0 (17)
0.25 Disagree with one AAAAX	<i>n/a</i>	97.1 (860)	<i>n/a</i>	1.8 (16)	1.1 (10)
0.5 Disagree with two AAAXX majority	<i>n/a</i>	<i>n/a</i>	97.8 (539)	1.8 (10)	0.4 (1)
0.75 Disagree with three AAXXX minority	<i>n/a</i>	22.6 (105)	9.7 (45)	66.5 (309)	1.3 (6)
1.0 Disagree with everyone AXXXX	32.1 (251)	19.8 (155)	10.9 (85)	3.3 (26)	33.8 (264)

Table 55. Distribution of intended disagreement by prior disagreement

Majority situation. When group was unanimous, the great majority (99%) chose not to increase their disagreement. This also applied at about the same percentages (97% and 98%) when only one or two others disagreed. It should be pointed out that when two people disagreed with the individual, although 6.2% changed their vote position (see Table 53), only 2.2% of those changes increased their disagreement (see Table 55). This could occur because if the group vote position was AAABB, and the voter changed vote from A to B, giving a new group vote of BAABB, there would be no increase in disagreement with the rest of the group.

It can be seen from Table 55 that subjects in a majority *cannot* increase their agreement. Therefore “vote change” in this case always means an increase in disagreement with the group.

Minority situation. When the voter was in a minority of two, in about one third (32.3%) of cases, the voter chose to reduce their disagreement, although still a small percentage (1.3%) chose to increase it. When a minority of one, in two thirds of cases (66.1%) the voters chose to reduce their disagreement. It can be concluded that where the voter is in a minority ($d_{Old} = 3, 4$), “vote change” nearly always involves reducing disagreement with the group. Only 4% of the minority vote changes resulted in an increase in disagreement.

To summarise, vote change, when the subject is in the majority, indicates the individual has moved away from the group, but when the subject is in the minority, nearly always indicates the individual has moved towards the group position. Therefore the vote change results shown in Table 53 illustrate the effect of group influence, and Table 55 shows how the normative influence demonstrated as a main effect operates in detail.

The figures also indicate a small but relatively constant factor of 1- 2% of events which go against predictions, such as breaking with a unanimous group (1.0%), or moving from disagreeing with three people to disagreeing with four people (1.3%). This may be a random or individual variation factor, and although small should be factored in to any model.

6.9.2.5 QV2: Effect of the rest of the group disagreement on vote change

How much the individual disagreed with the group did not provide a measure of whether the rest of the group agreed among themselves, or were in disagreement within themselves. For example an individual might disagree with everyone, but everyone else might also disagree among themselves. If everyone in a group disagrees with everyone else, then everyone is a minority of one. We might expect less vote change in this case.

To measure this, a group disagreement score for the other four members of the group was calculated, called **DRest**. The changed votes were then broken down by this variable for each value of **dOld**. Given an initial value for **dOld**, not all values of **DRest** were available. For example if the individual agreed with everyone else (**dOld** = 0), then the rest must also agree among themselves (**DRest** = 0). Table 56 shows the possible combinations of **dOld** and **DRest**, and in each cell gives:

- The percentage who changed their vote position in that vote situation,
- An example of the vote situation e.g. **AAAAA** (the voter is in bold), and,
- The number of times that combination occurred (in brackets).

Prior disagreement	Disagreement of the rest (DRest)				
	0.0 AAAA	0.5 AAAB	0.67 AABB	0.83 AABC	1.0 ABCD
0.0 Disagree with no-one	1.0% (AAAAA, 1625)	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
0.25 Disagree with one	<i>n/a</i>	2.9% (AAAAB, 886)	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
0.5 Disagree with two	<i>n/a</i>	<i>n/a</i>	8.3% (AAABB, 289)	3.8% (AAABC, 261)	<i>n/a</i>
0.75 Disagree with three	<i>n/a</i>	45.0% (BAAAB, 238)	<i>n/a</i>	25.3% (BAABC, 190)	14.7% (BABCD, 34)
1.0 Disagree with all	66.1% (DAAAA, 369)	68.4% (DAAAB, 247)	77.0% (DAABB, 61)	60.3% (DAABC, 78)	<i>n/a</i>

Table 56. Vote change by vote situation

Table 53 showed vote change as a function of the probability that the individual's solution choice will form a group majority, and showed a not only a threshold effect, but also trends. These trends may be attributable to the probability that another solution can form a majority, which factor can be seen in Table 56, The effect of the amount of agreement shown by the rest of the group will now be discussed for each individual disagreement level.

For $d = 0.0$, there is clearly a very low probability that any other solution will be accepted, as three group members would have to change position, but still 1.0% of cases showed a change of vote.

For $d = 0.25$, the probability of the alternative has increased, though only very slightly because there is still a clear majority, and two group members would have to change position. The percentage vote change has also risen only slightly, although it has more than doubled on the amount for $d = 0.0$.

For $d = 0.5$, the subject is still in the majority. If the opposing two agree, the alternative position they offer could form a majority if the voter changed to it. The likelihood of vote change in this case is twice as high (8.3%) as it is if the two others disagree (3.8%). The vote change is still only low, because the probability of the group changing is not as high as it might seem because individuals

tend to stick to their previous stated position, and the likelihood is that one or both of the minority of two will “convert” to the majority position.

For $d = 0.75$ the individual is now in a minority of two, and vote change rises dramatically to 35%. Vote change is much higher if the others all agree (45%) than if all the others disagree (15%). But even when all the others disagree, the vote change is still over twice that found than when $d = 0.5$, representing the influence of now being in the minority.

When $d = 1.0$ the subject disagrees with everyone, and there is clearly very little likelihood that the subject’s choice will form a group majority. In this case four in agreement against the subject produces no greater effect than three in agreement against the subject, perhaps indicating some sort of threshold has been reached in the ability of normative influence to change previously internalised positions. The case DAABB is interesting in that it involves two other possible candidates for the group majority, and produced the highest vote change. This might be expected if each contributes a probability of change.

In summary, Table 56 shows that, in general, where some or all of the group disagreed with the individual, vote change varies in a consistent way with the amount of disagreement in the rest of the group. This gives five possible influences on likelihood of a given vote change:

1. **Internalised position.** The tendency of the individual to remain consistent with their previously internalised position,
2. **Normative influence.** The tendency of the individual to vote from the group perspective, involving:
 - a) **Norm maintenance.** The tendency to remain within the group normative boundaries, and change position if not within those boundaries,
 - b) **Norm creation.** The tendency to change to a position that is within the group normative boundaries,
3. **Individual variability.** A small tendency to change arising from influences outside the model.

These influences are reasonable relative to the theoretical model. If an individual is not within the group boundaries, or if the group boundaries are undefined, this will tend to reduce confidence and encourage vote change. An individual identified with a group will tend to respond from the point of view of the group, rather than from their own point of view (as an individual). From the point of view of the group, the clearer the alternative group position, the more attractive it is. If there are two equally attractive alternate positions, then they may create more change than one alone. The small tendency to change, which lies outside this model, could occur because the subject re-analysed the question and came to a different conclusion. If so, this suggests that re-analysis is not common.

These ideas can be put as propositions. For an individual who has previously taken a position, and is facing one or more others in the group who have chosen different options, it can be proposed that:

1. *Individuals will tend to maintain their previously adopted position,*
2. *The likelihood of no change depends on the probability that the individual's current position will form a group majority, with a threshold effect occurring at the minority/majority boundary,*
3. *The likelihood of change to a particular alternative depends on the probability that the alternative will form a group majority, and,*
4. *A small amount of change will occur regardless.*

These propositions suggest that it may be possible to develop a computer simulation of normative group behaviour, using a few relatively simple rules. The results in Table 56 suggest some of the parameter values, for example the probability of remaining with the previous position seems to be about 33%, the random change factor about 1%, the threshold from 0% to about 45%, and the likelihood of change induced by alternate positions from 2% to about 20%, depending on the position. Such a program could operate dynamically, and may simulate the sort of sequence effects observed (e.g. McGuire et al., 1987).

These results do not suggest that individuals are automatons that mindlessly go with the group. Quite the contrary. The different percentages for different vote situations show an awareness of the probability of group change. Group identification implies that group members act *as if they were the group, or from a group perspective*, rather than as if they were robots. Being identified with the group, as something important to them, makes behaviour predictable only in a probabilistic sense, and certainly not in a mechanistic sense. Normative behaviour does not have to be without a rational foundation, only group focused.

It could be argued that the above results simply show that subjects consciously played the percentages to produce group decisions. There was no sense of this occurring during the sessions - subjects seemed genuinely keen to get the correct answers and the subject perceptions indicated that they strongly associated agreement with task correctness.

It could also be argued that the above results simply show that people act in their own best interests and if the success of the group is in those interests, they will go along. While not denying that individuals act in their own interests, it is proposed that identification causes the interests of the group to take on, as it were, a life of its own, to a degree supplanting individual self-interest. It is interesting to note that Table 56 includes several cases where the group has already reached a majority decision without the subject, and the vote of the individual is unlikely to affect that group decision (e.g. BAAAB, DAAAA, DAAAB). For example in the case DAAAA, whether the person who voted **D** changes or not will probably not (as we have seen) alter the near certainty that the group will take a position of **A**, and subjects can be expected to be aware of this. If the voter was simply concerned with the group outcome, the pressure to change a position they have previously established should be less, causing less vote change in these cases. On the other hand if subjects are motivated to reconcile their position with that of a group they identify with, then the pressure to change their previous position should still be high. The results show that in these cases vote change remained high, and two thirds of subjects still changed their position, even though they must know

that their vote was very unlikely to make any difference to the group outcome. This suggests that something more than rational assessment of consequences for the individual is operating.

In summary, a clear pattern has emerged from the analysis of the event record, sufficient to define a dynamic computer simulation of the normative process. However the pattern, although based on large numbers, is an after the fact pattern, and would need to be replicated before being confirmed. It would also be interesting to re-run the experiment with groups of larger size, which would give more varied group influence situations.

6.9.2.6 QV3: Effect of prior vote confidence on vote change

It was expected that the more confident individuals were, the less likely they would be to change their position. Table 57 shows the relation between prior vote confidence and vote change.

	Prior vote confidence (cOld)				
	1 Not Confident At All	2 Not Very Confident	3 Fairly Confident	4 Confident	5 Very Confident
% Vote change (of N)	32.2%	27.6%	20.2%	14.6%	8.6%
Change in disagreement (Δd)	-0.77	-0.63	-0.46	-0.33	-0.19
N	264	384	1124	1032	1411

Table 57. Vote change by prior vote confidence

There was a steady reduction in the percentage who changed their vote as prior vote confidence increases, just as expected (Stasser and Davis, 1981; Lowry, 1993). As the prior vote confidence increased, the average change in group disagreement generated by the voters also went down. These relationships appear to be essentially linear, with no suggestion of any threshold effect. Pearson’s r for the relationship between vote change and cOld was not strong ($r = -0.19$) but had a significant pearson chi-square probability of 0.000.

In Table 58, the same effect was broken down by treatment. As can be seen the group aware and confidence aware treatments were largely the same.

Treatment	Prior vote confidence (cOld)				
	1 Not Confident At All	2 Not Very Confident	3 Fairly Confident	4 Confident	5 Very Confident
Group aware (II)	32.0%	26.8%	20.7%	16.0%	9.3%
N	122	198	600	493	692
Confidence aware (III)	32.4%	28.5%	19.7%	13.4%	8.1%
N	142	186	524	539	719

Table 58. Vote change by prior vote confidence by treatment

However a breakdown by vote number showed some differences, as seen in Table 59.

