Team Interactions in Digitally-Mediated Design Meetings

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Jacob Ofori-Darko, Dragana Nikolic, and Chris Harty

Abstract

The complexity of multi-disciplinary design increasingly relies on the use of digital media to support design team interactions to communicate and understand the design. Digital media are often employed in design process to facilitate team interactions by allowing the team members to visualize and virtually walk through digital information. Hence, it is assumed that these spaces facilitate activities such as authoring, visualizing and sharing design information, as well as establishing mutual understanding of design content among team members. However, detailed understanding of how the design team interact to communicate and understand design information and how specific features of the digital media support activities and actions of the team during architectural design meetings within the context of practice appear to be limited. This study seeks to understand how the design team interact in digitally mediated spaces to communicate and understand design information and how salient features of the digital space mediate activities that emerge during collaborative design task. This paper describes initial analysis of design team activities in digitally mediated design meetings in an architectural design office in UK. The main empirical video recording of de-sign team meetings is ongoing. Initial results reveal that members in design teams accomplish task through sharing of information, description and explanation of design details, evaluation and prediction of alternative solutions, decision making, as well authoring, visualisation and navigation of design data. The paper concludes that design teams interact differently across varying digital media and associated data set and that task performance appears to be higher in digital spaces with varying features and rich data set.

Keywords

Team interaction • Digital media • Media use

30.1 Introduction

The increasing demand for effective collaboration among team members in the design process has made the team interaction critical in multidisciplinary collaborative design discourse. Team interaction is fundamental to accomplishing design goals as contributions of team members are harnessed in the creation of sound design solutions [1, 2]. Achieving effective team interaction in the design development process emphasizes the need to communicate and understand design content among multi-disciplinary team members [3]. The inherent complexity of multi-disciplinary design coupled with the challenge of their management has resulted in an increasing reliance on use of digitally supported collaborative media to mediate interactions of design team members [8].

Digitally-enabled collaborative media are means through which people generate, share and use information [4]. These spaces have emerged as powerful platforms, often employed in the design process to mediate team interactions by allowing the team members to visualise, virtually walk through and modify digital information to inform de-sign decisions [5–8].

J. Ofori-Darko (✉) · D. Nikolic · C. Harty
School of the Built Environment, University of Reading, P.O. Box 129 Reading, RG66AW, UK
e-mail: j.ofori-darko@pgr.reading.ac.uk

Hence, it is assumed that these media facilitate activities such as authoring, visualizing and sharing design information, as well as establishing mutual understanding of design content among team members. Consequently, growing efforts are being intensified to promote their integration into current collaborative design practices. Prior studies on mediated team interactions and role of digital media in collaborative design practice established that digital media support communication of design information to multi-disciplinary team members, and that teams better work together using variety of media, hence teams that often mediate their activities and actions with the use of media attain greater synergy in team work [6, 7, 9]. Others have observed that use of media in team interaction is underpinned by the complexity in work context [6, 8].

However, there is limited discussion on how the specific features of the media such as visualisation, interactivity and navigation functionalities and the associated data or information are used to facilitate activities of design teams during collaborative task performance within the context of architectural design practice. Digital media employed to facilitate collaborative team activities encompass both the medium of representation and the information or data communicated. Hence, features of the media become critical to understanding possible set of activities and actions enabled by the media and its consequence use in team interaction. Knowledge on what are the salient features of the media and the role of dataset to supporting activities of design teams within the context of practice are thus imperative to promote collaborative design task accomplishment. The goal of this study is to understand how the design team interact in digitally mediated spaces, and how use of salient features of the media and the dataset conveyed may shape emergence of the activities during collaborative accomplishment of tasks in architectural design meetings. Specifically seeking to explore the patterns of interactions among design team members across different mediated spaces, as well as interactions with media use and design data set.

30.2 Background

30.2.1 Team Interaction

Team interaction is considered as a prerequisite in design collaboration, since through it individual team members integrate their expertise to create a design solution [1]. The concept of interaction has been conceptualized in varying dimensions. McGrath [10] argues that team interaction is a continuous process involving communication and task performance among design teams. Through these engagements, members in a project team accomplish the goals of the project. Hence, in realising this, team members communicate and act together through verbal and non-verbal means. However, Liston [8] argues that project teams also interact with the materials and tools within their work environment to accomplish project tasks. Hence conceptualisation of team interaction needs include how technologies are employed to support team actions and activities [8]. The current study aligns with this position on the premise that, interaction in AEC project teams, being it design or construction stretches beyond communication and performance of task to encompass media use. Practitioners, in attempting to communicate and act together rely on the material environment of the task at some point to share and create information, and develop understanding of the design. Hence, this study posits that discussions on team interaction be extended to cover the use and features of the media and the embedded data set to provide a comprehensive understanding of the phenomenon. However, whilst Liston's assertion is deemed appropriate, her conceptualisation of mediated team interaction failed to account for how specific features and de-sign information contribute to use of the media. The premise being that types of actions carried out with the support of technology, coupled with how people use the media is contingent on media features and information. Hence, the current study seeks to extend Liston's proposition by investigating the role of media features and associated dataset in team interaction within the context of practice to reveal in-depth knowledge how people interact in mediated environments.

