CoDesign, Vol. 1, No. 1, March 2005, 19–37

Taylor & Francis
Taylor & Francis Group

Patterns of interaction in construction team meetings

JASON FOLEY and SEBASTIAN MACMILLAN*

The Martin Centre for Architectural and Urban Studies, 6 Chaucer Road, Cambridge CB2 2EB, UK

(*Received 1 July 2003; in final form 26 January 2004*)

Sir John Egan's 1998 report on the construction industry (Construction Task Force 1998) noted its confrontational and adversarial nature. Both the original report and its subsequent endorsement in *Accelerating Change* (Strategic Forum 2002) called for improved working relationships—so-called 'integration'—within and between both design and construction aspects. In this paper, we report on our observations of on-site team meetings for a major UK project during its construction phase. We attended a series of team meetings and recorded the patterns of verbal interaction that took place within them. In reporting our findings, we have deliberately used a graphical method for presenting the results, in the expectation that this will make them more readily accessible to designers. Our diagrams of these interaction patterns have already proved to be intuitively and quickly understood, and have generated interest and discussion among both those we observed and others who have seen them. We noted that different patterns of communication occurred in different types of meetings. Specifically, in the problem-solving meeting, there was a richness of interaction that was largely missing from progress meetings and technical meetings. Team members expressed greater satisfaction with this problem-solving meeting where these enriched exchanges took place. By making comparisons between the different patterns, we are also able to explore functional roles and their interactions. From this and other published evidence, we conclude that good teamworking practices depend on a complex interplay of relations and dependencies embedded within the team.

Keywords: Teamwork; Communication; Collaboration; Decision-making

1. Introduction and aims

The construction industry is renowned for adversarial and confrontational relationships between the parties, as reaffirmed by two major government-supported reports on the

*Corresponding author. Tel: 01223-331700. Email: sgm24@cam.ac.uk

CoDesign
ISSN 1571-0882 Print/ISSN 1745-3755 online
http://www.tandf.co.uk/journals
DOI: 10.1080/15710880412331289926

industry in the 1990s. The Latham Report (Latham 1994) and the Egan Report (Construction Task Force 1998) both recommended the need for improved working relationships between clients, designers and constructors as a key means to reduce construction costs, improve competitiveness and deliver buildings that meet the performance needs of clients. During the 1990s, there was a fortunate coincidence of purpose between, on the one hand, these views of the need of the industry to change its business processes and practices and, on the other hand, the objectives of the LINK research funding programme Integration in Design and Construction (IDAC), supported jointly by the Engineering and Physical Sciences Research Council and the Department of Environment, Transport and the Regions. The University of Cambridge has a long-standing interest in design research, and we were fortunate to obtain LINK funding to study the issue of teamworking practices in construction.

Our research had the overall aim of observing, identifying and describing the conditions necessary for effective teamworking, including the development of shared goals, the effectiveness of communication and the nature of team decision-making. A laboratory study assessed the impact of explicit goals and self-reflection on the team process. It demonstrated that team members perceived there were benefits in working to explicitly agreed team goals and pausing periodically for reflection on the process of teamwork (Busseri and Palmer 2000). Most of our research, however, was concerned with teams operating in real-world situations—*naturalistic decision-making* in the words of Klein (1998). We share Klein's motivation of following the lead of curiosity—rather than testing formal hypotheses—in situations where highly proficient decision-makers use their experience and expertise to perform the challenging task of constructing a building under all the confusion and pressures of an environment where there may be missing information, vague goals, time constraints and changing conditions.

We have observed a number of different building design teams at work: firstly, during an intensive design workshop to devise a strategic design approach for a primary school (Macmillan and French 2001); secondly, throughout a series of bi-monthly partnering workshops also for a school (Macmillan 2004); and thirdly, at a series of meetings held on the site of a large building project. This paper reports on the third set of observed meetings.

Our survey of the literature on teamwork has already been published (Macmillan 2001b), and it joins a number of texts covering a wide range of issues faced by teams, such as empowerment (Newcombe 1996) written primarily as guidance for practitioners. *Effective Teamwork* by West (1994) is a similar, earlier and more extensive example, grounded largely in the healthcare sector. The funding bodies of our study wished to see a short industry guide to effective teamwork as one of the main outputs, and this expectation has been met in the booklet *Effective Teamwork—A Best Practice Guide for the Construction Industry* recently published by Constructing Excellence (Eclipse Research Consultants 2004). Its intention is to help members of the industry to re-evaluate and re-assess their own business processes against best practice. The booklet defines what a team is, discusses what is expected of team members, suggests how to select members and how to lead a team, and addresses what are identified as six crucial aspects of teamwork:

- the promotion of team identity;
- the development of a shared vision and common goals;
- effective communication among team members;
- the encouragement of collaboration and full participation;
- facing, negotiating and resolving conflict head-on if and when it arises;
- the importance of periodic self-reflection on the team process.

In this paper, we report on the 'patterns of interaction' observed in project team meetings. We have taken this terminology from Richard Guzzo's work where, in the introduction to his joint book with Eduardo Salas on *Team Effectiveness and Decision Making in Organisations*, he writes: 'An analysis of group decision making and performance at this level might focus on patterns of intragroup interaction as members exchange information or coordinate their physical efforts as they work' (Guzzo 1995). Our focus is on teamwork rather than taskwork, our unit of assessment is the team rather than the individual, and our interest lies in decision-making (Cannon-Bowers *et al.* 1996). Because of our interest in design and the publication of this paper in a design journal, we have attempted to convey the observed patterns using a graphical format analogous to the graphs used in social network analysis (see, for example, Scott 1999). These patterns of interaction have already proved to be intuitively and quickly understood, particularly by the members of the observed team, and they have generated interest and discussion among both them and others.

