

## Chapter 11 - Teamwork Study: Discussion

### 11.1 Discussion of the results of Study 1 (network analysis)

#### 11.1.1 Initial analysis

The eighteen maps of interactions observed during Liveweek produced a graphic record that was easy to interpret visually, while the interaction matrices (and their associated social network analysis) put numbers to these observations, helping to determine whether the visual differences noted between the maps were significant.

What was immediately obvious was there *were* differences between the maps; the number of actors present during Liveweek, and the level of interaction between them varied considerably. The network density measurements indicated, however, that the overall level of interaction between actors was relatively low. The highest possible density value for any network is 1 (which indicates that all possible links between actors were made), while the minimum value of 0 would indicate that no links were made between actors. At Liveweek, the mean network density was just 0.03. This indicates that the actors were not interacting with as many others as they could: rather they were choosing to interact with just one or two people at a time, and often with no-one at all.

#### 11.1.2 Relations between network sizes and densities

The bar graph in Figure 10.2 shows that there was a bi-modal distribution of the network sizes during Liveweek. The peaks in the graph indicate that the number of people present at Liveweek was greatest just after lunchtime on both days. My own observation notes suggested that the augmented number of actors at these times could have been due to an influx of *visitors*. Among the people who visited Liveweek were colleagues of the team members, representatives of various interested organizations, and a few members of the general public who simply wanted to see what was going on. These people would pop in to the Liveweek hall for a while to watch or chat with the team members, but did not stay all day. By contrast, the core team members who were actually working on the design projects tended to remain in the Liveweek venue all the time. The fact that the peaks in actor number were recorded in the middle of both

Liveweek days is probably explained very simply, as the visitors had often done so during their lunch breaks.

Section 10.1.2 in the results chapter demonstrated that the sizes of the interaction networks observed during Liveweek *did not* correlate with their network densities. This is a little unexpected as one might have thought that as the number of actors increased, so too would the level of interaction within the networks, whereas the result indicates that there was no relationship between the number of actors and the level of interactive activity. The reason for this is likely to be a reflection of the demographic of the networks. As mentioned above, the larger networks were often generated by the arrival of visitors, who might have had somewhat different interaction patterns from the core team members. These visitors to Liveweek may simply have wanted to *observe* what was going on, or they may have arrived to meet someone in particular, or they might have taken a while to get involved in interacting with others – perhaps watching a while before striking up a conversation with members of the design teams. The picture is complicated by the fact that a number of the new arrivals, in particular on the Tuesday, took roles as temporary team members and I recorded them as such, rather than as visitors. A notable example is the Green team, who on the Tuesday afternoon were joined by four new temporary members, which raised the Green team's membership by a considerable proportion. With patterns of influx and change such as this in the system, it's small wonder that the patterns of interaction and network size do not closely match.

### **11.1.3 Analysis of individual actor characteristics**

The individual centrality and betweenness scores (which were presented in the results chapter in Table 10.3) begin to break down the observation data to show how the behaviours of *individual* actors at Liveweek varied. The centrality scores, which indicate how many interactions each actor made during Liveweek, show some considerable variation. From the centrality scores it is apparent that a wide spectrum of levels of interaction were represented at Liveweek, from actors such as SF, who was observed interacting with others on 26 occasions, to MC who was only once seen interacting with another actor.

Interestingly, the centrality scores of the Knowledge Capture team were all relatively low. I had believed that members of this team might have the highest centrality scores, as I had expected them to interact with many other team members in an effort to collect much data and information on how the event was running. In actuality, most of the Knowledge Capture team seemed to spend a lot of time working alone and in isolation, often at their computer workstations. Possibly they felt that they had set the event in motion, and by that stage it should “run itself”. Nevertheless, it seemed to me that there was a huge amount of data to be collected simply by watching what was going on and chatting with the participants, and I was surprised that the Knowledge Capture team was not more frequently engaged in such activities.

The betweenness scores of the individual actors represent the extent to which a node lies “between” other nodes in a network. Betweenness can indicate those actors that behave as “bridges” or “liaisons” between other actors. Many of the actors at Liveweek had fairly low betweenness scores, but what is interesting is that the highest mean betweenness scores are those of the Visitors’ group and the Knowledge Capture team. The actors in both of these teams were not involved practically in the design activity, so they were not required to remain with a single team to work on a design project. This meant that they were more free to move between teams, and for members of the Knowledge Capture team this was their expected role, as they were supposed to be moving between different teams organizing the event, gathering data and distributing information. So while the centrality scores of the Knowledge Capture team indicate that they did not interact as *often* as other actors, they did tend to *liase* between the different teams more often and this is reflected in their higher betweenness scores. The visitors’ high betweenness scores could also suggest that they tended to move between teams more than the actors in the design teams. In this case, it was likely that the visitors were moving from team to team to observe what was happening in each one, and looking at the different design projects.