Vote number	Prior vote confidence (cOld)				
	1 Not Confident At All	2 Not Very Confident	3 Fairly Confident	4 Confident	5 Very Confident
Vote No 2	43.5%	33.1%	27.4%	18.7%	15.9%
N	184	236	643	540	483
Vote No 3	6.3%	18.9%	10.6%	10.2%	4.9%
N	80	148	481	492	928

Table 59. Vote change by prior vote confidence by vote number

The prior vote confidence on the second vote can be taken to represent the individuals confidence in their own initial decision, which was made blind. It can also be taken as an indication of how difficult the individual originally saw the question. These percentages show a steady drop in vote change, as prior confidence increases.

However for vote set three the effect becomes less clear. The Pearson's r correlation between vote change and before vote confidence drops from - 0.19 in vote set 2, to - 0.10 in vote set 3. This may be because at vote 3, the questions subjects were still unsure on, tended to be those where all group members were unsure.

It was expected that the individual's prior vote confidence would have an equal effect across all disagreement states, and Table 60 shows the % vote change results for vote 2 only. The numbers in brackets are the number of cases in that cell which could have changed vote position.

Prior disagreement	Prior vote confidence (cOld)				
	1 Not Confident At All	2 Not Very Confident	3 Fairly Confident	4 Confident	5 Very Confident
0.0 Agree with everyone	0% (33)	0% (33)	2.5% (121)	0.8% (130)	0% (162)
0.25 Disagree with one	0% (23)	2.3% (44)	3.4% (119)	0.9% (115)	2.0% (102)
0.5 Disagree with two majority	15.4% (26)	4.7% (43)	5.9% (136)	7.0% (100)	5.0% (60)
0.75 Disagree with three minority	52.6% (38)	43.9% (41)	40.2% (102)	22.2% (81)	28.8% (80)
1.0 Disagree with all	87.5% (64)	76.0% (75)	72.7% (165)	64.9% (114)	62.0% (79)

Table 60. Vote change by prior vote confidence and disagreement

Where the voter is in the minority, as has been demonstrated, vote change generally involves increasing agreement, often abandoning a previously held personal position and adopting a group position. In this case, it would be expected that increasing prior confidence reduces the likelihood of changing one's prior personal position. The results generally show a steady linear decrease in vote change with increasing confidence.

When the individual is part of the majority, vote change means increasing disagreement by abandoning a group position, and selecting a less popular option. One might expect subjects who were very confident to be unlikely to change. However one could equally argue that subjects with low confidence would more easily abandon the group position, or more readily welcome and remain with it. The results for the majority case show the effect of prior confidence to be much less clear, non-confident subjects showing the greatest change when only in a majority of three (15.4%) and also the least change when in a majority of four or five (0%).

In conclusion, previous vote confidence seems to be a significant negative predictor of likelihood of vote change when the subject is in a minority. In a majority situation, the effect of prior confidence is much less clear.

6.9.2.7 QC1: Effect of prior vote confidence on vote confidence

As expected, prior vote confidence was strongly correlated with the after vote confidence ($r = 0.663$ ***, vote 2). This relationship applied equally to the group aware treatment ($r = 0.63$) and the confidence aware treatment ($r = 0.67$), and was found both at vote number 2 ($r = 0.66$) and at vote number 3 ($r = 0.66$). This supports the persistence of confidence result found earlier.

6.9.2.8 QC2: Effect prior vote disagreement on vote confidence

The issue of how vote confidence was affected by group disagreement was a difficult one. The *confidence change* (or Δc) variable was the difference between the post and the prior vote confidence, and was calculated to offset initial differences in confidence between questions that could generate correlations, such as that found between **cOld** and **dOld**. The mean value of Δc for vote 2 was 0.54, while for vote 3 it was only 0.072, indicating that nearly all of the change in confidence occurred in vote 2, with very little change occurring in vote 3. This reflects the earlier finding that the difference in confidence between votes 2 and 3 was not significant (see Table 32).

The rest of this section considers only second vote events, where the prior variables (**dOld** and **cOld**) were given blind. Table 61 shows the correlations between the confidence and disagreement variables for vote 2.

Vote confidence	Individual disagreement	
	Prior disagreement (dOld)	Post disagreement (dNew)
Prior confidence (cOld)	-0.179 ***	-0.053 ns
Post confidence (cNew)	-0.298 ***	-0.095 ***
Change in vote confidence (Δc)	-0.114 ***	-0.056 ns

Table 61. Correlations between vote confidence and group disagreement (vote 2)

Most of the correlations are significant even though weak, because each cell involved over 2,000 events. As can be seen the correlations for Δc , which removed prior differences, were much lower than for **cNew**, which didn't.

There were two measures of disagreement that could affect vote confidence. The first was the prior disagreement (**dOld**), which was the disagreement that had ensued from the last vote, and the second was the new disagreement (**dNew**), which was the new disagreement that would result from the current vote, if no-one else in the group changed, i.e. it was the *intended disagreement*. As can be seen the correlation between Δc and **dNew** was not significant, but the correlation between Δc and **dOld** was significant. This suggests that changing one's vote to the group majority, or intending to agree, does not generate more confidence, but finding that one's previous vote matched the group's position did, i.e. *changing* to the group position did not create confidence, but *being* with the group position did.

More detail on the form of the relation between confidence and prior disagreement (**dOld**) can be seen in Table 62.

Prior disagreement =	Majority			Minority	
	0.0	0.25	0.5	0.75	1.0
Vote confidence (cNew)	4.4	4.2	4.0	3.8	3.5
Vote confidence change (Δc)	0.66	0.58	0.65	0.41	0.38
No vote change	0.66	0.59	0.64	0.40	0.40
N1	475	395	341	222	141
Vote change	0.75	0.13	0.75	0.44	0.37
N2	4	8	24	120	356
N	479	403	365	342	497

Table 62. Vote confidence by prior disagreement (vote 2)

New confidence drops steadily as previous disagreement increases, but this could be an artifact of question difficulty, as discussed. Vote confidence *change* (Δc), which takes into account any differences in initial confidence, does not show a steady drop, but drops suddenly as the subject moves from being in the majority to being in the minority. The threshold effect is as predicted, and in the direction predicted. However it was expected that subjects who found themselves in a minority would experience a decrease in confidence, whereas in fact they also increased in confidence by 0.41 and 0.38.

To explore this, the results were further broken down by whether or not the subjects changed their vote, but as shown in Table 62, subjects who did not change their vote when they discovered they were in a minority, still showed increases in confidence of 0.40. In other words confidence increased in *all* cases, even when subjects found that everyone else disagreed them. As shown in Table 62, for the 363 vote events where subjects found themselves in a minority, and they did not change their vote, confidence on average rose by 0.40, almost half a scale point. Why didn't it go down? Further analysis showed that this increase in confidence occurred for almost all values of **DRest** as well, except in the case where everyone disagreed with the individual, and the rest of the group were all unanimous in their disagreement, in which case the change in confidence was about equally split between increases and decreases. It seemed that any exposure to the group increased vote confidence, except where everyone was against the individual, when it remained about the same. It seemed that simple exposure to the rest of the group, even when they disagreed with the subject, raised confidence, as a sort of background effect. Perhaps this can be understood in terms of the uncertainty many people felt when having to make decisions alone. As one subject reported:

This experiment was very helpful. It illustrated quite well how I find myself unable to take a 100% positive stand to answers that I myself am not positive about unless other people are there to contribute their opinions.

Indeed mean confidence was higher for events where there was no vote change (mean confidence = 4.1, SD = 1.1, N = 3524) than for events where the subject changed their vote (mean confidence = 3.3, SD = 1.2, N = 746).

Table 63 shows the same comparisons for intended disagreement as have been made for prior disagreement.

Intended disagreement =	Majority		Minority		
	0.0	0.25	0.5	0.75	1.0
Mean vote confidence (cNew)	3.5	3.2	3.4	3.6	3.8
N	162	208	137	42	18
Vote confidence change (Δc)	0.38	0.41	0.38	0.34	0.82
N	149	186	122	38	17

Table 63. Vote confidence by intended disagreement (vote 2 - changed votes)

The threshold effect found with prior disagreement was not found for intended disagreement (this table shows only those cases where the vote changed, as where subjects do not change their vote d_{Old} and d_{New} must be identical). These results suggest that, when subjects changed their vote, the new group agreement had very little, if any, relation to the new vote confidence. In fact the highest mean increase in vote confidence occurred for voters who voted to disagree with everyone else. The small number of cases where this occurred mean little can be read into this. It could for example have been an attempt by outvoted subjects to use their confidence rating as a tactical attempt to influence others towards their position.

In conclusion, individuals seemed to gain confidence from exposure to the group position, even when that the group position contradicted their own opinion, and even when they continued to disagree with the group position. Moving to agree with the majority did not in itself generate any more confidence, but finding oneself in agreement with the majority, it appears, did generate an increase in confidence.

6.10 Overall comments

At the end of the session subjects were invited to e-mail a message to the experimenter with their overall impressions of the experiment, using the e-mail internal to FORUM DGSS. Groups 5 to 18 generated 61 such mail responses (a software problem prevented the mail function operating for groups 1-4). Subjects were especially asked to indicate which method they felt was the best, and why, as well as any overall impressions they might have. These messages were analysed to identify any themes.

6.10.1 The best method

As expected, a lot of comments indicated the group aware treatments (II and III) were the best (44%), although two respondents (both from the same group) felt that the blind method was the best, because it was quickest. Of the 27 messages which mentioned that the group aware treatments were the best, 8 did not distinguish between treatments II and III, such as:

This was quite fun however the blind test was annoying due to the fact that I could not compare my answers with other members of the group. The other two methods were far clearer and probably achieved a much higher percentage of correct answers.

The first one was the hardest when you couldn't see what the majority of the group thought was right.

This exercise was a very good way to see how groups made decisions as a whole. In exercise one [blind] you were very much on your own, in exercise two [confidence aware] you could judge exactly how the rest of the other group felt about their answers. In exercise three [group aware] you had a fair idea about how the other group members felt about their answers.

However 19 of the 27 replies felt that treatment III (group aware and confidence aware) in particular was the best method. The conclusion that the confidence aware method was the best, was overall the most consistently mentioned theme, being mentioned in 31% of all mail messages, such as:

. . . test one [treatment III] was really the only one that would be worthwhile, as it is much easier to make a group decision based on the weighting that each member gave their answer to each question.

Hmm I felt the see votes and confidence was the best, it allowed us to compare our answers and change them if we felt the rest of the group had a valid point. The see votes method was also far better than the see nothing method. The first method [treatment III] better allowed us to interact with others.

I think that the first way (votes and confidence) is the best one, because it relates more to what can really happen during a meeting. I found the two others ways inefficient -especially the last one [Blind] - in the help of common decision making.

This could be considered, surprising considering that treatment III, confidence aware, seemed to have made little practical difference in any of the measures taken, including the subject's perceptions of the sessions. However the same result was found in a similar earlier study (Lowry, 1993), where again confidence ratings had no practical effect but were considered valuable by subjects.

6.10.2 Waiting for others

A number of comments also noted that it was annoying having to wait for the last person in the group to finish before you could go on:

I enjoyed the test, however I did not like waiting on the other members of the group to put forward their answer so that I could carry on. I think that for most of the test I was just waiting on the other members of my group which was quite frustrating.

It was a really good session, except I think you need the same sort of people who would go at the same speed in each group.

The waiting was an artifact of the experiment. In a real asynchronous interaction task phases would have close date/times so subjects could make their contribution and then leave. After the close of the first vote they could then return to contribute a second time.