2. How teams work

One definition of a team is a group of people with complementary skills who are committed to a common purpose and hold themselves mutually accountable for its achievements (Katzenbach and Smith 1993). Syer and Connolly (1996) set out a number of factors that contribute to team identity, for example, having a clear vision, shifting the focus from personal needs to team needs, a membership that reflects the nature of the task in terms of size and resources, and the team's willingness to take ownership of the problem. Successful teams benefit from their members' understanding, and from optimism, confidence and satisfaction; such teams lead to better decisions and more efficient use of resources (Denton 1997). However, simply bringing together team members does not ensure they will function well together—teamwork indifference may result in mediocre performance, and the team may be undermined by disorganisation or poor communication (Cooley 1994). Some team members may opt out of the process—so-called 'social loafing'—leaving others to do all the work (Erez and Somech 1996); team members may waste time in disputes (Hackman 1987). Groupthink—in which the desire to achieve consensus (perhaps arising from loyalty to the team leader) becomes more important than the quality of decisions—is another risk under certain conditions, as identified by Janis (1972), who also observed that the output of the whole team may represent poorly the capacity of its parts, and arises from illusions about unanimity and invulnerability (Janis 1982). Groupthink has been re-examined by many others (see Turner and Pratkanis 1998). Individual behaviour in teams is affected by a wide range of factors, such as members' personalities, mental abilities, skills, knowledge and expertise, their current values, motivations and commitment, and the constraints put upon them by their organisational loyalties and the demands of the task and its environment (Goodman 1986, Driskell *et al.* 1987, Hackman 1987, Belbin 1993).

By sharing information among members, a team is able to make best use of its pooled knowledge, although there is evidence that knowledge that is held in common—rather than that held by a small number—is more highly influential in decision-making (Chernyshenko *et al.* 2003). Good communication is vital. Yet teams that bring together people from different professional backgrounds and that use different terminology open up real risks of poor communication and misunderstanding. Gruenfeld *et al.* (1996) report that groups of strangers are less likely to communicate disagreement, while team members are most open to information from those they feel

are their equals (Abrams *et al*. 1990). Team members may also need to make their personal preferences and assumptions explicit in order to build up trust and understanding (Rentsch *et al*. 1994). Conflict can arise when team members have different priorities, goals and/or constraints (Sonnenwald 1996). The conflict between individual and team goals can present a serious threat to the success of a team (Larson and La Fasto 1989). At worst, power struggles and unresolved differences in opinion can halt team progress (Bolmar and Deal 1992).

Team meetings are one of the forums where the participants come face to face and have to resolve problems and achieve consensus. Belbin (1993) poses a question to illustrate clearly the issues that newly formed teams face in tackling a complex construction project: 'What happens when people are locked together by force of circumstance in a working association into which not one with any advanced knowledge would have entered freely?' Belbin separated team roles, such as ideas generator, habitual critic or progress-chaser from functional task-related roles. He noted the importance of having a mix of team roles within a team, and that competition could develop among team members vying to occupy particular roles. More recently, he has identified different types of work (Belbin 1997) and subsequently written about the allocation of different types of work among team members (Belbin 2000).

The 'circumstance' in which the project team may find itself will vary and develop over the duration of a project's lifetime, and interaction relationships will inevitably alter to suit different situations. Managing teamwork can therefore be difficult to achieve, particularly in attempting to ensure the team shares knowledge and arrives at consensus-based and effective decision-making. Kline (1995) outlines this further when he writes: 'Integration is a human action. The result—synthesis—is negotiated, situationally dependent, and contingent on the participants. If the participants share the same habits and the same position in time and space, communication is easier and knowledge more likely to be disseminated.' A major element in allowing the development of effective communication in teamwork is often dependent on the physical or social context as well as the language used. Habermas (1998) contended that 'the ideal speech situation is a valid critical standard against which all apparent consensus can be called into question and tested.' Ideally, these arenas for discussion—particularly team meetings—achieve that. However, 'the ideal speech situation' can also be, in Tzanne's view, the 'creation of miscommunication' (Tzanne 1999).

Teamwork is further complicated by the 'locking together' of individuals within the team. The theory of the 'speaker' and 'addressee' explains what happens when two people interact in a communicative way and indicates a general flight path of interaction during a discussion between two people (Thomas 1987). In this situation, the speaker directs speech to the addressee, who in turn becomes the speaker—a shifting of roles in its simplest form (Hanks 1996). Complex relationships develop if the discussional situation is a group or team: the potential for dialogue interaction is multiplied, and individual roles often shift during conversations, based on reassessments of the current situation (Dyer 1977, Tzanne 1999). Social interactions and their dynamic nature—situations, roles, directions and goals—have been investigated by many, including Drew and Heritage (1992) and Thomas (1987). In Tzanne's (1999) view, social interaction can increase the potential for misunderstanding amongst the team members, making it increasingly difficult for them to reach agreement or consensus. Consequently, the need to pull together understanding in situations of group discussion can become critical and difficult to manage, especially when the members of the group have low awareness of the degree of misunderstanding.

3. Case study approach

We were fortunate to have the opportunity of attending regular meetings held on the site of a major UK building project. Table 1 outlines details of the project case study, the team meetings monitored and our method for recording our observations.

4. Project team meetings: the context

Team meetings are, of course, only part of the activity that team members have to perform as part of their responsibilities for delivery of the project. Other actions take place in smaller separate groups and many, perhaps most, by individual team members; they are also dispersed among several environments. Table 2 summarises different

Table 1. Case study details and team meeting samples.

Case study details	The project is a £46m lottery-funded exhibition centre. The building comprises a 5000 m^2 hall plus a 40 m high tower. The construction cost is £16m. The start of the design work began in 1998 with on-site substructure beginning March – August 1999 (Phase 1). Phase 2 started in December 1999. The client consists of a committee of enthusiasts, designed to run the management side of the property group. They were concerned to achieve cost certainty and quality and chose to use the JCT 80 form of contract. Following an advertisement in Official Journal of the European Communities, six contractors were selected for pre-tender evaluation and five were invited to tender.
Team meeting observed	Observations were undertaken over a nine-month period, which was part of an eighteen-month construction programme. Nine team meetings were observed, of which there were four types: **1. Progress meetings.** The aims of these monthly meetings were to monitor progress against the agreed construction programme, to identify problems and obstacles to progress, and to review contractual issues and requirements. Five meetings were monitored at approximately monthly intervals. **2. Technical meetings.** The aims of these monthly meetings were to resolve technical/design-detailing matters critical to the project programme. These meetings were also held monthly and were interspersed between the progress meetings. **3. Interim technical/cost reviews.** The aims of these meetings were to review cost items and technical issues. One was monitored. **4. Strategy/problem-solving meeting** These meetings were held to consider future and forthcoming risks and threats to the project, and to provide an opportunity for open discussion and negotiations of contentious items so as to anticipate and resolve problems and avoid protracted claims and disputes. One of these was monitored.
Observational method	All the observations were carried out by the first named author. The team being monitored refused permission to video- or tape-record the team meetings, so the observations had to rely on hand-written notes of the discussions and hand-recorded timings of the communication patterns. A simple coding system was adopted for recording the nature and extent of the exchanges among team members, i.e. who spoke and for how long, and who replied. Hand-written notes regarding the content of the exchanges were also made. All notes from the observed meetings were written up as soon as possible after they had taken place. Given that we were not allowed to use any electronic recording method, this was the best way we could devise to collect the data and to ensure that the insights gained from the observations were recorded. We have used hand-written recording methods previously for studying team processes (Macmillan 2001a, 2004). As Klein (1998) says, the study of naturalistic decision making relies partly on the insights of the observer, while the unique circumstances of the meetings make replication impossible. We are also aware, of course, that the presence of the observer may also influence the team members' behaviour, but we have made no allowance for this.

