EXPLORING THE DESIGNER-CONSTRUCTOR TEAMWORK INTERFACE TO IMPROVE COLLABORATION: A REVIEW OF CURRENT LITERATURE

Hazel Ponton[1], Allan Osborne[2], David Greenwood[3] and Neill Thompson[4]

[1,2&3] *Department of Mechanical and Construction Engineering, University of Northumbria at Newcastle, Newcastle-upon-Tyne, United Kingdom, NE1 8ST, UK*

[4] *Department of Psychology, University of Northumbria at Newcastle, Newcastle-upon-Tyne, United Kingdom, NE1 8ST, UK*

The construction industry has been criticised over several decades for functioning and producing output with low levels of productivity when compared to other manufacturing-based industries. One possible solution to improve productivity is the adoption of collaborative working practices by project teams, particularly designers and constructors during the design phase. Arguments in support of the need to manage the design process effectively during a construction project are well documented. Issues such as providing the client with a sustainable, affordable, quality design that adds value to their business needs, requires attention. Managing the interpersonal interface between designers and constructors during the design phase is a vital requirement of design management practice. Design management is a discipline that requires a thorough understanding of the nature and culture of the different professionals to improve the social behaviours and performance of teams, which in turn may improve project outcomes and thus industrial productivity. The current study, which is part of an ongoing project, presents the position of the design management literature focused on the interpersonal behaviour between designers and constructors. Following a strategically focused review of the extant literature, current themes relevant to Teamwork Quality (TWQ), specific to the designer-constructor interface, are presented. The findings confirm the presence of 14 articles that explore collaborative teamwork behaviour between designers and constructors and that survey methods dominate publications in this area. Few studies capture the power of space and place by observing 'live' industry practice, particularly from a longitudinal perspective. Recommendations include the identification of research themes worthy of future exploration that may assist in teamwork performance concerning productivity. An increase in the use of alternative methodological approaches such as ethnographic and action research is also justified and discussed.

Keywords: behaviour, collaboration, design management, performance, teamwork

INTRODUCTION

The Latham (1994) and Egan (1998, 2002) reports, which were targeted at the UK construction industry, called for greater collaboration and innovation. They have been recently supported by the Farmer Review (2016) that addressed the ongoing problems

[1] hazel.ponton@northumbria.ac.uk

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of fragmentation and adversarial behaviour, including negative working practices in project teams. One of the outcomes of this drive for change is the increase in popularity of contractor-led procurement routes that have led to primary or main contractors taking more responsibility for the design subprocess to improve collaboration, productivity, and to reduce cost (Gray and Hughes 2001). This development has resulted in those who traditionally directed the design subprocess finding themselves as subcontractors participating in multi-disciplinary teams (Greenwood *et al.,* 2008). The effect of these new procurement routes means main contractors are often contractually responsible for and thus need to manage the entire design process. Although the design process accounts for a relatively small proportion of the overall project cost, it has a significant impact on the characteristics, construction, and whole-life cycle cost of projects. The effective management of the design process is vitally important to the success of a construction project (Tjell and Bosch-Sijtsema 2015).

Emmitt and Ruikar (2013) have shown that due to the uncertainty and complexity of construction projects, the most critical inter-relationship within a site-specific, project-based organisational structure is the dynamic relationship that exists between the design and construction subprocesses. Eynon (2013) has explored the interdependent relations between the actors involved with these subprocesses—namely designers and constructors—from a holistic perspective to understand the professional disciplines, i.e., concerning their views, backgrounds, and preferred working practices. He introduced the notion of 'tribes' as a means to distinguish between the two disciplines, surmising that silos or positions of 'tribe of design' and 'tribe of construct' are different in several ways: Ways that have the potential to create conflict and hinder effective performance (see Table 1).