6.10.3 Process satisfaction

In designing this experiment, the experimenter was quite accepting that subjects would find the experiment boring, as there was no discussion and no commenting, and the questions were simple multi-choice, and were not very emotive or personal questions. However during the experimental sessions, subjects gave a great deal of attention, and mostly did not look bored. And in the unsolicited comments a number of participants said they enjoyed the process, or found it interesting or intriguing, or even *fun*. One explanation is that subjects were making these comments to please the experimenter, and there will be an element of this. Another explanation is that exposure to group position information is a naturally arousing activity, even without rational information exchange, and even without personal interaction:

I enjoyed using this system. I found the feedback from the other group members useful answering questions that I was uncertain of.

However it was fun and interesting to find out what the others had answered especially in questions where you were unsure of the answer.

This was quite fun however the blind test was annoying due to the fact that I could not compare my answers with other members of the group.

Thanks for the opportunity, Brian! Educational and useful to demonstrate alternative means of communication. I really enjoyed it and I hope our group will get the tickets.

This is a very interesting and wonderful way to make decisions.

These comments support the earlier idea that voting can be a form of human communication, but rather than from individual to individual, this communication is from individual to group, and from group to individual. This form of communication can even when only valence information is exchanged. It may be that the group normative process provides the energising emotional satisfaction experienced in group discussion, as well as generating agreement and confidence.

6.11 Summary of results by hypothesis

The outcomes for the experimental hypotheses proposed are as follows:

H1a *That in an anonymous electronic group, facing a group task, the availability of group position information alone, in plain text form, will result in significantly less disagreement compared to when such group position information is not available.*

SUPPORTED

H1b *That in an anonymous electronic group, facing a group task, the addition of plain text confidence information will not result in less group or individual disagreement, compared to when such vote confidence information is not available.*

THE EXPECTED RESULT WAS FOUND

H1c *That in an anonymous electronic group interaction, the availability of lean text group position information alone, in plain text form, will exert a continuing but decreasing effect on disagreement across repeated votes.*

SUPPORTED

H2a *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more confidence, for a group task, compared to when group position information is not available.*

SUPPORTED

H2b *That in an anonymous electronic group interaction, the addition of plain text confidence information, will not result in more individual vote confidence, for a group task, compared to when vote confidence information is not available.*

THE EXPECTED RESULT WAS FOUND

H2c *That in an anonymous electronic group interaction, the availability of lean text group position information alone, will exert a continuing but decreasing effect on choice confidence across repeated votes.*

NOT SUPPORTED

H-PS *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more perceived process satisfaction, compared to when group position information is not available.*

SUPPORTED

H-PA *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more perceived group agreement compared to when group position information is not available.*

SUPPORTED

H-GA *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more perceived group awareness compared to when group position information is not available.*

SUPPORTED

H-TC *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more perceived task correctness compared to when group position information is not available.*

SUPPORTED

H-DA *That in an anonymous electronic group interaction, the availability of plain text group position information alone, will result in a significantly more decision acceptance compared to when group position information is not available.*

SUPPORTED

H3a *That groups will generate more disagreement on the preferential questions than the intellectual ones.*

SUPPORTED

H3b *That groups will have lower confidence on the preferential questions than intellectual ones.*

SUPPORTED

7. SUMMARY AND DISCUSSION

This chapter will summarise the major theoretical and experimental conclusions of this study, discuss the experimental results found in terms of their theoretical implications, and finally discuss the contribution of this study and its implications for future practice and research.

7.1 Summary

This section repeats the summaries given at the end of each subsection throughout main text.

7.1.1 Communication setting

Based on a review of research and theory related to communication setting, focusing on the area of GSS, it was concluded that:

1. Regarding the communication setting:
 - a) The traditional communications model of Sender-Channel-Receiver must be extended to a Sender(s) - Transmission interface - Receiver(s) enhanced model, to account for multi-media signals, network transmissions and intelligent communication interfaces,
 - b) The communication setting is defined by the properties of the transmission interface,
 - c) Attempts to characterise communication settings based on the single media dimension of “richness”, over-simplify the real variety inherent in communication settings,
 - d) Media “richness”, even as one feature among many, appears to be less significant to users than previously thought,
 - e) Comparisons between communication settings (e.g. face-to-face vs CMGS) tend to confound many properties, including some properties of the communication as a whole, and therefore are difficult to interpret,
2. Media preferences attributed to task equivocality may equally be attributed to interpersonal relating, and if so, choice of rich types of communication setting may be less because they remove ambiguity than because they support it, as a social lubricant,
3. In communication, the transfer of meaning or information is not solely a property of signal transmission, but depends also on abstract shared constructs by which the receiver creates meaning,
4. Media richness and cues filtered model predictions that CMC and CMG provide “cold”, socially ineffective communication settings, must be moderated by whether a relational or social context is in place,
5. Regarding many-to-many communication:
 - a) The well known one-to-one, and one-to-many, forms of communication linkage, can be extended to the concept of many-to-many communication, this dimension giving increasingly powerful and condensed forms of communication,

- b) The defining feature of many-to-many communication is the ability of the transmission interface to process many signals into one without losing significant information,
 - c) A task situation that requires many to communicate with many seems to be the critical defining characteristic of informal discussion meetings,
 - d) Many-to-many linkage provides a highly condensed form of communication, which is especially suited to discussion situations, and occurring either through non-verbal back channels or through comment valence, may be what allows group members to contribute to and keep in touch with the group position in dynamic group discussions,
 - e) Formal voting is an example of many-to-many communication, but in face-to-face situations takes so long that it is infrequently used,
6. Communication setting complexity, asynchrony, linkage, and transmission cost were suggested as important features which could be defined independently of sender, message and receiver, and which could be used to define a taxonomy of communication settings, which suggested that:
- a) The natural communication settings for successful computer-mediated interaction seem to be asynchronous ones,
 - b) Computer-mediated interaction reduces transmission cost and lowers the messaging threshold, allowing more spontaneous interaction, rather than creating new communication settings,
 - c) A single GSS may include several distinct communication settings (eg E-mail, bulletin board, and voting),
 - d) Processing by the transmission interface embodies the rules of the computer-mediated social environment created by the CMGS designer, whether intentional or not, and there are marked differences between different systems in this regard,
 - e) CMGS research into the differences between communication settings will be clearer if it varies only one property of communication setting,
 - f) Comparisons should recognise that different communication environments may evoke naturally different methods for the same task (cf. locomotion is achieved by swimming in water and walking on land),
 - g) Research into electronic group process activities will be clearer if it is carried out within a single communication setting, and preferably within the same CMGS,
7. Comparisons between GSS and face-to-face groups suggest that the weak generalisations that GSS improves task focus, may improve task performance, and increases equality but results in less consensus and decision acceptance, lower process satisfaction, and usually takes longer,
8. Very positive decision room findings seemed to contradict general GSS findings, but on closer examination the differences were attributable to confounding variables, a favourable research design, and a lack of controls. When these conditions were rectified decision room style results seem to fall in line with the results of other studies,

9. The exception to the trend that CMGS has difficulty generating agreement was Converse, which offers limited “few-to-few” linkage over a plain text network, which suggests that linkage is more important in agreement generation than media richness.

The main conclusion of this section was as follows:

If

- Media richness is less significant than supposed
- The natural communication setting for computer-mediated interaction is asynchronous
- The critical defining characteristic of informal meetings is many-to-many interaction
- Voting is a form of asynchronous, many-to-many communication that is very slow
- The main contribution of computer support is to reduce communication transmission cost

Then

An asynchronous, many-to-many, plain-text communication setting may provide a natural base for computer-mediated groups, one where the computer could provide the processing power to manage a many-to-many interaction which simulates the informal vote type process it is proposed occurs in dynamic, face-to-face group discussions.

This conclusion is contrary to what would be expected from media richness, cues-filtered-out and rational information exchange theories.

7.1.2 Task

In a review of research and theory on task and task type, focusing on the area of GSS, it was concluded that:

1. Tasks are usually defined in terms of the behaviours they elicit in the individual, and McGrath’s commonly used task type classification is based on this property of tasks,
2. Since the behavioural set elicited by a task can be very large, this equates to defining a task as goal directed behaviour,
3. Unless *group task* is to imply a group can have a goal, it must mean all members of the group hold a common behavioural goal, which implies a cooperative group,
4. The behaviour elicited from an individual given a task in a group is different from the behaviour elicited when the same task is given to them alone, therefore the “same” tasks given to individuals and to individuals in a group are not the same tasks, and “task”, as defined, is not an objective entity,
5. The extra interaction work required by group tasks includes combination, coordination, control, and confidence generating activities, and the first, (combining group member contributions, either additively, conjunctively or disjunctively), is a necessary requirement for group tasks,
6. Individual task-focused measures, such as number of different ideas brainstormed, are not sensitive to non-task group output, such as the development of common understanding, generation of agreement, and development of personal relationships,

7. The combination of individual contributions could be considered to be a task in itself, but this approach generates confusion regarding the term “task”,
8. Process loss theory interprets non-task interaction activities as “process losses”, implying they are best eliminated, and explains the “group effectiveness problem” in terms of process losses. It raises the paradox that people join groups, exert effort to interact, and yet generate a negative result in task terms (compared to what they would have done had they worked alone). It is a one-process model,
9. The integrative model provides a more positive perspective to group interaction, and attributes (task) process losses to aspects of the model outside the task process, namely:
 - a) **The group process.** Group combining activities are attributed to a purposeful individual and group process generating group unity,
 - b) **The interpersonal relating process.** Evaluation apprehension (a proposed process loss) and other interpersonal effects are attributed to a purposeful process of relating to others, and
 - c) **The communication setting.** Production blocking and similar proposed process losses are attributed to the synchronous nature of the communication setting, which makes turn taking necessary, and does not store communications,
10. The integrative model explains group interaction in terms of positive processes, rather than as a task distraction, and does so without paradox.
11. It avoids the need for the concept of *group task* by recognising the *group combining process*, which, although it can occur in many ways, is generally considered by the integrative model to be a *social* combination process,
12. In face-to-face brainstorming groups, the process generating group agreement reduces member diversity, which reduces the number of task ideas produced by the group, and hence task performance,
13. Process loss theory has been extended to include process gains, theoretically introduced by GSS, but:
 - a) The success of both computer-mediated and nominal groups at act generation tasks, seems to mainly reflect the absence of the group process that generates agreement in face-to-face groups, and, i.e. like a set of individuals that do not interact.
 - b) GSS groups seem to work like nominal groups. The information exchange provided by GSS does not appear to produce significant process gains, compared to nominal groups, matching the earlier finding for face-to-face groups that synergy is generally a rare occurrence,
 - c) Other GSS gains seem mainly due to the communication setting, and contingent upon task,
14. Across a variety of task types, the task process operates as well in electronic groups as it does in face-to-face groups,
15. Across a variety of tasks, the group process responsible for cooperation and the generation of agreement operates poorly in electronic groups.

The main conclusion of this section was that computer mediation changes the normal balance in groups to favour the individual, rather than the group. It is able to support the task resolution process effectively, but not the process generating group agreement. Therefore this study has focused on the generation of agreement as the major weakness that must be addressed by computer-mediated groups.

7.1.3 Interpersonal relating

Based on a review of research and theory on relating, focusing on the area of GSS, it was concluded that interpersonal relating:

1. Involves the creation of a cognitive construct, the relationship, which may have an effect even before relational communication starts,
2. Allows information about the other person as an individual to be carried forward from one communication to the next, giving a basis for familiarity and predictability,
3. Operates in a one-to-one manner,
4. Begins with personal identification and recognition of the other person,
5. Does not operate well if the other person is not recognisable or anonymous,
6. Involves arousal and affect, perhaps based on the psychological process responsible for social facilitation (the change in behaviour that occurs when individuals feel they are being watched), which may be either positive or negative,
7. Is a two way turn taking process,
8. Develops through interactive steps of mutual self disclosure to increasing levels of understanding and intimacy,
9. May use ambiguity to support this process of mutual adjustment to the other person,
10. Is evoked when subjects believe they will meet the other person again and be recognised,
11. May be naturally evoked by rich communication settings where communication involves unique sender information, such as face or voice, even without verbal interaction,
12. May occur across electronic channels, using plain text, especially if subjects have a relational context.