Table 2. Types of learning situations in a typical construction project.

Environment	Situation	Objectives	Within	Between
Discussional space	Team meetings	Learning Communicating Problem-solving Feedback Information distribution Decision-making	Teams	Individuals Team members
Activity space	Task completion	Gathering data Researching relevant information Testing probable solutions Completing tasks	Organisations Projects	Teams and individuals Projects

situations in which the activities of construction team members take place; the highlighted cells in the table show where case study observations took place.

It is important to distinguish between team or individual situations as these will ultimately affect relationships and behaviour (Busseri and Palmer 2000). Situations where team members may find themselves were further subdivided into 'discussional' and 'activity' environments for the benefit of understanding the need for different interaction processes and objectives. Our observations did not capture:

- events happening between team meetings (conversations, information flow and so on)
- individual designers' actions in their own environments
- individual designers' communication with other team members outside of team meetings.

These have been described as the 'activity' environments and will not be discussed here.

The team meetings were held under time pressures and were highly focused. Some aspects of teamwork are therefore accounted for only partially, and some events only partially captured. What we sought was to prepare a time line of communication among team members, recording who spoke to whom and over what period of time. In this way, it is possible to map the direction of communication, the extent of communication input and the resulting patterns as they relate to the following four major areas of interaction.

- who speaks and how much
- what people say
- how they say it and to whom
- their role(s).

In presenting the patterns of interaction in the following figures, we plotted the interactions in each of the four different types of meeting. We adopted the following conventions.

- The seating plan approximates to the actual seating positions adopted for the first progress meeting. Team members sat in different places in subsequent meetings,

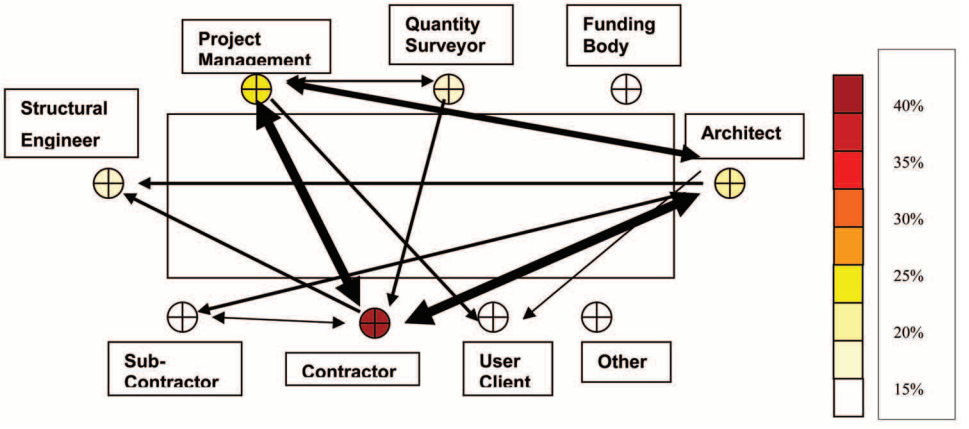

Figure 1. Interaction flow analyses of communication input over five team progress meetings.

Table 3. Progress meeting character table.

Meeting type	Objectives	Discipline present	Communication input (%)	Total time spent in five progress meetings observed = 14 h 25 min
Progress meeting	Monitor progress against agreed construction programme.	Contractor	46	
	Identify problems and obstacles to progress.	Project management	15	
	Recording.	Architect	16	
	Contractual issues and requirements.	Structural engineer	9	
		Quantity surveyor	8	
		User–client	3	
		Funding body	1	
		Subcontractor	1	
		Other	1	

although we noticed a tendency to choose approximately the same seats at each meeting.

- The 'contractor' had on occasion more than one representative at the meeting, but for clarity we added together their inputs and have shown them as from one single source.
- In the figures, in each of the four types of meeting, we have added together the interactions to provide an average picture for each meeting type.

5. Communication during five progress meetings

The contractor engaged in communication for almost half the time (46%) progress meetings were observed, nearly three times more than any other discipline. However, the contractor consistently had a greater number of representatives present during each meeting. In this respect, the high percentage of the contractor's engagement in communication is related to the objectives of this meeting type (see table 3).

The architect and project manager both had similar input to the meetings, although they had very different roles. The architect was lead designer and therefore took on a leader role; the project manager adopted a mediator and contextualiser role. The structural engineer and quantity surveyor had a similar input into the meetings and had roles considered to be more advisory. The user-client, funding body and subcontractor had very small inputs into the meetings and were periphery to almost all of the discussions during the meetings (see figure 1).

6. Communication input during two technical meetings

These meetings were dominated by one or two issues, with smaller items addressed over the rest of the meeting time. Figure 2 clearly shows the contractor (37%) and the architect (33%) dominating the meetings. The project manager's role was of mediator between the contractor and architect, with the other core disciplines (the user–client, structural engineer and quantity surveyor) having a limited amount of input.

The two meetings observed were single-issue led and focused on workmanship and the quality of design production details. They were dominated by the architect and contractor as they attempted to resolve the effects of bad workmanship on the rest of the construction and poor design drawing details. The user-client was not present during the first technical meeting and had very little input in any discussions during the second meeting.

The other team members were generally observers and had supporting roles. Surprisingly the subcontractor was not present during the technical meetings when issues concerning them may have benefited from their presence. There were noticeably fewer team members present during the technical meetings than for the progress meetings. See table 4 and figure 2.

