

# Talking to Strangers: An Evaluation of the Factors Affecting Electronic Collaboration

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## ABSTRACT

This empirical study examines factors influencing the success of a commercial groupware system in creating group archives and supporting asynchronous communication. The study investigates the use of Lotus Notes™ in a workplace setting. We interviewed 21 Notes users and identified three factors that they thought contributed to the successful use of Notes databases for archiving and communication. We then tested the effect of these factors on 15,571 documents in 20 different databases. Contrary to our users' beliefs, we found the presence of an active database moderator actually *inhibited* discussions, and reduced browsing. Further paradoxical results were that conversations and the creation of group archives were more successful in databases with large numbers of *diverse* participants. Conversations and archiving were less successful in smaller, more homogeneous, project teams. Database *size* was also important: a large database containing huge amounts of information was more likely to be used for further conversations and archiving, than a small one. This result again ran counter to users' beliefs that small databases are superior. We discuss possible reasons for these findings in terms of *critical mass* and *media competition*, and conclude with implications for design.

## Keywords

Asynchronous communications, newsgroups, group memory, empirical studies, workplace interaction, interpersonal communication.

## INTRODUCTION

Group collaboration and communication are beginning to be widely supported by technologies such as the Internet, electronic mail, Lotus Notes, shared file systems and distributed databases. These technologies provide electronic support for group activities such as discussion, the creation of shared archives, and more structured processes including the execution of workflow tasks. Recent technological innovation has also produced electronic "virtual places",

such as MUDS and Media Spaces which are intended to partially mimic the physical locations in which users currently meet, work and talk [1, 5, 8, 9, 20, 26].

While there has been a great deal of technical innovation, our understanding of the deployment, social impact and use of these technologies is more limited. Pioneering early work [7,19] investigated the use of bulletin boards and electronic mail in organisations, studying the impact of these technologies on group processes. This work showed that technologies such as email promoted the growth of virtual communities [7]. Furthermore, both email and bulletin boards can modify traditional patterns of communication within organisations. Electronic communications are more likely to cross organisational boundaries, and they allow greater contribution from geographically remote workers. These changes in communication patterns engender greater commitment in remote workers to organisational goals [19]. Recent work on mediated communication has investigated interaction genres in electronic communication, and documented the emergence of new conversational conventions. These new conventions are more likely to emerge under carefully managed conditions [17,18].

The current empirical study investigates Lotus Notes, a technology that is designed to promote electronic collaboration. Notes supports two key aspects of collaboration: *communication* and *group memory*. Like bulletin boards and email, it supports asynchronous communications. The permanent nature of these interactions means that conversations can be stored and accessed later. The persistence of such conversations, combined with the fact that Notes is a distributed document database, means that it is possible to create structured group archives [2,6]. These archives can take the form of group memories, allowing collaborators to store, access and re-use information about key processes, technical discussions and reference documents.

This study uses both quantitative and qualitative methods to identify factors influencing electronic collaboration, in the use of Notes databases. We interviewed 21 Notes users to obtain their perceptions about the key benefits and drawbacks of this technology. The critical questions addressed were: (a) how do electronic discussions promote

work-related conversations and what factors impede effective interaction; (b) what enables groups to generate and maintain useful archives of reference information? We identified two factors that all users felt contributed to the successful use of databases for both interaction and group archival functions: the presence of *database moderation*, and restricting database *size*. A third factor, the *diversity* of database contributors, was more controversial: some users argued the benefits of diversity, while others maintained that small numbers of similar participants were vital for successful database collaboration. We then quantitatively investigated the effect of these three factors on 15,571 documents in 20 different databases. We discuss possible reasons for our findings in terms of *critical mass* and *media competition*, and outline outstanding theoretical issues that need to be addressed. On the basis of our findings, we also suggest new technical features that might be added to groupware systems to promote more effective electronic collaboration.

### THE NOTES SYSTEM

The Notes installation we studied is used by Lotus corporation for carrying out different aspects of its business. It is probably one of the largest groupware installations. It consists of more than 22000 databases each of which can contain up to sixteen thousand documents. The current study does not set out to evaluate this whole Notes installation, we focus here on only a subset of the applications and databases that Notes supports.

The basic unit of organisation and communication in Notes is the document. Databases consist of sets of documents. All databases share the same underlying infrastructure, and the same user interface for accessing information. Databases support a number of different functions ranging from email and bulletin boards, to workflow, newswire services and general corporate policy information.