This study thus positions itself within the larger literature of technology use and social action in organisations. Specifically, the study draws on DeSanctis and Poole [8] Adaptive Structuration Theory (AST) to empirically investigate the interplay between digitally-enabled collaborative media and team interaction. The perspective of AST is that technology possesses structures which stimulate emergence of social actions. Hence, these structural features are key to influencing use of technology.

In communicating to execute project goals, team members interact to exchange in-formation and knowledge about the content of the design as well as construct mutual understanding of the design [11–13]. In the view of Haberman [11], information sharing is key to achieving effective discussions among team members towards realisation of the team task. Several studies investigating group interaction process have considered exchanges among team members in terms of information and knowledge sharing, critical to the execution of the collaborative task [4, 8]. This is due the fact that member's ability to contribute to the interaction process is partly linked to their awareness and understanding of the task

content. This assertion about communication in team interaction is considered relevant in developing empirical under-standing of design team inter-actions. The premise is that a lot of design activities rely on availability and adequacy of design data, and thus need to be supported for effective interaction. Again, design team members whether within the same discipline or different disciplines are meant to work together to deliver a shared design solution. Hence, individual understanding of the design content need to be realigned to reflect the team's overall view [2, 10–13].

Consequently, developing a common understanding among team members about content of the task and expected solution becomes relevant for effective team interaction and as such key to contributing to the project goals. In addition to building mutual understanding about the details of the design, team members also carry out tasks such as decision making, problem solving and generating alternatives to accomplish project goals. Since teams interact for specific purpose, members' actions towards realisation of the team's goal become essential in the work of the members. These constructs relate specifically to task performance where behaviours and actions of members in the team results in a specific outcome or product. This study adopted the constructs such as decision making, creation/generation, due to their relevance to the discourse of team interaction in design team meetings. This was done on the premise that members in design teams interacting to deliver a collaborative solution, often generate and choose alternatives considered relevant towards delivering the design product [2, 8, 13].

30.2.2 Mediated Team Interactions in AEC

Several studies have been conducted to investigate team interactions in mediated environments. Whilst a lot of studies have sought to investigate role of media features in collaborative activities, variations of the medium and dataset have not been decoupled and interrogated [4, 6, 13]. Although, features of the medium provide useful insight to understanding set of actions promoted, the data set as argued possess varying forms of information relevant to stimulate different engagements with users in the interaction process [6, 8]. Hence, stand to engage differently with different form and state of design data. Whist some studies have considered both the characteristics and use of media, others have aligned mainly to media use [4, 9, 13]. For instance, Liston [11], building on DeSanctis and Pooles' [8] Adaptive Structuration Theory (AST), developed Mediated Interaction Approach (MIA) framework to investigate role of media use in team interactions. MIA considers the role of media in the interaction process. It provides a set of media use concepts such as communicative, information sharing and decision making, as well as purpose of media which are relevant in capturing instances of media use in team meetings. However, MIA does not address key aspects of media such as features and the data set, which are considered key in the AST conceptualization of media use [8]. Hence, this study extends discourse of role of digitally-enabled collaborative media by incorporating features of media, model content and the work context to empirically capture how specific features of the media as well as content of data represented are used to mediate team activities. The current study considers investigation of the medium and design information as relevant for deepening understanding of role of media in team activities.

Despite these variations, studies on use of digital media in team interactions have contributed to the debate on media use in team activities. For instance, in a study con-ducted by Liston [8] on role of media in shaping team meetings, within the environment of multiple media use, it was observed that team interaction changes across different medium. Liu [7] in evaluating effect of virtual reality (VR) on design review for post-occupancy analysis where he compared VR with other media concluded that interactions vary across different range of media. However, issues on how the specific features of the media and associated data set are used to support actions and activities of team members within the context of architectural design practice have not received much discussion in these prior investigations. This development makes discourse on the interplay between team interaction and use of media inclusive. This study seeks to address these limitations by providing a detailed investigation on how design team members interact across different media with varying characteristics and dataset to accomplish collaborative design task.