7. Communication input during one 'interim technical' meeting

This meeting was single-issue-led and focused on a dispute between the architect and structural engineer on one side and the contractor and subcontractor on the other (table 5). The dispute centred on the lack of quality of the design drawing details and a subsequent lack of progress on a lift set-up issue.

The manufacturers and constructors of the lift had joined the team as subcontractor to the main contractor. They had a viewpoint to the lift problem that was in line with that of the contractor and were needed to clarify certain issues so that solutions could be found. The project manager's role was of mediator and co-ordinator on issues to do with the construction programme in terms of actual progress.

Again, there is a pattern with the communication triangle between the three main disciplines. In this case, however, the architect has a larger amount of communication input into the meeting. The contractor and project management make up the other points of the triangle (see figure 3).

8. Communication input during strategy/problem-solving meetings

During this meeting (table 6), input was evenly distributed between the disciplines. The client was more involved, but had three representatives, more than any other discipline. Two other disciplines were introduced to the normal project team: (1) the mechanical and electrical subcontractor and (2) the fit-out subcontractor. Their involvement arose from the long-term outlook of the meeting (the Phase 2 fit-out) and the prominent involvement these disciplines would have later in the project.

Project managers were more prominent in this meeting as they were the discipline assigned to organise and co-ordinate strategies. The contractor is a vital element in the organisation of site works. The subcontractors were more prominent during this meeting, as they would take a larger stake in the construction programme during the start of Phase 2 fit-out. Up until now, they had been little involved during progress meetings and only slightly more during technical meetings. See figure 4.

9. Comparisons of interaction relationships between team meetings

9.1 *Progress meetings*

The contractor dominated the progress meetings (see figure 1) as progress feedback was the main objective for this meeting type. The contractor also had more members of their organisation present than any of the other disciplines. The contractor's role was mainly that of 'speaker'—feeding or providing information from on-site to the other consultants. The rest of the team ('addressees') relied on the contractor for detailed progress reports to ensure that any obstacles to progress were tackled by the whole team at an early stage. Although this is to be expected during the construction phase, there is a possibility that too much weight and expectation are given to the contractor with an emphasis on 'total output' or progress.

The contractor—as speaker—takes up a position in the social arena of the meeting where he is defined rigidly (by the rest of the team) as the feeder of information, based on a tightly set-out code. This code symbolically consists of the contract and the construction programme from which the contractor based the priced tender for the project. The contractor is intrinsically tied in to a role that can be clearly defined in terms of output—that of reaching precise aims in a set programme—which in effect becomes an assessment tool. This situation resulted in the contractor being the central focus of meetings; any shortfall on their part is highly visible. However, despite the overwhelming communication dominance by the contractor, the contractor's representatives did not dominate the meeting in terms of pressing opinions or views. By having such a prominent and defined role, they were more like a target of assessment. The architect's role—as lead designer—was often to point out shortfalls in progress from the contractor, creating a situation that tended to fuel conflict within the team. This was a familiar pattern in the observed progress meetings.

The project manager—as the organiser of all the meetings and whose role it was to keep a tight rein on proceedings—had an important part to play in the meetings. During these situations, the manager tended to change quite rapidly depending on who spoke and what they were saying. For instance, his role involved checking items, showing concern, probing for more details, managing time and mediating between the parties. On occasion one role lasted for lengthy periods, but on other occasions, changes of role could happen quickly. The contractor—who tended to have more than two members present

Table 4. Technical meeting character table.

Meeting type	Objectives	Discipline present	Communication input (%)	Total time spent in two technical meetings observed = 2 h 55 min
Technical meeting	Resolve technical/ design-detailing matters critical to programme	Contractor	37	
		Project management	14	
		Architect	33	
		Structural engineer	7	
		Quantity surveyor	5	
		User–client	3	
		Funding body	1	

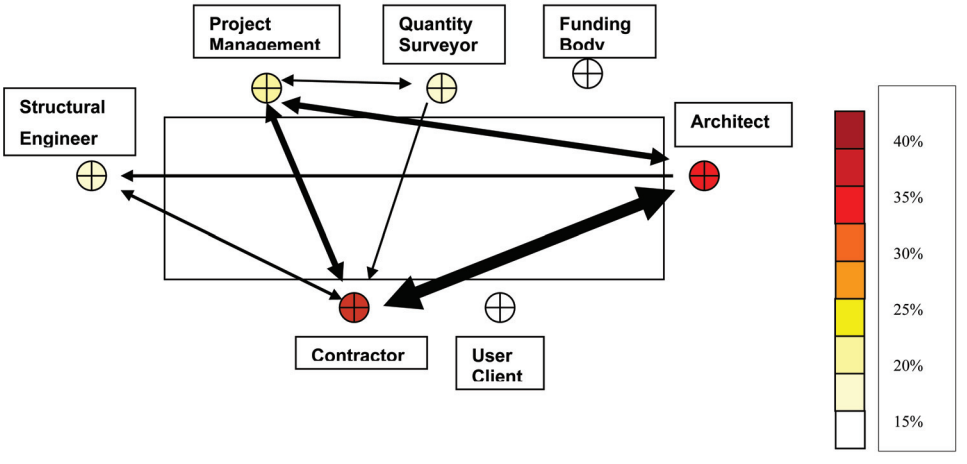

Figure 2. Interaction flow analyses of communication input during two team technical meetings.

for each meeting—was observed to use several 'languages', able to respond to different types of issue in the language appropriate to the issue (progress, technical and so on). In this sense the contractor may be described as 'multi-lingual', i.e. having the skill to respond to issues of project management, mechanical engineering, electrical engineering, contractual matters, etc., as and when required. The interaction relationship between project management and the contractor was observed to be complex as the focus of interaction and direction of information shifted.

9.2 *Technical meetings*

Communication in technical meetings was dominated by the contractor and the architects; between them, they spent 70% of the meeting in communication, mainly interacting with each other. Each meeting tended to focus on one specific issue (for example, 'quality of workmanship') with other less urgent matters filling the remaining time allocated for that meeting. The meetings often took on a character of dispute

Table 5. Interim technical/cost review meeting character table.