The main conclusion of this section was that interpersonal relating is a one-to-one interactive process, distinct from group influence, and relational context should be distinguished from the group or social context shortly to be discussed. If communications in a group are anonymous, and contain no sender signature information, this prevents the relationship from developing, as it prevents relational information from carrying forward from one communication situation to the next.

7.1.4 Group

Based on a review of research and theory on group influences, focusing on the area of GSS, it was concluded that:

1. Cohesive groups generally have common attitudes and conduct, and tend to agree. The cohesive force, common in face-to-face groups, seems to be missing in most computer-mediated groups,
2. Cohesion has traditionally been conceptualised and operationalised as sum of the interpersonal attractions between members of the group,
3. However cohesiveness occurs in groups whose members dislike each other, does not correlate with measures of interpersonal relations, and occurs equally strongly in large groups where interpersonal relations are not feasible,
4. Identification is one of the traditional forces of social influence, and has a powerful but implicit effect on behaviour,
5. Social identity theory states that when an individual joins a group, the "social identity" of the group becomes part of the personal identity of the group member,
6. Social identity theory makes a clear distinction between social attraction, based on group identification, and interpersonal attraction, based on personal like and dislike of individual members of the group,
7. In conformity experiments, people adjust to the group position, not because of any rewards, reasons, rationality or friendships, nor due to any direct or external pressure from other group members, but because they have taken on a common identity, the identity of the group, and to disagree would contradict the identity they have assumed,
8. Social identity theory provides a general theory of group interaction, based on cognitive processes, that applies to groups of all sizes, and accounts for a wide variety of social phenomena (conformity, stereotyping, discrimination, prejudice, ingroup cohesion, deindividuation, inter group competition and polarisation), without positing the operation of anything beyond that which occurs in the mind of the group member,
9. There is a tendency to see the group unifying process only in a negative light, as labels like conformity and "groupthink, particularly if it is operating in isolation, but operating alongside a task resolution process and a personal interaction process, its contribution is generally beneficial,
10. Polarisation is due to group influence. It occurs more in computer-mediated groups than in face-to-face groups, not less, and does not require a rich medium of exchange. Polarisation research suggests that individual salience, as when face-to-face, negates group influence, even if subjects do not communicate face-to-face,
11. Adaptive structuration theory proposes that technology is appropriated according to the larger social context, and only systems that support existing social patterns will thrive,
12. Confidence is raised when subjects are in agreement with the group position, and lowered when subjects find themselves disagreeing with the group position,
13. The generation of agreement in groups may occur through the exchange of relatively simple position information, or choice valence, rather than through the exchange of complex "social" information, i.e. social information (as opposed to interpersonal information) is neither complex nor "rich",

14. The major force generating agreement in groups may involve an impersonal group normative process, based on the identification of the individual with the group, where individuals position themselves relative to the group until a clear group position emerges,
15. In cooperative groups involved in informal face-to-face discussion, a process of many-to-many exchange is proposed to occur, via back-channels or comment valence, which effectively involves an on-going informal "vote", which elicits the group's position, and evokes normative influence. This implies that in group discussions,
 - a) Group members will tend to immediately propose solutions, as part of the process by which the group position is elicited,
 - b) Group members will show a marked interest in the positions of others,
 - c) They will position themselves relative to what they perceive as the group position,
 - d) Rational information exchange is not necessary for this process,
 - e) Rational conflict resolution is not required for agreement to be generated in this way,
 - f) If the group cannot agree, group member confidence will go down, and likelihood of individual position change will go up,
 - g) There will be a threshold effect, and once a group position emerges, any alternative proposed after this is unlikely to be accepted.
16. The necessary and sufficient conditions for the operation of the group unifying process are:
 - a) **Common group task.** The group is facing a situation or task which requires a cooperative group response, and whose consequences accrue to the group as a whole,
 - b) **Available group position information.** The individual group member is aware of the group position (if any) and can easily compare the group position to their own position,
 - c) **Group identification.** The individual perceives him or herself as a member of the group and expects to be congruent with the group in this situation,
17. Since there is nothing in any of the above conditions that obviously demands a rich medium of communication, group normative influence should be able to operate in distributed computer-mediated groups interacting through plain text communication channels.

The main conclusion of this section was that the group unifying process is a powerful influence on behaviour, separate from interpersonal relating and rational task analysis, which can operate in a computer-mediated environment. The view that agreement is generated in meetings only when some group members successfully win others to their position by personal influence (Sia et al., 1996b) is challenged. Rather it is suggested that although personal or rational influence may be used to tip the balance, group influence provides the main social driving force for the generation of agreement.

7.1.5 The integrative model

The integrative model proposed can be summarised by the following propositions regarding cooperative groups:

1. The nature of group activity derives from the nature of individual activity,
2. Group activity operates on three levels, attributable to three separate individual and group processes, and can only be partially explained by a one or two-process approach,
3. Each process has a different nature and arises from a different source, is subject to different conditions, uses different inputs and generates different outputs, and can therefore operate independently, and be isolated experimentally,
4. The processes generally interact to create consistency, because they arise within a single individual,
5. Because the three processes arise independently, and can operate in parallel, they give rise to occasional paradoxical inconsistencies in behaviour,
6. Process inputs and outputs are multi-threaded to accommodate the parallel processes,
7. The three processes represent the three aspects of the communication situation - the sender, the message, and the receiver (the communication setting is considered to be background),
8. The unit of operation for the task process is the individual, for interpersonal relating it is the dyad, and for the group unifying process it is the group,
9. Cooperative groups produce not only task output, but also relational connections, and group unity or agreement,
10. Individuals in cooperative groups may work not only to resolve the given task, but also to relate personally to others in the group, and to develop and represent the group identity, depending on the salience of the task, the other individuals, or the group,
11. The three processes are normally intertwined with respect to behavioural outcomes of group activity, and may interact in complex ways.

The integrative model takes the focus away from the communication setting and turns it to the human processes operating within that setting. Inherent to this approach, and to the integrative model, is the idea that groups don't make decisions, only individuals do. Groups generate agreement and confidence. Software that aims to help groups come to better decisions need only help individuals in the group make better decisions.

Also inherent in the model is the idea that any process can affect any output. For example, task decisions about people may need to take into account the conditions and nature of those people, information often only available through interpersonal relating. Conversely disagreement over task analysis can lead to personal dislike, as can non-conformity to norms.

7.1.6 Experimental results

The main experimental results were:

1. **Disagreement.** Many-to-many exchange of group member positional information alone:
 - a) Radically reduced group disagreement, and

- b) Increased vote confidence,
2. **Score correct.** The individual score correct was significantly higher for the group aware sessions, compared to the blind sessions, which could be attributable to the benefits of normative influence, as the blind group was more likely to be correct (52%) than chance (25%),
 3. **Likelihood of vote change.** Subjects tended to remain with their previously internalised position, but proportion of vote change increased as the disagreement of the individual with the rest of the group increased, showing a threshold effect as the individual became part of a minority,
 4. **Direction of vote change.** Vote change seemed to be related not only to the probability that the subject's current position could form a group position, but also to the probability that an alternative position could form a group position,
 5. **Confidence.** Finding one is already in agreement with the group, raised individual confidence, but changing one's previous position to match the group's position, did not immediately do so,
 6. **Group identification.** Subjects' satisfaction with the task process, their agreement with the group decision, their confidence that the group's answers were correct, and their commitment to the group decision, interrelated to form a single factor, which was called group identification, suggesting that group agreement, process satisfaction, task solution confidence, and group decision commitment tend to go together,
 7. **Individual identification.** Subject's dissatisfaction with the task process, their disagreement with the group decision, their belief that the group's answers were incorrect, their lack of enjoyment of the process, and their degree of self rather than group focus, formed a factor that was called the individual identification factor, which was separate from the group identification factor.

The finding that group identification and individual identification were separate factors suggests that individuals can both identify with a group *and* identify with their own position. This may have led to the apparent contradiction of a low correlation between questions asking whether individuals agreed with the group and whether they disagreed with the group, questions that were expected to factor together. From the perspective of the integrative model however it is possible that individuals could have strong identification with a group, and at the same time feel strongly about their individual position.

7.2 Discussion

7.2.1 Generating agreement in groups

Figure 22 shows the change in group disagreement brought about by the main treatment. Why did the exchange of a few characters of textual information produce such a significant change?

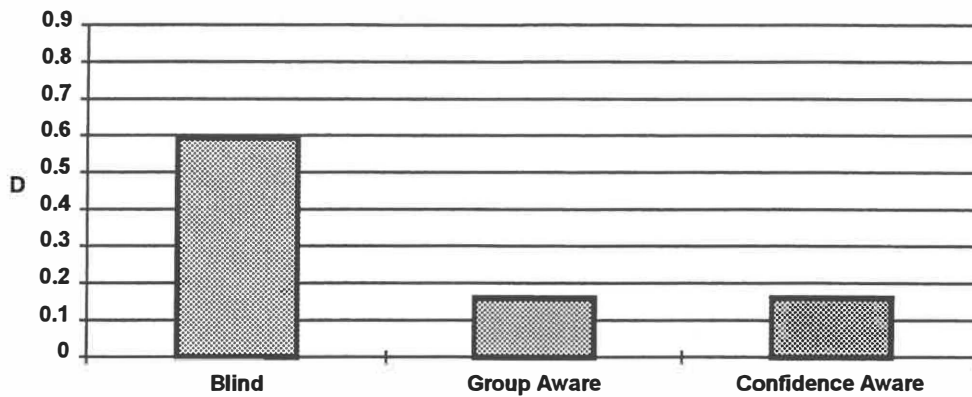


Figure 22. Average group disagreement by treatment

The interaction was not through a “rich” medium, nor could the information exchanged be described as “rich”. No reasons were given to convince people to change their position. The questions were very varied, and half of them had no real correct answer. There was no personal context or social presence operating around the communications. There was no basis offered for the development of trust, nor any support for persuasion of any form. There was certainly nothing that could be called a discussion, and a more impersonal form of interaction could hardly be imagined. Yet after only two rounds, the treatment groups achieved 66% consensus, compared to 9% for the blind baseline group. The change in distribution of disagreement is shown in Figure 23 ($D = 0$ means unanimity, $D = 0.0 - 0.7$ is a majority, and $D = 0.8 - 0.9$ is a hung group). As can be seen, in the group aware treatment a majority decision was reached in all 204 cases.

