Chapter 9 – Teamwork study: procedures

This chapter will give details of the methods that were used to collect and analyse data at the Teamwork event.

9.1 Situation of the study

9.1.1 Timing and location

The Liveweek of Teamwork 2002 was held during the week beginning Monday June 10th 2002. The hall where Liveweek took place was not large enough for all of the teams at once, so for this reason, the teams were divided into two groups. The first group, comprising three teams, took part on Monday and Tuesday of Liveweek. The second group, of four other teams took part on the Wednesday and Thursday. The Friday of Liveweek was devoted to presentations prepared and given by each of the teams.

The team I chose to study was part of the Monday/Tuesday group. So it was during these two days that I collected my data. I was also present on the Friday for presentations; however the data I recorded then were not used for my analysis.

Liveweek was held in the Florence Hall of the Royal Institute of British Architects (RIBA), 66 Portland Place, London. Florence Hall is located on the first floor of this imposing building. At the time of the study, it also housed a café that served visitors to the RIBA. There were two main entrances to the hall, both along the same side, and both exiting to the main stairway of the building. Opposite each doorway, running the entire length of the hall were two areas of seating and tables that were used by the café customers. This left a central area of roughly 20 metres square that was allocated to the Teamwork event. In this central Teamwork area were a number of grouped desks and chairs. Each team was allocated one of the desk areas. A schematic map of the Liveweek location is shown in Figure 9.1. On each group of desks were between 3 and 5 networked PC's. Each of these "team computer networks" comprised a "workgroup" that was connected to a central Teamwork server that was located at the far end of the hall near the Knowledge Capture Team's area. With the exception of the Knowledge Capture Team, Team members only had access to their own workgroup's computers. The Knowledge Capture Team were, however able to

access any of the computers on the network. All of the computers had access to the Internet and Email.

Some of the large café tables on either side of the hall also served as meeting areas for the teams. These were used at irregular intervals whenever the teams wanted to hold a team meeting away from their working areas. The advantage of the café as a meeting location was that the circular café tables were large enough for all of the team members to sit around at one time, and to converse with each other as a team. The café tables were also large enough to hold structural drawings etc. so that every one could see them. This was not the case at the Team working areas, where the desks were irregular in shape and cluttered with computer workstations and so on.

There was one telephone in the hall that was used by Teamwork; it was located near to the Knowledge Capture Team's area. Many Team members however had their own mobile phones, which they used during the event.

To one side of the hall, next to one of the café areas, was a large outdoor balcony. This was accessed via a glass door to one side of the café area. Outside there were several café tables and chairs for customers of the café to sit at. This area was considerably quieter than indoors, and was occasionally used by team members when they wanted to work in a quiet area away from others.

