Wiki Brainstorming and Problems with Wiki Based Collaboration

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Abstract

As organisations increasingly rely on geographically dispersed workforces there is an emerging need to collaborate on projects that span distributed teams and different time frames. This includes a need for collaboration in the form of brainstorming. Wiki may provide a powerful medium for asynchronous distributed collaboration in such situations.

A design for evaluating the use of wiki as a shared workspace for asynchronous distributed brainstorming is described. Implementation of this design was unsuccessful and it was considered that failure may be the result of fundamental problems with wiki as a collaborative technology. A revised design is presented for the evaluation of problems with wiki-based collaboration and the factors affecting such collaboration, based on hypotheses derived in part from traditional brainstorming research.

A natural structure of factors affecting wiki-based collaboration emerged from the results which are discussed. Study conclusion presents 'The Wiki Cycle', a diagrammatic representation that highlights the process factors that affect the success or failure of wiki-based collaboration and which shows the interaction of these factors by way of a series of feedback cycles.

This provides a framework for future work by making explicit some of the process factors and dynamics that affect wiki-bases collaboration.

Key Words: Brainstorming; Wiki; Distributed Asynchronous Collaboration; On-line Communities; Distributed Communities.

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1 Introduction

*"The art of progress is to preserve order amid
change and to preserve change amid order."*

Alfred North Whitehead.

1.1 Collaboration

Collaboration is the process of interaction amongst people. However, it is an ambiguous term and interpretations can vary wildly. Collaboration in the workplace, for example, can be between individuals, teams or whole enterprises. It can be synchronous (between people available at an instance in time, like instant messaging) or asynchronous (where the communicating parties do not need to be present at the same time, like e-mail). It can be ad hoc or structured. Structured collaboration represents a process that is well understood and can be predicted to a large extent, for example the creation of monthly management reports in companies. Ad hoc collaboration cannot be predicted, either in terms of frequency or content. E-mail for example.

Just as much of an organisation's information will be held in unstructured data as is held in structured data and therefore unstructured collaboration is often of the greatest value. The now widespread use of e-mail reflects this. Organisations are becoming increasingly keen however to harness unstructured data and to give it structure, since this can promote effective information sharing which can lead to faster and better decision making. One aspect of this is seen in the pooling and generation of new ideas.

1.2 Traditional Brainstorming

Organisations in today's fast paced environment are "increasingly relying on their employees to generate creative solutions to business problems" (Satzinger, 1999). For many businesses, a well used collaborative method for generating and pooling ideas is brainstorming. A key concept in brainstorming is that participants should not only come up with new ideas but that they should also 'spark off' from associations with the ideas of others to expand on and develop these ideas. Traditional brainstorming involves a group of individuals in a room, thinking of ideas, and voicing their opinions to the group. This format supports the mutual stimulation of ideas and the overall aim is to be as imaginative as possible without any fear of criticism (which is ruled out). Only afterwards do the members evaluate the ideas generated.

However there are problems associated with traditional brainstorming. Firstly, research shows that the generation of ideas can still be hampered by a fear of criticism, despite direct criticism being ruled out. Secondly, it relies on participants being able to meet at the same time and in one location.

1.3 Asynchronous Distributed Collaboration and Brainstorming

As organisations rely more and more on geographically dispersed workforces there is an increasing need to collaborate on projects that span distributed teams. As a result, arranging meetings, both in terms of time and location, becomes increasingly impractical.

There is a variety of software available to deal with this kind of scaling up of collaborative processes. This includes software specifically for the idea generation and creative processes. This gives the potential for truly worldwide collaboration and brainstorming. However, a common problem with such dedicated software is the potential cost to organisations of global implementation with no clear guarantee of the financial reward. Correctly evaluated and deployed electronic collaboration against real and clear business needs can be of enormous value to a company, saving both time and money. However, deployment of inadequate solutions can be extremely costly. Modern organisations recognise the potential for electronic collaboration but they are also acutely aware of the dangers of inadequate deployment. In a typical organisation, a wide range of collaboration methods, like telephone, e-mail, and instant messaging are already well established and users are adept at moving rapidly between the most appropriate technologies to suit a particular task. There are pitfalls, however. For example, the popularity of e-mail may have lead to its overuse in organisations to the extent that it will continue to be used even where a more efficient and effective tool is available. As such, providing new and more appropriate tools for a particular collaborative activity is not always sufficient for it to be used. One potential tool for asynchronous distributed collaboration is wiki.

1.4 Wiki

The wiki concept was invented by Ward Cunningham in 1995 ("Wiki History", C2 Wiki, 2004). It was created as a means to develop collaborative web pages by allowing information and associations to be added freely by any user. Put simply, a wiki consists of web pages where everyone has rights to edit everything, and editing is not discouraged but encouraged. They provide a means to develop collaborative web pages by allowing users to freely edit both the content *and* the structure. As such it is a collaborative workspace where everybody has the ability to add to, amend and organise the content as they see fit. It provides a shared medium through which users from all around the world can collaborate. Users visiting a wiki page can simply click on the 'edit' button, make changes to the page, and click the 'save' button. Links to other wiki pages can easily be made by writing capitalised words together LikeThis (a format known as CamelCase). This example would link to the page titled 'LikeThis'. Where the page does not already exist in the wiki a new page is automatically generated. While complex mark-up knowledge is not required for wiki, there are simple syntax conventions for some formatting functions, such as horizontal lines or external web links.

Because a history of all wiki changes is maintained in a database and a log of changes can be made available to all users, any change deemed unfit can be reversed by administrators or potentially any other user at the click of a button. As such, the system is essentially self-regulating. Errors can be corrected easily and any vandalism of pages can be reversed in minutes. Because the content and the history are controlled by the users, the only content that survives is the content that everyone has agreed is best. As such, data on a wiki has a survival-of-the-fittest, evolutionary feel.

1.5 Wiki Based Collaboration and Brainstorming

Wiki-based collaboration could be a very practical platform for asynchronous distributed brainstorming. It can be installed on a web server, enabling browser based access, which removes many of the costs and restrictions associated with managing the individual client software and dedicated infrastructure that may be required of other solutions. It also immediately opens up truly global access to anyone with an internet enabled PC, laptop, PDA or smart phone. Browser-based applications already have search and information retrieval facilities built in and can be readily personalised to individual users. A further benefit is that internet users will already be familiar with

some of the means of browsing, navigating and searching using wiki. The new functionality provided by a wiki, such as editing pages and creating links and new pages, should therefore be an extension of their already established mental model. Wiki, being browser-based software built on worldwide standards, also means the potential for tight integration with existing technologies like weblogs and RSS feeds for example, as well as being adaptable to incorporate new technologies in the future.

A further advantage is that, while brainstorming may be an interesting extension of its functionality, wiki already has a variety of other potential uses, for example in project management, knowledge management or as a collaborative environment for document creation.

A wiki can allow many developing ideas to be captured quickly and promotes the organic structuring and growth of these ideas as they develop. The pooling nature of the wiki supports mutual stimulation and as the site develops it becomes easier for participants to 'spark off' from and elaborate on existing ideas. Crucially, not only is this supporting ad hoc collaboration and data in the early stages but as the page develops and the information crystallises, it should be seen to capture more structured data as it progresses.

1.6 Project Aims and Report Structure

The initial aim of the project was to assess the potential use of wiki as a distributed brainstorming tool to establish how effectively it could be used to facilitate the rapid and successful growth of ideas.

The first chapter of the literature review is concerned with idea generation in traditional, non-computer mediated brainstorming. It identifies the low level process gains and losses with the technique that have been derived from traditional brainstorming research.

The review also shows that successful brainstorming may rely greatly on its contextual setting and that a variety of higher level factors may affect the process gains and losses within this setting, such as whether users have received appropriate training. A range of these factors are also highlighted in chapter one of the literature review.

Chapter two of the review is concerned with wiki use as a distributed collaborative tool that could be applied to brainstorming and highlights some of the potential problems associated with wiki use. These can be viewed as further factors that may affect the brainstorming process gains and losses.

Design phase 1 describes how findings from the literature review were used to develop a logical framework for evaluating wiki use in brainstorming. The framework was based on the identified process factors that affect traditional brainstorming and the recognised factors affecting wiki. These are then related back to the relevant low-level process gains and losses from the traditional brainstorming literature to complete the framework.

Design phase 1 continues with a description of a wiki brainstorming case study, 'MSc IP Brainstorm Wiki', that was to be used for the evaluation. It was based on an open forum brainstorm for students and lecturers about the Information Processing MSc course at the University of York and possible ways in which it could be improved. A description of the contextual holistic approach that was to be used to evaluate it is also given and it is explained how this was to be guided by the established framework.

However, it was quickly realised that the brainstorm wiki was not going to be successful. Too little data was being collected to be able to successfully evaluate the use of wiki as a tool for brainstorming. It was thought that the failure of the wiki might highlight fundamental problems with the nature of wiki-based collaboration itself and the emphasis of the project was shifted to become an attempt to evaluate wiki-based collaboration in general. A new aim was to establish a more complete picture of the factors that cause the recognised problems with wiki-based collaboration and how they interrelate.

In design phase II, a set of hypotheses were formulated regarding wiki-based collaboration failure. The hypotheses were based on the framework generated for design phase I in order to maintain the grounding in the traditional literature. Doing this gave the evaluation of the new collaboration technology a firm grounding in research based on traditional brainstorming, as a well established and highly studied means of collaboration. The limited remaining time left for data collection (see Appendix A for timeline) meant that a triangulation approach to data collection was considered strategic so that different threads of research could carry on simultaneously. Design phase II describes the methods and sources used to achieve this. These included the 'MSc IP Brainstorm Wiki' case study, a new case study of a real-world wiki use in the Department of Management Studies at the University of York, and hypothesis testing by asking experts in the field of wiki and on-line collaboration.

Results are split into two parts. The first part is based on findings from observations of the two case study wiki. The second part is based on interview data relating to the two case study wiki as well as the opinions of the wiki experts.

Discussion of the results builds on the information obtained during the literature review and is based around an emerging structure that appeared during results analysis. This structure is based on the interactions between the various factors that were seen to be affecting wiki-based collaboration. It was felt appropriate that the emerging structure should determine the structure of the discussion rather than allowing it to be constrained by the structure of the hypotheses or that of the results sections.

The conclusions section describes what were considered to be the crucial factors affecting wiki-based collaboration. These are related back to recognised wiki problems. The conclusions section also describes a diagrammatic representation of the emergent structure that was established entitled 'the wiki cycle'. The study concludes with a discussion of some of the limitations of the current study and suggestions for future work in this area.

2 Literature Review

2.1 Traditional Brainstorming

2.1.1 What is Brainstorming?

It is crucial in the first instance to appreciate exactly what is meant by the term 'brainstorming' since it is a term that is frequently misused and misunderstood. Its interpretation varying even between the various scientific papers produced from brainstorming studies. Brainstorming was first proposed by the advertising executive Alex Osborn in his book 'Applied Imagination' (Osborn, 1967). He invented it as a tool to assist idea generation, to be used in creative problem solving (CPS). As such it should not be confused with the process of idea generation itself, nor that of creative problem solving.

Osborn himself defined brainstorming as "a conference technique by which a group attempts to find a solution for a specific problem by amassing all the ideas spontaneously by its members" (Osborn, 1967). He also described it as "a means of group problem solving that considerably increases the quality and quantity of ideas produced by groups" (Osborn, 1967). The emphasis of brainstorming was on coming up with as many deliberately unusual solutions as possible and to push the ideas as far as possible. Crucially, it was only ever seen by Osborn to be a supplement to individual ideation and was never considered to be a replacement. He was keen to emphasise the importance of individual ideation both before a brainstorming session and after in achieving maximum creativity.

A traditional brainstorming session typically comprises a group of four to fifteen people working together in a room suggesting ideas which are noted down, usually on a flipchart or blackboard, for analysis at a later stage. A facilitator should be present to introduce and coordinate the session and to ensure that the brainstorming rules are followed. The introduction should involve detailing the purpose of that particular session and should also include an outline of the rules of brainstorming.

Osborn (1967) defined four basic rules of brainstorming. All aim to promote flexibility and fluency by overcoming motivational and social factors that can inhibit idea generation. The four rules are:

1. Criticism is ruled out. This includes self criticism as well as criticism of other. Judgement of ideas should be deferred until a later stage. The premise is that even a seemingly foolish idea can spark off better ones.

2. 'Freewheeling' is welcomed. The wilder the ideas the better. Wild and exaggerated ideas should be encouraged as these may in turn spark off more valid ideas.

3. Quantity is wanted. The more ideas the better, as this will increase the capture of a good idea and the chance of sparking off new ideas in others.

4. Combination and improvement of ideas is sought. The aim is to elaborate on and expand the suggestions and ideas of others, using the ideas of others as inspiration for your own. At the same time, combination of existing ideas can allow the exploration of new possibilities.

While the emphasis was on these guidelines, Osborn also made a number of suggestions to encourage effective brainstorming:

Firstly, a brainstorming session should have a facilitator who should:
- Have taken a course in creative problem solving.
- Guiding the idea generation process.
- Be able to ask stimulating questions.
- Plan and schedule meetings and follow up sessions.
- Teach and reinforce the guidelines and provide practice and orientation for participants.

Secondly, participants should:
- Not be from different levels of seniority.
- Have a range of experience with the task.
- Be between 5 and 10 in number.

Thirdly, a brainstorming session should:
- Be recorded by someone.
- Be preceded by individual ideation.
- Be followed up by individual ideation to allow incubation time.

Osborn claimed that by following the brainstorming rules "the average person can think up about twice as many ideas when working in a group than when working alone" (Osborn, 1967)

As brainstorming has steadily gained in popularity since its inception, the practice of the technique has often lost its way. Despite being a simple technique, adequate training in its appropriate use is crucial to its success. This was a feature recognised by Osborn himself. Failure over time not to comply with the basic guidelines of brainstorming has meant that today the term has different meanings to different people and it is commonly used in modern organisations to represent nothing more than an informal discussion. The importance of this dilution of the terms meaning should not be underestimated and it is a point which will be returned to, but for now it should be clear that to study brainstorming in depth we must first be sure of the original meaning of the term as defined by Osborn.

2.1.2 Process Losses in Traditional Brainstorming

Traditional brainstorming has enjoyed a lot of scientific interest regarding its effectiveness. Much of this work has concentrated on comparing the productivity of group brainstorming with that of nominal groups (groups comprised of individuals who generate ideas alone and whose results are then pooled). This usually involves setting the two groups the same brainstorming task and then comparing the pooled nominal group results with those of the physical group.

The most common basis for comparison is the number and quality of ideas generated (Diehl & Stroebe, 1987 and 1991; Dennis et al., 1996; Pinsonnealt et al., 1999; Dennis et al., 1999) and a number of such papers have shown that nominal groups outperform interactive groups both in terms of the number and quality of the ideas produced (Taylor, Berry, Block, 1958; Diehl & Stroebe, 1987) though the increased quality of ideas is often considered to simply be a side-effect of the increased number of ideas. Diehl & Stroebe, in their 1987 summary of brainstorming research, concluded that brainstorming groups have never outperformed nominal groups. Mullen, Johnson & Salas (1991), by statistical analysis of previous work, noted that productivity was "significant and of strong magnitude" between such groups both in terms of quantity and quality of ideas. Based on such comparisons, some authors have entirely discounted the usefulness of group brainstorming. (Diehl & Stroebe, 1987, 1991; Mullen, Johnson & Salas, 1991)

A number of reasons have been suggested for the apparent productivity loss in traditional brainstorming groups:

Mullen, Johnson & Salas (1991) identified three classes of mechanism that can be used to explain the productivity loss: 'Procedural mechanisms', which include problems of how task time is split between participants, such as when participants interrupt one another, 'social psychological mechanisms', which represents the effects the group can have on the individual in a session, and 'economic mechanisms' which represent when participants intentionally withdraw from participation or make no effort.

1) Procedural mechanisms

Cognitive interference: This effect, highlighted by Lamm & Trommsdorff (1973), is where a participant's ideas generation is interfered with by the content of the ideas verbalised by the other group members.

Duplication: Numerous individuals coming up with the same ideas. This is not a problem in traditional brainstorming but it is noted in relation to nominal group technique and it may have an influence in wiki-based brainstorming. (Lamm & Trommsdorff, 1973)

Production blocking: Also highlighted by Lamm & Trommsdorff (1973), this phenomenon is where ideas are not verbalised as they occur because only one group member is able to speak at a time. While there is always time later on in a session to verbalise the idea, it seems that this does not happen in practice. This may be the result of participants suppressing ideas that they were not able to immediately verbalise because they may seem less relevant or less original later in the session. Alternatively, limited short-term memory may mean users simply forget their idea while listening to another speaker. Listening to another speaker may even distract them from their own thought process and so prevent them from thinking up new ideas. Another possibility suggested was that of nominal groups having more speaking time than interacting groups. Research in brainstorming has been based around 'equal man hour' comparisons, where participants are given an equal amount of time in both individual or group conditions, with the result that nominal group members effectively get more 'air-time'. Although not noted in the literature, it also seems possible that users having more time to reflect on their idea in such circumstances may hold them back (by increasing evaluation apprehension). Ideas that would otherwise have been contributed without much thought would now be more considered. Diehl & Stroebe (1987) assessed the effects of production blocking by introducing artificial blocking into nominal groups. They found that subjects able to suggest ideas as they came to them produced approximately twice as many as they do when they have to wait for other participants to finish speaking. In total, as we will see, they assessed three major explanations of production loss in brainstorming. These were production blocking, evaluation apprehension and free-riding. While all three factors were seen to affect productivity, they concluded that production blocking affected it the most and provided the most convincing evidence. The results from this work and subsequent research (Diehl & Stroebe, 1991) ruled out the following explanations:

Speaking time: They ruled out the possibility that the difference might be caused by individuals in brainstorming groups having less speaking time than those that brainstorm individually by performing experiments where the length of time available to groups and individuals was varied.

Re-evaluation of ideas: The suggestion here was that participants listening to the comments of others may be distracted from looking at the chart of existing ideas or from making their own

suggestions. By including experiments that involved introducing production blocking into nominal groups, they also concluded that blocking was unlikely to result from a re-evaluation process that was thought might occur when participants were listening to the suggestions of another while waiting to raise their own suggestion. i.e. it was not the distractive quality of communication that was causing blocking.

Thought distraction: No difference was seen between a group blocked by lights that could hear other contributors and a group blocked by lights that could not.

Forgetting ideas: Diehl & Stroebe (1991) also looked into the suggestion that participants may be forgetting ideas or that they may try to avoid losing them from short term memory by rehearsing them, and that subsequently they are unable to come up with new ideas during this time. As one of the experiments in their 1991 study, Diehl & Stroebe studied the effect of external storage of ideas in brainstorming. They found that providing participants with notepads to externalise ideas and overcome the blocking effect did not have a profound effect on productivity. However, they did consider that participants may not be making the best use of note-taking as it is not an efficient alternative to keeping ideas in short term memory, being both effortful and time consuming.

Mullen, Johnson & Salas (1991) found that their results were inconsistent with those of Diehl & Stroebe since they found production losses to be highly consistent with basic social psychological mechanisms and only moderately consistent with procedural mechanisms (while being highly inconsistent with economic mechanisms). From their perspective, then, the primary focus should be on eliminating the production losses that relate to basic social psychological mechanisms, rather than those that relate to procedural or economic mechanisms.

2) Social psychological mechanisms

Cognitive uniformity: In a group environment, where everyone is hearing the same stimulus provided by the suggestions of others, there is likely to be a trend towards mutually similar suggestions (Lamm & Trommsdorff, 1973) and therefore away from the more 'free-wheeling' type responses. They also suggest that this might be augmented by motivational pressures as "interpersonal agreement is psychologically more comfortable than disagreement".