Meeting type	Objectives	Discipline present	Communication input (%)	Total time spent in one interim technical meeting observed = 2 h 40 min
Interim technical/cost review	Review of cost items and technical issues.	Contractor	29	
		Project management	15	
		Architect	37	
		Structural engineer	6	
		Quantity surveyor	6	
		Subcontractor	7	

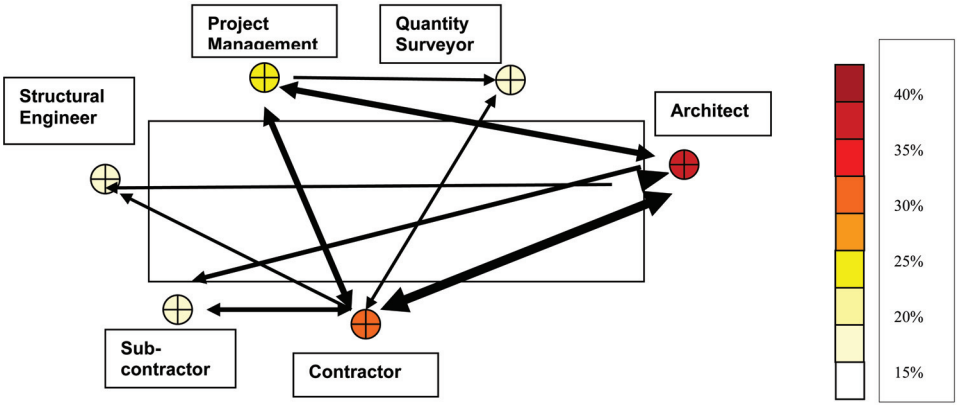

Figure 3. Interaction flow analyses of communication input during one team interim technical/cost meeting.

between the contractor and the architect with project management mediating between them, as can be seen from their input level (14%). Other consultants tended to have minimal input, and generally to support either the contractor or the architect when and if required. Typically, the subcontractor supported the contractor, and the structural engineer supported the architect.

An example taken from the first technical meeting centres on the team finding a solution to a specific problem that was critical to progress. This issue revolved around workmanship and the impact this would have on the rest of the programme in terms of cost, time and quality. As the issue was focused on workmanship, discussions centred on the contractor's responsibilities. As the architect was the lead designer his functional role was emphasised by the attempt of the team to find a solution, which also demanded certain contractual and social requirements from the contractor. It was particularly noticeable that the project manager was far more motivated to encourage the team ('team' in effect here meaning the contractor and the architect) to find a solution quickly, with little emphasis on understanding the root of the problem in the first place.

There were noticeably fewer team members present for these meeting types; for example, the user-client and the funding body were often absent, possibly owing to the

Table 6. Strategy/problem-solving meeting character table.

Meeting type	Objectives	Disciplines present	Communication input (%)	Total time spent in five progress meetings observed = 4 h
Strategy/ problem-solving meetings	Consideration of future/forthcoming risks and threats to the project.	Contractor	27	
	Open discussions/ resolution of problems to avoid protracted claims and disputes.	Project management	21	
		Architect	16	
		Structural engineer	18	
		Quantity surveyor	2	
		User–client	9	
		Subcontractor	7	

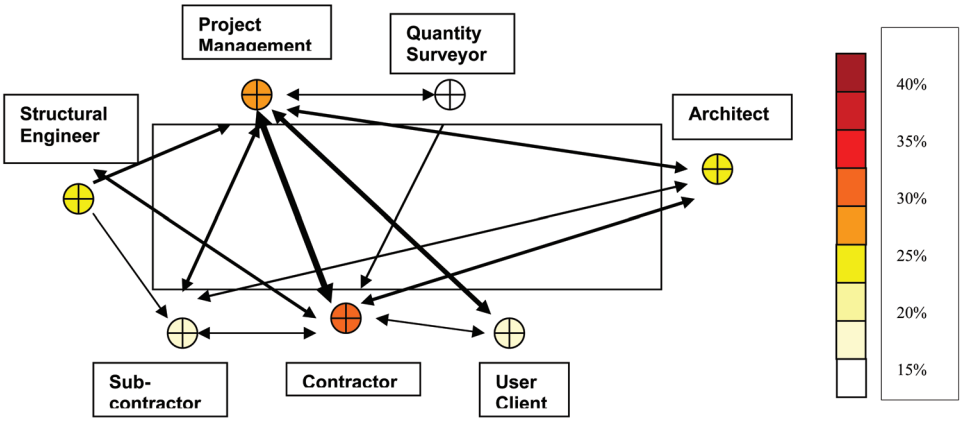

Figure 4. Interaction flow analyses of communication input during one team strategy/ problem-solving meeting.

'technical' nature of the meetings. Figure 2 shows the clear interaction triangle of the three main contributors to the meeting, more defined here than in the other meetings observed.

9.3 *Interim technical/cost review meeting*

The interaction patterns for the interim technical/cost review and the technical meeting are very similar, except that the communication input by the contractor and the architect are reversed, with other team members having very similar input levels to the other technical meetings. The other major difference is the addition of the subcontractor to the project team. The contractor and the architect again dominated proceedings, with project management establishing a role of mediation and control as this meeting was also single-

issue led. The technical meetings focused on the disciplines of the contractor and the architect. In the situations observed, confrontation was more likely to break out when discussions became narrowly defined and concerned just a few team members, thus restricting communication, described here as 'funnelled dialogue'.

9.4 *Strategy/problem-solving meeting*

During the strategy/problem-solving meeting, the team tended to focus on long-term strategies in the construction programme. Strategies are a combined sequence in which stages or activities in a process are executed or planned. Discussions focused on potential problems that were not yet fully defined, or that required an accumulation of accurate information in the long term developed from hypothetical situations. Strategies to inform possible solutions to problems that had not yet arisen took priority, enabling the team to form constructive communication relationships rather than blaming each other.

Often in meetings, the core team would be joined by subcontractors or peripheral disciplines, such as interior designers, landscape designers, and exhibition specialists, enabling a wider breadth of knowledge and experience to enter discussions and expand communication. One positive outcome of this type of situation is the prevention of a rigid approach to communication, where familiarity and expectation between some members of the team can dictate communication and collaboration. During the strategy/problem-solving meeting, communication was less concentrated around the three main parties (contractor, architect and project manager), but rather was evenly spread across the team, as shown in table 6 and figure 4.