Table 1. Eynon's tribes of design and construct

Tribe of Design	Tribe of Construct
Iterative	Linear
Possibilities	Cost-driven
Ambiguous	Deadlines
Options	Schedule
Visual	Practical
Creative	Certainty
Intuitive	Factual

Eynon (2013) demonstrates the opposing traits of the tribes: Iterative versus linear; ambiguous versus factual; and creative versus practical. Not only are the relations between designers and constructors based on contractual boundaries, which may result in adversarial behaviour and conflict, but they are also influenced by different values, culture, education, and history. These opposing perspectives have the potential to lead to problems that may impact on the performance of the project team, and ultimately the project, mainly while working under pressure to complete a bespoke construction project on time and to cost.

Although it is acknowledged that the distinct phases of a construction project need to be efficiently and effectively managed, the tenet of the current study is that priority must be given to the design phase. Considering the legacy of financial responsibility, the design process holds if not successfully executed, it is argued that the interactions between designers and constructors need to be effectively managed to safeguard the success of construction projects for the benefit of all stakeholders.

The unique focus of the current study is twofold. First, to systematically review the extant literature to identify publications that explore the interactions between constructors and designers at an individual (micro level) in the context of contractor-lead design projects. Second, from the outcomes of the first step, to review the research methods used in the identified publications. By reviewing the literature in a systematic way, the current study aims to reveal previously unidentified knowledge gaps and to evaluate the methods used to inform knowledge in this domain.

SYSTEMATIC LITERATURE REVIEW

A systematic literature review was chosen as the most appropriate technique to gain an overview of earlier studies in a structured way (Tranfield *et al.,* 2003). Jahan *et al.,* (2016) have explained systematic reviews are ranked very high in research. They go on to explain the method provides a complete summary of the current literature relevant to a research question.

During the study two databases were used: Scopus (Sco), and Web of Science (WoS). Both databases were chosen because they contain a large number of high quality peer-reviewed journals that publish work focused on the construction industry. To focus on the most recent data, only journal papers and conference papers published since 2000 were chosen.

A systematic, extensive search was completed under the 'title/abstract/keyword' field in the databases. The following Boolean topic word pattern was used during the initial search: ("construction industry" OR "building industry" OR "architectural engineering and construction") AND (design AND management) AND (teams OR teamwork) AND (communication) AND (behaviour OR behavior) AND (dynamics).

The initial search identified 150/15 (Sco/WoS) articles in the different databases. These articles were then reduced to 132/1 (Sco/WoS) after discarding irrelevant articles or publications, e.g., biochemistry and medicine, and multiple articles across both databases. The results were then filtered by reading the abstract, keywords, and title, discarding those publications that were unrelated to the focus of the topic.

The result was a list of 14 publications. The fact that only 14 articles met the criteria for the dataset was surprising; however, it indicates that the relationship between designers and constructors has received sparse attention.

The next step in the process was to establish a set of constructs to allow the dataset to be coded. These constructs allow for the identification of possible gaps in the existing literature by applying an analytical framework.

Using Analytical Categories

To be able to identify knowledge gaps concerning effective, collaborative teamwork interactions between designers and constructors, the current study adopted the theoretical perspective of Teamwork Quality (TWQ). TWQ is a measure of collaboration in teams (Hoegl and Gemuenden 2001) and was considered to be an appropriate theoretical lens from which to study the selected publications that explore the interactions between constructors and designers. Increased collaboration is the countermeasure suggested by Latham (1994), Egan, (1998, 2002), and Farmer's (2016) reports. According to Hoegl and Gemuenden's (2001) work, TWQ has the following six constructs:

- Communication: Issues such as frequency, formalisation, structure, and openness of information exchange.

- Coordination: Issues such as a degree of common understanding, interrelatedness, working together, delegated, and parallel tasks.
- A balance of member contributions: Issues such as the contribution of all task-relevant knowledge and experience.
- Mutual support: Issues such as cooperative rather than the competitive frame of mind and mutual respect.
- Effort: Issues such as shared expectations regarding effort, workload, sharing, and prioritising.
- Cohesion: Issues such as interpersonal relationships, commitment, togetherness, team spirit, belonging, and trust.

The resulting 14 papers were studied, reviewed, and coded against the above six TWQ constructs within the boundaries of the primary aim of the publication (see Table 2).