Social influence: This represents when particular members of the group have a dominant effect over the group (McGrath, 1984 cited in Pinsonneault et al., 1999). This might happen, for example, if a group of staff were accompanied by a more senior member of staff in a brainstorming session

Evaluation apprehension: This explanation, which revolves around self-criticism, has received a great deal of attention. It is based on the assumption that many people are unwilling to state some of their ideas because they are afraid of negative evaluation, despite the instructions in brainstorming. It seems plausible that the suppressed ideas are also likely to be the most original or 'way-out' ones. This effect has been show in groups that are told they are being observed and rated (Diehl & Stroebe, 1987) and in groups that are told that other group members are experts (Collaros & Anderson, 1969). Experiments by Collaros and Anderson (1969) showed that the greater the number of experts there were *perceived* to be in a group, the less productive the group became. Participants admitting feeling inhibited when another participant was thought to have greater expertise. They also felt their groups were less pleasant than the non-expert groups. However, Diehl & Stroebe (1987) had different results. Two experiments were performed by Diehl & Stroebe in their 1987 study in order to establish the effects of evaluation apprehension and the second of these showed that while it may be a factor, it does not appear to account for the productivity gap

between interacting groups and nominal groups as the gap is similar in both low and high evaluative conditions.

Observational learning: Watching others perform the same task may lead to some imitation of their performances. Pinsonneault et al (1999), regard this as a process gain, although Lamm & Trommsdorff, who originally noted it in their 1973 review of traditional brainstorming made no such claim. Although not seen in the literature, it seems plausible that this could lead to process gain or process loss depending on the level of performance of the group members. As a process loss this is distinct from productivity matching as it would involve specifically learning bad performance traits as opposed to simply applying less effort.

Distraction: Lamm and Trommsdorff (1973) suggest that face to face interaction involves social-emotional stimuli unrelated to the task, which may distract participants from the task.

3) Economic mechanisms:

Free-riding/Social Loafing (Kerr & Bruun, 1983, Diehl & Stroebe, 1987): It seems in the literature that there are different meanings of the terms 'free-riding' and 'social loafing'. Kerr & Bruun (1983) interpret free-riding as motivation losses that result from participants feeling their ideas are dispensable, while they interpret social loafing as motivation losses as a result of a lack of identifiability in a group. Meanwhile others, including Diehl & Stroebe (1987), consider the term free-riding to be an umbrella term that represents both types of motivation loss. For the purposes of this study, the latter interpretation will be followed. Essentially, members of groups do not work as hard as when they work alone. The assumption is that any reduction in the ability for individual performance to be monitored will also reduce the perceived accountability and therefore motivation of the subject to produce ideas and make suggestions. Group members may therefore free ride on the suggestions of the other group members if all the suggestions are being viewed only at the group level. As well as decreased identifiability, it has also been shown that perceived effectiveness of suggestions may have an effect (Harkins & Petty, 1982). If so it is likely that increasing group size would decrease this perceived effectiveness and thus increase free-riding. While there is support for the role of free-riding, experiments by Diehl & Stroebe (1987) that increased the accountability in groups determined that it is not a major cause of productivity loss in traditional brainstorming. They suggested that "temptation to free ride should vary as a function of the cost of contributing" and that since there are no time costs (as participants are already committed to attending the session) and since brainstorming is almost effortless, there should be little temptation to free ride. Williams, Harkins & Latane (1981, cited in Paulus & Dzindolet, 1993) also suggest social loafing is unlikely where participants can be identified with their ideas, as is the situation in traditional brainstorming.

Production matching: Participants may be uncertain as to the expected level of individual productivity and will therefore be likely to compare their productivity to that of those around them and to then match their own productivity with that of the others (Paulus & Dzindolet, 1993). The result in interactive groups is that performance will tend towards a group mean. Paulus & Dzindolet (1993) demonstrated this by comparing individuals in nominal pairs with partnership performances and found that individual performance levels within interactive pairs was more similar than that between individuals in nominal pairs. By splitting the brainstorming time into 5 minute blocks they found that social influence starts early in the session and is maintained throughout. They also showed that this was true even when different problems were used. They predict that this could have an important effect. They feel that other production losses (like evaluation apprehension, production blocking and free-riding) are likely to occur early in the

brainstorming session and that the production matching effect could lead to an initial low level of group performance becoming the normal level of performance that will be maintained throughout the session (even if the other production losses are not major factors during the later stages). Although not specified in the literature found, it seems plausible that nominal group members might also tend towards a higher performance level than interactive groups. This is because they are likely to predict an average performance level for the rest of the group that is greater than the level that is likely to be acheived in reality. (This is in keeping with work looking at the "illusion of group effectivity", a concept proposed by Diehl & Stroebe (1991) which will be discussed shortly).

Mullen, Johnson & Salas (1991) concluded that "the long-lived popularity of brainstorming techniques is unequivocally and substantively misguided" and from the research findings published in both the 1987 and 1991 studies, Diehl & Stroebe emphatically concluded that "group sessions should not be used to generate ideas."

Overall then, production blocking was highlighted as the most likely weakness of traditional brainstorming by Lamm & Trommsdorff (1973) and based on their research Diehl & Stroebe (1987,1991) wholly endorsed this view and concluded that if production blocking could be reduced, brainstorming groups could increase their productivity. Others, including Mullen, Johnson & Salas (1991) disagree, citing social psychological mechanisms as the most likely cause. What is clear, though, is that there are a number of interpretations for productivity loss and many are not mutually exclusive. The effects seen in reality are likely to be the result of a complex interplay of all these factors. Sometimes having supplementary and additive effects. For this reason the full range of these factors should be considered when evaluating a new tool for brainstorming, such as wiki.

Despite this apparently overwhelming evidence that brainstorming simply doesn't work, the brainstorming technique is as popular in the modern work place as it has ever been. The 'illusion of group effectivity' (Diehl & Stroebe, 1991) has been suggested as a possible explanation for the continued success enjoyed by the brainstorming technique. Paulus et al., (1993), showed that even though interactive brainstorming leads to productivity loss compared to nominal groups, participants report that they think they produce more ideas working in a group than they do working individually. They also showed that nominal group members generally felt they would have been more productive had they been working in a group. There appears to be a tendency for participants in groups to perceive their performance more favourably and to overestimate the number of their own ideas. Paulus et al. (1993) showed that individuals in groups being able to compare their performance with that of other group members is a "key factor in the favourable evaluation of group brainstorming". This could be simply because in a 6 person group they are seeing the ideas of 6 people generated in the same time as it would take them to generate those of only one person. Alternatively it may be the result of individuals having trouble distinguishing between which ideas were there own following a session and which were the ideas of others in the group.

2.1.3 Process Gains in Traditional Brainstorming

As well as process losses, there are also some notable process gains identified in traditional brainstorming research:

1) Procedural Mechanisms

Cognitive stimulation: The opposite of cognitive interference, this is where the utterances of others in the group elicit ideas from another group member (Lamm & Trommsdorff, 1973).

2) Social Psychological Mechanisms

Observational learning: Watching others perform the same task may lead to some imitation of their performances. (Lamm & Trommsdorff, 1973) As mentioned earlier, this could be interpreted as potentially a process gain or a process loss.

Social recognition: Caused by members of the brainstorming group wanting recognition of their input from others (Goethlans and Darley, 1987, cited in Pinsonneault et al., 1999)

Task orientation: Focussing on the task (as opposed to the other group members) improves productivity (McGrath, 1984, cited in Pinsonneault et al., 1999)

3) Economic Mechanisms

Drive arousal: The presence of other participants can be arousing and enhance performance of simple tasks. (Green and Bushman, 1987, & Zajonc, 1965, cited in Mullen, Johnson & Salas, 1991). As brainstorming primarily seeks quantity rather than quality, it can be said to be a simple task.

2.1.4 Critique of Traditional Brainstorming Research and Factors Affecting Process Gains and Losses

A major problem in the evaluation of brainstorming in the past has been the variation in interpretations of the term 'brainstorming'. Isaksen, in his 1998 critical review suggests that problems regarding correct definition of brainstorming have manifested themselves in much of the research into traditional brainstorming. In this comprehensive review, Isaksen raises some very salient points regarding the usefulness of much traditional brainstorming research and makes suggestions for future research. The trend in traditional brainstorming research has been to compare the performance of collaborative interacting groups with that of pooled nominal groups. Isaksen claims that the finding from such research, that collaborative group participation inhibits ideative productivity, simply "reinforces the original intention of Osborn", since the initial purpose of the brainstorming technique was to promote the ideative productivity that he recognised was lacking in such groups. The intention was not to replace nominal group work but simply to facilitate group work where group work was a necessity. For example, where the resources available as a group are not matched by any one individual. As Isaksen points out, "Working as two or more individuals who influence each other through interaction is an important organizational reality". This is true of many of today's organisations and with knowledge and expertise becoming more specialised and being distributed between more people, it seems likely that this will only get more pronounced in the future.

In a real world setting there are a number of competing factors that can affect the process gains and losses of any given collaboration method and therefore, as suggested in Lamm & Trommsdorff's 1973 review, idea generation in groups must be studied within that larger context to be able to give a holistic assessment of its associated advantages and disadvantages.

Traditional research is further criticised on the basis that it commonly takes the brainstorming task out of the context to which it naturally belongs as a part of creative problem solving (CPS). Brainstorming in interactive groups is thought to make people feel better about the idea-generation

process, provide a greater sense of satisfaction and confidence with the results (Gallupe, Bastionutti & Cooper, 1991) and promotes a sense of group ownership in the solution of shared problems (Greenberg & Folger, 1983 cited in Paulus et al., 1993). This in turn is thought to boost cohesiveness of the group. As cohesive groups are thought to be more likely to collaborate (Cartwright, 1968) this may boost group productivity in general as well as potentially benefiting later stages of the problem solving process, such as when the group needs to work together to implement the ideas generated. The extra satisfaction and sense of ownership with group results generated in traditional brainstorming may also be beneficial later on in getting an idea accepted for implementation. Increased participation in problem solving might therefore have longer term benefits regarding group productivity, idea implementation and change management processes that are unable to be captured by traditional research.

As well as these, Isaksen (1998) highlights a number of other factors that can affect the process gains and losses in brainstorming and these should be taken into account during evaluation of the technique:

Facilitator presence: Very few of the traditional brainstorming studies are performed in the presence of a facilitator, despite the clear recommendation of facilitator presence made by Osborn. The facilitator could have a profound effect on the brainstorming process in a number of ways since they are responsible for preparation of the session, focusing the group and its resources and keeping them on track as well as ensuring the brainstorming guidelines are understood and followed. Mullen, Johnson & Salas (1991) also raise the issue of experimenter presence and how this will affect process gains and losses. Specifically they tested the hypothesis that while it should have no effect on the procedural mechanisms, the presence of an experimenter is likely to affect the social psychological mechanisms by making participants of the brainstorming group "slightly more self-attentive" and lone participants of a nominal group "considerably more self-attentive". The suggestion being that nominal group productivity is likely to increase proportionally as a result. They also felt it would affect the economic mechanisms and reduce productivity loss in groups as the tendency to free ride would be lowered. Their findings showed that there was "significantly greater" productivity loss in the presence of an experimenter than when the experimenter was absent". It is also likely that the level of expertise of the facilitator will be a factor and the level of facilitator training may therefore be an important consideration. This also brings us to the subject of user training.

Training: Another notable omission from the bulk of the research into traditional brainstorming is the effect that dedicated brainstorming training for the users may have on the process. Osborn suggested the importance of training in brainstorming technique and also pointed to the facilitator as an important figure in ensuring necessary training is in place. Mullen, Johnson, & Salas (1991) also recognised the area of training as a potential influence on productivity. Isaksen (1998) notes that for many of the traditional studies covered in their review where training took place, the training is provided by a researcher with little brainstorming qualification other than having read the rules. While this may in fact reflect the real word scenario fairly accurately the impact of adequate training of the facilitator is once again highlighted here.

Individual ideation: Osborn suggested that a session should be both proceeded and followed up by a period of individual ideation. However, group brainstorms in traditional brainstorming research often have no such opportunities for individual ideation. This goes against Osborn's suggestion that brainstorming is not meant to be a replacement for individual ideation (Osborn, 1967).

Group composition: Working in groups is often a necessity as organisational knowledge is distributed amongst its staff and getting together is the only way to ensure participants are able to share thoughts on a variety of aspects of the problem and to maximise the joint capabilities of the group. Lamm & Trommsdorff (1973) recognised "combining cognitive resources" as an effect in group participation, where solutions to problems may require various cognitive skills or ideas from a variety of different experiential backgrounds. Osborn suggested that groups should ideally comprise self-starters who have a range of experience with the topic being brainstormed and also made it clear that group members should not come from a mixture of different levels of seniority. However, it appears that such effects have been ignored in much of the subsequent literature. The majority of studies use college students as subjects. This raises a number of issues. Students are probably one of the least likely groups to have been involved in a traditional brainstorming session previously. A group of students is also less likely to have the wide range of cognitive skills and experiential backgrounds, nor the level of distributed knowledge that might be expected in members of a real organisation.

Group history: This is a further problem associated with using student groups in research as student subjects are unlikely to have worked together as a group prior to the study and are unlikely to work together again subsequently. In fact, it is likely that the student subjects will not even know each other prior to the study. This is an unlikely situation in a real world setting where participants are likely to have interacted and collaborated previously and will probably anticipate doing so again in the future. Paulus et al. (1993) recognised that "groups in natural settings may have learnt to work effectively together."

A relationship of honest and earned trust between participants seems to be an important factor in brainstorming success and the history of the group is crucial to this. An aim to augment this relationship is one of the reasons for 'ice-breakers' or warm up sessions often held before a brainstorming meeting, often involving brainstorming on simple nonsense problems to get people comfortable with the process and each other.

Nature of the problem being addressed: Many traditional studies into brainstorming effectiveness have considered trivial artificial questions such as "What would be the implications of waking up to find you have an extra thumb" which clearly require no previous knowledge or expertise. By using similar problems, the studies are allowing comparisons to be made across studies. However, the problems used do not accurately reflect the way brainstorming is commonly used in organisations where generally the group need to brainstorm on a very real and often difficult problem. A real world problem is also likely to be relevant, engaging and of interest to all group members and there will be a real business need for a solution. Participants are therefore likely to feel a greater sense of ownership of 'real' problems than they would for the sort of trivial problems typical in traditional brainstorming research. It is felt that the greater sense of ownership will help drive the brainstorming process and that the lack of 'real' problems used in experiments could have a detrimental effect on the quality and quantity of ideas being generated.

Process Satisfaction: Participant satisfaction with the process and with outcome/ideas generated is thought to possibly affect productivity, although it is clear that any effects are only likely to emerge after continued use of the brainstorming technique by any particular group. This may be the 'illusion of group effectivity' initially, but, although not noted in the literature, it seems possible that a belief in the productivity of the technique and happiness in the outcomes could serve to boost its productivity over successive sessions, perhaps to a level of 'actual productivity'. Alternatively, it may even be considered that losses due to the inefficiency of brainstorming can be offset by the benefits gained in terms of team building as a result of process satisfaction.

This summary of problems with traditional brainstorming has served to highlight some factors that could affect process gains and losses in brainstorming sessions. Mullen, Johnson & Salas, (1991) also recommend several more factors to examine at evaluation which may affect the balance of the process gains and losses:

Group Size: It would be expected that each of the three mechanisms would cause productivity to fall more as group size was increased. More people in the group would mean increased evaluation apprehension, increased production blocking and increased free-riding for example. Osborn's original suggestion for group size was between 5 and 10 participants. Bouchard and Hare (1970) found that there was a significant effect due to size of group. While larger groups produced more ideas, they noted that for real groups there was a "leveling-off effect" as the increase in the number of ideas became less as the group size increased. They felt that this might be the result of time being monopolised in an inefficient manner in groups and that effective time management was the crucial factor.

Clearly then, it is a very complex interplay of mechanisms that determines how well or badly brainstorming works in groups. A review of the traditional brainstorming literature has allowed a number of process gains and losses to be identified. The review also identified a number of important factors that can affect these process gains and losses.

2.2 Wiki Based Collaboration and Brainstorming

Despite the volume of scientific literature that claims traditional brainstorming is ineffective, it is still a hugely popular technique in modern business. Some suggest its continued success is the result of the 'illusion of group effectivity'. Others maintain that brainstorming can still work, despite the research findings, as long as the rules and guidelines are followed, the appropriate training is given and that the process is viewed in full organisational context. Whatever the reason, the continuing popularity of brainstorming means that new collaborative brainstorming technologies are required that will meet the needs of organisations.

As we saw in the introduction, increasing globalisation means that businesses are increasingly relying on distributed knowledge and distributed work teams that cannot easily meet face to face in a traditional brainstorming environment. There is a clear business need for collaboration across these groups, which includes a need for distributed idea generation. Fears of high implementation costs associated with many dedicated software solutions might make wiki a very viable alternative as a brainstorming tool. However, despite being in existence since 1995, wiki use is still fairly rare within organisations and it seems there are a number of potential problems regarding user uptake of the technology which must be taken into account.

2.1 Problems with Wiki Collaboration

Wiki have not been the subject of much research work and many of the current findings regarding factors affecting the successful use of wiki are derived from trial and error testing in organisations. A review of the limited literature and of wiki-related Internet sites was conducted to gain an insight into known problem areas with wiki use that could be incorporated into a logical framework for evaluating wiki use.

2.1.1 Ownership and Anonymity

Many users seem to have a problem with the idea of shared ownership of data within wiki. A common complaint may be "I don't want someone to edit my work". The idea of handing over ownership of your work to the community is central to the concept of wiki but it seems that this might be difficult for users to grasp. Those users that see their input as belonging to them more than to the community are likely to become easily frustrated with the process when 'their' input is changed or deleted by another user.

Fear of Destructive Input: Despite the in-built version control in wiki, graffiti and spam are a noted cause for concern to new users. Since recent changes can be viewed by users and destructive input can be readily rolled back, the problem is likely to be more to do with user misconception with how wiki works and misconception like these can lead to mistrust of the wiki contents. Another fear is of edit wars, where "two or more contributors repeatedly revert one another's edits to an article". ("Edit War", Wikipedia, 2004)

Mistrust: How much users trust in the security and contents of a wiki and the wiki community is likely to be a deciding factor in how well used it is ("Trust and Responsibilty", C2 Wiki, 2004). Users may refuse to place trust in wiki contents simply because changes can be made by anyone and incorrect, incomplete, redundant or out of date information in the wiki will increase this mistrust. The nature of wiki could lead to uncertainty as to the integrity of the system.

Communities are built around trust. When the trust is destroyed, the community is crippled. ("Why Wiki Works Not", C2 Wiki, 2004)

Individual credit: Users may also be prevented from participating in wiki collaboration by the fact that their contribution may subsequently not be attributable to them as an individual (Paquet, 2003).

2.1.2 Recorded Data Structure

Van Deursen & Visser (2002) in their study of the use of wiki as a data repository, note that the ability for all users to change the underlying structure of wiki means that wiki data structure by its nature is "less explicit but more flexible" making it more suitable where the underlying structure is likely to change. Comments on Meatball Wiki, a wiki about on-line communities and culture, suggest that users can become frustrated by a lack of navigability in wiki ("Why Wiki Works", Meatball Wiki, 2004).

A lack of familiarity with the ownership concept, plus the changeable content and structure may make wiki collaboration seem out of control or chaotic to new users. By its nature, wiki actually helps bridge the gap between chaotic and ordered information but crucially the existence of history and the ability to roll back data changes means that it will always progress towards the common goal of the community. A common problem is users move off topic on pages.

Fear of Refactoring: Clearly natural refactoring of wiki data and structure by the community should sort out these issues but it is suggested that this may not occur as naturally as it should. By its nature wiki is a work in progress, but it is suggested that even though it is free for anyone to edit wiki, people are reluctant to change what others have written or delete what they think (or even know) is wrong.

If wiki content is only added to and no editing of existing content or structure takes place the wiki will become difficult to navigate and read, leading to confusion. This can lead to users finding wiki chaotic.

The lack of contribution could be due to users not feeling free or at liberty to make changes. Alternatively it may be the result of a lack of confidence of any individual user that they can appropriately reformat information added by the rest of the community. They may feel they are not knowledgeable enough or they may feel that they don't understand well enough the message that others are hoping to convey. ("Knowledge Management", C2 Wiki, 2004)

Clearly if refactoring fear does exist then the idea of information crystallising ("Wiki", C2 Wiki, 2004) in a page might not be as clear cut as it at first seems. However, this may not represent a problem for the purposes of a brainstorm since one of the aims of traditional brainstorming is to keep all ideas to promote maximum opportunity for the 'sparking off' of new ideas. For this reason, the ability for other users to refactor and delete comments may in fact be a drawback of wiki-based brainstorming.