#### **11.1.4 Clustering of actors**

The ANOVA test for clusteredness showed that there was a significant tendency for members of the same teams to interact with one another, rather than to interact with members of other teams. On first impression, this finding seems to state the obvious; the teams would naturally spend more time working with each other than outside of their teams, that is after all the reason that the teams were put together. The result of the clustering test is, however, worth pointing out because it shows that the participants at Liveweek did actually engage in team-like behaviour, rather than dispersing their interactions between many different teams, which might have occurred, had they not been fully committed to their team's design project.

#### **11.1.5 Relationship between density of network and links to non-team members**

The results in section 10.1.5 indicated that there was a positive correlation between the density of an actor's personal network (their egonet) and the frequency of links that were made by that actor to fellow team members. This correlation suggests that as an actor's egonet becomes more active (i.e. it contains more links), the interaction links are more likely to be with fellow team members than with "outsiders". This kind of pattern was also discovered by Wellman (cited by Scott, 2003), who found that in family networks, there was also a correlation between network density and the proportion of members within who were kin. He concluded that family networks are denser because the relatedness between family members encourages network members to maintain mutual contacts. The fact that a similar pattern was found in the teams at Teamwork might suggest that this is also the case for fellow team members. Perhaps this was a sign that an atmosphere of "team spirit" was emerging, prompting the actors within the teams to interact more often with members of their own team than with those of others.

#### **11.1.6 Social network map of all interactions observed at Liveweek**

The "Map of all Observed Interactions During Liveweek" (Figure 10.5) was primarily created to generate a visual representation of the observed interactions. The image that it offers is striking, and to my mind is the clearest way of representing the organization of the interaction networks that developed over the course of Liveweek. From this map we can clearly see that some of the teams were organized differently from others, and how. For example, the Blue

team comprises actors who are strongly connected as a team, interacting many times with each other; meanwhile, the Knowledge Capture team is far more loosely connected, both within the team and outside of it. The Green team comprised many actors, some of whom created their own separate sub-network (actors RT5, RT6, RT7 and RT8), which didn't interact at all with the other Green team members.

Another aspect that the network map highlights is the variance in levels of connection of different nodes. For example, it's clear on the map that characters such as MC, RMcW and CG don't have many connections to others in the network, while nodes such as AT, SF and DM have many. The visual distinctiveness of some of these nodes corresponds with some of the network measures calculated by the UCINET analysis software. For example MC RMcW and CG all have both low centrality and betweenness scores, while AT, SF and DM have high centrality and betweenness scores. The map therefore made some of the patterns and structures in the network *visible* and readily recognisable; in essence it was a way of representing the numeric data and matrices in a highly accessible form.

## **11.2 Discussion of the results of Study 2 (dialogue study)**

### **11.2.1 Actors' skills and roles**

In Table 10.5 in the results chapter, I presented the principal skills and roles of each participant, along with their genders and nationalities. Determining the roles of the team members (namely whether they were architect, engineer etc.) was often difficult, and the team member's roles were certainly not immediately evident to me during Liveweek while I was collecting the data. It was only after many repeated viewings of the video data while I was transcribing the dialogue, along with detailed inspection of my own notes, and consultation with other members of the Knowledge Capture team that I could be sure that I had identified the roles correctly. I believe that this was primarily due to the fact that the overwhelming majority of the participants of Liveweek were members of the construction industry, to whom the parts played by various team members were immediately evident because they were so familiar with the construction environment and people within it. I, however, as a researcher with little in-depth knowledge of the construction industry struggled to work out what each team member's speciality was, whether it be architect, services engineer, technical

draughtsman and so on; all these roles were unfamiliar to me. Nevertheless, this process of identifying each of the actor's specialist roles was very important with regards to the later analysis of the data. It enabled me to work out things such as who was working within their own specialist domain (critical when determining whether an actor was offering specialist advice to another), and to identify when team members took on work in a role to which they were not accustomed (such as when one of the engineers assisted with the theatre stage design – which was primarily an architectural issue at the time).