FINDINGS

Communication

The communication category emphasises the importance of member communication in a collaborative team setting. Included in the TWQ construct are issues such as the frequency, formalisation, structure, and openness of information exchange. Six articles were found where the primary focus was communication, with perspectives or participation from designers and constructors (as well as other participants, i.e., the client). Two of these articles, one by Gorse and Emmitt (2003) and one by Gorse and Emmitt (2007), use 'live' meeting observations to categorise and interpret project team member behaviour. The studies observed meetings over some time, allowing data to be collected longitudinally, which adds to the richness and quality of the findings.

One of the findings discovered by Gorse and Emmitt (2007) is the lower than expected levels of negative emotions, and critical discussions present during the meetings. Their research suggests that low levels of adversarial interaction may impact on the project team's ability to challenge problems and create necessary conflict for effective performance. The necessary conflict is an essential requirement for a project to achieve a successful project outcome. Emotions and conflict are areas that require greater understanding.

With the primary focus on measuring innovation in the construction industry, Gambatese and Hallowell (2011) adopted interviews (following initial questionnaires) to collate data about some on-going and past projects. The findings from the article included the identification of innovation as a method to improve project team member communication, specifically concerning integrating the design and construction disciplines. Two articles in the communication category explored innovative technologies to improve project collaboration and effectiveness. These were Hatem *et al.,* (2012) and Hosseini *et al.,* (2018). Both articles considered the effectiveness of interdisciplinary team members working virtually and face-to-face. Using a simple simulation of a design task, Hatem *et al.,* (2012) found that project team members could perform as effectively, if not slightly better, when interacting virtually.

Table 2 Articles by categories and their key features

Category	Author	Data collection	Journal	Primary research theme	Findings
Communication	Gorse and Emmitt (2003)	Observe project meetings	Engineering, Construction and Architectural Management	Interpersonal communications during project meetings.	Bales' IPA can be used to identify the characteristics and effects of team member behaviour during project meetings.
	Gambatese and Hallowell (2011)	Interviews (initial questionnaires)	Construction Management and Economics	Enabling and measuring innovation during construction projects.	Successful innovation leads to better communication as well as the integration of the design and construction disciplines.
	Hatem *et al.*, (2012)	Simplistic simulation	Advanced Engineering Informatics	Comparing the effectiveness of face to face and computer-mediated collaboration.	People collaborate as effectively using IT communication methods as working face to face.
	Hosseini *et al.*, (2018)	Interviews	Construction Innovation	Impacts of virtual working on the effectiveness of construction project teams.	A novel insight of virtual and hybrid project team's performance. The importance of face-to-face interactions.
	Gorse and Emmitt (2007)	Design meeting observations	Construction Management and Economics	Communication behaviour during management and design team meetings.	Negative emotions and critical discussions were so low to suggest a lack of necessary conflict.
	den Otter and Emmitt (2007)	Mixed method (interviews, checklists, data log and documents).	Engineering, Construction and Architectural Management	Exploring team communication: Balancing synchronous and asynchronous communication in design teams	Common understanding requires interactions to stimulate the team's social development.
Coordination	Forgues and Koskela (2009)	Longitudinal case study (mixed qualitative methods)	International Journal of Managing Projects in Business	Influence of collaborative procurement on the performance of integrated design teams.	Traditional procurement hinders team efficiency, while new procurement modes have a positive impact.
	Lingard *et al.*, (2012)	Mixed method (observations, interviews and documents)	Construction Management and Economics	Understand the integration issues of designing for construction health and safety.	The complexity of integrating H&S into construction design, particularly during the design decision-making process.

cont.