30.3 Methodology

30.3.1 Research Design

The purpose of this research is to investigate how design teams interact to undertake collaborative task, communicate and understand design information and how specific features of digital media mediate the activities and actions in design team meetings. The research was conducted in a large architectural design firm based in UK with involvement in digital design

practices. The study used video and audio recordings of three design meetings involving architects, and structural engineers. The design teams employed different types of digital media including 3D virtual walkthrough model, mo-bile devices and interactive display screens to mediate their activities. Data was collected over a period of three months, spanning between January and March 2018. The sessions produced 6 h of video and audio recordings. Two video cameras fixed on tripods, were positioned to capture activities at the workspace as well as interactions of participants with various digital media. Additional sound recorder was used to record verbal interactions of team members. The sound recorder was placed on top of the desk. Before recording commenced, the purpose of the study was explained, and participants' consents were sought as part of ethics requirements.

The data was segmented and transcribed in line with analytic interest of the study, which seeks to capture instances of verbal and non-verbal actions of design teams as they interact to accomplish collaborative design task. The transcription was done using a qualitative video transcription software called Transana Professional 320. Data was analysed through iterative processes of coding and continuous refinement to achieve inter-coder reliability. Mediated Interaction Analytic coding scheme [9] was adapted and modified to include features of the media and the embedded design dataset (see Table 30.1).

30.3.2 Results

The main empirical video recording of design team meetings in a digitally-mediated space are ongoing. Initial findings of a six-hour transcribed data are presented. The results are presented in line with the key concepts in the analytic coding scheme (see Table 30.1). The analysis seeks to understand how design teams engage with salient features of digitally-enabled collaborative media and design information during task accomplishment.

Features of media: Design teams incorporate varying forms of digital media with unique features in their task performance activities. The findings revealed that design teams significantly employed wide range of digitally-enabled collaborative media, such as multi-display projector screens, wall displays, interactive screens, mobile devices and 3D models to mediate activities. These media had varying features and capabilities, with which the design team relied to support activities during design meetings. The observations showed that capability to support multiple activities, and interactivity of display interface appeared to regulate set of actions enabled by the media (see Fig. 30.1). Remarkably, clear majority of actions engaged by the team seemed to emerge from the multi-display projector mediated design meeting. This suggests that participants had opportunity to leverage on walkthrough, 3D mark-up and annotation functionalities to perform different activities. Whilst these features provided opportunities for different sets of actions and activities to be enacted, the observation revealed that design teams employed other traditional media, such as 2D paper drawings to augment use of digital media during task performance. This development could be attributed to constraints imposed by the media. The indication is that, opportunities in digital interventions introduced to mediate team activities spread across variety of media, each with unique potentials. As asserted by Liston [9] and Fard [4], needs of the team in accomplishing design task vary, and unpredictable, hence should be supported through multiple means.

Interaction with media: Collaborative design teams interact, both with technologies within their work environment, and with each other via features of the media. In ascertaining how participants engaged with media, the analysis revealed that design teams interacted with media mainly in four differently ways. These interactions ranged from viewing/pointing, navigating, annotating, and authoring. From the observations, viewing/pointing activity appeared as dominant whilst authoring occurred occasionally during the meeting process (see Fig. 30.2). However, mode of visualisation seemed to differ

Table 30.1 Analytic coding scheme (Adapted and modified from Liston [9]; Leicht et al. [13]; DeSanctis and Poole [8])

Communicative/task activities	Interactions with media/design information	Media feature/capability	Design information
Exchanging	Viewing/pointing	Media type	Form/nature of design information
Understanding	Navigating	Level of sophistication-complex/simple	Level of detail
Problem solving	Annotating/mark-up	Level of interactivity	Availability/access
Decision making	Authoring content	Data display	
	Purpose of media use		

Fig. 30.1 Design team leveraging on multi-display capability of media to visualise multiple set of data simultaneously, and perform 3D mark-up activities

Fig. 30.2 Participants interacting with digital media via viewing, pointing and annotating during design meetings

across different mediated meeting environments. For instance, while the team in digitally-enabled multi-display supported meeting had opportunity to view variety of information simultaneously, the case of the was different. The overemphasis of visualisation activity could be that, participants had a need to thoroughly comprehend the design, and make informed decisions. Visualising design information aids understanding of design information thereby reducing cognitive load of members and improve deliberations in design meetings [7].

Purpose of media use: In terms of purpose, media primarily was used to support undertaking of activities such as visualisation, information seeking, referencing and authoring of design data, as well as managing the transitions in the interaction process. Through visualisation of design information, participants in the collaborative design work obtained better understanding of the content and details of the design data and thus provided contributions to enrich the conversations around the design. These are considered healthy since they enhance the team's understanding of the design, consequently contributing to better informed design decisions [14, 15]. As part of the demands of the task, where the team sought to critically appraise the proposed design solutions, the analytic potential of the media, especially, the 3D virtual walkthrough model, was seen instrumental in addressing project goals. Consequently, design teams are provided with opportunity to scrutinize design options, hence delivering better solutions.