### **11.2.2 Overall results of the dialogue coding**

The table in the results chapter that shows the summary of the dialogue coding (Table 10.6) highlights some interesting patterns. Other than the uncategorized statements, whose frequency was unfortunately fairly high, the two most frequently uttered kinds of statement were those that concerned offering information, and those that were statements about the design. This was not unexpected, as during Liveweek one could have predicted that many of the dialogue exchanges would have concerned sharing of design information between actors. The high number of queries (code J) also reflects this, as actors were asking questions in order to gain information. The least frequently uttered statements, however, were social exchanges and feedback utterances. This was surprising, one might expect that in a collaborative open-plan environment the level of social exchange and reflective comment would be high. Perhaps the low incidence of these kinds of utterances indicates that the focus at Liveweek was on the work in hand rather than on social interaction, possibly because the time scale of the event was so short, meaning that the pressure to complete the task at hand was very strong.

### **11.2.3 Utterance types used by each actor**

Table 10.7 in the results chapter shows the distribution of utterance types for each individual actor. At this stage in the analysis the value of having determined the roles of each actor became obvious. Having worked out who in the team were architects, services engineers, computer specialists and so on, it was possible to put each actor's dialogue into context. For example, two actors shared the highest percentage of utterances in Coding Group 1, which represented utterances that *offered information*; these actors were BM and RH. Both of these actors were services engineers, who spent much of their time during Liveweek working on CAD models of the building's services features,

such as electrical cabling and air duct systems. BM was working primarily on two-dimensional models of these systems, while RH worked on three-dimensional models, eventually producing a three-dimensional “walkthrough” model of the building and services that could be “played” to show a virtual walk through the building on the computer. Consequently, these two characters were working with detailed technical information, and part of their roles during Liveweek was to communicate this technical information to the other team members. BM was actually one of the characters that spoke least during the whole of Liveweek, but when he did communicate, it was often in answer to a direct query regarding his work. For example, during one of the team meetings, while the engineers were explaining progress on the engineering model so far, he added:

*BM: We've kind of focussed on the panel*

And later in the same meeting, when asked by the team leader (SS) how long it would take him to finish the CAD model, this was his response:

*SS: When do you think the electrical model will be: ready?*

*BM: E:m (2) in abo:ut, two hours I think. (2)*

Similarly, at one point when RH (who was generally much more talkative than BM) was working with SS, the team leader, to solve a design problem, said:

*RH: put a little upstand. (1) Which you'd probably have anyway, in the masonry, to make the connection.*

All three of these utterances were coded as utterances that *provided information*. They are also examples of responses that *only* BM or RH could have provided, as they had the particular skills and insider design knowledge that meant they knew the answers.

To return to some of the other actors, MP had a particularly low score in the information-offering category (Code Group 1), and a correspondingly high score in the information-seeking category (Code Group 5). SR also had a high score in the information-seeking category, although he didn't have a particularly low information-offering score. These two characters were notable as they were not

part of the Yellow team (who were the focus of this dialogue study), but members of the Knowledge Capture team. Their dialogue with the Yellow team members primarily concerned the gathering of knowledge and information on how the teams were progressing, hence their high information-seeking scores. SR however also had a role as one of the organizers of the event; so some of the team members went to him for advice on what was required of them as participants of Liveweek. This then explains his why his information-offering score was not particularly low.

SS was the team leader, a role that had been decided by the team members in meetings prior to Liveweek. Unsurprisingly then, it was SS who had the highest score in coding Group 2 (Organizing statements) of all the team members. This included high scores for both subcategories in this group, i.e. statements that organized *people*, and statements that organized *process*. Of the other team members, the only actor whose score for organizing statements approached SS's was MW. The interaction between SS and MW in the dialogue was interesting, with a few apparent skirmishes between them for control of the team. This wasn't particularly exposed in the dialogue analysis, as I was not trying to measure aspects of control or of power within the group. In flow form networks however, power struggles could have some impact on the networks' configuration. For instance, in fungal mycelium, which is an example of a natural biological flow-form network, power struggles between networks (individual flow-forms) can result in the formation of "demarcation zones" which neither individual will cross (Rayner, 1997). In future work, it could be of interest to study the impact of power struggles on human flow-form systems.