One suggested solution to refactoring fear and the other problems of wiki is to ensure that users have suitable training and that there are wiki users in place who have the specific task of refactoring data on the wiki.

2.1.3 Technical Issues

Syntax: There is some suggestion that technical issues may be a problem with wiki.   Ward Cunningham adopted a 'do the simplest thing that works' approach to wiki at its conception (Cunningham, 2004).   This provides maximum flexibility but, depending on the particular implementation, it also means users may be required to learn a new, albeit simple, syntax to use it to greatest effect. This may be a particular problem for new users.

Overuse of E-mail: Many people are very used to e-mail and users may not be prepared to change to a new communication medium simply through force of habit, despite the obvious advantages in terms of version control, preventing duplication of effort and in ensuring that relevant information is not so easily lost when there is a change of staff.

3 Design Phase I: Wiki Based Brainstorming

3.1 Problem Analysis

There is an increasing need for collaboration across distributed work groups, which includes a need for distributed idea generation and wiki-based brainstorming may be a means to provide new freedoms in terms of synchronicity and geographical location to the process.

A finding of the literature review was that much traditional brainstorming research claims that brainstorming does not work. However, the continued wide scale use of the technique means that, effective or not, further study is still warranted, whether in terms of extending the current scope of the brainstorming technique or in terms of optimising the process. As well as allowing asynchronous, distributed idea generation, the different ways in which the process gains and losses are affected by wiki-based brainstorming may mean that it is able to increase the effectiveness of the process and it may even outperform traditional brainstorming.

A number of process gains and losses associated with traditional brainstorming were identified in the literature review. The majority of research has concentrated on controlled experiments which have aimed to test the effects of these process gains and losses on group productivity. However, the review also showed that successful brainstorming may rely greatly on its contextual setting and that a variety of factors may affect the process gains and losses within its natural setting. Some of these factors were also highlighted in the literature review. By concentrating on experimental studies manipulating specific process gains and losses traditional research has meant that these factors have often not been fully accounted for. The subsequent lack of empirical work performed on real groups with real needs has been shown to be a source of criticism.

The literature review showed that 'brainstorming' is an ambiguous term that has been defined in a number of different ways in different studies. For the purposes of this study, the definition of 'brainstorming' is based on the original concept as defined by Osborn (1967), the inventor of the technique, including both the four rules of brainstorming and the guidelines he specified for its successful application. Ideally therefore, an electronic brainstorming tool should adhere to Osborn's original concept of brainstorming as fully as possible. While many are designed with this in mind, brainstorming is one of many potential functions of wiki for which it has not been purpose built. However, it is felt that to a certain extent, the nature of wiki itself may promote the rules of brainstorming without the need for further guidelines or instruction aside from those needed for general wiki use. As any contribution to wiki can be made anonymously, ideas are likely to be generated more freely than in traditional brainstorming as direct criticism is no longer possible. This should lead to greater number of ideas which is in keeping with Osborn's original rules. There is also no limit to the quantity of ideas or the amount of freewheeling, rearranging or linking together of ideas in unusual ways that can occur. In fact, the simple way in which wiki pages can be created and linked could provide a whole new means for combining existing ideas in different and novel ways. Furthermore, the 'information crystallising' nature of wiki can help to ensure that the ideas remain organised and easy to refer back to, boosting the potential for the 'sparking off' and building up of existing ideas.

Whilst traditional brainstorming is a well established means of collaboration which has been studied extensively, previous research work regarding wiki use in general is minimal. Although it is likely that some users have naturally started to use wiki as a scratch pad for idea generation, its potential application in brainstorming does not appear to have been formally assessed previously. Adding

brainstorming as a potential application of wiki to its already established range of uses would further increase the value of this cheap and powerful multi-function tool. While it seems plausible in theory there is a clear need to evaluate the ability of this existing collaboration technology to be used to hold a successful distributed asynchronous brainstorm. The aim of this study was therefore to perform such an evaluation in order to determine how idea generation occurs in wiki and how it differs from that seen in traditional brainstorming.

3.2 Research Design

3.2.1 Design Options

Study of this subject could have taken the scientific qualitative approach favoured in traditional brainstorming research, based on more laboratory-style experiments. This would have allowed more precise and quantitative measurements of effects as well as direct manipulation of the various factors that effect brainstorming. However, in order to achieve this it would have been necessary to narrow the scope of the problem greatly and perhaps most significantly, the process could not have taken place in a natural context. The artificial setting may have a pronounced effect on the results from a study of this nature given the complexity and context related nature of the process gains and losses that are likely to be involved. This was noted as a limitation of previous studies in the critique of traditional brainstorming research. For this reason and since wiki use, particularly as a means of distributed collaboration, is still in its early stages, a more holistic approach was considered more appropriate to try to elicit an overview of the situation in the first instance.

The chosen design follows a task oriented approach, looking primarily at the brainstorm process itself rather than the setting and context in which people contributed although a setting oriented approach was considered, aimed at looking at the way users work on location with the tool. For the greatest triangulation, covering both aspects would have been ideal, but this was considered beyond the scope of this project.

3.2.2 Contextual Holistic Case Study Approach

Research Strategy: The approach adopted involves a case study approach to collecting data. The findings from a wiki brainstorm case study were to be evaluated by comparing them to findings from the traditional brainstorming research.

Focussing on one case study allows a holistic approach to be adopted. This allows the full intricacy and subtlety of the complex real world situation to be explored in depth, although this may also allow fewer generalisations to be made from the findings. Ideally, different complimentary strategies should be compared in order to offset the flaws in each. Consistencies found across a range of studies like this would allow more accurate generalisations to be made. However, the lack of previous literature on this subject means there will be little scope to compare results, but it is hoped that the findings will provide a basis for comparison for future work in this area.

Research Methods: A holistic case study approach will require the use of a variety of methods and sources of data to capture the full complexity of the real world situation.

McGrath (1993) highlights the 'dilemma of empirical science' in which he noted that 'all methods have inherent flaws-though each has certain advantages'. As with research strategies, these flaws cannot be avoided but by triangulation, using a variety of methods and sources, all aspects of the

problem can be covered. By combining the various methods and sources in an evaluation, the strengths of one can offset the weakness of another.

Research Analysis: Data will be subject to a detailed qualitative analysis. Social collaboration involves a great deal of uncertainties and ambiguity and a qualitative approach is the most suited to capturing these social realities.

3.2.3 A Framework for Evaluation

As the subject does not appear to have been formally assessed previously, the development of a new framework for evaluation was an important part of the study. The framework was primarily based on the process gains and losses in traditional brainstorming and the factors that affect them, as derived from the review of traditional brainstorming. It was elaborated by including noted problems from the review of wiki in order to generate a sufficiently rounded framework that would be suitable for evaluation.

Traditional studies emphasise the importance of process losses in particular, notably evaluation apprehension, production blocking and free-riding. Reducing process losses may be important to the success of a wiki-based brainstorm just as it is considered important in traditional brainstorming and they will form an important backdrop for the evaluation. However, in order to present a holistic case study, it was important to consider all the possible areas of production gain and loss as derived from the literature review.

Pinsonneault et al. (1999) suggested a means of assessing overall brainstorming productivity by looking at process losses and gains from brainstorming research. This formed the basis for a summary table of process losses and gains (Table 1). This table however, has been amended and adapted significantly based on findings from my own literature review. The structure of the resulting table follows that of the discussion of the process losses and gains in the literature reviews.

Table 1: A Summary of Process Losses and Gains in Traditional Brainstorming

		Title	Description
Process Losses	*Procedural mechanisms*	Cognitive Interference	When people get overly engaged in other contributors suggestions instead of generating their own ideas.
		Duplication	When many contributors are working on the same or similar ideas, unaware of each other, effort is wasted without any additional gain. Derived from nominal group studies.
		Production blocking o Speaking time o Re-evaluation of ideas o Thought distraction o Forgetting ideas	Ideas are not verbalised as they occur because only one group member is able to speak at a time.
	Social psychological mechanisms	Cognitive uniformity	General tending towards mutually similar suggestions.
		Personalisation of issues	When individuals associate discussed ideas to personal matters between them and other participants.
		Social influence	Members of the group having a dominant effect within the group.
		Evaluation apprehension	Members of the group being unwilling to state some of their ideas because they are afraid of negative evaluation.
		Observational learning	Watching others perform the same task may lead to some imitation of their performances. May also be a processes gain .
		Distraction	By social-emotional stimuli unrelated to the task.
	Economic mech's	Social loafing/free-riding	Reduced ability to monitor individual performance may reduce the perceived accountability and motivation of the subject to contribute.
		Production matching	Compare their productivity to that of those around them and to then match their own productivity with that of the others.
Process Gains	*Procedural mech's*	Cognitive stimulation/synergy	Utterances of others in the group elicit ideas from another group member.
	Social psych mech's	Observational learning	Watching others perform the same task may lead to some imitation of their performances. May also be a process loss.
		Social recognition	Caused by members of the brainstorming group wanting recognition of their input from others.
		Task orientation	Focussing on the task (as opposed to the other group members) improves productivity.
	Economic mech's	Drive arousal	The presence of other participants can be arousing and enhance performance of simple tasks.

Table 1 therefore summarises the process gains and losses from the literature review, but in order to analyse a real world case study it is necessary to have a framework based on the social and contextual factors that might affect these process gains and losses in a real world setting. A framework was derived from the relevant social and contextual factors that were recognised in the literature review of both traditional brainstorming and wiki (Table 2). The first column of the framework shows some of the process gains and losses that these factors are likely to affect.

Table 2: A Framework for Assessing Wiki-based Brainstorming

Factor name (and relevant process gains and losses)	Summary
Factors Derived From Traditional Brainstorming Literature (Chapter 1)	
Facilitator presence • Cognitive uniformity • Cognitive interference • Social influence • Evaluation apprehension • Distraction • Social loafing/free-riding • Cognitive stimulation/synergy (by seeding/suggesting) • Task orientation • Could affect recorded data structure/training category	A facilitator could have a profound effect on the brainstorming process in a number of ways. A facilitator can teach and reinforce the guidelines, ask stimulating questions, guide idea generation, plan sessions and appropriate seeding questions and provide warm up and practice in the technique. Osborn recognised the importance of this role.
Training • Cognitive interference • Could affect many other categories depending on the nature of the training.	Osborn suggested the importance of training in brainstorming technique.
Individual ideation • Duplication	Osborn suggested that a session should be both proceeded and followed up by a period of individual ideation.
Group Composition • Social influence • Evaluation apprehension • Observational learning • Social loafing/free-riding (reduced if bosses present) • Social recognition • Drive arousal	Osborn suggested that groups should ideally comprise self-starters who have a range of experience with the topic being brainstormed but they should not come from a mixture of different levels of seniority.
Group History • Cognitive uniformity (due to group norms) • Personalisation of issues • Evaluation apprehension • Social recognition • Drive arousal	A relationship of honest and earned trust between participants is important and the history of the group is crucial to this.
Nature of the problem being addressed • Evaluation apprehension • Social loafing/free-riding	A real world problem is also likely to be relevant, engaging and of interest to all group members and there will be a real business need for a solution.
Process Satisfaction • Drive arousal • Could affect other categories at the following session	Participant satisfaction with the process and with outcome/ideas generated is thought to possibly affect productivity. This may even be true of the 'illusion of group effectivity'.
Group Size • Production blocking • Evaluation apprehension • Social loafing/free-riding • Cognitive stimulation/synergy • Drive arousal	More people in the group would mean increased evaluation apprehension, increased production blocking and increased free-riding for example.

Factors Derived From Wiki Literature (Chapter 2)	

Ownership and Anonymity
   • Cognitive uniformity
   • Personalisation of issues
   • Social influence
   • Evaluation apprehension
   • Observational learning
   • Social loafing/free-riding
   • Production matching
   • Social recognition
   • Task Orientation
   • Drive arousal
	Contribution may be affected by social factors of not wanting to edit other people's information or not wanting to add information that can be deleted easily by others. If users are identifiable in their comments this may also make then apprehensive about the possibility of criticism.

Recorded Data structure
   • Cognitive interference
   • Duplication
   • (Technology based) production blocking (based on ease of adding data)
   • Cognitive stimulation/synergy
   • Could affect process satisfaction category
	How well structured wiki content is may affect the success of a brainstorm as it may affect navigability and cognitive interference.

Nature of Technology
   • (Technology based) production blocking
   • (Technology based) cognitive interference
	The system being too difficult to use could affect brainstorming success by increasing cognitive interference (although here it would be from the technology rather than from the other users) and thereby increasing production blocking (again by the technology rather than the other users). Syntax in wiki may be a specific issue for less technical users.

The developed framework was used as the basis for evaluating wiki-based brainstorming such that the findings from the research could be related back to the relevant process gains and losses. It should be noted at this point that the framework is intended only as a point of reference and guidance for the evaluation. The holistic research approach adopted meant that effort was made at all times to include capture of insight and information that was beyond the scope of this framework.

3.2.4 The Case Study

To avoid the same criticisms as much of the traditional brainstorming literature, the aim was for the case study to be based around real participants, brainstorming on a real topic for which there was a real need for input. The process would then be studied in a natural context where the idea generating and creative processes were driven by a real need.

A possible case study was established of a wiki at a translations company. The wiki was used as a means of supporting existing office based staff as well as translators based around the world. The distributed nature of the users would have been ideal for evaluation purposes. Unfortunately this opportunity didn't materialise and a substitute case study was manufactured.

A course feedback wiki was created for the Information Processing MSc (MSc IP) course based at the Computer Science Department of the University of York. The participants were students and lecturers of the course. The reader is reminded at this point that traditional brainstorming research received criticism for relying too heavily on students as subjects. For this study, however, they were considered appropriate as they were a real group whose members knew each other and had interacted previously. The brainstorming topic chosen was specifically ways of improving the MSc IP course for future students. This was created within the context of an informal chat about the

current MSc course that the student subjects were completing at the time of the project. While a driving organisational need would not be present (as the department already had more traditional feedback mechanisms in place), it was hoped that the participants would be keen to contribute due to a natural sense of interest and concern with the subject. The participants were informed that the output of the brainstorm would be given to the course organisers for their consideration. The intention here was to give the students a sense that contributing to the wiki had real world value.

The wiki distribution used for the study was Tiki wiki v.1.7.8 ("TikiWiki", TikiWiki, 2004), using PHP script and a MySQL database and it was running on a UNIX server at the University. The wiki was configured to ensure that users did not have to log in to make changes to the wiki contents and that it was impossible for any changes made to be traced back to a particular user. For the duration of the test period, the wiki was therefore openly editable. Users were able to edit any page of the wiki (except for a static introductory page which explained the project). In order to preserve wiki history records for evaluation, users were not given permission to be able to remove pages. They were, however, able to remove all content on a page and all links to that page which would essentially have the same effect. Users were able to view the wiki history but they were not able to affect it in terms of deletion of history or rolling back of pages to a previously stored version. Some changes were made to the wiki interface to create a suitable look and feel for the brainstorming application. This involved trying to keep the interface as simple and intuitive to use as possible with easy access to the brainstorm contents.

A simple introduction and basic wiki instructions were provided on the opening page of the wiki (see Appendix C) to ensure that users could get familiar with the syntax and get started rapidly. More detailed guidance was provided on a separate static web page (see Appendix C), including an introduction to the concept of wiki, reference links and a printable instruction sheet (see Appendix C). While wiki instructions were provided, specific brainstorming instructions were not. The intention was to evaluate the potential for wiki as a brainstorming tool in the absence of specific brainstorming instructions. This is also in keeping with the idea of studying the real-world use of brainstorming where rules and guidelines are frequently not specified. Where they are specified, they are commonly not enforced or followed. Clearly, while the brainstorming ideals will not be emphasised or enforced during the trial period, they will become an important part of the evaluation framework and the process of evaluating the brainstorm wiki.

The author took the role of a participant observer in the study, in the form of a partial facilitator for the wiki. This facilitation role included performing some initial seeding of the wiki. This was assisted by two other students of the MSc IP course. Some initial topics and questions were added that it was hoped would promote discussion and provide a suitable starting point for the brainstorm. This was in keeping with Osborn's suggestion that the facilitator in a traditional brainstorming should seed the discussion to get the process started.

The wiki-based Information Processing MSc brainstorm was opened to the students and lecturers by means of an e-mail invitation. The e-mail was designed to promote interest and encourage participation in the event. Once live the wiki was to be left as much as possible to find its own natural structure, but changes to structure and content would be made if it was felt it was becoming detrimental to continued wiki use not to do so. As facilitator, the author also acted to promote use of the wiki during the test period.

While the basis of a case study (the 'case') is "normally something that already exists" (Denscombe, 1998), it was felt that a carefully manufactured case study could be equally valuable as long as it too was based around a real group with real history and a real brainstorming topic that would be of

real concern and interest to the subjects. Although manufactured, it essentially represented a natural case study environment.

3.2.5 Data Collection

Multiple methods of collecting data were utilised in order to capture the complexity of activities involved in the context of a real life setting and to achieve an appropriate level of triangulation. The methods used were as follows:

Wiki Data

To a certain extent, the ideas generated by using the wiki were expected to structure themselves over time. As wiki history is stored, the data at the end of the test period provided not only a view of the end state of the wiki brainstorm, but also a traceable history of the changes made during the course of the brainstorm. Wiki users were encouraged to add comments to their entries explaining their thoughts during data additions and data changes. This would make the thought process running through the history easier to follow and interpret correctly.

Qualitative analysis of this wiki output was to be performed at the end of the test period. It was hoped that this data would provide insight into process factors of idea generation by showing how data was added to and refactored over time.

A suitable means to evaluate the resulting wiki data had to be established. Due to the lack of previous literature on the subject, this was not something established during the review. As it is essentially time-line based data, in the same way as say a tape recording or video recording, it was decided to use similar methods to those used to analyse these data sources. The aim was to use qualitative analysis software (QSR NVivio 2.0) to code the emerging wiki data and subsequently group themes and establish trends in the wiki data. Code generation would be assisted by, but not restricted to, the factors highlighted in the established framework.

It was hoped that, as well as showing patterns of activity, the data would also give a sense of the fluency and the flexibility of idea generation in a wiki-based brainstorm. Fluency being a measure of the quantity of ideas generated and flexibility being a measure of the range of ideas generated.

An alternative design possibility that may have affected wiki data was to include a login system for the brainstorm. This would allow the comments of specific users to be identified. This would have been useful in distinguishing between users and in determining individual trends in the data. It would also allow tracking of exactly how many participated which could have a bearing on the validity of the emerging data and subsequent findings. However, it was decided for two reasons that the brainstorm should be entirely anonymous. Firstly, it keeps the system simple and easy to use, which was felt to be important in achieving a reasonable response rate. Secondly, in keeping with traditional brainstorming practice, it meant problems of criticism were largely ruled out. Criticism could still occur of course, but the ability for users to remain anonymous should promote more honest and open discussion and remove any fear of their ideas and suggestions receiving criticism.

User Questionnaires

The evaluation framework was also to be used to derive a questionnaire that was to be distributed to the users of the brainstorm wiki at the end of the test period. It was hoped that these would provide

insight into the experiences of the user with wiki and determine how they felt about its use in brainstorming and idea generation. It was also hoped that it would help elicit the perceived benefits or problems with the wiki-based approach. 'Postal' style On-line questionnaires were to be used. This would make completion and submission as easy as possible to help achieve a reasonable response rate. Care would be taken not to make the questionnaire too long so that replying to it was easy and the prospect was not off-putting.

User interviews

Interviews of selected users were to be performed as it was felt that this might provide greater insight into the intricacies and subtleties of the use of the wiki, particularly with regard to the social aspects of wiki use.

Observation

A possible approach would have been to observe all or a subset of users as they used the tool to brainstorm. However this may be impractical since the intension of the Brainstorm Wiki was that users could return at will during the test period and there would therefore be no way to test it a natural context as there would be no way of being present on such occasions.