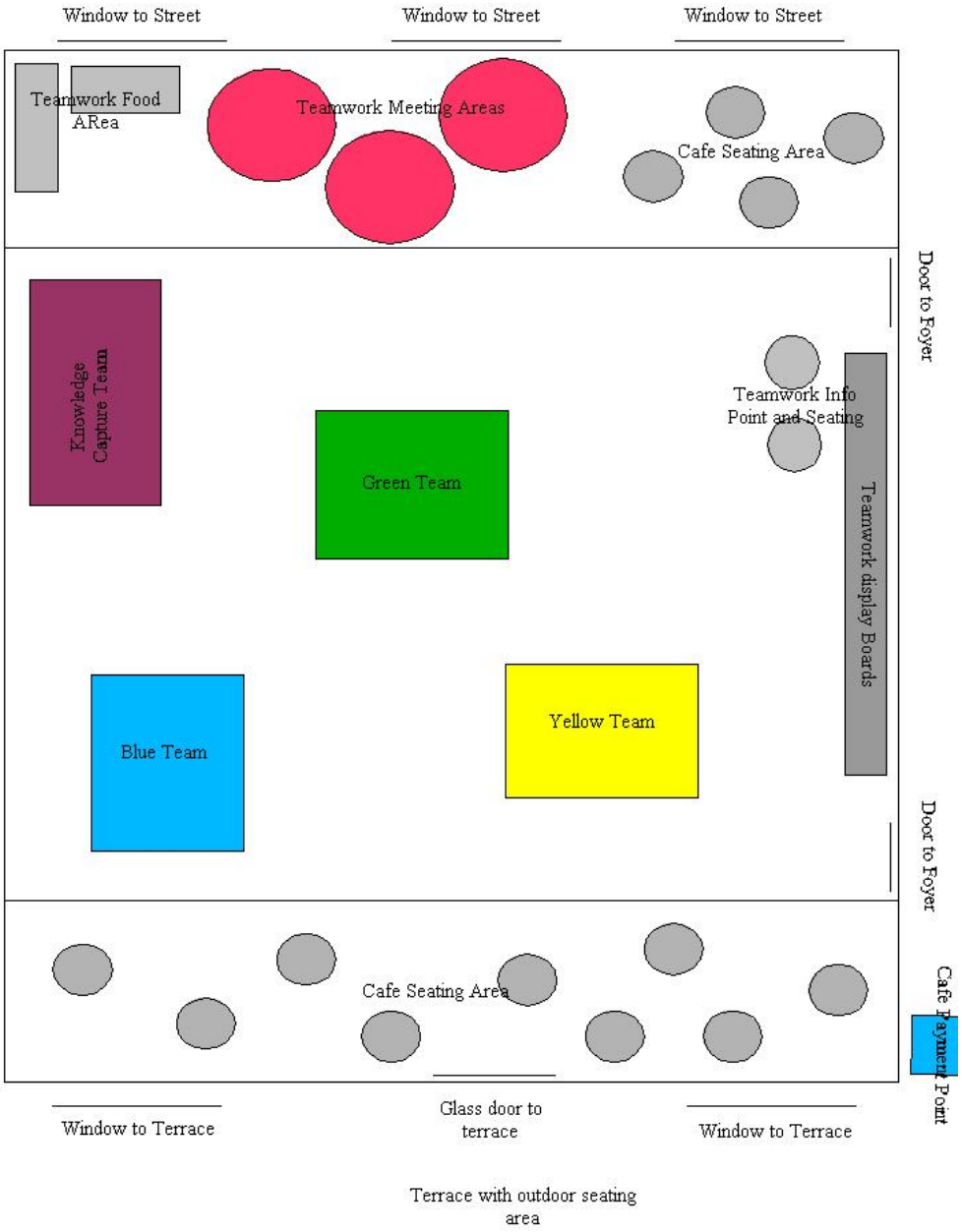

Figure 9.1. Schematic map of the RIBA hall where Liveweek was held

9.1.2 Access and consent

I was given permission to participate in Teamwork as an observer, and given unofficial membership of the "Knowledge Capture" team that had been put together to collect data during Liveweek. I was allowed to attend and observe a number of the pre-meetings (although I did not collect data at these), and also at Liveweek. In addition, I was given permission to approach a chosen team leader with a view to recording video data of themselves and their team at work during Liveweek. The first team leader that I approached declined, however the second accepted and so it was this team that I chose to follow during Liveweek.

9.1.3 The study population

The core participants in Teamwork were the members of the various design teams. Each team comprised ten to fifteen people in total, however on each day roughly eight to ten were present. On the days that I collected data, there were three teams present. They each named their teams, but for the purposes of this report, I shall refer to them as the Blue, Green and Yellow teams.

The members of these teams came from all areas of the construction industry and had a variety of specialist skills. They included architects, structural engineers, quantity surveyors, fabricators, services engineers (heating /ventilation/electrical systems specialists), and others.

The Blue team comprised members from just one (very large) company, but the other two teams were made up of members from various different companies. In all the teams, some of the members had worked together before, through both intra and inter-company collaboration, but not all of them. Each team had had a number of pre-meetings, but not all of the members had been to all, or even to any of these. So Liveweek was the first time that the members of the teams had worked together on a single project.

A number of the participants were non-native English speakers; this was most notable in the Green and the Yellow teams, who included members from Germany, Sweden, Portugal, Belgium and the UK. These members had a noticeable difference in spoken English skills. However, all communication during Liveweek was conducted in English, and no occurrences were recorded of other languages being used.

Of the team members (including the Knowledge Capture team) 91% were male, and 9% were female, although this ratio varied considerably on an individual team level. The age demographic was biased toward younger people. 51% of the team members were estimated to be between the ages of twenty and thirty, 24% with estimated ages between thirty and forty, 21% between forty and fifty, and 4% over the age of fifty.

On the two days that they were working on the design task, the participants all wore t-shirts printed with different logos according to which team they belonged to. The team members had designed the logos themselves during the meetings before Liveweek.