#### **11.2.4 Correlations between utterance types**

One of the questions that emerged during the dialogue coding was whether there was a reciprocal relationship for each actor between the scores of information-seeking and information-offering statements. In other words, did the people who asked the most questions offer the least information and *vice versa*; were some people the "question-askers" and others the "question answerers"? To solve this, I conducted the correlation test between Codes in Group 1 (offering information) and those in Group 5 (information-seeking) (see Figure 10.6). The results of the correlation test implied that there is indeed a weak negative correlation between them. This suggests that the people who sought the most information in the team were not the same as the people who offered

information. I found this particularly interesting when considered within the wider context of this study. What is possibly being highlighted here is that were *directional* flows of information within the team, with requests for information (questions and queries) flowing in one direction between actors, and the responses were reciprocally flowing back. This pattern could have been analysed further by conducting a *directional* network analysis on the team's communication. In such an analysis, two networks would be considered concurrently, the first concerning who asks for information, and the second dealing with who provides it.

### **11.3 Discussion of the results of Study 3 (artefact analysis)**

Since the Yellow team's task was to design a building, it was not a surprise to find that the most common use of computers by the team members was for working on computer aided design (CAD) files. CAD files made up the vast majority of the data collected in the Knowledge Capture team's screen shots. Nevertheless, a number of different uses of the computers are also apparent in the screen images. For example, a number of the workstations were used for word processing and writing documents. This is probably a reflection of the many reminders from the Knowledge Capture Team for the design teams to document their work. Other computer programs that were occasionally used included one that was used by team members to access remote email. This was of particular interest, because it indicated that team members were creating and maintaining communication links with people outside of the Liveweek hall. Electronic communication of this kind was not captured by the network analysis in Study 1, but it represents some of the ways that the team members maintained links with those outside of Liveweek.

The results of the artefact study alone are relatively brief, and to my mind not particularly illuminating. This was because very little could be deduced from the data in isolation. Once the artefact data had been combined with the video data, I was able to make comparisons between the two, which allowed me to determine the users of each computer workstation and every computer file. At that point, the artefact analysis took a big step forward. It was then possible to compare the programs and files used by different team members, to work out who had used which workstations, and most significantly, whether files had been shared between different team members working on different workstations. The

results of the artefact study are therefore discussed in much more detail in section 11.4.2, where I deal with relations between the artefact data from Study 3 and the dialogue content data from Study 2.

#### **11.4 Discussion of combined analysis results**

The results of this study do, I feel, begin to come alive when the three separate sub-studies are related to one another. In reality, for this part of the analysis the data were considered in a somewhat “holistic” fashion, where all the data and analysis thus far were put together and considered as if there were no boundaries between them; *any* pattern that emerged during this combined analysis was considered seriously. However, for the purposes of clarity, I have presented the results of this process (in the previous chapter), and my discussion of the results (in this chapter) in a more structured fashion, and according to what I found. So, I have dealt firstly with relations between the Network Analysis of Liveweek (Study 1) and the Dialogue Content Analysis (Study 2), and subsequently with relations between the Dialogue Content Analysis (Study 2) and the Artefact Analysis (Study 3).

##### **11.4.1 Relations between the social network and dialogue content data**

As I discussed in Chapter 7, if there had been strong correlations between the data from the individual sub-studies, it would have suggested that I had discovered a consistent pattern of communicative flow within the system. The results from all fourteen of the dialogue coding categories were tested for correlation with five of the network measures that emerged from Study 1. In total therefore *seventy* potential relationships between the two data sets were tested for statistical significance. But, after this comprehensive testing, only three points of significant correlation were found between the two data sets. Nevertheless, although the correlative relationships between the two data sets were limited, they did exist, and this suggested that perhaps I had found some factors that might have been weak indications of flow-form patterns. As indicated in the results chapter in Table 10.9, the three factors that correlated with each other were as follows:

- The size of the actor's network (from Study 1) was positively correlated with the number of utterances the actors expressed to organize people (Code D from Study 2). To my mind, this makes perfect sense, as it suggests that those actors who were most influential in organizing the actions of others tended to have the biggest networks. If one is organizing a team of people, or a process, then it makes sense to try to work with many of those people as possible, rather than with just one or two.
- The density of the actor's network (from Study 1) was positively correlated with the amount of positive advice and suggestions they offered to others (Code B from Study 2). This also seems logical. Density of the network is a representation of how many links they made within their network, compared with how many links they *could* have made. Those who offered most advice and suggestions to others might not necessarily have had the largest networks, but they were communicating *often* with the people within their own network. Being an advice-giver, or one to whom others turn to for solutions seems a very effective way of integrating with others and consolidating one's position within a team.
- The percentage of links that an actor made with fellow team members as opposed to actors from other teams (a result from Study 1) was positively correlated with the amount of advice they offered to others (Codes B and C from Study 2). This result actually corroborates that found in the previous paragraph, as it suggests that those who gave advice tended to give that advice to members of their own team, rather than to members of other teams. Perhaps this is another indication of how actors established their positions within their teams, developing a role as a person to whom others turned to find out specialist knowledge; it also suggests that information was shared within teams, but not outside of them.