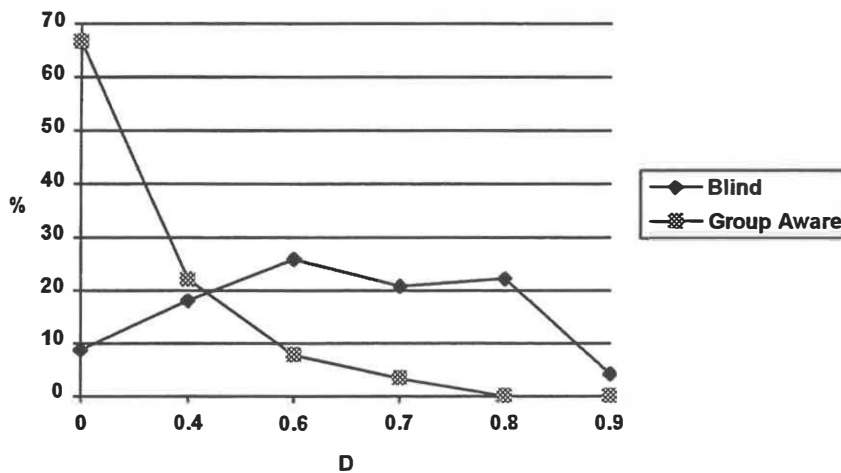


Figure 23. Disagreement frequency distribution by treatment

The integrative model suggests that the group aware treatment was effective in generating significant group agreement because it successfully invoked the process responsible for generating agreement in groups. It provided both the necessary and sufficient conditions for the generation of agreement in groups. This matches the results from polarisation studies, which suggest that group

normative influence is *more* effective in computer-mediated groups than in face-to-face groups, rather than less. Face-to-face groups provide a complex multi-process situation, where group normative influence may tend to be neutralised by personal interactions, unless good task reasons are applied (Sia et al., 1996).

The vote change caused by normative influence was not a sudden one since, as shown in Figure 24, group disagreement continued to drop on the third vote, though not as much, but still indicating a continuous influence operating against the natural inertia of individuals to remain with their previous choice. The graph suggests a curvilinear relation with diminishing returns for increasing vote rounds. This continuing influence does not imply the operation of a simple rational or factual one-off effect.

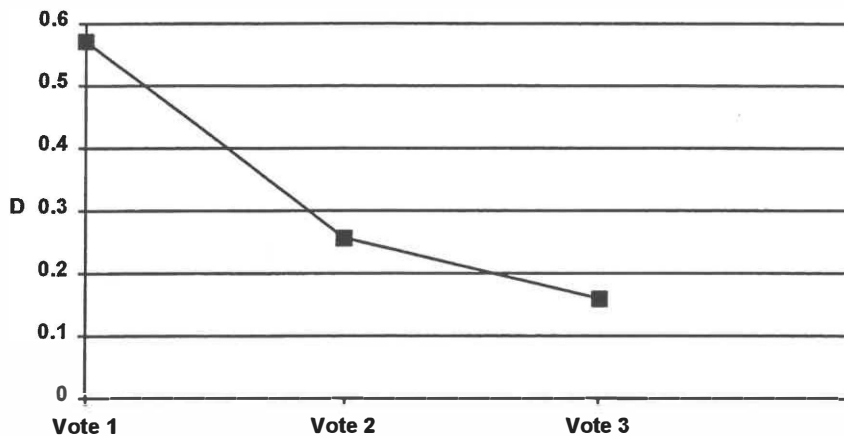


Figure 24. Average group disagreement by vote set

The low number of *Don't Know* responses (2%) to the questions asked is an interesting result in itself. Half of these questions had no correct answer at all - they were infinitely difficult - yet participants hardly ever chose the *Don't Know* option. One can understand the need to take a position on the final vote, but there were two straw votes before that. Why didn't subjects choose the rational *Don't Know* response more often? It seems that "It does not compute" is not a common response option for human subjects. One explanation can be given in terms of the normative process which it is proposed is taking place. For this process, *Don't Know* is very unhelpful to the group, and if everyone responded this way, the process would fail. Group members must take a position in order that a group position can emerge, and perhaps they did just that. On a group level, even if an individual does not fully know, if they contribute *some* information, then individual errors should balance out.

The conformity experiments suggest that exposure to minimal group position information can produce strong normative influence. Polarisation research also suggests that computer-mediated interaction increases, rather than decreases, group normative influence, because of a reduction in individuation. The degree of this effect is shown in Figure 25, which gives the percentage of individuals who changed their position as a function of the amount of disagreement they experienced as individuals.

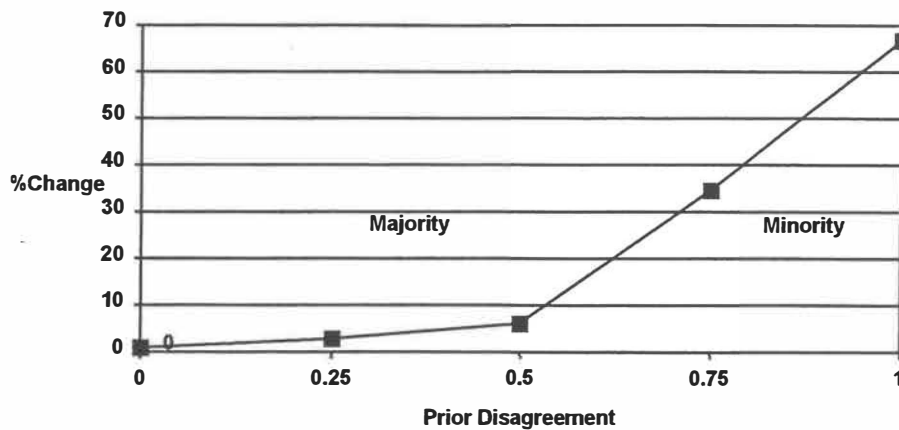


Figure 25. Vote change by prior individual disagreement

The graph demonstrates the effect of being in a minority on likelihood of vote change. As one subject in this experiment commented:

Discovered the power of the group to influence others in decision making . . . Very aware of the group in the decision making process even though not being able to communicate with them. In the last test [Blind] it was very hard to make decisions without the support of the group.

People instinctively believe that it is in their best interests to be with the group, and instinctively fear if they are not in any group. If computer-mediated groups are to “thrive”, CMGS must accommodate and support this natural group process. The experiment carried out in this research shows this is possible, and computer mediated groups can invoke the same process that generates agreement in face-to-face groups, and make it work across a distributed, plain-text computer network.

7.2.2 The interpersonal process

Why, by contrast, did the exchange of vote confidence information, in essentially the same manner as was done for position information, have no additional effect on group disagreement? It could be expected that if the position of group members influenced the individual’s choice, then knowing how confident each group member was of their choice would provide:

1. More rational task information, or
2. More reason to be influenced by the position.

This did not occur, contradicting the view that informational influence or personal influence generate agreement. A similar experiment, which predicted that personal influence would have an effect, tried three times to generate it, but was forced to conclude, as here, that personal influence has no significant effect on agreement, or if there was it was small (Lowry, 1993). It is from studies such as this that the conclusion that computer-mediated groups cannot easily form agreement derives. However this study shows that the opposite is true.

If group normative influence was a one-off effect rather than a continuous influence, it could be argued that there was no room for further improvement due to the confidence influence, however the normative effect seems to be a continuous influence operating against the equally strong tendency of the individual to remain with their initial decision. If voter confidence had any influence, it should have added something, even if only at vote 2.

The integrative model however predicts the result found. It proposes that confidence is not part of the normative process generating agreement in groups, because it has no effect on the merging operation that is at the heart of the social process generating agreement. In democratic groups, when the votes are counted, all group member positions are equivalent, as everyone is just “a group member”. Confidence represents a personal state, and therefore can be expected to be relevant to the interpersonal relating process. However in this experiment, the interaction was anonymous, which prevented the interpersonal process from operating effectively. Since the process voter confidence is expected to be part of did not operate, and it was not part of the process which was operating, it is not surprising that confidence was found to have no effect on disagreement.

Yet after the experiment, of the comments that mentioned treatment differences, 70% reported that they felt that treatment III (Confidence aware) was the best of the three interaction methods. For example:

Test 1 [Blind] This one was the hardest to do as there was no feed back Test 2 [Group Aware] This was a lot better as there was the opportunity to gain consensus. Test 3 [Confidence Aware] was the closest to face to face discussion. Quite an interesting system.

The comments suggested that subjects were comparing the methods to the situation they knew best, face-to-face interaction. In face-to-face interaction, confidence is relevant, because the interpersonal relating process can operate, and in this case subjects might be more likely to internalise (or be persuaded by) the position of someone who is very confident. Therefore they might expect confidence information to improve the interaction by providing relevant personal information. However although many subjects expected confidence to have an effect, their behaviour responded not to their expectations but to the reality of the situation, which was that under anonymous conditions the interpersonal process could not operate, or if it did, it did so only weakly.

7.2.3 Task process

The experimental design excluded the exchange of task information for research purposes only. It is not proposed that task information exchange is unnecessary in CMGS. Several subjects provided unsolicited comments indicating that they missed being able to discuss the questions, such as:

I found it slightly frustrating not being able to communicate or discuss the questions. Apart from that I found the exercise intriguing.

Very interesting to take part in the experiment. It makes a forced choice however. No discussion between group members in the true sense of the word.

As one subject pointed out, lack of discussion meant that there was little learning or creation of common understanding:

It is a good way to make decision. It can save a lot of time, while [there is] no argument, no time is used up for one by others. But not discussing is not helpful to the person's understanding.

7.2.4 Interpersonal process

What occurs when groups cannot achieve a majority and are split? In this case other processes may play a significant role, in the form of personal influence or appeals to reason. The group cohesive process implies that in such groups it is not necessary to convince everyone. It may require only a few people to be swayed, using personal or expert influence, to bring the whole group around. The integrative model does not deny the role of personal or rational influence, but only allocates them a secondary role in the generation of agreement.

There is no doubt in the author's mind that the absence of informational and personal information was felt, as illustrated by the following subject comment (author's emphasis):

I felt the influence of others in my decisions. Where I felt my decision to be correct, and saw the entire group disagree, I felt powerless to influence them. However, where I was uncertain of my decision, it was great to be able to see what the majority of the group felt. Cheers, it was fun, and reasonably interesting.

Although the subject felt supported by the group, and gained confidence from the group, they also at times felt unable to exert *personal influence* on the rest of the group, and this brought with it a sense of individual powerlessness.

7.2.5 Combined processes

It is not hard to see how the group cohesive process could underlie or influence a great deal of apparently rational discussion. Within the context of a discussion, and working with the other two processes, it would provide valuable closure, and raise confidence. If it can be assumed that individuals have thought out their individual positions, group influence is complementary to the task process. However where individual task analysis has not occurred, the results can be disastrous (Janis, 1972). The term *groupthink* (Janis, 1972) poorly describes the group process presented here, which is not a thinking process at all, but a social unifying process. The integrative model implies that groups don't think at all, only individuals do.

The method adopted in this study, where the group normative process worked in isolation, is not recommended for practical application. It was adopted solely to demonstrate the effect. The three processes proposed are naturally designed to operate together in a complementary fashion. As reported by one subject after the experiment:

I enjoyed the session. I can now see how we are easily led by decisions others have made and make strongly. I'm not sure if I would like to make all my decision this way - I feel I would be strongly pulled in the majority direction rather than going with what I truly feel and know. I also miss the feedback from discussion with others and verbal communication.

This comment expresses the dynamic tension between group influence and individual judgement, as well as a desire for person-to-person interaction and mutual understanding that was missing from this experiment.

7.3 Research contribution

The contribution of this research lies on two levels, the experiment itself and the integrative model which it supports.

The main significance of this research lies in its support for the integrative model of group interaction. The general area of group interaction contains many theoretical models. Some focus mainly on one process, usually the task process, such as media richness theory (Daft et al., 1987), process loss theory (Hackman and Morris, 1983), and theories of rational information exchange (Huber, 1984; Winograd and Flores, 1986), although it is more common to find recognition of two distinct levels of analysis, for example task vs socio-emotional (Bales, 1950), informational vs normative (Deutsch and Gerard, 1965), task vs social (Cues Restricted theory, Sproull and Kiesler, 1986), social vs personal (Social Identity Theory, Hogg, 1992), or interpersonal vs social (SIDE, Social Identification/Deindividuation model, Walther, 1997). In other words, the concept of multi-level group activity is not new, but few models go beyond dichotomies. McGrath (1990) has proposed a three-process model (TIP, Time Interaction and Performance, McGrath, 1990), with many similarities in its form to the integrative model, but differing on some of the key entities. The integrative model derives from an interpretive approach, looking from the perspective of individual within the group, rather than of the experimenter without. Working from the same perspective, Finholt and Sproull (1990) proposed three very similar processes, although little else in their model matched the integrative model. The integrative model seems to be unique in extending three distinct conceptual levels of behaviour consistently across the input-process-output framework generally used by theorists. It offers a theory with both wide applicability and conceptual parsimony. Its contribution is to provide a general conceptual framework which, as has been shown, can explain a wide variety of current findings in a reasonable manner.