A key feature of Notes databases is that they support *structured conversational* interaction. Like many Internet newsgroups, it is possible to construct a conversational thread in Notes. One user can therefore create a topic by asking a question, or raising an issue. Other users can then contribute responses to that question which are automatically stored with, and presented immediately after, the original question. In cases where there are multiple responses to a topic, these are stored in sequential order. Furthermore, this structure is recursive, so that it is also possible to generate "responses to responses" and so on. Again, each "response to a response" is stored following the originating "response", so that the conversational thread can be straightforwardly followed.

Documents can also be organised by *topic*. Users can categorise documents according to their content, by applying a category label. These labels can then be used to

cluster and view related documents together. Another type of structuring is provided by the *database view*. Each database supports a number of different views. Views are methods to cluster or categorise documents in different ways according to the different attributes of those documents. This is especially useful in browsing: selection of a given view displays the titles of all documents clustered according to the attributes relevant to that view.

A final important feature of Notes is that, although email is also read and written through a Notes database, email is separate from other databases. Notes does not routinely operate like many Internet special interest groups which rely on email distribution, via listservs. In these special interest groups, participants subscribing to a given discussion receive email updates whenever a new message has been added to that discussion. Delivery through email is often referred to as a "push" model. In contrast Notes uses a "pull" model, where users explicitly have to access the database, rather than having the information automatically delivered to them through email. A demographic difference between Notes and Internet newsgroups is in the number of subscribers. While some Internet newsgroups have over ten thousand subscribers, this installation of Notes has far fewer: the maximum number of contributors in any of the Notes databases we studied was 381.

### INTERVIEWS

We began by interviewing 21 users of Notes databases. As part of a study of both email [25] and database usage, we asked users general questions about the databases that they used regularly. These questions included what they used databases for, what made a database successful or unsuccessful, and the problems that they experienced in using databases for conversational and archival functions. We also asked them to compare databases with other applications such as email, to highlight the differences and overlaps between the two technologies. We also elicited design suggestions about how databases might be improved. Our main focus here was on the use of databases for work related purposes, so we did not discuss our survey participants' views and usage of recreational databases which are also part of the Lotus Notes installation.

The study participants were office workers representing four major job types: 4 high level managers, ie. people who had other managers reporting to them; 7 first level managers; 7 professional workers with no management responsibility, and 3 administrative assistants. We interviewed all participants for 1-2 hours using semi-structured questions. Interviews were carried out in the presence of each participant's computer, and people were encouraged to demonstrate their statements by reference to their actual system. We analysed our interviews by collecting user comments about each issue described above. We present representative quotes from participants about these issues,

and where there was substantial disagreement or inconsistency between participants' opinions, then we present quotes representing alternative points of view.

## **DATABASE BENEFITS AND PROBLEMS**

### **Conversational functions of databases**

So what were databases being used for, and what benefits do they offer for work-related collaboration? The first function is *conversational*. Databases are used as places for asking technical questions and holding discussions. Sometimes discussions are initiated by a simple request for information from one participant. That request may elicit a one-shot answer or evolve into a full-blown discussion, depending on the complexity or controversy of the issue.

One user described a class of database that allows the sales force (the "field") to pose questions and hold discussions about technical, specification and pricing questions for communications products. One key benefit is that the database provides a place for putting these questions to people who are experiencing common problems. This combination of an informed and motivated broad readership increases the chances of generating a useful answer and disseminating expertise [19].

*"there's a communication products sales discussion, with views by different products. And that's great, because chances are, you know, if someone in the field has a question, everyone has the question. So the sales discussion is a great place, you know for publicly storing Q and A's. .... if someone posed the question, and some sales rep has the answer, they'll put in the answer too. Anyone can contribute..."*

The fact that discussions can then be stored and publicly accessed, provides ready and re-usable answers to frequently asked questions.

*"It's kind of a way to look for items if you need a specific item, or look for certain help, but it's also meant that say if you had a question, you know, how do I order this... somebody else would respond .... and then you would have a record of actually how to order it, ..... so we all could look at the answer."*

Another key benefit of making old conversations available, is that it gives new people recently joining the group access to what has gone before. This can enable them to catch up with previous interactions, provides some prior context, project history, and sense of how the group operates.