4 Design Phase II: Problems with Wiki-based Collaboration

4.1 Problem Analysis

As mentioned in the introduction, the amount of input to the MSc IP Brainstorm Wiki was disappointing. After six days, only two occasions were seen where users had added comments to the wiki, despite attempts to promote involvement during this period. Promotion efforts included sending further e-mail to encourage use, this time via the student representative for the course. An e-mail was also sent to staff to invite them to participate and to ask them to encourage contribution from the students they were supervising. This was sent by my supervisor on my behalf.

The basis for failure of the wiki-based collaboration was unknown but it meant that insufficient data was gathered to be able to pursue the evaluation of wiki as a brainstorming tool. Clearly from the low response rate there were either problems relating to wiki-based brainstorming, problems relating to wiki-based collaboration in general or problems with the original research design for the MSc IP Brainstorm.

Having read of only tentative interest shown in wiki by industry and a number of failed attempts at wiki-based collaboration during research for the project, the emphasis of the project was shifted. It changed from being an evaluation of the use of wiki as a distributed collaborative brainstorming tool, to an attempt to evaluate wiki-based collaboration in general, in order to establish a more complete picture of the factors that cause the recognised problems with wiki-based collaboration and how they interrelate.

A number of proposed problems with wiki-based collaboration were identified during review of the limited literature and during review of related web and wiki site references. From the literature, it also seemed plausible that similar factors that affected collaboration in the form of traditional brainstorming may affect wiki-based collaboration as well, such as facilitator presence and the need for appropriate training for example.

The new aim would therefore be to determine the factors that cause the recognised problems with wiki-based collaboration and how they interrelate, based on the review of wiki literature and incorporating the detailed findings on factors that affect traditional brainstorming. This was felt to be appropriate since while very little scientific literature on wiki-based collaboration is available, traditional brainstorming as a means of collaboration has been studied extensively.

An adapted design was needed to pursue this new train of thought in the limited evaluation time that remained (see Appendix A for timeline).

4.2 Research Design

4.2.1 Triangulation Approach

A possible design might have been to concentrate specifically on why the MSc IP Brainstorm Wiki had failed by concentrating on the users of that wiki. However, it was felt that in order to be able to make more appropriate and valid generalisations from the findings regarding general wiki-based collaboration, a more holistic approach was needed. It was felt that triangulation, using a variety of different methods and sources, would be the most appropriate to gain a full insight into the range of

factors that affect wiki-based collaboration by taking into account aspects of a variety of different types, sizes and uses of wiki. This also meant that different threads of investigation could continue at once which was considered a strategic choice given the limited time available for data collection. It was hoped that the triangulation approach would allow a more complete insight into the issues and that it would provide sufficient data to allow some assessment of the relative importance of the noted problems with wiki. In order to guide the various threads of the investigation a set of hypotheses were established.

4.2.2 The Hypotheses

The framework of factors affecting brainstorming developed for the initial design (Table 2) became the basis for developing a set of hypotheses as to why wiki fail (Table 3). Table 3 outlines the general hypotheses and how these were derived from the table 2 categories (and therefore the literature). It also includes short versions of the hypotheses which were used in gathering results. These hypotheses formed the basis of the evaluation. It was hoped that by incorporating findings on collaboration in the form of traditional brainstorming to collaboration in the form of wiki, extra insight might be gained on the factors, particularly the social factors, which affect wiki-based collaboration.

It should be noted at this point that, as with the framework in design phase 1, the hypotheses are intended only as a point of guidance for the evaluation. The holistic research approach adopted meant that effort was made at all times to include capture of insight and information that was beyond the scope of these hypotheses.

Table 3: Hypotheses for Evaluating the Factors Affecting Wiki-based Collaboration

Area of interest	Hypothesis
Understanding and Training	Category derived from 'Training' category in traditional brainstorming section and 'Nature of Technology' category in wiki section of table 2. While it seems the mechanics of wiki use are easy to grasp, a lack of familiarity with the wiki concepts such as joint ownership of data and the freedom to edit any data may cause problems with user satisfaction with the process. Training may be considered essential to help overcome this. Primarily it is felt that training would be crucial not only in teaching the syntax etc but more importantly in teaching the concept of wiki. *1: Specific training in appropriate wiki use would be very beneficial to new wiki users, particularly regarding wiki culture and social aspects of wiki use.*
Group Size and Composition	Category derived directly from 'Group Size' and Group Composition' categories in traditional brainstorming section of table 2. A successful wiki may require a core number of active users in order to keep the subject going. The range of different types of users may also affect wiki success in the same way as they can affect traditional brainstorming. *2: A core of regular active users is needed for a wiki to be successful.*
Group History	Category derived directly from traditional brainstorming section of table 2. Group history was considered important in traditional brainstorming research. Users who recognise each other, have worked together before and anticipate working together again are more likely to collaborate effectively using a wiki than those that haven't. Group history could provide a sense of community and therefore it may be equally important in wiki. *3: A sense of community and therefore group history is important to wiki success.*

Nature of the Task	Category derived from 'Nature of Problem' category in traditional brainstorming section of table 2. Just as different types of problems could effect process gains and losses differently in traditional brainstorming success it is felt that different styles of using wiki (for example as a knowledge management tool, as a project management tool or as a collaborative document authoring tool) may effect different process gains and losses in wiki collaboration. The different styles of wiki use may also build on different conceptual models of how wiki works. A lack of clear delineation between these different uses (and therefore these mental models) may cause problems by making wiki seem more complex, confusing and overwhelming. However, the different functions may also be a way to boost usefulness and subsequent adoption of wiki. *4: Different ways of using wiki (for example as a knowledge management tool, as a project management tool or as a collaborative document authoring tool) may cause problems by making wiki seem more complex, confusing and overwhelming to new users.*
Process Satisfaction	Category derived directly from traditional brainstorming section of table 2. Most of the literature claims that traditional brainstorming is not an effective process. Popularity of the technique is claimed to be due to a high level of process satisfaction. It is thought possible that wiki may suffer from the opposite problem. Despite the obvious potential for wiki, process satisfaction can be low due to confusion with how to use the wiki effectively. The perception is clouded further by common concerns about graffiti, insecurity, and inaccuracy of data. It is possible that negative perceived effectiveness of wiki may reduce its actual effectiveness due to lack of enthusiasm for, trust in and commitment to the wiki concept. As such, addressing perceived effectiveness in the first instance may be important to wiki success. *5: Perceived effectiveness is crucial to wiki success.*
Overuse of E-mail and Other Technology	Category derived from 'Technical Issues' in wiki literature section of table 2. The over-reliance on and overuse of e-mail in society was highlighted as a technical issue in chapter 2 of the literature review. Users might use e-mail over wiki even when it is a less appropriate form of communication. This might affect the success of wiki. *6: The current over-reliance on e-mail in society will affect the success of wiki.*
Recorded Data Structure	Category derived directly from wiki literature section of table 2. Wiki contents may become less structured over time as users move off topic within pages and add information in the wrong places, leading to redundancy. This is not a problem with wiki so much as a problem with how people use wiki. *7: In theory wiki contents should become more structured over time. In practice they may become less structured. This is less a problem with wiki but more a fundamental problem with how people use wiki.*
Ownership and Anonymity	Category derived directly from wiki literature section of table 2. Wiki should be anonymous. Anonymity removes any sense of individual ownership, thereby promoting shared ownership of data. This is in keeping with wiki culture. Anonymous users are more likely to add, delete and refactor wiki data in an uninhibited and honest fashion. *8: Wiki should be anonymous. Anonymity removes any sense of individual ownership, thereby promoting uninhibited addition, deletion and refactoring of wiki data.*
Facilitation	Category derived directly from traditional brainstorming section of table 2. It is thought that corporate wiki may require facilitation in some form. Wiki culture suggests facilitation is provided by the user base as a whole. However, other methods of collaboration use a facilitator as an integral part of the collaborative process (in a brainstorming session for example). Wiki might benefit from an individual or a group of individuals with the specific role of facilitating and overseeing the wiki. *9: Corporate wiki should be facilitated.*

4.2.3 Data Collection

In order to achieve maximum triangulation of results a number of different methods and sources were used:

1. The literature review of recognised problems with wiki which largely came from web and wiki sites.

2. MSc IP Brainstorm Wiki case study data: The small amount of data from the brainstorm wiki was analysed to see if any trends or patterns could be seen that might be relevant to the hypotheses.

2. MSc IP Brainstorm Wiki user interviews: These took the form of informal unstructured interviews of randomly selected students either in person of via instant messaging. This approach was adopted since it was felt that if users were not prepared to participate in the brainstorm, then it was unlikely that they would be willing to participate in a more formal interview or a questionnaire.

3. E-mail to wiki experts: Experts in the field of wiki and on-line collaboration (see Appendix B) were contacted by e-mail to determine their opinions on the hypotheses and the subject in general. Short versions of the hypotheses were given in the e-mail (see Appendix D) to help boost response rate, but a link was also provided to a webpage containing fuller descriptions of the hypotheses.

4. Department of Management Studies Intranet Wiki case study: The existence of another wiki on campus at the University of York was established that was also experiencing some of the identified problems of wiki-based collaboration. The wiki was being used as the basis of an intranet for the Department of Management Studies. The department also had a static external website but their intranet was entirely based upon wiki. The department was made up of about 30 staff, all with access to the wiki. Some users external to the department also had access. Access was restricted by computer hardware addresses and subsequently the wiki was not available via any computer external to the department. Department members do not need to log in to the wiki in order to make changes and therefore, unless signed manually, their changes cannot be traced back to them. The wiki has been live for some time but it was never officially rolled out and users have not received specific training in its use. The existing wiki was studied and a set of interview questions was established guided by the established hypotheses and findings from studying the wiki (see Appendix E). Two users involved with the wiki and its future re-launch of the wiki were interviewed regarding problems and factors that may affect wiki. They were Dr. Antony Powell and Tony Simpson. Findings based on studying the wiki and the subsequent interviews both form a part of the results. This was an ideal second case study as it represents a real world use of wiki, the importance of which was discussed in design phase I (see section 3.2.4)

It was hoped that an understanding of the problems with the two case study wiki along with insight gained from opinions of wiki experts might be able to highlight the problems suffered by and factors affecting wiki and the ways in which they interrelate.

5 Results

The results are made up of two parts. 5.1 concerns observations made from looking at the two case study wiki. 5.2 comprises of feedback gained regarding problems with wiki and factors affecting wiki based collaboration from interviews with users of the case study wiki and e-mail responses from experts in the field. These responses are divided into sections based on the original evaluation areas as given in Table 3. The relevant hypotheses are noted at the beginning of each section but the reader is reminded that the hypotheses were only used as guidance for the evaluation and that comments under each section heading are not limited to direct responses to these hypotheses. Furthermore, comments are added under the section heading in which they are considered most pertinent rather than necessarily the hypotheses that elicited the response. This allows data to be gathered and recorded such that it is not limited to the initial hypotheses. This is in keeping with the holistic approach taken to evaluation as was noted in design phase II. Original responses can be found in the Appendices D & E. Details of the experts can be found in Appendix B.

5.1 Case Study Wiki Data

5.1.1 MSc IP Brainstorm Wiki Data

Some degree of cognitive stimulation was seen in the small amount of input that was made. All additions to the wiki were listed one after another as individual comments. Comments were generally added to the bottom of the page and there was no evidence of them being added where they were most appropriate within a page. There was evidence of one structural change when a new section was added. No attempts to refactor data were seen during the trial period.
The data gave no indication that the users felt any sense of shared ownership over the data and while users did not add their names, the comments of individuals were clearly distinguishable from one another. No effort was made to create any collaborative content.

5.1.2 Management Studies Intranet Wiki Data

As would be expected of an intranet, the content was primarily informational. The rest of the input was largely references to other resources, either as links to internet sites (such as the Departmental website or the University website) or links to local hard drives.

Looking at the Management Studies Wiki there was evidence of broken links and out of date information. There was also evidence of clearly important information but not necessarily regularly useful information and there were also empty pages on the wiki that had been created but not filled. Furthermore, there was evidence of information that was likely to be available elsewhere. In general the existing content seemed very structured, the data seemed largely static and there were no clear invitations for users to edit the data.

The Management Studies Wiki contained a section for a particular research group that showed signs of some different types of page use, including:

- Brainstorming – It was noted that users had identified the page type manually by adding "(very first ideas)" to the top and "...and more...?" to the bottom of the page.
- Meeting notes.
- Project management.

- Thought repository - to capture fleeting data and ideas.
- Things to do.
- Web page management and content preparation.
- E-mail storage – e-mail had been directly posted into the wiki to continue conversation from there.

5.2 Feedback from Wiki Users and Wiki Experts

5.2.1 Understanding and Training

Hypothesis 1: Specific training in appropriate wiki use would be very beneficial to new wiki users, particularly regarding wiki culture and social aspects of wiki use.

Technical understanding

Two students that used the brainstorm wiki said that they didn't like the idea of learning new syntax and one noted that they felt it "doesn't feel standard enough" and that this made them feel wary about using it. Antony Powell from the Department of Management Studies noted the need for wiki to appear more "polished" to the average user.

Benoit Brosseau highlighted the importance of training for non-technical users and for those that have no enthusiasm for technology. Benoit also sees having a what-you-see-is-what-you-get (WYSIWYG) interface and the ability to be able to copy and paste directly from Word and Excel as important features.

Wiki experts generally agreed with hypothesis 1 and did not see the mechanics of wiki as being a significant problem. Specifically, Denham Grey pointed out that "The technology is relatively easy" but that "participants sometime have problems with wiki culture". The experts in general placed more emphasis on the social aspects of wiki and as Sunir Shah noted, "With a compelling enough social organization, people will get over the technical hump".

Conceptual understanding

Adina Levin observed that while the basic concepts were fairly quick to learn they are "different from most people's experiences with static websites and single-user documents."

Tony Simpson from the Department of Management Studies said he "liked the idea" of wiki and specifically mentioned the fact that it is evolving rather than static.

A number of MSc IP students said similar things, but one added to this saying "It's certainly a nice idea...but it relies upon too many social niceties (trusting other people etc) for it to be workable." They found it off-putting that someone else is able to alter something you had written, whether malicious in intent or otherwise. They didn't like the thought that their ideas could be wiped off if someone decides they don't agree with them. They said that as a result it is "not worth my time writing anything". Another student said they didn't believe the concept of "creating the ultimate document" could work since they didn't feel that people want to overwrite other people's views. As they put it: "That's just how people are!" When asked if this would make them less likely to partake in wiki-based collaboration they said yes, it would. They described a "certain...pride in seeing your words 'in print' for everyone to see" and followed this by saying that they don't like the

"uncertainty and fragility of the data" you contribute to a wiki and that they "wouldn't edit somebody else's entry" in a wiki and that they "wouldn't want somebody else to edit theirs".

One student also expressed concerns about the accuracy of data in a wiki, saying "I'm always wary, even with Wikipedia, about the fact that anyone can contribute…you don't know what to believe or whether it is genuine."

Tony Powell added that many users "can't handle the untidiness" of wiki. The idea of something being necessarily incomplete.

Training

All users and experts asked felt training was important. Mark Neff also made the point that specific training in appropriate wiki use would be very beneficial to new wiki users, particularly regarding wiki culture and social aspects of wiki use. However, learning by participation and experience was also noted to be important.

5.2.2 Group Size and Composition

Hypothesis 2: A core of regular active users is needed for a wiki to be successful.

Denham Grey agreed with hypothesis 2 in terms of a community wiki. He noted that KmWiki has "a floating pool of peripheral participants".

Adina Levin and Mark Neff both recognised the importance of having a core of regular active users. Adina added that it helps to "identify and nurture the early group" in the early stages of a wiki implementation so that they can subsequently adopt a "train the trainer" role.

Sunir Shah also recognised the need for a core active group, to act as "the leaders and role models" of the group.

Benoit Brosseau suggested the alternative possibilities of a "professional animator" or "at least one individual that keeps the ball going".

5.2.3 Group History

Hypothesis 3: A sense of community and therefore group history is important to wiki success.

Tony Simpson saw group history as "fundamental in building a sense of community and trust". He also noted that to trust in a wiki community you must trust in their intentions and that trust relationships that don't naturally exist in a work environment may need to be promoted.

Benoit Brosseau agreed a sense of community and therefore group history is important to wiki success. Sunir Shah pointed out that a "sense of community or at least shared purpose is necessary for any collaboration".

Mark Neff added that a group history can be built up and that a wiki can still be successful without the group history needing to have been present before they started.

Denham Grey also noted that the required sense of community can develop over a period of time. He also said it "must be co-constructed by the emergent community rather than imposed".

Adina Levin points out the importance of both community and purpose and suggested that both need to be "cultivated within the culture of the group". She pointed out that a wiki "does not create these things on its own, any more than a physical meeting room creates the purpose of a group or the agenda of a meeting".

5.2.4 Value and Shared Purpose

It should be noted that this is a new section that is not present in the hypothesis table (Table 3). It was a logical category that was added based on the results obtained.

Students when asked about the lack of input on the brainstorm wiki suggested a lack of time as the main reason. There was also the suggestion that the system was not needed since an official feedback form system was already present for the course. The students did not feel the need to give their comments again as they "won't benefit from inputting". The wiki was of no significant value to the students. It was also suggested that it may have been more successful if users had the impression it had come through official channels rather than being a project.

In relation to the management wiki, Antony Powell said that "maximum value is the key" and also noted the value that a wiki would be to a young start up company where even the high level information is changing regularly. He feels users need to know it is there in the first instance and then they need to know what is in it for them and how it will help them in their role to be more efficient. He recognised that users need to "get something back" from the wiki. He also noted the organisational necessity of having users input data into wiki that is useful to the department but not to the individual as such. Asking users to provide process descriptions of their day-to-day activities was given as an example.

Tony Simpson noted that in an organisation there may be problems with or lack of motivation that might lead to a lack of contribution. He too pointed out that "if they [the users] don't see that it is there to makes life easier they won't use it". He emphasised that users "need to get some value out of it personally" in order to get involved. Later in the interview he made the point that the wiki intranet cannot be accessed remotely from off campus and that he found not being able to access it from home a real issue. This was noted independently by Antony Powell who explained that the extra need for security was the reason for this.

The wiki experts that were e-mailed were equally emphatic about this point despite it not being raised specifically in the hypotheses. Benoit Brosseau emphasised the importance of there being a real need for the wiki and pointed out the need to be sure that the right tool is used for the job by saying "Don't use a wiki when you need a forum or a blog or a news-driven CMS. There is no magic bullet."

Mark Neff also noted the importance of purpose for the wiki and said "I believe that a successful business wiki will be in support of a business issue or problem." He also noted that people are more likely to use a tool to solve a problem if they are "tasked to use the tool." He also mentioned the importance of setting the example, suggesting that if you use it collaboratively then others that are interested in using it will follow your lead. Additionally, he warns against forcing wiki use however, saying "do not waste your time trying to get them to use it. They will drag you down faster than you can pick them up."

Adina Levin noted the need for purpose by saying "wikis don't create successful communities on their own, just as meeting rooms don't create effective meetings and team culture".

Sunir Shah also emphasised the importance of "shared objectives" and the need to develop an "environment of exchanged value".

Denham Grey suggests that wiki generally appeal to only a "small sub-set of on-line participants," specifically mentioning those with strong identities, who do not necessarily mind if 'their' contribution is lost. He also suggested that the key to understanding the role of wiki and its future might be the "synergy between personal and public spaces, open space and private space dynamics".

5.2.5 Nature of the Task

Hypothesis 4: Different ways of using wiki (for example as a knowledge management tool, as a project management tool or as a collaborative document authoring tool) may cause problems by making wiki seem more complex, confusing and overwhelming to new users.

Benoit Brosseau agreed strongly with hypothesis 4 and suggested the need to "start small and not introduce every feature" at the outset. However, others, including Denham Grey had not found this to be a problem saying "a short introductory paragraph is sufficient to provide context". Mark Neff recognised that this may be an issue but also made the observation that the greater the number of uses, the greater the value. Tony Simpson noted that a problem might be getting people to know what they could do with it in the first place.

Denham Grey thinks the collaborative writing aspect of wiki is what makes it work.