#### **11.4.2 Relations between artefact data and content data**

I have already described in the results chapter the qualitative process of comparison and deduction that was used to connect the dialogue captured in the video recordings with the screen shots that were captured from the Yellow Team member's computer workstations. In this manner it was deduced that of the four workstations, three were each used principally by one team member, while the fourth was shared between two team members. Both these team members, MW and SS were structural engineers, but SS was the team leader. The video record shows that SS actually spent a considerable amount of time working with pencil and paper, preparing documentation, process maps and other records of the activities of the team.

#### **11.4.3 Percentage use of different programs**

Table 10.11 showed that there were three team members, MW, SS and SM who, as well as working with CAD programs, also spent a fair proportion of their time using a word processing package. The files that they worked on with the word processor were primarily documents about the team's experiences of Liveweek, and the Team's web page. MW in particular became more frequently occupied with documentation in the latter part of Liveweek, and the video transcription suggests that he finished his CAD model fairly early, certainly long before any of the other models were completed. The dialogue excerpt below (Figure 11.1), shows that SS actually delegated part of the organizational work to MW because he had finished his CAD model early. This explains why he shares some of the documentation work with SS, and also explains why he has a relatively high frequency of utterances in the dialogue that were concerned with organizational activities (Coding Group 2).

SS: *How much work do you still have today?/*

MW: *Nothin.*

SS: *You've stopped?*

MW: *Yeh I'm not doing any more on this three dee model, it's futile.*

SS: *so actually you're free.*

MW: *I'm free.*

SS: *free to (and do the)*

MW: *yeh (1) yeh (3) yeh, stuff like that. (1) Cos this model it's good, it's a full three dee (part of the ) model. It just won't have the elements, I mean there's no point (wasting on that).*

SS: *yeh. (2) Make sure you have ((inaudible))*

MW: *[the prom (.) the prominent geometrics. (1)*  
*That's what I'm doing now.*

SS: *And you are still around anyway, to coordinate, (1) you know (what else we've done) there's loads of stuff. (3). If you're happy to.*

MW: *(2) yeh<sup>↑</sup>*

Figure 11.1 Excerpt from a transcription of video-recorded dialogue, recorded during the second day of Liveweek (10.19am on Tuesday 11<sup>th</sup> June 2002). SS (female) and MW (male) are both structural engineers in the Yellow team. SS is the Yellow team leader, but in this dialogue, after learning that his work on the CAD model is nearly complete, she delegates some of the organizational responsibilities over to MW.

#### **11.4.4 File sharing between users on different workstations**

Table 10.12 showed that from the total of 299 files that were identified in the screen captures, there were seven files that were used by more than one team member, on different work stations at different times. All of these files were CAD models, but each was a different version of the design model, ranging from architectural models, to models of the ductwork and services, to a sightline study of the view that the audience would have of the theatre stage. There were two interesting patterns that seemed to emerge from the sharing of these files. Firstly, there were two engineering models, both of which were viewed on different occasions by different engineers. This suggests to me that these models were either being worked on by several engineers, or perhaps that the

files were being passed from one engineer to another for checking or appraisal of some form.

The second pattern was in the use of the shared architectural models. Three of the architectural models were viewed separately by an architect and an engineer. In these cases, one would assume that the architectural models were created by the architects, then subsequently they were viewed by the engineers. There are a number of reasons why the engineers might have wanted to look at the architectural models. Perhaps the engineers needed to check the architectural design model to find out what parts needed to be considered in terms of engineering; or perhaps they were referring back to the architectural model to try to solve a design problem.

The passing of files between different team members seemed to me to be a very important finding. It indicated that computer files were being used by team members as a means of communicating with each other. The dialogue communication was therefore being augmented by computer-based communication, through use of the the design model.