The integrative model does this by incorporating recent advances in social psychology. Social identity theory has been the key to unravelling the knot that has historically bound interpersonal and social activities together. It is essentially a cognitive theory, that posits a link between two constructs which do not exist objectively - the group and the self. Adding social identity theory to previous two-process models such as Bales (1950) has produced the integrative model, which therefore is also a cognitive theory. It leads to a clear prediction that runs contrary to the expectations of logical, positivist theories, namely that group influence can operate across lean electronic networks, and that distributed, computer-mediated groups can easily enact agreement, without using reason, and without requiring social presence. To demonstrate that normative influence alone generates agreement is difficult in dynamic face-to-face groups, because the three processes are so closely intertwined. Computer mediation allows the strand of group influence to be separated in an obvious fashion, and this experiment has shown the prediction to be true. This not only contradicts many previous theories, it also call into question the whole logical, positivist approach upon which those theories are based, not as a basis for experimentation, for which positivism remains the established paradigm, but as a basis for theorisation. It suggests that there is no substitute for an understanding of the psychological processes upon which behaviour is based.

The experiment itself provides clear evidence that distributed computer-mediated groups can enact agreement. The implication of this finding is to suggest that real groups can exist in electronic environments. In fact it predicts that they probably already do exist, and ethnographic Internet studies concur (Giese, 1996; Surrat, 1996). It suggests that the "special something" that generates agreement in face-to-face groups is group member position information which gives rise to information about the group position. In doing so it parallels findings on interpersonal relationships, which appear likewise to be able to operate in computer-mediated settings.

Is it somehow demeaning that human personal and social endeavour is possible across the wires that link computers? If technology were the measure, then that may be so, but if humanity, not machinery, is the measure, then the computer and its software is simply the setting within which human activity proceeds. Communication technology does not determine the humanity of the communication. We talk face-to-face using air molecules by a procedure that is as mechanical as any computer. The telephone, radio, and television are all machines, yet humans are no less human for using them. Computer interaction is just another vehicle. It is rather a tribute to the adaptability of human interaction, that it can grow, and possibly flourish, in what at first seemed to be a barren and hostile environment.

In summary, the main contribution of this research is to suggest a new approach to computer-mediated activity, one based on the human processes that create behaviour, rather than the technology which envelops it.

7.4 Future directions

This research suggests some future directions for the field of computer-mediated groups on practical and theoretical levels.

7.4.1 CMGS design

In the design of computer-mediated group support systems it is suggested that:

1. The existence of group normative and interpersonal processes, as well as the task process, be recognised in the design of system functions, as all three processes have important roles in group interaction,
2. The technology design allows the communication setting to be adapted to the requirements of the task meeting situation, as suggested by contingency theory,
3. The option for the choice to initiate actions be vested more in the individuals in the group than in a centralised meeting controller (or facilitator) method,
4. That informal group voting, as a form of many-to-many communication, be explored for its potential to assist in the generation of agreement.

7.4.2 Limitations and further research issues

Some research questions left unanswered by this study are:

1. **Group size.** Is the normative effect independent of group size, as might be expected? In different size groups, does the amount of vote change in response to different group agreement patterns match the tendency found for groups of five to maximise probability of group agreement?
2. **Conflict resolution.** What is the contribution of conflict resolution to the generation of group agreement? For example, it might serve to “inoculate” the subject against later informational influence of that type. Does the vote change pattern found in this study replicate for different size groups?
3. **Interpersonal interaction.** Would making the votes signed affect group agreement? Would allowing person-to-person interaction (e-mail) increase or decrease group agreement?

4. **Task information exchange.** What would be the effect of anonymous task information exchange on agreement?
5. **Task difficulty.** If the questions were such that subjects were more likely to be wrong than right, would group influence reduce score correct?
6. **Effect continuity.** Would a fourth vote round still produce more effect?

7.4.3 Research methods

This study suggests that in computer-mediated group research:

1. Measures should be taken of the output from all three processes, and that task measures include group learning results,
2. The complexity of communication setting beyond media richness should be recognised,
3. Which group interaction processes are likely to operate in the given situation should be clearly stated, as different hypotheses are likely to arise from different processes,
4. Group processes can be investigated by isolating them, or by separating their effects when they are working together.

The principle of isolating or separating out processes for the purpose of study seems to be a good way to reduce the complexity of the situation. A good example is the study by Casey et al. (1984), who fed discussion information to subjects as if from the computer, and thus isolated the exchange of task information. From this they were able to conclude that the effect of task information exchange on performance was only quite low, a result that has been born out by more recent studies (Pinsonneault et al., 1997). The study by Sia et al. (1996) separated task and normative processes, by presenting positions with arguments, and positions without arguments, and was thus able to clarify the old problem of persuasive arguments vs social comparison theory. This study has isolated the exchange of normative information, and was thereby able to demonstrate the effect of that process alone. It should be possible to isolate the personal interaction process in a similar way, perhaps by restricting information exchanged to subject information and personal states. This method requires a clear understanding of the three processes. For example, as noted, interpersonal relating can be evoked simply by face-to-face exposure, even without any verbal interaction.

7.4.4 Other issues

Some other key issues emerging from this study are:

1. The importance of research into multi-process interaction,
2. The possibility of simulation of group behaviour on computer models based on individual probability estimates, and
3. Ethical and integrity issues.

The integrative model suggests the complexity of group interaction arises less from the complexity of individual processes than from their dynamic interaction. What occurs when processes interact may therefore be a major area of future research (see Lea and Spears, 1991; or Sia et al., 1996, for example).

The normative process seems amenable to dynamic computer simulation, whereby the computer could simulate the behaviour of each individual in the group, using probabilistic rules. Such simulations could be calibrated on results reported earlier. If such a model then demonstrated the

classic properties of groups, such as in-group out-group discrimination, and polarisation, then this would be a major step forward in understanding group dynamics.

Finally, if the exchange of group information can have such powerful effects, there needs to be some guarantee of its integrity. Otherwise the group's "results" could be inserted by the person running the network. Dealing with such problems is part of making the electronic environment practical. For example each individual could have a "signature" which is added to all signed communication and cannot be altered, whether an e-mail, a bulletin board notice, or a vote, allowing verification of authenticity.

7.5 Final words

In creating systems and theorising about electronic groups it is easy to presume human nature is what we would like it to be. We see into galaxies, and alter DNA, but still so poorly understand ourselves. Perhaps we see in ourselves only what we want to see, the *sapiens* side, the side that flatters us. We change nature around us, but can we change our own nature? Do we want to? If we are, as proposed at the beginning, group animals, should we deny our basic desire to make "group adjusted" decisions?

Technology can lead or technology can follow, but technology that does not fit human nature is likely to be adapted to fit, or even discarded, by the people that use it. This suggests that the development of theory and practice in new areas of technology, such as computer-mediated groups, will proceed best if it seeks to follow rather lead human nature.

This concept, presented by Adaptive Structuration Theory, does not fit well with the idea that technology can improve on the inefficient natural state of groups. Will technology change human nature? As long as human nature remains as it is, all three basic human interaction processes proposed here will have a place. Technology is not, nor ever will be, either a cure or a substitute for human nature.

The role of the computer seems less to change the nature of human interaction, than to allow interaction in situations where it would otherwise be unlikely or impossible, such as groups whose members are on different continents. The world of "cyberspace" may be a new one, but the people in it are the same. Perhaps it is time for electronic environments to "come of age", as a potential basis for human interaction. This study, and the theory upon which it is based, suggest that computer networks can provide an environment with great potential for genuine human social activity.

8. APPENDICES

APPENDIX A: A GENERAL MEASURE OF GROUP DISAGREEMENT

Suppose N people ($N > 1$) are members of a group facing a problem with K response options ($K > 1$).

Define δ_{ij} , the disagreement between any two people in the group, one person choosing option i and the other person choosing option j , to be measured by the square of the difference between the positions of the two people:

$$\delta_{ij} = (R_i - R_j)^2.$$

Where for nominal data:

$$\begin{array}{lll} R_i - R_j = 0 & \text{if } i = j & \text{(both choose the same option)} \\ R_i - R_j = 1 & \text{if } i \neq j & \text{(choose different options)} \end{array}$$

for ordinal data $R_i = i$, and for interval and ratio scale data R_i is some real valued numerical response to option i .

The disagreement (d) between one person who chooses option i and the rest of the group can be defined as the sum of the disagreement between that person and each of the other group members, divided by the possible number of relationships.

$$\begin{aligned} d_i &= \frac{1}{(N-1)} \sum_{1 \leq j \leq K} \delta_{ij} f_j \\ &= \frac{1}{(N-1)} \sum_{1 \leq j \leq K} (R_i - R_j)^2 f_j \end{aligned}$$

where f_j is the number of people who chose option j . If all other participants choose the same option then $d = 0$ (no disagreement), whereas if they all choose a different option then $d = 1$.

Repeating the process for each of the N group members, adding the results and dividing by N gives the **average disagreement for the group (D)**.

$$\begin{aligned} D &= \frac{1}{N} \sum_{1 \leq i \leq K} f_i d_i = \frac{1}{N(N-1)} \sum_{1 \leq i \leq K} \sum_{1 \leq j \leq K} (R_i - R_j)^2 f_j f_i \\ &= \frac{2}{N(N-1)} \sum_{1 \leq i < j \leq K} (R_i - R_j)^2 f_j f_i \end{aligned}$$

The latter step is true because $(R_i - R_j)^2 = (R_j - R_i)^2$.

The minimum value of D is 0 (no disagreement).

$$D_{\min} = 0$$

The maximum value of **D** can be calculated as follows. For the numeric response case let R_{\max} and R_{\min} be the maximum and minimum response values. Then the maximum disagreement is achieved when the responses are spread as evenly as possible between only the two extreme values. If a is the remainder when N is divided by 2 then

$$D_{\max} = \frac{(R_{\max} - R_{\min})^2 (N + a)(N - a)}{N(N - 1)}$$

The relationship between D and variance

For the numeric response case the value of **D** can be shown to be directly related to the variance of the responses.

$$\begin{aligned} & \sum_{1 \leq i \leq K} \sum_{1 \leq j \leq K} (R_i - R_j)^2 f_j f_i \\ &= \sum_{1 \leq i \leq K} \sum_{1 \leq j \leq K} R_i^2 f_j f_i + \sum_{1 \leq i \leq K} \sum_{1 \leq j \leq K} R_j^2 f_j f_i - 2 \sum_{1 \leq i \leq K} \sum_{1 \leq j \leq K} R_i R_j f_i f_j \\ &= 2N \sum_{1 \leq i \leq K} R_i^2 f_i - 2 \left(\sum_{1 \leq i \leq K} R_i f_i \right)^2 \\ &= 2N(N-1) s^2 \end{aligned}$$

Therefore

$$D = \frac{1}{N} 2N s^2 = 2s^2$$

In other words the group disagreement as derived is equal to twice the variance.