Category	Author	Data collection	Journal	Primary research theme	Findings
The balance of member contributions	Zhang and Ng (2013)	Questionnaire	Journal of Construction Engineering and Management	An integrative understanding of factors affecting individual knowledge-sharing intention in construction teams.	Professionals are motived to share knowledge by their expectations of developing work-related confidence and capability.
	Pirzadeh and Lingard (2017)	Interviews	Journal of Management in Engineering	Social interactions between project actors about designing for health and safety.	Improvements in H&S design occurred when actors with H&S knowledge join the relevant social networks.
Mutual support	White and Siu-Yun Lui (2005)	Questionnaire	Strategic Management Journal	Cost of cooperation and control in alliances of construction projects.	Cooperation has a cost with working collaboratively with a partner, in an alliance. This cost needs to be recognised.
	Anvuur and Kumaraswamy (2007)	Literature review	Journal of Construction Engineering and Management	Partnering and alliancing in construction projects.	Partnering can create conditions for optimal intergroup contact, increase cooperation and improve team performance
Effort	No findings				
Cohesion	Ponton *et al.,* (2018)	Design meeting observations	ARCOM conference proceedings	Understanding the dynamics of design-construct behaviour through laughter and humour.	Collegiality and group dynamics may foster increased collaboration and the better integration of ideas among team members.
	Karlsen *et al.,* (2008)	Interviews	International Journal of Project Organisation and Management	The role of trust in project-stakeholder relationships	Effective communication and reliable behaviour are necessary to build trust in a project team.

On the other hand, Hosseini *et al.,* (2018) gathered data using interviews. They found that team orientation, leadership, performance, and member satisfaction were all detrimentally affected by working virtually. The difference in findings may be attributed to the different data collection methods, i.e. a simple simulation and interviews. den Otter and Emmitt (2007) contribute to the same debate concerning effective forms of communication through their exploration of communication via synchronous and asynchronous means. The article adopted a mixed method approach, which included interviews and project data and documentation scrutiny. The article did not singularly identify either means of communication as the most effective, rather the identification and use of the most appropriate method as a fundamental aspect of team performance. However, the publication also stresses the need for personal

interaction to accommodate common understanding and to stimulate the team's social development. The issue of successful collaboration between designers and constructors during the design process currently recognise the need and benefits of virtual working. However, the issues of how actors interact virtually still require further investigation.

Coordination

This category refers to issues such as the degree of common understanding, interrelatedness, integration, and working together. Two articles were identified as having the primary research focus in this area: These were Forgues and Koskela (2009) and Lingard *et al.,* (2012). Interestingly, both articles adopted a qualitative, mixed-method approach as their means of collecting data. Forgues and Koskela (2009) investigate the influence of collaborative procurement on the performance of integrated design teams. They discovered that traditional procurement hinders team efficiency, while new procurements modes, i.e., contractor-led design, have a positive impact on team performance due to an increased opportunity to practice interdisciplinary collaborative working. Lingard *et al.,* (2012) support the benefits of working collaboratively. However, they also recognise the complexities of doing so, specifically concerning designing for H&S. Teamwork collaboration is widely recognised across literature; however, how to resolve the complexities of this kind of work still requires further investigation.

Contribution

The balance of member contributions category refers to issues such as team members contributing all their knowledge and experience to a task, particularly when members of the team have expertise in different functional areas. Both of the articles found in this category are interested in knowledge, particularly knowledge sharing. Zhang and Ng (2013) discovered through questionnaires that the motivation of construction professionals to share knowledge links to their expectations of developing work-related confidence and capability. Pirzadeh and Lingard (2017) also focused on knowledge sharing but from a different perspective. Data gathered from interviews were used to identify social networks that highlighted the improvements in H&S aspects of the design once actors with construction expertise joined the social network and input knowledge into the design process. Again, the literature seems to support the importance of collaborative working. Similarly, it seems to support the notion that rich data can be established from an understood of a 'live' setting.