*"If you've been here for a while, you know how things run. I've been here almost five years, so I know the ins and outs, but ... once new administrators come on, it's great for them, but they just want to know the game, so.....[the database] is a good resource."*

### **Archival functions of databases**

A second class of benefit is *archival*: databases can serve as a repository for general reference documents. *Archives*

contrast with *conversational* use, because they are intended to be relatively self-contained technical or organisational summaries. Of course reference documents sometimes stimulate comments and questions, but the aim in writing them is to *provide* information rather than *elicit* it. One user describes the key characteristic of an archival document:

*"something that one could just read and it's sort of self-contained. There's some document where all the key things are there and you can count on the person being able to read it and get ninety percent of it"*

He contrasts this with accessing conversational information, which may be distributed over multiple interactions:

*"[the information] has got lots of pieces and you have to look at them all and it's dispersed and incoherent."*

Examples of reference documents include: product designs, product specifications, information about pricing, time-lines, plans, installation instructions and statements of policy and procedures.

*"it's ... a specific use that's kind of intended for sharing information of value to people, so if we have some specifications, we'd post them there. We have future ideas, we post them there. We have configuration information ..... it goes there."*

Similarly group data such as customers and contacts are archived reference materials, that are centrally located:

*"And this idea of group tools, I mean, that is a real value of Notes, which is that any group can set up ..... data bases that you can always go to. The contacts for your customers are in one place, the contacts for your providers are in one place. You know, and I've used those on the road ... and I was able to very quickly open up and find where I was going, or who I needed to contact. And status reports, I could find out what everybody in the group is working on at any given time. That kind of stuff is useful."*

Furthermore, providing *archival* information in a database means that users can access it directly, reducing the number of repeated requests for a writer to provide the same information via email or phone:

*"And the reference, and the documents database ..... it avoids a lot of unnecessary traffic of people, you know, they need the ... latest specification sheet. They need .... something on pricing. They want to get the most recent press release. ... all sorts of things that you need to publicly disseminate".*

In reality, conversational and archival usage may not always be distinct. There can be a causal relationship between the public discussion and reference functions of databases. One user describes how a corporate-wide discussion of software evolved into a reference document, setting out agreed practices for the group. The discussion was then consolidated and posted back into the database as a reference document.

"we started a discussion of coding standards, like how much do you indent yourself, and whether to use an underbar, and whatever. So here's something with 25 responses ... we got comments, not just from within our group, but people all over the company. .... And what would happen is periodically, we would repost our coding standards -- you know, how to do comments, how to do tabs, lots of other things. .... essentially, we had ... the [Product Y] coding standards. And this was an official document, you had to read it if you work on the team. And whenever it got revised, someone would send an e-mail, new coding standards"

However, despite these reported benefits of databases, as a discussion forum and place for reference information, their usefulness is not guaranteed. Even when users set up and use databases, these may not always promote effective discussion and collaboration. Relevant archival information and discussion may be hard to find in the presence of large amounts of low quality data:

"Occasionally .... there's information that I can answer ... someone looking for who reports to someone or, you know, looking for a copy of Computer World or something I just happen to have that's sitting on my desk that I can call them and say, well I have it, come by. But half the time, I would say ninety-five percent of [the database] is junk".

The prevalence of low quality data may mean that people are less likely to respond to other users' urgent requests and information:

"My main problem is getting people to pay attention to the fundamental ideas in the midst of all this noise and crap. That's my fundamental problem with [databases]"

### **Reasons underlying database success and failure**

We then went on to identify our users' beliefs about the factors underlying the successes and failures of different databases. Users described 3 different factors that affected success: the presence of a *moderator*; the overall database *size*; and the *diversity* of the people contributing to the database.

A commonly stated problem with using databases was *diffuseness* of conversational threads . Users reported that lengthy discussions with multiple interchanges often became so divergent that their main point was lost. People could end up repeating or recycling earlier parts of the discussion, or there might be parallel discussions about the same topic.

"things broke down, .... that discussion became so long and rambling that people couldn't find the main document."

A commonly stated solution to the problem of diffuseness was that databases had to be *moderated*. One user made the argument for moderation and described effective moderation strategies:

"what makes a successful application ..... is, you have to have a facilitator. You have to have somebody who comes

in and respectfully says, gee, that's very nice that you just bought a new car, but it's irrelevant. You know, don't ..... post questions about child care issues in our database. Sort of establishing the ground rules and moving quickly to adapt behavior once things get out of control or just taking ..... a threaded message train and stopping it and saying, this is all very interesting, but take it out of here. It's not the context for this application."

A second major problem was overall database *size*. Users not only experienced a lack of structure *within* a discussion thread, they also felt that *whole databases* quickly became *too large* and unwieldy, making it difficult to find relevant conversations. Users recommended that contributors make efforts to reduce database size by deleting redundant or irrelevant documents. Failure to manage database size can impact the viability of the database.