APPENDIX B: CONSENT FORM

I understand that I will be taking part in an experiment to trial different ways of making group decisions on a computer network, and to advance knowledge in this new area of research. I also understand that I will be asked **not to talk or communicate with other members of my group during the session**, except through the computer. In addition, any votes I make will be anonymous within my group and that I will not and cannot be identified individually in any report arising from this study. I also understand that this experiment requires participation by pre-arranged groups, and that should any member of the group not attend at the agreed time another time will need to be arranged for the entire group.

Knowing that my course supervisors had arranged an alternative if I did not wish to participate, I agree to participate and will do so honestly and to the best of my ability.

The first prize will be allocated on the basis of the number correct, and in the event of a tie, the total time taken.

_____ / ____ / _____
(PRINT NAME) (signature) (Date)

Group Name:

APPENDIX C: PRELIMINARY QUESTIONNAIRE

Group Name: _____

Please **circle one option** for each of the following questions about your group:

	Strongly Disagree	Disagree	In The Middle	Agree	Strongly Agree
	1	2	3	4	5
1. I feel that I am a member of this group					
2. I feel that I belong to this group					
3. I see myself as part of this group					
4. This group is a very good group					
5. I am happy to be part of this group					
6. I am content to be part of this group					

APPENDIX D: PARTICIPANT INSTRUCTIONS

1. Please move to a computer labelled with the same name as your group. Each computer is set up to go, so please do not touch the keys until told to start.

2. **General.** This is an experiment in how groups make decisions over computer networks. The task is to complete 12 general knowledge questions with as many correct as possible. The group majority answer will be taken as the group's answer to each question. If there is no majority (and the group is "hung") then that answer is marked wrong. Each group will get a **number correct** and a **time taken** score. The winner is the group with the greatest number correct, and, in the event of a tie, the lowest time taken.

Your group will be spread around the room and you are asked to imagine that you are each at your own computer in separate rooms. You must not make signs or talk to each other during the test or your group may be disqualified and your data invalidated.

3. **Procedure.** There are four stages shown on the menu:

- Practice
- Test 1
- Test 2
- Test 3

Each Test is done using a different group method. After each test you will be asked to give feedback on how you felt about that method (time taken to do this does not affect your "time taken" score).

4. **Practice Session.** From the Menu select **Practice** (Move cursor to **Practice** and press **ENTER**). You now see some instructions followed by three questions. Move the cursor down to Question 1 using the **down arrow key**, read the question in the area above. Press **V** to give your answer.

When done, look at the **green vote bar** above the main area - you should be able to see how some of the other people in your group voted. If not, press **SPACEBAR** or move the cursor up and down to refresh your display. You can also see how **confident** the others were (! is confident, ¼, ½ are less confident).

5. **Voting. EACH QUESTION REQUIRES EVERYONE TO GIVE THREE VOTES**, two practice votes (or "Straw Votes") and then a Final Vote. The rules are:

- a) **Your first vote is always "blind"** (you cannot see others votes until you have given your first vote)
- b) **You cannot second vote until everyone in your group has first voted.** Likewise you cannot final vote until everyone has second voted.
- c) **Only the Final Vote counts** to your group's score.
- d) **You cannot vote *Don't Know* on the Final Vote** (you must take a position).

Complete all votes for questions 1-3. Do not spend too long on each vote. If you are not sure just guess. The screen tells you what vote number your group is at for each question, and when it is completed. **If you think you have finished the entire test, press ENTER** to find any Not Voted items. If it says **TEST COMPLETED** then you can press **ESC** to leave that test. (wait for all to complete. . .)

6. **Feedback.** When you have finished the Practice session, select **Practice Feedback** from the menu and look at the questions there. Each set of feedback questions refers to how you felt about the previous test method.

7. You are now nearly ready to begin Test 1. Remember, work your way through the menu doing each test and giving feedback on how that felt to you. Please answer honestly. The last menu option allows you to type any general comments you have on the whole experience.

Note that each test uses a different group interaction method, namely:

- a) Don't See any other votes
- b) See other votes
- c) See other votes and confidence

These can be in any order. In one method you will not see how the rest of the group voted at all, so you **only need one vote**.

Remember, press ENTER and the computer will tell you if you have completed a test or not.

If you have any questions please ask them now.

APPENDIX E: TESTS USED

The following are print outs from FORUM DGSS of each of the three tests used in the experiment.

FORUM CMGS, Beta Version, WW Consultants

Printed 4:22pm 04 Jul 96

TEST A

Answer the following questions. Don't spend too long on each one.

- Move cursor to question
- Press V to Vote
- Press N to see if you have questions which are Not Voted on

START ITEM: Person A - Question 1, B - 3, C - 6, D - 9, E - 12

NOTE: You may have no votes waiting, but still not have given all your final votes, because some questions are waiting for other people in the group to complete their straw votes. In this case you will have to wait for other people in the group before you can finish the test.

- Question 1. SOLID is to GAS as ICE is to:
A. snow B. cold C. steam D. water
- Question 2. CANNY means
A. mean B. shrewd C. queer D. suspicious
- Question 3. Which word does NOT belong to this list?
A. lenient B. indulgent C. friendly D. tolerant
- Question 4. An interview always involves -
A. debate B. appreciation C. questions D. an audience
- Question 5. Which word does NOT belong to this list?
A. collision B. accident C. combination D. union
- Question 6. INDIGNANT means most nearly the same as -
A. angry B. determined C. agreeable D. intense
- Question 7. Which of the following would you put in a different class from the other three?
A. Julius Caesar B. Saint Paul C. Michelangelo D. Shakespeare
- Question 8. Global statistics indicate that the amount of money countries spend to protect their citizens from nuclear attack has increased in the last ten years by -
A. 10% B. 25% C. 75% D. 150%
- Question 9. Modern life has increased the chance of heart disease above that in our parent's time by -
A. 5% B. 15% C. 30% D. 60%
- Question 10. Which of the following is the most frequent reason given for not wanting to stay on a particular job?
A. too much supervision B. not enough money
C. too much demand for accuracy D. being kept late by the boss

- Question 11. YOGA is -
A. a sour milk B. a mental disease C. a religion of the East D. a sweetmeat
- Question 12. Which of the following types of behaviour have social researchers found to be most approved by parents?
A. marrying a person they admire B. helping them financially in their old age
C. seeking their guidance D. graduating from university or polytechnic

TEST B

Answer the following questions. Don't spend too long on each one.

- Move cursor to question
- Press V to Vote
- Press N to see if you have questions which are Not Voted on

START ITEM: Person A - Question 1, B - 3, C - 6, D - 9, E - 12

NOTE: You may have no votes waiting, but still not have given all your final votes, because some questions are waiting for other people in the group to complete their straw votes. In this case you will have to wait for other people in the group before you can finish the test.

- Question 1. FINGER is to ARM as TOE is to:
A. leg B. foot C. knee D. hand
- Question 2. TURMOIL means
A. anxiety B. confusion C. emergency D. terror
- Question 3. Which word does NOT belong to this list?
A. evaluate B. illustrate C. exemplify D. interpret
- Question 4. An accident always involves
A. chance B. injury C. a victim D. damage
- Question 5. Which word does NOT belong to this list?
A. solitary B. unitary C. last D. monopolistic
- Question 6. A DEVOUT person is one who is -
A. ambitious B. extraordinary C. conscientious D. religious
- Question 7. Which of the following has the highest reputation as a person of honesty and principle?
A. Talleyrand B. Charlie Chaplin C. Theodore Roosevelt D. Woodrow Wilson
- Question 8. Psychological research has found that people who lack self control tend to succeed in life -
A. frequently B. seldom C. very seldom D. never
- Question 9. How many nuclear weapons (each capable of destroying any city in the world) exist today in all countries combined?
A. 300 B. 1,000 C. 3,000 D. 10,000
- Question 10. Sociologists report that the average person falls in love for the first time at what age?
A. 24 B. 21 C. 18 D. 15

- Question 11. Which of the following is the most frequent reason given by employers for firing an employee?
 A. not getting along with co-workers B. not following rules set up for everyone's benefit
 C. being late for work and taking extended breaks D. not learning the job fast enough
- Question 12. What is the best length of stay when parents visit their grown up children's families once a year?
 A. 20 days B. 10 days C. 5 days D. 1 day

TEST C

Answer the following questions. Don't spend too long on each one.

- Move cursor to question
- Press V to Vote
- Press N to see if you have questions which are Not Voted on

START ITEM: Person A - Question 1, B - 3, C - 6, D - 9, E - 12

NOTE: You may have no votes waiting, but still not have given all your final votes, because some questions are waiting for other people in the group to complete their straw votes. In this case you will have to wait for other people in the group before you can finish the test.

- Question 1. GROUND is to FOOT as RAIL is to:
 A. station B. wheel C. iron D. sleeper
- Question 2. To BROOD means to -
 A. think B. look closely at C. mope D. ponder carefully
- Question 3. Which word does NOT belong to this list?
 A. admit B. concede C. acknowledge D. infer
- Question 4. People who are cold rub their hands together briskly because -
 A. the exercise gets the muscles warm
 B. skin friction gives a sense of warmth
 C. cold hands lose their sense of feeling
 D. it speeds up the circulation of air around the hands
- Question 5. Which word does NOT belong to this list?
 A. riot B. murder C. confusion D. mutiny
- Question 6. FACTION means most nearly the same as -
 A. party B. manufactured item C. arithmetical term D. series of facts
- Question 7. Generally which of the following jobs earns the most money?
 A. professors B. attorneys C. psychiatrists D. surgeons
- Question 8. Which of the following income brackets is the minimum that would be called "upper middle" class?
 A. \$25,000 B. \$32,000 C. \$40,000 D. \$48,000
- Question 9. How long does a person need to work at the average office job to become really good at it?

A. 3 months B. 6 months C. 1 year D. 1.5 years

Question 10. Which of these is most likely to cause you to lose your reputation in the community?

A. going bankrupt

B. conviction for speeding

C. conviction for income tax evasion

D. being arrested in a place not licensed for drinking

Question 11. How many people know their boy or girl friend's birthday?

A. 25% B. 50% C. 75% D. nearly all

Question 12. What percentage of people feel that "what you wear is what you are" ?

A. 80% B. 50% C. 20% D. 5%

APPENDIX F: RAW DATA CONVERSION

The first table shows the raw data for Group 1 as generated on 24/4/96 by the FORUM DGSS program. The fields were:

- **F_IDEA** What the user saw in the list display (there was also a detail display).
- **F_VOTE** The users vote response. Each set of five numbers is one vote series. Each individuals vote is given by their position in the set of five e.g. person A was the first position, B the second, and so on.
- **F_CONF** The users corresponding confidence vote.
- **F_PRI** A separate field used to store the responses to the Feedback questions.

The next table shows the conversion formats used and the meaning of the values, and the final table shows a sample from the converted single data file.