Apart from the core Team members, there were many other people present during Liveweek. The organizers of Teamwork itself were present during Liveweek, and formed a more loosely arranged group known as the "Knowledge Capture Team". The members of the Knowledge Capture Team were involved in the set-up, organization and running of Teamwork. During Liveweek, they moved from team to team, overseeing the design projects, advising the teams on what was expected, and collecting data on how the event was going. Most of the Knowledge Capture Team members were employed within the construction industry, however their role was to collect data on the event, rather than to participate in the design projects of Liveweek.

Also present were specialists from the IT industry. These included IT system designers, network engineers and CAD specialists, whose role was to set up, maintain, and advise on the use of the IT systems in use at Teamwork. Some of these people joined a particular design team, while others took roles as "consultants" within the Knowledge Capture Team during the week.

In addition to the direct participants of Teamwork, there were a number of visitors to Liveweek. These included members of the construction companies who had employees participating in Teamwork, and who wanted to see how it was going.

Finally, there were also a number of independent sales people, notably software salespeople, and a number of freelance management specialists who were involved in Teamwork, but who were not members of any specific team.

9.2 Overall comments on how the data were gathered

My position at teamwork was that of a non-participatory data-collector. I chose to focus the bulk of my data collecting activities on one team, and was accepted in this role by the team members. I stationed myself at that team's table, and moved with them when there was interesting data to record. Since I was also making observational recordings of the overall activities during Liveweek, I made sure that I was always positioned so that I could see the other teams in the hall.

Throughout this study, the team members were identified in the data by the initials of their first names and surnames.

9.3 Study 1 – The structure of interaction networks between team members

9.3.1 Data collection for Study 1

For this study, a record was made of interactions between people in the Liveweek venue. At approximately half-hour intervals, a hand-drawn map was made of the locations of all the people in the hall, their identities (if known) and which team they were a member of, if any. The teams had been given t-shirts with large logos on the back that identified which team they belonged to; this was used to establish team membership. If a person was not recognised as a member of any of the teams, they were marked as a "visitor". A total of eighteen maps were created in this way.

9.3.2 Analysis of data from Study 1

1. For analysis, the observation maps were transferred to a computer diagram drawing programme (Visio). The Visio maps were plotted on a grid background. This grid was used to identify who was interacting with whom: if two people on the map were no more than four grid squares apart, they were determined to be "next to" each other. Their proximity was taken to be an indication that they were probably interacting with one another (if not at the time of the map recording, then probably between then and when the next map was recorded half an hour later).

2. The interaction data from each map were entered into a computer spread sheet programme (Excel), as social network analysis matrices. A matrix was created for each of the eighteen maps. Another matrix was created that combined the interaction data from all of the maps. In contrast to the first set of matrices, which were binary, showing merely whether or not a particular interaction had occurred, the combined matrix was "valued"; the numbers in the cells indicated the *number of occurrences* of a particular interaction.

3. The data from all of these matrices were then exported to a specialist SNA computer programme (UCINET) for further analysis. Initially, the data were analysed using basic network statistics, such as counts of numbers of nodes and links, and network density.

4. To ascertain whether there were trends in the sizes (number of actors) or densities of the eighteen interaction networks over time, the size and density data were plotted as simple bar graphs, and the relations between them tested for correlation.

5. The centrality and betweenness values for each actor were calculated. These are both typical SNA measures, and were carried out using the UCINET software. The centrality score represents how many links that actor made with any other actors; it is a measure of how well connected a node is. Betweenness is a representation of the extent to which a node acts as a "liaison" or connector between other nodes.

6. A measure of “clustering” was also performed on the overall network data, to see whether members of the same team tended to interact together as a group, rather than with members of other teams. The tool used for this was another UCINET statistical measure, which was a form of ANOVA test.

7. The three different teams were also analysed separately, to ascertain whether the teams each contained actors with similar network roles, or whether any of the teams had characteristics that the others did not.

8. The data from the valued matrix (all the observation data combined) were then exported to another computer programme (named NetDraw), which generates visual “graphs” (network maps), from SNA matrices. Using this program, a single “interaction map” was created, showing who communicated with whom during Liveweek, and how often they did so. In this map, the widths of the lines used to connect nodes were determined by the number of times the interaction occurred.

9. This map was then examined for notable features. The kinds of features that were looked for included any strong links between actors, repeated interactions between the same groups of people, isolated individuals, and so on. The features that were identified were noted down for particular attention in the dialogue and artefact analyses.

9.4 Study 2 – Dialogic communication in the collaborative design process

This second study was conducted concurrently with Study 1. The object of this study was to collect and analyse the content of a single team’s communication during their two days at Liveweek.