"Usually the first database novices open up as -- novice group -- is a discussion database. It lasts two months. Then it's dead. Then you might as well take it down. No one uses it anymore. .... I think the big down side there is just the discipline of maintaining it, keeping it up, keeping it small."

"The other issue is, though, managing conversations in the databases and figuring out ways to delete them. So, messages that were relevant to that aren't going to be that interesting after a couple of weeks or a month or two."

A large unstructured database means that browsing can be unrewarding. Users said they often could not find a given topic, even when it existed in the database. Users may also accidentally reintroduce old discussion topics, without realising that there is a pre-existing discussion on the topic of interest. Accidental topic re-introduction can be problematic, because it may lead to multiple parallel discussions about the same issue. The problem of lack of structure is therefore intensified in large databases. One technical solution (described below) is to have pre-defined topics in a database: if users are encouraged to contribute only to specific topics, this can reduce divergence or duplication of related conversations. If a user cannot find a suitable pre-existing topic, then they add their contribution to a dummy category (referred to as "\*Discussion" in this quote). The database moderators then decide whether the dummy entry is a genuinely new topic or belongs in a pre-existing one.

"This is a fairly heavily structured database, and one of the concerns we've had ..... was that one of the causes of damage in structure is that people sort of arbitrarily contribute topics, and so we structured this -- only members of our group were allowed to create new topics. other people .....could create entries under the pseudo-topic \*Discussion, and the theory was that the moderator from our group. ... would always ... either say it belongs in this topic, or .... you could create a new item .....

*it was an implicit encouragement to use the topics that were there .....*"

A more controversial factor that our users felt affected database usage was group *diversity*. One set of users felt that group diversity not only increases the chances of getting an answer to an important but obscure question, but it also allows general discussion to be informed by multiple perspectives. One user describes a database that was predominantly about issues that were specific to a particular group. He points out the usefulness of having interested people from outside the group comment on, and contribute to that group discussion.

*"this is what I think was among the more successful bits of correspondence we've had..... we got comments, not just from within our group, but people all over the company .... and we had really a nice discussion of coding standards. It really helped."*

*"But we've had lots of discussion about these things. And they were very, very useful just the way you want, because we got a lot from within the group. But lots of people from outside will be reading this stuff and just think it was interesting, and they'd say, "Oh, you misunderstood something. That's a C++ trick."*

However other users felt precisely the opposite, arguing that group diversity was a *problem*. Why should this be the case? They argued that a small, homogeneous set of participants working on a common project should show more commitment to the success of that project, and be more motivated to answer the questions of others. Those participants should also be more knowledgeable about the topic under discussion, making their answers more useful. With small focussed groups, it is also possible to establish ground rules and keep information directly relevant to project goals.

*" What I like about database X is the repository -- well, specific items to my current job..... ongoing activities, you know, items to post for other people on our staff... we were working on a business plan, and you know, we'd had some discussions relative to the plan in [the database] ... you know that ... stuff is constrained to a certain set of topics. Those tend to be topics relevant to your job".*

## **QUANTITATIVE EVALUATION: DATABASE SELECTION AND MEASUREMENTS**

We then went on to further investigate these user observations about the reasons for success and failure in databases. We collected quantitative data drawn from 20 Notes databases. While there are interesting research issues surrounding how databases are established and how they fall into disuse, our focus here was on how databases are

normally used<sup>1</sup>. We therefore wanted to look at well-established, currently used databases, so the selected databases had to fulfil a number of criteria: *maturity* - older than 90 days; *size* - contain more than 100 documents; *currency* - contain documents that had been added in the last month. We excluded small, new databases from the sample because it was difficult to obtain meaningful statistics for these, and older databases where it was clear that they were no longer being contributed to or used. Finally, because we were interested in the use of databases as a workplace technology, we selected only databases which addressed work-related topics.

The databases fell into two main groupings. About half were *project* related: they were made up of discussions and reference documents concerning specific issues relating to the business and technical goals of individual projects and products. People here discussed the direction and focus of the project, they provided reference information such as project specifications, configurations, pricing, plans, progress reports, competing product information, news and contacts. The specific topics of these project databases were: personal information management products, strategic marketing, videosevers, research and development, spreadsheet products, and scripting. The remaining databases concerned *corporate* issues. These mainly addressed general topics that were relevant to multiple projects, although people might post specific project summary documents when these were generally relevant. These *corporate* databases contained discussions about new techniques, products and technologies, technical questions, tips and discussions. They concerned: Internet technologies, Notes tips, Windows programming, API programming, C programming, Windows 32 bit, OLE technology, business partners, and common installation. *Corporate* databases were similar in content and interaction style to newsgroup newsgroups addressing technical issues (eg. comp.lang.C or comp.lang.java).