F_IDEA	F_VOTE	F_CONF	F_PRI
Group 1 First Test, Treatment 2, Test B			
Question 1.	43333 33333 33333	55545 55555 55543	
Question 2.	44446 44444 44444	24344 55451 55555	
Question 3.	54454 44444 44443	23432 55534 55532	
Question 4.	53366 33363 33333	33335 43544 55532	
Question 5.	55456 55455 55555	22441 43442 55432	
Question 6.	53656 55755 55555	32232 42732 54234	
Question 7.	55555 55555 55555	41233 53534 53553	
Question 8.	45554 54554 55555	42333 41543 52543	
Question 9.	36566 66666 66666	41235 53344 53332	
Question 10.	65754 57555 55555	42733 47432 42442	
Question 11.	54554 54554 54555	45432 54542 53542	
Question 12.	56655 56555 56555	53334 53334 53543	
Feedback Question 1.			86865
Feedback Question 2.			53755
Feedback Question 3.			78665
Feedback Question 4.			88562
Feedback Question 5.			77665
Feedback Question 6.			33577
Feedback Question 7.			67252
Feedback Question 8.			23345
Feedback Question 9.			33484
Feedback Question 10.			53345
Group 1 2nd Test Treatment 1, Test C			
Question 1.	34445	15235	
Question 2.	64664	44532	
Question 3.	46665	13322	
Question 4.	64443	34534	
Question 5.	65556	24434	
Question 6.	56435	34333	
Question 7.	66666	33434	
Question 8.	44666	32544	
Question 9.	46644	33532	
Question 10.	63533	45434	
Question 11.	45656	31534	
Question 12.	54333	42434	
Feedback Question 1.			62765
Feedback Question 2.			52557
Feedback Question 3.			52266
Feedback Question 4.			32225
Feedback Question 5.			66255
Feedback Question 6.			64457
Feedback Question 7.			42223
Feedback Question 8.			52255
Feedback Question 9.			78845
Feedback Question 10.			73465
Group 1 Third Test Treatment 3, Test A			

Question 1.	36555	55555	55555	33535	54555	55555	
Question 2.	5454?	5554?	55545	2254?	3255?	34543	
Question 3.	5354?	55555	55555	2343?	33533	44442	
Question 4.	55555	55555	55555	45534	55545	55542	
Question 5.	56756	56655	56555	33733	23542	33433	
Question 6.	44746	44444	44444	32742	33452	44443	
Question 7.	46344	46444	46444	45443	45244	55554	
Question 8.	53465	54455	54455	22334	34333	44442	
Question 9.	56554	56554	55555	34334	34444	43543	
Question 10.	44445	44444	44444	43534	45543	55534	
Question 11.	55554	55555	55555	52354	55453	55443	
Question 12.	66465	66465	66465	32533	34543	44532	
Feedback Question 1.							66865
Feedback Question 2.							63846
Feedback Question 3.							67675
Feedback Question 4.							78777
Feedback Question 5.							77666
Feedback Question 6.							64747
Feedback Question 7.							46365
Feedback Question 8.							23445
Feedback Question 9.							43644
Feedback Question 10.							63647

Table 64. Sample raw data

Vote Response	Raw Data Value	Converted Value
Option A	3	1
Option B	4	2
Option C	5	3
Option D	6	4
Dont Know	?	0
Missing Value	[blank]	*
Confidence Response		
Not Confident at All	1	1
Not Very Confident	2	2
Fairly Confident	3	3
Confident	4	4
Very Confident	5	5
Voted "Dont Know"	?	?
Missing Value	[blank]	*
Feedback Question Response		
Strongly Disagree	2	1
Disagree	3	2
Slightly Disagree	4	3
In the Middle	5	4
Slightly Agree	6	5
Agree	7	6
Strongly Agree	8	7
Missing Value	[blank]	*

Table 65. Raw data conversion formats

The following defines the converted data fields:

GP Group Number (01-18)

TRT Treatment (1-3)

APPENDIX F: RAW DATA CONVERSION

- TST Test (A,B,C)
- ORD Sequence Order (First, Second or Third)
- SER Vote Series (First Vote, Second Vote or Third Vote)
- QN Question Number (1-12)
- VA-VA The Vote of persons A-E (1-4)
- CA-CE The Confidence of persons A-E (1-5)
- ANS The correct answer (only for questions 1-6)
- C Average Group Confidence (5-25)
- D Average Group Disagreement (0-20)
- S Score (0=Group Hung, 1=Incorrect, 2=Correct, 9=No correct answer)

GP	TR	TST	OR	SER	QN	VA	VB	VC	VD	VE	CA	CB	CC	CD	CE	AN	C	D	S
	T		D													S			
01	2	B	1	1	12	1	1	1	1	5	5	5	4	5	1	24	8	2	
01	2	B	1	2	11	1	1	1	1	5	5	5	5	5	1	25	0	2	
01	2	B	1	3	11	1	1	1	1	5	5	5	4	3	1	22	0	2	
01	2	B	1	1	22	2	2	2	4	2	4	3	4	4	2	17	8	2	
01	2	B	1	2	22	2	2	2	2	5	5	4	5	1	2	20	0	2	
01	2	B	1	3	22	2	2	2	2	5	5	5	5	5	2	25	0	2	
01	2	B	1	1	33	2	2	3	2	2	3	4	3	2	1	14	12	1	
01	2	B	1	2	32	2	2	2	2	5	5	5	3	4	1	22	0	1	
01	2	B	1	3	32	2	2	2	1	5	5	5	3	2	1	20	8	1	
01	2	B	1	1	43	1	1	4	4	3	3	3	3	5	1	17	16	1	
01	2	B	1	2	41	1	1	4	1	4	3	5	4	4	1	20	8	2	
01	2	B	1	3	41	1	1	1	1	5	5	5	3	2	1	20	0	2	
01	2	B	1	1	53	3	2	3	4	2	2	4	4	1	3	13	14	2	
01	2	B	1	2	53	3	2	3	3	4	3	4	4	2	3	17	8	2	
01	2	B	1	3	53	3	3	3	3	5	5	4	3	2	3	19	0	2	
01	2	B	1	1	63	1	4	3	4	3	2	2	3	2	4	12	16	1	
01	2	B	1	2	63	3	0	3	3	4	2	?	3	2	4	12	8	1	
01	2	B	1	3	63	3	3	3	3	5	4	2	3	4	4	18	0	1	
01	2	B	1	1	73	3	3	3	3	4	1	2	3	3		13	0	9	
01	2	B	1	2	73	3	3	3	3	5	3	5	3	4		20	0	9	
01	2	B	1	3	73	3	3	3	3	5	3	5	5	3		21	0	9	
01	2	B	1	1	82	3	3	3	2	4	2	3	3	3		15	12	9	
01	2	B	1	2	83	2	3	3	2	4	1	5	4	3		17	12	9	
01	2	B	1	3	83	3	3	3	3	5	2	5	4	3		19	0	9	
01	2	B	1	1	91	4	3	4	4	4	1	2	3	5		15	14	9	
01	2	B	1	2	94	4	4	4	4	5	3	3	4	4		19	0	9	
01	2	B	1	3	94	4	4	4	4	5	3	3	3	2		16	0	9	
01	2	B	1	1	104	3	0	3	2	4	2	?	3	3		13	18	9	
01	2	B	1	2	103	0	3	3	3	4	?	4	3	2		14	8	9	
01	2	B	1	3	103	3	3	3	3	4	2	4	4	2		16	0	9	
01	2	B	1	1	113	2	3	3	2	4	5	4	3	2		18	12	9	
01	2	B	1	2	113	2	3	3	2	5	4	5	4	2		20	12	9	
01	2	B	1	3	113	2	3	3	3	5	3	5	4	2		19	8	9	
01	2	B	1	1	123	4	4	3	3	5	3	3	3	4		18	12	9	
01	2	B	1	2	123	4	3	3	3	5	3	3	3	4		18	8	9	
01	2	B	1	3	123	4	3	3	3	5	3	5	4	3		20	8	9	
01	1	C	2	1	11	2	2	2	3	1	5	2	3	5	2	16	14	2	
01	1	C	2	1	24	2	4	4	2	4	4	5	3	2	3	18	12	1	
01	1	C	2	1	32	4	4	4	3	1	3	3	2	2	4	11	14	2	
01	1	C	2	1	44	2	2	2	1	3	4	5	3	4	2	19	14	2	
01	1	C	2	1	54	3	3	3	4	2	4	4	3	4	3	17	12	2	

01	1	C	2	1	63	4	2	1	3	3	4	3	3	3	1	16	18	0
01	1	C	2	1	74	4	4	4	4	3	3	4	3	4		17	0	9
01	1	C	2	1	82	2	4	4	4	3	2	5	4	4		18	12	9
01	1	C	2	1	92	4	4	2	2	3	3	5	3	2		16	12	9
01	1	C	2	1	104	1	3	1	1	4	5	4	3	4		20	14	9
01	1	C	2	1	112	3	4	3	4	3	1	5	3	4		16	16	9
01	1	C	2	1	123	2	1	1	1	4	2	4	3	4		17	14	9
01	3	A	3	1	11	4	3	3	3	3	3	5	3	5	3	19	14	2
01	3	A	3	2	13	3	3	3	3	5	4	5	5	5	3	24	0	2
01	3	A	3	3	13	3	3	3	3	5	5	5	5	5	3	25	0	2
01	3	A	3	1	23	2	3	2	0	2	2	5	4	?	2	14	16	1
01	3	A	3	2	23	3	3	2	0	3	2	5	5	?	2	16	14	1
01	3	A	3	3	23	3	3	2	3	3	4	5	4	3	2	19	8	1
01	3	A	3	1	33	1	3	2	0	2	3	4	3	?	3	13	18	0
01	3	A	3	2	33	3	3	3	3	3	3	5	3	3	3	17	0	2
01	3	A	3	3	33	3	3	3	3	4	4	4	4	2	3	18	0	2
01	3	A	3	1	43	3	3	3	3	4	5	5	3	4	3	21	0	2
01	3	A	3	2	43	3	3	3	3	5	5	5	4	5	3	24	0	2
01	3	A	3	3	43	3	3	3	3	5	5	5	4	2	3	21	0	2
01	3	A	3	1	53	4	0	3	4	3	3	?	3	3	2	13	16	1
01	3	A	3	2	53	4	4	3	3	2	3	5	4	2	2	16	12	1
01	3	A	3	3	53	4	3	3	3	3	3	4	3	3	2	16	8	1
01	3	A	3	1	62	2	0	2	4	3	2	?	4	2	1	12	14	1
01	3	A	3	2	62	2	2	2	2	3	3	4	5	2	1	17	0	1
01	3	A	3	3	62	2	2	2	2	4	4	4	4	3	1	19	0	1
01	3	A	3	1	72	4	1	2	2	4	5	4	4	3		20	14	9
01	3	A	3	2	72	4	2	2	2	4	5	2	4	4		19	8	9
01	3	A	3	3	72	4	2	2	2	5	5	5	5	4		24	8	9
01	3	A	3	1	83	1	2	4	3	2	2	3	3	4		14	18	9
01	3	A	3	2	83	2	2	3	3	3	4	3	3	3		16	12	9
01	3	A	3	3	83	2	2	3	3	4	4	4	4	2		18	12	9
01	3	A	3	1	93	4	3	3	2	3	4	3	3	4		17	14	9
01	3	A	3	2	93	4	3	3	2	3	4	4	4	4		19	14	9
01	3	A	3	3	93	3	3	3	3	4	3	5	4	3		19	0	9
01	3	A	3	1	102	2	2	2	3	4	3	5	3	4		19	8	9
01	3	A	3	2	102	2	2	2	2	4	5	5	4	3		21	0	9
01	3	A	3	3	102	2	2	2	2	5	5	5	3	4		22	0	9
01	3	A	3	1	113	3	3	3	2	5	2	3	5	4		19	8	9
01	3	A	3	2	113	3	3	3	3	5	5	4	5	3		22	0	9
01	3	A	3	3	113	3	3	3	3	5	5	4	4	3		21	0	9
01	3	A	3	1	124	4	2	4	3	3	2	5	3	3		16	14	9
01	3	A	3	2	124	4	2	4	3	3	4	5	4	3		19	14	9
01	3	A	3	3	124	4	2	4	3	4	4	5	3	2		18	14	9

Table 66. Sample converted data

APPENDIX G: FORUM DGSS TABLE OF CONTENTS

INTRODUCTION	1
Group Support Systems	1
How Is Group Support Used ?	2
Applications Of GSS	3
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Initial Requirements	5
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