9.4.1 Data collection for Study 2

A single project team was selected and their actions video recorded over the week. No attempt was made to select particular individuals in the team for videoing, but a focus was made on recording as much dialogue as possible. When the team members weren’t engaged in dialogue (which was usually when they were working independently on the design), video recordings were made of the work they were engaged in, such as views of computer screens etc.

The video recorder was set to show a real-time clock in the corner of the screen, so that all of the tapes contained a record of the time that the footage was recorded.

9.4.2 Analysis of data from Study 2

1. As discussed in Chapter 8, the procedure for analysing the dialogue collected for Study 2 was based on a methodology developed by Chi (1997), known as *verbal analysis,* which employs both qualitative and quantitative methods. The first stage was to catalogue the video material that had been recorded. This helped to identify and locate data from the videos later in the analysis. In cataloguing, the video data were unitised according to "scenes". A scene was deemed to have ended when the camera was paused, or recording was halted. A note was also made in the catalogue of the participants who took part in the scene, the time of the recording, the approximate length of the scene, a brief one or two line summary of the scene's subject, and an indication of the recording's sound quality (on a scale of 1 to 10, where 1 was poor and 10 was excellent.

2. After the data had been catalogued, a full transcription was made of every scene that included dialogue. It was decided that, although time-consuming, it was worth transcribing all of the recordings so that a full contingent of the data was available for content analysis.

The convention used to transcribe the data was derived from Silverman (2001) (see Appendix 1 for details).

3. Each scene was then analysed and coded for content, according to the *verbal analysis* methodology, which involves first investigating the data in a qualitative manner, to determine the coding categories that were to be used, before quantitatively analysing the coded data, as described in steps 4 and 5. The data were first segmented into appropriate fragments for analysis. In this study, segments were deemed to be "utterances" or "turns" taken by the speakers. Then a coding scheme was developed though qualitative examination of the data, where emergent patterns, such as repeats of similar kinds of statement, questions and so on were identified. In practice, a scheme developed by Lipponen *et al* (2003) who conducted a study in a similar computer-supported collaborative environment, was used as a start point. This scheme was first tested on a small portion of the data, and altered and adapted so that the categories became tailored to fit the patterns that emerged in the Liveweek data. Once the new scheme was finalized, it was used to code the entire data set. The scheme that was eventually used in this study appears overleaf(Table 9.1).

4. The coded results were entered into Microsoft Excel and investigated for recurrent patterns using Excel and SPSS. The total frequency (in the entire transcribed dialogue) of each kind of statement was calculated, as were the frequencies of statements in each of the six coding groups in the entire dialogue. The frequencies of statements in each coding group were also calculated on an actor-by-actor basis.

5. To see whether there were associative patterns in the kinds of statement used by each actor, correlation values were calculated on an actor-by-actor basis for all of the code combinations. So for example, the correlation value of code D (organizing the process) with code E (organizing the people) was calculated for each actor, to see whether the two kinds of statement tended to be associated with one another.

Content Analysis Coding Scheme			
Coding Group	Code Label	Type of utterance	Example from the text
Group 1 – Offering Information	A	Suggesting an idea (non-skilled, or non skill-specific)	SS: [we can do one for the landing on the moon with our team or something.
"	B	Providing skilled advice or suggestion of a positive nature (agreeing with another, or adding new skilled advice)	B SS: I think we can have columns (1.5) there
"	C	Providing skilled advice or suggestion of a negative nature (such as disagreeing with another, or saying they don't know something)	PB: You didn't want more than six hundred↓ (.) so you have to find some space
Group 2 - Organizing	D	Organizing the design process	SS: So I should actually give you (2) the SDNF files from the model (.) as it is now., (1) before the changes.
"	E	Organizing the people	SS: How much work do you still have today?/
Group 3 – Feedback and social exchange	G	Giving positive feedback ("that's good!", "nice work" etc.)	SS: yeh ((nodding)). That would be quite good
"	H	Giving negative feedback ("you muppet!", "that's stupid" etc.)	SS: don't say it so (0.5) cynical
"	N	Social exchange	SS: That (.) you know (2.5) Turkey hit the ball back to the one in, it was erm=
Group 4 – Statements about the design context	I	Contextualising statement (explaining what's being discussed etc.)	MW: I was working on the balconies right now.
"	K	Reporting a past action	SS: At the moment. (1) We're coordinating, you know, so that I know what every one is doing.