One of the key issues that was supposed to be addressed by Teamwork was that of interoperability between the different forms of CAD model, such as those produced by the architects, structural models, services models and so on. This was clearly taken to heart by the team members, who encountered a number of difficulties when they tried to connect the models from the separate disciplines into a single integrated model. Inconsistencies between the models were a persistent issue, and this was discussed on a number of occasions by the team members. What is interesting is the way that the shared physical context of Liveweek enabled a number of such issues to be dealt with more easily than they often are in “real life” construction projects. Rather than having engineers and architects located a long way apart in different offices, or even different companies, Liveweek put them next to each other, so that they could discuss the integration issues in person, and with the computer models in front of them. In the dialogue excerpt below, SS, an engineer, and PB, an architect discuss the differences between their respective CAD models by physically pointing out the same areas in the two different versions of the models on their computer screens (Figure 11.2).

*PB: if I look at this section, ((looking on his computer screen))*  
*SS: yeh*  
*PB: if, say you have (1) a column (2) ((pointing with mouse on computer screen)), then I have to start trimming this (1) to make er:*  
*SS: yeh but if you have yours-, you don't see anything on your (.) elevation. (2)*  
*PB: my section?*  
*SS: you don't even see the structure or-*  
*PB: (we also have the structure) The structure is part of the section, part of the architecture*

Figure 11.2 Excerpt from a transcription of video-recorded dialogue, recorded during the second day of Liveweek (11.02am on Tuesday 11<sup>th</sup> June 2002) between PB, an architect, and SS, a structural engineer in the Yellow team. They are both looking at their own computer screens, which each show their own versions of the CAD model. PB's is the architectural version, while SS's is the structural version. In this dialogue the team members are using their CAD models to communicate how their particular versions of the design correspond with one another.

Significantly, this dialogue again illustrates how the two different computer models were used as communicative tools. In this instance the computer models were being used as a medium for transdisciplinary communication. Both the architect and the engineer were working on the same overall design model, but they were looking at different “versions” of it on their computers, an architectural version, and an engineering version. The fact that they both had these models visible to each other on their computer screens meant that they could identify areas of similarity, and of difference, and still understand how these variations related to their own view of the design.

### **11.5 Overview and critique of the study**

Overall, while the results of this study are not conclusive, they *are* positive. At the outset, I suggested that if there were patterns that recurred between the different data sets from Studies 1, 2 and 3 (network analysis, dialogue analysis and artefact analysis), it was likely that a flow-form network was present. As I have explained in detail above, I did indeed find some correlation between the data sets, and certain features in the data were repeated in the three sub-studies. Unfortunately however, the correlations between the patterns that were found were not particularly strong. So, while the presence of a flow-form network at Liveweek is supported by the data, it is not supported very strongly.

In this penultimate section of the Liveweek discussion, I shall discuss what might have prevented the correlations between the different data sets from being expressed more clearly, and what more could have been done to bring greater clarity to the results.

### **11.5.1 Possible reasons for lack of strong relationships between the datasets**

One aspect that might have affected the data in all three studies was the sampling method. For reasons of time and other resources, the samples in the more detailed dialogue and artefact studies (Studies 2 and 3) were smaller than the network study (Study 1). The network analysis was conducted for the whole system, taking into account the interactions of everyone at Liveweek. By contrast, the dialogue analysis concerned the interactions of just one team (the Yellow team, which comprised 11 actors), while the artefact analysis dealt with just four computer workstations (used by five Yellow team actors). The intention was that the more time consuming dialogue and artefact studies would act as a micro-level examination of the system, while the network study was looking at the same system at a macro level. It is possible however, that using a small sample for the dialogue analysis caused some of the patterns apparent in the larger scale system to be cut out. Perhaps if a wider analysis of the dialogue at Liveweek had been conducted, analysing the dialogue of everyone, rather than just a single team, some patterns may have emerged more strongly. It is possible that some of the patterns in the network were indeed also apparent in the dialogue and artefact data, but since the latter were from such a small sample, they weren't strong enough to be statistically significant.

Another factor that may have affected the correlation between data sets might have been the frequency of the observational "snapshots" that were recorded for the network analysis. For example, the interaction data were recorded at hourly intervals, but this left out many of the interactions as they occurred in between the times when the observations were made. So actors such as GR and MW of the Yellow team appear from the network analysis not to have had any contacts with non-team members. However, my observation notes, along with the video data indicated that they did have contact with others, but perhaps not for extended amounts of time. In fact, these two actors had one of the most important out-of-team roles as participants in an inter-team design project, but

since these inter-team meetings did not last long, they were not recorded on the networks. This could point out a need to have taken more frequent observational data, but it also highlights the problem with taking “snapshot” type recordings. One simply doesn’t know from the data what has been missed.