Adina Levin notes that as well as training, it can be helpful to use "a vocabulary of effective wiki practices" such as knowledge management, collaborative authoring, project management and meeting support.

5.2.6 Process Satisfaction

Hypothesis 5: Perceived effectiveness is crucial to wiki success.

Benoit Brosseau points out that effectiveness is crucial to wiki success

Adina Levin adds that "perceived effectiveness is a by-product of success" and that therefore "it is useful and important to cultivate early successful experiences".

Tony Simpson said "there is no point having it if users are not enthusiastic about it. If forced to use it, it doesn't work".

5.2.7 Overuse of E-mail and Other Technology

Hypothesis 6: The current over-reliance on e-mail in society will affect the success of wiki.

In terms of overuse of technologies, both members of the Department of Management Studies that were interviewed agreed that e-mail was the most over used. Tony Simpson noted that instant

messaging had been taken up by users and he didn't feel the extent of overuse of e-mail was sufficient for it to be a problem in wiki implementation. Tony also noted that there was a significant amount of information available on the wiki was in the form of external links and that the wiki could be circumvented to access these if desired.

Antony Powell recognised the potential of wiki to bridge the gap between the informality of e-mail and the formality of a website, noting the balance between high-investment polished information and low-investment scruffy information. He also saw the need to make wiki "a part of what people do" to avoid users simply reverting to e-mail or the web. "So people start to say 'Shall we post this on the wiki?'" He feels that in an organisational environment such as theirs this requires a pull in terms of requests for information as well as the natural push of individuals choosing to post information.

This hypothesis also raised the issue of integration of wiki with other software. Denham Grey made reference to the current trend in blikis. A synergy between blogs and wikis. Mark Neff and Adina Levin both mentioned integration with e-mail and Adina noted that the Socialtext wiki is integrated such that users can receive e-mail notification of changes made to the wiki and users can also send pages to the wiki via email.

5.2.8 Recorded Data Structure

Hypothesis 7: In theory wiki contents should become more structured over time. In practice they may become less structured. This is less a problem with wiki but more a fundamental problem with how people use wiki.

Mark Neff felt that users may not make as many changes on the wiki over time and that growth and value may dwindle as a result.

Denham Grey agreed with hypothesis 7 and commented that "every wiki needs to develop annealing and refactoring practices and norms"

As Adina Levin pointed out: "Wikis don't organize themselves - people organize wikis." She sees "wiki gardening" as a skill that core members of the wiki need to have. Other team members can then pick up these skills by "osmosis and mentoring". While she felt this refactoring or gardening role could be filled either formally or informally, she was clear that either way "it must be filled". Further likening wiki to a meeting room she said: "Just as a meeting room will get cluttered if nobody picks up leftover papers and lunch wrappers, a wiki will get cluttered if nobody organizes it."

Students noted that when they first looked at the MSc IP Brainstorm Wiki they found it confusing. They found the large amount of text overwhelming and they felt that the layout wasn't obvious.

Tony Simpson of the Management Studies Department noted that in general the structure of wiki collaboration doesn't necessarily make sense to the user in the first instance. He linked this back to a need for a suitable induction process. With specific regard to the Management Wiki he noted that it included broken external links that had not been removed or updated, duplication of information and out of date information. He suggested that this may have led to users not using the wiki due to frustration.

Antony Powell felt users needed to understand better that "wiki is never finished" and that it is a "scrap book rather than textbook". However, he also highlighted that a departmental intranet like theirs needs to have the right types of information recorded. He notes that the high level structure in the management wiki is well known and that the department has very mature and well defined procedures so this structure should not get out of hand. However, he was also wary of the fact that there was "no means to assess quality" of information on a wiki. He also noted that a certain amount of variability in page structure was expected between pages. "Some [pages] are clearly very stable. Some are not."

5.2.9 Ownership and Anonymity

Hypothesis 8: Wiki should be anonymous. Anonymity removes any sense of individual ownership, thereby promoting uninhibited addition, deletion and refactoring of wiki data.

Denham Grey notes that this is a difficult area since signed entries can assist in building trust. He suggested that one way to overcome this problem is to start the annealing and refactoring of data on a new page, while linking back to the original contents and comments.

Mark Neff adds to this saying that while some people believe that wiki should be anonymous to remove the sense of individual ownership, others "crave the recognition and attribution they deserve for their contributions". He notes that it will depend on the composition of the group. He further expands on the difficulty that might face wiki-based brainstorming by noting that the lack of acknowledgement of contribution can make many users less interested in collaborating but that some users may also want to remain anonymous.

Adina Levin also warns of possible problems with anonymity in online communities as "people behave more politely and socially appropriately when they are accountable for their words and actions". She also makes reference to some of the various naming practices that are in place. That of creating NamePage's, which she recommends for newcomers, and that of ThreadMode discussion, where comments in a discussion are usually signed with a NamePage. Meanwhile she notes the "agile development" practice for collaborative editing, where there is no strict ownership, it is acceptable for people to modify pages, and it is not good practice to sign sentence revisions. She also highlights the practice of "regular refactoring of ThreadMode comments into the body of the page".

With regard to the Department of Management Studies wiki, Antony Powell is keen that there should possibly be individuals in charge of overseeing some of the wiki pages. While all can edit he feels that there should be one overall owner for pages and sections. Meanwhile he also recognises that a culture of sharing needs to be promoted as people tend not to give too much away, particularly with regard to their 'tricks of the trade'.

Tony Simpson also sees this loss of ownership as a problem for people when they hand over data to wiki.

5.2.10 Facilitation

Hypothesis 9: Corporate wiki should be facilitated.

Benoit Brosseau was clear that you "always need an animator" and felt that having someone restructure the contents every few weeks was "the secret for a successful wiki."

Sunir Shah draws a parallel between wiki and meeting rooms. Collaboration in a wiki is much like collaboration in a meeting room. He points out that "the major reason meetings fail is poor leadership and direction" and says that the same is true of wiki-based collaboration.

However, Denham Grey suggests that it is "better to have distributed governance and spread good practices" rather than having a facilitator as such.

Mark Neff noted that "It would be interesting to see how people facilitate a wiki and which practices tend to get the best results."

Adina Levin highlighted a few different forms that facilitation can take and notes that it will depend on "the purpose of the wiki and the culture of the team". She further added that discussion type collaboration is likely to benefit from facilitation in a similar way to face to face meetings. In general wiki use she suggested there is often a person or group of people who act as "leading wiki gardener - adding links, consolidating redundant pages, keeping the naming convention, marking items for deletion". Alternatively she notes that an initial structure may be set up by project managers and that team members are then responsible both for updating the content that they have been assigned ownership of and performing peer quality review of content they are involved with.

Tony Simpson felt the concept of facilitation was maybe too strong. Suggested users could possibly be seen as "shareholders". Users should feel involved with certain sections but perhaps not labelled as facilitators.

Antony Powell agreed that all users must feel free to edit the wiki content and structure but he believed "nominated individuals" should also be in place – particularly to deal with the structure. He felt it might be useful to be able to name an owner at the top of the page. For their organisation he suggested the owners of functional areas and the head of department should have a role to play. If they promote the wiki, its use should cascade down from there. He feels facilitators should seed the wiki and should also remind others when they need to add to it. Seeding in the early stages he considered vital as "sufficient maturity and critical mass" of content is needed for initial uptake. He also suggested that some form of wiki metrics might be useful to help facilitators to know which information is being used and updated and which is not.

6 Discussion

The discussion focuses on the recognised problems with, and factors that affect wiki-based collaboration and incorporates comment on both internet based wiki that are open to all and intranet based wiki in the workplace. Discussion will be centred on problem areas and factors associated with wiki-based collaboration in general but this will incorporate specific discussion on possible reasons for failure of the brainstorm wiki case study from phase one. As such the natural discussion of phase two of the project will incorporate a design evaluation of phase one. Discussion will therefore begin with an evaluation of phase two of the project before going on to discuss the findings.

6.1 Phase 2 Design Evaluation

6.1.1 The Framework and Hypotheses

The hypotheses for phase 2 were developed from a framework established to guide the evaluation of wiki brainstorming. This, in turn, was related to the process gains and losses from existing collaboration research on traditional brainstorming. The specific study of wiki is still in its early stages but by reference to another collaborative technique which has been studied extensively this research has built on an appropriate grounding in existing knowledge.

However, the complexity and intricacy of a real world setting must not be forgotten and it is unrealistic for a single framework or set of hypotheses to cover all the subtleties and nuances of collaboration on a social software tool such as wiki. For this reason the hypotheses were only considered to be a set of reference points for the evaluation. The framework, despite having originally been developed with wiki-based brainstorming in mind, was successfully applied to the evaluation of the problems with and factors affecting wiki based collaboration in general.

Clearly, by being based primarily on research into face to face meetings, the social aspects of wiki use will be tested more thoroughly than that of the wiki technology. This is appropriate as the literature review found that the social issues represent the most problematic aspect of wiki based collaboration.

6.1.2 The Sources

Results were obtained from a variety of sources. A greater time frame for data collection and evaluation would have been valuable but the triangulation approach taken allowed a real depth of understanding to be gained in the time available. This approach also meant that trends were able to emerge that allowed some insight into the interrelation and relative importance of the various factors affecting wiki based collaboration.

A case study of a very successful wiki might have been useful for comparing how the process factors were affected differently between this and the current wiki case studies. However, the 100% response rate from experts, who have been involved with some hugely successful wiki, provided a depth of knowledge grounded in lessons learnt from real life experience. It is felt that this compensated for the lack of a specific successful wiki case study. The variety of sources and their hugely varying levels of experience, from rank novices, like the student users of the MSc IP Brainstorm Wiki, to leading authorities on wiki meant insight was gained from users with a range of different levels of understanding of the subject. This provided a strong degree of triangulation.

Further triangulation was achieved by using different methods of data collection, including looking at the data on wiki case studies, hypotheses based e-mail communication and both structured and unstructured interviews.

6.2 Discussion of the Findings

Discussion of the findings follows a structure that emerged from the data during data collection and evaluation of the results. The emergence of this structure was a product of the holistic approach adopted. For this reason the discussion does not directly follow the structure of the results but results are instead referenced where they are appropriate in the emergent structure. This avoids the findings of the study being restricted by the initial hypotheses. To avoid confusion, where results are referenced in the discussion, they will be followed by the appropriate results section number in brackets. The emerging structure led naturally to the eventual production of a diagrammatic representation of the process factors affecting wiki based collaboration (see Fig.1, page 63) and the reader is referred forwards to this as it may aid navigation of the discussion.

6.2.1 Understanding and Training

Usability and user experience will be vitally important in adoption and subsequent success of any collaboration medium. A tool that makes life easier and more enjoyable will be adopted rapidly and used frequently. The results were clear that usability of wiki required a clear understanding of both the technical aspects (like syntax) and the conceptual aspects (like wiki culture and the sociology of collaboration).

Furthermore, apprehension is a common problem when introducing new technology to users in general and this is likely to be heightened in the case of wiki due to lack of understanding. Wiki is still a new technology for most people and for these users wiki-based collaboration will be a new concept.

Technical Understanding:

Wiki is easy to use and it is quick and simple for users to contribute to a wiki-based collaboration. However, the 'do the simplest thing that works' approach adopted by Ward Cunningham and many subsequent wiki designers has meant the introducing of some simple wiki syntax. Students noted that they disliked the idea of a new syntax to learn despite being from a technical background (5.2.1). For users more familiar with WYSIWYG editing, this may be even more of a problem.

This might be amplified by the fact that different wiki variants do not always follow the same syntax. The syntax, however simple, seems likely to cause some initial concerns regarding complexity which might prevent users from getting involved. For universal wiki use, in an office say, all users will need to be on an equal footing to prevent contents becoming biased towards the technologically savvy. A more familiar editing interface may be the answer, perhaps a WYSIWYG interface as suggested by Benoit Brosseau (5.2.1). Alternatively, it might simply mean ensuring sufficient technical training and practice to ensure familiarity with and adoption of the syntax.

One student noted that wiki in general "doesn't feel standard enough" and this made him wary from a technological point of view (5.2.1). Lack of wiki standards such as syntax may be an issue here

but it is likely that this sort of concern is largely the result of unfamiliarity with the tool. Again this could be overcome by appropriate training and practice.

Whilst there was discussion of making wiki more "polished" from a technical standpoint, it seemed that the greater problems with wiki are less to do with technical understanding and more to do with conceptual understanding. This was clear from the opinions of the wiki experts, Sunir Shah specifically noting that "with a compelling enough social organization, people will get over the technical hump" (5.2.1)

Conceptual Understanding:

The nature of wiki means that navigation and content are dictated by the wiki community as a whole. There is shared ownership of wiki contents in general and as such users are free to edit and refactor the shared data as appropriate. These are core concepts that the user needs to fully understand and be familiar with for the nature of wiki collaboration to make sense and be successful.

Talking to users of the MSc IP Brainstorm Wiki there was a real sense of difficulty in understanding the conceptual aspects of wiki and this had a noticeable effect on their trust in the wiki. Feedback from a number of students noted that they liked the initial concept of wiki despite having a very negative attitude in terms of perceived effectiveness of the tool (5.2.1). Two separate students showed an initial lack of belief that the idea of wiki could work at all, saying that it relied on "too many social niceties" and the fact that people don't want to overwrite other people's views (5.2.1). These comments raise two important issues. The first shows that the users conceptual problems with wiki based collaboration are focussed on the social aspects of wiki use. The second comment specifically highlights the user's confusion and lack of understanding of the concept of shared ownership of wiki data, the user still viewing the ideas they submit as belonging to them.

Liking the concept but not believing it can work in practice is likely to be a typical reaction from new users and the apparently strong degree of negativity from some users, as shown in the results, may represent a real problem in getting users to 'buy in' to wiki use. Users cited the fact that their comments can be deleted by other users as a concern (5.2.1), which highlights a mental model more in tune with traditional collaboration tools like e-mail, message boards and forums where ownership belongs to the writer rather than the community. It seems users, while able to grasp the idea of a shared collaborative workspace, may not naturally make the mental leap towards the idea of shared collaborative content within that space.

It appears that not achieving an appropriate level of conceptual understanding may be leading to a lack of trust in the wiki collaboration process which was preventing users from adding their comments. The link between lack of trust and lack of input was made explicit by one of the students who, when asked, confirmed that their lack of belief in the concept of 'creating the ultimate document' would make them less likely to contribute (5.2.1). Lack of conceptual understanding may be further accentuated by an engrained understanding and familiarity with the previously static-only nature of the web. This was noted by Adina Levin (5.2.1).

If users do not feel comfortable with the process on a conceptual level they are not likely to embrace it fully and use it to best effect. This may also lead to knock-on effects on a more mechanical level since if users are not refactoring data correctly, simple tasks like navigation will become increasingly difficult as data becomes more unstructured, reducing both usability and user satisfaction.

Wiki introduces a conceptual shift in terms of how people can work together and it is possible that for some users this may be so great that, subconsciously or consciously, they actually want wiki to fail. The lack of belief and subsequent negativity shown by some of the students may support this theory. If this is the case, the users may be actively looking for weaknesses in wiki to justify their reluctance in adopting the tool and this sort of mentality will clearly be harmful to wiki success. While this is unlikely to be a problem for an Internet based wiki where users can simply drop out of the community, it may present a more real problem for wiki in the workplace where staff are obliged to use the wiki.

Of course, the fact that a number of users noted a liking for the initial concept may also prove a useful starting point. Harnessing and promoting this initial spark of interest by describing the possibilities of wiki and pushing examples of its successful application as part of training may therefore be valuable.

Training

As was shown in the literature review, the important role of training for traditional brainstorming was recognised by Osborn and the obvious impact of social factors on wiki collaboration suggests it is likely to be equally important in the successful use of wiki.

For new users, initial perceived effectiveness of wiki may be low. A lack of trust in the technology in general plus a lack of user understanding both technically and particularly socially is likely to be the cause. The need for appropriate training in technical and particularly cultural issues was also recognised in responses from the experts (5.2.1). The importance of learning by participation and experience was also noted (5.2.1) and, related to this, Mark Neff also mentions the importance of leading by example (5.2.4).

It was clear from asking MSc IP Brainstorm Wiki users that while there were worries about the mechanics and syntax of wiki they seemed noticeably more concerned with the basic concepts of wiki. An 'introduction to wiki' web page (see Appendix C) was given to the Brainstorm Wiki users which included instructions for wiki use as well as a brief conceptual introduction. It also referred them to a particularly successful wiki implementation (Wikipedia). However, there was no way of knowing if users had read this or if they had visited either the brainstorm site or the example wiki site. The lack of subsequent interest in the wiki showed that this approach to building understanding may have been insufficient and that more active attempts to build up user understanding might have been beneficial.

Lack of specific training may also have been a problem in the Management Studies Wiki where the wiki had been live for some time but had never had an official roll-out and users have never had specific training in its use (4.2.3).

Training should therefore cover the technical aspects of wiki use but must be particularly focussed on the social factors that affect wiki use, aiming to reduce the process losses and boost the process gains in wiki-based collaboration, many of which may be shared with those derived from traditional brainstorming studies (see Table 1).

Brainstorming has set rules to overcome the social problems associated with the technique. Training in the appropriate application of these rules was important to boosting the effectiveness of group collaboration. This may suggest the possible benefit of generating strict wiki rules that can

be taught and followed by wiki users in a similar way. This would circumvent the need for users to consider all the underlying social psychological issues associated with the tool. However, as wiki can be used in many different ways, this may be impractical and may disrupt the flexibility of the tool.

Another role of training sessions may be to prove to users that wiki can work. This might involve describing case studies of where wiki have already been used successfully in corporations. This could help users overcome initial apprehension and boost perceived effectiveness and belief in the concept. Furthermore, training could be used to relate to users the potential range of uses of wiki and thereby increase the value of the wiki to the users.

In general, both technical concerns and conceptual issues, particularly regarding the sociology of collaboration, seemed to have a negative influence on perceived effectiveness of wiki-based collaboration. Expert opinion suggests that in general the conceptual understanding of users was the area that required the most attention. It was agreed that training was crucial in building up this understanding but the importance of learning by participation and experience was also noted (5.2.1).

6.2.2 Trust in the Concept

Perceived Effectiveness

Most of the literature on traditional brainstorming claims it is not an effective process. Popularity of the technique is claimed by some to be due to a high level of process satisfaction as the result of an 'illusion of group effectivity' (Diehl & Stroebe, 1991). The suggestion is that by being perceived to be effective it was being used despite actual ineffectiveness. Clearly if this is the case, then perceived effectiveness is a very powerful factor.

It is thought possible that wiki may suffer from the opposite problem. Despite its potential usefulness, process satisfaction can be low due to a lack of perceived effectiveness. As was highlighted in the literature review, this is often manifested in common concerns about syntax, graffiti, data insecurity, data inaccuracy and a general perception that wiki is chaotic.

Interestingly, many of the identified concerns with wiki from user comments actually related to apparent misconceptions about how wiki works (for example, a lack of understanding of the concept of shared ownership). This relates back to issues of understanding and particularly conceptual understanding, which have already been discussed.

However, perceived effectiveness only relates to understanding when users are new to wiki. Perceived effectiveness is clearly the direct result of actual effectiveness once the wiki is in use. The importance of this fact is reflected in Benoit Brosseau's comment that "effectiveness is crucial to wiki success" in response to the hypothesis that 'perceived effectiveness is crucial to wiki success' (5.2.6). It was also emphasised by Adina Levin, saying "perceived effectiveness is a by-product of success". These results suggest that success of wiki-based collaboration relies on momentum. A successful wiki will become more successful but, in the absence of counter measures, a failing wiki is doomed to failure. It seems that perceived effectiveness has a key part to play here. If users believe that the collaboration process is being successful and is providing value they are likely to feel increased process satisfaction and will continue using the wiki. This, in turn will continue to make it more successful and more valuable. However, if it is no longer perceived to be effective, process satisfaction will decrease, contribution will become less and in turn the process will become less valuable and less successful. The cyclic nature of the process explains

why perceived effectiveness may be crucial to wiki success in the outset to ensure that a positive loop is entered into rather than a negative one.