Table 9.1 Coding scheme used to code and analyse the video dialogue. I developed this particular scheme after having transcribed the video dialogue, but it was partly based on a prior scheme by Lipponen *et al* (2003). Continued overleaf…

Table 9.1. Continued from previous page.

Coding Scheme cont…			
Coding Group	Code Label	Type of utterance	Example from the text
"	L	Reporting an intended action ("what we are going to do is")	KR: Er: we're going to concentrate on the walls (.) er, using CADmeasure
"	M	Explaining the design, or explaining what is being shown	PB: (1) what (.) I assumed from this is (0.5) we had a box inside a box. (0.5) and this box inside a box actually had a roof on top of it (.)
Group 5 – Information-seeking statements	F	Stating a problem (identifying a problem)	PB: (2) and (.) I added (0.5) the stair (1) to get the truss through (0.5)? There we (.) run into some problems actually
"	J	Query	PB: And what about the columns?
Group 6 – Uncategorised statements	X	Not categorised	SS: oh.

9.5 Study 3 – Use of artefacts as communicative tools

9.5.1 Data for Study 3

Study 3 used computer data from Liveweek which had been captured on disk, to study how the team used artefacts.

At Liveweek, each of the teams had been provided with a small network of computers, comprising several computer workstations connected together via an Ethernet network. The team networks were also each linked to a central Teamwork server that managed the entire network. As part of the "knowledge capture" process of Teamwork, the organizers of Liveweek collated a series of CD's of the data files that had been produced by the design teams, both in the weeks prior to, and during Liveweek itself. These CD's contained a variety of different kinds of file, including:

- The design models that the team had produced (CAD models)
- Computer documents written by the team members, including letters, faxes, web pages, emails, and so on
- Screenshots captured at hourly intervals from each PC
- Scanned images of many of the paper sketches and handwritten notes that the teams had produced

9.5.2 Analysis of data from Study 3

All of the screen shot files on the data CD of the chosen team were analysed for content, according to a specially prepared coding scheme. The coding scheme is presented below:

Artefact Analysis Coding Scheme
1. File name of screen capture image
2. Computer name (either “Pooh”, “Piglet”, “Heffalump” or “Pootel”)
3. Date shown in the screen shot
4. Time shown in the screen shot
5. Name of active computer file in the screen shot
6. Suffix of the active file in the screen shot (indicates file type)
7. Programme being used to access active file
8. Brief description of what is happening in the screenshot

Table 9.2 Coding scheme for Study 3 (artefact analysis).

The coded data were entered into Microsoft Excel. They were then investigated and analysed using Microsoft Excel and SPSS. Basic statistics were recorded, such as the mean number of times a particular program was used on each PC, the number of times each file was opened on a particular PC, and whether the same files were opened on different PC’s.

In addition to the analysis of the screen captures, other files on the data CD were investigated. The data on these however were recorded in a more qualitative fashion. Notes were made of the file names, the kinds of file that they were, the author of the file (if it was recorded on the file itself), and general notes on the content of the files. Similar notes were made for the scans of design sketches. The primary intention with these notes was to use them for reference in the combined analysis where the artefact data were compared with with the network and video data from Studies 1 and 2.

9.6 Methods used to conduct combined analysis of data from all three studies

9.6.1 Relations between results of network structure and dialogue analysis (Studies 1 and 2)

To assess whether the social network analysis data and the content analysis results were associated in any way, a number of correlative tests were performed. Social network measures, such as betweenness and centrality were tested for correlation with the results of the dialogue coding.

9.6.2 Relations between results of artefact analysis and dialogue analysis (Studies 2 and 3)

The relations between the Content data from Study 2 and the Artefact data from Study 3 were investigated by a somewhat more qualitative approach than had been employed up until this point. A process of comparison and deduction was used to connect the dialogue captured in the video recordings with the screen shots captured from the Team member's workstations.

By looking for features such as matching times between the video recordings and the screen captures, or dialogue that related to computer files that had been produced by the team, more details regarding the way that artefacts and dialogue related were gleaned. Since the Team members had sometimes moved to different workstations, it was not always obvious in the screen capture data who had been working on a particular workstation at any one time, or who had authored a file. To deduce this, the *locations* and *actions* of the actors in the video recordings were scrutinised and compared with the content of the screen captures.

Having worked out who had authored or worked on each computer file, the artefact data were re-analysed with the user data included. Notes were made of who had used which files at which time, which of the workstations were shared and by whom, and whether any of the computer files such as CAD models were shared by multiple users on different workstations.