One issue that I suspect had a major contributory effect on the lack of correlation between the dialogue and network analyses was the way in which an “interaction” was recorded in the network study. In practical terms for this study, whenever two or more people were positioned in close proximity they were deemed to be interacting. A more complex study with unlimited resources may have captured these interactions in more detail; with perhaps video or audio capture devices being assigned to each Liveweek participant. In fact, a number of such devices were considered for use in this study, but in the end the financial cost was simply too high. So the simpler means of correlating interaction with close proximity was devised. Since the observational data were collected more or less hourly, it wasn’t in my view unreasonable to assume that between each observation, if people were seated or stood closely together, they would have interacted or conversed in some way.

The problem however comes in trying to relate the dialogue analysis (Study 2) with the network analysis (Study 1). Non-verbal communication was not analysed in Study 2, nor was the effect of sharing the same physical contexts, but these factors might have had an effect on how the team members were interacting with one another. People sitting next to each other may be looking at the same thing, listening to the same talk (from across the table), sharing facial cues and body language and so on. Actors in close proximity to each other would also have been subject to similar contextual factors. For example, those who were located near the restaurant would have been exposed to the same food smells, noises and so on; they would also have the same issues with their computer workstations if the cable connecting the network to the Internet were unplugged.

If the results of the network study and of the dialogue study *were* to correlate closely, it would indicate that “interaction” always involved dialogue. Since they do not, it does suggest that interaction involved more than dialogue alone, and that some of these other aspects were playing a role.

### 11.5.2 What the methodology left out; the space around the numbers

As a researcher of flow-form networks, I found the analysis of the data from the Liveweek study both fascinating, and incredibly frustrating. Time and again it felt as though I was tantalisingly close to finding something important, but the analysis methods fell just short of being able to express what it was. Having studied network flow systems in the past, I felt convinced that the success of Liveweek, which many of the participants reported, was due, at least in part, to a communicative flow of some form. But that kind of “hunch” just was not permitted under the methods I had chosen for analysing the event.

Liveweek was an exciting event, with a definite “buzz” to it. The people there were enthusiastic about what they were doing, excited about their projects, and very positive about the things they were learning that they could take away with them to their everyday workplaces. This I felt was simply not captured in my analysis. The cold hard facts of who talked with whom, the structure of their conversation and the kinds of computer files they used, seemed to leave out all that was *vital* in Liveweek. If I hadn’t been there, the results would suggest to me that it was a pretty boring event. I know that it was not. There was an element of “humanness”, of individuality and sheer intangible “magic” of the event (which was also reported by many others who were there) that was not expressed at all by my analysis.

The impossibility of expressing these intangible aspects was immensely frustrating. Having transcribed, analysed and coded the dialogue, I *knew* that there were moments of tension, laughter, confusion, excitement and so on. There was for example, a moment where the first walkthrough model of the design was finished by one of the team members. The news of this rippled through the team and before many moments had passed there was a crowd of excited team members standing around the computer looking at the model. They said things like “*It’s cool that you can walk in the ducts like that*” and “*look at that, that is impressive*”, but these bald statements do not, and indeed cannot capture the intangible feeling of excitement and curiosity over the model. Even I as a researcher who hadn’t worked on the design was interested. I remember (and noted) getting up and hurrying over to join the group of team members clustered around the workstation to see what was going on. And the model was exciting and intriguing to see. I could see the clashes in the model where a steel truss obstructed an air duct, I got an idea of the scale of the stage, and

significantly, I finally got to see a three-dimensional image of the theatre building that the team were working so hard to design. How does one capture those elements in a research study? I certainly didn't in the quantitative transactional analysis that I've presented here. Would a qualitative study have been better? Perhaps so, but that may have missed other features. More to the point, since the key outcomes of Liveweek seemed to me to be intangible and unpredictable, how would any researcher have known before the start of the event, which kind of method would have been most appropriate?