Fear of destructive input is a problem with wiki that was noted in the literature review. It was suggested that this might influence perceived effectiveness of wiki-based collaboration. For any new technology to be successfully adopted, users must feel comfortable using the tool and must trust in its security and stability. The open nature that makes wiki powerful also makes it vulnerable in terms of vandalism, graffiti and spam. It may seem more fragile to new users than the more traditional software that they are used to, since unlike most electronic tools, wiki users must not only trust in the software but they must also trust in the wiki community. They must trust that the software will not loose information, but they must also trust that the wiki community will not harmfully disrupt the information. Furthermore, they must feel sure that any harmfully changes will be noticed by the community and that these changes will be undone. Clearly wiki has failsafe mechanisms like the ability to roll back to a point in a stored history, but it will be important that users have the appropriate understanding of wiki to be aware of these features and the appropriate trust in the community to be comfortable that the features will be used correctly and appropriately by the wiki community.

The literature review showed that evaluation apprehension, or fear of criticism, is a noted problem in traditional brainstorming. This may equally be a problem in wiki. Criticism in a wiki could be in the form of constructive criticism, flaming or simply deletion of the original content from the wiki. This could increase evaluation apprehension in users making them less likely to contribute. This is likely to be particularly pronounced in certain types of wiki based work – for example, where opinions are sought. Furthermore, criticism can potentially start editing wars, as noted in the literature review, which can waste time for users and reduce process satisfaction.

Fear of deletion can also take the form of fear of potentially wasting effort. If users feel their efforts can simply be deleted on a whim, or that editing wars might result in their comments being lost, they may feel uncertain about adding the information in the first place. This was noted by one of the MSc IP Brainstorm Wiki users who said that the potential for their work to be deleted by another user made it "not worth [their] time writing anything" (5.2.1).

Anonymity in wiki may help reduce evaluation apprehension in the same way as in traditional brainstorming but while fear of criticism is only likely to occur where a user is identifiable, fear of deletion of data could occur in any wiki. An interesting idea, also derived from traditional brainstorming, is that stronger characters might be able to exert a dominating presence on the outcome of the wiki. The anonymity in a wiki would greatly reduce the chance of this but dominance could still occur as a result of greater contribution from some characters than others or a user being more at ease with deleting the comments of others. If the original poster does not feel greatly confident in their initial posting they may be unlikely to re-enter the information. Therefore, while in theory wiki content is the information that everyone has agreed is best, in reality it may be skewed to an extent by dominant characters in a similar, though perhaps less pronounced way, than in a meeting or a brainstorming session.

In summary, perceived effectiveness takes into account the whole spectrum of potential problems of wiki. Many of these may not even be actual problems of wiki, but if users perceive them to be, they could have a detrimental effect on wiki use and therefore its success. Users need to *perceive* wiki-based collaboration to be effective in order for it to *be* effective whether this is based on good training in the early stages or subsequent experience of successful wiki use. If users believe the

process is successful it will boost their belief and trust in the concept of wiki which will boost its use and subsequent success and value.

In terms of making a wiki successful this might mean strongly promoting and pushing the positive aspects of wiki during training and the early stages and being ready to answer questions and counter any criticisms about the process.

Belief in the Concept

From talking to MSc IP Brainstorm Wiki users it became apparent that some clearly like the idea of wiki and want it to work while others reject the concept from the outset. If wiki relies on momentum, those that want it to work will make it work simply by contributing. Those that don't will have the opposite effect by not contributing.

For a wiki to be successful, the community as a whole therefore needs to believe in the wiki concept. This might be easier in a web based wiki where the community can develop based on both an interest in the content of the wiki and an understanding and acceptance of the concept of wiki. Those that do not like the concept simply drop out of the community. In contrast, within an organisation where users are expected to use the wiki, the community might be based on an interest in the content of the wiki but not necessarily an understanding or acceptance of the concept. Allowing users to drop out of the community may be undesirable in an organisation and forcing users to contribute is likely to be unworkable. This is reflected in the results where Tony Simpson highlighted that "there is no point having it if users are not enthusiastic about it. If forced to use it, it doesn't work" (5.2.6). Instead effort may need to be made to build belief in the concept within the community. Belief in the concept is based on how effective a wiki-based collaboration is perceived to be in accomplishing goals both on a team or community level and at an individual level. For this reason the wiki must be suited to and provide value to the specific community.

6.2.3 Value and Shared Purpose

It should be remembered that the issue of value was not raised in the initial hypotheses and the emphasis placed on this topic in the responses (5.2.4) is therefore likely to be indicative of the perceived importance of this subject. On an Internet based wiki, both the community and the content are flexible. Users can come and go just as content can come and go. As a result, not only does the community define the content, but to a certain extent the content defines the community. As a wiki matures an elaborate interplay between the community and the contents will lead to a certain amount of settling of the two. This is not to suggest that the community or the contents ever stop growing or changing, but a certain level of cohesion will be achieved between them. The existing community is identifiable by such things as shared ideas and ideals, nomenclature, in-jokes and crucially shared purpose. This cohesion can evolve on a successful wiki but clearly there must be a certain amount of buy-in in the initial stages of a wiki in order to get the process started. For this reason it is vital to have in place from the outset some of the factors that bind the community together and particularly important is a well defined shared purpose.

Within an organisation the physical community is fixed and it is likely that all members of this physical community will be expected to form the on-line wiki community. This approach may cause problems as the community being fixed may stifle the fluidity seen in successful Internet based wiki. Now only the content can alter and not the community. This could restrict the dynamic nature of wiki to an extent but it could be avoided as long as no members of the physical community drop out of the on-line community. This means users must want to be a part of the wiki

community and choose to use the wiki. Unfortunately, as Denham Grey observed, wiki generally appeal to a "small sub-set of on-line participants" (5.2.4) and finding ways to overcome this problem and encourage the remainder may be crucial. This links back to promoting technical and conceptual understanding of wiki amongst users, making them aware of the potential and possibilities for wiki use and ensuring that the wiki provides value. To be used throughout the community the wiki will need to be of personal value to each user within their role as well as being of value to the community and therefore the organisation as a whole. This is reflected in Sunir Shah's comment that there is a need to develop an "environment of exchanged value" (5.2.4).

This problem was noted in the Department of Management Studies Wiki. Antony Powell recognised an organisational necessity to have users input data to the Management Studies Wiki that, while of value at an organisational level, would not have been valuable to the user at a personal level. The task of users adding process descriptions for their day-to-day work was given as an example (5.2.4). This is clearly of relevance and importance to the department as a whole, so that when staff members leave, some of their experience remains. However, individuals are unlikely to want to share what they see as *their* 'trade secrets' (potentially making themselves more dispensable in the process). This might be a fundamental problem in the use of wiki within organisations. While finding the balance between community value and individual value is a dynamic process based on mutual selection on an Internet wiki, it is much less dynamic in a work place where the user choosing the wiki is no longer an option. Striking this balance may be one of the crucial challenges for the success of wiki in the workplace. Denham Grey hinted at this when he noted the importance of the "synergy between personal and public spaces, open space and private space dynamics" (5.2.4).

Perhaps then there may be a need for some organisational pull to the wiki by giving users tasks that require them to use wiki for example. If they have been specifically asked to add something to the wiki then clearly using the wiki becomes valuable in achieving their personal goal. This was recognised by Antony Powell who felt that in an organisational environment such as theirs, getting people to use the wiki may need a pull in terms of requests for contribution as well as the natural push of individuals choosing to contribute (5.2.7).

Other issues relating to value were also recognised in the Department of Management Studies Wiki such as the presence of broken links and empty pages on the wiki that had been created but not filled, as well as evidence of information that may also be available elsewhere (5.1.2). It seemed that some of the pages of real value may be masked by the volume of low-value pages with little or no information on them. Additionally, the inability of users to be able to access the intranet remotely from off campus may have also meant a significant loss of value (5.2.4).

Lack of value is also likely to have been a problem in the MSc IP Brainstorm Wiki. While it was designed as an informal alternative to formal feedback systems already in place, responses from students suggested that this was insufficient to give them a sense of purpose or need to use it (5.2.4). One user commented that they "wont benefit from inputting". This shows the importance of the wiki being of value on an individual level. All the students on the course were busy with projects and this was also given as a reason for not contributing. Clearly if users have little time, the value of the wiki will need to be even greater to ensure they get involved. This may be particularly relevant in wiki in the workplace.

Overuse of Existing Technologies

Wiki has significant value by being a much more logical choice than other communication media in a number of scenarios. However, for it to be successful it is crucial that it is used when these particular scenarios arise. Misuse of other collaboration techniques might therefore be a problem with wiki uptake and use. Overuse of e-mail is a particularly common problem in organisations and users will often collaborate by e-mail in preference to other potentially more efficient and effective methods.

Interestingly, looking at the management studies wiki (5.1.2), there was evidence of e-mail communication being posted to wiki and the conversation continuing on the wiki. This is not only a good example of the cross-over in collaborative techniques taking place but this might also be a very powerful way of shepherding users to start using wiki in the early stages. Since the information derived from this communication is now posted to the wiki it also becomes shared information which can save duplication of effort later on if the same issue arises. Furthermore, as noted in the literature review, having this sort of knowledge stored on the wiki rather than in personal e-mail helps avoid problems of loosing relevant information when there is a change of staff.

From the results it seems that an important area for the future of on-line collaboration is in developing stronger integration between collaboration mechanisms. The idea of developing greater synergy between collaboration techniques has been around for some time and it was also noted by a number of the experts, with specific mention of wiki synergy with e-mail and bliki (5.2.7). Greater tie in between wiki and e-mail at a technical level might promote greater value and therefore greater wiki use. A simple example would be inclusion of a 'wiki invite' button in wiki that sends an e-mail to invite users to join a wiki page. If tightly integrated with e-mail and instant messaging the wiki could send the message by instant messaging if the user was online or by e-mail otherwise. Invites could be stored under a user's page on the wiki much in the same way as an inbox in e-mail so users could easily refer back by time line as well as via the standard wiki structure. This could be linked with e-mail or RSS feeds updating users when any of these pages (or any chosen pages) are updated. It is possible to imagine a lot of internal e-mail becoming invites to wiki pages.

Increasing the synergy between wiki and other means of collaboration would increase its value by being more useful and more flexible. This may take away from the simplicity in terms of the software but while simplicity in terms of software is fine for technically minded users, simplicity in terms of usability for the community and added value of the software is likely to be the key for corporate wiki. Future work may need to concentrate less on the individual nature of collaborative tools like wiki, e-mail and internet messaging but instead on how to make all of these collaboration methods work together in the most simple and intuitive way.

Multiple Uses

Returning to more conventional wiki implementations it is clear that wiki is already a powerful tool that can be put to many different styles of use. These include document authoring, knowledge management, project management and of course brainstorming. Making users aware of the range of potential applications of wiki will undoubtedly boost its usefulness and value, as recognised by Mark Neff (5.2.5), and this may also boost its subsequent adoption and use. However, these different styles of wiki use may build on different conceptual models of how wiki works. A lack of clear delineation between the different potential uses and possibilities of wiki may cause problems by making it simply seem more complex, confusing and overwhelming to the user - as the wiki concept in itself may seem confusing enough. Benoit Brosseau agreed with this idea and suggested that the solution may be to avoid introducing every feature from the outset (5.2.5)

Traditional brainstorming is known to be affected by the type of problem to be solved. It is likely that wiki use could equally be affected by the type of task that it is to be used for as the different uses of wiki are likely to be affected by different process gains and losses. For example, while an identifiable, creative brainstorming type task could be affected by evaluation apprehension, the task of creating a collaborative contacts page would not. This must be taken into account when studying the potential problems of wiki and more detailed research into each of the specific styles of use is warranted.

One area of the Department of Management Studies Wiki showed signs of different styles of wiki use (5.1.2). An interesting observation on a brainstorming style page was that the creator of the page had manually differentiated this page from the other page styles (possibly subconsciously) by adding "(very first ideas)" to the top of the page and "...and more...?" to the bottom of the page. This may suggest the need for a technical addition to wiki so that the user is able to select the page styles to be applied to a page. This extra formality may help lower confusion for other users by allowing a more uniform means to differentiate the pages. This extra formality may however be detrimental to wiki flexibility and as Denham Grey noted "a short introductory paragraph is sufficient to provide context" (5.2.5). A middle ground may be to ensure all users have an appreciation of each of the styles of use and that they have a shared vocabulary such that they can use them to best effect. Such a "vocabulary of effective wiki practices" was suggested by Adina Levin (5.2.5).

The "(very first ideas)" comment may also tie in with another potential problem of wiki noted in the literature review - that of feeling exposed when adding data that is only half complete. By its nature wiki is a work in progress but many users may feel apprehension about adding information to wiki because of a desire for their work to look correct and complete if it is going to be visible to others. Following the 'wiki-meeting room' metaphor used by Sunir Shah and Adina Levin, wiki can be likened to a meeting room and wiki-based collaboration can be likened to a meeting. In a real life meeting with users working on a shared document there are likely to be clues to the completeness of the document that are less obvious in a text-only collaborative environment like wiki. Users being able to separate pages into styles may also help them convey the state of completeness of pages to the community and thereby reduce these feelings of evaluation apprehension. This may also reduce editing apprehension of other users wishing to change the shared content of the page. The idea of reducing evaluation apprehension in order to promote contribution also leads to the importance of trust in the wiki community and contents.

6.2.4 Trust in Content and Community

Good training to build up understanding will boost users trust and belief in the wiki concept by boosting perceived effectiveness. Meanwhile, a sense of shared purpose will help in ensuring sufficient contribution is made to the wiki to maintain the momentum by boosting the value of the wiki to the users. However, a wiki-based collaboration will not be of value unless the users trust that the wiki contents are accurate, complete and up to date and this requires trusting in the community that they will keep it this way.

Trust in Content

In theory wiki contents should become more structured over time. In practice they may become less structured as users move off topic within pages and add information in the wrong places, leading to redundancy. As wiki grows the structure can become more complex and difficult to navigate. This could impede wiki use by making it physically more difficult to find the appropriate information or the most appropriate place to add information. This increases the complexity of the process for the user which can lead to a number of problems. Firstly, it may mean required information is not found. Secondly, if adding data, it may be added in the wrong place. This may also result in duplication of data. Thirdly, if users are not sure where to put information, they may neglect to add it at all for fear of putting it in the wrong place or creating duplication. Clearly, in an openly editable environment, confusion breeds further confusion. The result is that wiki can be perceived as chaotic and out of control and this perception can lead to dissatisfaction with the wiki process in general. Students observed that they found the MSc IP Brainstorm confusing and the fact that wiki structure is confusing to new users in general was also noted by Tony Simpson (5.2.8). This problem could partially result from where users add data in the first instance. It seems that users do not always add content in the most logical way in wiki. This was seen in the MSc IP Brainstorm Wiki where content was added to the bottom of the wiki page in a time-line fashion, rather than adding it where it would be in context and more appropriate (5.1.1). This may reflect a mental model more in tune with collaborating using tools like e-mail and electronic forums.

The literature review also noted problems where users move off topic on discussion pages, such that the title of the page no longer reflects the contents, making navigation more complex. Navigation of wiki was a noted problem in the literature review. This is difficult to solve since navigation must be based around ever changing user content. Not only is it difficult to structure pages with navigation akin to traditional web pages but also, since the names of the pages themselves form the links, it depends on user input as to how well named the pages are and how well the pages remain on-topic. Theoretically however, data structure should never become a problem since all users can edit the structure of pages as well as the data contained therein to make it more logical. It seems, though, that this may not work very well in practice. It appears that despite wiki being open to editing, users may be reluctant to change or delete information that others have written even if they think it is wrong. This fear of refactoring may be a further by-product of a poor conceptual understanding of wiki as a shared workspace with shared ownership over contents. The result is that the concept of knowledge crystallising naturally in a page, as was suggested in the introduction, might be less natural than it at first seems. This is reflected by the suggestion by Denham Grey that refactoring and annealing practices and norms need to be developed by the community (5.2.8).

One aspect that seems to affect refactoring, as noted in the literature review, is to what extent users feel free to change information, although there was no mention of this in the results obtained. Training should help overcome this apprehension but it will also be important that all information that is stored on the wiki is free for editing. Where users do not want others to edit content, that content should instead be placed on a static web page. Alternatively, in some implementations, wiki pages can be locked so that not all users can edit it. The danger here, however, is that of breaking the wiki concept. Too many static wiki pages will suffer with the same problems of information freshness and accuracy as traditional web pages. If they are to be used, it may be important to ensure that they are clearly differentiated from open pages to avoid confusing the user's mental model.

Users need to trust that the structure of wiki pages is sound and accurate. If they do not, the value of the pages drop for the user and this will lead to lack of participation.

An interesting area for future work might be to determine to what extent wiki content is added in context and to what extent refactoring of existing data occurs. It would also be interesting to see how wiki training can affect these natural activity patterns of wiki users.

As well as data structure problems there may also be problems that arise simply as a result of too much information. If too much data is generated in a wiki, users may have trouble tracing the information they require and returning users may have trouble finding the changes in information they have already reviewed. This could lead to having to cover old ground again and again.

This links in with the idea of cognitive interference (see Table 1) since users will have to spend a lot more time reading and navigating in order to fully take into account the comments of other users - this may make them less likely to add their own ideas. Since users have unlimited time in which to add data to the wiki, this may not be a problem. However, it may stop them contributing based on frustration and a subsequent lack of process satisfaction if the structure is too complex and data retrieval is too slow.

Furthermore, users need to trust in the information that is provided on the wiki, that it is correct and up to date. One student said "I'm always wary, even with Wikipedia, about the fact that anyone can contribute…you don't know what to believe or whether it is genuine" (5.2.1). This represents a real fear of users and trust in the information can be lost rapidly when broken links and out of date information are found on the wiki. If they don't trust in the accuracy of the information the value of the wiki drops and they will stop participating.

Trust in the Community

Apprehension about the concept of wiki or the accuracy of content may affect wiki use but apprehension can also come in the form of evaluation apprehension in the same way as was described in the traditional brainstorming literature, with users fearing that their contribution may be criticised. This may be the result of user uncertainty about the correctness or completeness of their ideas and assumptions, or fear that other users will disagree with their viewpoint or consider their suggestion valueless. Criticism on a wiki could also come in the form of deletion and the possibility of their contribution being deleted may make evaluation apprehension greater. To overcome these fears will require trust in the community and as Tony Simpson of the Management Studies Department noted to trust in a wiki community you must trust in their intentions. This trust may be affected by group size, composition and history.

Group Size, Composition and History

These are all factors derived from the study of traditional brainstorming. Group composition and size, as well as group history were considered important factors in the success of brainstorming as they can affect the session dynamics by changing process gains and losses such as production blocking, evaluation apprehension and free-riding. Cleary production blocking is not relevant to wiki but evaluation apprehension and free riding are.

Group Size: In terms of group size, 'the more the better' might be best in wiki-based collaboration. Well defined collaborative wiki have been shown to thrive on large user numbers, like Wikipedia for example. A greater number of users can mean increased cognitive stimulation and synergy. Equally wiki can be used successfully by one user in the form of a personal wiki. However, in terms of a collaborative wiki, there may be a minimum number of users that are needed for it to be successful.

There was evidence from talking to brainstorm wiki users that some of them had visited the site but had not made any additions. Such individuals are technically known as 'lurkers' (Denning, Kate & Davies, 2001, cited in Andrew, Holley & Pheiffer, 2004). This is likely to occur in many wiki and therefore a count of active users might be a more appropriate measure when considering success or failure of wiki. Active users are those that add or change the wiki data rather than simply reading it. The results show that a core of active users is essential to ensure regular contribution to the wiki to progress towards the shared goal (5.2.2). Denham Grey noted the importance of the floating pool of participants in KmWiki (5.2.2), suggesting that the core users do not need to be fixed as long as a certain number are present at any one time. The importance of the core users as trainers and role models was also noted by Adina Levin and Sunir Shah (5.2.2). Mark Neff also mentioned the importance of leading by setting the example (5.2.4). This relates back to the observational learning process gain as discussed in the literature in relation to traditional brainstorming.