For each of the 20 chosen databases we collected data about: (a) the total *number, age, author* and *size* of all documents; (b) dynamic information such as *how often* databases were accessed and *read* as well as *who contributed* documents; (c) information about conversational structure, ie. the *length* of each conversational thread, and the percentage of conversational threads that were "*dead-ends*" because they failed to elicit a response. Overall we analysed the properties of 15,571 documents, which figured in 6,979 conversations, which were read 118,007 times in the course of the study.

All the databases we looked at here were "open", so that any corporate employee could access them and contribute

numbers of documents from elsewhere. In addition, early usage may include long discussions among the participants of how the discussion will be conducted. There are similar issues when databases fall into disuse. The final stages of database usage constitute occasional reads and sporadic attempts to determine whether the base is still active, for example: "*Is there anyone out there?*"

<sup>1</sup>When databases are very first established, they usually show atypical patterns of use, both because contributors have to agree on conventions of usage, and also because databases contain very little content. Often early usage is very intensive: database administrators may attempt to stimulate early discussion, sometimes by generating a large number of open questions or comments, or importing large

documents and discussion. However, because databases differed in their focus, eg. whether they were concerned with project or corporate issues, there were large differences in the numbers of people contributing. Both writing and reading behaviour reflect this. So while only 17 people made comments in the scripting discussion database, 381 different people participated in the discussions about MS-Windows. Similarly, the spreadsheet database was read only once a day on average, as compared with the average number of 93 daily reads of the Windows 32 bit discussion. Conversational structure also varied widely: threads in the Internet database were usually around 4 messages, whereas in the videosever database they were only one message long.

### TESTING THE HYPOTHESES

We wanted to assess the importance of the three factors that our users had suggested would lead to successful usage, namely *moderation*, *group diversity*, and *database size*. We examined their impact on both *archival* and *conversational* functions. To do so, we devised two different measures for each function. To assess the *conversational* function, we first looked at the length of each conversational thread, on the assumption that longer threads would be an indicator of engaged discussion. Threads were simply defined as the number of messages responding to an initial question or comment. We did not distinguish between different response types ("*responses*" versus "*responses to responses*") so that subtopics and side conversations were all treated as part of the same thread. *Thread length* alone may be too simple a measure, however, since users complained that one problem with interpreting database conversations is precisely when threads become too long and diffuse. A second complementary measure of conversational quality, was therefore whether or not a given contribution had generated any response (*deadends*). A database full of deadends is one where users often get no responses to initial suggestions, and they do not usually receive answers to questions. Such a database is not fulfilling its conversational function.

Turning to the *archival* function, one aspect of a useful archive is that people want to read the material in it. One approximate measure of the effectiveness of the database as an archive, is the simple number of documents in it that are read per day ("*read rate*"). However, people might read documents for multiple reasons including to converse about them, so a pure archive would therefore consist of documents that are often read but usually not replied to. We therefore computed a *browsing* measure of the ratio of reads to writes. We expected that in an archival database this ratio would be high because people would read multiple documents without responding to many of these.

### The effects of moderation

We first looked at the effects of *moderation* on conversational and archival database functions. Almost all

users had argued that some form of moderation promoted good discussion and effective archives. Analysis of the database themselves, combined with user comments, indicated that there were two main forms of moderation. In the first, the database is structured with a number of pre-defined topics. The aim is to prevent arbitrary topic proliferation, and users are encouraged to contribute only to pre-defined topics, and use a dummy topic (\*Discussion in the quote below) if their contribution does not fit these. The role of the moderator is to devise these initial topics and generate new topics only when a dummy contribution is both novel and relevant. Databases with this form of moderation usually had detailed documentation of "rules of conduct" posted as early documents in the database. (This material is similar to that included in Internet newsgroup Frequently Asked Questions). Users were encouraged to read the rules of conduct before using the database. These explained topic structure and the use of dummy categories, for example:

*"The database is divided into fixed categories, each of which is subdivided into topics. Unless you are a manager (ie moderator) of this database, you have two choices when making a contribution: 1) You can compose a "Response" to any item under any topic or category. 2) You can compose a "Discussion Item". In this (second) case, you select a category from a list, and the topic is always set to "\*Discussion". Make up a title to describe the subject of your entry. This structure allows the [moderating] team to organize the topics in each category of the database, while providing the flexibility for everyone to comment in each area and on each category".*

A second, weaker, form of moderation was in *summarising* and *archiving* discussions. Summaries help new people to catch up with ongoing topics, without having to read all messages, and may also reduce the likelihood of repeating prior conversations. Again databases often contained the moderators' statement of intent:

*"The manager of this database will be proactive in keeping the database clean and up-to-date. ... I will use my poetic licence to distil the vital issues out of contributors documents...I will move older documents into the Archived State".*

Of the remaining databases, some showed no form of moderation, in that there was no early document stating how conversations were to take place. Alternatively, where there were statements of this type, the "rules of conduct" were libertarian in tone: *"Welcome to the C language discussion. The only rule is that your note be about C in some way"*

We compared the 11 unmoderated databases (those with no restrictions on topics and no explicit structuring) with the 9 showing some form of moderation (those with pre-ordained categories or active summarisers and deleters). The results are shown in Table 1 (asterisked results show differences are statistically significant at 0.05 level using a *t test*).

Contrary to our users' views, however, we found that moderation *discouraged* conversations. Moderated databases had shorter conversations with many more dead-ends. Furthermore, moderation also seemed to reduce browsing, despite the additional topic structuring that moderation provided. Both types of database were read equally often.

	# Conversations analysed	Mean conversational thread length	Mean % of dead-end conversations	Mean browsing (read/write ratio)	Read rate (mean reads/day)
Unmoderated (n=11dbs)	3797	2.55*	46.4*	73.41*	31.58
Moderated (n=9dbs)	3182	1.65	68.95	10.08	12.55 (ns)

Table 1 - The effects of moderation

Why should moderation have these paradoxical effects? One possibility is that providing pre-ordained categories reduces spontaneity in discussions, making it harder for people to decide where to add their contribution. Moderation may also reduce users' willingness to participate in discussions. Some users strongly disliked pre-ordained categories, and some moderated databases contained comments about the undesirability of restricting message topics:

"Why does the category field have a fixed list of choices? What is wrong with letting people coming up with their own categories?"

In moderated databases, there were often requests to add new categories to the restricted set provided. Users' comments clearly indicated the need to broaden discussion topics beyond the current set provided. Failing that, comments suggest the creation of a competing more "open-ended" database to discuss the same issues without the restrictions of pre-ordained topics. On several occasions, we observed that dissatisfaction with restricted topics led to the construction of competing parallel "open-ended" databases:

"I think we need a few more categories such as Debugging, Technical Q & A, Programming in Windows etc. If not perhaps we can create an additional company wide-database to handle such things."

"We should probably start a Windows Technical discussion [database]. Also it should use the vanilla (ie open) discussion forms. I intensely dislike being limited to canned categories"

Restricting the scope of discussion may also explain the effects on browsing behaviour. If conversational topics are

perceived as more restricted in moderated databases, this may reduce the likelihood of users browsing these for information.

### Effects of diversity

The next factor we investigated was *diversity*, which we defined as the number of different people contributing to the database. Are databases that have a small number of participants better focussed because participants share objectives, common ground and are thus more motivated to participate in discussions? Or is it better to have a broad range of contributors, with necessarily more divergent perspectives? Different users had argued the merits of both *diverse* and small groups. The data show that diversity is usually *beneficial*: databases with larger numbers of contributors had longer conversations ( $r_{(1,18)} = 0.64, p < 0.01$ ), with fewer deadends ( $r_{(1,18)} = -0.46, p = 0.05$ ). In addition, more diverse databases were read more often ( $r_{(1,18)} = 0.46, p = 0.05$ ), although there is no impact on browsing ( $r_{(1,18)} = 0.34, p > 0.05$ ).

Why should this be the case? On closer inspection, diversity was found to be related to the *function* of the database: of the ten databases with the smallest number of writers, eight were focussed around *project* issues. Likewise, eight of the ten largest concerned *corporate* topics (chi squared = 5.20,  $p < 0.05$ ).

So why do project databases tend to show fewer conversational and archiving functions? One possibility is that project databases do not have *critical mass*. It may be that a certain number of contributors are necessary to stimulate and maintain conversations and that project databases simply do not have enough people.