It was particularly noteworthy that, at the conclusion of the meeting, the team agreed that they had performed more satisfactorily in terms of productivity (resolving issues) and enjoyment (social relationships) than during the other meeting types. Unfortunately, in the attempt to avoid interfering with the teamwork process, almost all our observations were undertaken passively and team members were not generally asked about their satisfaction with the team process. It was only at this meeting that such a comment emerged spontaneously. In retrospect, it would have been useful to survey satisfaction levels at the conclusion of each meeting.

10. Analysis: the patterns of observed interaction

When we combine the three communication input amounts from the main players in the team (contractor, architect and project manager), it emerges that 78% of the total amount of time in communication is concentrated around these three individual functions. Despite these meetings taking place during the construction phase of the project, this is a surprising finding, given that at least eight people were present at most of the meetings. Our observations suggest that the three main parties formed a core group acting as agents for some of the others—the contractor, for example, communicated on behalf of subcontractors and the user-client tended to communicate through other disciplines to engage with the contractor. In other words, some of the interactions between the parties are indirect rather than being direct. We have sought to capture this in figure 5, which clearly illustrates the indirect nature of interaction between, say, the user-client and the contractor. This pattern was observed in all meeting types, although there was a slight variation during the strategy/problem-solving meeting where communication patterns were less well defined as the user-client had a larger presence, and a more diverse range of disciplines was present at that meeting.

Figure 6 shows clear principal communication relationships between a core group within the team. The diagram illustrates four triangles. The first triangle is formed by the three dominant disciplines (contractor, architect and project manager) and this is where most communication interaction occurs. A second main triangle, shows the inclusion of the structural engineer, as this team member has the next largest amount of communication input into all meetings. The other two minor communication triangles indicate the interaction of the other two disciplines in the core team, that of the quantity surveyor and the user-client. These patterns are generalisations, as there were variations depending on the issues and topics addressed during any one meeting.

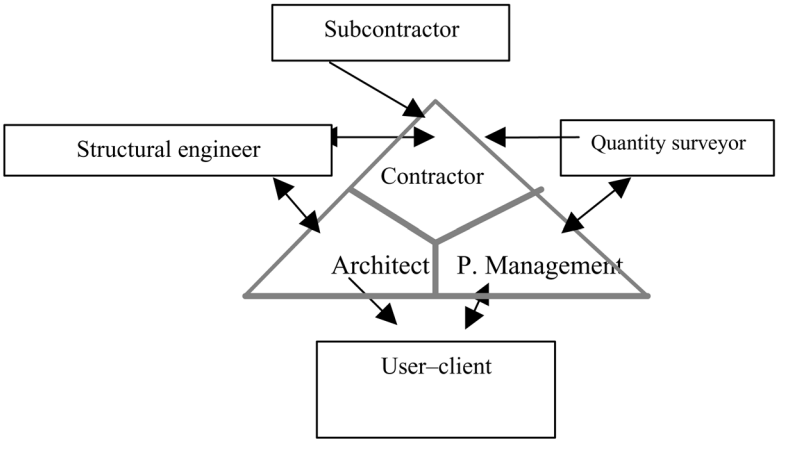

Figure 5. The core group within the team and relationships of communication interaction with the other disciplines.

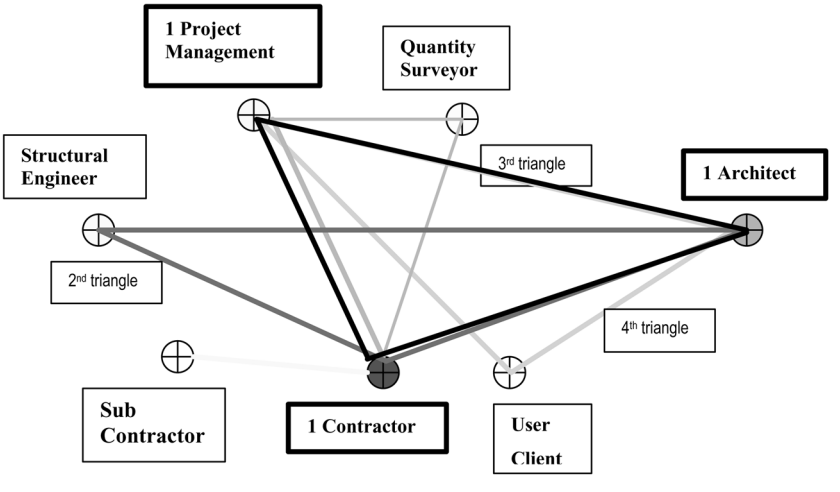

Figure 6. The core triangle (1) and other feedback loops within the team.

From the core triangle, the contractor interacted mainly with the architect, project manager and the structural engineer, with an additional one-way relationship with the subcontractor (when present). As subcontractors were present only as and when required, interaction with the contractor tended to be based on a feedback relationship to the contractor directly, but to the rest of the team indirectly. The architect interacted with the project manager, the structural engineer and the contractor. The project manager communicated with the contractor and the architect, with additional one-way communication with the user–client. The structural engineer interacted with the contractor and the architect. The structural engineer interacted mainly with the contractor and the architect, again indicating these two disciplines are pivotal during team meetings.

11. Team role development

As team meeting interaction was concentrated on three main disciplines (contractor, architect and project management), a tendency to exaggerate the 'functional' roles rather than the 'team' roles of those disciplines occurred. Functional roles are determined by the technical skills and knowledge of that team member (Belbin 1993). As a result, the team found it difficult to focus on their 'team' roles. The pressures to identify workable solutions quickly resulted in individuals searching for solutions within their own area of expertise, and encouraged collaboration in the search to identify joint solutions. However, there were limited opportunities for the team to reflect on their team roles or on developing the social relationships of the team in general.

Table 7 indicates how the team members related to each other in terms of their role functions during all the meetings observed. This approach is adapted from Belbin's (1993) nine team roles and is simplified to form a role character table. Two of the three main disciplines (contractor and architect) have an interaction analogy of primarily *speaker* but differ in their additional traits. The contractor has a secondary trait of *listener* while the architect has an additional trait of *observer*. The project

Table 7. Role functions based on communication input and interaction relationships observed during all team meetings[a].