I would suggest that what I have noted as a limitation of my Liveweek study, actually points to the limitation of the methodology in general. One of the questions I sought to answer through this study was whether we could use analytical methodology to gain insight into a human flow-form network. It seems to me that we can, but it is by no means a complete solution. I have learned things through my analysis that I could not have discovered through a more qualitative analysis, patterns have emerged that could *only* have emerged through analytical study. Yet aspects are still lacking. The issues point again to the way that when data are treated in an abstracted or reductionist manner, it can have a major effect on the picture that emerges. The methodological issues of my Liveweek study are reminiscent of the problems associated with the Lumeta Internet map, which I discussed in Chapter 7. Because I was present at Liveweek, I *know* that the people at teamwork were interacting, and that the content of their information exchange *did* relate to the manner in which they were interacting. The analytical investigation of the data suggested, however, that there is only weak correlation between the *structure* of the interactions and their communicative *content*, when one would expect the correlation to be much stronger.

What has become evident, both during the data collection at Liveweek, and in my subsequent analysis of the data is just how vital it is to retain an awareness of exactly what one is doing with each of the tools. For example, the network analysis was trying to make sense of the data through a process of *reduction*. Overall observations and interactions were *reduced* to a series of maps of nodes and interactive links. *Meaning* however could only be given to this reductive analysis by re-associating the results with the *context* in which they originated. It would not have been possible for me to connect the patterns seen in the results with their contextual meanings if I had not been personally present at the

event, and without my detailed notes of impressions of what was going on, I would have been stumped at many points in my analysis. I knew what made sense and what did not in my data because I had *been* at Liveweek, I had seen things happening, and knew what it felt like to be involved.

### **11.5.3 Liveweek as a flow-form network?**

Human communication was manifested in many different forms at Liveweek. These included dialogue, computer communication, telephone communication, visual communication, body-language, and so on. The list could be expanded almost infinitely. By necessity, because resources were limited, my own particular study looked in depth at just a few of these forms of communication. The hope was that these few would be enough to provide a variety of “snapshots” of the communicative system that could be pieced together, hologram-like to generate an idea of the underlying communicative network structures, if any existed. The problem is, that in any complex flow-form network, ALL forms of communication contribute to the structure. This could explain why the nature of the communicative flows at Liveweek was hard to determine; I was only looking at a part of the whole system.

Nevertheless, there were elements of the communicative structure that were brought to light in my analysis that strongly suggested that there was indeed a complex flow-form network in existence. The strongest evidence in support of this was the repeat of some patterns between the datasets, and the manner in which some parts of the data sets correlated with one another. But there were also other indications that a flow-form network might have been present. For example, while there *were* boundaries within the system, these boundaries were clearly *dynamic*; as I've discussed earlier in this thesis, the boundaries within a flow-form network are *always* dynamic. At Liveweek, the teams developed distinct identities and modes of approach to their work. The way the Yellow team behaved was different from the Knowledge Capture team, and from the Green Team; this much was clear from the network analysis. However, the team identities were not finite, nor were their boundaries absolute. Team members occasionally crossed temporarily from one team to another, parts of some teams worked together on special joint projects, and resources were shared between teams.

Another element of the communicative structure that hinted at flow-form was the rapidity with which the designs emerged. Rather like a rapid-travelling fungal rhizome structure (such as the bootlaces of the honey fungus that I discussed in Chapter 6), the progress of the Liveweek teams' design activity was extremely rapid. In just two days, all of the teams produced designs that under normal construction industry conditions would have taken weeks. Moreover, the teams had considered and resolved more design problems much earlier than in a normal design; and they had done so to the greater satisfaction of those involved. In a normal construction project, fabricators and other engineers are often not brought in until quite a late stage in the design. It is at this point that new technical problems are discovered. At Liveweek however, architects, engineers, fabricators, and so on had all been brought together from the start and so had a greater *involvement* from an early stage in the project. Many of the participants said that they were much happier about the design they had co-created than in a conventionally produced project. This could well have been because they had all had an *input* from the beginning and had been given much more opportunity to voice their concerns and deal with potential problems. It could also have helped to generate the intangible positive "buzz" within the teams as they worked, which I discussed earlier in this chapter, and which made the teams' progress so exciting to watch and be involved with.

In all, I am satisfied with the outcome of this Liveweek study as it contributed to the PhD. At the outset my aim was to investigate whether, and if so how, communicative networks might develop in a human social context. Yet since the study took place at an early stage in my research, my approach to data gathering was intentionally flexible. I wanted to get as much data as I could with the methods I had knowledge of at the time. This resulted in a rich dataset which, when analysed in the light of the Inclusional framework that I had chosen to work within, gave rise to new and innovative theoretical work on the nature of communicative flow. This study therefore not only serves as a set of empirical findings that exemplify the power of the flow-form concept, but it is the original work from which the flow-form network model was developed.