While the results show that a suitable number of core users are essential, looking back at the brainstorming literature it is conceivable that for certain tasks a large number of users in general may be detrimental. For example, in a brainstorming type task, where it could lead to increased evaluation apprehension and free-riding. It is possible that in the MSc IP Brainstorm Wiki, while evaluation apprehension was not a problem due to the anonymity, participants may have been failing to take part on the basis that they feel their lack of input will not be missed (Free-riding). This may be a particular problem on wiki in the workplace where the wiki community is based on a real world community of known size.

In general though, increasing the size of the community, as long as the community is focussed on a common goal, should mean increased contribution which should help progress towards the common goal.

Group Composition: Composition of the group might affect how the wiki is used. If different levels of seniority are all using the wiki, problems may arise due to the balance of power. This relates back to the findings of Collaros and Anderson (1969), highlighted in the literature review, who found that the greater the number of experts there are perceived to be in a group, the less productive the group becomes. Users may suffer greater evaluation apprehension for example if they are named in opinion based or brainstorming type tasks for example. It may also have benefits too however, where wiki users are identifiable, by reducing problems of free-riding and prompting contribution for users seeking social recognition.

Group History: The history of the group may be very important in wiki, in the same way as it is in brainstorming. Users who recognise each other, have worked together before and anticipate working together again are more likely to contribute to a collaborative wiki. The closer the members are, the more trust they have in the community in general and the more they care about the input of other community members. In brainstorming, history can cause problems of cognitive uniformity, where all participants end up following only one possible thread of ideas. This is less likely to be a problem for idea generating tasks in a wiki, since there is no definite time line and users are therefore less likely to fall into a pattern of ideas. In general wiki use, an element of cognitive uniformity may in fact be an important feature, allowing the wiki community to develop such that its members are on the same wavelength and are pursuing shared goals.

The results showed a clear need for a sense of community (5.2.3), but they also highlighted that a pre-existing community, particularly a geographically localised one, might not actually display the trust or cohesion in real life necessary for a successful on-line community. Tony Simpson noted

this saying that trust relationships that don't naturally exist in a work environment may need to be promoted (5.2.3). Furthermore, Mark Neff and Denham Grey remind us that a pre-existing community is not actually necessary at all (5.2.3), suggesting instead the idea of emergent communities. Mutual trust, cohesion and a general sense of community can build up within the wiki and the key is therefore the shared sense of purpose in the first instance. This may highlight a fundamental problem of the MSc IP wiki where it was assumed that the physical sense of community would mean an easy translation to an online sense of community. Despite the existence of the real world community, an unsuccessful mapping from this to an online community has led to lack of contribution. This ties in with Denham Grey's observation that the required sense of community "must be co-constructed by the emergent community rather than imposed" (5.2.3).

However, it must not be forgotten that while a pre-existing, real life community might not be a requirement, a real life sense of community may be able to help boost the on-line sense of community and it may also provide the common purpose necessary to get the on-line community started. Interestingly, the increased sense of community that can develop on-line could even go full circle and promote a stronger sense of community in the real world.

So while a pre-existing real world community may be very helpful in building an initial on-line wiki community, it is not necessary for a successful wiki and equally it does not guarantee the success of a wiki.

The literature noted the 'ice-breaking' technique in traditional brainstorming to augment the sense of group history and familiarity. Adopting some equivalent informality in wiki use may be of value in promoting group involvement. This ties in with Adina Levin's suggestion of including NamePages (5.2.9). While, these are also of practical value, they could also be used as a useful wiki ice-breaker by asking new users to provide a few facts about themselves on their NamePage.

6.2.5 Enthusiasm and Contribution

We have seen that increased belief in the wiki concept will naturally boost enthusiasm for contribution. The other major factor affecting enthusiasm was shown to be value - how valuable the tool is to the community as a whole and also how much use it is to individuals within that community. If users believe the collaboration is being productive they will be more enthusiastic about the process which will increase the amount of contribution. Clearly though, if the wiki-based collaboration is of sufficient value to the user, contribution could occur even without the user being particularly enthusiastic about the process.

Novelty

Wiki is a new concept for many people and for these users the novelty value of wiki may be very powerful. There is a certain novelty value in free and open editing of web pages simply because users are used to them being largely static.

This novelty could mean enthusiasm in the early stages. Since early stage success has been shown to boost continued success by positive feedback, harnessing this initial enthusiasm could be crucial in gaining momentum and ensuring the continued successful use of the wiki. However, novelty is clearly not sufficient in itself to secure the future of the wiki, and it may be sensible to also utilise this early novelty period to train users in the ways and concepts of wiki to allow continued success.

The results from this study showed that users of the MSc IP Brainstorm Wiki noted that they liked the idea of wiki in the early stages but the lack of editing on the wiki showed there were no strong signs of enthusiasm as a result of this (5.2.1).

6.2.6 Ownership and Anonymity

There are two common different modes of writing in wiki. Document mode and thread mode. In document mode, once data is entered users no longer have any ownership over it. In thread mode contents are signed by users and thereby they retain a certain amount of ownership over that comment. The 'certain amount' is noted since all data on an openly editable wiki page is essentially shared by its very nature. The extent to which ownership of thread mode comments means that they cannot be altered or changed is decided entirely by social convention.

Document Mode

Users seem to have a natural sense of apprehension about editing wiki data in document mode. This seems to be based on the assumption that as they didn't write the information it must therefore belong to someone else. The apprehension may result from fear of loosing the original information should their change not be considered appropriate or fear of offending the original writer. Wiki, so long as the community is vigilant enough, should never loose important information as it can always be rolled back and if wiki ownership is truly shared there should be no means of offending the individual writer. However, just as criticism being ruled out in brainstorming does not eliminate the fear of criticism neither does the conceptual lack of ownership eliminate entirely the feelings of ownership.

As well as the possibility of offending the individual writer, an author may fear offending the community in general (as communal owner of the page data) for example if their proposed alteration goes against the majority opinion. Brainstorming studies showed that evaluation apprehension is greater when more people are present and when people of greater authority are present. It seems reasonable therefore that the evaluation apprehension felt when changing the words of an entire community will be high, particularly as the view expressed in the wiki at any given point is known to be the consensus view - and to therefore have great authority.

Evaluation apprehension it seems could have a dramatic effect on how much users contribute to editing and in the worst case it could lead to no editing at all.

It appears that a natural tendency, probably in an attempt to avoid evaluation apprehension, is to add comments or suggestions to the wiki contents rather than changing them and in many wiki communities this has led to the generation of a specifically defined mode of editing known as thread mode.

Thread Mode

Thread mode allows comments to be made regarding the data without changing the main document mode text of the page. This can lead to wiki-based discussion. Thread mode discussion is often found at the bottom of a wiki page or on a separate page. Often thread mode comments are signed to make them identifiable to the user, and the signatures frequently form links to 'NamePages' giving details about that user. Adina Levin notes that the creation of 'NamePages' is something that she promotes (5.2.9). Commonly thread mode conversations of this nature are allowed to

continue until they naturally finish and the thread is then refactored into document mode. The importance of the regular occurrence of such refactoring is another point that Adina Levin makes (5.2.9).

Crucial to the idea of thread mode is that ideas can be signed and can therefore be traced back to an individual user. This is useful as it means a user can be contacted for further information regarding their comments. It may also increase trust in the comments, as suggested by Denham Grey (5.2.9) and promote the sense of community. Furthermore, it gives users a greater sense of ownership over their comments. This might make users more likely to participate by giving them a greater sense of personal reward from contributing and the potential to receive any social recognition that their comments may deserve. This is an important factor as the possibility of reward is likely to greatly increase process satisfaction. This was recognised by Mark Neff who noted that some users "crave the recognition and attribution they deserve for their contributions" (5.2.9). He also notes that this will depend on the composition of the group. It is likely to be a useful feature in a wiki in the workplace as it may act to increase the drive of users to contribute and in a very competitive workplace this desire for recognition could be very high. The ability to receive praise and recognition is a clear benefit of thread mode and the use of this is seen in Meatball Wiki ("Meatball Wiki", Meatball Wiki, 2004) where a 'barn star' system is in operation whereby users are awarded stars in recognition of significant contribution within the community. The barn stars are added to the users name page.

However, while identifiability may have its benefits, it does also run contrary to the idea of shared ownership of data that can be edited and built upon by anybody. When considered carefully though, the inclusion of thread mode actually better reflects the real world sociology of collaboration. If we take the meeting room analogy again and imagine two people collaborating on a paper document in the real world, it would be expected that they would converse about possible alternatives (with ideas identifiable to themselves) before changing the document based on the outcome of their conversation. This allows clarification of understanding and the resolving of topics of contention.

Both these modes of collaboration (verbal and written) in the real world are being performed through different modes of collaboration on the wiki (document mode and thread mode), the difference being that here both wiki modes are text based and are therefore less easily distinguishable. This may cause confusion for users, as might the fact that some text is owned entirely by the collective while some is owned, at least in part, by the individual.

This confusion could be exacerbated by the existence of wiki pages containing a blend of different modes and this could add to existing confusion based on the different styles of wiki use (like brainstorming and document management). This could be detrimental to understanding, process satisfaction, trust in the wiki content and belief in the wiki concept.

Clearly, to avoid these problems, users need to be clear about the distinction and need to know how to use them appropriately. Traditional meetings have clearly differentiated modes of communication (speaking, writing on white boards etc) and styles of collaboration (question and answer, brainstorming etc). The equivalent collaboration modes and styles in wiki may need careful consideration to ensure the differentiation is equally clear to users. This may mean changes to the actual design of wiki but it could simply mean creating a set of standards and guidelines and ensuring users are familiar with them. This brings us back to the idea of the 'vocabulary of effective wiki practices' suggested by Adina Levin (5.2.5). Crucially, however, any guidelines and standards must only be used to make sure everyone has a shared reference point from which to

move forward. They, just like all aspects of wiki, must remain flexible and able to change with the community. The best way to establish such guidelines is likely to be from looking at the styles and conventions that have developed in established wiki. Since these have been established by the community as a whole, they provide the most reliable tried-and-tested guide to what works and what doesn't. Without clear guidance and training in the first instance, the potential benefits provided by different modes and styles of collaborating using wiki may be outweighed by the increasing complexity.

Login Anonymity

As well as anonymity of comments within the page being an issue, there is also a question mark over the issue of login anonymity.

The question of evaluation apprehension is an important one in traditional brainstorming. Many electronic brainstorming tools claim to overcome traditional problems of evaluation apprehension by making the system anonymous. Where opinions are asked for on a wiki, users may feel more comfortable giving honest opinions in the knowledge that they are not directly traceable back to them. Login anonymity in wiki may help overcome this problem to an extent by helping to establish a sense of shared ownership over the data. It is also likely to boost uninhibited and honest input to wiki content. This could be particularly valuable in brainstorming type wiki tasks and other uses where evaluation apprehension might be felt. By removing any sense of individual ownership, login anonymity may also promote uninhibited deletion and refactoring of wiki data. However, it might also promote graffiti, trouble making and free-riding and for this reason alone corporate wiki may need to require a login. This might also reduce the chance of free-riding. This is reflected in Adina Levin's comment that "people behave more politely and socially appropriately when they are accountable for their words and actions" (5.2.9).

Another problem with anonymity may be free-riding. As long as users are using wiki through a personal desire to help reach a common goal, free-riding should not be a problem. However, free-riding may be more of a problem where wiki collaboration is required by an organisation but where there is low personal value to be gained from participating.

Diehl & Stroebe (1987) established that free-riding was not a significant cause of production loss in traditional brainstorming. Their belief was that free-riding should vary as a result of cost of contribution. Since traditional brainstorming is practically effortless and involves no time costs (as participants are already attending the session) the effect of free-riding would be negligible. The same is not true of wiki-based collaboration however where it is up to the user whether they visit the wiki and how long for. There is also increased effort introduced by the fact that information has to be sorted through and new information has to be typed in. It is a much more active process than attending a meeting and therefore without sufficient motivation the increased costs of contribution in terms of both time and effort are likely to promote free-riding.

Due to the variety of uses of wiki, it is impossible to say whether wiki should require login or not, as different uses are likely to be affected differently. This may tie in with the idea of having set different statuses for pages. This way a brainstorming page might be entirely anonymous while an important structural page like the home page might be identifiable. Building this into the wiki structure may even be valuable as long as the flexibility of pages was maintained. The increased structural complexity may be outweighed by the decreased technical cognitive interference from the perspective of the user. I use the phrase 'technical cognitive interference' as a logical extension of 'cognitive experience' in traditional brainstorming literature. The difference being that technical

cognitive interference is interference with your mental processing by a technical tool, such as wiki, rather than another human.

Control of the wiki really needs to be established by the community as a whole, rather than being imposed by particular members of it, otherwise the sense of shared ownership is lost as well as increasing the chance of loss of value to individuals within the community. Wiki should therefore be best made as free as possible with few restrictions and clear invitations to edit. Ideally in an organisation, this will mean that the system should grow from the ground up rather than being imposed from the top down. This natural evolution should however be accompanied by encouragement and support from management in terms of providing training and leading by example.

The brainstorm wiki was made entirely anonymous at the design stage in the hope that this might help convey the concept of shared ownership of wiki data. Clearly the brainstorm wiki was unsuccessful although it is impossible to say how the anonymity affected the outcome. Other problems with ownership were noted however, one user saying they "wouldn't edit somebody else's entry" in a wiki and that they "wouldn't want somebody else to edit theirs" (5.2.1). This represents a clear problem with conceptual understanding of the purpose of wiki collaboration, but strong feelings like these from some users is likely to be a common problem and this ties in with Denham Grey's comment that wiki will only appeal to a "small sub-set of on-line participants" (5.2.4). This may be a particular problem for wiki in smaller organisations.

6.2.7 Facilitation

Theoretically the user base as a whole should provide all the facilitation that is needed, in keeping with the idea of "distributed governance" as noted by Denham Grey (5.2.10). While this is clearly good practice and should be promoted within the community, in reality it may not be sufficient to maintain the structure and therefore the value of the existing content.

The practice of having a facilitator as an integral part of the collaborative process is seen in other methods of collaboration, for example in brainstorming meetings. It seems plausible that wiki may also benefit from an individual or a group of individuals with the specific role of facilitating the wiki. This was the theory behind the design choice to be a participant observer in the MSc IP Brainstorm Wiki. Particularly, it seemed necessary at the outset to have some initial structure and content in the wiki to get the process started. When establishing a wiki it seems logical that it should not start as a blank page but there is a danger in using a facilitator to do this as the resulting data may feel like it 'belongs' more to the facilitator than to the community. Clearly, this runs contrary to the shared ownership concept and could lead to increased evaluation apprehension and refactoring fear. This might be particularly true in a corporate wiki where a lot of the wiki structure is likely to be well defined and can be added at the outset. This might be a problem with the Department of Management Studies Wiki. Antony Powell noted that the department had a well defined structure and set of procedures. While this makes for a well defined and well laid out wiki site in the first instance, it also increases the chance that users could view it like a static web page. This may give the impression that the data is somehow more permanent and unchangeable.

One way to overcome problems of individual ownership might be to assign different users to different areas of the wiki to ensure that their designated areas are kept up to date. Such a system was suggested by Antony Powell (5.2.9). As wiki grows however it would be crucial for users to be reassigned/redistributed to cover the new areas as they develop. This increases bureaucracy however, the removal of which is likely to have been a reason for installing the wiki in the first

place. Furthermore, giving different areas of the wiki facilitators could still mean ownership issues where users feel that data in each section 'belongs' more to the relevant facilitator than to the community, although this may be less marked than if facilitation is performed by one individual. The sense of ownership could also be enhanced if the name of the owner/facilitator of the page was also present on the page.

Using specified wiki facilitators might therefore be problematic. When wiki is working correctly, there should be no real need for specific facilitation as the community as a whole should act to facilitate the wiki. Denham Grey supports the idea of "distributed governance" while recognising that it requires the spread of good working practices to be successful (5.2.10). However, this by itself may not be sufficient and others are of the opinion that facilitation is a necessity for successful wiki (5.2.10). This may partly be due to a lack of good practices in the community, but this in turn may be the result of deeper social psychological issues surrounding wiki-based collaboration. If this is the case some extra nurturing of the contents and structure is likely to be valuable in ensuring that it is kept under control so that users don't loose trust in the contents. As a middle ground then, it might be best if facilitation is done without the explicit knowledge of the community as a whole, with the facilitator simply acting as a very keen contributor. This type of stealth facilitation would give the impression that the community as a whole was editing and refactoring correctly which would help promote trust in the community and belief in the wiki concept.

In an organisation, the role of facilitation might be particularly important. In a web based wiki community, users are interested in the content of the wiki but they also have a belief in the concept of wiki itself. Those that do not can simply drop out of the community. However, in an organisation, the intended community may have a shared interest in the wiki contents but not a belief in the wiki concept itself. Where users are allowed to drop out of the organisation's wiki community, this may not be a problem, but users dropping out in a smaller community like this might mean a significant loss of value for the community as a whole. Since users forced to use a wiki are likely to loose enthusiasm for it, a role of 'promotional facilitation' might be useful, where the role is simply to support wiki use, provide training and guidance and promote the development of the online community. This promoting of the tool and empowering of the user approach to facilitation is in keeping with suggestions originally given by Osborn for the role of facilitator in traditional brainstorming. While promotion of the wiki did occur, it is felt that a lack of this type of active and hands-on 'promotional facilitation' in order to build the on-line community in the first instance might have been an important contributing factor in the failure of the MSc IP Brainstorm.

If a facilitator is used, their specific role may be a key factor in wiki success. A facilitator that merely refactors information is likely to be useful in keeping the wiki in check, but in the long term some of their time might be more effectively spent in promoting wiki, demonstrating its potential, ensuring adequate training and spreading good practices in the community. As we have seen, forcing the use of wiki is unlikely to be effective. Providing value and empowering users such they can choose to use wiki is likely to be a much more effective approach.

It is likely that the approach to facilitation taken will depend very much on the nature of the particular wiki and its community. An interesting area for future work would be to study the various approaches to facilitation and establish to what extent each one benefits wiki.

Of course, official facilitation also relates back to training in that the facilitators should themselves be well trained in wiki concept and culture as well as the technical aspects of wiki. The noted importance of the social aspects of wiki should be well understood by facilitators and they should be well aware of the process gains and losses that relate to wiki-based collaboration.

Figure 1: The Wiki Cycle

THE WIKI CYCLE

Factors that can have both **positive** and **negative** effects: Dashed red lines represent negative effects and solid black lines represent positive effects. Boxes with dashed outline are duplications of those found in the main diagram.

7 Conclusions

A unique insight into the factors involved in wiki success and failure has emerged from an evaluation based on knowledge gained from traditional brainstorming research. This evaluation demonstrates a number of social factors that are common to both form of collaboration.

A number of potential problems with wiki-based collaboration were highlighted in the literature review. Discussion of the results obtained in this study allowed elaboration of these problems by way of evaluation of a number of process factors that affect wiki use. It was shown that the problems commonly associated with wiki-based collaboration can be explained in terms of these process factors.

From the evaluation of results emerged a pattern of how the various process factors interrelate. This emergence of this structure led to the development of a diagrammatic representation of the process factors affecting wiki based collaboration. This has been named the 'The Wiki Cycle' and it is shown in Figure 1 (see page 63). The aim of this diagram was not only to identify the various process factors that affect and drive the wiki-based collaborative process, but also to show the full interrelation of these factors so that the dynamics of wiki-based collaboration were expressed.

7.1 The Wiki Cycle

Integral to wiki success is momentum. Wiki users should have a clear common goal and this should reflect their shared individual interests. In so doing, the wiki then becomes more than just a 'shared workspace' as defined in the introduction but also an 'environment of exchanged value' as defined by Sunir Shah. Regular contribution to the wiki leads to progress towards the common goal and a sense of achievement in the community. This boosts process satisfaction which increases the drive towards reaching the shared goal whilst also increasing user trust in the community and in the content of the wiki and belief in the wiki concept itself. This positive feedback mechanism means that if a certain momentum can be established and sustained, wiki can become largely self-propagating and self-maintaining. As shown in 'The Wiki Cycle' (see Fig.1, page 63) there are a number of factors involved in achieving and sustaining this momentum and from these we can establish how the combination of factors determines the success or failure of wiki-based collaboration. This also allows us to pinpoint why the potential problems of wiki occur.