Discipline	Total input (%)	Interaction analogy	Role function	Description
Contractor	40	Speaker/listener	Doer	Collating and engaging experience
Architect	21	Speaker/observer	Activator	Abstracting, designing and leading
Project manager	16	Listener/observer/ speaker	Mediator/ contextualiser	Arranging strategies, finding solutions, managing
Structural engineer	10	Listener/observer	Thinker	Testing, producing and advising
Quantity surveyor	6	Listener	Absorber	Resourcing
User-client	3	Listener/sensor	Sensor	Observing and reflecting. Background player
Subcontractor[a]	2	Speaker/listener	Doer	Providing concrete experience and giving feedback
Other	2			

[a]The total possible input time over the nine team meetings observed is 23 h, 20 min.
[b]The subcontractor was only present during team meetings when information needed to be communicated to the core team.

manager is both *listener* and *observer*, and has a third element of *speaker*—indicating the varied roles of that discipline. The moderate, but important input into team meetings by the project manager facilitated relations between the contractor and architect, who between them dominate all meetings and would seem to have a clearer 'functional' outline in their roles.

In terms of 'role functions' of the core players, the contractor and architect in these meetings may be characterised as *doer* and *activator* respectively. By contrast, the project manager can be characterised as a *mediator/contextualiser*. The other team members act as '*communication input valves*', in effect attempting to prevent certain role functions from dominating communication during team meetings. This was clearly acknowledged during the strategy/problem-solving meeting where all team members had an input, as discussed above. It was less apparent during the other meetings, where discipline domination was evident. The examples above indicate that the case study team is dominated by the functional roles of:

- collating and engaging experience (contractor)
- abstracting, designing and leading (architect) and
- arranging strategies, finding solutions and mediating (project management).

There was, accordingly, less emphasis on roles concerned with:

- testing, producing and advising (structural engineer)
- resourcing (quantity surveyor)
- observing and reflecting (user – client)
- feedback (subcontractor).

This illustrates that the whole team performs with a focus on achieving tasks without necessarily being concerned how the tasks are achieved or indeed why they are not achieved in a satisfactory manner. This is neatly summed up by a quotation from a member of the case study team, when he said: 'Construction tends to focus on what needs to be done and not on how we do it.'

12. Conclusions

Teamwork involves a complex interplay of relations and dependencies embedded within the team. Successful interdisciplinary teamwork depends on effective interaction among the participants. In this study, we were fortunate in being able to observe what is in effect the same team (although its membership was not absolutely constant), working on the same project, meeting together regularly but for four different technical purposes. Crucially, we found that the purpose of the meeting affected its character and the patterns of interaction among team members. We have sought to capture these patterns in a graphical format that illustrates clearly the extent and scale of the interactions, and the different characters of the meetings.

We noted that the problem-solving meeting was characterised by a richness of interaction and communication, and resulted in a spontaneously positive self-assessment of the meeting. It would be too deterministic to claim, on the basis of our study, that wider participation automatically leads to more effective decision-making. We do not have any measure of effectiveness that we could apply, and neither were we methodical in asking team members after each meeting about their perceived

effectiveness. In retrospect, this is a matter of regret about our research design. It arose partly from our wish not to interfere in the team meetings and partly from the difficulties associated with construction site meetings where urgent inspections and other business need to be performed. What we can say is that, in this particular set of circumstances, greater satisfaction about the team process among team members occurred when interaction was enriched by the engagement of many team members (figure 7).

By contrast, restricted patterns of interaction, such as that shown in figure 8, occur when perceived disagreements or conflicts arise but are accompanied by input from too limited a range of team members; and where proceedings are dominated by too few interests. Restricted patterns of interaction may even encourage the development of conflicts. Our study further suggests that where interaction is restricted, team role development is also affected. Dominant team members may deflect discussion away from an issue or reduce the potential for individuals to learn in the way that, for example, Habermas (1988) would have considered ideal. Unevenly distributed knowledge and skills can discourage learning, to the detriment of both individuals and teams, not only in the short term but also in the long term. How individuals act within a team is affected by the uncertainty surrounding individual behaviour in the context of the group. Ultimately, the process and success of communication within a team both depend on team members defining their relationships to one another as a team and not as a set of individuals.

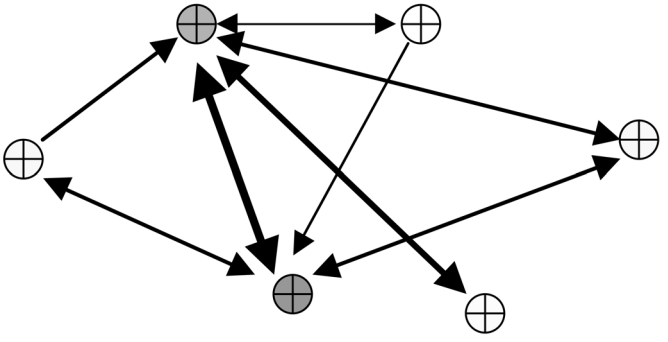

Figure 7. Enriched communication.

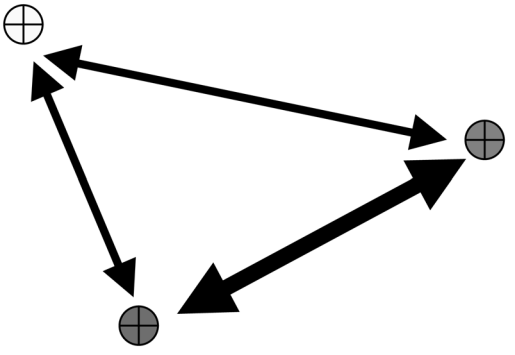

Figure 8. Restricted communication.

Acknowledgements

This work was carried out as part of research project called 'Measuring the Effectiveness of Interdisciplinary Teamwork in Construction'. It was funded by the Engineering and Physical Sciences Research Council and the Department of Environment, Transport and the Regions under the LINK 'Integration in Design and Construction' research programme. The support of the industrial collaborators is also gratefully acknowledged.

References

Abrams, D., Wettherell, M., Cochrane, S., Hogg, M. and Turner, J.C., Knowing what to think by knowing who you are: self-categorization and the nature of norm formation, conformity and group polarization. *Br. J. Soc. Psychol*., 1990, **29**, 97–119.

Belbin, R.M., *Team Roles at Work*, 1993 (Butterworth Heinemann: Oxford).