An alternative explanation is *media competition*. The project databases may have had contributors sharing the same physical location, and collocated participants have multiple media available for interaction. When collocated participants need to communicate, they can use the database, email or talk face-to-face. In contrast, the contributors to a corporate database may be more geographically distributed and hence less likely to interact face-to-face. As a consequence more of their interaction is likely to take place in the database.

One difficulty experienced in project databases was achieving commitment to using the database frequently. Several projects tried to use a database as a "teamroom" for group discussions, but noted that this was only successful when all participants regularly accessed and used the database for all such interactions. If team members failed to access the database, then people often ended up having project discussions in email, because they were more certain that other project members would be reading email. As a result discussions sometimes moved out of the database and into email.

"if I send you an e-mail, I have high confidence you are going to read it. If I put it in a database, I have not so much high confidence that you're going to get to it."

"we have these team room databases that we're using. That means a number of things ... are in a common team database. That only works .....[when] .... everyone uses the database. If not everyone uses the database, then you've still got to email things to people."

The same *media competition* occurred between project databases and face-to-face discussions. In project settings, research has shown that brief unscheduled face-to-face interactions between project members occur multiple times a day [12, 13, 24, 26]. Unless these verbal conversations are documented, this means that important discussions are "missing" from the project databases, because they took place in face-to-face settings. Furthermore it may be more effective for certain questions to talk to a person directly, rather than go through the database:

"After going through the database for a few months, I couldn't see that I was really missing anything. I mean a few odds and ends .... but what directly affects our organization, I know anyway. And there's enough connection verbally with [other team members] if I need to go and find someone, I can do it."

Urgency was another factor in project settings: people said that they were unlikely to post to a database. If they needed a rapid answer to an important question, they would seek the person out to talk in person. Again the consequence would be that the conversation goes unrecorded.

"Well [the database] is like this wealth of information that's there if you can find things. But if you need something in five minutes you don't go there."

### The effects of database size

We next looked at the impact of *database size*. The general feeling among users was that keeping a database small was essential for both archival and conversational functions. In databases with large numbers of documents, they argued that the overall focus is often diffuse, there may be parallel discussions on a given topic, and topics can be difficult to find. All of this can make both accessing and conversing difficult.

Our data show that small databases are not necessarily more effective however. We found that larger databases had longer conversations ( $r_{(1,18)} = 0.57, p < 0.05$ ) and fewer deadends ( $r_{(1,18)} = -0.56, p < 0.05$ ). Large databases were also more effective as archives: they were read more often ( $r_{(1,18)} = 0.57, p < 0.05$ ), although there was no effect on browsing ( $r_{(1,18)} = 0.38, p > 0.05$ ). How can we explain this? One possibility is that our users' concerns about information access and conversational diffuseness may be outweighed by the sheer amount of information in large databases. It could be that interesting information and ongoing discussion may be more important than structure or focus. This may

also relate to *diversity*: larger databases also had more writers ( $r_{(1,18)} = 0.88, p < 0.001$ ).

### CONCLUSIONS

What theoretical implications can we draw from this work? Let us first consider what factors are important in promoting *conversations* in electronic media. Contrary to the impressions of our users and several database designers, we found that moderation does not promote effective database discussions. Rather than facilitating conversation, attempts to maintain conversational focus by imposing a rigid topic structure may *inhibit* interaction. Providing prior topics may actually serve as a filter on conversations: if users are uncertain of the structure of the database, or its "rules of conduct", they may choose not to participate. Furthermore it was clear that some users so disliked structured interaction that they created alternative databases for more open discussions. Other research has also shown the inhibiting effects of overstructuring interaction in the context of workflow systems [3].

Our findings on the beneficial conversational effects of *diverse* groups and *large* databases, are also paradoxical in the light of some of our users' comments. The fact that extended conversations took place in large diverse databases bears out research documenting the effectiveness of interaction and helpfulness of strangers in electronic settings [19]. One explanation of this relates to *critical mass* [15]: even if a user does not know an informed individual to whom they can directly put their question, with a diverse enough database, then there is a reasonable chance that *someone* will be willing and able to answer.