Engagement with design information: How the design team interacts with information remains essential in understanding the interplay between technology and social interaction, since data communicated via a medium possesses unique characteristics sufficient to stimulate emergence of social action [8]. Initial findings in this study revealed that, participants in the design team engaged with different information, varying both in content and level of detail to accomplish a collaborative activity (see Fig. 30.3). However, the observations indicate variations in the way participants engaged with the design information. Interestingly, the team appeared to engage more with the 3D walkthrough virtual model compared to other forms of information. This could be attributed to the fact that walkthrough capability of virtual model afforded the team an
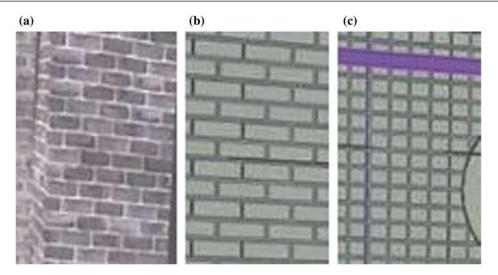
Fig. 30.3 Design team engaged with different forms of design information

opportunity to access various dimensions of information embedded in the model. Be-sides, since 3D virtual walkthrough model possesses large amount of spatial information, participants occasionally had to reference or query content of information as they built understanding and developed the design. Prior studies, for example, Liu [7] in his investigation on post-occupancy VR supported design meetings, observed that participants undertaking team activities engaged with different forms and content of design information to address specific purposes. Hence, use of multiple of set of information become critical to facilitating collaborative activities due to their complementary role in participants' information needs.

Communication activities: This study describe communication activities as exchange and development of understanding toward enhancing design solutions during meetings. The analysis characterised two key types of communicative activities-exchanging, understanding, and which we discuss below.

Information exchanges: In team interactions, how team members exchange information among themselves is considered critical since participants rely on available information to understand and meaningfully contribute to team deliberations. The observations revealed that design teams as part of their activities seek to share information considered relevant in advancing team activities. Interestingly, participants across different mediated meetings observed had to exchange information generated at individual and sub-group levels among the entire team. However, the analysis indicated that participants in most often struggled to make their ideas visible to the team. This means that digital media employed to support team activities probably lacked capability in aiding communication of information from individual and sub-group to the larger team. Fard [4], in similar studies, observed that exchange of information generated by individuals appear to suffer since digital resources provided in mediating interactions lacked that functionality.

Developing understanding: The findings revealed that team members devoted most of their efforts in design meetings developing understanding through description and ex-planation of the design content. However, the observations indicated evidence of variations across different mediated design meetings. From the analysis, descriptive activities appeared to be dominant in design meetings mediated by mobile devices such as tablets, iPad and smart phones, whereas explanation activities featured prominently in BIM and 3D virtual walkthrough model mediated meetings (see Fig. 30.4). In design meetings, participants are often provided with orientations and explanation surrounding the content and rationale of design decisions to enable them familiarise with the task, and make meaningful contributions. This finding appears to be consistent with earlier studies that teams spent most of their activities in design meetings building collective understanding of the design, since the requirement of delivering shared design solutions tied to the overall team performance [4, 7].

Task performance activities: Analysis of the video data indicated that design teams mainly resolve design problems and take informed decisions during the design meeting. In all the cases, design team members resolved problems identified in the design model through extensive discussions and generation of alternatives. Although, decision making and problem-solving activities were witnessed in these meetings, the observations showed variations in their emergence. For instance, in the 3D BIM model mediated design meeting, participants engaged in a wide range of decision making and problem-solving activities compared to the other settings. This could be attributed to the fact that, nature and complexity of the design task

Fig. 30.4 An instance of design team developing mutual understanding of design content and intent through engagement with media and with the members during a design meeting

coupled with content of the design information stimulated the discussions. These observations were anticipated, since prior studies report of existing variations in meeting task performance, which according them emanate from differences in information content, context and task complexities [6, 9]. Hence, the media employed to facilitate accomplishment of collaborative design task needs to be aligned with the task characteristics and the need of the team members.

30.3.3 Conclusion

The findings indicate that design team interaction involves constant exchanges, development of understanding, decision making as well as engagement with multiple digitally enabled collaborative media and design information during design meetings. The design team interactions were accomplished through sharing of information, descriptions and explanations of design details, evaluation and prediction of design options, decision making, authoring, visualisation and navigation. The study reveals differences in team interaction across different media and design information with varying characteristics and level of detail. The study also highlights variations in design team interaction with media and information when communicating and developing understanding of the design. Again, the study shows that level of sophistication and interactivity, coupled with display features of the media, as well as design information contribute to higher task performance. The study seeks to leverage on practical implications of using digital media to support collaborative design tasks, thus contributing to organisation of collaborative work around mediated environments. These findings which are initial result of an ongoing study draws on video and audio data. Supplementing this data with follow up interviews with the team members involved in the interaction process might enhance understanding of phenomenon under investigation.

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