Belbin, R.M., *Changing the Way We Work*, 1997 (Butterworth Heinemann: Oxford).

Belbin, R.M., *Beyond the Team*, 2000 (Butterworth Heinemann: Oxford).

Bolmar, L.G. and Deal, T.E., What makes a team work? *Organis. Dynam*., 1992, **21**, 34–44.

Busseri, M. and Palmer, J., Improving teamwork: the effect of self-assessment on construction design teams. *Des. Stud*., 2000, **21**, 223–238.

Cannon-Bowers, J.A., Salas, E. and Pruitt, J.S., Establishing the boundaries of a paradigm for decision-making research. *Human Fact*., 1996, **38**, 193–205.

Chernyshenko, O.S., Miner, A.G., Baumann, M.R. and Sniezek, J.A., The impact of information distribution, ownership and discussion on group member judgment: the differential cue weighting model. *Organis. Behav. Human Dec. Proc*., 2003, **91**, 12–25.

Construction Task Force, *Rethinking Construction: The Report of the Construction Task Force*, 1998 (Department of the Environment, Transport and Regions: London).

Cooley, E., Training an interdisciplinary team in communication and decision making skills. *Small Group Res*., 1994, **25**, 5–25.

Denton, H.G., Multidisciplinary team-based project work: planning factors. *Des. Stud*., 1997, **18**, 155–170.

Drew, P. and Heritage, J., *Talk at Work: Interaction in Institutional Settings*, 1992 (Cambridge University Press: Cambridge).

Driskell, J.E., Hogan, R. and Salas, E. Personality and group performance. *Rev. Personal. Social Psychol*., 1987, **9**, 91–112.

Dyer, W.G., *Team Building: Issues and Alternatives*, 1977 (Addison-Wesley, Wokingham, UK).

Eclipse Research Consultants, *Effective Teamwork—A Best Practice Guide for the Construction Industry*, 2004 (Constructing Excellence, London).

Erez, M. and Somech, A., Is group productivity loss the rule or the exception? Effects of culture and group-based motivation. *Acad. Manage. J*., 1996, **39**, 1513–1537.

Goodman, P.S., *Designing Effective Work Groups*, 1986 (Jossey-Bass: London).

Gruenfeld, D.H., Mannix, E.A., Williams, K.Y. and Neale, M.A., Group composition and decision-making: how member familiarity and information distribution affect process and performance. *Organis. Behav. Human Dec. Proc*., 1996, **67**, 1–15.

Guzzo, R.A., Introduction: at the intersection of team effectiveness and decision making. In *Team Effectiveness and Decision Making in Organisations*, edited by R.A Guzzo and E. Salas, 1995 (Jossey-Bass: San Francisco, CA).

Habermas, J., *The Theory of Communicative Action. Vol.2, Lifeword, and System: A Critique of Functionalist Reason*, 1988 (Beacon Press: Boston, MA).

Hackman, J.R., *The Design of Work Teams*, 1987 (Prentice-Hall: Englewood Cliffs, NJ).

Hanks, W.F., *Language and Communicative Practices*, 1996 (Westview Press: Oxford).

Janis, I., *Victims of Groupthink*, 1972 (Houghton Mifflin: Boston, MA).

Janis, I., *Groupthink—Psychological Studies of Policy Decisions and Fiascos*, 1982 (Houghton Mifflin: Boston, MA).

Katzenbach, J.R. and Smith, D.K., *The Wisdom of Teams*, 1993 (Harvard Business School Press: Boston, MA).

Klein, G., *Sources of Power: How People Make Decisions*, 1998 (MIT Press: Cambridge, MA).

Kline, S.J., *Conceptual Foundations for Multidisciplinary Thinking*, 1995 (Stanford University Press: Stanford, CA).

Larson, C.E. and La Fasto, F.M., *Teamwork: What Must Go Right; What Can Go Wrong*, 1989 (Sage: London).

Latham, M., *Constructing the Team*, 1994 (London, HMSO).

Macmillan, S., Successful teamwork from day one: running an interdisciplinary design workshop. In *Interdisciplinary Design in Practice*, edited by R. Spence, S. Macmillan and P. Kirby, 2001a (Thomas Telford: London).

Macmillan, S., Managing an interdisciplinary design team effectively. In *Interdisciplinary Design in Practice*, edited by R. Spence, S. Macmillan and P. Kirby, 2001b (Thomas Telford: London).

Macmillan, S., *Promoting Teamwork Through Partnering Workshops: A Case Study of Partnering Workshops in the Construction of Oakfields Primary School, Wickford, Essex*, 2004 (Constructing Excellence: London).

Macmillan, S. and French, C., Successful teamwork from day one: running an interdisciplinary design workshop. In *Interdisciplinary Design in Practice*, edited by R. Spence, S. Macmillan and P. Kirby, 2001 (Thomas Telford: London).

Newcombe, R., Empowering the construction project team. *Int. J. Proj. Manage.*, 1996, **14**, 75–80.

Rentsch, J.R., Heffner, T.S. and Duffy, L.T., What you know is what you get from experience: Team experience related to teamwork schema. *Group Organis. Manage.*, 1994, **19**, 450–474.

Scott, J., *Social network analysis: a handbook*, 1999 (Sage: London).

Sonnenwald, D.H., Communication roles that support collaboration during the design process. *Des. Stud.*, 1996, **17**, 277–301.

Strategic Forum, *Accelerating Change*, 2002 (Rethinking Construction: London).

Syer, J. and Connolly, C., *How Teamwork Works: The Dynamics of Effective Team Development*, 1996 (McGraw-Hill: London).

Thomas, A., *Classroom Interaction*, 1987 (Oxford University Press: Oxford).

Turner, M.E. and Pratkanis, A.R., Twenty-five years of groupthink theory and research: lessons from the evaluation of a theory. *Organis. Behavi. Human Dec. Proc.*, 1998, **73**, (2/3), 105–115 (one of the papers in this special issue celebrating the twenty-fifth anniversary of groupthink theory, issue edited by M.E. Turner and A.R. Pratkanis).

Tzanne, A., *Talking at Cross-Purpose: The Dynamics of Miscommunication*, 1999 (John Benjamins: Amsterdam).

West, M., *Effective Teamwork*, 1994 (British Psychological Society: Leicester, UK).