But does the fact that larger diverse groups have more active conversations mean that strangers are more helpful than project colleagues when one has a question? Another competing explanation for the effects of *size* and *diversity* relates to *media competition*. Our smaller, less diverse databases tended to be used for project work. Projects have face-to-face meetings where urgent issues are raised outside the database. In project settings, users with an urgent question may also know the local expert. They may prefer to ask the expert directly about that topic in email or face-to-face, and not post publicly to the project database. People may also not wish to reveal their ignorance to their whole project group, by posting to the database. Other reasons for not posting to the project database are that users may be unsure how often the database is read, leading them to repost urgent or important information in email, thus "siphoning" conversations out of the database. Furthermore, project members may only post to databases when they have failed to find their answer by direct face-to-face or email contact. Again this would be consistent with research on the social aspects of information retrieval. This work shows that initial attempts to find information take the form of personal requests to local community experts, only later are questions directed at more anonymous sources [21].

Turning now to the *archival* functions of databases, there is a similar picture. Firstly, the results for moderation, diversity and size are almost identical with the conversational findings: large, diverse databases are read more than small project-oriented ones, and unmoderated databases are browsed more. Again these are paradoxical results, given our users' complaints about the unwieldiness of large diverse databases, and the benefits of moderation and structure. One possibility is that people only read databases if they contain enough interesting material, so that project databases may be too specific, and contain too little information to attract large numbers of readers. Another possible explanation relates to social recommendations [10, 14]: whether a given person accesses a database may depend on recommendations and more diverse databases have more people to recommend them than small project databases.

Future empirical work should address these various hypotheses. In particular it would be interesting to analyse the behaviours of small project groups who are geographically distributed. This would test the competing *critical mass* versus *media competition* hypotheses. According to the *media competition* hypothesis, a small distributed group would have few opportunities to interact face-to-face and so more database discussions should take place. *Critical mass* would argue that small groups are inherently unlikely to hold effective conversations, so that geographical distribution should have no effect on database usage.

Other work needs to contrast the uses of databases with other workplace communication technologies, eg. email and face-to-face interaction. How do these media combine in different workplace settings? Our users alluded to the differences between database interactions and those in email. Email was seen as more appropriate for urgent or private interactions and for more ephemeral project tasks such as reminding or making arrangements. It was seen as being less appropriate for archiving, group discussions and collating information [25]. Both email and databases also contrast with face-to-face interaction. Although face-to-face communication is interactive [16], it does not provide a permanent record of the interaction [5,22,23]. More work needs to understand media trade-offs, so that media can be appropriately combined to support the full range of group activities [20,26].

Further questions concern the "natural history" of databases. What parameters influence the growth of different databases? Why do some databases never reach critical mass? What causes decay and lack of interest in a database? What types of competition occur between databases addressing related topics? Are there different patterns of growth and decay for different classes of database, eg. project versus corporate, as our results suggest here?

There are also technical and design implications to these results. Some of the project groups may have experienced *media competition*. One reason for copying a database conversation into email is that users are uncertain whether database messages are being read. One technical solution would be to provide *notification* in email to all database participants, when there are changes in the project database. The new database message would not be copied into email, (otherwise conversations of general interest start being "siphoned" out of the database and into email), but the notification could provide a hypertext link back to the posted database message, allowing straightforward access to it. Alternatively users might be given visual notification information about the general state of database activity, for example the icon representing the database glowing red to indicate rapid change [11].

Another perspective is that technology should *encourage* media competition, by combining asynchronous databases with other synchronous technologies, allowing users the flexibility to choose between different media. Some project group members said they used face-to-face communication for synchronous communication about important or urgent issues, but currently, larger distributed groups do not have direct access to synchronous media. One possibility for larger distributed groups would therefore be to integrate asynchronous communications in databases with synchronous interaction technologies. A user reading an important message, who wants to contact that person could automatically access the sender via some combination of audio, video, shared workspaces or a MUD, to discuss the content of the message further. A number of systems have recently explored how synchronous and asynchronous communications might combined in this way to provide the benefits of synchronous interaction to distributed groups [4, 20,26].

Finally, we need to construct theories of mediated communication to explain these data. Our results here are paradoxical in terms of face-to-face accounts of communication: few would claim that face-to-face conversations with large groups of comparative strangers are more useful and rewarding than discussions with small numbers of known colleagues. An adequate theory must explain the results we obtained here, and account for such differences between mediated and face-to-face communication.

## ACKNOWLEDGEMENTS

Irene Greif, Lyn Walker, Lyn Cherny, Bob Kraut, Will Hill, and Loren Terveen all made valuable comments about this work. Thanks to Lotus Development Corporation for supporting part of this research, to Candy Sidner for help with interviews, and discussion, also to all the people who participated in the questionnaire study. Lastly, thanks to Sal Mazzotta who wrote the analysis programs for part of the data.

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