The results showed that a core number of active users are required for successful wiki collaboration as, without constant attention and input, wiki can build up areas of redundancy and out of date information that turn the positive feedback mechanism based on process satisfaction, trust in the community and wiki content into a negative feedback mechanism where these effects are reversed. The danger is that once wiki fails and belief in the system is lost, it may become difficult for users to regain the required level of trust and belief in the potential of the process. Building and maintaining momentum is therefore critical and while there is potential for wiki to be largely self propagating and self maintaining, achieving this state may require a certain amount of dedicated attention in the early stages.

A proposed copy of the wiki cycle was sent to the wiki experts for their consideration and comment. Response was limited due to time constraints but the feedback received was, however, very positive. It is hoped therefore that this cycle might provide a useful point of reference for future research in this area and it may also be valuable for developing appropriate training and guidance

methods. However, as Adina Levine confirmed, a simpler organisation plan may be more appropriate for specifically helping individuals to integrate wiki into their organisations.

It must also be remembered that while it may be a valuable overview, a representation like 'The Wiki Cycle' will also be a gross simplification of real-life wiki use, where the difference between success and failure could be slight and might well depend on very subtle differences in the particular environment and community in which wiki is used. It is clear that there is no one-size fits-all approach to wiki, but it is hoped that a number of factors and their interrelation have been identified that can be taken into account when establishing wiki and it is hoped that 'the wiki cycle' helps to make these more explicit.

7.2 Key Factors in Wiki Collaboration

It is clear from looking at well known examples such as Wikipedia, that wiki based collaboration can be both a successful and productive process. However, the results obtained in this study made it clear that establishing a wiki and an on-line community are two entirely separate things and the latter is clearly vital to the success of a wiki-based collaboration. This study highlights the fact that failure of wiki collaboration is usually little to do with the technology itself but is instead due to the lack of a strong wiki community. This lack may be based on a number of factors. It may be the result of fundamental issues of user understanding of wiki, it may be that they don't trust it or it may be that it simple doesn't fit into their current needs to the extent that is of value to them at a personal level. In summary, the results showed that wiki is successful where the community is strong and the project established that there are three key factors that affect success or failure of a wiki based brainstorm.

7.2.1 Understanding

This includes understanding of the social and technical aspects of wiki. Understanding of the social factors was found to be particularly vital. A good level of understanding promotes trust and belief in the system. A particularly important aspect of this was that users should have a good understanding of the concept of distributed ownership, whilst also being clear on the need for, and nature of, specific collaboration modes, like ThreadMode, that allow more individual style comment.

7.2.2 Trust

This includes trust in the technology, in the wiki contents, in the wiki community and belief that the concept can and will work. It can be seen that, whatever the technique, for group creativity to work, mutual trust must first be established. The idea of electronic communication is well established, with the use of e-mail, instant messaging and weblogs, but wiki introduces a number of social factors that users are perhaps not familiar with in an electronic environment. This is a crucial difference that makes wiki stand apart from other collaborative tools. Until now, trust in new collaborative software has meant gaining trust in the technology, but trust in wiki requires not only trust in the technology but also trust in an on-line community. This is a major conceptual shift for many users and this is heightened by a familiarity with the previously static-only nature of the Internet. These social issues cannot be avoided as the same flexibility that raised these concerns is also responsible for providing wiki-based collaboration with its power. For this reason, while the rise of e-mail was rapid, the rise of wiki is likely to be a more gradual process as users become

increasingly familiar with the concepts and social aspects involved in being a part of an on-line community.

7.2.1 Value

However, as is common with collaborative software once implemented, it could still fail due to a lack of strong incentive to use it. The intention of a wiki in the workplace, for example, must be to meet the needs of all members of the organisation and not simply the needs of management. If the tool is not valuable on a personal level it will not get the level of use needed to maintain momentum. This may be a particular challenge in the successful implementation of wiki in the workplace as corporate ideals may not always match the ideals of the individuals that make up the wiki community.

More value in general might mean more contribution and more refactoring, but more functionality and tighter integration with existing collaborative technologies would also increase value. Perhaps a fundamental advantage of wiki is its multitude of uses, and just as real world processes overlap, a tool like wiki could help mirror such overlaps in the digital workplace. It could be envisaged that an initial unstructured wiki-based brainstorm, for example, might evolve into a full structured collaborative document like a training document or a presentation. Couple this already multi-function tool with a range of other collaboration technologies such as e-mail, RSS and blogs and it can be seen that wiki may even form the perfect basis for a full collaboration portal.

A key finding of this research was the important difference recognised between wiki in the workplace, where users do not choose to partake and Internet based wiki, where contribution is open and optional. The important factor affected was shown to be value - in terms of the balance between individual value and organisational/community value.

7.4 Structured and Unstructured Data

Wiki is based on a balance between structured and unstructured data, order and chaos. Input is driven based on value and this is what drives it forward. Collaboration, as defined in the introduction, can be either structured collaboration or unstructured collaboration. The nature of wiki is unusual in that it can incorporate both of these forms of communication. This may make it complex to a new user but it also makes it very powerful. The balance between structured and unstructured data on the wiki is crucial to its success. If data becomes too structured it may loose its value as a result of inactivity and no longer introducing new ideas. Equally, wiki can become too chaotic and clearly this will also reduce value and trust.

7.5 Outcomes

Despite failure to fully explore the potential of wiki in use in collaborative brainstorming, the subsequent change of emphasis of the study allowed a unique approach to be adopted towards evaluation of the wiki which led to insights that might not have been gained otherwise. This approach made it possible to successfully evaluate the potential problems of and process factors affecting wiki, as a little studied form of collaboration, based on findings from a review of traditional brainstorming as a well studied form of collaboration.

As well as developing 'The Wiki Cycle', the project also led to the development of a basic framework for evaluating wiki and a basic set of guidelines for successful wiki use. The guidelines are presented within 'Recommendations for Further Study'.

In correspondence with Sebastien Paquet, an expert on knowledge sharing and social software, he noted that "at this point successful wiki are the exception rather than the rule" and that "what makes the difference between success and failure is now one of the key challenges". It is believed that the developed 'Wiki Cycle' is a step in the right direction and it is hoped that this might provide a useful starting point for further analysis of this fascinating social collaboration technology.

8 Recommendations for Future Study

This study highlighted some of the sociological differences between Internet-based wiki and wiki in the workplace. Web based wiki builds up a community from a global pool. Users choose to become a part of the wiki and choose to return to it based on interest and value. A wiki in the workplace, however, will build a community from a much smaller pool, and while all users are free to come and go from a web-based wiki, there may be certain expectations and requirements for users to participate in the wiki. Furthermore, the users of wiki in the workplace may not have the technical orientation of those found in web-based wiki communities. More detailed study of the differences between these two types of communities and how this affects wiki use would be extremely valuable in determining the specific implications for organisations establishing internal wiki.

The study showed how while distributed governance is the ideal, specific facilitation might be a necessity, particularly for a wiki within an organisation. Looking into the different ways in which wiki can be facilitated could be a useful avenue for future research to determine which approach works best in both a wiki in the workplace and an Internet based wiki.

Taking a holistic evaluative approach to wiki has enabled a valuable overview of the complicated interplay of factors that determines success or failure of wiki. However, using qualitative techniques it is difficult to fully establish the relative importance of these various factors. Further evaluation might focus on quantitative study of the individual factors to attempt to establish their relative importance. A quantitative experimentation approach to evaluation, in a similar style to that seen in traditional brainstorming, might also allow a more detailed study of the specific process gains and losses in wiki-based collaboration. However, the dangers of de-contextualising evaluation of a social tool as was highlighted in the literature review must be remembered.

The effect of training on the success of wiki may be particularly interesting and establishing the most effective means to train users in both conceptual and technical aspects of wiki use would be useful future work.

This study is grounded in the sociology of collaboration and little emphasis has been given to the technical aspects of wiki. Ward Cunningham promotes the idea of the 'simplest workable solution' and the recognised successes of wiki proves that this approach works, but simplicity in terms of design of the tool may not promote simplicity in terms of usability. This study found that the different modes (like document and thread mode) and styles (like brainstorming, knowledge management) involved in wiki use may affect users' conceptual understanding of wiki-based collaboration. Future work might look at how wiki technology can be shaped to find the simplest solution from the perspective of the users (to reduce technical cognitive interference) without destroying the simplicity or flexibility of wiki that helps make it powerful.

A variety of factors have been shown to affect wiki in general and it is clear that these factors may have different effects depending on different styles of wiki use. It might be useful to identify a case study which displays a range of different styles of use (brainstorming, document authoring, knowledge management etc) and to study the uses independently to see how these are affected by the various process factors.

It is clear that the nature of wiki lends itself to the building up and sparking-off of ideas in the same way as is seen in a traditional brainstorming session but without being constrained in terms of

participants being in the same place at the same time. The wiki-based brainstorm in this case study failed to build a suitable community for the study, but the potential for wiki use as a brainstorming tool is still great. Future work might involve performing a similar study to that proposed in the phase one design but ideally using a pre-existing corporate wiki community that is already well established. An important lesson learnt from this study is that establishing a suitable wiki-based collaboration for a case study requires considerable time and effort since it requires first building up an on-line wiki community based on trust and shared value.

From the study, a number of guidance points were derived that may help ensure wiki failure is avoided. Future work could look at these in more depth and possibly test different guidance instructions to see which work best in practice. Specific instructions that work best might vary depending on context, community and the styles and modes of wiki use. This would have to be taken into account when creating guidelines. The suggested guidance points based on findings of this study are:

A) Ensure users have an appreciation of the key drivers of the wiki cycle as elaborated on in the project conclusion.
    a. Understanding - of the social and technical aspects of wiki.
    b. Trust - in the technology, the contents and the community as well as belief in the wiki concept.
    c. Value - of the wiki to the users both as a community as a whole and as individuals within that community. This requires progress towards common and individual goals.
B) Initial careful seeding of the wiki structure and content by a core of wiki users. Content should be meaningful and of value but care should be taken that the content does not get so much that users lose ownership over it.
C) Ensure training for all users in both the technical and social aspects of wiki - incorporating explanation and building up of a shared language of potential styles and modes of wiki collaboration. Both the framework developed from the study of social psychology in traditional brainstorming and the dynamics of wiki shown in the developed wiki cycle could be beneficial when designing training or guidance for wiki, though, unless highly simplified, they would be unlikely to form a part of the training itself. Wiki users should ultimately become good 'wiki citizens'. ("Good Wiki Citizen", C2 Wiki, 2004)
D) Make written guidelines available following training on wiki concepts, culture and etiquette - covering wiki styles and modes of use.
E) Promote success – by giving examples of successful wiki use and by being prepared to answer all user concerns with confidence. Wikipedia's 'replies to common objections' page may be a good place to start with this. Be ready to counter users that reject the idea from the outset. ("Replies to Common Objections", Wikipedia, 2004).
F) As suggested by Mark Neff, use the tool and lead by example.
G) Ensure a core number of active users are present in order to keep up momentum of the cycle.
H) Promote distributed governance but with careful facilitation to plug the gaps – possibly 'stealth facilitation' to add value and some 'promotion facilitation' to promote the development of the on-line community.
I) Promote creation of personal pages/NamePage's and perhaps use these to increase value to the user, to create a sense of community and introduce an element of informality.

9 References

Andrew, D., Holley, D., & Pheiffer, G. (2004). Working with wiki. Unpublished: Presented at the BEST conference in April 2004.

Bouchard, T. J., & Hare, M. (1970). Size, performance and potential in brainstorming groups. *Journal of Applied Psychology*, 54, 51-55.

Cartwright, D. (1968). The nature of group cohesiveness, In Cartwright, D., & Zander, A. (Eds.). *Group Dynamics: Research and Theory* (3rd Edition), 91-109, NY: Harper & Row.

Bennet, J. L., & Karat, J. (1994). Facilitating effective HCI design meetings, In Proceedings of CHI '94, ACM, 198-204, NY.

Charlesworth, I., Davis, M., & Holden, J. (2003). *Workgroup and Enterprise Collaboration: Reducing the Costs and Increasing the Value of Collaborative Working*, Hull: Butler Direct.

Collaros, P.A., & Anderson, L.R. (1969). Effect of perceived expertness upon creativity of members of brainstorming groups. *Journal of Applied Psychology*, 53, 159-163.

Cunningham, C. (2004) The Wiki, Microsoft Research Social Computing Symposium - Session #3, 3/29/04 4:50 PM (Pacific), Retrieved from: http://murl.microsoft.com/LectureDetails.asp?1076. Last visited: Aug 25, 2004.

Dennis, A.R., Aronson, J.E., Heninger, W.G. & Walker, E. (1999). Structuring time and task in electronic brainstorming. *MIS Quarterly* 23, 95-108.

Dennis, A.R., Valacich, J.S., Connolly, T. & Wynne, B.E. (1996). Process structuring in electronic brainstorming. *Information Systems Research* 7, 268-277.

Denscombe, M. (1998). *The Good Research Guide.* Buckingham: Open University Press.

Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology*, 53, 497-509.

Diehl, M., & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. *Journal of Personality and Social Psychology,* 61, 392-403.

Gallupe, R.B., Bastianutti, L.M., & Cooper, W.H. (1991). Unblocking brainstorms. *Journal of Applied Psychology* 76, 137-142.

Harkins, S.G., & Petty, R.E. (1982). Effects of task difficulty and task uniqueness on social loafing. *Journal of Personality and Social Psychology*, 43, 1214-1229.

Isaksen, S.G. (1998). A review of brainstorming research: six critical issues for inquiry. Buffalo, NY: Monograph #302, Creativity Research Unit, Creative Problem Solving Group - Buffalo.

Kerr, N.L., & Bruun, S.E. (1983). The dispensability of member effort and group motivation losses: free rider effects. *Journal of Personality and Social Psychology*, 44, 78-94.

Lamm, H., & Trommsdorff, G. (1973). Group versus individual performance on tasks requiring ideation proficiency (brainstorming). *European Journal of Social Psychology*, 3, 361-387.

McGrath, J.E. (1993). Methods for the study of groups (excerpt from Groups: interaction and performance). In Baecker, R.M. (ed.) *Groupware and Computer-Supported Cooperative Work*, 200-204, San Mateo, CA: Morgan Kaufman.

Mullen, B., Johnson, C., & Salas, E. (1991). Productivity loss in brainstorming groups: A meta-analytic integration. *Basic and Applied Social Psychology*, 12, 3-23.

Osborn, A.F. (1967). *Applied Imagination: Principles and Proceedures of Creative Problem Solving (Third Revised Edition.)*, NY: Charles Scribner's Sons.

Paquet, S. (2003) A socio-technological approach to sharing knowledge across disciplines. Ph.D Thesis, University of Montreal. Retrieved from: http://www.iro.umontreal.ca/~paquetse/SebPaquet-PhDThesis.pdf. Last Visited: Sept 5 2004.

Paulus, P. B., & Dzindolet, M. T. (1993). Social influence processes in group brainstorming. *Journal of Personality and Social Psychology*, 64, 575-586.

Paulus, P. B., Dzindolet, M. T., Poletes, G., & Camacho, M. L. (1993). Perception of performance in group brainstorming: The illusion of group productivity. *Personality and Social Psychology Bulletin,* 19, 78-89.

Pinsonneault, A., Barki, H., Gallupe, R.B. & Hoppen, N. (1999). Electronic brainstorming: The illusion of productivity. *Information Systems Research* 10, 110-133.

Satzinger, J.W., Garfield, M.J., & Nagasundaram, M. (1999). The Creative Process: The Effects of Group Memory on Individual Idea Generation. *Journal of Management Information Systems*, 15, 143-160.

Taylor, D. W., Berry, P.C., & Block, C. H. (1958). Does group participation when using brainstorming facilitate or inhibit creative thinking? *Administrative Science Quarterly*, 3, 23-47.

Van Deursen, A. & Visser, E. (2002). The reengineering wiki. In Proceedings 6th European Conference on Software Maintenance and Reengineering (CSMR), IEEE Computer Society, 217–220.

Wiki References:

Edit War [Last visited: Aug 26, 2004]. On Wikipedia. Retrieved from http://en.wikipedia.org/wiki/Edit_war.

Good Wiki Citizen [Last visited: Aug 25, 2004]. On C2 Wiki. Retrieved from http://c2.com/cgi/wiki?GoodWikiCitizen.

Knowledge Management [Last visited: Sept. 6, 2004]. On C2 Wiki. Retrieved from
http://c2.com/cgi/wiki?KnowledgeManagement. Comment posted by WiebeVanDerWaals, May, 10, 2000.

Meatball Wiki [Last visited: Sept 9, 2004]. On Meatball Wiki. Retrieved from
http://www.usemod.com/cgi-bin/mb.pl.

Replies to Common Objections [Last visited: Aug. 20, 2004]. On Wikipedia. Retrieved from
http://en.wikipedia.org/wiki/Wikipedia:Replies_to_common_objections.

TikiWiki [Last visited: Sept. 6, 2004]. On TikiWiki. Retrieved from http://tikiwiki.org.

Trust and Responsibilty [Last visited: Sept. 6, 2004]. On C2 Wiki. Retrieved from
http://c2.com/cgi/wiki?TrustAndResponsibility.

Why Wiki Works [Last visited: Sept. 6, 2004]. On Meatball Wiki. Retrieved from
.http://www.usemod.com/cgi-bin/mb.pl?WhyWikiWorks.

Why Wiki Works Not [Last visited: Sept. 8, 2004]. On C2 Wiki. Retrieved from
http://c2.com/cgi/wiki?WhyWikiWorksNot.

Wiki [Last visited: Aug 5, 2004]. On C2 Wiki. Retrieved from http://c2.com/cgi/wiki.

Wiki History [Last visited: Sep 7, 2004]. On C2 Wiki. Retrieved from
http://c2.com/cgi/wiki?WikiHistory.

Appendix A: Timeline of Important Project Events

Date	Project Event
Thur 12th Aug:	MSc IP Brainstorm Wiki goes live. Mail sent out to Students.
Mon 16th Aug:	Follow up e-mails to students and Computer Science staff to promote wiki.
Wed 18th Aug:	Point at which it was clear that MSc IP Brainstorm Wiki had failed.
Wed 18th Aug:	Interview with Tony Simpson, Dept of Management Studies.
Thur 19th Aug:	Interview with Antony Powell, Dept of Management Studies.
Fri 20th Aug:	E-mail 1 (Hypotheses) sent out to experts.
Tue 24th Aug:	50% response rate to e-mail 1.
Mon 30th Aug:	100% response rate to e-mail 1.
Wed 1st Sep:	E-mail 2 (The Wiki cycle) sent out to experts.
Fri 10th Sep:	Project report hand in.

Appendix B: Wiki Experts

Details of the experts who took part in the study.

Name and e-mail	Description
Benoit Brosseau benoit@brosseau.org	A consultant of open source technology with experience of wiki. (http://www.brosseau.org/index.php)
Denham Grey dgrey@iquest.net	A knowledge management consultant and expert in virtual teams, communities of practice, distance learning and social affordance for knowledge creation. Founder of KmWiki (http://www.voght.com/cgi-bin/pywiki?KmWiki), author of 'Knowledge-at-work' blog (http://denham.typepad.com/km/) and CEO of the knowledge management firm GreyMatter.
Adina Levin alevin@alevin.com	A founder member of Socialtext (http://www.socialtext.com/) a leading social software development company. She has expertise in strategic marketing and product planning in a variety of emerging high-tech markets.
Mark Neff mneff@csc.com	A knowledge management specialist with expertise in knowledge communities, collaborative processes and technologies. Work has included a wiki-based collaborative thesis and other contributions to CoachUniverse Wiki (http://www.coachuniverse.com/BaseQuicki/wiki.cgi).
Sunir Shah sunir@sunir.org	A social software developer for Socialtext and founder of Meatball Wiki – a wiki focussed on online culture and communities. (http://www.usemod.com/cgi-bin/mb.pl?MeatballWiki)

Appendix C: MSc IP Brainstorm Wiki Details

Appendix D: Wiki Experts E-Mail

Appendix E: Department of Management Studies Wiki Interview