Mutual Support

This category is defined by issues such as team members operating with a cooperative rather than the competitive frame of mind. The construct is also interested in issues such as mutual respect between team members and the need to develop other team members' ideas and contributions, rather than trying to outdo each other. Two articles with different perspectives and different data collection methods were found to have their primary research focus in this construct. White and Siu-Yun Lui (2005) collected data from questionnaires to verify the idea that although cooperation in an alliance is important for collaboration, cooperative teamwork comes with a financial cost. This cost needs recognition for future partnering ventures. Anvuur and Kumaraswamy (2007) took an alternative approach to research cooperation by focusing on the benefits of partnering, principally through carrying out a literature review; then, ascertaining that partnering can create conditions for optimal intergroup contact, increase cooperation, and improve team performance. Again, the data

collection methods adopted in the category lacked the use of 'live' data, although they do support the practice of working collaboratively - as long as the cost is recognised and included in a partnering agreement.

Effort

This category is concerned with issues such as shared expectations regarding effort, workload, sharing, and prioritising. The systematic literature gathering process found no articles where 'effort' is the primary focus of the research. This is an interesting finding because the designer-constructor interface depends on shared and understood expectations regarding the design, which has clear workload implications.

Cohesion

The final category is concerned with team cohesion. In the context of TWQ, cohesion is relevant to interpersonal relationships, commitment, togetherness, team spirit, belonging and trust. Two articles fall into this category. First, Karlsen *et al.,* (2008) explore the role of trust in project stakeholder relationships. The findings include the need for effective communication and reliable behaviour to build trust. The research gathers data from interviews. The second article in this category is by Ponton *et al.,* (2018). Observations of design team meetings form the data collection, with attention paid to critical events of joint laughter. Collegiality and group dynamics were found to possibly increase collaboration effectiveness and the better integration of ideas among team members. The use of 'live' data allowed for the capture of natural laughter events in their setting, rather than individual, retrospective perspectives captured from surveys. The importance of productive team cohesion as an ingredient of successful collaborative working is demonstrated in both articles.

DISCUSSION AND RECOMMENDATIONS

Surprisingly, a relatively low number of publications were found (14). The number highlights a need for greater understanding about all the TWQ constructs of communication, coordination, the balance of member contributions, mutual support, effort and cohesion - all in the context of designer-constructor behavioural interactions during contractor-led projects.

In light of the increasing use of virtual communication technologies, highlighted by a number of articles (see Hosseini *et al.,* 2018 and Hatem *et al.,* 2012) in the review and the opposing positions of the team members identified by Eynon (2013), finding a way to make virtual interaction as productive and collaborative as possible, if not more productive than face-to-face approaches, while maintaining necessary social interactions and team social development, is an area for future investigation.

A further consideration is the findings by Emmitt and Gorse (2007) into the lower than expected levels of negative emotions and critical discussions present during design meetings. Eynon (2013) identifies the 'tribe of design' to include the need for creativity and possibilities, but if these traits are not present during interactions between designers and constructors through a lack of critical discussions, then the potential for the team to produce innovative solutions may be limited. Emotions and conflict are important considerations. Low levels of adversarial interaction may impact on the project team's ability to challenge problems and create the necessary conflict for effective performance, collaboration, and innovation.

Finally, the data collection approaches of the publications included a variety of methods. The most common being interviews, with others including observations of

'live' meetings, review of project documents, and questionnaires. In terms of making recommendations for future research, a qualitative 'in-vivo' approach allows for a rich contextual understanding of the interactions between designers and constructors. By carrying out qualitative 'in-nivo' data collection longitudinally, perhaps a deeper understanding of interactions can be accomplished. This would suggest applying approaches, such as ethnographic and action research. Neither of these approaches has been adopted in this specific context before and could, therefore, provide previously 'unseen' worthwhile insights in future studies.

Acknowledging the restricted focus on the behaviour of designers and constructors in the current study, the following future research themes have been identified.

- A broader examination of the interactions between designers and constructors, in relation to opposing working practices and the need for collaborative working. The examination may include the issues of communication, coordination, the balance of member contributions, mutual support, effort and team cohesion.
- In-depth analysis of virtual working practices between designers and constructors to identify potential issues caused by opposing working practices, which stem from different values, culture, education, and history.
- Further examination of the impact of emotions and conflict on innovative, collaborative design team practices.
- Use of longitudinal 'live' data, i.e., ethnographic and action research, to capture the power of space and place.

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